

## REPORT 2

Dear authors,

I have some minor questions to you: first reflects the selection of your sampling. Can you provide some further information about the sampling: a) number of people, b) how you selected your sampling, c) how you analysed your data/or used for your modelling etc. Additionally, I wanted to ask you if you could provide some critical reflection of using participatory hydrological modelling: a) what's the advantages/disadvantages of using your approach like what are the main lessons; b) limitations. Finally, I wanted to ask you if you can provide a discussion about your experiences with transdisciplinarity research and how for example power relationship in the case study influenced your results.

### Responses to reviewer 2

We are very pleased by Reviewer 2 comments, that have been included in the 3<sup>rd</sup> version of the document, a version that already included many of these concerns, but that had room for further improvement.

- 1) Regarding information on the stakeholder sampling, we have included more information in paragraph 190: "As Figure 2 shows, the hydrological model structure was built with inputs from the stakeholders by discussing: i) causes of the water crisis, and ii) management strategies to solve the crisis. Levels of citizen participation varied depending on the modeling stage. In stage 1 stakeholders' consultation was part of our own participation in five meetings of the Voluntarily group where Key Actors previously selected by the Governmental effort, discussed possible causes for the lake desiccation, (information later transformed into model variables). In stage 2, in depth interviews and photointerpretation with key local stakeholders' and local agriculture experts were used to better improve the modeling process (including characteristics of each plot in terms of assets, production, and general reasons for changes). In Stage 3, possible strategies and scenario analysis were determined conducting group semi-directed interviews with 10 representatives of governmental and non-governmental organizations (table 1) for each of the different land uses identified (more information in Ocampo-Melgar et al., 2021)."
- 2) Regarding critical reflections about the experience and approach, this new version of the manuscript has a paragraph with reflections in each one of the steps in section results, that answers to this comment. For example in paragraph 360, about step 4.3 we mention: "In this step, although we agree with previous research that stakeholders' involvement improves hydrological model acceptance within the community (Voinov and Gaddis, 2008; Voinov and Bousquet, 2010; Basco-Carrera et al., 2017), as well as helps opening doors to alternative information that the community may have, we also found that this does not necessarily reduce conflicts, as the information found in this case was not what some stakeholders were expecting.". Similarly in paragraph 425, step 4.4 we discussed the following: "Regardless of the stakeholders' feedback that helped improve the model and the interesting combination of strategies and novel information that was gathered during the process, as we learned from the Aculeo case, the scientific process of progressively adjust model and results may be perceived as lack of certainty by some participants, especially by those that support certain theories that are discarded in the process."

- 3) To address reviewer suggestion of discuss power relationship in the case study, this new manuscript includes paragraph 450 that tells what happened after the modeling process: “The process and model results were key to support conversations and strategies evaluation during the first year of the Collaborative meetings (2018-2021). However, other political changes and economic interests affected the internal dynamics of this collaborative group that had a short span of funding (2 years). At the same time, as the model results not necessarily validated all opinions and expectations, it was no longer useful for some stakeholders at the AVGC.”. Additionally, discussion section in this new version is completely focused on our “insights for science society initiatives involving hydrological modeling under limited information, and when underlying conflicts may demand a more cautious, but still, participatory process, to help uncover crucial elements for the modeling process success”. This discussion mentions 5 key points, in which the *no neutrality role of the hydrological model* is an aspect that responds directly to reviewers Comments.

### **REPORT 3**

Dear authors,

Please see attached file for more detailed questions and comments.

This account will be of interest to experts interested in conflicts over water management, presenting a first-hand account of the challenges that modellers can face when they are involved in conflict resolution. As a social scientist involved in participatory research, there was little original content in the paper, with the authors confirming many foundational observations about conflict, uncertainty, and science-society relations. As a contribution to participatory water management and conflict resolution, the results are of minor interest. Alternately, as an account in which some of the foundational critiques of top-down participation are experienced and grappled with, then the paper offers a valuable window into the position and learning of the modellers. A first-hand account of these challenges is interesting.

Such a re-framing of the paper would entail a reasonable amount of work, mostly taking the form of reflection and self-critique. This suggestion may not appeal to the authors, which is their prerogative, but could be implemented with a few additional elements to the paper.

### **Responses to Reviewer 3**

We appreciate Reviewer 3 comments on how to improve the manuscript. In fact, as reviewer can corroborate, the second version of the manuscript addresses completely this re-framing suggestion. The manuscript better described the process step by step, including critiques and comparisons of our findings against the literature review. Discussion is including specific information regarding suggestions and critical reflections on the limitations on both the approach followed, and participation in hydrological modeling.

