

Interactive comment on “Potential climate change impacts on the water balance of regional unconfined aquifer systems in South-Western Australia” by R. Ali et al.

Anonymous Referee #2

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General comments

This is a mostly well written and comprehensive case study of the potential impacts of climate change on the water balance components of a number of aquifer systems that are in high and increasing demand. It is good to see a study that brings together the various components of climate impacts on groundwater systems, including increasing future demand for groundwater.

The study couples a process based recharge model with a numerical groundwater flow model to quantify water balance components and identify seawater intrusion risks for

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a number of unconfined aquifer systems in southwest Western Australia. The paper compares the results of a range of modelled scenarios with variations in climate and groundwater extraction.

The technical extent of the study, coupling the outputs of a recharge model that takes account of variations in both climate conditions and land surface conditions with a groundwater flow model to quantify aquifer storage and discharge changes, is an important step forward in this field of study, at least in the Australian context. I think it is this bringing together of the various hydrological modelling components – groundwater recharge and flow models and synthesized climate data sets – that provides some scientific novelty in the study. If this is the intention, it should be clearly emphasised in at least the introductory section of the paper.

Specific comments

I have only one main concern with the paper and a few comments on minor issues. My main concern relates to the storage change component of the water balance predicted by the model and its implications for the other water balance components. I accept that the model results are intended to provide comparison between scenarios with alternative climates and groundwater extraction rates. However there seems to be a significant conflict between the described historical conditions of these aquifer systems, in which extractions have increased by orders of magnitude while rainfall has decreased by about 15% over recent decades, and the modelled increase in storage in the historical and recent climate scenarios. In the example of the Central Perth Basin the 39.3 mm would equate to several metres of potentiometric rise in the aquifer over the 23 years of the simulation (when divided by a typical specific yield and multiplied by the years of the simulation). This concern may perhaps be resolved by providing a rationale for the increase in aquifer storage under the modelled conditions. However, the increase in storage leads to a further issue with the way the results are discussed.

For many of the alternative climate scenarios there remains a positive change in stor-

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age. While the amounts of discharge to drains, the ocean and to confined aquifers are less than in the historic scenario, the positive storage change (suggesting that there is a net gain in saturated thickness by the aquifer over the term of the simulation) would be expected to result in an increase in discharge fluxes over the term of the simulation. The individual water balance components in the future scenarios are correctly described as being lower than in the historic scenario. However, the discharges are described in the discussion and conclusions as reducing under the future climate, when in many of the future climate scenarios the positive storage change suggests that over the period of the simulation the discharges are unlikely to decrease and more likely increase. If this is the case then this needs to be made clear in the discussion of the results.

This may be able to be addressed in the paper simply through explanation of the intents of the comparison of results between scenarios. But the implications of the positive storage change within each of the scenarios should also be made clear.

Minor comments

Page 6376, Lines 5 – 10 Are the conditions for equation 2 stated correctly? Two of the three conditions are the same.

Page 6378, Lines 1 – 15 It's not entirely clear here whether the recharge models were calibrated separately or if the groundwater flow model was calibrated when coupled to the recharge model. Further clarification required.

Page 6378, Lines 18 – 26 The explanation of scenario (i) is not very clear and I couldn't understand the rationale for creating this scenario's climate data set in this way. Why add the remaining 10 yr of climate data at the end of the process?. The paragraph could perhaps be altered to improve clarity of explanation.

Page 6369, Line 1 Is Christensen et al. 2007 a suitable reference for “recent advances in modelling”?

Technical corrections

Page 6368, Lines 17 – 26 A few minor grammatical errors in this paragraph

Page 6374, Line 15 Typing error in GI units (typed as GII)

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