A Summary of Revisions and Responses on "From scenario to roadmap: A web-based participatory watershed planning system for optimizing multistage implementation plans of management practice scenario under stepwise investment" (Manuscript JEMA-D-23-01828R1)

With regards to comments from Reviewer #6:

Overall, the manuscript presents a comprehensive overview of the significance of watershed planning and the challenges associated with implementing best management practices (BMPs) that satisfy multiple stakeholders. It describes the design of a web-based participatory watershed planning system that enables diverse stakeholders to propose investment constraints and reach a consensus on optimized roadmaps for specific BMP scenarios. The system integrates a BMP roadmap optimization method and provides a user-friendly interface for stakeholders with varying knowledge backgrounds and roles to participate in an iterative workflow. The manuscript outlines the overall architectural design of the web-based system, including three key functional designs: integration of the roadmap optimization method, visualization of roadmaps from spatial and temporal perspectives, and definition of multiple stakeholder roles with diverse watershed management standpoints.

In terms of language and grammar, the manuscript is well-written and there are no major errors. However, there are a few minor changes that could be made to improve clarity, such as rephrasing some sentences to be more concise and removing unnecessary words or phrases.

Thanks for the reviewer's approval. We have revised carefully throughout the manuscript to eliminate unclear or redundant sentences.

- ***Major***

Major points that require scientific validation or clarification include:

1. ***The claim of designing a user-friendly web-based participatory watershed planning system needs validation, including the criteria used to determine its user-friendliness and how the system was validated.***

   In this manuscript, the basic criterion for realizing a user-friendly web-based participatory watershed planning system is the easy-to-use interface for stakeholders with different knowledge backgrounds and diverse roles, as stated in Section 2.1 "Basic idea". This criterion is fulfilled by the design of multi-perspective visualization of roadmaps, as illustrated in Section 2.4. The user-friendly system is guaranteed by the integrated pre-prepared BMP roadmap optimization suite (implemented by professional modelers and encapsulated in the backend) that exposes a small set of essential parameters for non-expert stakeholders to lower barriers to use, as illustrated in Section 2.3.

   Section 4.2 clarified the effectiveness of the case study system in both quantitative (i.e., the progressive shifts in the optimized roadmaps from the three-round optimizations by different stakeholder groups) and qualitative (i.e., the rationality and diversity of the optimized roadmaps) manners. Section 4.3 evaluated the designed watershed planning system qualitatively from stakeholder-, model-, and system-oriented perspectives referring to the evaluation criteria for successful environment decision support systems proposed by Walling and Vaneeckhaute (2020). The conclusion can be made that the designed system could promote the application of the state-of-the-art BMP roadmap optimization method among multiple stakeholders with different knowledge backgrounds and standpoints. We have revised the manuscript throughout to reflect the above contents.

2. ***The study's focus on an agricultural watershed planning case study for soil erosion reduction raises questions about the broader applicability of the system and methodology to other types of watershed management scenarios.***

   The watershed planning system designed in this study adopts the BMP roadmap optimization method proposed by Shen et al. (2023), which is intended to be a universal framework and not confined to specific scales of watersheds or watershed management goals with various BMPs. Main requirements for applying the method and the system include quantifying BMP's time-varying environmental effectiveness and its representation in the watershed model, and improving the BMP scenario cost model. Therefore, technically, any selected BMPs and customized watershed model in any study area aiming at various watershed management needs can be applied with the method and the system. We have revised the last paragraph of Section 4.3 to clarify this point.

3. ***The manuscript mentions a BMP roadmap optimization method proposed by Shen et al. that is currently under review (used 25 times in this research), which raises concerns about the validity and effectiveness of the method until it is published and peer-reviewed.***

   Before we submitted the previous version of this manuscript, our prior study (the BMP roadmap optimization method proposed by Shen et al.) was listed as "awaiting editor decision" after being reviewed by Water Resources Research (WRR). Sorry for that paper's long peer review process (including an about-one-month editor-decision procedure after reviewers' comments were ready). From the last round of reviewing of that paper, the comments we got are all from the editor, including the requirement of grammatical revision and the editor's requirement of removing the ten-dashed lines around the South Sea of China from a figure (we were really surprised because it seems beyond the science). We revised the grammar of that paper and resubmitted it on April 19 with an explanation of why the map-revising requirement from the editor could not be met. The current status of that paper is waiting for the editor's decision. To not affect the reviewers' judgment of this manuscript, we also posted the latest revised manuscript of that paper on the BMP roadmap optimization method to the ESS Open Archive server approved by AGU/WRR officially, which can be freely accessed at https://doi.org/10.22541/essoar.168298699.99491102/v1. We hope this is acceptable to the reviewers.

