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Hydrology and Earth System Sciences Discussions

Interactive comment on "A multi basin SWAT model analysis of runoff and sedimentation in the Blue Nile, Ethiopia" *by* Z. M. Easton et al.

Anonymous Referee #1

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General Comments

This paper attempts to provide an informative and interesting narrative on the potentials of topography- and water balance-based hydrologic modeling on the Blue Nile Basin. Conceptually, the effort is plausible as the conjunctive use of water balance-based hydrology and topographic characteristics may potentially provide a sound tool for the betterment of hydrology representations for the BNB settings. As such, the effort in this manuscript appears a useful contribution to the literature, but major work is needed in many areas of the paper, such as, in properly framing the scope of the study; in clearly presenting specific objectives; identifying the focus of the research and providing details on the most important aspects of research; careful proof reading to avoid

noncoherent statements and redundant sentences; improving the logical flow between paragraphs; technical errors related to missing references, misspelling of references, wrong table/Fig. reference, potential data./unit errors, and others. Therefore, prior to considering for publication, significant revisions are needed.

Specific Comments

This manuscript needs to mention clearly the specific objectives (goals) of the study and presentations need to be farmed with focused scope of the study. The introduction falls short of presenting the specific objectives and scope of the study. Also, throughout the article it is hard to follow what the main focuses are without framed objectives and scope of the study.

The purpose of the paper is not clear if it is a model development or an application, or both. As it now reads, the authors have previously developed and applied this water balance-and topography-based SWAT (yet to be published), which makes the effort in this paper to be merely an application of SWAT-WB on BNB. The authors need to mention the focus and the specific contributions of this paper and its additions to the previous papers, in other words, there needs to be a clear statement with regard to what this paper adds on top of these previous papers. If the authors's focus is on SWAT-WB application of on BNB, the article also needs to be refocused to do so. Presenting a summary of the methodology of model development and calibration process from the previous papers was helpful in obtaining general insights; however, careful considerations need to be made in having more focus on model applications specific to BNB (examples: information on management model inputs- tillage, -crop planting...; important default inputs used; calibrated parameters if changed from default; validation processes, lessons learned that may be useful to other watershed with similar settings).

This modeling approach, developed to identify runoff contributing areas, is evaluated by traditional-approach where by modeling results are only evaluated by directly comparing observed and predicted flows at the outlets of the test watershed. Though,

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conceptually, the method followed in this paper seems a sound approach, the validity of predictions with regard to distribution of runoff contributing areas is unknown. Hence, this means that the findings and results achieved using this approach is only indicative not definitive, unless they are tested with field-based data. In addition, the application of the model at such a larger scale, such as BNB, makes the modeling results to be more likely dedicated by calibration process rather than the actual processes involved. Therefore the authors need to acknowledge this and restrain from making definitive remarks/comments/conclusions with regard to predicted spatial runoff distributions presented that are not tested against field data.

This study also fails to perform model validation, a necessary and critical step in model applications. Validation of streamflow predictions could have been done on selected subbasins, by excluding them from the calibration process (Or it could be done by dividing the observed data for (a) selected subbasin(s) into calibration and validation periods). Without validation, it is hard to establish the credibility of the modeling results and their ability to replicate predictions. Moreover, at the scale of application and in the context of BNB, there is no mention on how these-HRU-based runoff results will be communicated to the ground (at the first place) for them be useful in guiding any management decision making.

As mentioned in the manuscript, the main hydrology model parameters controlling the amount of infiltration and runoff were determined mainly by the baseflow data, which in turn was determined from baseflow separation (Arnold et al., 1995...). More elaborations on this technique may be desirable as this is the key part of your calibration process. The suitability of this baseflow separation technique at the BNB context and for the various subbasins, varying in size, location, and may be other watershed characteristics.