Nonetheless, there is always room for improvement, and we followed these suggestions to better address reviewer comments. See below for more information:

## 1) what is 'participation'?

The authors do not define what they mean by participation and therefore sit within a vague and implicit understanding. I suggest that the team engage with a typology (e.g., Arnstein 1969 or Callon 1999) to assess the type of participation that they were able to implement. This would situate the lessons and findings within the discourse on participation. As a reader, their venture appears to be more of a consultation or informing exercise, with meaningful power remaining with the research team rather than being distributed to participants. That has implications for what can be said about 'participation'.

**Response 1:** In the second submitted manuscript, line 175 we mentioned “In the line of the participatory modeling literature and the categories of participation (Basco-Carrera et al., 2017), the Aculeo Lake modeling followed a consultation during the modeling stage and a discussion during the scenario analysis, going back to a co-design to refine the model structure and input used in the modeling stage (Figure 2)”.

To better address Reviewer comment in this 3<sup>rd</sup> version we are adding: “Basco-Carrera et al., (2016) levels of participation for water resources planning and management is partly based on the Ladder of Participation by Sherry Arnstein (1969), a description of 8 levels of citizen participation that is linked with power over decisions being made, Bruns (2003) that proposed an extended ladder including terms such as autonomy, advising and enabling, and Mostert (2003) that takes these ladder into water policy defining levels of citizen influence from information, consultation, discussion, co-designing, co-decision making and independent decision-making.”

## 2) problem designation and boundary work

The authors take as foundational the need for modelling to inform discussions, existing policy, and the economic basis for water governance. While acceptable, these boundaries impose a particular framing onto the discussions - something the authors explore with their recognition of including community-determined alternatives that are of less significance than the agricultural adaptations. Along with these boundaries, and in the figures provided, there is no account of 'how the problem was defined and chosen'. In the 'understanding the problem' (Figure 2) there is some indication of the 'questions that would like to be answered' relative to what is possible to model, but no reflection on whether this discussion was open to stakeholders, whether there were dissenting views, or whether some stakeholders withdrew due to the definitions. In a related way, there was no clarity on how the stakeholders were chosen, whether they all had equal voice, and how decisions were aggregated (i.e., table 2 implies levels of agreement but does not grapple with the nature of the sampled participants nor who was excluded or why the group (table 1) is tilted towards government and commercial participants.

**Response 2:** As reviewer mentions, indeed we believe that hydrological modeling process and outcome can help water management decision-making and even transition into more transdisciplinary processes. In fact, in the Aculeo basin is an example where many strategies can be implemented to address social revolt, but later result in mal adaptation; or the contrary, do not test ideas because it may have little impact, but could answer doubts that are increasing mistrust.

However, as we explain in Line 72, this modeling process was never intended to be participatory, but we saw the opportunity to use the existent collaborative process to frame the modeling process

(not the opposite) and incorporate more participation in stages of the modeling: “In this article we will explore these participatory modeling best practices recommendations in a case study that was 1) not originally intended as participatory, 2) in a community experiencing conflict over an environmental catastrophe and 3) while other governmentally-lead attempts at finding collaborative solutions were being implemented”. Later in line 143 we explain that “Although the AVGC and the hydrological modeling were designed to be implemented in parallel, giving the level of conflict and large number of uncertainties, we saw an opportunity to actively participate in the AVGC process and advance towards a more collaborative hydrological modeling.”. As we mention in line 76, “Insights from behind the scenes during the Aculeo Lake modeling process are used to develop guideline that contributes to participatory modeling and transdisciplinary efforts in contexts of high conflict and poor information on the hydrological system”. What we mean with this, is that we did not have any influence on “how the problem was defined and chosen” during the AVGC discussions; but we used those different problems presented to better structure the model and include variables that could give some answers to those questions and concerns.

From this more disorganized experience is that we reflected and assembled a participatory modeling process that has nonetheless limitations that are explored in this revised version. In line 261 we mention: “The main results from this research are presented in a 5-steps guideline that indirectly resulted as the main outcome of this engagement that started a traditional modeling and slowly transitioned into a more participatory process”. Later in each step we include reflections of science-policy challenges, such as in line 429 where we present the certainty demanded from science: “Regardless of the stakeholders’ feedback that helped improve the model and the interesting combination of strategies and novel information that was gathered during the process, as we learned from the Aculeo case, the scientific process of progressively adjust model and results may be perceived as lack of certainty by some participants, especially by those that support certain theories that are discarded in the process.”

