Drought effects on old-growth forests compared to new-growth forests in Central and Eastern Europe

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Abstract

Climate change is increasing the occurrence of extreme weather events, such as droughts and heatwaves *(Imbery et al., 2018)*. This is a serious threat to forests in the temperate climate zone of Europe due to their limited adaptability to heat and drought *(Sen, 2015).* Especially the intensification of so called hot droughts has led to more forest dieback in recent years *(Allen et al., 2015)*. But the response of forests to drought can vary greatly based on their different characteristics *(Norman et al., 2016)*. For example, several studies showed that forest type *(Grossiord, 2019), (McDowell et al., 2020),* but also forest size *(Vranckx et al., 2014), (Morán-López et al., 2016)*, can have an impact on the behavior. Likewise, naturalness could play an important role, as forests sometimes differ greatly from their natural state due to decades of human use and the resulting changes in forest structure and composition *(Sabatini et al., 2018)*. However, the extent to which human actions influence the vulnerability of forests to drought is still uncertain. Therefore, this work tried to figure out how far the natural behavior of forests varies based on several characteristics, but also whether there is a difference in the sensitivity of forests with varying naturalness and how the reaction is influenced by different drought intensities. For this purpose, satellite data of eastern and central Europe during the droughts in the summer months of 2018 and 2019 were used for a calculation of the *vegetation condition index* based on the *normalized vegetation index* and the *normalized moisture index* for each forest patch. Then, suitable new-growth forest areas were found for the comparison of forests with different naturalness. The drought intensity were classified by different meteorological indexes as the *standard precipitation index*, *standard precipitation evapotranspiration index*, *soil moisture* - and *temperature anomalies*. The study results revealed that particularly hot and intense forms of drought had a strong effect on old-growth forests in the study area. Overall, coniferous forests and larger forest areas showed a lower impact of drought (see figure 1), while a high response was measured in deciduous forests and medium forest areas (see figure 1). Additionally a higher sensitivity of old-growth forests could be measured in areas affected by intense and hot droughts (see figure 2). In total, the results show a high variance and partly differ from those of other studies, which highlights the

serious importance of further research on the vulnerability of forests to droughts. Especially the higher sensitivity of old-growth forest demonstrate the need of further research to precisely determine the influencing factors for a development of mitigation strategies, as drought occurrence is expected to increase in the future, causing further intensification of the impact on Europe's last old-growth forests.

