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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.

Anonymous Referee #1

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The authors present a modeling analysis of BMP effectiveness in controlling/reducing sediment yields from the Blue Nile basin. The authors explore the implementation of buffer strip, stone bunding and reforestation on reducing sediment yield from the basin via scenario analysis. They initialize and parameterize the SWAT model for the BNB and calibrate it to measured flow and sediment data at the outlet on the Ethiopia-Sudan border. The model yields good results for flow and sediment at the border. While the paper is of interest to readers of the journal, it is currently in need of much work to be acceptable. The manuscript is rife with grammatical errors, and is need of a through editing to improve grammar, sentence structure, and overall flow. I have tried to correct some of the more obvious grammatical and sentence structure errors noted below, but it is by no mean a complete list. Some of the major problems are: 1. There is no

discussion of results presented, and thus we as readers are left to speculate what the results can be utilized for and indeed what the significance of the results are. I think inclusion of a discussion would answer some of the questions I have raised below in the specific comments, and would certainly be needed for the work to be acceptable for publication. 2. Perhaps my major concern is with how the various scenarios were parameterized, particularly with how forestation was modeled and with how buffer/filter strips are incorporated into the model. The SWAT model conceptualizes sediment reduction in filter strips as an infinite sink, thus there is no trap efficiency reduction over time, nor any recognition that HRU size should dictate filter width. Trap efficiency decline over time certainly occurs with pollutants such as sediment (e.g., Verstraeten et al., 2006. Hydrol Proc), and that the sediment loads assumed to be assimilated by the filter strips are unrealistically large in some cases.

Specific comments

Pg 5501 which version of SWAT was used?

Ln 7 what process is this referring to?

Ln 24 insert "is between "degradation" and "adjusted"

Pg 5502 ln 2-3 might also add that the model input include the tabular data associated with the spatial data

Ln 20-21 5000 soil types for the world, not the Blue Nile, might be better to report the number of soils in the basin

Pg 5503 Ln 16 remove "A"

Ln 26 "attest" is not the correct word here, I assume you mean test

Pg 5504 Ln 7 I do not think a NSE of 0 indicated acceptable model performance. A NSE of 0 indicates that model performs no better than simply using the observed mean value, you might reconsider how you define acceptable performance. Later you

say NSE>0.5 is satisfactory. This is the definition I would use here as well

Pg 5055 Eq 3.Ln 7 “curb” does not seem like the best word choice, perhaps reduce is better

Ln 16 “built” not “build”

Ln 18 “. . .and hence, is represented. . ..”

Pg 5506 Ln 6-7 a filter strip of 1 m seems rather small

Ln 25 “hamper” is not the best word choice, perhaps reduces, or prevents

Ln 26 “supplanted” would be better as replaced

Ln 27-29 “The evergreen forest was selected because it provides adequate cover against rainfall throughout the year. In addition, the evergreen forest could be easily adapted since it has larger area coverage as compared to other forest type, see Table 1.” I am not sure I understand what these sentences are saying

Pg 5507 Ln 2-3 did you not change the actual land uses? It seems that your simulation of forestation was done by simply changing the USLE_C and CN2 values, in which case all the other parameters associated with the previous land uses were left in default? If this is correct, it is somewhat concerning as the evergreen parameters in the model are quite different from cropland, shrubland, and barren, and even mixed forest, and deciduous forest. Did you also adjust the growth and ET parameters to reflect the land cover change? Parameters like the leaf area index and mannings N, and optimum temperature differ quite a lot among these land covers. How were these differences reconciled? And what effect might they have had on the model outcomes?

Ln 6 “transience” is not the right word here. Something that is transience is said to be transient, or brief. I am not sure what is meant here.

Ln 9 I don’t think you mean to indicate that the CN2 value was -0.02, which is impossible. Perhaps you meant to indicate that the base CN2 values were adjusted by

-0.02.

Ln 11 above you said that CN2, Alpha_bf and rechrg_dp were the most sensitive for sediment “the most three sensitive parameters for flow and sediment. . ..” Here you now say that there are 4 most sensitive for sediment and they are different than above. Of course flow parameters influence sediment parameters, in as much as correctly predicting the timing and magnitude of runoff generation is important in predicting sediment, but the wording of this section makes it confusing as to which parameters are most important for which processes.

Ln 23-26 These sentences do not work. Does the first refer to the calibration period? As it is now, I cannot tell.

