

Reply to Referee 3

Overview: We would like to thank the reviewer for his/her dedication in reviewing the manuscript. We are also thankful for his/ her consideration and constructive suggestions and comments.

Reviewer summary: The paper “Representation of seasonal land-use dynamics in SWAT+ for improved assessment of blue and green water consumption” reports an application of the SWAT+ model in Africa. The authors implemented seasonal dynamic land-use in SWAT+ in order to improve vegetation growth simulation and to obtain more realistic temporal patterns of the blue and green water consumption from simulated evapotranspiration. Results of the simulations (static and dynamic seasonal land use) in terms of ET were compared to the ET values estimated by using remote sensing. The authors concluded that the seasonal land-use dynamic approach produces better ET results, which provides better estimations of blue and green water.

General comments:

Reviewer comment: The paper is very similar to a previous work that has been published in 2020 by the same research group (Nkwasa et al., 2020). The latter paper showed a better performance of the SWAT+ model by using the seasonal land use dynamic (ET at HRU level after the implementation of trajectories in SWAT+ model was compared to the default SWAT+ model). In addition, in 2019 the authors published a study carried out in the same basin applying SWAT+ with dynamic land use and the authors concluded that detailed seasonal land use maps are essential for quantifying annual irrigation water use of catchment areas. For these reasons, it seems difficult to find the novelty of the present paper. Hence, I invite the author to revise the introduction in order to better focus on the advancement of knowledge proposed in this study. Taking into account that the methodological approach (seasonal land-use dynamics in SWAT+) has already been published, the authors should better focus on the green and blue waters.

I suggest major revisions, the current version cannot be published in HESS.

Authors Response: The reviewer comment is well taken. The manuscript will wholly be revised to focus on the blue and green water.

To make a clear distinction with earlier studies, we will first introduce blue and green water, specifically how it is important but difficult to map. However, mapping the blue and green water is possible with agro-hydrological models such as SWAT but then they need a better representation of the seasonality/cropping seasons. Hence, this can be done by the trajectory approach in SWAT+ as suggested by Nkwasa et al. (2020). The innovation is that we use an agro-hydrological model (SWAT+) to represent blue and green water for different cropping seasons. Additionally, we use remote sensing ET for evaluation of simulated model ET.

Methodology:

Reviewer comment: a better description of the remote sensing ET evaluation is needed, the reference IHE Delft, 2020 is not listed.

Authors Response: The reviewer comment is well taken. We will give details on the remote sensing ET and also include IHE Delft; 2020 in the reference list.

Reviewer comment: More details on irrigation are needed, for instance, the source of water for irrigation (i.e. from the river, shallow aquifer, etc). Analyzing table 1, it seems that the option auto-irrigation was used. Please explain it. Did the author compare the amount of auto-irrigation to the actual irrigation (data provided by farmers)?

Authors Response: We agree with the reviewer suggestion. The revised manuscript will include the details of irrigation such as the source of water (river). We will also evaluate the auto-irrigation in comparison with the actual irrigation through the information gathered in the field. All the details will be added in the revised manuscript.

Reviewer comment: In my opinion, the equations and description of the RMSE, PBIAS, and NSE are not necessary.

Authors Response: We agree with the reviewer comment. We will not include the description of the RMSE, PBIAS and NSE in the revised manuscript.

Reviewer comment: For which period was the model run?

Authors Response: The model run from a period of 2008 to 2013. The year 2006 and 2007 was a warming period. Details will be added in the revised manuscript.

Reviewer comment: Figure 2 has already been reported in Msigwa et al., 2019 and for this reason, I suggest do not report it here.

Authors Response: We agree with the comment. However, we plan to revised the figure and add new information like temperature and take a long analysis of rainfall like 30 years. According to reviewer 2 comments.

Reviewer comment: I suggest adding a new map in figure 3 with the land use (static land use).

Authors Response: The comment is well taken. We will add information on both the trajectory and static land use maps.

Reviewer comment: Calibration needs a better presentation. It seems that the calibration was performed for the static and dynamic approach, please show the calibrated parameters in both simulations. A table with calibrated parameters for both simulations is expected. What about validation?

