EDITORIAL

Editorial to the thematic issue:

Silviculture and forest production under climate change

Dear readers,

It is with great honour that we present to you this thematic issue “Silviculture and forest production under climate change” with the contributions of unique research work dealing with the current environmental problems. The ongoing global climate change poses a challenge for various sectors, including forestry. On the one hand, forest ecosystems are exposed to and threatened by climate change and, on the other hand, forests have the ability to influence the course of climate change, by regulating the water regime and air quality, carbon sequestration or reducing climate extremes. It is therefore important not to see climate change only as a threat causing large-scale forest disturbances and economic recession, but also as an opportunity for innovative approaches in forest management, protection and silviculture.

Climate change gradually and significantly affects the ability of forests to fulfil their functions and provide ecosystem services to the human society. In recent years, there has been a constant increase in average air temperature in Central Europe, increasing inequality in the distribution of precipitation, increasing frequencies of storms and torrential rains followed by floods. Evaporation is generally increasing because of higher temperatures while available moisture in forest ecosystems is significantly decreasing. The result is an increase in the incidence of long-term droughts, followed by an increase in stress factors for forest tree species and also the occurrence of forest fires, in extreme cases. The simultaneous effect of these factors reduces the vitality of forest stands and positively affects the population dynamics of insect pests and increases the occurrence of fungal pathogens. In the conditions of Central Europe, Norway spruce is a particularly vulnerable tree species, but, actually, all our main commercial tree species are threatened. In the Czech and Slovak Republics, unplanned salvage logging has accounted for ca 65% of the total timber harvest in the last 10 years as a result of the above-mentioned factors, of which 80% to 85% were the coniferous tree species.

Depending on the habitat conditions and the specifics of the stand, climate change may also have a positive effect. Tree growth and the stand production can be positively affected by increased CO₂ concentrations in the air. The result is therefore a change of habitat potential for silviculture of particular tree species or their mixtures. As a result of climate change, habitat conditions are shifting into lower forest vegetation zones. This significantly worsens the conditions particularly for species with high demands on soil and air humidity. For these reasons, it will be necessary to apply various adaptation measures, based on a change in the species composition with the aim of creating mixed stands that show high stability and economic viability at the same time. Simultaneously, it will be necessary to replace declining spruce stands in the lower and middle elevation zones with more resistant species, such as European larch, silver fir and Scots pine. In deciduous trees, a higher proportion of economically highly valuable species, such as oaks, maples and wild cherry, is expected. We must also not forget the significant potential of the introduced tree species, such as Douglas fir, northern red oak, ponderosa pine and black pine, including new species that have not been used in forestry in Central Europe so far. On the other hand, caution is advised, as climate change may accelerate the spread of invasive tree species such as *Ailanthus altissima*, with a negative impact on native tree species. However, the desired change in the tree composition based on an increasing diversity will require higher initial costs for artificial regeneration and tending interventions. In genetically valuable stands, natural forest regeneration is one of the most important adaptation measures. When establishing mixed stands, group mixing is generally recommended; prolongation of the regenerative period and the use of continuous-cover silvicultural methods lead to the creation of more stable structurally differentiated stands. The general economic goal that is realistically achieved in the natural conditions of Central Europe is the structure of a forest mixed in groups, spatially and age-wise significantly structured with tree species corresponding to the expected climate development.

Successful implementation of these measures requires a change in decision-making in forest management, comprehensively considering changing natural conditions, economic indicators and environmental limits of forest cultivation. What our forests will look like for future generations and what the resulting impact of climate change will be on forestry is in the hands of forest managers, depending on supportive forestry research and (we must not forget) publishing scientific papers in the Central European Forestry Journal.

This monothematic issue contains 7 papers including one review paper “**Assisted migration vs. close-to-nature forestry: what are the prospects for tree populations under climate change?**” The authors reviewed biological background and limits of mechanisms by which tree populations may cope with climate change: adaptation by natural selection, gene flow, epigenetic phenomena and phenotypic plasticity, as well as forest management strategies which rely on these mechanisms. It was argued that maintaining genetic diversity is important in the long-term view but natural selection cannot ensure sufficiently rapid response to environmental change. On the other hand, epigenetic memory effects may change adaptively relevant traits within a single generation, while close-to-nature forestry practices are the basic requirement to make use of epigenetics.