The study sends a conflicting message in the abstract with regard to modeled sediment results. Overall this abstract needs careful revision to reflect precisely the findings of the study, limitations with the sediment predictions, and its implications or the

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next steps suggested. Also, besides the runoff transport factor, timing and amount of sediment predictions by the model may be governed (among others) by land use and management, such as tillage timing and equipment, and planting dates assumed/used as an input to the model. Information related to these model inputs and how they might dictate the model outputs need to be presented.

More specific comments /technical errors

Abstract

Page 3840 line 10-11: The abstract doesn't reflect the study findings, particularly model limitations with respect to modeling sediment losses as presented in the discussion and conclusion part of the manuscript. Page 3838 line 12: check subbasin area, comments on the watershed description; Table 2

Introduction

Page 3841 line 20-25: Revisit the remark by Liu et al., 2008. "that infiltration-excess runoff is rare (Liu et al., 2008). I don't believe Lie et al., 2008 findings are a definite comment based on field-based assessment, rather a suggestive note. Page 3842 line 4-9: revise the whole paragraph, and also make sure specific goal/objective (s) is/are stated precisely and clearly. Page 3840 line 20: Add reference for Steenhuis et al. (2010) Page 3841 line 1: Check the spelling for the "Asharge " Page 3841 line 20-25: add reference for White et al., 2009 Page 3842 line 5-9: HRUs define the first time it is used.

2 Materials and methods Page 3842 line 20-25: specify that ARCSWAT is SWAT version with ARC GIS interface. Page 3843 line 5-10: add reference for Steenhuis et al. (2010) Page 3844 line 12: reference Easton et al., 2008a, or proof read. Page 3844 line 15: provide the range of intensity for the "high intensity" storms (low), and the proportion of rain corresponding to this and/or "low" intensities. Page 3845 line 2-4: Indicate this is annual rainfall. Page 3845 line 19: check the area of Anjeni watershed

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in the test and Table 2. Page 3846 line 5: BNB define when used first time. Page 3847 line 5: ENTRO define when used first time.

3 Model calibration Page 3848 line 21: add reference for Arnold et al., 1995 Page 3850 line 14: SCRP-define when used first time. Page 3850 line 20: MUSLE-define when used first time, it is only defined later in Line 23 Page 3850 line 27: add “in” before the watershed

4 Results

Page 3851 line 4: the use of “sediment yield” here conflicts with your definition in line 7-10. Page 3851 line 16, 18: It seems that you have referred to a wrong table

Page 3851 line 16, 21, be consistent with the use of E/Nash Sutcliffe Efficiencies/NSE

Page 3851 line 26: indicate whether the normalized discharge is measured or predicted.

Page 3853 line 3-4: Data (if taken from Table 2) only matches for Anjeni, not for Jemma. “4mmy−1 in the Jemma subbasin to as high as 44mmy−1 for Anjeni”.

Page 3853 line 7-9 and Page 3853 line 11-14: Conflicting comparison sentences, particularly with the Gumera sub-basin, Gumera has relatively higher ïĄŘB value.

Page 3853- line 24 - 3853 line 1-3: Results that are HRUs-based may be difficult to translate into actual fields for management purposes?

Page 3854 line 23-25 : “This sediment was subsequently mobilized during the higher flows that are typically peak after the sediment peak is observed (e.g., the sediment peak occurs approximately two weeks before the flow peak) (compare Figs. 4 and 7).” It is hard to observe this from the figure presented and the scale it is presented.

Page 3855 line 9-15: revisit the sentences. In the writing, make clear distinction between (1) the occurrence of landcape erosion and gully erosion (during and following peak flow) and potential gully erosion following accumulation of interflow, and 2) how

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SWAT represents these processes. Obviously, SWAT doesn't have a routine to predict gully erosion. Hence, it seems that predictions from landscape erosion (over-predicted to compensate erosion coming from gully erosion), from gullies (during and following peak flow), and again from gullies (during interflow accumulation), and channel are not represented accurately. With such problematic findings, I am not sure if the predictions are any good to be of use for directing management decisions. Or, it may be intricate to extract practical implications from these modeling results (particular regarding sources of sediments, as indicated in the abstract.

