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Chloride accumulation in the soil and groundwater under a downslope oak hedge reveals the impressive evapotranspiration of wooded linear structures below a temperate climate

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Although it is an essential element in plants, Cl- is excluded to a large extent by roots during absorption of water and nutrients, and its concentration rises as a function of evapotranspiration. Compared to herbaceous vegetation, high transpiration rates are measured for hedgerow trees. This article deals with the influence of a tree hedge on the soil and groundwater Cl- concentrations and with the possibility to use Cl- as an indicator of transpiration and water movements in the hedge vicinity.

Cl- concentrations were measured over one year at different depths in the unsaturated zone and in the groundwater along a transect intersecting a bottomland oak hedge in the North-West of France, under an oceanic wet temperate climate. We observed a strong spatial variation of Cl- concentrations, with very high values up to 2 g L-1 in the unsaturated zone and 1.2 g L-1 in the upper part of the groundwater. These concentrations contrasted with the low values measured in the unsaturated zone far from the hedge (10 mg L-1) and in the deepest part of the groundwater (60-70 mg L-1).

Cl- accumulation in the unsaturated zone at the end of the growing season allowed us to identify the active root zone extension of trees. The root zone begins at the surface under the hedge and widens out at depth at an increasing distance from the hedge, extending laterally on at least 10 m on both sides of the hedge. While the root zone is deeper at the upslope side of the hedge, it is nearer the ground surface downslope, where the development of roots is limited by the water-table close to the surface.

Cl- concentrations varied along the year. In winter, upslope of the hedge, downwards leaching partly renewed the soil solution, while under the hedge or farther downslope the lack of any significant water movement resulted in Cl- accumulation. For a bottomland hedge, the proximity of the water-table probably increases the water availability of water for tree transpiration. The measurement of Cl- concentrations in the unsaturated zone under hedges at the end of the growing season would allow us to detect whether topographic, pedological or climatic conditions are likely to limit water renewal or favour transpiration and to produce a strong salinisation of the soil, as observed in the present study. The 2 main conclusions are 1) the contrasted evapotranspiration between fields and surrounded tree hedges has been underestimated in eco-hydrological catchment studies; 2) Cl accumulation in soil and groundwater could then be an easy accessible indicator of the lateral influence of a tree hedge on water dynamic at the catchment scale.