

1 **Review of Hillslope hydrology under glass: confronting fundamental questions of soil-water-**  
2 **biota co-evolution**

3  
4 ***General Comments***

5 The authors describe the use of several point-scale and hillslope hydrologic models to  
6 investigate the best design for a set of experimental hillslopes at the Biosphere 2 complex near  
7 Tucson Arizona. The authors are conducting a study that is rare in the hydrologic science  
8 community. Modeling first and then using an experiment to interrogate that model of how the  
9 system should work. As the authors rightly note this approach should allow for the strong  
10 inference approach to science advocated by Platt (1964). The key objective of the paper as  
11 outlined by the authors is to explain how hydrologic models were used to design the  
12 experimental hillslopes that are to be constructed at the Biosphere. The authors meet this  
13 objective very well. I do however think more specifics about what the design process indicates  
14 about what specific questions can and cannot be answered by the hillslope that is ultimately  
15 constructed would improve the manuscript and make it a valuable benchmark to compare the  
16 hillslopes performance to over time.

17  
18 ***Specific Comments***

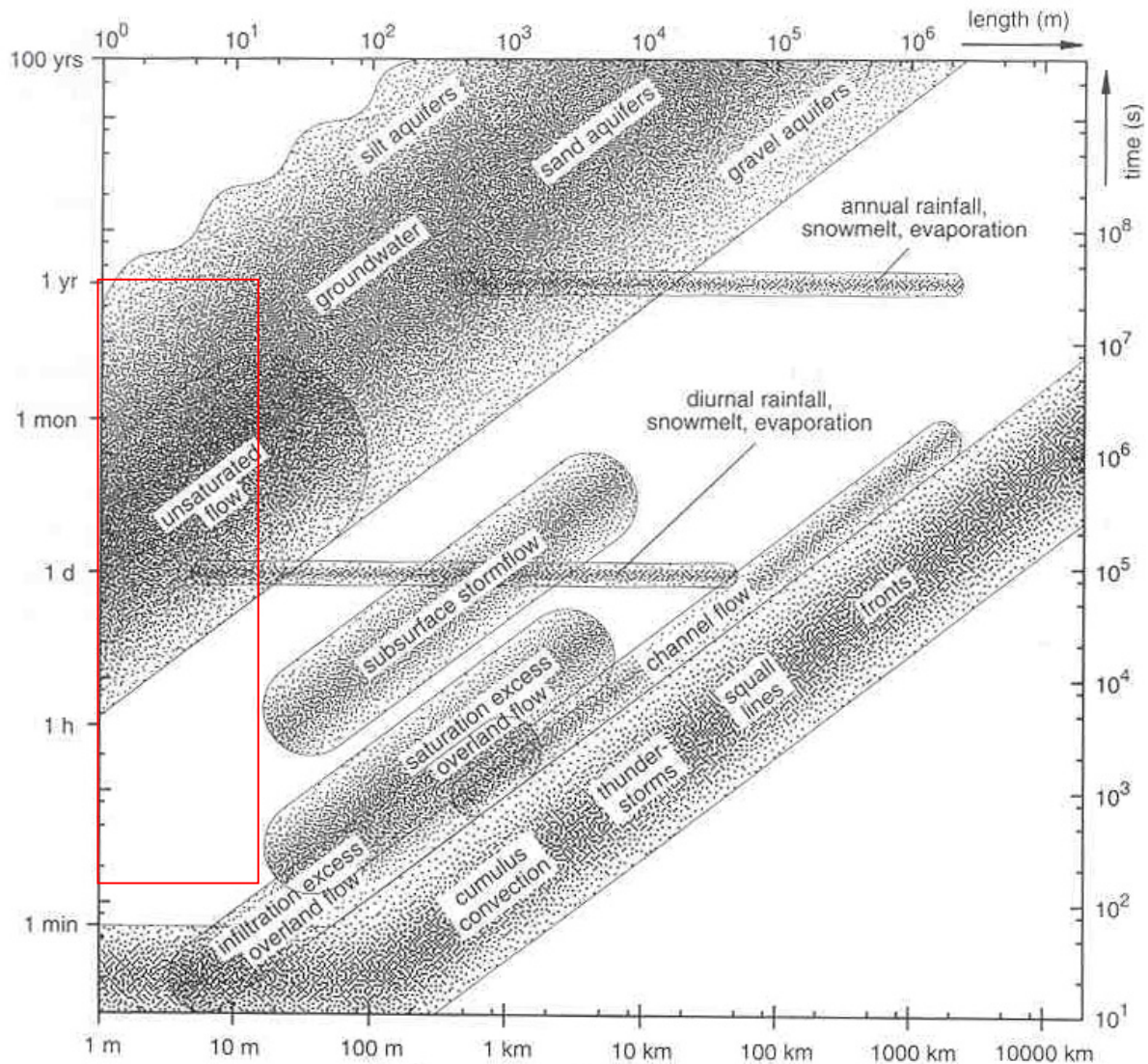
19 The authors do an excellent job laying out the design criteria for the proposed hillslope. These  
20 objectives seem reasonable and defensible to this reviewer.

