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Hydrology and Earth System Sciences Discussions

Interactive comment on "Sediment management modelling in Blue Nile Basin using SWAT model" *by* G. D. Betrie et al.

G. D. Betrie et al.

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We would like to thank the reviewer #2 for the constructive comments. We appreciate his/her critical reading and valuable comments. We replied to all comments and reference is made to the revised manuscript in case of changes. These changes are shown in yellow highlighter in the revised manuscript.

Comment: pg 5498, line 19-20: This sentence is very broad. The impact of the work can still be made clear and probably be more meaningful if it is stated more specifically.

Response: We made it clear and specific; pg 5497, line 27-29 "This study indicates that BMPs are very useful in reducing sediment transport and could be used for reservoirs

sedimentation management in the Eastern Nile basin."

Comment: For scenario-2 is SLSUBBSN changed by HRU or subbasin? Changing it by HRU would be the most appropriate, I think, in this situation. However, it is not clear in the text how it was done. It needs to be explicitly stated how it was done since the "default" method is to do it by subbasin.

Response: We changed SLSUSBBSN values by HRU. The SWAT model interface has an option to edit the subbasin inputs such as Subbasin (.sub), HRU (.hru), Management (.mgt), and etc. We used this option to change SLSUBBSN values of agricultural HRUs. This explanation has been included in the text (pg 5504, line 15-17). Also, we explicitly mentioned which input file was edited in the Table 3.

Comment: I would like to see the statistical calculations for the monthly average values (compiled from the daily results) as well. This would make for more equal comparison within the literature. Also, flow calculations should be split between the two seasons so they can be considered in conjunction with the sediment calculations.

Response: We have aggregated the daily values into monthly averages and calculated the monthly statistics and added it in the text (pg 5505, line 27-29 and pg 5506, line 30-31) "The monthly flow simulation matched the observed flow with NES=0.82, RSR=0.42 and PBIAS=10% for calibration period and NES= 0.79, RSR= 0.46, and PBIAS= -8% for validation. The simulated monthly sediment concentrations matched the observed sediment concentrations with NES= 0.92, RSR= 0.29, and PBIAS= -0.21% for calibration and NES= 0.88, RSR= 0.34, and PBIAS= -11% for validation". Also, we have split the wet season flow that is shown in fig.3.

Comment: Pg 5508, line 9: did you check the input data to see if that was the cause of the peak mismatch? Is it? If not, what are other possible causes?

Response: We believe that the precipitation is the most likely reason since it has a lot of missing data. Literature has also reported that precipitation data is the main constraint

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for accurate modelling of discharge in the Blue Nile (Steenhuis et al., 2009). We have included this in the text, pg 5506 line 15-18.

Comment: Correct the actual number of years in the calibration and validation periods: twice it is stated that there are 14 years total. However, 1990-1996 is at most 7 years and 1998-2003, minus 2001, is at most 5 years.

Response: We have corrected this, pg 5501 line 27.

Comment: Pg 5509, line 5-9: how did you determine the erosion categories?

Response: The soil erosion in the basin classified into low (0-20 t/ha/yr), moderate (20-70 t/ha/yr), severe (70-150 t/ha/yr) and extreme ($\geq$ 150 t/ha/yr) classes categories. The low class represent the erosion extent less than the soil formation rates, which is 22 t/ha/yr in the Ethiopian highlands (Hurni, 1983). The moderate class represents erosion rates less than the average soil loss, which is 72 t/ha/yr (Hurni, 1985). We considered extreme class one fold higher than the average soil loss and the severe class two folds higher than average soil loss. We included this into the text, pg 5507 line 17-23.

Comment: Pg 5509, line 10-20: What happens when you combine one or more of the BMPs in a single scenario?

Response: We think that combining one or more of the BMPs in a single scenario will increase the sediment reduction in subbasins and the basin scale. We have included this into the revised manuscript, pg 5510 line 15-16.

Comment: How realistic is it to add these BMPs? Is it something that land managers would be willing to do, or would it involve a major change in management/equipment/profit/ etc. All of the BMPs take land out of production and involve labor for installation and maintenance.

