

***Interactive comment on* “Do users benefit from additional information in support of operational drought management decisions in the Ebro basin?” by Clara Linés et al.**

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Reply to Anonymous Referee #2

We thank the reviewer for the time and effort to review the manuscript and for providing suggestions to improve it. We include below answers to the specific comments and indications of how the manuscript could be change to address the issues raised by the reviewer.

[Referee] I have approached "Do users benefit from additional information in support

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of operational drought management decisions in the Ebro basin?" by Clara Linés and co few times by now. The paper touches a very timely topic and (it seems that it) takes an interesting approach to quantify the value of different information attributes on decisions that various stakeholder can take across various spatial scales. The paper demonstrates application of the methodology is Ebro River Basin in northern Spain, which is highly regulated and intervened by socio-economic activities, in particular irrigated agriculture and hydropower generation. As far as the context of the paper is concerned, the paper is certainly inline with aims and scope of HESS and can attract a large portion of the journal's readership. However, at this stage the paper suffers from major issues. In particular, the paper is quite disorganized in terms of sectioning and the sequence of materials provided. Second, it seems that presentation in the paper lacks effective strategy, which hinders the reader to get involved with the paper. Finally, the level of details regarding the data obtained through interviews, methodology used for modeling, experimental setup and investigation made is quite low, in a way that the work is indeed not producible, if someone wants to apply the same approach in another case study. I do believe the paper should go under major revisions, in terms of the rationale and the content provided and resubmitted for another round of review, this time focusing on the specific results and findings.

Reply: We thank the reviewer for underlining the timeliness of the topic and that its contribution to the readership of HESS. We do apologise though that it appears that the organisation of the paper was not, to the reviewer, as clear as it could be and will endeavour to improve this clarity. We hope and firmly believe that the improvements we propose to the structure will benefit its clarity and remove the confusion.

[Referee] Below, please see my specific comments

1) The paper is poorly written. The use of English can (and must) be improved in many parts of the paper (e.g. P1, line 8; P2, line 7-9 among others). In addition, it is very hard to read the whole paper in one sitting (at least I was not able to accomplish) due to long sentences and the existence of a lot of text. I strongly suggest a major editorial

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effort before the paper resubmitted.

Reply: We have carefully analysed the sentences referred to, and can unfortunately not see any grammatical issues with these. However, we do agree that those and other sentences in the manuscript are long, and that such long sentences make reading the text more difficult.

Suggested change: We will review the manuscript and shorten sentences that are unnecessarily long, and summarise the text where possible. Also, the changes of the paper structure suggested as a response to comment 3 will help reduce the length of the paper. We will carefully revise the paper again to ensure correctness of the English grammar used.

2) It seems that the paper has missed positioning itself in the broader context of the current socio-hydrology research. On the one hand, review of previous studies in other parts of the world has been largely ignored. This includes for instance missing previous works on performing semi-structured interviews, developing decision support models through stakeholder engagement, and quantifying the value of information. The paper requires framing itself very clearly in the introduction.

Reply: The intended scope of our paper is to perform a stakeholder oriented analysis of the value of information for drought management decisions. We therefore positioned the paper primarily in the context of research that explores the value of information to decision making. This is the reason why we motivate in the introduction our study from that perspective, primarily providing references that call for this type of research and calling on examples of previous studies that have addressed the quantification of the value of information in support of water management decisions, both from a stakeholder oriented perspective and from a scientific perspective. We do agree that this paper also fits to some extent within the context of the developing field of socio-hydrology in that it explores the co-evolution of the availability of water and the decisions taken by humans (in this case farmer and irrigation operators). While the emerging field

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of socio-hydrology (Sivapalan, 2002) is a broad field (see also the review of the first biennial of the proclaimed IASH Panta Rhei decade, McMillan et al., 2016), our work is related most to the working group on Drought in the Anthropocene (van Loon et al., 2016), which explicitly addresses the inefficiency of drought management due to poorly understood feedback between people (and the decisions they make) and drought conditions.

As noted in response to the comments of the first reviewer, the objective of the semi-structured interviews was primarily to build our understanding of how the farmers behave as a function of their expectation of water availability, and we do not consider our approach to these interviews as the main contribution of this paper. We have selected this approach as semi-structured interviews are a specific method suited to gather stakeholder input. We agree that its use in hydrological research can be better contextualised by including references to other research that use semi-structured interviews to develop an understanding of stakeholder behaviour.

Suggested changes:

We will extend the introduction to position our research within the context of the emerging field of socio-hydrology, referring in particular to the current poor understanding of how the decisions people make contribute to an efficient management of drought. We will include references (see above) as appropriate. In the methodology section we add the following references about the use of semi-structured interviews:

- Carr et al (2011), that use semi-structured interviews to understand what drives the decision of farmers to reuse wastewater in Jordan.
- O’Keeffe et al (2016), that describe an example of application of semi-structured interviews to gather data on farmer water use practices in two Indian districts.

