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What and how should we teach so as to prepare the next generation of hydrologists for a rapidly changing world?

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In principle, we can learn from history and from historical data how a hydrological system behaved in the past. But what can we learn about new situations? Can we predict with confidence how our natural systems will function under changing boundary conditions? If the answer to this question is negative, then how can we prepare future generation to deal with these issues?

I think that we have to focus on understanding physical processes at scales where they demonstrate organised behaviour, or – to put it in other words – at scales were patterns emerge. In recent years we have seen how the reductionist approach is incapable of predicting uncertain situations. Instead, we will have to focus on recognising dominant behaviour and on modelling this behaviour in the simplest terms possible. This brings us to the question how we can identify and conceptualise dominant and secondary behaviour in connection to a changing environment and subject to changed forcing.

What does this mean for education? I think we have to teach basic physics and basic physical principles and processes at plot scale, but also at the scale of hill slopes, watersheds and river basins. This has to be strongly intertwined with field work. Only in the field can students recognise the processes and the thresholds that need to be passed for certain processes to become active. Next, students should learn how to conceptualise the hydrological world within a rejectionist framework of hypothesis testing; how to develop and use diagnostics to test hypothesis; and, more importantly, how to develop and use creativity to generate new hypotheses, in dialogue with the experimentalist and field hydrologist.

Finally there are issues related to process. Learning should consist largely of learning by doing: literature studies, field work, experiments, colloquia, exercises, presentations, paper writing, discussion groups. Lecturing should not be more than 50% of the contact time and should be interactive and meant to inspire. It should involve phd students that can introduce the students to the latest fields of research.

Finally there are things we should not do. Don't teach or use standard, commercial or established models. Only provide the student with instruments to build their own models, for instance in Matlab, Fortran or in spreadsheets. Teach them how to think critically and creatively and to challenge established approaches and formulas.