Hydrol. Earth Syst. Sci. Discuss.,
https://doi.org/10.5194/hess-2017-116-RC2, 2017

Hydrology and Earth System Sciences
Discussions

Interactive comment on "Minimum forest cover for sustainable water flow regulation in a watershed under rapid expansion of oil palm and rubber plantations" *by* Suria Tarigan et al.

Anonymous Referee #2

Received and published: 28 July 2017

General comments:

I found the topic and results described in this manuscript to be quite interesting. There is very limited information available in the literature to date regarding the potential effects of expanded production of rubber or oil palm trees, using SWAT model or any other modeling approach. Thus I think that the information reported in this manuscript will ultimately prove to be a useful contribution to Hydrology and Earth System Sciences (HESS) and the existing literature in general. However, I believe that the current manuscript suffers from several deficiencies including inadequate review of existing literature, insufficient description of SWAT and key input parameters (including coeffi-

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Discussion paper

cients used for rubber tree and oil palm tree in the crop parameter file), lack of in-depth description of SWAT calibration and validation results, and an inadequate description of the simulated watersheds. Specific comments regarding these issues are provided below.

Specific comments

1) Abstract: The Abstract needs to be considerably revised to reflect more of the actual quantitative results of the study versus the "general discussion" that dominates much of the abstract between lines 9 to 24. The revised abstract should include a summary of the baseline calibration and validation results.

2) Lines 43-45: I would suggest you rewrite this sentence to read something like: "This vertical movement of water in the soil determines how much water flows as direct runoff and how much percolates to the water table where it sustains baseflow or groundwater (references)."

3) Lines 49-68: Please include citation and discussion of some "big picture" studies regarding the impacts of Palm Oil and/or Rubber Trees in the southeast Asia region such as those listed immediately below.

Mukherjeea, I. & B.K. Sovacoo. 2014. Palm oil-based biofuels and sustainability in southeast Asia: A review of Indonesia, Malaysia, and Thailand. 37: 1-12. DOI: 10.1016/j.rser.2014.05.001.

Wilcove et al. 2013. Navjot's nightmare revisited: logging, agriculture, and biodiversity in Southeast Asia. Trends in Ecology and Evolution 28(9): 531-540. DOI: 10.1016/j.tree.2013.04.005.

Ziegler et al. 2009. The Rubber Juggernaut. Science 324: 1024–1025. DOI: 10.1126/science.1173833.

Ziegler et al. 2011. Recognizing Contemporary Roles of Swidden Agriculture in Transforming Landscapes of Southeast Asia. Conservation Biology 25(4): 846-848. Avail-

able at: http://www.jstor.org/stable/27976544.

4) Lines 69-70: Please expand this discussion to provide a broader review of different modeling and other analysis methods, beyond the option of SWAT, available to assess the impacts of expanded rubber and oil palm plantations in the southeast Asia region.

5) The expanded paragraph noted in comment 3 should be followed by a specific paragraph about SWAT including relevant review studies about SWAT and a more in-depth review of how SWAT has been used for land use change analyses. Note that the Zhang et al. (2013) article you cite in line 76 is not a very good choice regarding reviews of SWAT studies; please instead cite one or more of the studies listed on the webpage at http://swat.tamu.edu/publications/special-issues/ or in the "SWAT Publications box" in http://swat.tamu.edu/. Please also cite some relevant SWAT "land use change studies" (see the SWAT Literature Database that can again be accessed on the SWAT model homepage) such as those listed here:

Babel, M.S., B. Shrestha and S.R. Perret. 2011. Hydrological impact of biofuel production: A case study of the Khlong Phlo Watershed in Thailand. Agricultural Water Management. 101(1): 8-26. DOI: 10.1016/j.agwat.2011.08.019.

Marhaento et al. 2017. Attribution of changes in the water balance of a tropical catchment to land use change using the SWAT model. Hydrological Processes. 31(11): 2029–2040. DOI: 10.1002/hyp.11167.

Tan et al. 2015. Impacts of land-use and climate variability on hydrological components in the Johor River basin, Malaysia. Hydrological Sciences Journal. 60(5): 873-889. DOI: 10.1080/02626667.2014.967246.

Tarigan et al. 2016. Mitigation options for improving the ecosystem function of water flow regulation in a watershed with rapid expansion of oil palm plantations. Sustainability of Water Quality and Ecology . 8: 4-13. DOI: 10.1016/j.swaqe.2016.05.001.

