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## Increased vulnerability of European ecosystems to two consecutive extreme summers

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Extreme summer temperatures in western and central Europe have become more frequent and heatwaves more prolonged over the past decades. The summer of 2018 was one of the driest and hottest in the observational record and led to losses in vegetation productivity in central Europe by up to 50%. Legacy effects from such extreme summers can affect ecosystem functioning over several years, as vegetation slowly recovers. In 2019 an extremely dry and hot summer was registered again in the region, imposing stress conditions at a time when ecosystems were still recovering from summer 2018.

Using Enhanced Vegetation Index (EVI) fields from MODIS, we evaluate how ecosystems in central Europe responded to the occurrence of two consecutive extreme summers. We find that only ca. 21% of the area negatively impacted by drought in summer 2018 fully recovered in 2019.

We find that the strongest EVI anomalies in 2018/19 diverge from the long-term relationships between EVI and climate, indicating an increase in ecosystem vulnerability to heat and drought events. Furthermore, 18% of the area showed a worsening of plant status during summer 2019 in spite of drought alleviation, which could be explained by interannual legacy effects from 2018, such as impaired growth and increased biotic disturbances.

Land-surface models do not simulate interannual legacy effects from summer 2018 and thereby underestimate the impact of drought in 2019 on ecosystems. The poor representation of drought-induced damage and mortality and lack of biotic disturbances in these models may result in an overestimation of the resilience and stability of temperate ecosystems in the future.