Authors Response: We did not calibrate the SWAT+ model, our aim was mainly to improve the spatial distribution of blue and green water consumption and not discharge simulation. We evaluated the simulated ET by comparing with the remote sensing ET. We will include more explanation in the revised manuscript's methodology section.

Result section:

Reviewer comment: Methods reported in Lines from 324 to 335 are not reported in the “Material and methods” section. What is the aim to show them in Figure 8? In my opinion, this section should be eliminated.

Authors Response: The comment is well taken. We will include a brief explanation of the methods for estimating blue and green ET that we have compared with the SWAT+ model results in the revised manuscript. The aim of comparing blue and green ET estimates was to provide evidence that the blue ET estimates from dynamic SWAT+ model show no statistical difference with the blue ET estimated using remote sensing with Van Eekelen method.

Reviewer comment: Line 335. Caption Figure 8. Msigwa et al. 2020 is not reported in the references. Is this reference the same as that reported in Line 355 Msigwa et al. 2021 (missed in the reference)?

Authors Response: Thank you for the comment we will include the references in the reference section in the revised manuscript.

Discussions:

Reviewer comment: Innovative aspects of your research should be highlighted and presented against the state-of-the-art. The authors reported (LINE 355) that blue and green ET estimates from SWAT+ for the mixed crop land-use show no significant difference in the values from the two methods (EK and SWB) assessed in the upcoming paper by Msigwa et al., (2021). This is not the aim of the present paper.

Authors Response: The comment is well taken and Line 355 will be revised. We will present our research results against the state-of-the-art in the revised manuscript.

Reviewer comment: Please discuss the difference between Figure 5b and fig. 5c and their comparison with figure 7. I did not understand why static and dynamic ET do not match for static land use areas. In the upper right corner, figure 5b shows the green areas in correspondence with the static land use (see fig 3). The large difference is difficult to explain with a different number of HRUs. In addition, a large difference remains between dynamic and satellite ET (Fig 5a and 5b) that needs to be explained.

Authors Response: The reviewer's comment is well taken. Detailed explanation of the relationship between figure 5a, 5b and figure 7 will be provided in the revised manuscript.

The number of HRUs will be different because the input land use maps have different number of land uses classes. Dynamic model the land use map (trajectory map) had 40 land use classes while the static land use map had 14 land use classes. However, the same number of subbasins is maintained to try and preserve a similar model structure.

We acknowledge that we have not explained how we corrected some unrealistic trajectories in the land use maps when implementing trajectories in the dynamic model. When implementing the trajectories, some unrealistic trajectories were noticeable for example; a trajectory of irrigated banana and coffee land use to forest land use to forest land use in the March, August and October maps respectively is unrealistic Therefore, we change that trajectory to be forest land use in the dynamic model which could be the reason why the static and dynamic ET could be different even for the static land use map in some regions. This information will be clearly elaborated in the revised manuscript.

The ET from dynamic could not reach maximum satellite ET because the satellite ET estimates also have uncertainties in the mountainous areas because of the presence of cloud cover. There are no observation data in these areas that we can validate with.

Reviewer comment: Please discuss differences in water balance components between static and dynamic scenarios.

Authors Response: The reviewer's comment is well taken. Explanation of differences in water balance components between static and dynamic will be included in the revised manuscript.

Reviewer comment: Please discuss the limit of the present study.

Authors Response: The point is taken. We will include the limitation of our study in the discussion section of the revised manuscript.

Reviewer comment: Conclusions need to be improved.

Authors Response: We agree with the reviewer's comment. We will improve the conclusion section in the revised manuscript.

Reviewer comment: The authors reported, “The maps with calculated blue water use from the dynamic SWAT+ model correspond to the known irrigated area and the calculated blue water amount is in line with previous studies”. The first assertion is obvious since the authors set the irrigation in that areas. The second was expected since the authors refer to their previous papers.

Authors Response: We agree the statements made are obvious considering we have implemented the irrigation in the specific areas. We will clearly rephrase the sentence to mean that with the dynamic model, irrigation was implemented especially during the dry season unlike in the static model where there was no irrigation implementation. Thus, the static model does not give reliable estimates of blue ET.

Reviewer comment: The paper needs to be carefully checked for typing errors (see some of them have been highlighted in the file enclosed)

Authors Response: The reviewers typing error corrections are noted. We will implement all the corrections and check for other typing errors in the revised manuscript.