Ecological assessment and its importance for forest resource security

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Abstract. The forests of Krasnodar region are characterized by their uniqueness and rare biological diversity of forest species, the combination of two forest structural regions, which create a unique flavor of natural landscapes, their recreational attractiveness and ecological significance for Russia. The fall of one or more trees in a forest is a phenomenon usually associated with the natural dynamics of the ecosystem and accepted as such. When such events occur in forested areas or along wooded strips along busy suburban roads, the phenomenon is perceived as a traumatic event because of the possible negative consequences for people and property and the associated environmental impact. This creates a poor ecosystem that requires careful preventive action. Several factors, often in combination, can cause a tree to fall. The article presents the main results of monitoring carried out as part of a forestry case study. Through the analysis of meteorological data and the interpretation of geotechnical and geophysical surveys, some conclusions have been drawn about the causes of tree falls.

1 Introduction

The importance of effective management of natural resources and environmental protection, considered as a single systemic object necessary to meet the economic needs of the region and ensure the quality of life of its residents, is emphasised by the current situation of forestry in the Krasnodar Region and the environmental situation [1-2].

Topography and geological structures significantly affect the diversity of both general landscape formations and detailed flora, mainly under certain hydrothermal conditions. This difference is especially evident in mountainous areas with their diverse morphology.

When considering how relief impacts the development and spread of vegetation, the key aspects are:

- vertical zoning of natural zones;
- features of slope exposure (determining the intensity of solar illumination and the degree of their heating);
- hydrological conditions (including atmospheric and soil humidity);
- aeration (caused by the air flow dynamics).

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The critical role of relief in the processes of moisture migration and distribution of nutrients along slopes is also noted, which directly affects the composition and structure of the vegetation cover.

Among the main parameters of relief are absolute height, slopes and slope aspect. In mountainous areas, absolute height is associated with various climatic characteristics, including the level of solar radiation, temperature conditions, precipitation volumes and atmospheric movements, which significantly determines the composition and distribution of soils and vegetation.

Plant height is the most important parameter for assessing vegetation cover, indicating the maturity of ecosystems, establishing the level of quality, and indirectly defining the type of vegetation present. In mountainous areas, the slope of the earth's surface plays a decisive role in shaping local landscape features, including flora diversity.

Forest biocenoses, key elements of the ecosphere, guarantee the regulation of the most important ecological cycles, emphasising the importance of their preservation in pristine condition (Fig. 1).

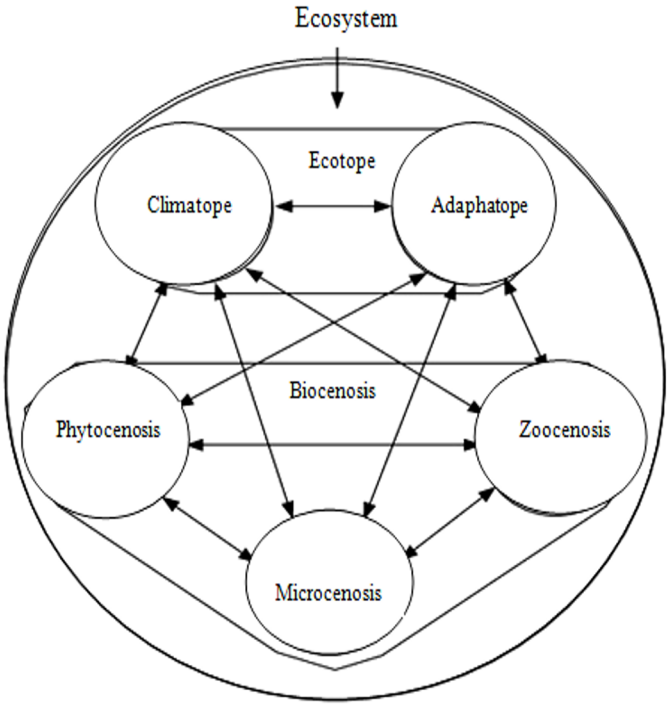

Fig. 2. Structure of biogenesis (biotope and biogeocenosis).

About a quarter of the area of the Kuban region is covered by forests with a total area of close to two million hectares. Valuable tree species such as oak, hornbeam and fir are common in these forests, while beech and edible chestnut are found exclusively in areas of the North Caucasus [3-4].

The biomass of forests in Krasnodar Krai is affected by a variety of elements: the specificity of the growth area, epidemics of insect pests and permanent foci of pathologies, as well as extreme meteorological phenomena and climatic and soil conditions, anthropogenic interventions and other living and non-living factors. These impacts, as a rule, have an integral effect [5-6].

The dominance of a specific factor leading to the deterioration or death of forest stands is possible at different periods of forest development under specific conditions [7-8].

The forests of the Kuban region have a significant impact on the maintenance of ecological balance. They fulfil critical functions, such as climate regulation, water balance and prevention of soil erosion, thus playing a key role in maintaining the ecological well-being of the region [9-10].

2 Methods and materials

The forest acts as a natural accumulator of fresh water, controlling its outflow from the mountain heights to the plains, ensuring the replenishment of the Azov-Kuban artesian basin. Fig. 2 shows a cartographic representation of the distribution of forests in Krasnodar Krai.

