Geophysical Research Abstracts
Vol. 20, EGU2018-6828-2, 2018
EGU General Assembly 2018

Estimating changes of potential natural forest community composition using multidisciplinary approach in Hungary

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Climate change is expected to affect the compositional and structural attributes of forest vegetation in the Carpathian Basin. Forest dynamics is closely related to climate trends, soil features and surplus water.
The aim of the investigation was to determine the distribution of potential natural forest community (PNF) categories according to past, present and future climate.
Potential natural forest communities (PNF) are the forest vegetation that would be expected under given site factors (e.g. climate, geomorphology, geology, soil, hydrology) without human intervention or hazard event. Potential vegetation can differ appreciably from the original natural and actual vegetation.
In our complex research PNF categories were determined for 57 forest regions according to the following site factor combinations: climate, hydrology, soil type, soil depth, soil texture based on the Hungarian National Forestry Database. The following climate sensible zonal PNF categories cover the largest part of the Carpathian Basin: beech woodlands, sessile oak-hornbeam woodlands, turkey oak - sessile oak woodlands, loess steppe forests. This present PNF maps provide a reference state for the future changes.
PNF shifts were estimated mainly from climate trends (indicated by the change of the Forestry Aridity Index) using meteorological observations from the past and based on regional climate change scenarios until 2100.
PNF categories without surplus water are particularly sensitive to evapotranspiration demand and soil water holding capacity. Thus surplus water affected PNF categories (riverine ash-alder woodlands, riverine willow-poplar woodlands, riverine oak-elm-ash woodlands, swamp woodlands) are influenced indirectly by climate change. Actual evapotranspiration was derived from remote-sensing products. The Budyko model was applied in a spatially-distributed mode for the climate impact analysis. Field measurements were carried out to determine the effects of the hydrological extremes on the soil water holding capacity. The water stress was defined using a modified Thornthwaite-type monthly model.
The temperature and precipitation records observed in the last 50 years refer to warming and drying trends in the summer, which is projected to be more intense by the end of the century. An increase in the frequency and severity of extremely hot droughts can lead to a higher evapotranspiration rate and a limited amount of available water, especially on sites with low soil water holding capacity. Consequently, a significant change in the composition of the plant species and the potential vegetation cover is expected, especially in the case of drought-sensitive forest communities. Estimated spatial distribution data of potential natural forest communities provide a multidisciplinary aspect for supporting adaptation in forest ecosystems and nature conservation.

Keywords: potential natural forest community, climate change, site factors, soil water holding capacity

Acknowledgements: The research was supported by the Higher Education Structural Adjustment Fund (FSA).