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BIOMASS OF MOUNTAIN & FOREST VEGETATION IN CHECHEN REPUBLIC

Idris Abdurashidovich Bayrakov (a)*
*Corresponding author

(a) Chechen State University named after A.A. Kadyrov, Grozny, Russia, idris-54@mail.ru

Abstract

This research aims to comprehensively assess the current state of the mountain-forest belt in the Chechen Republic. The assessment is crucial for formulating tasks related to forest renewal and protecting against further anthropogenic impact. The Chechen Republic is categorized as a region with deficient forest cover, measuring less than 20%, significantly lower than the 80% recorded a century ago. Following the logging of valuable forest-forming tree species like the eastern beech, along with various types of oak, ash, maple, and others, less valuable species and shrubby thickets have replaced them. This shift has altered the hydrological regime, impacting water regulation and leading to an activation of landslide processes. Consequently, the research aims to map the territory and develop cartographic schemes, including a map of the forests of the Chechen Republic, a cartographic scheme indicating the resistance of mountain forests to external influences, and a cartographic scheme illustrating anthropogenic damage to the forest complex. The primary research method involved geobotanical field route studies at reference points with landscape profile layovers. The findings reveal a powerful anthropogenic impact, particularly unauthorized logging, leading to the substitution of valuable tree species with less valuable ones. The conducted studies demonstrate that the forest complex of the Chechen Republic is currently undergoing significant anthropogenic impact, primarily through unauthorized logging, resulting in substantial changes in the composition of tree species.

Keywords: Birch, Chechen Republic, mountain forest belt, oriental beech, oak, tree species

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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 (CO2) and water (H2O), 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, he devoted little space to forest vegetation, moreover, an analysis of their condition was not made, but nevertheless the work is relevant today (Rudakov, 2022; Simonenkova et al., 2019).

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 (Bayrakov, 2007).

2. Problem Statement

Over the past century, the forest cover in the Chechen Republic has undergone a substantial decline, resulting in notable alterations to the hydrological regime and an escalation in landslide activity. The primary contributor to this decline is identified as anthropogenic impact, notably unauthorized logging. This situation underscores the pressing requirement for a thorough evaluation of the present condition of forest landscapes. Such an assessment is imperative to guide initiatives aimed at the revitalization and safeguarding of these crucial ecosystems.

3. Research Questions

1) Current State of the Mountain-Forest Belt:
   i. What is the present condition of the mountain-forest belt in the Chechen Republic in terms of its composition, density, and overall health?
2) Impact of Unauthorized Logging:
   i. How has anthropogenic impact, specifically unauthorized logging, influenced the forest complex in the Chechen Republic? What are the observable changes in tree species composition and ecosystem dynamics?
3) Resistance of Mountain Forests to External Influences:
   i. How can the resistance of mountain forests to external influences, including anthropogenic factors, be assessed? Is it possible to map the resilience of these forests to various external pressures?

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4) Mapping Anthropogenic Damage:

i. To what extent has anthropogenic activity damaged the forest complex in the Chechen Republic? Can this damage be effectively mapped to identify areas of significant concern? 5. Implications for Renewal and Protection: - What are the implications of the research findings for the renewal and protection of forest landscapes in the Chechen Republic? How can these insights guide strategies and initiatives aimed at mitigating the impact of unauthorized logging and fostering the regeneration of the forest ecosystem? Answering these research questions will provide a comprehensive understanding of the current state of the forest landscapes in the Chechen Republic, allowing for informed and targeted measures to address the challenges posed by anthropogenic impact and facilitate the renewal and protection of these vital ecosystems.

4. Purpose of the Study

The purpose of this research is to conduct a comprehensive assessment of the current state of the mountain-forest belt in the Chechen Republic. This assessment involves mapping the territory using cartographic schemes, including a map of the forests in the region, a cartographic scheme illustrating the resistance of mountain forests to external influences, and a cartographic scheme depicting anthropogenic damage to the forest complex.

The primary objective is to evaluate the extent of anthropogenic impact, particularly unauthorized logging, on the forest complex in the Chechen Republic. Through geobotanical field route studies at reference points and other methods, the research aims to identify observable changes in forest composition and health attributable to human activities.

