We would like to express our gratitude to Dr Sopan Patil for his meticulous review. We provide below detailed answers (in black) to the remarks made by the reviewer (in blue). Line numbers and section numbers refer to those from the submitted manuscript.

Reviewer 1:

The Santos et al. manuscript presents an interesting study on the integrated water resource management (IWRM) modelling approach to explore the impacts of climate change and future demand scenarios at a catchment in Northwest France. While the overall scientific approach appears to be sound, I have a few comments and suggestions below, which will hopefully improve some aspects of the paper's presentation:

We thank the reviewer for his positive feedback.

1) The Methods section presents three versions of the hydrological model: calib, uninf, and iwrm. If I understood it correctly, only the calib version of the model is used for parameter calibration and model validation using the observed streamflow data, and the other model variants, uninf and iwrm, do not have the corresponding observed data to gauge their performance. However, Table 5 in the Results section shows the model performance of all three variants. So, what are the uninf and iwrm variants being compared against? And what is the point of showing which model variant performs best? As I understand it, each model variant serves a totally different purpose, and they are not competing against each other.

The reviewer is right, we do have three versions of the hydrological model, and the Calib version is the only one used for parameter calibration of the GR hydrological model. Since the available measured streamflow is, by definition, influenced by water uses in the catchment, the Calib version of the model incorporates observed withdrawals and releases (as described in section 2.2.3). By doing so, the simulated streamflow of the Calib version of the model is supposed to represent influenced streamflow. The uninf version of the model uses the same parameter set, but does not incorporate observed withdrawals and releases. Its objective is to dispose of a model version that simulates natural hydrology. It is therefore used to assess the impact of water uses on the Sèvre Nantaise hydrology (by comparing its output to a model version that incorporates water uses) and the projected evolution of natural hydrology. Finally, the iwrm version of the model still uses the same parameter set as for the other models, but incorporates water uses through the outputs of water demand models, and includes the management rules for deciding water withdrawal restrictions. This version of the model is necessary to simulate future projected influenced hydrology and water uses and assess the impact of water use scenarios and climate change on diverse indicators.

All three versions of the model simulate streamflow at the same stations, as a consequence the three of them can be evaluated against measured streamflow as performed in Table 5. By evaluating the three models against this same streamflow time series, we aim to i) show that the Calib version is sufficiently well calibrated, ii) illustrate the impact that not considering water uses can have on the performance of modelling (here by comparing the Uninf performance to the Calib performance) and iii) verify that the model version that uses water demand models (iwrm) performs reasonably well, before using it for projections. Therefore, we do believe that evaluating all three models against measured streamflow is totally meaningful.

We will however work on better justifying this approach and better introducing it. We will provide details on the KGE calculation, which compares observed data (i.e. influenced streamflow) with, respectively, simulated data from the “Calib” model (i.e. influenced simulated streamflow), from the “Uninf” model (i.e. uninfluenced simulated streamflow) and from the “iwrm” model (i.e. estimate of influenced simulated streamflow based on uses and management rules).

2) In my opinion, the water demand and release models of the iwrm variant are the most important contribution of this paper. However, more information might be needed to determine the robustness of the water demand and release models presented here. Not much information has been provided about the input data used for the models described in Appendix B. Where has this data been sourced from?

Water demand and release models indeed rely on numerous input variables. For instance, the cattle watering models rely on the number of heads for each cattle type, on the demand per head, on the source of withdrawal (natural environment or drinking water network) and on the daily partition over the year. The values of these variables for the reference period come from multiple sources, all in French, and most available by request only. There is unfortunately no database available, for privacy and economic reasons. For example, the number of heads was retrieved from local Agricultural chambers, the demand per head results from an estimation that was retrieved in a report from the SDGRE 49 (Schéma Départemental de Gestion de la Ressource en Eau du département 49), the source of withdrawal (natural environment or drinking water network) was provided for only two drinking water providers, therefore we had to extrapolate this information, and the daily partition over the year was retrieved from a report named « Étude sur la gestion quantitative de la ressource en eau en Bretagne. Analyse de la pression de prélèvement, définition des volumes disponibles, CACG, 2021 », which provided the monthly partition of annual water cattle consumption. As can be seen from this single example, the data sources of the inputs of the water demand and release models are very diverse, incomplete and sparse. An as complete as possible listing and description of these data sources, and the hypotheses made to address data gaps, is available in Santos et al. (2023a), in French. However, we do not believe that such information should appear in the present manuscript, because i) it could easily double the number of pages in the manuscript, ii) this is very specific to the Sèvre Nantaise catchment case: in another catchment, even another French one, different data sources might exist, different information could be available or missing and the actual figures would not necessarily be transferable to other areas. We believe that the actual added value of the Appendix B presenting the water demand and releases models are the equations, which can thereafter be applied using any available source of data. We understand that such a limitation prevents from any form of direct reproducibility in this part of our study, but this is not something we can avoid here.