4. ***The custom system for the Youwuzhen watershed in China, targeting soil erosion for a five-year period (2011-2017), may be considered outdated, and it is unclear why the***

authors did not validate the methodology to make a clear judgment about the software or web-based system, especially considering the current year is 2023.

The reason for selecting current modeling data in the period (2011-2017) is we have not gotten the updated data from the local administrative department after our collaborative project finished, including the yearly monitored soil property data for reflecting BMP effectiveness (e.g., organic matter and mechanical composition, see Table A.2 of the Appendix).

We want to emphasize that the choice of data does not affect the validation of the example implementation of the system design. The system designed in this study, dependent upon the BMP roadmap optimization method, aims to explore how to promote the state-of-the-art method to be applied for actual watershed management. The evaluation of different BMP roadmaps relies on simulations of the watershed model, which are affected by various modeling data, including meteorological data and BMP effectiveness data. Once we keep the modeling data the same for all evaluations, the different results can be attributed to the differences in BMP roadmaps, which are sufficient for evaluating the system design. Therefore, the simulation period selected in this study does not affect the validation of the example implementation of the system design.

5. ***The manuscript appears to rely heavily on the work of Shen et al. (under review), presenting a descriptive manual for their paper with a detailed step-by-step tutorial for soil erosion as a case study, which may not be suitable for stakeholders. Additionally, the use of external models and approaches from other researchers may distract the reader, and it is recommended to use hierarchical figures or flow charts, and provide small paragraphs to define and justify the statistical methods used.***

The proposed system design adopted the work of Shen et al. (2023) to provide the functionality of optimizing BMP roadmaps according to user-specific investment plans. This manuscript addresses a different scientific issue, not the descriptive manual of Shen et al. (2023). Shen et al. (2023) focused on proposing an effective optimization method for the implementation plan of BMPs under stepwise investment. This study further explores how to facilitate the participation of stakeholders with different knowledge backgrounds in proposing investment plans and reaching a consensus on optimal BMP roadmaps. The fourth and fifth paragraphs of the Section Introduction state this relationship.

In this manuscript, Figure 1 also presents the relations between Shen et al. (2023) and this study, i.e., Figure 1a is the simplified flowchart of the BMP roadmap optimization method, and Figure 1b is the iterative participatory workflow designed for stakeholders in this study. We revised the first paragraph of Section 2.1 “Basic idea” to emphasize this relationship. Besides, Figure 2 divided the components of Shen et al. (2023) into different functional layers, e.g., the core implementation of the method constitutes the BMP roadmap optimization suite in the software server layer on the server side.

We believe the text and figure mentioned above may help readers understand the connections and differences between Shen et al. (2023) and this study.

6. ***The manuscript's section on the study area and watershed management goal, including the Youwuzhen watershed's characteristics, may raise concerns about the watershed's suitability for BMP analysis due to its small size and invulnerability to soil erosion due to low slope conditions.***

   The Youwuzhen watershed has been severely eroded by water in the past decades because of its natural conditions and human activities (e.g., forest destruction). The natural conditions include not only the steep slopes (up to 52.9° and with an average slope of 16.8° over the entire watershed) but also the climate characteristics (e.g., concentrated and intense thunderstorm events from March to August), forest condition (e.g., secondary or human-made forests with scatter distributions), and soil condition (i.e., granite-red soil with high erodibility). We revised the study area description in Section 3.2 to clarify this point, which we believe that this watershed may well validate the performance of the proposed system.

   Besides, the system design of this study is not confined to specific scales of watersheds and watershed management problems. Please also refer to our response to the second major comment of the reviewer.