Furthermore, the study seeks to understand the implications of these findings for efforts aimed at the renewal and protection of forest landscapes in the Chechen Republic. By elucidating the current state of the forest ecosystem and the drivers of change, the research aims to inform targeted strategies and initiatives to mitigate the impact of unauthorized logging and promote the regeneration and preservation of these critical ecosystems.

5. Research Methods

The research will employ a combination of geobotanical field route studies, cartographic analysis, and other relevant methods to achieve its objectives:

1. Geobotanical Field Route Studies:

i. Geobotanical field route studies will be conducted at reference points within the mountain-forest belt of the Chechen Republic. These studies will involve systematic observations and data collection on the composition, density, and health of the forest vegetation. Landscape profiles will be laid out to capture variations in terrain and vegetation characteristics.

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2. Cartographic Analysis:

i. Cartographic analysis will be used to map the territory of the mountain-forest belt and to develop cartographic schemes. This will include the creation of a detailed map of the forests in the region, highlighting different forest types, distribution patterns, and areas of interest. Additionally, cartographic schemes will be developed to illustrate the resistance of mountain forests to external influences and the extent of anthropogenic damage to the forest complex.

3. Data Collection and Analysis:

i. Data on anthropogenic activities, particularly unauthorized logging, will be collected through field observations, satellite imagery analysis, and consultation with relevant stakeholders. These data will be analyzed to assess the impact of human activities on forest composition and health.

4. Statistical Analysis:

i. Statistical analysis may be employed to quantify and analyze the collected data, including trends in forest composition, density, and health, as well as the extent of anthropogenic damage.

5. Interdisciplinary Approach:

i. The research will adopt an interdisciplinary approach, drawing on expertise from fields such as ecology, forestry, geography, and cartography. This will ensure a comprehensive understanding of the complex interactions between human activities and forest ecosystems.

By combining these research methods, the study aims to provide a robust assessment of the current state of the mountain-forest belt in the Chechen Republic and to inform effective strategies for its renewal and protection.

The territory of the Chechen Republic is located on the northern slope of the Main Caucasus ridge and the interaction of various natural and climatic factors has formed various types of landscape complexes: mountain moderately humid; mountain moderately semigumid; mountain moderately semiarid; mountain cold-temperate; alpine meadow and glacial-nival (Elemanov & Abylmeizova, 2022; Litvinskaya, 2021a).

The woody and shrubby vegetation of the forest landscapes of the Chechen Republic occupies almost the entire low–mountain and mid-mountain parts, as well as mosaic spots on the flat parts and in the floodplains of rivers. Occupying heights up to 250 m above sea level in the eastern part and up to 400 m in the western part of the territory (Bayrakov et al., 2006). The upper limit of forest vegetation in the wooded and Pasture ridges rises to 1900 m, and in the high mountain ridges – the Rocky Ridge and the Lateral Ridge with its spurs up to 2800 m above sea level. The mountain-forest zone is dominated by moderately humid and warm climatic conditions, where winter temperatures are -1.5 -5.00, and in summer 17.0-22.00, the average annual temperature ranges from 8-9 in the lower part and up to 6-7 in the upper; The amount of precipitation varies from 500 to 900 m, most of it falls during the warm period. As we move eastward and with altitude, the sentimentality of the climate increases.

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Broad-leaved woodlands create the lower forest belt, birch and pine woodlands are located in the upper forest belt. The main difference between the forest belts is that they are located at different heights, and according to the species composition of tree species, the lower parts are occupied by oak and mid-mountain forests dominated by eastern beech (Nagalevsky et al., 2021). The sulfur tip of the broad-leaved forest is bordered by forest-steppe vegetation, which was formed under anthropogenic influence: areal logging and agriculture.

The research was carried out by the method of ground reconnaissance surveys of plantings, laying of test areas in virgin forests and in logging areas of various ages with logging sizes of 0.25–1.0 hectares.

In the process of studying the age structure and structure, growth characteristics and productivity of plantings, methods generally accepted in forestry and taxation were used.

6. Findings

As of now, no specific findings have been provided for the research on the mountain-forest belt in the Chechen Republic. The findings will be obtained through the implementation of the outlined research methods, including geobotanical field route studies, cartographic analysis, data collection, and statistical analysis. Once the research is conducted, the findings will include insights into the current state of the mountain-forest belt, the impact of unauthorized logging, the resistance of mountain forests to external influences, and the extent of anthropogenic damage to the forest complex. These findings will contribute to a comprehensive understanding of the ecological dynamics in the region and inform strategies for the renewal and protection of forest landscapes in the Chechen Republic.

