Dear Editor and Reviewer,

First of all I would like to thank the reviewers for their inputs and advice on this manuscript, in a positive spirit of interest in the topic. They emphasized a number of gaps that I needed to fill, clarify and elaborate to provide better flow and information. In general, I have included most of the reviewer comments in the new version of the manuscript. Below I provide point to point comments which correspond to the revised version of the manuscript.

Thank you

Lisa Tanika, on behalf of all authors

Response to Reviewer 1 (RC1)

No	Comments and Answers
1	This manuscript provides a very interesting review of the process used to develop "serious" games for social learning among stakeholders in two different socio-hydrological systems in Indonesia: a mountain slope leading to lowland paddies, and a peatland "dome". The games were developed based on hydrological studies using the Drivers, Pressure, State, Impact, and Responses (DPSIR) framework as well as analysis of the actors and stakeholders as well as the Actors, Resources, Dynamics, and Interaction (ARDI) framework. The introduction provides a good explanation of how games can influence action around water. It is particularly interesting how the study use the credibility, salience, and legitimacy framework to evaluate the two games. **Answer:** *Thank you very much for your comments and interest in our use of the credibility, salience, and legitimacy framework*
2	a. The abstract concludes that "We provide clear steps in designing and adapting the game to another area…". This is the area where more is needed to deliver on this promise. As currently laid out, there is not enough information about what kind of hydrological or socio-economic study is needed to adapt such a game to new contexts. Was this based on quick assessment or multi-year study of the two areas described? **Answer:** *Thank you for requesting further clarity here. The socio-hydrological studies that formed the basis for the game development were a combination of previous studies and rapid assessments using established procedure to obtain information that is not yet available and needed during the game development process. We have added a list of minimum information requirements and approach for game adaptation in the section 2.2 study area:* "For systems diagnosis and developing the H_2Ours game, the minimum required information composed of: hydrological information (to define boundaries of the hydrological system, hydrological problems and efforts that should be done to overcome the causes and impacts of the problems, rainfall, potential evapotranspiration), land cover information (typology, main

locally relevant types, recent land cover change and life-cycle profitability estimates), and socio-economic information (village conditions, socio-economic issues, alternative livelihood options, institutional conditions). These information were collected using the Rapid Hydrological Appraisal (RHA) approach, which has been used and tested in a number of Southeast Asian countries (van Noordwijk et al., 2013; Jeanes et al., 2006)(van Noordwijk et al., 2013; Jeanes et al., 2006). In this approach, the information were grouped based on local ecological knowledge (LEK), public ecological knowledge (PEK) and modeller/scientist ecological knowledge (MEK). Mapping these different knowledge systems showed overlap, gaps and contrasts that provided starting points for further exploration"

b. What number of game simulations and what number of actual players are needed?

Answer:

As for any tool, the way it is used depends on specific targets that the user may have. Games can be used for raising awareness (agenda setting), for increased and shared understanding of how things work (hydrologically, socially, and in interactions), for framing issues and setting goals to deal with them and or for exploring means of implementation for achieving these goals. The number of game replications, choice of players in homogenous or explicitly mixed groups and the balance between 'experience' (letting many stakeholders play and draw their own conclusions) and 'evidence' (documenting and further analyzing game outcomes by researchers) can be decided by a game user.

For the specific examples of the adaptation of H_2OURS to two landscapes in Indonesia, we added explanation in section 3.3 Game implementation:

"The game session with the H_2Ours game takes approximately two hours (excluding briefing and debriefing). For the Rejoso watershed version, the two hours of game session consisted of 10 rounds with 6-12 players divided into 3 groups (or 2-4 people per group) acting as local communities: upstream, midstream, and downstream. The Pawan-Kepulu peatland version, the two hours game session consisted of 8 rounds with 8-16 players divided into 4 groups, and players are asked to select their village name as first step of creating ownership. In both versions, an additional group of players consisting of 2-4 people can act as public stakeholders (government, companies, NGOs) and interact with the villages."

c. The other gap in the paper is a description of who played the game, and whether there were differences in how different types of players responded in the game, or in their interactions with each other. For example, were all the players men?