7. ***The link provided in the manuscript to access the watershed planning system is not functional, which raises questions about the ability to judge the system's performance (I couldn't even register as a citizen).***

   We apologize for the bug in registering new users. We have fixed it now. The system also provides a series of accounts corresponding to different stakeholder groups for functional demonstration. We recommend logging in with these accounts to explore the system and then registering a new account for further use.

8. ***The manuscript's title could be improved to reflect that it is a case study of an agricultural watershed planning system for mitigating soil erosion, along with discussions on technical selections, frameworks, software, programming languages, and the self-developed BMP roadmap optimization suite by Shen et al. (under review), as well as limitations of the web-based participatory watershed planning system.***

   Thanks for the reviewer's comment. We have revised the title accordingly: "From scenario to roadmap: Design and evaluation of a web-based participatory watershed planning system for optimizing multistage implementation plans of management practices scenario under stepwise investment."

   In this manuscript, Section 2 illustrates the basic idea and overall design of a web-based participatory watershed planning system for BMP roadmaps. The system design is independent of specific technical implementations. Section 3 presents a case study of an agricultural watershed planning system for mitigating soil erosion. In this case study, the system design is instantiated as the customized system with specific technical selections, including the self-developed BMP roadmap optimization suite by Shen et al. (2023).

   We revised the last paragraph of Section 5 "Conclusions and future work" to discuss the limitations and corresponding future directions of the system.

9. ***The manuscript's organization may need improvement, as it appears lengthy and may benefit from a more concise structure.***

   In general, this manuscript followed the “IMRaD” structure: the introduction, methods, results, and discussion. The “Basic idea and overall design” presents the “methods”. Since the “results” relies on the specific system implementation and experimental design, we set “Case study of an agricultural watershed planning system for mitigating soil erosion” and “Experimental design and evaluation” sections other than one to improve readability. We believe this structure can clearly express the logic structure of “actual watershed management demands—system design—role-play experiment based on the case study of system implementation—conclusions and future works.”

   Besides, we have condensed the main text of this manuscript to improve clarity. We hope it acceptable to the reviewer.

10. ***The abstract could provide more information about the results and their implications when read in isolation, including the impact and global relevance of the findings for publication in an international journal, as well as the soundness and justification of interpretations and conclusions based on the data.***

    Although the experimental results in the case study of this manuscript were evaluated in both quantitative and qualitative manners, the qualitative result and implication are more worthy of attention for readers of the Abstract in this study. Therefore, we revised the last two sentences of the Abstract to be “The experimental results show that the optimal roadmap sets exhibit progressive improvements across three optimization rounds started by different stakeholders, effectively capturing the varying perspectives of stakeholders and facilitating consensus-building among them. The idea of system design and example implementation can serve as a valuable reference for developing related user-friendly environmental decision support systems.”

- ***Section-by-section***

1. ***Introduction: could be improved by more clearly outlining the objectives and aims of the study. Additionally, it would be beneficial to explicitly state the study's contribution to the field.***

   In the Section Introduction, we first raised the actual watershed management needs for multistage BMP implementation plans (the so-called BMP roadmap in this manuscript), considering realistic conditions such as investment constraints that involve multiple stakeholders. Then we concluded through the literature review on BMP scenario optimization methods that the state-of-the-art method could optimize BMP roadmaps from a specific BMP spatial scenario considering stepwise investment. However, the application of this method is over-specialized and complex for non-expert stakeholders to participate in. Therefore, we clarified the objective and aims of this manuscript: designing and evaluating a web-based participatory system to assist various stakeholders in proposing investment constraints, analyzing and electing optimal roadmaps, and reaching the final consensus. Through the multistakeholder role-play experiment in the case study, this manuscript contributes a valuable reference for developing user-friendly environmental decision support systems based on the state-of-the-art optimization method for watershed management. We have revised the Section Introduction to clarify these points.