6.1. Tree-shrub vegetation of the mountain-forest belt

Vegetation in the Middle highlands is more diverse than in the lower highlands, dead-covered forest areas are rare. The territory of the lower and middle mountain forests is a zone of intensive forest use, continuous logging is common here, in place of which shrubs or secondary meadows develop.

The soils are rather monotonous, mainly mountain-forest, having different thickness and color (Degtyareva et al., 2020). The thickness of the soil layer does not exceed 0.7 meters, more often up to 0.4 meters. The soil is gravelly. In the places of distribution of carbonate rocks, arrays of humus-carbonate soils are slightly distributed (Bayrakov et al., 2020; Bayrakov, 2021a).

Forested areas account for 22% of the total area of the Chechen Republic. The complex history of the development of landscapes of mountainous territories has determined the existence of plant communities of different evolutionary ages within the same landscape.

It is in mountain landscapes that the greatest number of relict and endemic species, a combination of plants that penetrated the Caucasus in different geological epochs. The modern variety of exogenous landforms, slope exposures, and air microcirculation features also determine the biological diversity of landscapes. The north-eastern slope of the Greater Caucasus leads the entire Caucasus in terms of biodiversity.

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Anthropogenic impact on forest ecosystems at the first stages of human economic activity in gathering wild fruits and berries and hunting. This has led to a significant reduction in the number of animals such as bison and deer. Deforestation was limited.

Later, mass logging began. Of the species composition of the forest, the beech is of the greatest interest for

i. economic use, and later for trade. To date, only 71% of all forested areas are indigenous stands. Where exploitation is available, the mansions have long been replaced by less

ii. valuable stands with the advantage of hornbeam.

The ecosystem of wet hornbeam buchina is widespread in the basin of the rivers Assi iFortanga and their tributaries, Argun, Basa, Hulkhulau, Gumsa, Michik, Aksai, Yamansu, Aryksu.

This is the most widespread type of forests on the territory of the Chechen Republic, occupying 23% of all forests of the republic (84 thousand hectares). It is distributed on the northern slopes of the Sunzha, Foothill, Pasture, Rocky and Andean ridges. On the southern slopes, wet buchina occurs only within the Pasture and Mountain ranges, where it occupies the lower parts of the slopes of wet narrow gullies. On the upper parts of the beams and on the strongly dissected relief, this type is replaced by fresh buchins.

The type tends at altitudes of more than 1700-2000 meters to gently leveled or hollow-shaped depressions. Within a powerful indigenous stand, surface erosion is weakly manifested, while in sparse stands that have undergone intensive logging or grazing, soil flushing is observed, and the litter becomes loose, low-power – 2-8 cm - and consists of leaf litter. In the indigenous stands, the soils are powerful, up to 70 cm, loamy and slightly gravelly (Bayrakov, 2021b; Erzhapova et al., 2022). The underlying rocks are conglomerates, sandy-clay shales, limestones.

On the lightened sides of the northern slopes in their lower part (250-450 meters) oak forests are replaced by buchins. The spread of this type depends and the steepness of the slopes and the marks of absolute heights play a major role. On the Montenegrin ridge, the wet buchina spreads to the highest levels. At altitudes of 1500-1600 meters and above, the wet buchina can itself lay down the upper limit of the forest area, turning into park maple bushes or birch forests.

In highly full-bodied weeds, the participation of other breeds is insignificant, but as the root stand becomes overgrown, the role of impurities increases.

Beech reaches a height of 30-35 meters. Fautiness, windiness and clutteriness are observed in overgrown forests. The average closeness of the indigenous beech forests is 0.76+0.14.

The clearings formed as a result of the wind are quickly tightened by the spreading crowns or covered with snow. With a high closeness of the crowns, the undergrowth suffers, growing into forked and twisted trees. In hard-to-reach places, almost half (48%) of the trees are overgrown, only 11% are ripe, and only 5% are ripe.

The mountain–forest belt is differentiated into broad-leaved, small-leaved and coniferous forests, creating separate belts (Figure 1).

Broad-leaved forests create forest belts, birch and pine forests are located in the upper forest belt.

