

Interactive comment on “Optimizing micro watershed management for soil erosion control under various slope gradient and vegetation cover conditions using SWAT modeling” by Ghulam Nabi et al.

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Received and published: 30 November 2017

The paper applies the widely used Soil and Water Assessment Tool to simulate the influence of stone soil and water conservation structures as well as vegetation cover changes in various small watersheds in Pakistan. Although the authors put with no doubt a lot of effort into measurements and model setup, the paper lacks in its current stage many criteria of a sound scientific paper. The authors need to

reorganize the entire paper and they also need to include much more information on

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the study area conditions as well as on the whole modelling procedure and related (unclear) assumptions or parameter settings, to mention only a few. The authors also need to improve the discussion of the procedure and the results against existing literature. Information is further needed on the reliability of the procedure,

the results and on uncertainties. I was confused by reading the upscaling section, since this is not a model upscaling (as described in the section title), but just a spatial analysis of the slope ranges of the study area. The title is misleading, since the authors did not carry out any form of optimization. Finally, the authors need to improve the literature review: The newest paper that they cite is from 2012! Alone

considering SWAT, there has been some progress during the last 5 years regarding the further development and application of the model. In the current stage of the manuscript I think it cannot be accepted (rejected), it needs a total rewriting. In the following I have listed some detailed comments that might help the authors to understand my decision.

Title: Change and do not use optimization, since you did not carry out any kind of optimization.

Abstract: The abstract is the first thing that is read. That means that you need to attract the reader by the abstract. Write clear, crisp and exiting. In the current version, the abstract needs to be restructured and focused. You need to write clearly what is already there and what you simulated regarding erosion measures, explain your experimental design, the scenario development. If this is more a test of the suitability of

SWAT than write it clearly. But if the test of the effectivity / efficiency of measures to mitigate erosion is in the focus then write this. Right now it is not clear enough.

- Line 17: What was optimized? What kind of methods did you use for optimization? As far as I can see you did not carry out an optimization procedure (as mentioned before). - Line 19: I would write "..basis for a small but representative catchment".

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Remove "Catchment-25" - Line 22: Why these short calibration and validation periods?
- Line 23: Delete "after successful calibration and validation". - Line 25: Write that you developed scenarios. How do these measures look like? Briefly describe! How were these measures implemented into the model? You can do this by brief concise sentences. - Line 26: "...caused by the loose stone structures.." - Line 26: Explain why the sediment yield reductions showed such large variations! - Line 29-30: Shorten and focus sentence. - Line 30-31: How can a model be upscaled by using slope classifications??? Be clear and precise. In my opinion you did a spatial analysis of slope range distribution in the study area(s). - Line 31-33: Shorten and focus sentence.
Page 2 - Line 2: How do you know that the model results are reliable? Your calibration / parameter setting procedure is unclear to me, so I have doubts about this statement.

Keywords: Remove "Model Upscaling"

Page 2: Introduction General comment: The text of the intro is too a large part trivial and repetitive. Why not starting with a literature review on soil erosion problems in the world, in Pakistan and in your study region to make clear how severe the problem is? You could also start with the section below (see my comment below). - Line 18 ff: Provide a brief overview on such tools. WEPP is only one example. There are more tools that could be also interesting to you. See for instance Aksoy, H. & M. Levent Kavva (2005): A review of hillslope and watershed scale erosion and sediment transport models. *Geoderma* 64(2-3), 247-271 Merrit, W.S. et al. (2003): A review of erosion and sediment transport models. *Env. Modell. & Software* 18: 761-799. De Vete, J. et al. (2013): Predicting soil erosion and sediment yield at regional scales: Where do we stand? *Earth Science Reviews* 127: 16-29

- Line 23: But SWAT includes just a modified version of USLE (MUSLE), you should mention that. - Line 27: You could start the intro for instance with this section (you might modify it, but it would be definitely better than the current start of the intro. - Line 31: "...loss for Pakistan". Page 3 General comment: Provide somewhere here or before an overview on soil conservation measures, firstly more general, then more

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specific for Pakistan / your study areas.. - Line 28: Are these common soil conservation measures? If yes, you should mention that before (overview on soil conservation / protection measures, as mentioned before).

- Line 29: 1.1 SWAT model description General comment: Why is this section part of the intro? I would move it to the Material and methods chapter (see my comments below). - Line 32: "It is commonly used to simulate water and soil loss in small agricultural watersheds". This is just not correct. You might read in most SWAT-related papers (currently over 2000) that is mostly used in large watersheds, and nearly all of the papers of the main developer of the SWAT model, Jeff Arnold, state that the model was developed for watersheds and large river basins. Example from Arnold,

J.G. and N. Fohrer (2005), Hydrol. Process. 19, 563–572, first sentence of the abstract: "SWAT (Soil and Water Assessment Tool) is a conceptual, continuous time model that was developed in the early 1990s to assist water resource managers in assessing the impact of management and climate on water supplies and non-point source pollution in watersheds and large river basins". Page 4: - Line 6: "Srinivasan et al. (1998)..." Please use newer literature from P. Gassman, J. Arnold, and many others, where such reviews are updated. Have a look at the SWAT literature database: https://www.card.iastate.edu/swat_articles/ - Line 6: "Modified Universal Soil Loss Equation.." Explain difference between MUSLE and USLE! Includes peak flow! - Line 10: KUSLE, CUSLE, etc. Change style of writing (superscript K, C, P, etc.), otherwise it is confusing. Line 28: 1.2.1 Portayal of study area. General comment 1: Move this section to the Material and methods section, I would name the section just "Study area". Or "Description of study area". General comment 2: Add information on hydrology, topography and land management (crops, tillage, etc.), storm events, air temperature. Please explain the existing soil conservation measures. - Line 29: How did you optimize the micro watersheds for soil erosion estimation?? Please reword, you did not optimize anything. Page 5: - Line 1: "...an area of 2 ha..". This is from my experiences too small for SWAT. - Line 3: Any soil erosion-relevant storm events? Any river

