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The role of plant physiology in hydrology – looking backwards and forwards

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The measurement, understanding and modelling of evaporation and its components is fundamental to many requirements in hydrology. Transpiration, the uptake of water from the soil, transport through plants and loss into the atmosphere through the stomata, is a key component of evaporation. Apart, perhaps, from the contribution of vegetation structure to interception losses, arguably, it is mainly in transpiration that vegetation has a major role in hydrological control. Transpiration can be determined and understanding developed from micrometeorological and soil moisture studies. However, because of the close links between understanding the controls of transpiration and its determination and studies at the leaf, plant and plot scale, it is unsurprising that major contributions to the measurement and understanding of transpiration have been contributed by physiological studies of transpiration.

This paper charts some experiences of a plant physiologist at a hydrological Institute and aims to illustrate with examples where a physiological input has contributed to an improved understanding of transpiration. The paper also attempts to identify areas where physiological insight is likely to yield dividends in the future. As a backward look a number of questions are asked and the answers to these questions, largely provided by physiological studies, reveal the added value of physiological studies particularly when conducted alongside other disciplines, in clarifying our knowledge of hydrological behaviour at vegetated land surfaces. Some questions asked are:

- ***Why is there a disagreement in the estimates of forest evaporation made using micrometeorological and soil physics approaches?***
- ***Why is transpiration from European forests low and conservative?***
- ***Why is tropical rainforest transpiration so low?***

- ***What is the first signal that plants need water?***

Detailed physiological studies, particularly in forests, have contributed to answering these questions. Important information has emerged about the importance of understories to forest transpiration, the moderating of transpiration by negative feedbacks with atmospheric humidity deficits and insensitivity of forest transpiration to soil moisture deficits. In the future there should be further improvement of methods that quantify individual plant water use and more pragmatic means developed to assess when vegetation is in need of water.