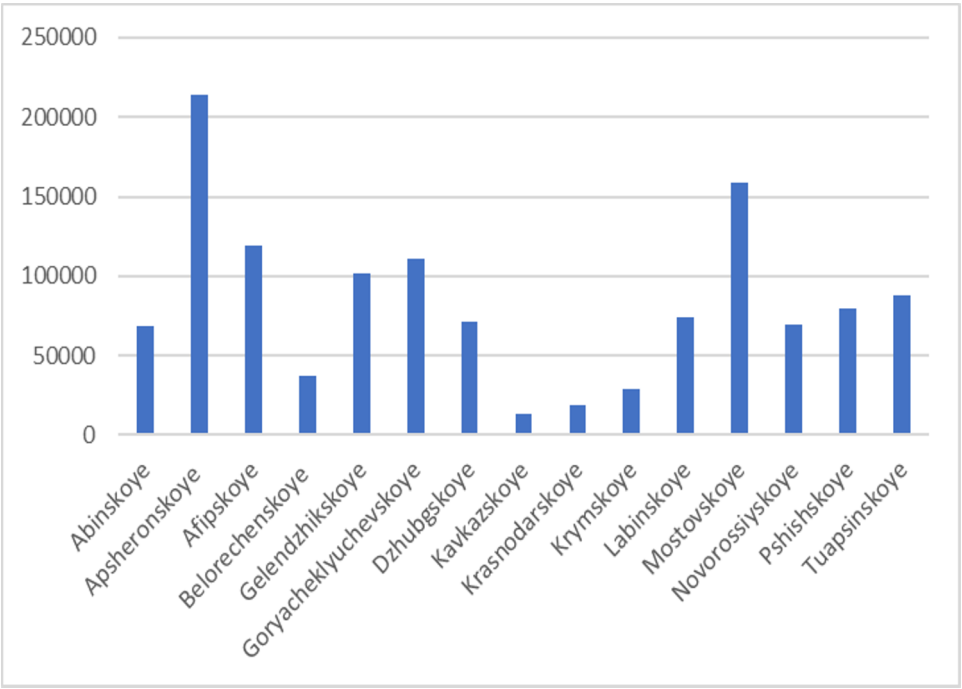

Fig. 2. Forestry on the territory of the Krai (thousand hectares).

As a result of a comprehensive analysis, including ground-based monitoring of forest lands conducted by specialists within the framework of state forest pathology control, as well as the application of data from expeditionary surveys and using modernised remote sensing techniques for the purposes of inventory of lands outside the forest cover zone and in need of reforestation measures, areas of forest plantations in Krasnodar Krai, the condition of which is considerably worse than in the past, have been identified.

3 Results

In the context of impacts on forest plantations and their widespread distribution, the main types of negative impacts have been identified, namely:

- pathologies caused by various plant pathogens;
- types of harmful insects that destroy or weaken plants;

- abiotic influences (not related to living organisms);
- extreme meteorological conditions (drought, soil overwatering, ice);
- factors caused by soil and climatic specifics of the region, human impact, forest fires.

All of the above causes deterioration of health and forest pathological condition of the leading forest forming species in the territory.

The detailed percentage distribution of the main causes of forest degradation is presented in the Fig. 3 below.

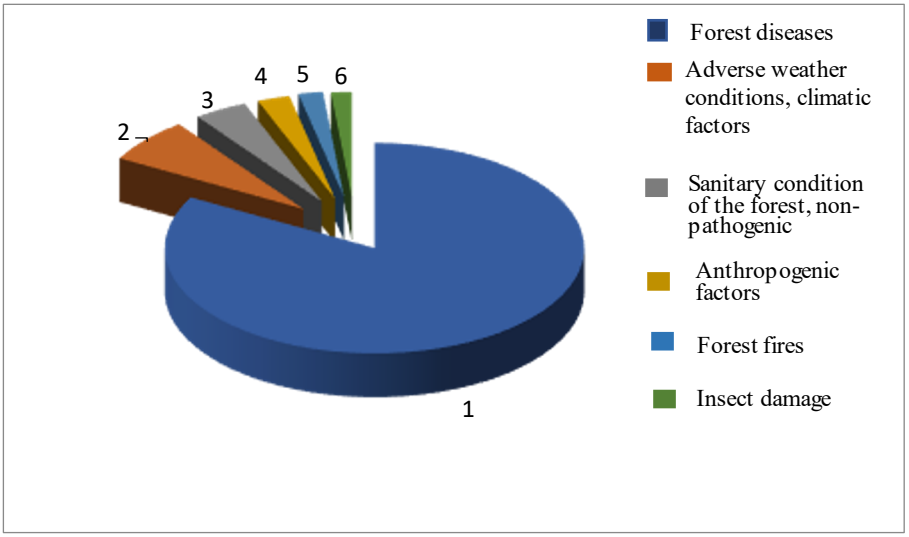

Fig. 3. Causes of weakening of forest plantations in 2023.

High fire danger in forest areas is often the result of a combination of climatic factors and vegetation types.