2. ***Methodology: could be improved by providing more information on the statistical analysis methods used to analyze the data. Additionally, it would be beneficial to provide a clear description of the variables used in the study.***

   As stated in response to the 9th major comment of the reviewer, we regard the Section "Basic idea and overall design" as the "Methods." In this section, we illustrated the basic idea and overall design of the web-based participatory watershed planning system. The core components of the system design are separately introduced in Sections 2.3 and 2.4. There are no statistical analysis methods designed for this system. The BMP roadmap optimization method is encapsulated to expose the only interested parameters for stakeholders: the investment constraints. Please see Section 2.1 "Basic idea" for more details.

3. ***Results: could be improved by providing more interpretation of the results and relating them back to the research question.***

   Section 4.2.1 presented the quantitative results of the role-play experiment in the case study. For example, the progressive improvements across the three-round optimizations started by different stakeholders demonstrated from the Pareto fronts in Figure 7. Section 4.2.2 presented the qualitative results by introducing the rationality and diversity of the optimized roadmaps. Section 4.3 concluded that the system design and example implementation could effectively capture various perspectives of stakeholders and facilitate consensus-building among them during the participation in optimizing BMP roadmaps, which answered the research question focused on in this manuscript. We have revised this section accordingly.

4. ***Discussion: could be improved by more clearly outlining the implications of the study and suggesting future research directions.***

   The discussion of the implications of the system design and potential future directions are given in the second and third paragraphs of the Section 5 "Conclusions and future works."

5. ***Conclusion: could be improved by more clearly outlining the study's contributions to the field.***

   We revised the first paragraph of the Section 5 "Conclusions and future works" to outline the contribution of this study to the field of developing environmental decision support systems.

6. ***Overall, the sections provided are well-written and provide a clear overview of the research problem and its significance. However, the sections could be improved by incorporating the recommendations provided above.***

   Thanks for the reviewer's comments. We have revised all sections of this manuscript to clarify the aims, methods, results, and contribution to the field, according to the comments from the reviewer.

➢ ***Minor***

● ***abstract***

Overall, the language and grammar errors are minor and do not significantly affect the scientific content of the manuscript.

in the abstract, line 2 could be rephrased as Planning multistage implementation plans, or roadmaps, based on the spatial distribution of best management practices (BMPs) is essential for achieving watershed management goals under realistic conditions.

In line 7 the phrase optimization need could be rephrased as need for optimization for clarity.

Furthermore, some sentences could be rephrased to improve clarity and flow. For example, in line 8, it could be clearer to say This study designed a user-friendly web-based participatory watershed planning system to assist a diverse group of stakeholders in reaching a consensus on optimized roadmaps.

In line 10, reaching a consensus on optimized roadmaps should be reaching a consensus on the optimal roadmap.

In line 17, few but essential parameters should be a small set of essential parameters.

In line 18, interactively participatory process should be interactive participatory process.

In line 24, multi-stakeholders should be multi-stakeholder.

In line 27, reference for the ease-to-use design should be reference for the user-friendly design.

Thanks for the careful review. We revised the abstract following these suggestions and checked the manuscript accordingly.

● ***introductions***

Line 35: Add such as before soil erosion and non-point source pollution to improve clarity.

Line 39: Change BMP scenario(s) to BMP scenarios to match the plural usage in the sentence.

Line 59: Replace falls with fall to match the subject-verb agreement in the sentence.

Line 103: Replace participatory system with participatory watershed planning system to improve clarity.

We have revised accordingly.

line 60-62, need reference for " this approach cannot further arrange the optimized BMP scenario into multistage implementation plans, "

lines 73-75, need reference "However, this method only loosely combines independent optimization results and does not optimize the roadmap in an overall optimization problem that considers multistage investments"

Both “this” refer to “this type of approach” in the respective paragraph. We changed “this” to “this type of”.

Lines 95-96 " To facilitate this process, watershed planning system that utilizes user-friendly interfaces for ease of use for stakeholders without " this increase the uncertainty in the model

In our view, the watershed planning system can facilitate the application of the state-of-the-art BMP optimization method with two necessary preconditions: the pre-prepared specialized models by professional modelers that expose a few interested parameters for stakeholders and the user-friendly interface to participate. Therefore, the uncertainty in modeling is handled by experienced modelers. We revised this sentence: “To facilitate the participation of non-expert stakeholders in this process, based on pre-preparing specialized models by professional modelers on the backend, a watershed planning system that utilizes a user-friendly interface that doesn’t require intensive specialized knowledge of BMP scenario analysis becomes the uncontested choice.”

