Interactive comment on "Evolution of hydrological sciences from dimensions of object, discipline and methodology" by L. L. Ren et al.

Anonymous Referee #2

Received and published: 27 February 2015

This paper aims to demonstrate the evolution of hydrological sciences from three dimensions: object, discipline and methodology. The topic is meaningful, which attempts to provide systematic knowledge of the evolution. However, lack of clarity in explanation and organization issues make this article difficult to follow. It fails to provide a comprehensive overview also because of the limited literature it covers.

Referee comment 1: Section 2: this part talks about "approaches of hydrology". However, if methodology is one dimension you meant to discuss in section 3, what's the purpose of this part?

Author Response: Section 2, entitled 'Remark on Approaches of Hydrology', provides the general overview on approaches in hydrology. In Section 3.3, the authors would like to emphasize the evolution course of the methodology dimension from the past to the present along the time coordinate axis of the development, both theoretical and practical.

Referee comment 2: Section 3.1: discussion in this part depends on one literature in 1987; it would be helpful to find more up-to-date papers to support your theory.

Author Response: Yes, the description in Section3.1 depends upon the literature in 1987. The authors found out that this aspect of the up-to-date references was few, but we will pay more attention to this aspect. As stated in Section 3.1, object dimension refers to research object, i.e. answering or solving the problem in hydrology. As shown in Figure 1, it is also the problem dimension. With the progress of science and technology, the ability to control and manage water was increasing. The appearance of hydraulic projects requires not just a description of hydrological phenomena, but also a prediction of hydrological variables. Engineering hydrology, also called applied hydrology, emerged as the times required, in response to the requirement of the construction of hydraulic projects. Engineering hydrology aims to serve for the design and operation of hydraulic projects, and to solve practical problems of water conservancy projects, such as flood control, irrigation, hydropower generation. Water resources hydrology belongs to a comprehensive cross-disciplinary subject, in which water resources system is taken into consideration, including the quantity, quality, and potential energy of surface water and groundwater flow. Meanwhile it needs not only science and technology knowledge related to water, but also needs the knowledge of economics and management. It adopts the combination of quantitative method and qualitative one.

Referee comment 3: Page 7, line 26: "people will be one of the biggest agents: : :." Suggest revision.

Author Response: Page 7, line 26: the sentence has been modified to "people will be the biggest agents: : :."

Referee comment 4: Page 8, line 7: the first three terms are not even defined. Assuming they are all important stages in the evaluation process, explanation is expected.

Author Response: Yes, the first three terms, viz. deterministic hydrology, stochastic hydrology, and isotope hydrology, were not defined owing to the limited space and hydrologists' familiarity. We will give some explanation as follows in the revised manuscript.

Deterministic hydrology refers to using deterministic approaches to solve hydrological issues, e.g. deterministic hydrological models. Deterministic relationships can be formulated in a causal way by making use of the fundamental equations and hence can be used for examining "what happens if" questions in a reliable way. There are two main uses of deterministic models – explanatory one for furthering our understanding of a particular system and forecasting one for producing estimates of some future or changed state. In both instances, there exists a range of model types, from lumped to spatially distributed. Model conceptualization and building usually follows a number of steps. Outcomes computed by models are determined once the input and boundary conditions are given, no matter who inputs data to drive model. That's to say, the same inputs will produce the same results. But nor do stochastic approaches in hydrology. Stochastic approaches represent the bulk information (frequency, statistical distribution, dependence) not the details (spatiotemporal occurrence, dynamics). In the statistical approach it is not usually possible to take causal processes into account, which renders the extrapolation potential more limited than that of the deterministic approach. On the other hand, the stochastic approach may be able to deal with systems that are too complex to be dealt with in a deterministic way. Isotope hydrology is a field of hydrology that uses isotopic dating to estimate the age and origins of water and of movement within the hydrologic cycle. Isotope hydrology uses stable and radioactive isotopes of water and its dissolved constituents to trace hydrological processes, including the pathways of rainfall and snowmelt to, and interactions between, aquifers, lakes and rivers. One common application involves the use of stable isotopes to determine the age of ice or snow, which can help indicate the conditions of the climate in the past. Another application involves the separation of groundwater flow and baseflow from streamflow in the field of catchment hydrology.

Referee comment 5: Section 4: in the end, many questions are listed as suggestions for future work. However, many of those have been studied at different scales (such as "what crops should be planted within a catchment"). It should be mentioned that most of the questions don't have a universal answer but differ by case. Suggest revision.

Author Response: Yes, in Section 4, we have added the sentence that most of the questions don't have a universal answer but differ by case in the manuscript.