Dear Ting Sun,

Thank you very much for handling our manuscript and for your feedback. We have addressed your feedback through:

1) Moving a subsection to the Appendix. This significantly improved the readability.
2) We further improved the phrasing in our conclusions to make them more readable as well.

We would also like to highlight that the questions raised by Reviewer 3 are due to their inability to access the revised manuscript, whereas Reviewer 1 had access.

For clarity, reviewer and editor comments are highlighted in blue, our responses are in black, and any newly added text appears in italics. All sections and line numbers refer to the revised version of the manuscript after implementing feedback from the minor revision.

With regards on behalf of all authors,

Emmanuel Nyenah

Response to Editor

The reviewers have now evaluated your responses. While most of the earlier concerns have been addressed satisfactorily, a few issues remain—particularly regarding the readability of the manuscript.

We have revised the manuscript and moved Section 7 (Differences between the outputs of the reprogrammed and legacy software) to the Appendix. It is now referenced in the main text under quality assurance (Section 4.6). This revision reduces the number of main sections from 9 (previously 10) to 8, thereby supporting our main conclusions while improving the overall readability of the manuscript.

The referenced text under section 4.6, Lines 358-360, reads:

"*Comparison of legacy and reprogrammed software output. We verified that the reprogrammed software produces similar outputs to the legacy software, as demonstrated in the global water balance and analysis of renewable water resources (see Appendix).* "

Response to Reviewer 1: Rolf Hut

I thank the authors for the thorough re-working of the manuscript. In this version, I am more than happy to recommend this for publishing.

Thank you once again for your feedback, which greatly helped improve the manuscript. We are glad to hear that you are now satisfied with the revised version.

Response to Reviewer 3

The authors have addressed my comments and suggestions overall well. This work could be published in GMD after further addressing my following comments and suggestions properly:

Thank you for the valuable feedback on our original contribution, which greatly helped us improve the manuscript.

1. I am not sure it is my handling technique of the website or other reasons I could not reach the updated or revised version of the manuscript. This makes it difficult to check whether the authors have made substantial revisions on the manuscript accordingly.

We appreciate your comment. However, we have substantially revised the manuscript, as also noted by Reviewer 1. These revisions addressed all previously raised concerns. To further improve the readability, as requested by the editor, we have moved Section 7 to the Appendix (see also Editor response).

2. Although the purpose of this manuscript is to give guidance or instructions for the model users to better employ this WaterGap software, the reviewer still considers that at least this update need validation to check the accuracy and reliability of this new model. For example, additional designed cases be included for simulations from the traditional and the new models, and observations are used to check the model performance for hydrological variables. At current version of the manuscript, it is difficult for the reviewer to judge that whether these new features could influence the model performance or not.

Thank you for the comment. Importantly, we have not introduced any new features with the software rewrite. Thus, the goal of this manuscript is not to evaluate the model's performance, but rather to examine the reprogramming process itself. Nevertheless, we assess whether the new model provides similar results to the original version (through a comparison of the water balance and spatial differences in long-term renewable water resources) and explain possible discrepancies.

The goal of the manuscript is not to provide guidance or instructions for model users to employ. These goals were clearly stated in the introduction section (Section 1, Lines 74-81) and the abstract (Lines 18-23) of the first and second revised manuscripts. We are convinced that our revised version conveys a clear message about the research gap we are addressing in this manuscript.

To reiterate, we define the goal of the manuscript as follows (Section 1, Lines 74-81):

“To address this research gap and support the reprogramming of other legacy software, this paper provides a detailed account of the reprogramming process of GHM WaterGAP (Döll et al., 2003; Müller Schmied et al., 2024) and the characteristics of the new software. Reprogramming aimed to enhance the software’s sustainability for long-term research use by a broad community and to increase the reproducibility of the computational research performed with this model. The success of the reprogramming was assessed by comparing the legacy code to the reprogrammed version according to numerous specific sustainability criteria and FAIR4RS principles. It is important to note that our goal in reprogramming WaterGAP was not to improve the model output; the reprogrammed software was to result in the same model output as the latest WaterGAP version 2.2e (Müller Schmied et al., 2024).”

3. The structure. This manuscript describes a lot of aspects of the developed new model. For a scientific paper and publication, it is suggested that only the key findings and importance information should be included in the manuscript in a well-structured order. For example, the IMReD structure, i.e., Introduction, Method/Methodology, Results, Discussion, and Conclusion. The excessive will lead the reader to be unfocused on specific parts and lose the key information that this manuscript intends to present, so make the structure and organization of this manuscript more fluent and concise.

We appreciate the reviewer's feedback regarding the structure and organization of our manuscript. Please see the response to the editor where we elaborate on the new changes regarding the paper structure. We, however, believe that our original revisions to the paper have already improved the manuscript's structure.

Importantly, the paper, at its core, follows the IMReD structure (section 1 is the Introduction, section 2 is a somewhat traditional data or background section, section 3 is the methods, section 6 is the results, and section 7 is the discussion); however, we include additional sections to describe the programming process and software architecture (Sections 4 and 5). Additionally, instead of a traditional discussion section, we include a "Lessons Learned" section, which aligns with the paper's objective.

We guide readers through this structure as explained at the end of the Introduction (Section 1, Lines 83-87):

"The paper is structured as follows: Section 2 introduces the WaterGAP model and the legacy software. Sustainability criteria for research software and methods relevant to this study are presented in Section 3. After describing the reprogramming process in Section 4, we present the architecture and new features of the reprogrammed software in Section 5. In Section 6, we evaluate the new WaterGAP software against selected sustainability criteria and the FAIR4RS principles and share lessons learned for others undertaking similar efforts (Section 7). Our conclusions follow in Section 8 "

4. L124-124: If the model already runs at the 30 arc-minute resolution, the simulated results could be compared with the traditional model against observations, and also the 5 arc-minute resolution could be then done.

A model comparison against observations is already available in a recent publication (Müller Schmied et al 2024, see Section 7 Evaluation of WaterGAP v2.2e), where we compare streamflow and total water storage anomalies from the model (forced by various climate forcings) against observational data.

In the current paper, we are reprogramming the same model, WaterGAP 2.2e, as a sustainable research software. Including a separate model performance comparison would deviate from the paper's scope and significantly increase the length of an already extensive manuscript.

Additionally, the 5 arc-minute resolution version of the model has not yet been reprogrammed, and this paper only focuses on the 30 arc-minute resolution as stated in the manuscript (section 2, Lines 117-120).

References

Müller Schmied, H., Trautmann, T., Ackermann, S., Cáceres, D., Flörke, M., Gerdener, H., Kynast, E., Peiris, T. A., Schiebener, L., Schumacher, M., and Döll, P.: The global water resources and use model WaterGAP v2.2e: description and evaluation of modifications and new features, Geosci. Model Dev., 17, 8817–8852, https://doi.org/10.5194/gmd-17-8817-2024, 2024.