References:

Carr, G., Potter, R.B., Notclif, S. (2011) Water reuse for irrigation in Jordan: Perceptions

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of water quality among farmers. *Agricultural Water Management* 98 (2011) 847–854. doi: 10.1016/j.agwat.2010.12.011

McMillan H., et al. (2016) *Panta Rhei 2013–2015: global perspectives on hydrology, society and change*, *Hydrological Sciences Journal*, 61:7, 1174–1191, DOI:10.1080/02626667.2016.1159308 O’Keeffe, J., Buytaert, W., Mijic, A., Brozovi, N., Sinha, R. (2016) The use of semi-structured interviews for the characterisation of farmer irrigation practices, *Hydrol. Earth Syst. Sci.*, 20, 1911–1924. doi:10.5194/hess-20-1911-2016

Van Loon A. et al. 2016. Drought in the Anthropocene. *Nature Geoscience* 9, 89–91. doi: 10.1038/ngeo2646

Sivapalan M. Savenije H. Blöschl G. 2012. Socio-hydrology: A new science of people and water. *Hydrol. Process.* 26, 1270–1276. Doi: 10.1002/hyp.8426

3) The paper is extremely disorganized and is poorly sectioned. The section related to Results in particular is very long relative to other sections and is hard to follow. Most importantly, the results section includes even the results of semi-structured interviews that basically provides the data support for developing the decision model. I believe a great portion of what is presented in the results can go under a new section related to the data support and model development.

Reply: We opted to include all results, both from the semi-structured interviews as well as from the model phase, in the result section. Since the model development depends on the results of the survey phase, the drawback of this choice is indeed that a large part of the content of the manuscript needs to be in the results section.

As proposed by the reviewer, an alternative to avoid this would be to include a separate section reporting the results of the semi-structured interviews (including both method and outcomes), followed by another section that discusses the model design and options. In this case the result section would contain only the results of the model runs to

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quantify the value of information. This alternative structure would also shorten the text by merging the content now divided between the methods and the results section.

Suggested changes: We propose to restructure the article as suggested. The outline for the manuscript following the alternative option mentioned above is included at the end of this document (Annex 1).

4) The way that paper presents the information and findings through text, tables and figures seems not very well thought. For example, a central part of this paper is the decision model, with which the value of new information can be assessed for various stakeholders. After reading the paper this part of the paper quite a few times, I am not still slightly clear about how the model has been developed. A schematic and some formulas would certainly help. To facilitate following the paper, I believe a standalone section is required to discuss the experimental setup and how the results should be viewed. Figures are very hard to understand. Similar to the other reviewer, I do also have problem with understanding Figures 4 (and 5 and 6 and 7). The discussion is also extremely long and rather scrambled. I believe synthesizing information under appropriate subsections would be very helpful.

Reply: The model combines the decision of the farmers of what and when to plant and the decision of the reservoir operators on whether to apply curtailments to the amount of water that can be supplied to farmers. The choices of the farmers are schematically represented in figure 3. The information that drives those decisions and the relations between the parameters as defined in the model are represented in Table 1. We agree that the table can be difficult to follow. In figure 1 (below) we have incorporated the information from Table 1 in a schematic form to make it more visual. We will replace Table 1 with this figure and provide a succinct description in the text to explain the figure.

We also expect that including a standalone section of the model design as also proposed in the answer to comment 3 will help to make it clearer as well. A description

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of the new outline will be included in the “Approach and data” section (see reply to comment 3 and Annex 1).

Please, see the reply to comment 4 of reviewer 1 for an explanation of figure 4 and the corresponding suggested improvements.

The expected final results of the analysis is the total benefit for the farmers. This benefit depends on the decisions taken during each season, which in turn depend of the information used to inform them. Two information scenarios are tested: one that represents the current use of information (the decisions are informed by the reservoir levels only) and another that represents the use of additional information (the decisions are informed by reservoir levels and snow cover data). Perfect information and No information scenarios are also used as a reference of the potential value of the information. Figures 5-7 present these results. In Figure 5 the total benefit for the period for each of the scenarios and thresholds is shown. The difference between the perfect information and the no information scenarios shows the potential value of using information, as the use of uncertain information is expected to scale between these two extreme situations. This is shown in the first two columns of the Figure 5. However, as can be seen in the following columns that represent the information scenarios, the use of non-perfect information in this case can result in losses when water availability is overestimated. Figures 6 and 7 show the total relative value of the two information scenarios with respect to the reference scenarios. The relative value is negative, because the losses are higher in these two information scenarios than in the No information scenario, as seen in Figure 5. However, we can see that the losses are lower when using the additional information through the comparison of each pair of columns. The columns on the left show the relative losses when considering only the reservoir levels, while those on the right show the relative losses when also considering the snow cover. These show marginally less losses. Figure 7 has the same structure as Figure 6, and shows the result of lowering the cost of planting, and therefore reducing the losses incurred when the water availability is overestimated. As a result of the reduction in the losses,

we can see that the relative value of the information increases with the reduction of the costs.