Nonetheless, regarding this specific point, we will properly refer to Santos et al. (2023a) in the Appendix describing the Water demand and release models, to allow readers to find more detailed information about the data sources.

Reference:

Santos, L., Tales, E., Bluche, A., Thomas, A., Mounereau, L., Thirel, G. Etude HMUC : Rapport Phase 2. État des lieux / Diagnostic / Constitution de la modélisation. 197 p https://hal.inrae.fr/hal-04008873, 2023a.

Is the model implementation done in spatial grids, or is it spatially lumped at the subcatchment level?

We believe that this question applies to the water demand and release models. As written in the first line of the Tables of Appendix B, « Equation (are given) for location a and day d. Areas can be either municipalities or plots (for irrigation). The water demands are thereafter summed up over the diverse areas a of each hydrological modelling unit ». We will replace in this Appendix the word « areas » by « Locations » to avoid any misunderstanding, as it represents the same modelling unit. We will also replace "hydrological modelling unit" with "sub-catchment" to be consistent with the Material and Methods section. If the question applies to the hydrological model, as explained in section 2.3.1, we apply the GR6J model onto 32 sub-catchments in a semi-distributed manner.

The cattle watering model equation allows for information on different cattle types. How many different cattle types were considered? And how is their water demand calculated?

There are nine types of bovine cattle, two types of pork, sheep, goats, poultry, horses and rabbits, which makes it 16. The water demand is calculated thanks to the first two equations in Table B1. If the question related to the unit consumption, it was retrieved for each cattle type from the report from the SDGRE 49 mentioned in the previous answer and is available in Santos et al. (2023a). We will refer to this report but not detail all cattle types and unit consumptions in Appendix B for the sake of conciseness. Regarding the scenarios, the rate of evolution of the number of heads was considered for three groups of bovine cattle, one group for pork and poultry, and the number of heads for other cattle types was not modified, due to the low number of heads in the catchment.

The same question applies to the demand calculation for other uses.

We understand the rationale behind your question. We retrieved withdrawals for all main industries, which we used for 2008-2020. We will not answer into details to this demand but we will once again refer to Santos et al. (2023a).

Also, why does the formula for drinking water demand add cattle and industrial water demands to the population's consumption?

This is because a fraction of these water demands are made to the drinking water network (see the $R_{\mathrm{DW}}(i, y)$ and $R_{\mathrm{DW2}}(i, y)$ variables in the related equations).

Perhaps it might be useful to provide a detailed schematic, maybe at a subcatchment level, of how the different water demand models are feeding into the base hydrological model to create the iwrm variant.

Thank you for this interesting suggestion. Actually, the water demand and releases models do not interact with the base hydrological model internal variables, only with its simulated streamflow. We propose below a figure that explains the main water fluxes in the iwrm model version. In this figure, a catchment comprising an upstream subcatchment is shown, as it allows to show both a catchment with a dam reservoir, and a catchment with no dam reservoir. We hope this improves the understanding of the iwrm modelling. This figure could be inserted in section 2.3.2 Integrated water resources management modelling.