Page 3855 line 28-29: the data in Table 3 has problem (unit, magnitude??). Descriptions made from this table may also have a problem. For example, for Ribb and Border, modeled sediment yield = modeled sed. Export/area (off course the units are wrong), but this also doesn't seem to work for Anjeni watershed.

You noted in the text, Page 3851 line 7-10, "The sediment yield is an estimate of sediment delivery from an HRU into the main channel during the time step, while the sediment export from a subbasin includes both the sediment yield from the HRUs and any sediment 10 eroded or entrained from the channel". So, are the modeled sediment yield = sum of sediment losses from all HRUs in the subbasin?

Page 3856 line 1-4: Avoid making conclusive statements without providing actual data supporting it. In addition to the hydrology, there may be other factors, such as landuse and its managements, playing important role here. I don't completely agree that gully erosion also occurs only as a result of only wetting up of soils from the interflow. Typically, gully erosion may also occur from running concentrated water forming narrow channels during or immediately after heavy rains. Make sure your statements are also supported with references.

Page 3856 line 5-8: There was no any mention of what the "surfical geology" of the region look like, their formation, and/or how they were utilized in the modeling process. It seems inappropriate at this stage to make such conclusive statement, without

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describing what they are and how they helped confirm accuracy of sediment sources predictions.

Page 3856 line 17: describe the specific surfical geology of the Jemma that contributed partly to the high sediment loss.

Page 3856 line 27-29-: Wrong Fig. is referred; and even after correcting it, the whole sentence will be redundant as you have already made the same statement in line 9-14.

5 Discussion

Page 3857 line 9-10-: revise this sentence, Avoid such vague statements; be specific as to what aspect of water resource you are referring to, availability, quantity, quality.

Page 3857 line 15: again, check the spelling “Asharge”

Page 3857 line 20 and Page 3858 line 15: The values presented in Table 4 seem to have problems. May be the unit should be t/km2, even then, the annual sediment losses from each land uses presented are minimal in a practical sense. Note that if you the units are in t/km2, all land cover will have sediment yield <0.2 t/ha.

Page 3857 line 23-24: Revise the sentence, to parallel it with previous sentence by avoiding the use of “however”. Page 3858 line 1: modify the first sentence. . ..suggestion an application of, or Use of the modified SWAT “SWAT-WB”.. Page 3858 line 9: check spelling “gulley erosion” Page 3858 line 10-14, revise the sentence. The earlier version SWAT considers, slope soil erosivity and management into consideration also, in SWAT not all land covers produce the same erosion, unless they happen to have these factors (among others) matching.

Tables and Figures

Table 2: For the table to be able stand alone, define r2, NSE (also note that be consistent with the abbreviations used in the text throughout the manuscript. Indicate for each subbasins if the analysis are daily or monthly. Be consistent with the naming of

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the outlet, El Diem, border (figures, text, and tables) Area for the Anjeni watershed presented in the table is not consistent with the text. Under the Normalized, indicate it is, “discharge” Are all predicted flows? If yes, explain why normalized discharge is not equal to “direct runoff” + “ground water”. If there normalized ‘discharge’ presented in the 6th column is observed/measured, then you need to indicate that, and revise the Table caption to capture any changes.

Table 3: Again, define r2, NSE; also read comments made for Page 3855 line 28-29.

Table 4: Read comments made for Page 3857 line 20 and Page 3858 line 15.

Figure 1: Include countries boundary, and/or include name the outlet (El Diem) a “border” to be consistent with the naming system used in the Tables, Text, & Figures.

Figure 2: What is the significance of ENTRO in the braket? Also, use capital A and B in the Figure Caption. Figure 5: Proof read the Fig caption, delete “s” after subbasin Figure 6: Delete the second sentence in the figure caption. Figure 8: Define BNB; the legend for the discharge for the Gumera is too small to read.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 3837, 2010.