INVITED COMMENTARY

HYDROLOGICAL PROCESSES
Hydrol. Process. **17**, 2087–2089 (2003)
Published online in Wiley InterScience (www.interscience.wiley.com). DOI: 10.1002/hyp.5133

Hydrology and ecology meet—and the meeting is good

Barbara Bond*

Department of Forest Science, Oregon State University, Corvallis, OR 97331, USA

*Correspondence to:
Barbara Bond, Department of Forest Science, Oregon State University, Corvallis, OR 97331, USA.
E-mail: barbara.bond@orst.edu

As a 'hybrid' scientist (I call myself an 'ecophysiologist') as well as an 'eco' partner in collaborative research with hydrologists, I've watched the growth and development of the new hybrid field, ecohydrology, with great interest. I've asked colleagues if they've heard of this new paradigm. Hydrologists typically respond enthusiastically by naming people who are helping to define the field, and they identify high-profile, international programs and recent conferences and special issues of journals devoted to ecohydrology. Ecologists, at least in my informal sample, are less likely to be aware of ecohydrology as an emerging discipline, but many will add something like, 'but I suppose you could say that's what I've been doing for most of my career'.

Of course, this isn't surprising, because the ecohydrology paradigm is emerging from the discipline of hydrology. But if ecohydrology is the science that studies the mutual interaction between the hydrological cycle and ecosystems (Porporato and Rodriguez-Iturbe, 2002), perhaps it is time for ecologists to participate more actively in discussions that seek to define opportunities for this emerging field. To that end, a group of ecologists, hydrologists and atmospheric scientists at Oregon State University organized a 10 week seminar series, 'Perspectives on Ecohydrology', during the fall of 2002.

One goal of this seminar series was to promote cross-disciplinary communication. A hydrologist discussed her analyses of long-term streamflow measurements, inferring change in transpiration by vegetation in different places or at different times from the streamflow patterns; another shared studies of flowpaths and residence times of water in catchments, leading to discussions of how vegetation influences, and is influenced by, those flowpaths. An ecologist shared studies demonstrating a profound influence of small variations in elevation on species composition of plant communities due to differences in depth of the water table. She and another ecologist shared their recent data demonstrating significant vertical and lateral 'hydraulic redistribution': mass flow of water from moist to dry soil regions through living roots. Other participants talked about studies relating soil water content and nutrient cycles, about the potential influence of water tables on growth decline and mortality of Alaska yellow cedar, and about the strong influence of airflow patterns in and above the canopy atmosphere on transpiration and transport of water, and hence on soil water availability and plant growth. Along the way we taught one another some of our vocabularies. We learned, for example, that the hydrologists in the

Accepted 22 April 2003

group define the 'riparian area' of a stream in a fundamentally different way than do the ecologists—as the 'saturated zone' versus the region defined by a plant community type, respectively. Many of the hydrologists in our group were not familiar with the concept of the 'soil–plant–atmosphere continuum' (SPAC; Barbour *et al*., 1987); many of the ecologists had not heard the term 'discretize', which was frequently used by hydrologists.

All of the scientists participating in our seminar series had been involved for many years, even decades, in research that could be labelled 'ecohydrology', whether they had heard of the term or not. But it is not 'news' that much of what we might now call ecohydrology is not 'new' (Bonnell, 2002): it has been around for a long time under different names. A fundamental quest of plant ecophysiology is to understand the role of soil and atmospheric water (in addition to other environmental factors) in determining the distribution and function of plant species (Billings, 1985). Understanding how soil water affects distribution and function of plants has recently been described as a central component of ecohydrology (Rodriguez-Iturbe, 2000). Peter Eagelson's (2002) wonderful new text, *Ecohydrology*, provides an up-to-date examination of biophysical controls over the fluxes of matter and energy through the SPAC, and introduces intriguing ideas about optimization of canopy structure and function. To many, these topics are the very essence of 'ecosystem science' (e.g. Waring and Running, 1998).

