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Quantifying Landscape Temperature Mitigation of Forests and Wetlands

Abstract

The regulating services of forests and wetlands to mitigate landscape temperatures are increasingly important with ongoing climate change and more frequent heat events. While the reduced temperatures found in forests and wetlands are recognized, the wider contribution of forests and wetlands to landscape cooling remains largely uncharacterized and unquantified. We established a new method that allows for a quantification of the land cover specific cooling capacity of landscapes by researching different land cover shares in relation to temperature ranges and temperature extremes. For this we combined time series of MODIS daytime land surface temperature (henceforth LST) and CORINE land cover data. We classified these time series by stepwise temperature ranges (-10/-5 °C to +35/+40 °C) and by the occurrence of hot days (days with mean LST ≥ 30 °C). As explanatory variables, we used the time series of MODIS normalized difference vegetation index (NDVI) and classified the dataset using the greenest pixel composite. In our study area, covering parts of northeastern Germany and western Poland, the fragmented landscape shows heterogeneous temperature patterns including urban heat islands, warm agricultural areas, cool forests and cold wetlands. We found that at high temperature ranges only forests and wetlands remained comparably cool with LSTs, up to 20.8 °C lower than the maximum LST in the study area. The analysis of land cover shares and LSTs revealed the cooling effect of forests and wetlands in higher temperature ranges as well as on hot days. The relation of LST and NDVI indicated vegetation cover as the cause. We propose our approach as a useful means to quantify landscape level temperature regulation. Equally, we advocate for management to identify these ecosystem services and their current and potential contribution, with implications for sustaining and increasing, both tree cover and wetlands and thereby adapting landscapes to climate change.

Keywords: surface cooling, climate change mitigation, ecological indicators, forests, land surface temperature, NDVI