Fragmented Woodlands and Catchment Recharge: The Impact of Hedges and Edges

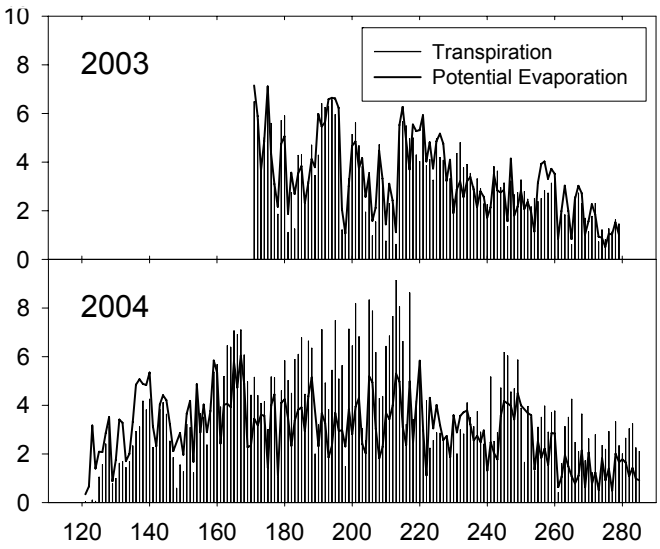
Mathias Herbst, John Roberts, David Gowing, Paul Rosier & Nathan Callaghan
Centre for Ecology and Hydrology

Key questions

- Does woodland planting in lowland catchments lead to an increase in evaporation and a reduction in recharge?
- Does the size of a woodland make a difference (see Roberts & Rosier 2006)?

Hedgerow measurements

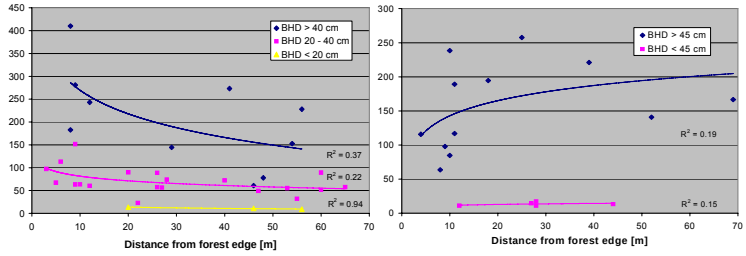
- The transpiration from a hawthorn dominated hedgerow as measured by the sap flux technique reached peak values around 8 mm d-1 and a seasonal average of approx. 3.5 mm d-1. These rates are higher than in other temperate deciduous woodlands, except short-rotation coppice and wet woodlands. The high water loss through transpiration was mainly caused by the high stomatal and boundary-layer conductances of hawthorn leaves. The canopy was always closely coupled to the atmosphere ($\Omega = 0.2$) and a substantial fraction of the energy used for transpiration was advected. A model accounting for the response of canopy conductance to irradiance and vapour pressure deficit has now been derived (Herbst et al. 2006a).
- The fully leafed hedgerows intercepted on average 57% of gross rainfall (PG), if related to the projected surface area of the hedges. The corresponding fraction for the leafless period was 45%. The Gash model of rainfall interception was parameterised for hedgerows and predicted their interception loss from daily rainfall data with reasonable accuracy (Herbst et al. 2006b).



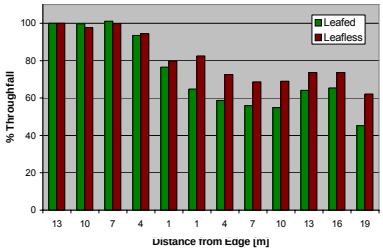
Daily hedgerow transpiration [mm d-1] from sap flux measurements compared to potential evaporation after Priestley & Taylor (1972).

Woodland edge measurements

- A field study to quantify the 'edge effect' was carried out from April to November 2005 on two opposing edges of a mixed deciduous forest (Wytham Woods). The measurements included microclimate and soil moisture, a transect of net rainfall across the edge, and transpiration (sap flux) in ash, oak, field maple and hawthorn trees of various sizes and at various distances from the edge. The secondary data analysis is currently in progress. Preliminary results indicate that an edge effect on rainfall interception is restricted to a narrow zone not wider than 10 m, but that changes in transpiration are detectable over a distance of at least 50 m into the forest.
- The magnitude of the edge effect, however, depended on tree physiology. Ash (and hawthorn) trees at the edge lost twice as much water through transpiration than trees of similar size inside the forest. Field maple trees were only weakly affected by the proximity to an edge and Oak trees did not show a significant trend.
- A link between hydrological and physiological models is required to quantify the water balance of fragmented woodlands: The enhanced turbulence around a forest edge means more physiological control of transpiration!



Average transpiration rates of ash (left) and oak (right) trees of various diameters (BHD) vs. their distance from the edge.



Net rainfall transect across the north edge of Wytham Woods.

Find out more...

Herbst M, Roberts JM, Rosier PTW, Gowing DJ, 2006. Seasonal and interannual variability of canopy transpiration of a hedgerow in southern England. Tree Physiol., in press.
Herbst M, Roberts JM, Rosier PTW, Gowing DJ, 2006. Measuring and modelling the rainfall interception loss by hedgerows in southern England. Agric. For. Meteorol., in press.
Roberts JM, Rosier PTW, 2006. The effect of broadleaved woodland on Chalk groundwater resources. Quart. J. Engin. Geol. Hydrogeol. 39, 197-207.

Contact: Mathias Herbst mher@ceh.ac.uk