

## Review of “Darwinian hydrology: can the methodology Charles Darwin pioneered help hydrologic science?” by C. Harman and P. A. Troch

### general comments

In this paper, the authors argue that applying the Darwinian method to hydrology may help the hydrological science forward. They showed several examples on how Darwin came to his theories, discuss why Newtonian physics are not always enough and they give several examples where (part of) Darwin’s methods are used in hydrology-related fields and several examples to which it could be applied.

I agree that the Darwinian method is indeed a method that may enhance hydrological science and should thus deserve attention in the community. However, there are a couple of issues that should be improved before publication. These involve mainly 1) the definition of what the Darwinian method is and 2) the structure of manuscript.

#### 1. Definition of Darwinian method:

After reading the manuscript a couple of times, I still find it difficult to tell what exactly the Darwinian method is. I expected to find a clear answer in section 2, but I have the feeling that it is best summarized in the first paragraph of section 3, P6420, L 11-20 (or is hypothetico-deductive approach the Darwinian method?). But also there it is not completely clear to me where the ‘heuristic’ approaches described in section 2.2 come in. The statement ‘They do not define the Darwinian approach’ (bottom page 6417) appeared strange to me; the authors probably mean that these heuristics are only a subset of the Darwinian approach? I therefore suggest that the authors start section 2 with a clear definition of what the Darwinian approach is and subsequently explain/describe each part of it in separate subsections.

#### 2). Structure of the paper:

I think the manuscript can be greatly improved by some restructuring. Here are some suggestions:  
**General:** The tone of the manuscript sometimes reads in a way that the Darwinian approach should be used because Darwin was successful with it (and where the goal is to be a Darwinian). For example on P6421, L12-14: I think this statement should be turned around: Argue that, in order to better explain hydrologic regimes, filters and functional patterns the Darwinian approach may help. Also on P6434, L7-15: It reads like we have to do these things in order to be Darwinian. While I think it’s better to state it in a way that the holistic Darwinian approach is better to explain hydrological phenomena than the ad-hoc explanations about the holistic interactions or the regionalization techniques to predict model parameters.

**Introduction:** I would start the introduction with the ‘problem’: i.e. Newtonian physics is not enough to tackle all the questions in hydrology. Then follow that the Darwinian approach is suggested, but that it is not clear what this exactly is. This brings you to the objective of this paper to clarify what the approach is and how it can be applied to the field of hydrology.

**Section 2:** see suggestions of point 1.

-P6412, L17-19: This is the main objective of the paper and should thus go in the introduction.

-P6414, L7-29: This has nothing to do with the Darwinian method. It is rather the state of the art in hydrology followed by the problem definition. It should thus go into the introduction.

**Section 3:** In this section several hydrological examples are mentioned in which (part of) the Darwinian approach is applied and where it could/should be applied. However, the section is, in my opinion, a bit messy. In 3.2 and 3.3 the Budyko curve and the Dunn-diagram are discussed as examples that show there is no pure randomness in catchment behavior. I suggest to move these sections to a separate section (or even in the introduction) since these are clear examples that Newtonian physics cannot explain everything.

In 3.4 a hydrological example is given where (part of) the Darwinian approach has been successfully applied. In 3.5 the authors discuss how the heuristics described in section 2.2 can be applied to hydrology (while in the example of 3.4 they have been applied as well) while again reference has

been made to the Dunn-diagram as an example of where the Darwinian approach could help to explain this diagram.

I suggest to

- make clear in the title of section 3.4 that this is an example where the complete Darwinian approach was applied.

Also make clear reference where which part of the Darwinian approach was applied: e.g. P6426-27, L24-L2 is a space for time substitution. P6427 is largely hypotheses formulations. P6428, L16-26: the set of circumstance are defined.

-Section 3.5: I am not sure if this section should be on the same level as section 3.4. Maybe section 3.5 should go first (as these are examples where only small parts of the Darwinian approach have been used in hydrology) and end with the example of section 3.4 (where the full Darwinian approach has been applied).

#### **specific comments**

P6409, L20-21: This increasing number of papers seems rather a couple of papers.

P6410, L9: The question posed is not really followed by an answer, but rather by a statement about Newtonian physics.

P6415, L23: convert inches into SI-units.

P6423, L1-23: Does this mean that the Darwinian approach cannot be used for regimes and filtering over time?

Section 3.2: add a figure of the Budyko curve and indicate where the different envelopes are.

P6427, L8: to which combination are you referring to?

P6428, L7: Make clear that the hypothesis presented 'here' does refer to the hypothesis presented on page 6427 and not to the thermodynamic hypothesis

P6428, L16: Make clear which hypothesis 'This' hypothesis is.

I found the used English rather difficult. As a non-native speaker I had to look up many words (I usually do not encounter these problems when reading papers!) and perhaps it may be worthwhile to avoid (some of) these words in order not to lose audience. Below a list of some of the words I had to look up (although I am aware that these selected words are only based on my lack of English while some of them may not be easily substituted):

corollary, intelligibly, tithe, judiciously, heresy, meticulous, churning, artifices, happenstance, elucidation, hold sway, circumspect, engender

#### **Some typos:**

P6408, L19: 'tested'

P6409, L2: add point after 'own'

P6409, L4: 'coming'

P6409, L27: 'argued'

P6426, L1-2: 'generation'

P6430, L1: add space between 'measurable' and 'parameters'