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Interactive comment on "The benefit of using an ensemble of seasonal streamflow forecasts in water allocation decisions" *by* Alexander Kaune et al.

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We thank the reviewer for taking the time to review the manuscript and for the helpful comments and suggestions. Here we provide answers to the specific comments and indications of how we propose to improve the manuscript to address the issues raised by the reviewer.

General comments This manuscript presents the benefit of using an ensemble of seasonal streamflow forecasts in water allocation decisions with an emphasis on those decisions in dry seasons and dry years. This is very important for farmers to choose which crop to plant and to decide on the area to be cropped. And also, the manuscript

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described the development of new approaches for the reservoir inflow estimates to replace the fixed inflow with the forecasted inflows, decision model to emulate the feedback loop between simulated reservoir storage and water allocation to irrigated crops, inflow forecasts, etc. The authors have briefly evaluated the approaches and identified effectively, and find that there is a quite much higher inconsistency and lower accuracy in estimating water available for allocation during dry seasons and dry years. This is a good and new insight of present manuscript to enhance our understanding of the water allocation for the farmers. The subject is relevant to the journal, the manuscript is well written and structured.

1. However, at present, the focus of manuscript is not particularly strong and it seems that the authors are not entirely sure about the key message they wish to convey. There are some aspects are suspected as follows: Firstly, the equations (on pages 6-8) to determine the available water for allocation needs more variables related to complicated relationships among the water demands and feedback loop among the reservoirs.

Reply: We appreciate the comment of the reviewer on the clarity of the message we would like to convey. To strengthen that message, we propose to revise the last sentence of the abstract as follows: “Our results show that seasonal streamflow forecasts can provide benefit in informing water allocation policies, particularly through earlier establishing final water allocations to farmers in the irrigation season. This allows them to plan better and use water allocated more efficiently”.

We also propose to make the three key messages accompanying the paper clearer:

1. The existing water allocation policy in a highly regulated basin is emulated in a decision model, and subsequently extended to inform allocation decisions with a seasonal streamflow forecast. 2. Using the FoGSS seasonal forecast to inform allocation decisions is shown to allow final annual allocations to farmers to be established one and a half months earlier than under the current policy. This is important as it helps farmers

plan better and use allocated water more efficiently. 3. FoGSS forecasts derived from the POAMA GCM data perform marginally better than those derived from resampled climatology (ESP+); though forecast uncertainty requires a trade-off between better estimates of available water and the cost of downward revisions of water allocations to farmers.

Regarding the equations to determine the available water for allocation, these have been established to include several variables such (in order of priority); water allocated to meet environmental needs; town water allocations; high security allocation; irrigation, conveyance losses, and finally general security allocation, which is allocation that is the focus of this research. Note that the water available for allocation is the total volume in the (two) reservoirs, plus the expected inflow which is derived from the streamflow forecast. While we agree that there quite complex interactions, we have established these equations based on the current water policy and regulations in the basin. In doing so we have purposefully kept the equations as simple as possible while staying true to the policy. Through comparison with recorded allocation decisions made under the existing policy we demonstrate that these decisions are reasonably well emulated.

2. Secondly, it is necessary to discuss the nonlinear processes of higher water demands and tradeoffs among the water users and reservoirs behind dams in the study area in dry seasons and dry years. These processes are suggested to presented more in detail in the context “4.2 To what degree does the seasonal forecast help in the decision process?”.

Reply: We agree that the interaction between water demand and availability, and tradoffs made is highly complex. We propose to extend the discussion in section 4.2 to include these interactions. The following paragraph will be added to Section 4.2.

Allocation decisions made depend not only on the available water in reservoirs and the expected inflows, but also on the actual demand from the crops planted by farmers.

In our study demand is taken as the sum of the entitlements of farmers, reduced by the use reduction factor we introduce. Given the water allocated to meet their entitlement, farmers will make their decisions on the crops they plant for the season. In the Murrumbidgee basin, farmers may, however, also trade the water they are entitled to; or store part of their allocation for use in the next season by deciding to leave it in the upstream reservoirs as carry-over (Horne, 2016). As a result, there are quite complex feedbacks as the decision to carry water allocated over to the next season will influence the allocation decisions at the basin level in that next season. Decisions made by the farmers on what and how much to crop are complex and depend on a range of factors that include the available water through allocation, but also economic factors and personal preferences. The allocation-use reduction factor we introduce to consider these decisions made by farmers, and we find a value an average use of 78% of water entitled to best emulate actual decisions made, on average. While this factor could be optimised mathematically, a detailed understanding of how farmers make decisions is then required. Línes et al (2018) develop a decision model based on interviews of farmers in the Ebro basin in Spain, showing that decisions of what to crop depends on their perception of water availability and will differ between seasons considered wet and seasons considered dry, as well as their aversity to risk and technological capacities. They find that the availability of information on available water as the season develops, such as provided through a seasonal forecast will influence perceptions of water availability and consequently cropping decisions. Further research into how farmers in the Murrumbidgee basin make decisions using for example agent-based models (Wens et al., 2019) could shed more light on the influence on water allocations decisions made at the basin levels.

Wens M., Johnson JM, Zagaria C. Veldkamp T. 2019. Integrating human behavior dynamics into drought risk assessmentâĂŤA sociohydrologic, agentâĂŘbased approach. WIREs Water. https://doi.org/10.1002/wat2.1345

3. Thirdly, the better quality of figures in the text and supplementary materials are

suggested to provide. Reply: We will make sure quality of the figures will be improved and will include these to a higher resolution.

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