Suggested changes:

- We will replace Table 1 by Figure 1 (included below), providing also a succinct description of the figure in the text.
- We will change the outline of the paper as outlined in Annex 1 below. The expected results will be explained in the approach section to facilitate following the paper.
- The discussion section will be structured in three subsections to make this clearer (see annex 1)
- We will critically review and improve the supporting texts for figures 5, 6 & 7.

5) While the paper is long, it does not provide information required to reproduce the work or to at least understand the process of data gathering through semi-structured interviews and model development. As noted above, it is not clear how the model has been developed as a result it is not possible to really examine the truthfulness of the results and the relevance of the discussion provided.

Please see our replies to comment 4 above and to comment 2 of reviewer 1 for an explanation about the model development and the data gathering through semi-structured interviews respectively, and the corresponding suggested improvements to the manuscript. In addition to the explanations included in the manuscript, we are happy to share the model code upon request for reproducibility.

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Annex 1 - Alternative outline for the manuscript:

1. Introduction
2. Approach and study area

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3. Stakeholders' consultation

3.1. Method

3.2. Responses

3.2.1 Confederación hidrográfica del Ebro

3.2.2 Canal de Aragón y Cataluña (CAyC)

3.2.3 Farmers in the Canal de Aragón y Cataluña irrigated area

4. Decision model

4.1 Farmer Decision: Crop areas

4.2 Reservoir operation decision: Water restrictions

4.3 Crop water demand and benefit

4.4 Model Options

5. Quantifying the effect of additional information

6. Results

6.1 Farmer decisions and curtailments using perfect information

6.2 Value of additional information for the decisions

7. Discussion

7.1. Potential value of additional information

7.2. Effect of the cost of planting on the value of information

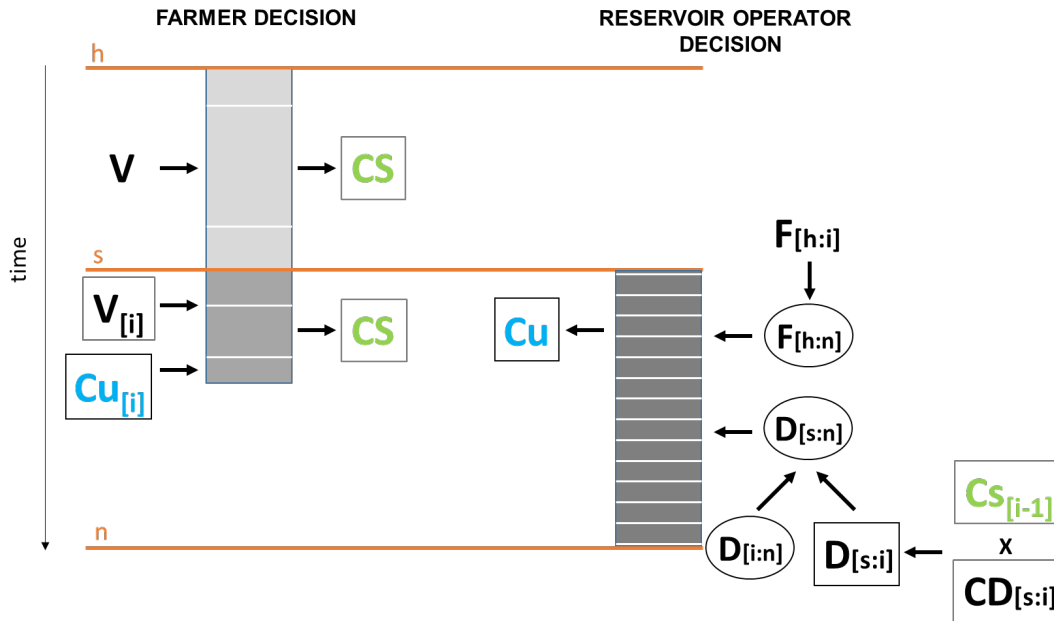
7.3. Value of the information for the different types of farmers

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Parameters	Period []	Availability and sources
F – Inflow	s – start of irrigation season	V known to decision maker (from data)
D – Demand	i – current decision date	 known to decision maker (from model)
V – Volume	n – end of season	 unknown to decision maker (estimated)
CS – Crop surface	h – start of hydrological season	
CD – Crop demand		
Cu - Curtailments	[s:i] from s to i	

Fig. 1. Model decisions and their inputs and outputs.

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