

Interactive comment on “lumpR: An R package facilitating landscape discretisation for hillslope-based hydrological models” by Tobias Pilz et al.

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Dear Reviewer,

thank you very much for your efforts on examining our manuscript. In the following we will answer your comments point-by-point.

General comments: Authors have developed an R package, lumpR, for watershed discretization in hillslope-based hydrological models. While developing an open source package for catchment discretization is the main goal of this manuscript, this paper does not introduce any new algorithm for hillslope delineation and semi-distributed hydrologic modeling that is su-

rior to the existing approaches. As discussed in Section 2.3, series of SHELL and MATLAB scripts are already available to process data for the LUMP modeling approach. As a result, most of the paper reads like a user manual for the R package.

This summary is correct regarding the novelty of single algorithms. However, the integrative approach realized in LumpR provides an innovative and automated combination of single approaches. We shall, therefore, point out that our software package contains more than a mere transformation of the existing SHELL and MATLAB packages. The existing code has been revised, checked and, where necessary, optimized. Furthermore, a number of additional processing steps and functionalities were added and the applicability was simplified. The presented sensitivity analysis was only possible by massive fully automated replicative application of lumpR over a (for a hillslope-based approach) relatively large scale (1000 km²), which would have not been possible with any other existing software.

On the other hand, the sensitivity experiment described as the case study in this paper is the strongest component of this paper. Therefore, I suggest authors to expand on the sensitivity experiment by considering some of the limitations they discuss as well as examining the impact of catchment discretization on other components of the water budget.

How general are the findings from the sensitivity experiments? Do you expect to obtain similar results if you implement the approach in other basins?

Thank you for acknowledging our efforts on the sensitivity analysis. Generally, it needs to be stressed that the presented sensitivity analysis and the related conclusions are case-study and model specific.

It is therefore legitimate to ask for an extension of our analyses (also with respect to other components of the water budget). We would argue, however, that the main

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objective of our manuscript is to introduce a newly compiled software package. Furthermore, it was our intention to do this along with a short review of existing algorithms and software for landscape discretisation and a case study which should contain at least a small scientific additional benefit. The latter we see in presenting a first and novel approach of sensitivity analysis of typical spatial discretisation parameters.

In our opinion, the extension of the paper by including more models, study sites and/or other water budget components lies beyond the scope of our manuscript, and also the GMD journal. The paper shall therefore rather serve as a stimulation of further research. In the revision we shall further comment on this in our manuscript as well.

Major comments:

1) Page 8-L10- Authors mention that they implemented the LUMP algorithm as the basis for development of the R package. However, it is not clear whether the semidistributed approach that is implemented in the LUMP model is superior to other discretization approaches in other semi-distributed modeling approaches. What are the advantages of using the LUMP approach compared to other discretization approaches?

As we see it, hillslope-based discretization provides certain advantages (see a) below). LUMP and lumpR are just software tools to facilitate hillslope-based discretization. Their specific merits are recounted in b):

- a. Regarding the advantages over other semidistributed approaches, a general feature of hillslope-based discretisation concepts is that it is especially useful in regions of heterogeneous runoff generation mechanisms (mentioned in page 5 L 11-13 of the manuscript and Bronstert, 1999, 10.1002/(SICI)1099-1085(199901)13:1<21::AID-HYP702>3.0.CO;2-4).

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- b. The main advantages of the LUMP algorithm over other hillslope-based discretisation algorithms is, first, its semi-automated nature allowing to automate and reproduce the discretisation process while retaining a certain degree of flexibility by allowing to integrate expert knowledge (supplemental information, specification of discretisation parameters, manual adjustments of intermediate results in GRASS). Second, contrary to other hillslope-based algorithms, via the multi-scale discretisation it is applicable over large scales with relatively little effort (LUMP publication, *Francke et al., 2008, 10.1080/13658810701300873*). lumpR extends this merits by extending the options to fully-automated usage mode and optimized data handling, processing and storage.

We shall clarify these points in the revision of the manuscript.

- 2) Please switch Figure 1 with Figure 2 as it makes sense to have the discretization approach first and then the software structure.

We decided to put Fig. 2 to Sect. 3.2 after Fig. 1 as the latter demonstrates the general structure and workflow of the package whereas the former exemplifies the LUMP algorithm as specific part of the lumpR software package. For parity reasons, we chose not to extend too much on one particular approach in the review section. However, we acknowledge that Fig. 2 facilitates understanding the concept for readers unfamiliar with the this scheme. We added a reference to Fig. 2 in the review section.

- 3) Page 10-L10-Could you please explain Environmental Hillslope Areas?

Actually *environmental* is a typo in the manuscript and it should read *Elementary Hill-slope Area*. It is the basic unit for calculation of a representative catena and, thus, one can think of it as a single specific hillslope. The EHA constitutes the basic element which the following steps of aggregation and generalization build upon. We thank

the Reviewer for pointing this out and acknowledge the insufficient description in the manuscript. We will improve the understanding in the revision.

4) In Section 3.2-It will be great if you can refer to different components of Figure 2 as you explain various functions.

5) Page 10-L20-What criteria are used to further subdivide each LU to terrain components?

We will try to clarify Sect. 3 as a whole by better referring to the presented graphics and presenting more details of the algorithms. To subdivide the LU into TC a parameter has to be specified giving the number of TC to be generated. The partition is done by evaluating the derived LU (i.e., the averaged representative toposequence) properties and employing a minimisation of variances approach (described in the LUMP paper of *Francke et al., 2008, 10.1080/13658810701300873*).

6) Figure 4- It seems reservoir volume is always overestimated compared to observations for various sensitivity runs. Can authors explain the reason for this behavior?

There are several potential reasons for this observation. As the most likely can be considered: (i) uncertainties in the reservoir parameterisation in the model (e.g., we use a static parameterisation of reservoir abstractions which are, in reality, dynamic; furthermore, sedimentation in the model, i.e., loss of reservoir volume, is in our case not considered); (ii) uncertainties in the observations (e.g., due to deficiencies of the rating curve); (iii) rainfall input uncertainty (as is also discussed at page 24 L 4 ff.); (iv) model parameterisation uncertainty (the model has been run with standard parameterisation for the area without further calibration). We shall expand Sect. 5.2 accordingly (or re-structure Sect. 5).

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7) Figure 6- It is not clear how general is the results of this figure. Do authors predict that similar sensitivity pattern will be obtained if a different hydrologic model is used?

Actually, this is a question we have in mind as well. Apart from speculations we cannot give an answer yet. Generally, it needs to be pointed out that the presented sensitivity analysis is case-study and model specific. Please also respect our general comments further above on that issue (the second point of answers).

8) Additional information about soil and land-cover parameters are required and how discretization approach impacted parameter selection for each hill-slope.

The different discretisations did not affect soil nor land-cover parameters. They merely modify the fractions of soil and vegetation types that are assigned to the spatial units. We hope this answers your question. We will explicitly point this out in our revision.

We hope the stated concerns and questions have been addressed sufficiently and as expected.

Yours,

Tobias Pilz (on behalf of all co-authors)

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