

Vegetation as an intermediary in the coupling between hydrology-soil moisture-atmosphere.

Garry Willgoose, Patricia Saco and Alice Howe

The University of Newcastle, New South Wales, Australia

Climate models have had a patchy record in terms of predicting the hydrology response to climate. Hindcasts have commonly had the hydrology mass balance in error by factors of up to 3. This is typically attributed to scale effects (i.e. spatial variability), and while these scale effects are unquestionably important, we argue that the fundamental approach to predicting hydrology from climate model forcing is problematic in arid and semi-arid climates. Hydrology is simply the difference between rainfall and evapotranspiration but in dry climates this difference can be 10% or less. Errors that are minor for either rainfall or evapotranspiration are significant, and even dominant, in the runoff calculation. Furthermore the transpiration response to water limitation is highly nonlinear, and dependent on soil and vegetation properties that are difficult to estimate. Current approaches with dynamic vegetation models are beginning to address the most glaring deficiencies in SVATS at the individual plant level, however, they still ignore the ecological adaptations that occur at the patch and hillslope level. These adaptations (mostly patchy and banded vegetation) aim to maximise the amount of water captured on the hillslope, and these adaptations are ubiquitous in arid regions worldwide. While for the atmospheric water balance these effects are minor they appear to dominate the terrestrial water balance for water limited landscapes. Our group has been using nonlinear dynamical models of vegetation growth on the hillslope to understand the self-organising behaviour of the interaction between vegetation growth, infiltration and water scarcity. We will summarise this work, argue the relevance of this work for the sub-grid representation of the terrestrial-atmosphere interaction and present some ideas on the use of ecosystem optimality as a parsimonious way forward.