- 21  
22 1) A simple design that enables lots of people to answer different questions.  
23 2) Relevance to the local semi-arid climate.  
24 3) Spatial variability must be present.  
25 4) Hillslope must have subsurface flow  
26 5) Enough soil moisture so plants can grow  
27 6) Technical feasibility.  
28 7) Limit surface erosion

29  
30 These design criteria themselves though start to limit the universe of questions that will be  
31 answerable with the hillslope once it is constructed. The authors do not touch on the  
32 limitations that these design criteria themselves place on the experimental space which is  
33 available. With full knowledge of the limitation of space in any paper it would be nice if the  
34 authors addressed what was ruled out and ruled in with these design criteria briefly after  
35 covering the design criteria in the paper.

36  
37 A way to possibly help the community visualize the limitation imposed by the various design  
38 criteria is to place the design criteria within the context of a commonly used descriptive figure  
39 in hydrology

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1  
 2 [Grayson and Blöschl, 2001] The Red box seems to me the domain that the hillslope will  
 3 operate within. Other design factors may further constrain or expand this region. A comment  
 4 from the authors about this would be appreciated.

5  
 6  
 7 The authors then step into how they used models to further refine the model design and settle  
 8 on a specific hillslope design (slope, climate, soil texture etc.). They first use a simple wetting  
 9 front model and then use a Boussinesq model of the hillslope. Next they move to developing a  
 10 3D HYDRUS model of the system. In their discussion of these models they do not clearly outline  
 11 the conceptual model that informed the specific application of these models. Such a  
 12 description might include the major physical parameters and processes involved to greater  
 13 specificity than is currently done in the manuscript. A simple table might be a useful approach  
 14 to addressing this concern. My concern here is that the reader is not offered a unified vision of  
 15 where the authors are going by using the multiple models in sequence as they did. I wish to

1 emphasize however that I think the use of multiple models was robust and is an approach to be  
2 recommended for other modeling applications.

3  
4 More worrisomely in terms of supporting the ultimately advocated design is that the HYDRUS  
5 model version appears to come out with different results than the parsimonious model. I draw  
6 this conclusion from lines 9 and 10 on page 4426 of the paper. I may be misreading this  
7 statement and this statement is only saying that the HYDRUS model did not develop saturation  
8 due to the constraints introduced by the parsimonious model simulations. In either case some  
9 clarity needs to be offered. If my first interpretation is correct the authors need to state why  
10 the differences and how this difference may alter their overall design conclusions.

11  
12 Having constructed the 3D model the authors take it for a test drive with some simple climate  
13 sensitivity studies. The precipitation approaches they take provide information about how  
14 climate patterns of wet and dryness in the region influence the subsurface hydrologic response.

15  
16 The authors then discuss how the modeling has informed the design of the hillslope. This  
17 discussion in general is satisfying.

18  
19 A concern of mine however is the lack of specificity offered in the questions that hillslope might  
20 answer hydrologically. The authors list several questions at the end that the hillslope might  
21 answer. Similar to other places in the manuscript these questions are overly general. Given, as  
22 the authors argue, the groundbreaking nature of the Biosphere hillslope experiments I would  
23 like to see more specificity in these questions and would, uncharacteristically for myself, prefer  
24 some carefully couched hypotheses that can be falsified with the hillslope. The hillslope  
25 experiment promises to be very useful for the earth science community. It will only be as  
26 useful as the robustness of the hypotheses and questions that we use the hillslope to address. I  
27 wish the authors would be more specific as this paper provides the authors the chance to  
28 clearly state what they think will happen. The paper would thus serve as a good benchmark to  
29 compare actual experimental results from the hillslope over the years as the experiment  
30 evolves with time.

31  
32 ***Technical comments-***

33 Most of these are stylistic comments and are simply this reviewers opinion.

34  
35 Page 4412 line 9 Is spontaneous really the right word?

36  
37 Page 4414 line 27 delete the in front of Biosphere 2

38  
39 Page 4414 line 28 delete some of the and delete finally

40  
41 Page 4414 line 29 replace the word soil with the word parent material

42  
43 Page 4415 line 1 the word complex can be deleted

44

1 Page 4415 line 8 perhaps scientists involved is better than scientific community

2

3 Page 4426 line 27 - Entire sentence is used with Fig. 4 instead figure 4 could simply be  
4 parenthetically called out at the end of line 2 on next page

5

6 Page 4427 line 3 - similarly here Figure 5 could simply be called to at end of second sentence in  
7 this paragraph with this first sentence being deleted as unnecessary.

8

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## REFERENCES

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13 Grayson, R. B. and G. Bloschl (2001), Spatial modelling of catchment dynamics, in *Spatial*  
14 *Patterns in Catchment Hydrology: Observations and Modelling*, edited by R. B. Grayson and G.  
15 Bloschl, pp. 51-81, Cambridge University Press, Cambridge.

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