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Hydrology and Earth System Sciences
Discussions

Interactive comment on "Towards ecosystem accounting: a comprehensive approach to modelling multiple hydrological ecosystem services" *by* C. Duku et al.

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Title: Towards ecosystem accounting: a comprehensive approach to modelling multiple hydrological ecosystem services Authors: C. Duku, H. Rathjens, S. J. Zwart, and L. Hein

General Comments: The manuscript describes the development and application of an ecohydrological catchment model, SWAT, to assess hydrological ecosystem services in terms of service capacity and service flow of crop water supply, household water

supply, nitrogen leaching and soil erosion control for a meso-scale, agricultural catchment in the Upper Ouémé watershed in Benin. The paper sets out to make a concrete, quantitative link between a (semi)-process based, spatially distributed, numerical hydrological modelling and the concept of ecosystem accounting of (eco)hydrological ecosystem services which are provided by water fluxes within a catchment. By doing so, the authors pursue an original concept which has the potential to combine catchment functioning and multiple catchment uses in one analysis and potential decision-making framework.

This topic fits very well within the scope of HESS with its specific emphasis on the study of hydrological interactions with human activities. However, the current presentation of their methods and assumptions show several severe shortcomings which need to be addressed before final publications:

1. The overall structure of the manuscript is not well composed. Both abstract and introduction do not give the right impression on the content of the article. It is not explained which hydrological ecosystem services exist and why four specific ones have been chosen for this study.

2. Description of the study area lacks some critical information on type of land-use, specifically what kind of rain-fed crops and why kind of rice (wet or dry rice cultivation in a savannah ecosystem?), what kind of current water supply for domestic use, groundwater conditions, status of current land degradation, erosion, nutrient pollution of surface and groundwater resources. Without this background information, it appears difficult to understand the necessity to analyse corresponding ecosystem services.

3. Substantial lack in the application of the SWAT model: the given parameterisation data are not detailed enough, calibration and validation data on a monthly basis appears not to be sufficient to assess daily soil moisture patterns for the crop water supply, testing data for sediment and nutrient fluxes are not sufficient to say anything about model performance; not information are given on how the groundwater recharge is set

up, which appears essential to evaluate groundwater abstractions of private households

4. Section 3.2.3 on water purification and denitrification appears to be wrong – there are no information given on fertiliser rates of the agricultural fields; nutrient leaching through groundwater recharge and nutrient leaching into surface water resources are not considered, and it is not clear how the denitrification rate is linked to water supply.

5. The ecosystem service function to assess soil erosion control is oversimplified: does Equation 7 include intercropping?

6. In the conclusion it was suggested that such a tool is appropriate for decision-making in water and land management, an idea which I strongly reject. Although it is relatively easy to set up a SWAT simulation run for larger catchments, it is extremely difficult to obtain spatially and temporally correct representations of the underlying (eco)hydrological processes and interactions. Without appropriate, high-resolution and high-quality testing data, SWAT results may be used in relative terms, but not in absolute, hence not for decision-making.

I would advice the authors to consider a complete re-structuring of the article. Rather than spending long sections on discussing why the SWAT model would be the best model, how it was tested and validated (with as it seems limited success), and the trend interpretations of the service flow and capacity, I would suggest to give a concise introduction on why and how to do ecohydrological service flow and accounting, why the SWAT model is appropriate for this purpose, and use the watershed in Benin as a hypothetical test case, on what could potentially be achieved with such a framework. The discussion could then focus on parameter, model and ecosystem function uncertainties which need to be overcome before such a framework could be considered fit for decision-support applications. In its present form, the manuscript contains too many weakness regarding model concept and application to be considered for publication. I therefore suggest major revision.

Specific Comments:

Abstract: the first half of the abstract is not really addressed in the article

Introduction: see comments above

P. 3480, line 12: in the contrary: discretisation type does have a significant effect on aggregated hydrological attributes.

P. 3480, line 20: not sure what is meant what 'ecohydrological models should do' – I would rather give a generic definition about the capacities of ecohydrological models, which processes and interactions with biogeochemical and vegetation processes are included, which models are available etc.

P. 3481, line 6: which type of stakeholder? Not sure why this is mentioned here.

P. 3481, line 12: there should be a longer section in the introduction on hydrological ecosystem services and here a explanation, why these ones have been selected

P. 3481, line 15: refer to other studies who used SWAT in Benin, e.g. C. Hiepe, 2008, PhD thesis at Uni Bonn, or the studies by Bossa et al. 2012.

P. 3481, line 24-25: land degradation has not been mentioned before – is that an important feature of the catchment? If yes, where is it addressed (potentially in the erosion control service)? Competition for scarce water resources (e.g. agricultural versus domestic use) should be mentioned earlier in the introduction

Section 3.1.1: this should include a short description of the model processes, spatial and temporal scales and resolution etc.

P. 3483, line19: not sure how raster cells of 500x500 metres will solve SWAT's original problem of matter routing, this resolution is still too coarse to capture many heterogeneities regarding land-use, slope, hillslope-river connections and connectivity patterns

P. 3485 line 5: information on the extraction rates from shallow aquifers and streams are required.

P. 3486, line 5: The approach to re-calibrate and re-validate manually the grid-based simulations of the model requires justification. Section 3.2: this section belongs to the introduction section

P. 3487, line 2: more information are required on the agricultural system, especially on the rice plantations: why kind of rice is grown, - I assume upland, rainfed rice, - is this adequately included in the SWAT parameterisation?

P. 3489, line 3: water consumption per capita has to be given.

Section 3.2.3: water purification appears to be the wrong wording, also check comments in the general comment section above.

L 3496, line 11: does the model state that soil erosion is currently not a problem? Is there any other evidence?

P. 3501, line 1-2: This sentence needs re-writing: are you referring to the temporal scaling of water fluxes, i.e. quick runoff of water originating from high-intensity storms versus low intensity rain and its capacity to increase soil moisture? How is this related to crop and land management?

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