Response to reviewer's comments
Manuscript number (hess-2023-25)

Note: Below are the reviewer's comments in black, and our responses in blue.

Referee#2:

The paper on Monetizing the role of water in sustaining watershed ecosystem services using a fully integrated subsurface–surface water model by Tariq Aziz et al presents an interesting case study of integrating subsurface–surface water model with valuation of ecosystem services. However, there are few queries about the methodology adopted as well as the results presented and discussed. A line-by-line comment is given below:

We appreciate your positive evaluation of our work. In the revised version of the paper, we will address all the queries you have about the methodology and results presented.

Introduction

Page 1, L 24-25: What is the relationship between subsurface water and ecosystem services? Kindly extend on this point in the introduction to provide a clear picture of how subsurface water is linked to ecosystem function and, as a result, the production of ecosystem services. Furthermore, a conceptual diagram connecting subsurface water with various ecosystem services would help readers connect the paper by providing a clear picture.

We appreciate your suggestion to provide a more detailed explanation of the relationship between subsurface water and ecosystem services in the introduction, and to include a conceptual diagram that illustrates this connection.

We agree that this is an important aspect of our study, and we will certainly take your feedback into consideration for our revised paper. We plan to expand our introduction to provide a more comprehensive overview of how subsurface water is linked to ecosystem function, and how these functions contribute to the production of ecosystem services. Additionally, we will include a figure to illustrate the connections between subsurface water and various ecosystem services.

Methodology

217-219: How the observed data is used to run the model. Did you run the model for all 9 sites for surface water flow calibration, or did you run it in an integrated fashion? This is unclear. Please clarify the same for Groundwater Monitoring Network wells.

We apologize for any confusion regarding the use of observed data to run the model and the approach taken for surface water flow calibration and groundwater monitoring network wells. The model was run continuously for the 2000 to 2017 time interval, with gridded, daily temporal resolution climate forcing as the primary input to the model. All nine surface water flow gauges were concurrently used for calibration, in conjunction with the 10 groundwater monitoring wells. We will make sure to clarify this aspect of the methodology in the revised manuscript.

217-219: It would be better to indicate on what time scale the model is calibrated/validated? Daily, Monthly, Hourly?

We agree that it is important to indicate the time scale used for calibration and validation in our modeling study. To clarify, we used a daily time scale for model calibration and validation. We will make sure to specify this in the revised text to enhance the clarity of our work.

219: 221: Is the model validated? if yes, mention years for calibration and validation

Thank you for raising this point. For the purpose of our study, the model was calibrated over the full 2000 to 2017 time interval, and the performance metrics are calculated/reported for the same time interval. Accordingly, the model performance metrics reflect the same time interval over which the ecosystem service analysis is conducted. A formal validation was not conducted as our intention was to optimize model performance for the full 18 year interval.

Results:
The paper makes no mention of the model's performance. For instance, how the model behaved at various gauge stations.

We appreciate your feedback and agree that the model's performance should be clearly presented in the manuscript, and we note that reviewer 1 also raised this point (see above). We will provide a clear presentation of the model's performance in the revised manuscript through supplemental material and enhanced methodology description.

268-271: Are these value aggregate for all gauge station and observation well?

The model performance metrics presented here are indeed aggregated across all stations. In the revised manuscript we will present the model performance metrics on a per station basis, along with additional graphical material depicting simulated vs observed conditions.

277-280: Check figure 5(a), Can you show the observed and simulated graph of the stream flow? Similarly for surface water storage as well and mentioned the NSE and PbIAS value for each zone/site.

Thank you for the suggestion; in the revised version of the paper, we will include observed and simulated graphs for stream flow and surface water storage, as well as the corresponding NSE and Pbias values for each zone/site.

277-280: Check figure5 (b), Is the watershed evaporation one of the outputs from the model? What are others? mention either in methodology or results?

Yes, the model outputs include surface evaporation, subsurface evaporation, and subsurface transpiration. We will clarify this in the revised version of the manuscript.

289: Table 1: Is this value calculated or obtained from secondary sources?

The marginal productivity of water value mentioned in the manuscript is derived from the water production function, which represents the relationship between ecosystem services values and the volume of water consumed in producing them. The slope of this production function gives us the marginal productivity of water value. For our study area (i.e., SNW), the marginal productivity of water is $0.45/m^3.

Discussion:

The discussion section focuses heavily on the results and very little on the validity of the findings. Most important, the authors provide little reflection on uncertainty in their data, models, and underlying assumptions. What does that mean in terms of reliability of the modelled results? The authors should consider where their modeling efforts. shine versus where they fall short, and how the shortcomings can be addressed. I would suggest the authors to discuss the results based on model uncertainty, and future implications of the study in terms of valuation of ecosystem services as well.

We agree with your comment regarding the importance of discussing the validity and reliability of the modeled results in the discussion section. We also appreciate your suggestion to reflect on the uncertainty in the data, models, and underlying assumptions and to discuss the shortcomings of our modeling efforts and how they can be addressed. This comment aligns with a comment made by Reviewer 1 as well. In the revised manuscript, we will address these concerns by adding a section related to model limitations and uncertainties associated with our study. Furthermore, we will add a subsection to the Discussion section that will specifically focus on the future implications of the study in terms of the valuation of ecosystem services.

Conclusion:

The conclusion may be subsequently modified.

After incorporating all the suggested changes and revising the manuscript, we will modify the conclusion section to ensure that it accurately summarizes the key findings of our study and their implications. We will ensure that the conclusion section is in line with the updated results, limitations, and future implications discussed in the manuscript.

Finally, we thank the reviewer for taking the time to review our manuscripts. Their insightful suggestions and feedback are highly valuable and have significantly contributed to improving the quality of our research work.