Spatio-temporal controls on catchment ecohydrology: lessons learnt from eucalypt forests

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Abstract: Evapotranspiration is a major component of the water balance and is spatially variable due to variations in land cover and topography. Among different processes included in evapotranspiration (e.g. transpiration, soil and leaf evaporation, canopy interception) transpiration is the most important component in forested catchments of south-east Australia. The amount of water transpired by trees can be divided into water transpired under stressed and water transpired under non-stressed conditions. While prescribed values of soil moisture are commonly used to define the transition between water-stressed and unstressed conditions, several other variables (e.g. atmospheric humidity, radiation, nutrient availability) can at different times limit vegetation water use, either individually or in combination.

Assessment of physiological response to water stress can be included in hydrological modeling based on a mechanistic framework. A suite of physical models have been used to predict stomatal conductance as a function of water availability in soil and atmosphere and can be included in models of ET such as in the Penman-Monteith equation, depending on the complexity of the hydrological model. Estimation of ET via such models requires extensive data inputs – data that are not readily available in many instances. As an alternative, ET is often simulated more conceptually, as supply-limited, i.e. depending on the soil moisture availability. In reality transpiration is also strongly controlled by atmospheric demand, particularly during demand-limited periods.

Based on empirical data and theory, we revised a supply-limited evapotranspiration function by including atmospheric (VPD) regulation of transpiration during periods when soil moisture is not limiting, using the HBV hydrological model. Surfaces of potential evapotranspiration (ET_p), air temperature and vapour pressure deficit were spatially modeled taking into account the influence of topography on forcing variables. Results showed that aggregated climate variables are superior to the average of point (gauge) measurements for application in lumped hydrological models over a complex terrain. In addition, inclusion of atmospheric-induced limitations to transpiration into the ET sub-model, using only a single extra parameter, made a significant improvement in streamflow simulation.

This study is a coupling of previous process-focused field research on transpiration dynamics of *Eucalyptus* forests, with alternate approaches, to improve modeling of larger-scale catchment water yield. An extension of this study will focus on testing the application of the new ET sub-model for similar catchments.

Keywords: *Evapotranspiration, streamflow, vapour pressure deficit, eucalyptus, water yield*