Wangpimool et al. 2017. The impact of Para rubber expansion on streamflow and

other water balance components of the Nam Loei River Basin, Thailand. Water. 9(1) DOI: 10.3390/w9010001.

6) Lines 71-73: These two current sentences have grammatical problems. As a part of comment 4, I suggest that you revise the text as follows: “A useful tool to answer this question is the Soil and Water Assessment Tool (SWAT) ecohydrological model (Arnold et al., 1998; 2012), which quantifies the water balance of a watershed on a daily basis (Neitsch et al., 2009) and has been recommended for the evaluation of hydrological ecosystem services of a watershed (Vigerstol et al., 2011).”

7) Study area description: The two study watersheds should be described in depth in this subsection rather than being referenced later in subsection 2.2 (please describe the area of the watersheds in km2 rather than ha). More detailed land use information (percentages of each type of land use) for the two watersheds should be provided (rather than waiting until subsections 2.3.1 and 3.2 to describe some of that information), as well as more information about the natural vegetation, and rubber and oil palm plantations (growth cycles, management practices, time period of plantation development, etc.). Further details about the typical porosity and other characteristics of the soils in the study watersheds would also be useful.

8) In relation to comment 6, some description of all six macro watersheds shown in Figure 1 should also be provided in the Study area description subsection. Who defined these six watersheds and why? It is clear that hydrologic data was collected for the watersheds but the current text is vague regarding the overall purpose of these six watersheds.

9) Also in relation to comment 6, please describe the “small watersheds” referenced in lines 144-145 and 195-196 and shown in Figure 1 in the study area subsection, rather than waiting to describe those in current section 2.3.1 (and that information does not need to be repeated at the start of section 3.2). What other hydrologic data were collected for those small watersheds besides the C values?

10) Please rewrite “C&BFI” as “C and BFI” throughout the text.

11) A SWAT Description subsection needs to be added to the manuscript. This should note the specific version of the model used for the study (including the Revision number) and provide a succinct overview of the model, especially regarding components that were particularly important for the study you conducted. A description of the crop parameters used for the rubber and oil palm trees, and other vegetation in the watersehds, should also be provided (those parameters could be described later in the methods if more appropriate). See the Wangpimool et al. article listed in comment 4 above regarding revised rubber tree crop parameters they used in their study.

12) The information in current subsection 2.2 needs to be revised to present key aspects of your methods in a more coherent manner. Some suggestions:

a) A separate subsection is needed describing the various input data used in the study (including citation of Table 1), which could be a part of the expanded study area description. More complete citations of the input data sources are needed. Information such as the number of subwatersheds delineated for each watershed (and the number of HRUs used is also pertinent) should be discussed in this subsection rather than at the start of the Results section. Consider moving the information in section 5 to this subsection.

b) An expanded description of the SWAT calibration and validation procedures is needed, which again should be in a separate subsection. This should include a description of the calibration parameters used in the study, including the default value (or initial value range) and the final calibrated values. Please also provide a description of any sensitivity analyses that was performed and provide a description of the specific baseflow separation techniques that were used in the calibration process. A description of measured baseflow data, or proxy baseflow data obtained via literature sources or expert opinion, is also important in relation to the use of the BFI indicator in your study.

c) I suggest you then introduce a third subsection that describes the specific C and BFI methods that were used in your analyses.

13) Please expand on your discussion of the calibration and validation results. This should include showing hydrograph comparisons between the simulated and measured outputs and discussion of your results in the context of model evaluation criteria suggested in the two Moriasi et al. studies listed here:

Moriasi et al. 2007. Model evaluation guidelines for systematic quantification of accuracy in watershed simulations. Transactions of the ASABE. 50(3): 885-900. Doi: 10.13031/2013.23153.

Moriasi et al. 2015. Hydrologic and water quality models: performance measures and evaluation criteria. Transactions of the ASABE. 58(6): 1763-1785. Doi: 10.13031/trans.58.10715.

14) Line 131: I think the word “was” should be “were”. Why were simulated values that were within an “order of magnitude” of the measured values considered acceptable? It appears that the average measured and simulated C values reported in Tables 5 versus 6 were almost identical; that would indicate that the “order of magnitude” criteria is unnecessary?

15) Sentence in lines 184-185: The phrase “as acceptable for a good watershed service” in this sentence sounds odd. A suggested revision is: “The Ministry of Forestry of Indonesia considers C values < 0.35 to be adequate to support required ecosystem services for Indonesian watersheds (citation).”

16) Conclusions: Some expansion of your Conclusions section is warranted. Please include additional quantitative information from both the baseline testing results as well as the C and BFI analyses.

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