Having clarified this, to better respond to this comment, in this 3<sup>rd</sup> version we have included figure 2 to better explain the process and placed figure 3 (earlier figure 2) in the section that better explains how information was collected and used in the different the stages. Section 5, discussion now only presents reflections on the challenges of the participatory modeling in general and the role of this type of tools “when underlying conflicts may demand a more cautious, but still, participatory process, to help uncover crucial elements for the modeling process success” (line 470). We also have included information about what happened after both the modeling and the AVGC process finished.

Regarding participants, in line 206 we mention: “A refined list of those 12 strategies mentioned along with a list of other strategies that are being applied in similar basins, were presented to 25 individuals from nine stakeholder’s groups that were previously selected as key actors by the AVGC process (Table 1) to elicit their interest or concerns about the strategies.” What we mean by this, is that we did not select stakeholders, as they were identified and already participating in the collaboration process for almost a year when they were interviewed by our team conducting the hydrological modeling.

To respond reviewers’ question on the stakeholders’ power over results, in line 213 we mention that “All stakeholders had equal voice, and information was not aggregated, but only used to better understand the degree of acceptability of each strategy”. Finally, to better clarify the group of

interest of each type of stakeholder we have included a column in table 1 with the categories: government, private and society.

3) the grammar and language are not to a publishable level and will require further editing for clarity.

Overall, when I read the paper, I enjoyed the aspects where the team struggled with their role within the process. For example, when the team reflects on withholding any recriminations in order to remain 'objective' the question I had was 'why?' The lingering positivism and desire for objectivity is misplaced within a stakeholder engagement where the participants are attempting to contribute to decision making; if, on the other hand, the authors were remaining impartial in order to present objective information for decision making, then it is not participation. If there are 'culprits' then the team refusing to say so - in the hopes of maintaining dialogue - does help the culprits. When the authors find themselves caught between these interests and expectations, the paper is interesting and represents a useful contribution for other experts interested or compelled into public debate. This reflection, along with the argument that modelling requires more funding in order to contribute to decision making (ln. 525), shows me that the modellers have attempted to exclude themselves from critical reflection. In doing so, they are left to recognise that conflicts and uncertainty makes for difficult situations in which scientific expertise is subject to public critique.

**Response 3:** We are glad that the reviewer has enjoyed aspects of the article related with the struggles of transdisciplinarity, as it was our original goal. In this second version we better present separately both the process and positive results that proved participation it is important; but also, the challenges and limitations that we encountered due to the existent level of conflict and maybe the ingenuity of the team. This third version has also reviewed the grammar, hoping to be at a publishable level.

In this version, we are not excluding ourselves from the reflection, but we are including learnings in each step (result 4), and devoting section 5 to present four messages that show, as the reviewer mentions that there is unavoidable “struggle that modellers can have find themselves involved in debates where values are in dispute, stakes are high, and uncertainty is endemic”: 1) Conflictive situations require facilitated participation, 2) the need to accept manageable uncertainties, 3) approaching positions have a limit, and 4) the no neutral role for the hydrological model. Specifically in point 4 we discuss why “recognizing the political role of the hydrological model is part of making the process and us, researchers, better at identifying ways to address science society interaction and communication when stakes are high, decisions urgent, and uncertainties irreducible (Funtwicz and Ravetz, 1993)”.

Regarding “the team refusing to point at culprits”, we are clarifying in the text that we meant at reaching to conclusions early in the process “when the hydrological balance study was still in process” (line 434). But we also want to stress that we believe that pointing out at culprits is neither at aim at “remaining impartial in order to present objective information for decision making”, but it is because usually water problems do not have a single source of problem. To stress this, we have included the sentence and references that explore many aspects of this and other case in line 435: “a complex combination of factors (Barria et al., 2020), affecting unequally multiple actors for sometimes indirect reasons (Trimble et al. 2021; Ocampo-Melgar et al., 2022 *under review*), and with very different and valid points of view (Ocampo-Melgar et al., 2021).

Trimble, M., P. R. Jacobi, T. Olivier, M. A. Pascual, C. Zurbriggen, L. Garrido, and N. Mazzeo. 2021a. Reconfiguring water governance for resilient social-ecological systems in South America. Pages 113-135 in J. Baird and R. Plummer, editors. *Water resilience: management and governance in times of change*. Springer International Publishing, Cham, Switzerland.

Ocampo-Melgar A, Barria P, Chadwick C, Diaz-Vasconcellos, R. (under review). Rural transformation and differential vulnerability: Exploring adaptation strategies to water scarcity in the Aculeo Lake basin (Chile). Manuscript submitted to *Frontiers in Environmental Science*