Ecohydrology—a completely new idea?

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I do not wish to become embroiled in differentiating between ecohydrology and hydro-ecology definitions (Kundzewicz, 2002). My brief comments relate to whether this upsurge in interest in ecohydrology or hydro-ecology is entirely new when concerning lateral fluxes of water, chemical and sediment transfer.

Post-war academic hydrology was very much dominated by engineering hydrology as encapsulated by standard texts such as Linsley *et al.* (1949, 1958) and Wisler & Brater (1949). "Non-engineering" hydrology gained prominence in the 1960s, especially through forest-related, land management questions linked with the impacts of forest conversion to other land uses (agriculture, urbanization). The first International Forest Hydrology Symposium in 1965, hosted by Pennsylvania State University, produced the classic proceedings volume, unfortunately long out of print (Sopper & Lull, 1967). In fact, the establishment of long-term experimental programmes, notably in the United States (Coweeta) and South Africa (Cathedral Peak), even before the Second World War, had already stimulated interest in forest hydrology. Later, Law's (1956) conclusions in the UK that the planting of coniferous forest in reservoir catchment areas (for catchment protection) was to the detriment of water yields (i.e. increased interception losses) further accelerated an interest in forest hydrology.

By the end of the International Hydrological Decade (IHD) 1965–1974 of UNESCO, significant contributions to hydrology from additional disciplines began to emerge (e.g. environmental physics (evaporation), hydrogeology, fluviogeomorphology, physical geography, soil science–soil physics). I would place this new group (including forestry) under "environmental hydrology". Because of their strong field-orientation, this "environmental" group took a close interest in physical processes as well as the water balance and mass balance of nutrients and sediment transfer. A good example of this upsurge in interest in physical processes was the seminal book on hillslope hydrology by Kirkby (ed., 1978). Subsequent development of digital terrain models for runoff procedure (e.g. the Australian TOPOG—O'Loughlin, 1981, 1986; and the UK TOPMODEL—Beven & Kirkby, 1979; Beven *et al.*, 1984) in the 1970s and 1980s provided a spatial perspective of the impacts of land-use change on runoff, erosion and sediment deposition and, more recently, water quality. In the meantime, Bosch & Hewlett (1982) provided a global synthesis of forest conversion on catchment water yield based on 94 experimental basins. Bruijnzeel (1990) provided a similar synthesis for moist tropical forests, including consideration being given to the effects

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of forest disturbance on streamflow regime (e.g. floods, dry-season flow). Details of the impacts of tropical forest conversion on biogeochemical cycling, as well as sediment production and yield, linked with hydrology were also included in Bruinjzeel's synthesis.

A parallel development was the "acid rain" issue in the 1980s, which stimulated a closer working relationship between hydrology and chemistry to further strengthen the broad interest of "environmental" hydrology within North America and Europe, even though this development bypassed those of us in the Southern Hemisphere hydrology community. The special issues in the *Journal of Hydrology* (vol. 116, 1990) and *Water Resources Research* (vol. 26(12), 1990) provided examples of the achievements.

The above landscape perspective is now commonly thought of as part of ecohydrology, as perceived, for example, within the Ecohydrology Project of the International Hydrological Programme (IHP) dealing with ecohydrological processes. In this context, I do not consider "ecohydrology" a new development. This landscape perspective was in existence long before "ecohydrology" gained prominence in hydrology terminology.

What is new, is the beginnings of coupling landscape processes (involving water, nutrient transfer, sediment transfer) with in-stream hydrobiology, and the critical role of riparian zones within this coupling. Also included here is the coupling of surface water–groundwater processes through the hyporheic zone (e.g. Chestnut & McDowell, 2000). The latter has been neglected within traditional hillslope hydrology investigations, for example.

Thus the ecohydrology umbrella is providing a means of integrating landscape hydrology with freshwater biology, and this is the important paradigm shift.

REFERENCES

Beven, K. J. & Kirkby, M. J. (1979) A physically-based variable contribution area model of basin hydrology. *Hydrol. Sci. Bull.* **24**(1), 43–69.

Beven, K. J., Kirkby, M. J., Schofield, N. & Tagg, A. F. (1984) Testing a physically-based flood forecasting model (TOPMODEL) for three UK catchments. *J. Hydrol.* **69**, 119–143.

Bosch, J. N. & Hewlett, J. D. (1982) A review of catchment experiments to determine the effect of vegetation changes on water yield and evapotranspiration. *J. Hydrol.* **55**, 3–23.

Bruijnzeel, L. A. (1990) *Hydrology of Moist Tropical Forests and Effects of Conversion: A State of Knowledge Review.* UNESCO IHP, Humid Tropics Programme, Paris, France.

Chestnut, T. J. & McDowell, W. H. (2000) C & N dynamics in the riparian and hyporheic zones of a tropical stream, Luquillo Mountains, Puerto Rico. *J. N. Am. Benthol. Soc.* **19**(2), 199–214.

Kirkby, M. J. (ed.) (1978) *Hillslope Hydrology.* Wiley, Chichester, West Sussex, UK.

Kundzewicz, Z. W. (2002) Ecohydrology—seeking consensus on interpretation of the notion. *Hydrol. Sci. J.* **47**(5), 799–804 (this issue).

Law, F. (1956). The effect of afforestation upon the water yield of water catchment areas. *J. British Waterworks Assoc.* **38**, 489–494.

Linsley, R. K., Kohler, M. A. & Paulhus, J. L. H (1949) *Applied Hydrology.* McGraw-Hill, New York, USA.

Linsley, R. K., Kohler, M. A. & Paulhus, J. L. H (1958) *Hydrology for Engineers* (Second edn, 1975) McGraw-Hill, New York, USA.

O'Loughlin, E. M. (1981) Saturation regions in catchments and their relations to soil and topographic properties. *J. Hydrol.* **53**, 229–246.

O'Loughlin, E. M. (1986) Prediction of surface saturation zones in natural catchments by topographic analysis. *Wat. Resour. Res.* **22**, 794–804.

Sopper, W. E. & Lull, H. W. (eds) (1967) *International Symposium on Forest Hydrology* (Proc. National Science Foundation Adv. Science Seminar held at the Pennsylvania State University, University Park, 29 August–10 September 1965). Pergamon Press, Oxford, UK.

Wisler, C. O. & Brater, E. F. (1949) *Hydrology* (Second edn, 1959). Wiley, New York, USA.