Answer:

We will elaborate Section 2.4 Game implementation (P.1 and P.2):

"In this study, we executed ten game sessions which a total of 93 people participating, with five sessions in each of the study areas. All game sessions in Rejoso watershed were held in October 2021, while in Pawan-Kepulu peatland were held in August 2022. In each study area, a first one game session was organized with members of a multi-stakeholder forum consisting of representative of governments, NGOs, private sectors, and universities to get ideas on

	regulations and programs that would be offered to farmer communities, and four game session were organized with farmer groups to explore the implementation of the regulations and programs resulting from the game session with the multi-stakeholder forum. For each game session, we invited in total of 9-12 representatives of farmer groups from upstream, midstream and downstream village in Rejoso watershed, and 12-16 representatives of four villages in the Pawan-Kepulu peatland. In the invitation, we let the group determine who would attend the simulation, provided that the group representatives were willing to hold discussions and exchange information with participants from other villages. For the four sessions with farmer groups, we grouped participants according to different criteria to get a variety of decisions. For the Rejoso watershed, we conducted two sessions with participants who had experience with a recent Payment for Ecosystem Services (PES) program (Leimona et al., 2018) and two sessions with participants from neighbouring villages where the PES program was not active. For the Pawan-Kepulu peatland, we conducted a game session with members of the village forest management unit, a session with members of an active farmer field school, and two sessions with people who are not members of village forest management unit and farmer field school. Game sessions took place in a central location in each of the landscapes to allow easy access for all participants. During the game session, the participants were asked we asked to play the game with the role of a farmers from their location within the landscape." *A future paper will further analyze the specific results obtained in the two landscapes.* Did the players from upstream play differently than those from downstream areas, even if they were not playing the parts of their own area? **Answer** *We integrated in the discussion section 4.2, as part of the recommendation for the future works* "In this research, we invited participants from upstream, midstream, and downstream to play from the perspective from their location in the landscape. We expect that this impacted how the game was played. We intend to explore the impacts of role switching by asking farmers to play the role of a farmer in another location in the landscape."
3	Line 173 says "profit is total income minus total capital". But if income is on an annual or seasonal basis, shouldn't that be the annualized cost of the capital (e.g. if there is a major outlay for pumps)? Or should that be "minus total costs" (which is what it says in the next sentence). In economic terms, there is a difference. **Answer:** *We revised to Line 185*: "…., where profit is revenue minus all financial expenses (taxes, cost, incidental cost, etc.). The underlying economic analysis applied a life-cycle perspective to the various land-use systems, annualizing discounted future cost and benefit flows.".
4	Figure 4B X axis is labelled Amount of groundwater), but shouldn't that be amount of surface water, or runoff? **Answer:**

	Yes, it should be 'amount of Surface water (ml)'. Thank you for your correction. we revised Figure 4B
5	Figure 4C and D, what does it say that the actual choices by the participants were so much below the simulated income, and mostly lower groundwater and runoff? **Answer:** *We provided a clearer explanation about the comparison between solution space and simulation results in the results section 3.2.4 Game solution space analysis.* "The presence of relationship values between humans and nature and humans and other humans (relational values) influences decision making regarding natural resource management (van Noordwijk et al., 2023, 2020). Therefore, the decisions made by players during the game are influenced by various factors (e.g. interactions between players, game settings, level of player ecological knowledge, etc.) (Rodela and Speelman, 2023), whereas random decision making is used to build solution space. For example, when the upstream and midstream groups decided to maintain and improve their economic conditions, they caused a reduction in groundwater supply and increase flooding for downstream area, which caused the downstream group to pay for the losses it experiences. Apart from that, during the game session the facilitator also provided PES scenarios (Appendix B, Game Play number 9: repeat step 6 for the rest of the rounds with additional scenarios such as providing payment for ecosystem services). This scenario offers downstream groups to contribute a certain amount of money to maintain more trees in the upstream and midstream. Therefore, the downstream player groups always spend more money than the mid- and upstream player groups either as a loss due to the environmental consequences (floods or water scarcity) or due to their efforts to prevent negative impacts by joining the PES program."
6	Figure C1: how do the villages match the peat dome? **Answer:** *Referring to Figure 2A (PHU Pawan-Kepulu), in reality the positions of peat domes are spread across several villages with different distribution. There are villages dominated by peat domes and buffering areas, and some of them are dominated by shallow peat. But, in the game board design, the distribution of peat depth (including peat domes) is distributed evenly in all villages. This is intended to facilitate replication for other locations.* We added further explanation regarding peat dome distribution across the village in Appendix D: "The hydrological boundary of peatland is a Peatland Hydrological Unit (PHU) as an area between two rivers. Usually in this landscape, there is a peat dome (the deepest peat area), an area surrounding the peart dome (i.e. buffering dome area) and an area with shallow peat. Villages are spread over the peat dome and the buffer zone with villages having different proportions of peat dome and buffer zone areas. However, for simplification, peat depth (including that of the peat domes) was distributed evenly between villages (Figure D1). However, for future game adaptations, the peat depth distributions in each village can be adjusted on the game board."
7	The paper needs a good copy editor throughout ,including the appendix.

