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Climate changes impact, adaptive genetic capacity and vulnerability of the forest tree species

Georgeta Mihai (1), Maria Teodosiu (1), Marius Victor Birsan (2), Alexandru Dumitrescu (2), Alin Madalin Alexandru (1), and Ionel Mirancea (1)

(1) « Marin Dracea » National Institute for Research and Development in Forestry, Bucharest, Romania (gmihai_2008@yahoo.com, teodosiumaria@yahoo.com, alexandru.alin06@yahoo.com, ionelmirancea@yahoo.com), (2) National Meteorological Administration, Department of Climatology. Bucharest, Romania (marius.birsan@gmail.com, alexandru.alin06@yahoo.com)

Researchers in the last decades have revealed a clear change in global climate, which cannot remain without effects on forest ecosystems. The most pessimistic climate change scenarios indicate increase of 4°C and higher in average annual air temperature until the end of the century, as well as changes in the rainfall regime and in the frequency of some extreme events (Salinger 2005). In Romania, the annual air temperature is projected to increase by 1.2°C during 2021–2050 compared to 1991–2020 (Cheval et al. 2017), and by over 2°C in 100 years, i.e. 1961–1990 vs 2061–2090 (Bojariu et al. 2015).

The ability of tree species to survive under changing climate depends on their intraspecific genetic variation in climate response. Therefore, assessment of adaptive genetic capacity of local species is essential for increasing forest productivity and stability in the context of climate changes. Proper choice of provenances with high plasticity are decisive for increasing the adaptability of tree populations to rapid environmental changes.

The aim of this study is to evaluate the adaptive genetic capacity and the impact of climate changes on Norway spruce growth and distribution in Romania. Norway spruce is one of the most important forest species in Romania, both for economic and ecological purposes. It covers about 22% of the national forest area and 77 % of the coniferous forest area (approximately 1,450,000 ha) (NFI 2012). Since the middle of the 19th century, Norway spruce was the most cultivated species outside its natural range.

Based on data from a long-term provenance experiments network and climate variables over last 50 years, we have investigated the impact of climatic factors on growth performance and adaptation capacity of Norway spruce populations. Combining the adaptive genetic variation with analysis of nuclear markers we obtained different images of the genetic structure of Norway spruce populations. Spatial genetic analyses have allowed identifying the genetic centers holding high genetic diversity which will be valuable sources of genes able to buffer the negative effects of future climate change. This approach based on both ecological and genetic variables will allow us to predict the species response to climate change.

Based on growth response functions and RCP4.5 scenario we could project the shifts in species distribution for 2050s and 2100s and identify which will be the areas where the populations will be maladapted over the next decades. Strong correlations were found between the level of nuclear diversity and population suitability for future climate.

Therefore, the strategies for conservation and management of forest genetic resources have to rely on the intraspecific genetic variation of the valuable genetic resources.