Response: We believe there is a possibility of adding BMPs for two reasons (i) soil erosion problem well recognized by land managers or decision makers (ii) there are

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experiences of using traditional BMPs (Osman andSauerborn, 2001; Nyssen et al., 2003). However, we admit that implementing BMPs is complex issue since it involves resources and requires willingness of the land managers. Thus, this research is very helpful for land managers to understand the cost and benefit of BMPs implementation. This implication is stated in the text, pg 5510 line 18-21.

Comment: What is the impact of the small scale of the BMPs relative to the basin size modeled (filter width of 1m and locally built stone bunds versus 90 m GIS cells)? What is your HRU size range? What about subbasin size range? Do you think the differences in the scenario results are reflecting the effects of the BMPs accurately? What happens if you model one of the subbasins with the same scenarios but at a finer DEM resolution?

Response: We have not understood exactly this comment, but we speculate the question is about the effect of 1m versus 90 m cell on results. The 1m filter is not modelled explicitly; it only considers the reducing effect when flow and sediment would pass a 1m strip. Only in the erosion computations (USLE) the time of concentration, slope length and average slope are considered that may depend on the field sizes.

Comment: Do you think the differences in the scenario results are reflecting the effects of the BMPs accurately?

Response: We admit that results may have some limitations; however, we think these results at least reflect the relative effects of scenarios. Moreover, it is in line with published literature values of the study area (Herweg and Ludi, 1999; Descheemaeker et al., 2005; Gebremichael et al., 2005). A detailed discussion is included in the response for reviewer 1; please see the response to Reviewer 1and the revised manuscript, pg 5509 line 13-30.

Comment: What happens if you model one of the subbasins with the same scenarios but at a finer DEM resolution?

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Response: We think that a finer DEM gives better estimation of the slope locally and could improve the accuracy of results. Nevertheless, we believe that the 90 m is still able to give global picture.

Comment: Pg 5509, line 20-30: why was reduction greater on some subbasins than others? What generalizations of BMP effect can be drawn based on characteristics of the subbasins you studied?

Response: We have added this explanation into the manuscript, pg 5508 line 20-26"It is interesting that filter strips and stone bunds effectiveness became greater as the cultivated land size decrease and the proportion of the area for slope class $\leq$ 20% increase. This is expected because a higher overland flow concentration occurs as the steepness and agricultural area increase. The reforestation effectiveness became greater as the percentage of agricultural area decrease in a subbasin. This was expected because the sediment yield from agricultural land is higher, and subsequently, masks the effectiveness of the reforestation on sediment reduction."

Comment: What generalizations of BMP effect can be drawn based on characteristics of the subbasins you studied?

Response: We have drawn this generalization and included into the revised manuscript, pg 5510 line 11-14 "Results showed filter strips, stone bunds and reforestation are quite useful to reduce sediment yield in subbasins and the basin scales. However, their relative effectiveness are dependent upon percent of land allocated, percent of slope class and implementation location in subbasins and the basin".

Comment: A map of landuse as related to the BMPS would be very helpful as well as discussion (possibly with a table or figure) on the % of land placed in BMP as compared to the effectiveness % of the BMP, probably by subbasin. Is the reduction per ha of each BMP consistent across the entire basin or is it more effective to put the BMP in certain subbasins?

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Response: We have included fig. 6, which shows landuse (a), filter strips and stone bunds (b), reforestation (c) maps. Also, we have presented the percent of land placed in BMP as compared to BMPs effectiveness (%) in Table 5. We have included the following text in revised manuscript, pg 5508 line 27-31 to pg 5509 line 1-4 "A comparison of land placed in BMP and their effectiveness in percent for each subbasin is depicted Table 5. Filter strips and stone bunds effectiveness were the highest in subbasins 4, 1 and 5, higher in subbasins 6, 11, 13, 10, 12 and 14, and low in the rest of subbasins. Reforestation effectiveness was the highest in subbasins 4, 1 and 14, higher in subbasins 9, 13, 5, 7, 5, 15 and 2 and low in the remaining subbasins. It is interesting that the highest reduction per hectare was seen in the subbasins near the outlet. In general, the effectiveness of reforestation is consistent in sediment reduction for the entire subbasins. While the effectiveness of filter strips and stone bunds are consistent except subbasins 3 and 8, which are characterized by the steepest slope class."