gauges? You need to provide this information at least as an overview already here, you can provide more detail on it later on (as you do). - Line 5: Which water conservation structures? - Line 14: Why made the topography of the area it difficult to assess the selected site? - Line 15: "Considerable effort was required to accurately delineate the watershed for estimating the HRU and subbasins". What does that mean? Explain. There might be readers that are not familiar with SWAT, so it is necessary to explain what it means. By the way, I guess you mean delineating the HRU and subbasins.

2. Materials and methods General comment: You need to restructure your paper. You could arrange this chapter such as (just a suggestion!!!):

Material and methods Study area Model description Model input (including a table with data type, source, data description/properties) Model setup and calibration (including the validation)

Then you could create a following chapter describing your scenario development

- Line 19: Slope data from where (source)? - Line 20: Runoff and sediment data from where? Gauges? That's why you need to include a table that describe your data (see my comment above). - Line 27-28: "Meteorological, measured runoff, and sediment data for the period 2009–2011 were collected from the Soil and Water Conservation Research Institute (SAWCRI), Chakwal District Department." From where in the study area are these data? Where are the stations located? Describe on the example of the map. Why were exactly these locations for the rainfall gauges, weather station, etc.

selected? It is important to discuss and explain the results! Page 6 - Line 1: 2.2 Model setup and simulation General comment: As mentioned before, move it to a Material and methods section. And even more important, I would name it "model setup and calibration", where you could also include the validation. - Line 3: Which version of ArcSWAT was used? - Line 4: How did you "evaluate" that your subbasin parameters database is appropriate? - Line 4f: Write more straightforward, you might combine these two sentences. Say how the HRU delineation works and that you need to set

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threshold values, etc. Needs to be explained in the SWAT description - Line 10: Why did you select these parameters? Did you perform a sensitivity analysis? How did you do the calibration? Manually? Automatically (there are several automatic procedures existing for SWAT). You need to better describe the calibration and validation procedure. Later you write that you've done the calibration manually - why?

3 Results and discussion General comments: The results are not well discussed against existing literature. How reliable are the results? Can the procedure be transferred to similar areas? What about a discussion of the uncertainties? That's all necessary to add! 3.1 Model calibration and validation General comment: As mentioned several times before, modify this section (name it model setup and calibration and move it to the "Material and methods" chapter. - Line 15: "...the SWAT calibration procedure of Santhi et al. (2001a) was adopted.." The reader does not know what the SWAT calibration procedure of Santhi is. You need to explain that! Why not using a sensitivity analysis (LH-OAT or any other suitable method) followed by an automatic calibration such as SWAT-CUP or other existing procedures for SWAT? - Line 15ff: Model simulation quality measures: There are some more statistical measures that would be good to consider, for instance PBIAS and others, see as guideline Bennet et al. (2013): Characterising performance of environmental models. *Env. Modell. & Software* 40, 1-20. - Line 21: OK, now you explain it - but you need to explain that earlier. What is "event basis" to you? Explain. Usually SWAT is not made for simulation soil erosion events (see in the manual: "SWAT is a continuous time model, i.e. a long-term yield model. The model is not designed to simulate detailed, single-event flood routing"), although a loading functions is used (The loading function estimates daily

organic N runoff loss based on the concentration of organic N in the top soil layer, the sediment yield, and an enrichment ratio). I am sceptical to use it for such small area events, since the model structure is not "made for it". - Line 30ff: You need to provide some of this information already in the study area description (as mentioned before). Regarding the following results: Can you explain spatially these differences?

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Page 7 3.2 Model application with conservation structures General comment: Include / improve description of these measures! Describe early how you implemented these measures into the model. How did you come to the parameter values that were used to "implement" these measures? Page 8 3.3 Soil erosion estimation and effect of conservation structures General comment: Due to Fig. 5, these conservation structures look a bit like small sediment retention basins. Have a look at the paper of Strauch et al. (2013), J. Environmental Management 127 (2013) S24-S36, they modified the routing of water to better simulate the effect of such (similar) sediment basins in Brazil. - Line 5: "...modifying the SWAT parameters..". See my comments above. - Line 10: "...were modified..". Again how did you come exactly to these values? It is not enough to say due to the users manual and a literature study. What exactly did you use from literature / the manual? If this is a trial-and-error procedure than discuss it as an experiment with uncertainties. - Line 27: Do not write the title of the study / the book into the text! Just cite the authors.

Page 9 3.4 Soil erosion estimation 5 under different scenarios General comment: As mentioned before, restructure the paper, explain the "experimental design", add a scenario section - you haven't mentioned anything about scenarios yet! - Line 14: "Theoretical basis" for these scenarios? Policy recommendations? Environmental protection recommendations? Or own "experiment"? How did you come to the parameter values that describe parts of these scenarios?

Page 10 3.5 Model upscaling for Attock and Chakwal districts General comment: This is confusing - this is not a model upscaling procedure, it is just a spatial analysis of slope ranges!

4. Conclusions: - Line 30: Conclusions can be drawn. - Conclusion 3: This might be a recommendation, but it is not a conclusion that can drawn from the results from your investigations. - Conclusion 4: OK, but you cannot make this statement as a conclusion from the results from your investigations.

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2017-532>, 2017.

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