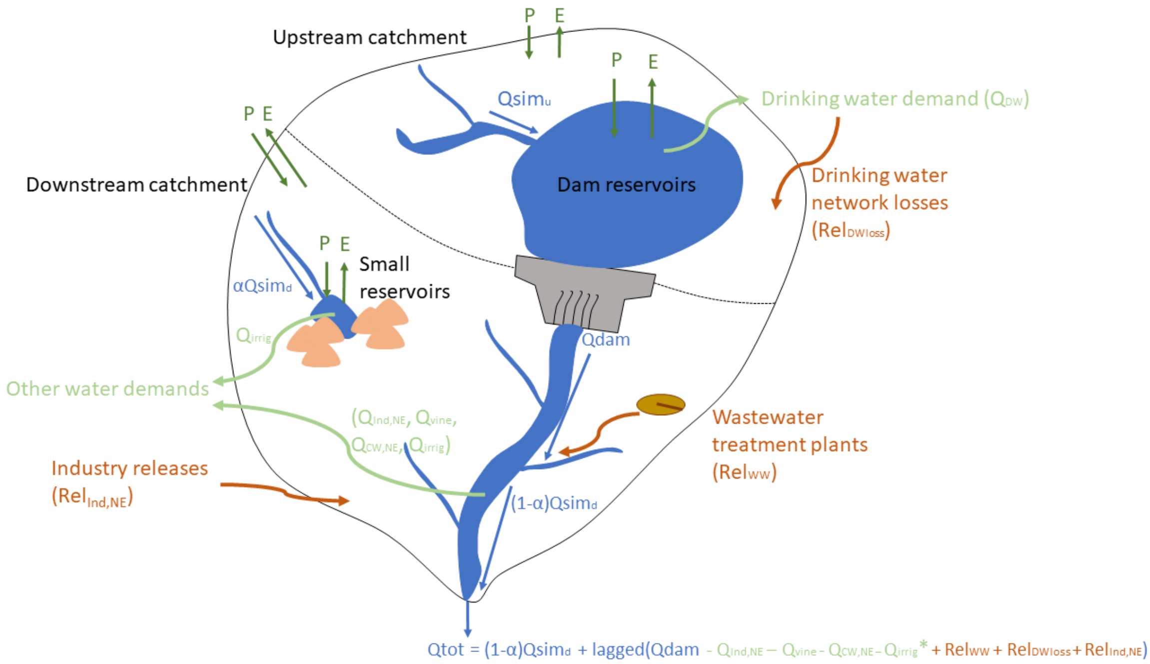

Figure: Schematic of the functioning of the integrated hydrological model. Two catchments are shown: the upstream catchment includes a dam reservoir (corresponding to MU1 and MU3 in the Sèvre Nantaise catchment), while the downstream catchment does not include any dam reservoir (corresponding to all other MUs). Small reservoirs and the related water demands, as well as wastewater treatment plants can be present in both cases but are shown in the downstream catchment only for graphical purposes. The dam reservoir outflow (Qdam) is determined according to the management rules given in Table B3 and is delayed towards the catchment outlet proportionally to the hydraulic distance from the dam to the outlet. The simulated streamflow in the downstream catchment ($Qsim_d$) is given by a GR6J model. Part of this (α) is captured by small reservoirs. The total streamflow at the outlet is the sum of all streamflows (from the dam, the downstream catchment and the water releases) minus the water withdrawals, which are delayed according to the hydraulic distances between the withdrawal and release points. All other fluxes and notations are detailed in Appendix B. Natural fluxes are in dark green, streamflow is in blue, water withdrawals in light blue, and water releases in dark orange.

3) Another potentially innovative aspect that has unfortunately been sidelined in the paper is information from the stakeholder workshops. I think more detailed information is needed on how the three future scenarios were initially designed and on the specific value added by the stakeholder feedback. As currently presented, we are only seeing the final product, and the importance of stakeholders in shaping these scenarios for the local conditions is being ignored.

Thank you for this suggestion. While our approach with stakeholder workshops used for designing the water use scenarios is definitely better than just designing scenarios between scientists, we do not see this approach as the most innovative aspect of our study. In other words, we believe that, although this approach is not yet that widespread, we did not "invent" anything. We also believe that what is replicable in other studies is already presented in the article, namely i) performing a literature review, followed by ii) the proposal of scenarios by scientists and finally iii) the discussion with stakeholders resulting in modification of the scenarios.

Globally, the scenarios that were initially proposed were neither rejected nor heavily modified. Some elements that emerged from the stakeholder workshops are (non-exhaustive list):

- The bird flu that was ongoing on the territory was not considered in the initial scenarios. As it seems to lead to a significant decrease of poultry cattle, the scenarios were modified to consider that;
- Vine spraying to prevent frost damage is an emerging issue in the catchment. The scenarios were modified to add this water demand;
- The need to consider specific practices, such as agroecology or the type of irrigation. The agronomic modelling cannot consider this and information about the current practices could not be provided by stakeholders, so the scenarios were not modified following these remarks;
- The trends of the evolution of populations were modified to better represent the local dynamics (see the evolutions in urban areas in the scenarios);
- The alternative scenario, previously named "adaptative" scenario, was renamed as some evolutions cannot be considered as adaptations;
- A newly planned inter-catchment water transfer was added.

We will add this information to the Appendix describing the scenarios.

4) Lastly, while the iwrm model presented in this study seems innovative, it is certainly not the first one to have attempted a quantification of future water demand. There have been a large number of studies conducted using other models, most notably WEAP, to address water demand management and forecasting. In this context, I find it troubling that the presented iwrm model, and its results, have not been discussed in the context of other existing models. It would be quite valuable for the authors to discuss the similarities and differences in the specific aspects of their iwrm model and others found in the literature.

We thank the reviewer for this suggestion. We will add a description of some iwrm approaches in the introduction, and we will also better discuss the results in regards to the literature.