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The main difference between the forest belts is that they are located at different heights, and according to the species composition of tree species, the lower parts are occupied by oak and mid-mountain forests dominated by eastern beech.

The northern tip of the broadleaf forest is bordered by forest-steppe vegetation, which was formed under anthropogenic influence: areal logging and agriculture. Forest - steppe vegetation is represented by the following species:

i. Quercus robur;
ii. Acer campestre;
iii. Acer platanoides;
iv. Carpinus caucasica;
v. Tilia cordata;
vi. Ulmus scabra;
vii. Fraxinus excelsior.

There are many wild fruit trees here:

i. Pirus caucasica;
ii. Malus orientalis;
iii. Prunus divaricata;
iv. Cornus mas;
v. Mespilus germanica;
vi. Grataegus;
i. Juglans regia.

The lower mountain forest belt is occupied by beech and beech-hornbeam forests. Significantly less area under oak hornbeam forests.

6.2. Beech woodland

The beech woodland, occupying an area larger than the rest of the woodlands, is also the most ancient, belongs to the tertiary flora of the republic and is represented by only one species of Fagus orientalis, located on all slopes except the southern orientation.

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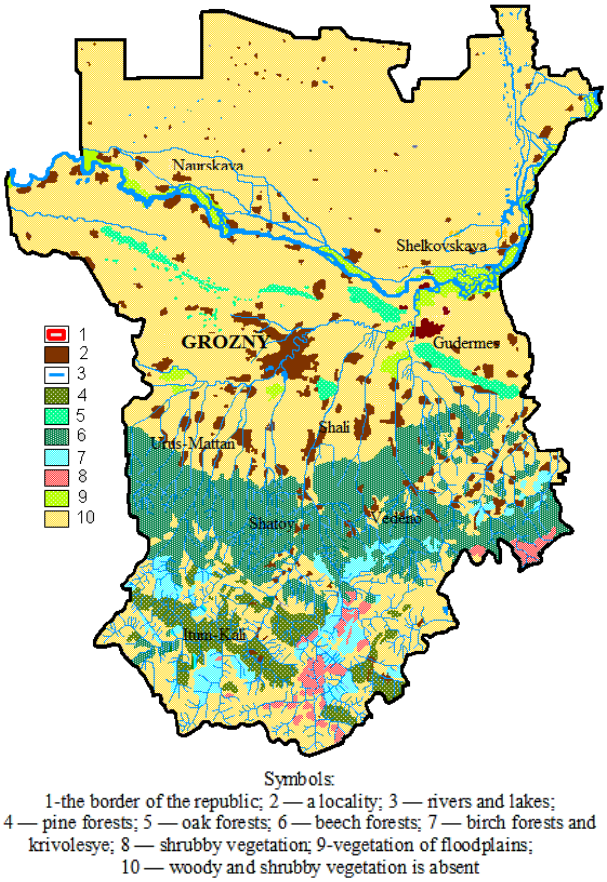

Figure 1. Forests of the Chechen Republic

Constantly Fagus orientalis accompanies Carpinus caucasica, quite often in beech forest can be found:

Acer campestre,

Acer platancidea,

Tilia cordata,

Tilia caucasica,

Pyrus caucasica,

Ulmus glabra.

The following relics can be called frequent:

Acer laetum;

Taxus baccata;

Sorbus torminalis;

Ostrya carpinifolia.

The lower tier of beech woodlands is occupied by:

Corylus avellana;

Swida australis;

Thelycrania australis;

Euonymus europaea;

Euonymus verrucosa;

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Euonymus latifolia;

Sambucus nigra;

Lonicera caucasica;

Viburnum opulus;

Periploca graeca;

Lonicera caprifolium;

Vitis sylvestris.

The grassy cover in the forest area is as follows:

Dentaria quinquefolia;

Dentaria bulbifera;

Asarum intermedium;

Sanicula europica;

Alliaria petiolata;

Fragariavesca;

Veronica chamaededrys;

Festucamontana;

Poligonatum glaberrium;

Poligonatum polyanthenum;

Geranium pusillum;

Geranium rotundifolium.

Oak massifs are located in the low mountains, so on the Tersko–Sunzhenskaya upland they are found up to heights of 1100 m. above ocean level. On wooded and Pasture ridges they dominate up to 1500 m and are represented by the following species:

Quercus robur;

Quercus petraea;

Carpinus caucasica;

Acer campestre;

Acer platanoides;

Acer laetum;

Ulmus foliacea;

Fraxinus excelsior;

Tilia cordata;

Tilia caucasica.

