Selecting Tree Species to Improve Runoff Retention by Biofiltration Systems

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Biofiltration systems are highly valued in urban landscapes as they remove pollutants from stormwater runoff, however, they currently play a minor role in reducing runoff volumes. Integrating trees with biofiltration systems may improve runoff retention performance, as some trees can transpire large volumes of water. High transpiration rates will rapidly deplete stored water, creating greater storage capacity prior to the next runoff event, however, this will likely expose trees to frequent periods of water limitation and drought stress. Selecting appropriate tree species therefore requires an understanding of how rapidly trees respond to water availability, how they use water and control transpiration rates, and finally how they respond to soil drying. We selected 20 tree species and quantified evapotranspiration (ET) and drought stress (leaf water potential; Ψ) in relation to the water content of the substrate. To compare species, we developed metrics which describe: (i) maximum rates of ET under well-watered conditions, (ii) the sensitivity of ET and (iii) the response of Ψ to declining substrate water content. Using these three metrics, we classified species into three groups: risky, balanced or conservative. Risky and balanced species showed high maximum ET. As substrates dried, only the balanced species down-regulated ET to delay the onset of drought stress; whereas risky species did not. Conservative species showed low maximum ET and only showed reduced ET and drought stress at low substrate water contents. Balanced species with high ET are more likely to improve the retention performance of biofiltration systems without introducing significant drought risk. Risky species may enable greater storage capacity and retention potential, but only if used in combination with an internal water storage (i.e. a saturated zone) to reduce drought stress.
Tree species showed a wide range of water use behaviours and describing their response to drying substrates allowed us to assess their suitability for use in biofiltration systems.