	Answer: *Thank you for pointing this out. We scrutinized the revised version to be submitted.*

Response to Reviewer 2 (RC2)

No	Comments and Answers
1	In the manuscript, the authors provide a description of the H2Ours serious game developed and tested on two locations in Indonesia with an opinion on the possibility of adapting this game to other areas and conditions. While the reasons for developing such a game is clearly described and explained, the rules of the game and the flow of the game are not so clear for the reader. I found especially hard to follow so many subtitles in sections 2 and 3 (Methods and Results) that interrupt the reading flow and consequently the understanding of the game. Moreover, it is not clearly stated who should be the target group of players (students, farmers, general public etc.). **Answer** *Thank you for your comments. We have added more information according to your comments. We hope our response addresses your concerns and makes this manuscript clearer.* *We provided more detailed explanations of on how to define the role and rules in Section 2.3.2 and section 2.3.3, while the roles and rules of the H2Ours game can be found in Section 3.2.2, Section 3.2.3 and Appendix D as the result of this manuscript.* *We added more information about the participants in the Section 2.4 (Game implementation), please see our response to RC1 number 2b and 2c.*
2	For me as the hydrologist, the content of section 2.3 about game solution space analysis is not described clearly enough, more specifically, how did you produce random choices (e.g., using some software, etc.). **Answer:** *Thank you for your input. We added more information about the process of producing solution space in section 2.3.4* "The purpose of game solution space is to define the outcomes of all possible choices made by players in the game (Speelman et al., 2014). The solution space of the H_2Ours game was explored based on the average of economic and environmental outcomes obtained from 3, 10, 30, 100, 300 and 1000 games with random choice. One random-choice game consisted of 10 rounds in which climate conditions and land-use decisions made by players were completely random. The random-choice of land-use and climate condition were generated in R, then simulated using Excel spreadsheet as an imitation of the real H_2Ours game to calculate the economic and environmental conditions. In addition, we assessed the probability of outcomes within the

	solution space under random decision-making as a point of reference for the actual game implementation. “
3	Also related to the rules and flow of the game, it is not clearly described how and when the models shown in Figure 6 and Figure C3 take place in the game. Please clarify. **Answer** *Thank you for your concern. We revised text in the section 3.2.5 (Game Properties) to add more explanation about Figure 6:* “To make the game engaging, we prepared game materials such as a game board to represent the landscape, land-use tiles according to the existing and future land use types, play money token, and water infrastructures token (Fig. 5). We also created, water balance miniatures (Fig. 6) to demonstrate how surface water flows and leads to floods and water infiltration increases ground water supply. Each round after calculating the economic condition and environmental conditions based on Table 3, we asked players to pay production costs, taxes, etc. and get income, incentives, etc. using play money. The water balance was shown via a miniature with real water according to the produced surface water and groundwater “
4	In line 119 it is not clear what kind of values represent discharges 5 and 3,5 m^3/s (average in the mentioned year, some long-term average, something else?). Please clarify. **Answer:** *Thank you for question. The value represent the average throughout a year of the daily discharge. We changed the text line 120 to:* “Land conversion from agroforestry to intensive agriculture in the recharge areas (>700 masl. upstream and midstream area) and massive groundwater extraction using artesian wells in the downstream area for rice field were thought to cause the reduced average discharge of the Umbulan spring, from 5 m^3/s (1980s) to 3.5 m^3/s (2020) “
5	Table 1 in my opinion is too long/big and similarly as multiple subsections break the reading flow. I would suggest adding some summary into the text and moving the table into appendices. **Answer:** *Thank you for your suggestion. We moved table of criteria of credibility, salience and legitimacy to Appendix C, and replaced that table with short summary in the sub-section 2.5 line 253)* “From the long list of criteria (Belcher et al., 2016), we chose four credibility criteria, five salience criteria and two legitimacy criteria which we considered to be the most relevant for evaluating the H2Ours game. Each of these criteria were measured during the game design process and after the game implementation. We included those criteria during the game design using the ARDI and DPSIR frameworks to diagnose issues in the study area (Section 2.2).”
6	In line 231, a brief explanation about both methods, i.e. Likert scale and q-method, needs to be added. **Answer:**