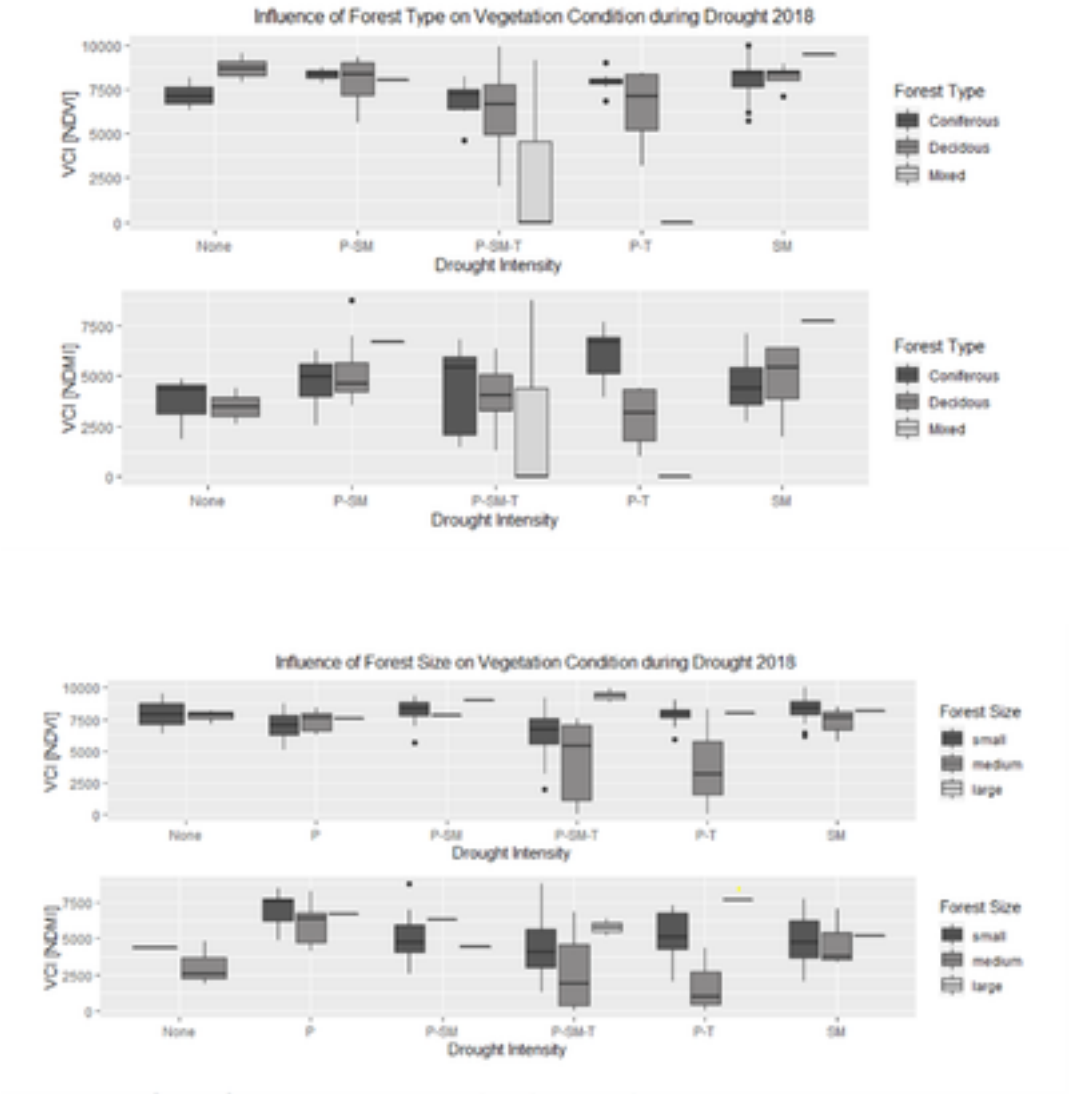

Figure 1: Influence of different Forest Cahacteristics on their reaction to Droughts

drought classes: ***None:*** *no droughts' impacts,* ***P:*** *precicipitation deficit,* ***P-SM:*** *precipitation and soil moisture deficit,* ***P-SM-T:*** *precipitation and soil moisture deficit with higher air temperatures than usual;* ***P-T:*** *precipitation deficit with higher air temperatures than usual,* ***SM:*** *soll moisure deficit*

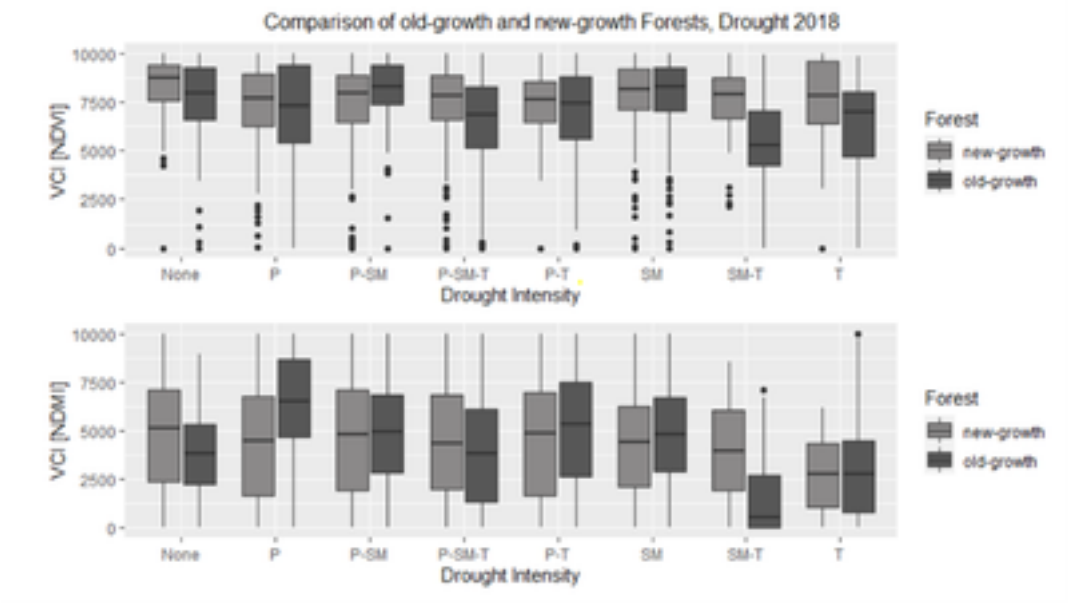

Figure 2: Comparison of old- and new growth forests during drought 2018

drought classes: ***None:*** *no droughts' impacts,* ***P:*** *precicipitation deficit,* ***P-SM:*** *precipitation and soil moisture deficit,* ***P-SM-T:*** *precipitation and soil moisture deficit with higher air temperatures than usual;* ***P-T:*** *precipitation deficit with higher air temperatures than usual,* ***SM:*** *soll moisure deficit*