The article “**Substitution of Norway spruce for Douglas-fir: changes of soil microbial activities as climate change induced shift in species composition**” is a case study, based on an assumption that this species is a convenient substitution for declining Norway spruce stands under current climatic change (extreme drought, bark beetle outbreak). In the

presented study, the respiration rate and nitrification intensity were compared in the stand parts dominated by Norway spruce and Douglas-fir in comparable site conditions. It was concluded that admixture of Douglas-fir will accelerate and promote microbial activities, resulting in faster litter decomposition (increased potential and actual respiration activity) and more pronounced nitrogen dynamics (nitrification).

The above-mentioned tree species was also an object of the paper “**Litterfall nutrient return in thinned young stands with Douglas fir**” dealing with both the amount and properties of litterfall in 18-year-old to 20-year-old stands with Douglas fir in 2011. Two experimental plots were Douglas fir dominated and one showed ca. 20–30% share of Scots pine at the beginning of observation. The experiments consisted of two treatments such as unthinned control and 50–62% trees’ density reduction accounting for 43–59% basal area reduction. It was concluded that young Douglas fir dominated stands react to very heavy thinning by a reduced amount of litterfall and a quicker rate of litter decomposition. This effect showed similar trend when compared to native conifers (Norway spruce, Scots pine).

The chestnut species is also considered to be in danger of extinction due to the effects of climate change, particular diseases (e.g. *Cryphonectria parasitica*) and land mismanagement. This is the crucial statement of the original article “**Soil erosion in Mediterranean chestnut tree plantations at risk due to climate change and land abandonment**”. This study quantifies soil losses in areas under tree canopies and open areas considering two plantations of different age; planted in the 1960s and 1990s. The results showed that the open areas and the youngest plantation show higher soil losses than the areas under the trees and the oldest plantation.

Another tree species with higher tolerance to dry periods and to a lower soil nutrient content is “**Northern red oak (*Quercus rubra* L.) as a species suitable for the upcoming seasons with frequent dry periods**”. The aim of this study was to assess the regeneration of Northern red oak and its growth in the first years after planting under given climatic conditions of recent years in an area characterized by longer dry periods. It also assesses the value of the Lang’s rain factor to evaluate local climatic conditions. The results of surveys on research plots with sessile oak and red oak plantations confirmed that in areas with higher temperatures and lower precipitation as expressed by Lang’s rain factor, Northern red oak can be successfully grown, showing better resistance to dry climatic conditions than domestic oaks in both growth and field performance first years after planting.

In the context of climate change, the crucial question is how silvicultural treatments should be modified, in order to reach favourable conditions for initiating natural regeneration of forest stands. Therefore, the last two articles dealt just with this issue. The aim of the first study “**Does shelterwood regeneration on natural Scots pine sites under changing environmental conditions represent a viable alternative to traditional clear-cut management?**” was to evaluate the influence of the basal area reduction (stand densities: clear-cut, 0.4, 0.6 and 0.8) and soil preparation (milling cutter, forestry mulcher, brush rake and control variant without soil preparation) on the regeneration of Scots pine in the conditions of natural pine sites (Northern Bohemia). Based on the research it was concluded that the best outcome of natural regeneration was achieved after seed cut decreasing the stand density to 0.4. This was manifested by sufficient seed numbers, highest regeneration density, superior seedling characteristics and positive effect on soil moisture and temperature characteristics. Additionally, shelterwood regeneration on natural Scots pine sites was recommended as a promising silvicultural approach and may in the future become an important tool in mitigating negative effects of climate change.

The last, but not the least important paper “**Silviculture as a tool to support stability and diversity of forests under climate change: study from Krkonoše Mountains**” is focused on appropriate adaptation strategies in silviculture to mitigate the impacts of global climate change on forest ecosystems in Central Europe. The objectives of this paper were to evaluate stand production, structure and diversity on eight experimental research plots in the Krkonoše Mountains. Subsequently, three variants of management were compared in mixed stands at the age of 17–20 years originating from natural regeneration. The results showed that structural diversity and tree species richness increased when adaptation thinning had been applied, while a decrease in diameter differentiation and total diversity was observed after thinning from below. Moreover, horizontal structure changed from aggregated spatial pattern to random distribution after the interventions, especially under adaptation thinning. The newly designed structuralizing adaptation thinning method seems to be a more suitable option in the given habitat and stand conditions compared to the commonly performed thinning from below.

We thank all authors for their contributions and professional approach to presenting their research areas. We also believe that these interesting papers grouped in a monothematic issue will receive sound feedback from the Central European forestry community.

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