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Estimating the vulnerability of European ecosystems to extreme events: The ecosystem perspective

Susanne Rolinski (1), Kirsten Thonicke (1), Anja Rammig (1), Ariane Walz (2), and Marcel van Oijen (3)

(1) Potsdam Institute of Climate Impact Research, Potsdam, Germany (susanne.rolinski@pik-potsdam.de), (2) Potsdam University, Karl-Liebknecht-Str. 24-25, 14476 Potsdam-Golm, Germany, (3) Centre for Ecology & Hydrology Edinburgh, Bush Estate, Penicuik, Midlothian, EH26 0QB, U.K.

Extremes of meteorological events may but do not have to cause damages in ecosystems. Climate change is expected to have a strong impact on the productivity and stability of ecosystems worldwide. So far, the impacts of extreme drivers on ecosystems have generally been studied regardless of the extremeness of the ecosystem response.

We base our analysis on a Probabilistic Risk Assessment concept of Van Oijen et al. quantifying the vulnerability of vegetation dynamics in relation to the extremeness of meteorological drivers such as temperature or precipitation. Here, the definition of extreme, hazardous weather conditions is based on the ecosystem response. Hence, instead of searching for extreme meteorological events, we define extreme ecosystem responses in terms of threshold levels of carbon uptake, and search for the meteorological conditions responsible. Having defined hazardous events in this way, we quantify the vulnerability of ecosystems to the such hazards.

We apply this approach on results of the dynamic process-based vegetation model LPJmL using climatic input for Europe from the WATCH-ERAI-REMO climate scenario with the SRES A1B emission scenario. Our results show that under current climatic conditions, the southern part of Europe already suffers severe heat and drought stress which is reflected in our approach by vulnerability values being high for precipitation, relatively high for the SPEI index, moderately high for temperature and quite high for the consecutive dry days. Thus, hazard occurrence is frequent enough to determine ecosystem vulnerability but this depends on the definition of the threshold of hazardous ecosystem responses.