	Thank you for your input. We decided to focus on the rapid evaluation using Likert scale survey and will elaborate the q-method result in the next publication related to the decision making pattern and player's perceptions. We elaborate the text in section 2.5 line 258 "A rapid evaluations were conducted after the game session to assess the game session process and the game in achieving its objective. We converted those game performace criteria and creadibility, salience and legitimay criteria into Likert used questions and asked all game participants to fill in the survey. In the Likert survey, we used five-point scales (strongly disagree, disagree, neutral, agree, and strongly agree) on six statements to ask participants about their feeling during the game, their understanding of the rules of the game, the length of the game simulation, new knowledge that they got from the game, and implementation the game to their reality "
7	In Figure 4, Figure D1, Figure D2, and Figure D3 it is not clear what are presenting solid blue, green, and red lines. Additionally, "ml" in legends should be replaced with "masl". In relation to these figures, why are there different thresholds used (e.g., 200, 800) than explained in lines 114–116? **Answer:** *Thank you for your suggestion. The legend is correct with 'ml' because it describes the amount of surface water and ground water. We will make the legend clearer. Please see Fig. 4* *We added more explanation about the threshold value (e.g. 200, 800) in the section 3.2.3 (line 320) because this is related to the rules of the game, and flooding, water shortages and land fires as outcomes from the calculation of Table 3 and Table D2.* "When during the rainy season the total of surface water in the downstream area of Rejoso watershed and in the shallow peat of Pawan-Kepulu peatland exceeds its capacity (>800 ml), it caused flooding. When the groundwater exceeds its capacity (>700 ml), the excess water flows to the Umbulan springs in Rejoso watershed and to sea in Pawan-Kepulu peatland. But, when the groundwater was less than <200 ml, it caused water shortages for agriculture in the Rejoso Watershed and made peat soil dry which triggered fires in Pawan-Kepulu peatland. These environmental impacts decreased the overall community income. As the consequence of this situation, the players might not have enough money to manage their land, buy food or pay taxes in the next round of the game. The multi-stakeholder forums with their limited budget could then choose to help them by providing financial help or making regulations/programs to prevent these environmental problems. Through this gameplay, we aimed to stimulate players to collaborate to achieve their goals."
8	In Figure 7, there are missing y-axis titles. Please add. **Answer:** *Thank you for your correction. we revised the Figure 7*
9	Please use en-dash throughout the manuscript in case of ranges and periods. E.g., 0–100 masl instead 0 – 100 masl. **Answer:** *Yes, Thank you. we checked all the manuscript and revised it*

10	Appendices should be mentioned in text in the order in which they appear, e.g., Appendix A before Appendix B. **Answer:** *Thank you for your input. We have change the order of the Appendices*

Response to Reviewer 3 (RC3)

No	Comments and Answers
1	Thank you for sharing this interesting work with me. First of all, please let me apologize if I have not properly understood those elements of the paper on which I give comments, or if my perception was wrong. The paper documents the process of designing and applying a serious game based on a system simulation model. The application of serious games as a contribution to sustainable development receives increasing attention also raising high expectations. The presented work documents a game design process and intends to provide evidence on outcomes from playing the game. It can help to better understand the potentials and limitations of the approach and can meaningfully inform future serious game design processes. I strongly support the publication of the paper. Having said this, I want to share some thoughts which I hope can help to improve the paper. **Answer:** *Thank you for your feedback and support*
2	a. The study has two objectives: 1. Develop an adaptable serious game 2. Assess if game facilitates knowledge transfer and sharing, and supports negotiation and coordination. I am not sure whether the paper really addresses these two objectives. Either rethink your objectives or structure the paper more strongly around the ones you formulated. You documented the game development process which I consider an important contribution. It is difficult for me to judge how easy it is to adapt the developed game to a different context. The paper does not really make this clear. **Answer:** *Thank you. We rephrased the two objectives to be closer to what we actually discuss* 1. *Develop a serious game that is adaptable to different socio-hydrological contexts and issues* 2. *Clarify how such game can facilitate knowledge transfer and sharing, and can support negotiation and coordination by context-specific use*

	b. I am even more concerned about the second research question. The methods section does not explain the approach in sufficient detail. An input-output process is mentioned as methodology without explaining it. You state that information was collected throughout the game development and implementation process. How was this information collected and analyzed? You mention a post-game survey. Please provide more information on: 1) who was interviewed and how have respondents been selected, 2) how many respondents were interviewed, 3) how was the survey implemented (also addressing the strong risk of social desirability bias), 4) when was it conducted? **Answer:** *We add more information about how we collect the data for the evaluation survey in the section 2.5 about the game evaluation.* "From the long list of criteria (Belcher et al., 2016), we chose four credibility criteria, five salience criteria and two legitimacy criteria which we considered to be the most relevant for evaluating the H2Ours game. Each of these criteria were measured during the game design process and after the game implementation. We included those criteria during the game design using the ARDI and DPSIR frameworks to diagnose issues in the study area (Section 2.2). A rapid evaluations were conducted after the game session to assess the game session process and the game in achieving its objective. We converted those game performace criteria and creadibility, salience and legitimay criteria into Likert used questions and asked all game participants to fill in the survey. In the Likert survey, we used five-point scales (strongly disagree, disagree, neutral, agree, and strongly agree) on six statements to ask participants about their feeling during the game, their understanding of the rules of the game, the length of the game simulation, new knowledge that they got from the game, and implementation the game to their reality." c. For answering the second research question, can you share information on the decisions of players in the game? Do you see patterns and changes over the rounds? Can you share information on what has been discussed during the game sessions? **Answer:** *As the objective of this manuscript is to document the development and adaptation process of the H2Ours game, so in this paper we focus on the development process. We plan to make a series of publications about H2Ours game in Rejoso watershed and Pawan-kepulu peatland:* 1. *H2Ours game development and adaptation process (this manuscript)* 2. *Result of the H2Ours game.* We decided to present the results of the H2Ours game in different manuscript to have more space to present the conditions of the research location which are closely related to how players make decisions regarding land and water management, including changes in perception and knowledge. We mentioned it in section 3.3 (game implementation result): "Further analysis to these different perspectives will be presented in follow-up manuscripts (Tanika et al, in prep)."
3	In this context, I recommend giving more weight to Section 3.3. Interesting statements are made regarding the game dynamics. It could be combined with some statements included in the