- ***Basic idea and overall design***

Line 114: change participate in proposing to participate in proposing the

line 117, the term see the simplified workflow depicted in the red dashed part in Figure 1 should be separated by commas to avoid ambiguity.

Line 118: add a comma after Figure 1

Line 118: while streamlining the use by inputting can be rephrased as while streamlining the use through inputting.

Line 154: on graphical interfaces can be rephrased as on a graphical interface.

Line 166: optimization task can be rephrased as optimization tasks.

Line 168: optimization-related can be hyphenated as optimization related.

Line 181: optimization tool execution can be rephrased as the execution of optimization tools.

We have revised accordingly.

Line 121: with different knowledge backgrounds and diverse roles to participate can be rephrased as with participants having different knowledge backgrounds and diverse roles.

We revised this sentence: "…to facilitate the participation of stakeholders with different knowledge backgrounds and diverse roles."

Line 128 the figure 1 is not explained in the text and it is not clear as a workflow for an average reader, in addition, the figure is too general to be used. figure 2 should be mentioned in figure 1 for better understanding, and even if you use the graph from other source, you have to summarize it in the text, as a reader we don't have to search about it in other publications

In general, I could not relate figure 2 to figure 1 in section 2 as it is unclear how thy use the same approach and I wonder how the optimization will be achieved

We added a brief introduction of the workflow of the BMP roadmap optimization method illustrated in the red dashed part of Figure 1 in the first paragraph of Section 2.1: "The workflow is an iterative optimization process of initializing/generating and evaluating BMP roadmaps under the framework of an intelligent optimization algorithm. The evaluations of each BMP roadmap are conducted by the customized watershed model and BMP scenario cost model according to the watershed management goals. Newly generated BMP roadmaps are screened to satisfy investment constraints before being evaluated. After the maximum iteration is reached or other conditions are satisfied, the optimization finishes and outputs optimal roadmaps."

Figure 1 presents the BMP roadmap optimization method that will be encapsulated in the back end of the system (Figure 1a) and the iterative participatory workflow designed for the easy-to-use front end of the system (Figure 1b). We believe Figure 1 has outlined key points of the work of Shen et al. (2023) and the proposed user interaction workflow in this manuscript.

Based on the basic idea illustrated in Figure 1, Figure 2 proposed the overall structure of the system. That means Figure 1 should be mentioned in Figure 2. For example, the BMP roadmap optimization suite in the software server layer and parts of the data layer of Figure 2 correspond to Figure 1a; the presentation layer and its interaction with the HTTP server correspond to the design of participatory workflow in Figure 1b.

We hope this revision and explanation are fine.

Line 122: add a comma after parameters

Sorry. But we cannot find the word "parameters" in Line 122. There are "based parameters" in Line 124, but this phrase is already followed by a comma.

Line 130: add a period after implementation

The phrase "implementation plan" is used as a whole. Thus, we think there is no need to add a period after "implementation".

In line 131, the word implementation should be pluralized to implementations to match the plural plans.

Here we use the term "implementation plan" as a whole, and thus we use its plural form as "implementation plans", not "implementations plans".

In line 137, has should be replaced with have to match the plural subject applications.

We have combined the first two sentences in this paragraph into one: "Section 2.2 presents the overall architectural design of the participatory watershed planning system using the web application architecture, the mainstream architecture in promoting the development of easy-to-use geographic and environmental modeling applications"

lines 167-172, it is not clear how the optimization results. obtained "the optimization results. The back-end business logic is the key component that handles all user-, data-, and optimization-related matters by interacting with other components or layers, including data querying, optimization task submission, and data parsing. The BMP roadmap optimization suite encapsulates models and tools of the roadmap optimization method as several interfaces to be loosely coupled with the business logic component (Section 2.3). HTTP server is"

The "optimization results" is "optimized roadmaps" derived from the BMP roadmap optimization suite. These two phrases are interchangeable in the origin manuscript (see the first paragraph of Section 2.3). To avoid misunderstanding, we revised to use "optimized roadmaps" throughout the manuscript.

lines 183-185 how and who decide that it is a universal modeling framework

As stated by Shen et al. (2023), the proposed simulation-optimization framework for determining the implementation plan of BMPs is intended to be a universal framework that is independent of BMP type, watershed model, optimization algorithm, and applied watershed scale. That means this framework can be implemented by other watershed models and optimization algorithms, and used for other BMPs and watershed management problems that are different from Shen et al. (2023) and this study.