Comment: The Conclusion section should state the main findings and resulting impacts or potential impacts of the study. The study design and statistical results do not need to be restated.

Response: We have removed the design and statistical results, and emphasized the main findings and impacts; see pg 5510 line 4-23.

Comment: Table 3 lists more than 14 variables but the text states that 14 variables were found sensitive. This needs to be corrected. Also, is there any order to the list for Table 4 (it is not obvious). Finally, if the listed "Fitted parameter values" are actually the values that were used in SWAT, then there needs to be some explanation of and justification of parameter values that are outside physically realistic boundaries.

Response: We corrected this in the text, pg 5505 line 6-19. We added an explanation for the fitted parameter values as is shown in Table 4. There is no order in the list.

Comment: Table 4 & 5 are restated in the text. Unless the text changes, the tables are not needed.

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Response: We have removed Table 4 and 5.

Comment: Figure 4: It would be helpful to indicate the outlet and stream network and to make the subbasin numbers larger and bolder.

Response: We have indicated this, see Fig. 5.

Comment: Figure 5: It would be helpful to indicate which subbasin contains the outlet.

Response: The basin outlet is contained in subbasin 4 and indicated in the text, pg 5527.

Comment: The paper could be substantially improved in the areas of English grammar, sentence structure, and word choice. Words like “demanded”, “understand”, “contentious”, “employed”, “eschewed” are used in places where their basic meanings are correct but the context is odd for the more subtle meanings or proper usages of those words. In many cases words that are normally used in reference to an animate, thinking creature are used in reference to a simulation model or other inanimate object. Below are a few specific suggestions, but the entire manuscript should be proofread for additional issues.

“top soil”, “south-western”, “through out” , and “miss match” are each one nonhyphenated word in the places they are used. Hyphens are occasionally used in “buffer strip” and “stone bund” where I don’t think they are needed. “Whereas” and “Therefore” seem to be used in an attempt to connect sentences based on a learned rule instead of a context-specific need to bridge two ideas; they can largely, if not completely, be removed.

Response: We specifically thank the reviewer for this valuable comment, and accordingly we have revised the English and made corrections.

Comment: pg 5499, ln 4: “is prevailing and induced. . .” this sentence is not clearly written.

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Response: We corrected this as is shown, pg 5498 line 7-9 “the green water storage of the Ethiopian highlands, where rainfed agriculture prevails has been diminished because of top-soil loss and this has caused frequent agricultural drought”

Comment: Pg 5501, line 20: add “Soil Loss” between “Modified Universal” and “Equation”; “HRUs soil erosion” reads more clearly as “HRU-level soil erosion”

Response: We have corrected this, pg 5500 line 16.

Comment: Pg 5502, line 25: delete “together”. It is redundant in this context.

Response: We have removed this.

Comment: Pg 5502, line 27: replace “enhance” with a more accurate word, such as “decrease”

Response: We have replaced this, pg 5501 line 15.

Comment: Pg 5506, line 1-5: you don’t need “, including base scenario”. Also, it would be clearer to describe the scenarios as various representations of the basin. “was implemented without BMPs” and “was implemented on agricultural HRUs” imply more than simply describing the scenarios – which, I think, is the intent of this paragraph. Try, for example, “In Scenario-1, buffer strips are placed on all agricultural HRUs that are . . .”

Response: We have incorporated this into the revised manuscript, pg 5504 line 5-17.

Comment: Pg 5506, line 25-30: “supplanted” and “adapted” are not the correct words here. This paragraph is a good example of where the strength of the research and scientific thinking are being masked by lack of clarity in the English writing.

Response: we revised this, pg 5504 line 29-31“. . . we replaced 8% of the area occupied by cropland, shrubland, barren, mixed forest, and deciduous forest into evergreen forest. The evergreen forest was selected since it has a wider coverage area than other types of forest in the study area”

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Comment: Table 1: change “dominated of” to “dominated by”; the description for water body is not clear in terms of how much of the area must be covered before the land is placed in this category.

Response: We have changed this, pg 5517. Water body description was replaced by “lake and reservoir”.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/7/C2894/2010/hessd-7-C2894-2010-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 5497, 2010.