Periods of abnormal drought and strong winds not only increase the chances of forest fires, but also provide conditions for rapid fire coverage of large areas.

The presence of mountainous terrain further aggravates the situation by making fire zones less accessible to firefighting units, which makes firefighting much more difficult.

The information system of remote monitoring contributes to the control of fire safety in forest areas.

Fire hazard surveillance should continue throughout the entire fire danger period, including:

- monitoring, accumulating and analysing data on the level of fire danger in forest areas based on weather conditions;
- analysing the level of fire danger in forested areas based on weather conditions, using universal or region-specific fire risk assessment scales.

By the beginning of 2023, 49.31 thousand hectares of forests affected by various damages or dead trees were registered in the Krasnodar Region cadastre, and by the end of the year - 6.24 thousand hectares of areas with similar problems.

The main reason for the reduction of areas in Krasnodar Krai with pest-affected or dead trees was the exclusion of data on their condition from the forest inventory registers of areas with such plantations, if the last check was conducted more than ten years ago due to the loss of relevance of the information.

The second reason is the display of information on the condition of forest stands using a weighted average category of damage for a particular species, or accounting for stands with a weighted average category of condition and/or loss of more than 10% of the total stock of

stands.

4 Discussion

Ignoring the environmental challenges, changes in the structure and composition of the Krasnodar Region's forest cover, and failing to consider the impact of natural and human factors on forest ecosystems, we will not be able to accurately predict future changes in the environment.

Among the key actions within the framework of forest conservation are comprehensive actions that include monitoring the condition of forests, accurate recording and cataloguing of the forest fund through the forest cadastre, and the conception and implementation of national programmes to improve forestry and increase the efficiency of the forestry sector.

State inspection of the current status of forest resources, their exploitation, protection and regeneration also plays an important role.

The fundamental rules and regulations governing forestry activities play a key role in forest conservation.

Organisations involved in forest conservation are responsible for a number of important aspects of forest management.

Their tasks include ensuring accurate accounting of forest resources, supervising the correctness and legality of all activities carried out by forest users. They must also actively intervene to prevent any violations of established standards and rules in the use of the forest, including fire prevention and sanitary safety in the forest fund.

It is also their responsibility to maintain sustainable forestry, including the implementation of reforestation and afforestation measures, improving genetic diversity and the quality of forest plantations, as well as controlling pest populations and preventing the spread of forest diseases.

5 Conclusions

An important direction in the management of forest resources is the implementation of strategies to protect forests from destruction, to maintain their health through pest and disease control, and to ensure sanitary safety of forest areas.

The above measures are important for maintaining biodiversity and improving the quality of the natural environment.

Implementation of measures to protect forest areas includes the following actions:

- development and implementation of measures to prevent pests and diseases in forest areas;
- sanitation and recreation measures; development and implementation of programmes to control pests and diseases in forest areas;
- actions to ensure the safety of forest products, covering the protection of both already harvested wood and products made from it; implementation of forest pathological control, which includes monitoring the spread of insect pests, tree diseases and damage to forests, nurseries, seed collection areas and plantations;
- conducting targeted forest pathological expeditions; monitoring compliance with forest protection standards in the course of forest management activities and use of forest resources, carrying out inspections for the sanitary well-being of forest areas.

References

1. S. Ovchinnikova, A. Kalinichenko, E. Schneider, E3S Web of Conferences **381**, 01029 (2023) https://doi.org/10.1051/e3sconf/202338101029
2. S. Ovchinnikova, E. Schneider, A. Borovkov, A. Lyamina, IOP Conference Series: Earth and Environmental Science **937(4)**, 042049 (2021)
3. E. Tsoraeva, L. Basieva, B. Kozyrev, BIO Web of Conferences **43**, 02005 (2022) https://doi.org/10.1051/bioconf/20224302005
4. E. Tsoraeva, P. Alborova, L. Bazaeva, D. Khanaeva, B. Kozyrev, E3S Web of Conferences **284**, 02003 (2021) https://doi.org/10.1051/e3sconf/202128402003
5. A.A. Vais, T.V. Batvenkina, S.L. Shevelev, O.S. Artemyev, I.A. Vorobeva, L.I. Romanova, and N. O. Motyrev, BIO Web Conf. **116**, 03018 (2024) https://doi.org/1051/bioconf/202411603018
6. E. Guzueva, F. Abdulmukminova, E. Kremleva, BIO Web Conf. **116**, 03003 (2024) https://doi.org/10.1051/bioconf/202411603003
7. B. Mamurov, BIO Web Conf. 93, 05004 (2024) https://doi.org/10.1051/bioconf/20249305004
8. M. Logachev, Y. Beresneva, BIO Web of Conferences **93**, 01017 (2024) https://doi.org/10.1051/bioconf/20249301017
9. L. Tang, G. Shao, Journal of Forestry Research **26**, 791-797 (2015) https://doi.org/10.1007 / s11676-015-0088- y
10. M. Kuzyakina, D. Gura, Al. Sekisov, N. Granik, Advances in Intelligent Systems and Computing **983(2)**, 403-416 (2019) https://doi.org/10.1007/978-3-030-19868-8_41