Sorry that Shen et al. (2023) was still under review (after minor revision after long editor-handling period) by Water Resources Research when this manuscript was submitted. It can be accessed online now at https://doi.org/10.22541/essoar.168298699.99491102/v1. Please also refers to our response to the second major comment of the reviewer.

Line 192: change agreed-upon to agreed upon

In general, we followed the usage that "agreed upon" would be hyphenated when it comes before a noun, for example, "it's an agreed-upon roadmap" or "the roadmap is agreed upon". So, the "agreed-upon BMP roadmaps" in line 192 was not changed.

Line 192: multi-stakeholders can be hyphenated as multistakeholder.

Thanks for the reviewer's suggestion. We have revised throughout this manuscript to use "multistakeholder" to align with current trends of usage.

- ***Case study of an agricultural watershed planning system for mitigating***

Line 264, I visit the given website " http://easygeoc.net:9091/." and tried to register as a citizen and it was not working on the demo version, in addition to that the page only contains a photos and some basic data that cannot help in the "watershed planning system" evaluation process.

We apologize for the inconvenience caused by the registering bug. We have fixed this bug. Please also refers to our response to the 7th major comment of the reviewer.

lines 353-354, you can write some headlines here with the reference/citation

The property lookup tables for land use/land cover and soil are essential data for watershed modeling. Rather than add some detailed headlines in the main text, we added a new Section "Data and code availability" at the end of this manuscript, where interested readers can find all data and code used in this study. We hope this is acceptable to the reviewer.

Line 265: open-sourced should be open-source.

We revised accordingly.

Lines 370-371, "The first knowledge type is not used in this case study since the roadmap optimization is based a pre-optimized BMP spatial scenario. " This makes this manuscript a tailored one.

Sorry for the misleading. We revised the sentence: "The first knowledge type is used for spatial optimization of BMPs to derive the cost-effective BMP scenario. The pre-optimized BMP scenario is included in this case study for roadmap optimization."

Line 282: consistent with the case study settings in the previous study could be revised for clarity to consistent with the settings of the previous study's case study.

Line 293: FileReader reads files could be revised for clarity to The FileReader reads the files.

We revised accordingly.

- ***Experimental design and evaluation***

Line 434: Replace actual requirements with specific needs.

We revised accordingly.

line 463, primarily meet should be replaced with meet primarily.

We think both “primarily meet” and “meet primarily” are grammatically correct. The former emphasizes that the top priority of the optimized roadmaps is to meet all requirements of multistakeholder. In contrast, the latter emphasizes that the optimized roadmaps should meet most requirements, but some requirements may not be met. Here we adopt the “primarily meet” to reflect our meanings.

Line 468: Add of before multi-objectives.

There was an “of” before “multi-objective”.

lines 470-471, where the sentence structure is a bit complicated.

We revised these two sentences as “Figure 7 depicts the Pareto fronts derived from the three optimization rounds in turn, with the candidate ranges of multi-objective marked as red rectangles. The process of each optimization round is described in detail below.” We believe the revision is more flow in this paragraph and more understandable.

- ***Conclusions and future works***

The section is well-written and mostly free of language and grammar errors.

However, there are a few minor errors, such as preprepared in line 602, which should be pre-prepared, and can not in line 627, which should be cannot.

Thanks for reviewer’s comments. We revised accordingly.

There are also a few inconsistencies in the use of capitalization, such as agreed-upon in line 599, which should be Agreed-Upon.

Here we think there is no need to capitalize the initials of “agreed-upon”.

Finally, some sentences are quite long and could be broken up for readability.

Thanks for the reviewer’s suggestion. We have broken long sentences in this section into short sentences for readability, for example, the first sentence of the first paragraph.