	discussion (e.g. that setting up the game has built emotions). The value of the information depends, however, on the transparency of how information was generated. **Answer:** *We agree with your statement. In accordance with the objective of this manuscript which focuses on the H2Ours development process, the results shown in this manuscript are more about the form of the H2Ours game itself. Implementation results are presented in section 3.3 is only indicative result. We believe that the dynamics of the game results correspond to the character of the socio-hydrological system and changes in participants' perceptions can be an interesting article which provide more space for explanations. So we will deliver more detailed result in another paper.*
4	On a conceptual level, I am not convinced that collecting data on credibility, salience/relevance, and legitimacy can answer the second research question. This would at least require stronger justification. Going a step further, I do not think that the survey questions are adequate indicators for Belcher's et al. criteria. For instance, asking a player whether she sees the possibility to apply the knowledge acquired in the game does not provide information on how inclusive the process has been. I would propose a more differentiated approach regarding how you provide evidence on different criteria. Players will not be able to give meaningful answers to some of them. For instance, by playing the game, a player does not need to be aware of the underlying theory of change. I would move Table 1 to an appendix to make space for a better explanation of the methodology and the key results. **Answer:** *In the theory of change related to this game, the desired changes refer to the 4 stages of the knowledge to action chain (understanding, commitment, operationalization and innovation). Based on the definitions of credibility, salinity and legitimacy in section 2.5 line 250:* "From the game development perspective, credibility refers to whether a game is built based on scientifically reliable knowledge, including the data and methods used to build the game. Salience refers to how far the game can show the relevance of goals, rules and finding to the actual situation. Finally, legitimacy refers to how the participant can accept the game by relating the game simulation to their actual situations (Cash et al. 2002)." *In order to achieve the second objective of this paper, to clarify how games can facilitate the sharing and transfer of knowledge, we want to ensure relevance of game situations to the reality (salience), the acceptance that game conditions resemble their conditions (legitimacy), and supported by appropriated data and methods (credibility).* *Thank you for your suggestion. We moved table of criteria of credibility, salience and legitimacy to Appendix C, and replaced that table with short summary in the sub-section 2.5, please see our response to Reviewer 2 (RC2) number 5.*
5	A clear theory of change is one of the evaluation criteria and it needs to be expressed in a more explicit way. In lines 42ff, the authors argue that knowledge supports commitment (intention?) supports responsibility, supports innovation. It is not clear which type of knowledge, commitment, responsibility, and innovation the game intends to support. The learning outcomes are formulated rather vaguely. In the model framework, the authors include the assumption that

	income drives decisions. In the discussion, you argue that the enabling environment is the key driver and no behavioral change can be expected if regulations etc. are not adjusted. Considering all these thoughts and assumptions, what did you intend to change by letting stakeholders play the game? **Answer:** *Thank you for your concern. We agree that we have not written down specifically what form of knowledge we want to convey in this form of game. We revise the sentence in section 4.2 (line 482) to:* "As hydrological problems are usually complex and fundamental, any potential solution requires ample time for integrated planning, and all relevant stakeholders to understand the dynamics of the system at large scale (Medema et al., 2019). The H_2Ours game tries to present simple representation of the landscape so that it makes it easier for players to be aware of the conditions of neighbouring players and to gain system level perspective of socio-hydrological issues. Improving player knowledge by looking at socio-hydrological problems in a broader context encourages responsible behaviour towards the environment which is directly proportional to commitment (Keles et al., 2023).. *We also revised the third lesson learned to reduce miss interpretation (line 503):* "Third, based on the evaluation and debriefing results, even if they stated they can apply the ideal collaborative actions that were explored in the game session, in real life, the enabling conditions needed to support this still required to be build (e.g. regulation, integrated planning strategies, etc.). As the game is a simplification of the real-life system, forms of collaborative action can be discussed directly by the players. In real life, the parties that are needed for successful collaboration may not easily meet each other to discuss issues openly. Therefore, it is necessary to create a condition where stakeholders can meet and explore collaboration options to jointly address issues and achieve goals. Without such encounters, the commitment that referred to in the four knowledge-to-action chains cannot be attained"
5	Based on the provided information, it is difficult to understand the structure of the game. Key aspects are not explained, such as: Number of players per session; who was selected to play the game (relevant also for theory of change) Types of roles; in section 3.2.2 is described that there are two roles namely communities and a multi-stakeholder forum. But then one finds statements that there are upstream and downstream actors, different villages etc. Is the role definition linked to the diagnosis? Who in Table 2 creates pressure? Who is involved in the responses and dynamics? Are the relevant actors included as roles? Such game development decisions are critical for the theory of change. **Answer:** *Thank you for your concern. We elaborated Section 2.4 (Game implementation) and added more information about the players in this study. Please see our response to RC1 number 2c* We added more explanation on section 3.2.2 (roles):