Shrubby plant species are represented by:

Paliurus spinachristi;

Cornus mas;

Corylus avellana;

Euonymus europaea;

Euonymus verrucosa;

Swida australis;

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Rhamnus cathartica;

Mespilus germanica;

Rhododendron luteum;

Ligustrum vulgare;

Rubus caesius.

In the formation of the composition of the grass cover take part:

Melica picta;

Athriscus silvestris;

Geum urbanum;

Polygonatum polyanthemum;

Serratula quinquefolia;

Viola hirta;

Viola reichenbachiana;

Viola odorata;

Salvia glutinosa;

Asparagus verticillatus;

Pulmonaria mollissima;

Asperula odorata;

Sanicula europaea;

Calamintha grandiflora;

Clinopodium vulgare;

Symphytum asperum;

Dryopteris filixmas.

Lianas are represented by the following species:

Lonicera caprifolium;

Perip-loca graeca;

Vitis sylvestris;

Solanum pseudopersicum.

The grassy cover of floodplain oak forests, depending on the density of stands, is well or poorly developed, there are everywhere:

Festuca nemoralis;

Brachypodium sylvaticum;

Heracleum sibiricum;

Urtica dioica;

Stachys sylvatica;

Vincetoxicum rehmannii.

Quite often you can find Glechoma hederacea, Vinatoxicum scandes. From early spring plant species can be found:

Ficaria calthifolia;

Arum orientale;

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Alliaria petiolata;
Corydalis marschalliana;
Corydalis roseapurpurea;
Allium ursinum;
Allium paradoxum;
Tulipa biebersteiniana;
Convallaria transcaucasica;
Carex sylvatica;
Scutellaria altissima;
Euphorbia villosa;
Aristolochia clematitis.

6.3. Birch forests

Birch forests are common on the northern macrosclines of the Rocky and Lateral Ridges. They are also found in patches on the highest northern macrosclines of the Pasture Ridge. They occupy the upper parts of the slopes, often form the upper border of the forest. Depending on the height of individual ridges, the lower border of birch forests descends to 1500 m on Pasture and up to 2000 m on Rocky Ridges. On the Lateral Ridge, their upper border reaches 2200-2500 m and is replaced by thickets of Caucasian rhododendron (Rhododendron caucasicum).

Stands here form Betula litwiniwii, Betula pendula together with Salix caprea. Birch forests with weeping birch are found everywhere, but more often in the area of the Lateral and Main ridges, mainly on sandy and shale substrates. Forests of relict Radde birch are common on limestone and dolomite substrates of the Rocky Ridge, although other types of birches are also present here.

Ecosystems of birch woodlands are developed and have a significant species composition of high-grass grassy cover.

The following species are represented in the rich and developed grass cover:
Betonica grandiflora;
Geranium palustre;
Geranium platypetalum;
Geranium robertianum;
Caloides;
Asperula molluginoides;
Solidago virgaurea;
Senecio platypfilloides;
Pimpinella rhodantha;
Filipendula ulmaria;
Aconitum orientale;
Delphinium schmalhausenii;
Polygonatum verticillatum;
Polygonum carneum;

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Linum hypericifolium;

Gentiana schisticalyx;

Polypodium vulgare;

Impatiensnol tangere.

They are not uncommon in birch forest where there is a very rich shrubby undergrowth of Fagetum-fruticosum, where it is very rare to find:

Rosa dumalis;

Rosa iberica;

Rosa pulverulenta;

Lonicera caucasica;

Rhododendron luteum;

Ribes biebersteinii;

Salix caprea;

Salix pentandra.

Shrubby plants are represented – Rhodococcum vitisidea, Empetrum caucasicum.

On the northern slopes of great steepness on the uppermost border of the forest, you can find a birch forest represented by Betuletum polytrichosum.

On a high mountain ridge (Lateral, less often Rocky), the upper strip of birch forest turns into birch woodlands.

Along with the birch, the Caucasian rhododendron and various types of willows grow here

Salix cinirea;

Salix. Kuznetzowii;

Salix hastate.

Even higher – solid thickets of Caucasian rhododendron with moss cover:

Vaccimium myrtillus;

Oxalis acetosella;

Festuca montana.