Pg 5508 ln 3 “it is worth to notice ..” should be “It is worth noting that 2001. . ..”

Ln 5-9 Why do you think the model did not capture the rising and receding limbs particularly well? How could the input data be at fault, is it due to precip data being underestimated on the recession and over estimated in the rising limbs, or other things such as coarse soils data that might not have accurate estimates of soil properties. Since it seems to be a systematic bias it would seem to indicate an inherent structural flaw with how the model represents the system.

Ln 8 “ascribed” should be changed to “attributed”.

Ln 10-11 “The SWAT sediment simulation part was calibrated from 1990–96 and validated from 1998 to 2003 at El Diem gauging station using daily sediment concentration.” Should b changed to “The SWAT sediment predictions were calibrated against measured data from 1990-1996. . .. . .”

Ln 11-12 again 3 “it is worth to notice ..” should be “It is worth noting that the sediment concentration data is available only for rainy season, which occurs from July to October”

Ln 13 “performance” should be singular.

Ln 14-18 “The simulated daily sediment concentration matched the observed for calibration period with NSE, RSR and PBIAS is equal to 0.88, 0.35, and -0.05%, respectively. On the other hand, the daily simulated sediment concentration showed good agreement to the observed with NES, RSR and PBIAS equal to 0.83, 0.61 and -11%, respectively during validation period.” Does not read correctly. Change to: “The simulated daily sediment concentrations matched the observed concentrations for the calibration period with a NSE, RSR and PBIAS equal to 0.88, 0.35, and -0.05%, respectively. The daily simulated sediment concentrations for the validation period showed good agreement with the observed concentrations with a NES, RSR and PBIAS equal to 0.83, 0.61 and -11%, respectively.”

Ln 13-16 remover this sentence “Thus we found the sediment simulation performance very satisfactory as compared to the performance range provided as a satisfactory (NSE>0.5, RSR_0.70 and PBIAS=$\pm$55%) by Moriasi et al. (2007).” It is not needed as you have already noted what acceptable performance is.

Ln 24 change “mimicked” to captured.

Pg 5509 ln 2 “concentration” should be plural insert “the” between “for” and “whole”.

Ln 5 “the SWAT model. . .”

Ln 14 by “the later” are you referring to bed load?

Ln 15-22 I find it hard to believe that a 1 m buffer along field boundaries would result in 44% reduction (51,000,000 t yr-1). Modeling the effectiveness of buffer or filter strips in SWAT seems somewhat suspect, particularly in a basin as erosion prone as the Blue Nile. Filter trap efficiency in SWAT is modeled as an infinite sink, which might be somewhat believable for dissolved nutrients such as N or P, but it is highly unlikely that a 1 m filter strip maintains trap efficiency particularly in light of the sediment volumes. Thus, large HRUs that produce considerably higher sediment loads surrounded by a 1m buffer strip result in the same sediment reduction as small HRUs that have a con-

siderable smaller sediment load. This results in unrealistically high sediment deposition rates in some of these buffers. Consider for example two square HRUs, one 10 m2 and the other 1 m2. The 10 m2 HRU has a perimeter of 12.64 m and the 1 m2 HRU has a perimeter of 4 m. If both produce the same erosion per m2, say 1 kg m-2 then the 10 m2 HRU produces 10 kg and the 1 m2 HRU produces 1 kg. Thus the 10 m2 HRU filter strip must trap considerably more sediment per unit length (10 kg / 12.64 m = 0.79 kg m-1) than the 1 m2 HRU filter strip (1 kg / 4 m = 0.25 kg m-1). Here I am assuming 100% trap efficiency, but it does not really matter what the trap efficiency is, because it is a constant for any HRU size. I realize that this is simply how SWAT handles the filter, but I think it is critical that you recognize that this is an issue with the model, and the results may or may not (I would argue) be realistic.

Ln 23-24 above you said forestation showed the lowest % reduction (11%), but in Fig 5. It is almost always the highest, certainly above 11%, some well over 70% and none under 11%! IS this a typo in the text or in the figure? Why would forestation affect he sediment yield so much at the subbasin levels and then result in the lowest impact at the basin level. Something does not seem to work out here. This is an example of where discussion might clarify the results being presented.

Pg 5510 Ln3 insert “the” before “upper”.

Ln 6 remove “A” and capitalize daily.

Ln 10 remove ”On the other hand” this implies that you are presenting results that counter the previous sentence, which you are not.

Ln 13 remove “computed to be” and replace with “was”.

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