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DYNAMICS OF NATURAL REGENERATION OF COMMON HORNBEAM (CARPINUS BETULUS L.) IN MIXTURES WITH OAKS UNDER THE IMPACT OF CLIMATE CHANGE

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Climate change accelerates aridification and modifies the precipitation regime, favoring hornbeam (Carpinus betulus L) over oaks (Quercus robur L, Quercus petraea L). The dynamics of natural regeneration are strongly disrupted by droughts and extreme phenomena, requiring the adaptation of silvicultural treatments to maintain the resilience of stands. Despite being a mesophilic species, hornbeam has a high drainage and shoot-forming capacity, as well as greater shade tolerance in the early stages of development compared to oaks.

Oaks require more light and are more vulnerable to prolonged droughts and heat waves in the seedling and sowing phase. Under the impact of water stress and climate change, hornbeam tends to suffocate the oak sapling, which leads to the simplification of the composition and degradation of the diversity of the stand.

Hornbeam (Carpinus betulus) stands in the Republic of Moldova are currently affected by a poor phytosanitary condition and severe degradation. Climate change and poor management in the past have led to massive drying, defoliation of the crowns and a reduction in the productivity of these ecosystems. Mesophilic species, such as hornbeam and beech, are found in Moldova at the southeastern limit of their natural range. Prolonged droughts and extreme temperatures during summer cause severe water stress, accelerating drying. Abusive deforestation and only partially completed maintenance work have disrupted the optimal structure of the forests. Defoliant and pathogenic insect attacks, correlated with extreme weather phenomena (such as massive frost), have seriously affected the stands in the research area [3] .

Biodiversity and increases the risk of soil erosion and landslides. To stop this process, the forestry sector focuses on ecological reconstruction and the substitution of stands where certain species are more resistant to drought and new climatic conditions. To understand the effects of above-ground neighboring vegetation interactions on seedling development, it is necessary to analyze how vegetation affects the light regime and the other microclimatic factors around the seedlings.

The dynamics of the natural regeneration of the common hornbear (Carpinus betulus l.) in mixtures with oaks under the impact of climate change, was studied in experimental areas within the National Botanical Garden (Institute) "Alexandru Ciubotaru", State University of Moldova, the results obtained were compared with observations from the "Codrii" Reserve and the "Plaiul Fagului" Scientific Reserve. The objective of this study was to evaluate the above-ground interactions that occur between neighboring vegetation and seedlings, in young oak plantations managed according to the natural vegetation sheath method. Three types of vegetation control used in sessile oak plantations in the research area were compared, vegetation control used in the natural vegetation sheath method; strong vegetation control, resulting in reduced above-ground interactions between vegetation and seedlings; and slight vegetation control, resulting in elevated above-ground interactions [1].

This study aims to model the current and future geographical distribution of common hornbeam under different climate scenarios. Furthermore, we focus on the differences between the predicted current and future potential distribution areas of the species in terms of area and location by means of change analysis. There is an urgent need to conduct scientific research in order to comprehend the impact of climate change on the geographical distribution of species that constitute an ecological niche. To meet this need, the current and future distribution areas of a species can be predicted by applying machine learning techniques.

The change analysis comparing the current and future potential distribution areas suggested that common hornbeam would be affected by climate change, expanding its range in the north. The findings can be used effectively to address biodiversity conversation planning and management as a whole and develop new strategies. In this way, future risks can be diminished.

Although these changes will happen gradually, even under the most pessimistic climate scenarios, their impacts on biodiversity and ecosystems will, over the long term, be very great. Modelling studies designed to predict changes in habitat suitability and species distribution for future scenarios of climate change will be important for informing scientists, managers, and policy-makers about risks to vulnerable species and ecosystems, and support proactive efforts to minimize the most negative effects, while potentially taking advantage of some positive changes that may accrue from climate change. As climate-related variables such as temperature and precipitation change, the effects on the survival, distribution, and other traits of individual tree species, as well as the species composition of forest biomes, will be crucial to the future of terrestrial ecosystems. There is a general prediction that under a warming climate, species will tend to shift to higher latitudes and higher elevations. Nevertheless, this generalization may not hold for the most sensitive and least abundant species, especially those that have highly specialized habitat requirements. These latter species may tend more to extinction than relocation in a rapidly warming climate [2].

Several recent studies from diverse locations have projected future climate-related changes in the habitats of ecologically and economically important plant species. In eastern Europe, significant habitat reductions are predicted for beeches including the common hornbeams, oaks, maples, alders, and other economically important species. The main objective of a forester is to obtain at the end of the regeneration period trees that grow quickly while exhibiting good quality [7]. However, neither natural regeneration nor planting allow this objective to be reached. Therefore, another method of renewing oak stands that combines some advantages of both, natural and artificial regeneration has recently been developed.

First, seedlings are planted at wide spacing; thereafter, the neighboring vegetation is regularly controlled. Vegetation is grown close to the seedlings so that the stem of the seedling is partly shaded, thereby reducing the development of twigs and branches on the stem, and the height of vegetation is restricted in the proximity of each seedling so that seedlings are not overtopped by vegetation, enabling them to maintain active growth. However, this method can only be applied on productive sites with high water and nutrient supply, where the impact of below-ground competition exerted by the neighboring vegetation is limited. On productive sites, seedling development is affected by neighboring vegetation mainly through above-ground interactions. The proximity of neighboring vegetation alters the microclimate around the seedlings which, in turn, influences seedling development [6]. Modifications in the light regime are probably the primary causes of the reduction of lateral branch development. The decrease in seedling growth, due to a decrease in total carbon assimilation, is also primarily induced by the reduction of incoming light, but may additionally be due to modifications in other microclimatic factors such as air temperature or air humidity. Light availability appeared to be a conspicuous link connecting the conservation and the silvicultural aspects of multifunctional oak forest management: Both young oak trees and multiple oak woodland specialist species are characterized by their need for increased sunlight exposure. This common denominator provides a sound basis for integrative management practices for forestry and nature conservation [4].

The concept of retention forestry offers purposeful approaches. So the harvest of valuable timber oaks or the creation of canopy gaps for oak regeneration can be used to release the crowns and trunks of habitat oaks from shading and competition. When looking at the management of oak woodland biodiversity hotspots, the re-establishment of (modified) historical forest management techniques, which increase stand openness and create transitional habitats that provide suitable oak regeneration niches, seems to be necessary. Not only the continuity of oak woodland cover and natural site conditions, but also the uninterrupted temporal continuity and availability of wood-related structural features turned out to be of particular importance for oak woodland specialist species. We identified an urgent need for systematic forest planning approaches that secure the long-term availability of these structural features within areas or "sustainability units" that are large enough to maintain viable populations of oak woodland specialist species [5]. In particular, conservation-oriented forestry measures should mainly be implemented in those areas, where the greatest effectiveness is to be expected. In the sustainability units, oak regeneration measures ought to take place either in close vicinity to old oak stands or directly in these stands. The choice of one of these options should be based on a careful consideration of the needs and possibilities of both silvicultural and nature conservation management [8].

To ensure the viability of mixed forests and reduce ecological risk, foresters apply a series of specific measures:

• Conservation and uneven successive cuts: Progressive cuts and the opening of irregular holes in the canopy are used, designed to ensure the optimal amount of light needed by the oak species.

• Interventions to help the seedling: Hornbeam specimens from the lower storey are extracted or thinning is performed to free the oaks from aggressive competition for water and nutrients.

• Ecological reconstruction: In severely affected areas, work is being done to partially or completely replace species, moving towards tiered structures and promoting species with greater drought tolerance.

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