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Interactive comment on "Stress-testing groundwater and baseflow drought responses to synthetic climate change-informed recharge scenarios" *by* Jost Hellwig et al.

Anonymous Referee #1

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The paper describes a study where a large-scale, high-resolution MODFLOW-groundwater model of Germany has been used to assess a range of potential changes to groundwater and baseflow drought hazard based on three change scenarios. The scenarios are: i.) a changed recharge regime with wetter winters and drier summers (SSHIFT), ii.) changes to antecendent conditions associated with three major historic episodes of drought in Germany (SEVENT), and iii.) recovery from drought (SRECOV). These scenarios were co-designed in part with the Climate and Water Initiative of southern Germany's federal states (KLIWA) (L67-86) with the aim of stress testing the sensitivity to drought of groundwater and baseflow. Although, the geographical focus of the study is Germany, the paper addresses questions relevant to a wide read-

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ership and is clearly in the scope of HESS.

The description of the model setup (Section 2) is adequate given that more details can be found in the paper by Hellwig et al. (2020) who developed the model. However, a critical assessment by the authors of the models suitability, including method of calibration and appropriateness of it's underlying assumptions, for the current application would be helpful. The description of the scenario design and modelling approach (Section 3) is generally clear and well-reasoned. However, the scenarios appear somewhat arbitrary. In particular, the formulation of the SRECOV scenario is less convincing than the other two scenarios. To assess the maximum duration for groundwater recovery from severe drought, the lowest simulated groundwater heads are taken as an initial condition and groundwater heads are simulated using long-term average monthly recharge as input until an arbitrary recovery has been achieved. Although adequately described, the motivation and justification for the details of this scenario are not given.

The results are presented well, both graphically and in their description in Section 4. The Discussion provides a number of interesting insights into the results. For example, the authors make the observation at L287-290 that: "the different responses of baseflow and groundwater are important to consider for an effective water management in a changing climate. For example, in a climate with higher annual recharge sums but more frequent summer droughts groundwater droughts might become less severe while the baseflow drought hazard becomes more severe with potential impacts on economy and ecology". Given that the scenarios that led to this observation were shaped by stakeholders, it would be interesting to know if and how stakeholders might use such information. More generally, given the nature of the set-up of the paper (e.g. L67-74) it would be interesting to hear the author's views on any specific implications of the results of their study for drought planning and management. These could be described, however briefly, in the Discussion.

Specific comments: L229 I think that the authors meant "relative" not "relevant"?

Section 4.1. The authors make a number of observations relating to the groundwater and baseflow changes being more pronounced under average conditions than for drought, and this is also highlighted in the Summary at L326. A brief interpretation and discussion of the implications of these observations would be helpful.

Section 4.3 and Figure 9. The main feature of the analysis of recovery time appears to be the essentially bi-modal nature of Trec, this being most evident in the Trec v Tmax plot in Fig. 9. It would be interesting to hear what the authors think might be contributing to this result. Does it reflect intrinsic characteristics of the modelled system, is it an artefact of the model structure or calibration, or is it some combination of both? Perhaps such a discussion could be added to Section 4.3?

L348-350. The first and only mention of the application of this approach to is in the Conclusions. This seems strange. IT may be appropriate to include these observations in the Discussion, but not in the conclusions?

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