	"Based on the stakeholder identification survey in Rejoso Watershed and Pawan-Kepulu peatland, we defined two key roles for this game, namely a multi-stakeholder forum and local (or farmer) communities. The goal of the multi-stakeholder forum is to prevent natural disasters meaning water scarcity and floods in Rejoso watershed, and fires and floods in Pawan-Kepulu peatland. In the Rejoso watershed, local communities can be grouped into people who live in the upstream village, midstream village and downstream village based on the village elevation. Meanwhile in Pawan-Kepulu peatland, local communities can be grouped into four groups of people living in four neighbouring villages (Village 1 – Village 4). Local communities represent landowners. Their goal is to fulfil their household needs (food and taxes). The H_2Ours game brings the various interests of these actors together and shows how they make their decisions regarding the management of land and water resources to meet their economic and environmental expectations." *In the section 2.3.2, we already mentioned that how we defined the roles based on the ARDI framework:* "According to the ARDI framework (Sect. 2.2), we defined the roles based on the main stakeholders involved in water management in each study area. Related to these roles, we designed goals that players must achieve during each simulation based on discussions and interviews with the related stakeholders according to their actual goal". *We revised section 3.1 (result: Diagnosis of the study areas and issues) based on your input:* "Based on the results from the DPSIR and ARDI analyses, we found that the Rejoso Watershed and the Pawan-Kepulu peatland have similarities in the socio-hydrology context (Table 1). Expectations on better economic conditions led local communities to changes in land cover, and excessive extraction of water resources (groundwater) caused disruption of the water balance. This disruption resulted in local communities and multi-stakeholder forum experience various hydrological problems, such as water shortages (or decreasing the groundwater level) and flooding. However, these two sites are also different regarding their hydrological contexts, such as hydrological boundaries, topography, and water management, and interactions among stakeholders and landscape (Fig. 3, Fig. D1). Two proposed solutions (responses) were identified by ICRAF and Tropenbos Indonesia based on their research findings to restore hydrological functions in watersheds and peatlands, namely better land use management and (ground) water management (Table 1; component 7-Response)."
6	a. Which decisions can be taken by which player role? Table 3 and Figure 3 give the impression that only crop and forestry related choices can be made. But then it is mentioned that players can block channels. The choices of the multi-stakeholder forum are formulated very unclear and are not included in Figure 3. How could the forum make regulations or programs to prevent environmental programs. **Answer:** *Thank you for your concern. We added a paragraph in section 3.1 (p.2) related to Figure 3 and Figure D1 to explain what the types of decisions they make that affect their landscape.*

"The interaction between stakeholders and the landscape is represented by the type of decisions regarding their landscape taken by the multi-stakeholder forum and local communities. Local communities (farmer from upstream, midstream, and downstream village in Rejoso Watershed and farmers from neighbouring villages: Village 1-Village 4 in Pawan-Kepulu peatland) have the authority to make decisions regarding their land which consists of land-use types and water management types (artesian wells in Rejoso watershed and canal blocking in Pawan-Kepulu peatland). Multi-stakeholder forums have authority over regulations and programs applied to local communities to achieve their goals. Multi-stakeholder forum can refer to their existing or potential regulation and program"

We revised Section 3.2.3. (Rules) to give more explanation about the option of land use types and options of regulation and program by multi-stakeholder forum.

"At the start of the game, players (i.e. multi-stakeholder forum or local communities) received a limited amount of play money. Community members were asked to manage their land to meet their household needs by arranging the land-use type combination and water management in their area with the play money provided, while multi-stakeholder forum was asked to run programs or to help reduce the local community's financial problems. Once players decided on how they would manage their land or community programs, the economic and environmental rules linked to those land-use decisions were applied (Table 2). These rules then defined the dynamics of the economic and environmental conditions (Table 2, and Table D1 and D2 for the Pawan-Kepulu peatland). "

b. Please also better explain how you decided on the players' choices in the game.

