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Modelling water fluxes from urban trees using ECOSTRESS and sap-flow data

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Urban trees experience a unique combination of stressors and environmental benefits from urban environments, which affect their physiological health and ability to deliver ecosystem service benefits. Understanding which tree species are resilient or vulnerable to extreme climatic events is crucial to managing a sustainable urban forest.

This study investigates species-specific variations in water fluxes of three popular urban tree species (*Acer pseudoplatanus, Tilia europaea,* and *Betula pendula*) in response to a high temperature event. We used sap-flow data from 12 trees in an urban woodland, collected from TreeTalker sensors within the University of Sheffield Urban Tree Observatory (UTO), a state-of-the-art urban tree sensor network in Sheffield, UK. Data were collected every hour over a 2-year period (2021-22), which included an extreme heatwave characterized by high atmospheric evaporative demands and lower rainfall. A significant decrease in sap-flow of ~30% was observed for *A. psedoplatanus* and *T. europaea* respectively in 2022 compared to 2021, following a 4-day extreme weather event with temperatures reaching 38.9^{o}C and Vapour Pressure Deficit (VPD) values of 5.8 kPa. *B. pendula* exhibited greater resilience to extreme climatic events with a ~5% decrease in sap-flow due to its low water demand. At the woodland scale, transpiration derived from sap-flow data was strongly correlated to evapotranspiration (ET) values from the ECOSTRESS Level 3 Instantaneous Evapotranspiration (ET_{inst}) satellite product under non-stressed conditions (R^2 =0.86; $p<0.001$). However, under stressed conditions during the heatwave event the relationship was much weaker (R^2 =0.38; $p<0.05$), which may be attributed to uncertainties in underlying ET algorithm.

This research elucidates the differing impacts of extreme weather conditions on three urban tree species and provides an assessment of their ability to continue to deliver ecosystem services. Whilst some caution should be exercised in interpreting ECOSTRESS ET data under temperature/water stress conditions, satellite technologies offer an exciting opportunity to remotely monitor water fluxes from trees in urban woodland at city-scales.