Under the canopy of rhododendrons grow:

Amagrostis arundinaceae;

Thalictrum minus;

Hyrericum hirsutum;

Anemone fasciculate;

Galium valantioides;

Asperula molluginoides;

Solidago virgaurea;

Senecio platypfilloides;

Pimpinella rhodantha;

Filipendula ulmaria;

Aconitum orientale;

Delphinium schmalhausenii;

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Polygonatum verticillatum;

Polygonum carneum;

Linum hypericifolium;

Gentiana schisticalyx;

Polypodium vulgare;

Impatiensnoli-tangere.

The mountain-forest complex of the Chechen Republic is a region that is poorly studied and those few publications of the middle of the last century (Grossgeim, 1948, 1950, 1952; Galushko, 1980) do not provide complete information about the state of forests.

Therefore, we have made an attempt to fill this gap somehow. 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 by almost 4 times. In our previous publications, we pointed out the inevitability of the loss of stability of these landscape complexes, if the nature of nature management in them does not change (Litvinskaya, 2021b; Ogureeva et al., 2022).

6.4. Number of geomass of humid landscapes

Number of geo masses of mountain and forest landscape throughout the mountain-forest landscape complex, the total phytomass on average is more than 180 t/ha, not very different in number to species and associations of vegetation. As is known, the main phytomass in the forest landscape complex falls on the aboveground part (80%), in which the grassy part is insignificant and amounts to no more than 0.3 t /ha (table 1).

Table 1. Geomasses of mountain temperate humid landscapes

Landscapes	**P**	**Pnadz**	**Pi**	**M**	**Mi**	**S**	**S_{AB}**	**L**	**L_{AB}**
Low Mountains	192	155	0,1	5,0	3,4	8877	3588	7534	671
Mountains of medium height	184	148	0,3	4,4	2,3	6200	3842	12492	1760
Average	186	150	0,2	4,6	2,7	6941	3772	11119	1458

Note: P – sumar phytomass, Rnadz.. aboveground phytomass, Pi – herbaceous phytomass, M – total mortmass, Mi – litter mortmass, S – total pedomass in layer 1 m, SAB – pedomass of AB horizons, L – underground lithomass in layer 1 m, LAB – lithomass of AB horizons. Phyto and mortmass values in dry weight.

The mortmass of the mountain-forest landscape, on average, is no more than 5 t / ha, here 60% falls on the forest floor. Litter, unlike other fractional parts of the mortmass (litter, deadwood, dead wood), is associated with annual processes, therefore, for mountainous humid temperate landscapes, as well as other forest landscapes, it is the most important fractional part of the mortmass.

The soil cover is one of the carbon neutralizer. The amount of pedomass on average for the entire type of landscape is 6941 t/ha, decreasing from 8877 t/ha in the lower highlands to 6200 t/ha in the middle highlands.

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7. Conclusion

The conducted studies reveal a concerning ecological state of the landscapes within the mountain-forest belt, signaling an active stage of degradation. The once predominant indigenous forest-forming species, including oriental beech, oaks, and ash, have experienced decline and are being replaced by less valuable species such as maple and hornbeam. Extensive areas, previously occupied by valuable species, are now dominated by shrubby vegetation, including hazel and medlar, due to widespread area logging practices.

In response to these findings, it is imperative that forestry measures are strategically directed towards the restoration of complex oak stands. This can be achieved through initiatives that promote natural regeneration, the creation of forest crops, and the implementation of logging care practices. Urgent attention is needed for the restoration of indigenous plantings in areas currently overrun by thickets of shrubs.

To address the ecological challenges effectively, it is recommended to focus on specific forestry actions. This includes promoting the natural regeneration of complex oak stands, creating forest crops, and implementing logging care practices. Additionally, attention should be given to reintroducing various oak, ash, and maple species, along with walnut fruit trees, in a belt up to 500 meters. In areas with depleted habitats, the introduction of Crimean pine and Sosnovsky pine into forest crops is deemed essential.

In conclusion, the findings underscore the urgency of proactive forestry measures to restore and protect the indigenous ecosystems within the mountain-forest belt in the Chechen Republic. By implementing targeted strategies, it is possible to mitigate the effects of degradation, foster the regeneration of valuable plant species, and contribute to the sustainable management of these critical landscapes.

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