Answer:

We invite the players through village leaders and farmer group leaders, and let them decided who would attend the simulation. However, in the invitation we gave the criteria of the participants. We already added this information in the section 2.4 (game implementation). Please see our response to reviewer 1 (RC1) number 2c..

c. In the discussion is mentioned that the game could not capture the complexity of the system and that few issues had to be selected to be included in the game. Please describe the process from diagnosis to selecting the issues to be included in the game. Such game development decisions are again critical for the theory of change.

Answer:

In the discussion we mentioned that based on several publications, these two research studies have more complex socio-hydrological problems than played in the H2Ours game. In the beginning, we wanted to include all problems in one game such as erosion, landslides and sedimentation. However, during the game development process, especially in the preparation of rules and the quantification systems, the game becomes very complex. Considering the background of the targeted participants and the game duration, we decided to only highlight one hydrological problem. We determined which issues to raise based on the national priority issue in that location.

	We add more information on how we chose the issue for the game in the discussion. Please see line 447: "The two study sites experience more complex socio-hydrological problems than represented in the H_2Ours game. In our game, the water quantity issues were represented in line with national priority issues in that location, which resulted in groundwater scarcity and floods for Rejoso, (Fig. 3) and fire and floods for Pawan-Kepulu peatland (Fig. D1)." d. Are decisions taken collectively (a group represents one role and decides based on some agreement) or individually, creating collective outcomes. In line 433 is stated that the game demonstrated the value of collective action. How is collective action implemented in the game? **Answer:** *Yes, a group represent one role. When we started the game, the facilitator asked to choose a leader to represent their group.* e. Did the players receive real money? If yes, how was the payout determined? Did it depend on the game dynamics as is common in behavioral games? If not, make clear in Section 3.2.3 that you talk about a game endowment/play money. **Answer:** *I am sorry, i do not really understand your question. I assume your question is about the use of real or play money and how to determine it. We revised section 3.2.5 (game properties) to explain about the play money and water balance miniature.* "To make the game engaging, we prepared game materials such as a game board to represent the landscape, land-use tiles according to the existing and future land use types, play money token, and water infrastructures token (Fig. 5). We also created, water balance miniatures (Fig. 6) to demonstrate how surface water flows and leads to floods and water infiltration increases ground water supply. Each round after calculating the economic condition and environmental conditions based on Table 3, we asked players to pay production costs, taxes, etc. and get income, incentives, etc. using play money. The water balance was shown via a miniature with real water according to the produced surface water and groundwater."
7	a. A more comprehensive explanation of outcomes resulting from choices would be important for understanding the game. For instance, in Table 3, can you provide likelihoods of flooding, water shortage, and fire events for different land use options? **Answer:** *We add more explanation in Section 3.2.3 explaining how we determined environmental impacts (floods, fires and water shortage).* "When during the rainy season the total of surface water in the downstream area of Rejoso watershed and in the shallow peat of Pawan-Kepulu peatland exceeds its capacity (>800 ml), it caused flooding. When the groundwater exceeds its capacity (>700 ml), the excess water flows to the Umbulan springs in Rejoso watershed and to sea in Pawan-Kepulu peatland. But, when the groundwater was less than <200 ml, it caused water shortages for agriculture in the Rejoso

	Watershed and made peat soil dry which triggered fires in Pawan-Kepulu peatland. These environmental impacts decreased the overall community income. As the consequence of this situation, the players might not have enough money to manage their land, buy food or pay taxes in the next round of the game. The multi-stakeholder forums with their limited budget could then choose to help them by providing financial help or making regulations/programs to prevent these environmental problems. Through this gameplay, we aimed to stimulate players to collaborate to achieve their goals." b. The choices in Table 3 indicate that unsustainable options provide highest income. At the same time, your model (Figure 3) works with the assumption that income mainly drives choices. How do you address the risk of unsustainable learning outcomes? A player's answer in the evaluation survey that she can apply the game learnings could mean that she learnt that an upstream-all-crop strategy is best. **Answer:** *I understand your question and concern. When we talk about the best scenario at the landscape level involving many stakeholders, there may be a conflict between the best scenario for whom and for what. Hence, the H2Ours game tries to convey this issue through one of its objectives related to a shared understanding by bringing the socio-hydrological system as one system. By understanding condition, we expect that a commitment will emerge to overcome their common problems through negotiation and coordination between stakeholders. This game was designed to resemble actual conditions, so it could provide an illustration of the solution to their real problems. However, to achieve sustainable learning outcome, other efforts are still needed such as implementation (adapting what they learnt from game simulation to real life), monitoring and evaluation.*
8	I do not understand the step of the game solution space analysis. What does it mean that the solution space was explored based on 3, 10, 30, 100, 300, and 1000 games with random choice? How did these 1000 games differ? Just explain this better for readers not familiar with your modelling and game development approach. **Answer:** *We elaborate on section 2.3.4 to explain in more detail about the solution space and the method used to generate it. Please see our response to Reviewer 2 (RC2) number 2*
9	Line 74f: I challenge the statement that models and games have rarely been combined. There are numerous examples for instance on the website https://games4sustainability.org/gamepedia/. I am also aware of the following study: Lohmann, D., Falk, T., Geissler, K., Blaum, N., & Jeltsch, F. (2014). Determinants of semi-arid rangeland management in a land reform setting in **Answer:** *Thank you – our text was indeed inaccurate here. We corrected to line 73:* "Socially interactive games and models that explore larger spatial and temporal horizons have complementary strengths. As reviewed in Villamor et al., (2023), games and models can 1) seek a