The participants in our seminar series agreed that there is no reason why the concept of 'ecohydrology' should not borrow questions and identities liberally from other disciplines. Indeed, there are great potential advantages if the 'label' inspires more interdisciplinary communication and collaboration. A potential pitfall, however, is that separate communities of scientists could work on similar problems in parallel rather than in collaboration, reporting their findings in journals and at professional meetings only to their own communities. Then, we run the risk of 'reinventing each others' wheels'.

Our seminar participants also agreed that the ecohydrology paradigm offers many fundamentally new ideas and opportunities. One of the most important of these is the *goal* of the scientific inquiry. Ecohydrology is widely touted as a tool in sustainable development and management of water resources (e.g. Zalewski, 2000). Historically, hydrologists have focused more than ecologists on applied problems. Ecologists stand to benefit hugely from the credibility, infrastructure and pragmatism of hydrologists in jointly solving real-world problems.

Finally, seminar participants concurred that collaboration between hydrologists and ecologists opens up important new scientific questions. We were not able to explore these exhaustively in the 10 week term, but our discussions included the following:

- *Biodiversity*. Can we predict the hydrological environments that produce the most diverse ecosystems?
- *Intra-inter-event interactions*. The hydrologists in our seminar group tend to focus on phenomena that occur during 'events', such as storms or debris flows, whereas the ecologists and atmospheric scientists tend to focus on inter-event conditions and longer term averages. Combining these perspectives offers possibilities for much richer understanding.
- *Dimensionality of fluxes*. Another important difference that emerged between hydrologists and ecologists in our group is their perspectives on the 'dimensions' of fluxes. Ecologists and atmospheric scientists tend to develop vertical (1-D) conceptual models of exchanges of matter and energy between the geosphere, biosphere and atmosphere. Most spatially explicit ecosystem models are comprised of multiple, contiguous pixels, each of which exchanges matter and energy independently through the SPAC. Hydrologists tend to develop 3-D conceptual models, but often these are restricted to the geosphere. Again, by combining these perspectives, a much richer understanding is possible.
- *Basin-scale focus*. Perhaps the greatest opportunities lie in establishing a common scale of focus for hydrologists and ecologists by expanding the view of 'watersheds' to 'airsheds', 'carbonsheds', etc. As gravity defines the geographic boundaries of water flow, it also defines heterogeneous regions through which matter and energy flow

and circulate. Transpiration by upslope vegetation affects water availability to downslope vegetation at some point in the future, and these interactions impact productivity of the watershed as a whole and complicate vegetation influences on streamflow patterns. Night-time emissions of energy from plant canopies cause air to cool and sink, perhaps flowing out of the 'airshed', carrying water vapour and respired CO_2 with it along the same pathways as streams, or perhaps warming at the surface and setting up basin-scale circulation patterns. These interactions, and their temporal dynamics, have important implications both to basic science and sustainable resource management.

Above all, members of our seminar group concluded that the blending of ecology and hydrology has great synergistic potential; ecohydrology can and should be more than a simple sum of the two disciplines. To accomplish this, we need to continue and expand our interdisciplinary communication.

REFERENCES

Barbour MG, Burk JH, Pitts WD. 1987. *Terrestrial Plant Ecology, 2nd Edition*. Benjamin/Cummings Publishing Company: Menlo Park, CA.

Billings D. 1985. The historical development of physiological plant ecology. In *Physiological Ecology of North American Plant Communities*, Chabot BF, Mooney HA (eds). Chapman and Hall: New York; 1–15.

Bonnell M. 2002. Ecohydrology—a completely new idea? *Hydrological Sciences* 47: 809–810.

Eagelson PS. 2002. *Ecohydrology*. Cambridge Scientific.

Porporato A, Rodriguez-Iturbe I. 2002. Ecohydrology—a challenging multidisciplinary research perspective. *Hydrological Sciences* 47: 811–821.

Rodriguez-Iturbe I. 2000. Ecohydrology: a hydrologic perspective of climate–soil–vegetation dynamics. *Water Resources Research* 23: 349–357.

Waring RH, Running SW. 1998. *Forest Ecosystems: Analysis at Multiple Scales*. Academic Press.

Zalewski M. 2000. Ecohydrology—the scientific background to use ecosystem properties as management tools toward sustainability of water resources. *Ecological Engineering* 16: 1–8.