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Hydrology and Earth System Sciences
Discussions

Interactive comment on "The Hydrological Open Air Laboratory (HOAL) in Petzenkirchen: a hypotheses driven observatory" *by* G. Blöschl et al.

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Dear authors,

Please find here below my comments regarding your manuscript entitled 'The Hydrological Open Air Laboratory (HOAL) in Petzenkirchen : a hypotheses driven observatory'.

A. Manuscript context and structure A.1. Overall context of the presented work The paper describes the 66ha large Hydrological Open Air Laboratory (HOAL) in Petzenkirchen, Lower Austria. A major aspect of the paper is developed around the fact

that this set up has been designed in a way to do hypothesis testing on open questions in hydrological sciences and related disciplines. Eventually, the purpose of the infrastructure is to 'advance our understanding of water related flow and transport processes involving sediments, nutrients and microbes in small catchments'. The catchment exhibits a wide range of runoff generation processes – this is supposed to offer the potential for representativity compared to larger catchments. The HOAL is operated jointly by the TU Vienna and the Federal Agency for Water Management, as well as it is embedded in the Vienna Doctoral Programme on Water Resource Systems funded by the Austrian Science Fund.

A.2. Structure of the manuscript and related developments 1. Introduction : the authors develop on the importance for a better understanding of water related flow and transport processes in catchments and their interactions across space and time scales – especially in the context of global change. Experimental catchments and environmental observatories are presented as clearly different entities, in that the latter are (a) designed and run on long term perspectives (i.e. not bound to a single project), (b) fostering interdisciplinary research, and (c) designed as networks to assist in collaborative research. The overall purpose of the paper is to illustrate how the experimental or monitoring setup of an observatory can be designed to allow meaningful hypothesis testing.

2. Science strategy of the HOAL : A key feature of the science strategy of the HOAL is that it is a long-term infrastructure for research on several key questions (some measurements already started in 1945) : âĂć What are the space-time patterns of water flow paths and evaporation in a small agricultural catchment ? âĂć What are the space-time patterns of erosion and sediment transport processes and what are their driving forces ? âĂć What processes are controlling nutrient and faecal p ollution dynamics ? A strong point in this strategy is that dissertation topics of students were thought and implemented over three generations – each building up on the findings of the previous one. When focusing on the interdisciplinary collaboration in HOAL, the PhD projects

of the students are introduced as an example for cross-fertilization between projects. While this is an important feature, this section – in its current form – reads a bit different from the rest of the manuscript (as directly referring to students and their invidivual work). Networking within the science community and beyond : An interesting point here is the collaboration with instrument companies – introducing HOAL as a test-bed for newly developed instruments. Only a few examples are given here – actually this could be further detailed, also since catchment hydrology is a discipline that remains measurement limited in many respects. Further progress will eventually come from new technological developments – HOAL (and similar observatories) can and should play a major role in this respect. Also in this same context, high frequency measurements of environmental variables appear to rapidly spread, as new instrumens operating at unprecedented temporal resolution become available. The manuscript could certainly gain further interest from developing on this aspect : new instruments, new data transmission technologies, centralized vs. cloud storage of data, new protocols for validating and analysing large datasets (e.g. 'big data paradigm shift' in science). How could HOAL and its related activities be contributing to these questions ?

3. Implementation : Dedicated monitoring and experiments : This is a very long and detailed section – which could certainly benefit from a restructuring : mentioned instruments include weather stations, eddy correlation stations, scintillometers, accelerometers, soil moisture monitoring network, saturation pattern monitoring network (two megapixels cameras), water quality monitoring network (including enzymatic analysers), tracer tests, geophysical surveys. This part of the manuscript is very long and could ber re-shaped along the various environmental domains that they are supposed to cover (e.g. atmosphere, vegetation, soils, river network). Managing HOAL : This is certainly a strategic part in operating and maintaining such a large infrastructure as the HOAL – but this section is actually also quite long and I am not sure if all aspects need to be dealt with in such detail (e.g. issues related to permissions, land owners, etc.) ?