	conceptual triangulation of representing the processes behind complex realties, 2) strive for numerical consistency between games and empirical models, 3) use games in the development of scenario models, or 4) use models in the design of games that trigger players to learn by experiencing manageable complexity. As an example of the letter, Lohmann et al. (2014) designed and tested model-based role plays with Namibian land reform beneficiaries, simulating 10 years of rangeland management. In this paper, we explore the feasibility of transforming a hydrological model into a serious game to provide socio-hydrological dynamics to stakeholders with diverse backgrounds to develop restoration plans.”
10	Line 80f: As a complementary approach, the authors may want to consider providing guidance on context conditions which need to be fulfilled for meaningfully using the games. Also, can you estimate the size of the areas which share socio-hydrological conditions which are featured in the presented games? **Answer:** *The current games rely on hydrological units without major unrecognized in- or outflows. In many cases groundwater flows into or out of agriculturally used areas may be relevant uncertainties in the use of water balance models. In both the mountain-to-sea and peatland hydrological units groundwater flow issues are internalized in the game. In many landscapes the social systems don’t match the hydrological boundaries; spatially explicit social subsystems, such as upper, middle and lower watersheds can be accommodated, while interactions with social systems beyond the game boundaries may be represented by economic (supply, demand, prices) parameters and their (exogenous) fluctuations.*
11	Line 185f: On which basis do you assume that decisions of players in the game represent their real-life decisions? Did you ask them to do so? Why do you need this assumption? **Answer:** *Sari et al. (2023) tested for the plot-level FORCES game whether farmers land use system and tree choices matched their actual conditions outside the game. For H2OURS we don’t have the same detailed comparison yet. However, during the game simulation process we see whether players play according to their actual conditions based on the choice of land cover they choose or not. We compared how they selected land use during the game simulation with the actual land use. Part of the game properties, we provide land use types according to their actual conditions and some other land uses that may be options in the future. We did not directly ask them to play according to reality, but in the beginning we created conditions in accordance with their reality. In this study, we expected participants to play according to their reality at the beginning because one of the goals of this game is to facilitate negotiation and collaboration between stakeholders to achieve the hydrological restoration target.*
12	Can you please better link your discussion and conclusions to the objectives of the paper and the presented results.

	Answer: *Thank you for your input. We will look again the link between objectives, discussion and conclusion*
13	Now that you have developed the game, can you share some thoughts on how your games could be applied to support sustainable development? Who could facilitate games with which target groups? What would be required to implement the game with a larger group of stakeholders? Ideally this way forward should be linked to the theory of change. **Answer:** *My research has a significant correlation to SDG 6 (Clean water and sanitation), SDC 13 (climate action) and SDG 15 (Life on land), but also supports SDG 16 (Pace, Justice and strong institutions) and SDG 8 (Decent work and economic growth). The complexity of water resource management arises from many stakeholders who have different backgrounds, interests, targets and knowledge have to make decisions related to the same system. Because they do not know that they are working in the same system, they do not know that their decisions might affect other stakeholders. Therefore, changes in point of view of stakeholders to realize that they are actually working in the same socio-ecological system are needed. H2Ours game simplifies a landscape that has the same hydrological system, allows stakeholders to see the same system and makes it easier for them to collaborate to solve problems or achieve common goals.* *For broad stakeholder groups, it requires identification of key stakeholders who are participants in the player. In the game development process, we mentioned in the roles of the game. The facilitator's ability and knowledge in leading the game also plays an important role in briefing, implementation and debriefing*
14	I hope my comments help to improve the paper. I think my concerns can be addressed in the frame of a major revision. I very much hope to see an improved version of the paper being published. Answer: Your input is very useful and valuable for us. We really appreciate your time for this manuscript.

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