4. Examples of specific hypotheses This section develops more specifically on the

9 PhD research projects carried out in the HOAL : how the research questions were crafted, the hypotheses formulated, tests designed, experiments carried out and outcomes analysed. Three examples are given in this context. As for example 2 on sources and flow paths of event runoff, one could argue that the proposed EMMA is subject to known limitations (it is also briefly mentioned and shown in figures that uncertainties related to end-members are assessed) – how is this aspect considered in the analysis ? How could new approaches (e.g. new tracers, sensors, protocols, etc.) be used/developed in the framework of HOAL to overcome these limitations ? This could be the opportunity for further strengthening the innovative character of not only the science questions, but also the new technologies that might be necessary to overcome the current knowledge gaps.

5. Lessons learned and outlook An important aspect is mentioned in this section, with the gained know-how remaining within the observatory after that PhD students have left since a HOAL manager has been hired and that log books are systematically archived. HOAL manager has proven to be a critical workforce for maintaining the quality of the instrument network and data. This section also provides quite detailed developments on how HOAL was set up and instrumented – focusing on technical difficulties encountered with e.g. flumes (opting between H- and V-flumes, freezing of flumes), soil moisture sensors, etc. Lessons regarding hypothesis testing : one outcome is that 'the more complex the processes are, the more difficult it is to set up clear-cut hypotheses'. This is illustrated with the technical constraints that one may face when using e.g. cameras for monitoring saturated areas in winter (clear sight) vs summer (vegetation cover). The outcomes of hypothesis testing turned out not to be always totally conclusive. This is closely related to the fact that in most cases experiments were not repeatable – essentially due to the randomness in weather and other boundary and initial conditions. As stated by the authors this has been and still remains a major issue in hydrology. Another point in this section concerns the extent to which the outcomes from HOAL are representative for other catchments in the world. One interesting point in this respect could be to structure the activities listed

and developed in the manuscript around the fundamental hydrological (and ecological) functions of catchments, i.e. storage, mixing and release – putting into perspective what physiographic controls act on these functions, inside the HOAL as well as in other catchments.

B. Overall assessment : This manuscript provides a very detailed description of the origin, purpose and design of the HOAL laboratory. Title of the paper is not covering all aspects that are dealt with in the paper – it is not only about hypotheses formulation and testing, many more aspects are actually developed (site selection, technical constraints, inter-disciplinarity, representativeness of findings, etc). This actually is a bit the strength and weakness of the paper at the same time. Given the complexity of designing and operating an open air laboratory of this size, it is certainly extremely useful to share these many aspects with a wider audience. Then again, the sheer number of details listed in the manuscript – covering a wide range of topics – sometimes causes the reader to lose the thread. The manuscript would most certainly gain clarity if shortened. It is questionable if all the details around technical difficulties in operating the instrument network really are necessary – at least some potential for shortening the manuscript lies in some redundancies related to technical information on instruments, data transmission, etc. Given the importance of long-term hydro-climatological observations, the considerable difficulties inherent to financial, technological and logistical issues, make this manuscript an extremely valuable contribution to the scientific community.

C. Suggestions directly related to the text : Page 6686-line 11-12 : change to '. . . when addressing issues related to climate change.' Page 6686-line 22-23 : change '. . . in their own right . . .' to '. . . individually . . .' Page 6689-line 18 : change 'At a first layer. . .' to 'First, overarching science questions . . .' Page 6696-Page 6697, section 3.1.2. : could the catchment description maybe include some references of prior work carried out on soil types, climate ? Page 6698-6699 : Developments on the LAN have been previously mentioned in the manuscript – maybe this is a bit repetitive ? Page 6715-line

18 : add 'k' to 'outlook'

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 12, 6683, 2015.