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Hydrology and Earth System Sciences Discussions

Interactive comment on "Projected impacts of climate change on groundwater and stormflow in a humid, tropical catchment in the Ugandan Upper Nile Basin" *by* D. G. Kingston and R. G. Taylor

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Reply to comments on "Projected impacts of climate change on groundwater and stormflow in a humid, tropical catchment in the Ugandan Upper Nile Basin by Kingston and Taylor"

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Response to anonymous Reviewer #1

We thank the anonymous reviewer (#1) for their helpful comments and provide a point-by-point response to their queries below.

1. "In chapter 3 there is reference to Todd et al., 2010 for temporal rainfall disaggregation and ClimGen pattern scaling technique – this paper is in preparation, and therefore it would be better to include references to a published material."

=> Further references can and will be added to provide additional explanations of these two aspects of the method. Arnell and Osborn (2006) introduce the ClimGen pattern scaling technique and Arnell (2003) describes the basis of the daily disaggregation technique.

2. "I would question why those 7 GCMs were picked from the pool of existing models – some additional motivation would be helpful."

=> Within the scope of this research it was not possible to use all CMIP-3 GCMs. The priority subset of 7 GCMs was determined on the basis of (i) a subjective evaluation of model quality and (ii) the use of the model (or its predecessors) in previous impact assessments. The priority subset was checked to ensure that it spanned the range of different changes in precipitation and sampled a range of 'plausible' different modelled global climate futures (e.g. Indian monsoon weakening/strengthening, magnitude of Amazon dieback).

3. "SWAT model used is stated to be a semi-distributed model, but there is no description of its units, their size, and connections."

=> The Mitano catchment was divided into five sub-catchments within SWAT. Figure 1 will be updated to reflect this. The SWAT references (Arnold et al., 1998; Di Luzio et al., 2004) provided give full technical details of the general model structure.

4. "The SWAT predictions appear to be of very poor quality (NS is a little higher than 0). Is it a problem of precipitation disaggregation technique, spatial rainfall variability,

or just SWAT model being unsuitable for the catchment?"

=> Month-to-month sequencing of river flow in the Mitano SWAT model is poor for parts of the calibration and validation period. However, the modelled long term monthly means and flow duration curve closely match those of observed river flow (Figure 2). These observations suggest that the underlying hydrology is adequately captured by the model. SWAT has previously been used successfully in equatorial Africa (Ndomba et al. 2008; Schuol et al. 2008). Although the precipitation disaggregation technique may contribute to the poor sequencing, this technique has been successfully used previously (Arnell, 2003, and other papers in this special issue). The precipitation data used to drive the model appear to be the most important factor in the poor sequencing of flow, as discussed in Section 4 and illustrated by Figure 3.

5. "…there is data from 5 daily rain gauges available for the 1965-1980 period. Would it be reasonable to use this data for calibration purposes instead of CRU data?"

=> Station-based precipitation data are only available for the period 1965-1980. This period is too short to accurately capture the full range of variability in the discharge of the River Mitano and so was not used to calibrate and validate the model.

6. "How many parameter samples for SWAT were used to investigate parameter sensitivity?"

=> The SWAT automated sensitivity analysis tests 27 model parameters and ranks them according to model sensitivity to variation in these parameters. Details of the SWAT sensitivity analysis tool can be found in van Griensven et al. (2006) as noted in the text.

7. "In Chapter 5.3 the authors say that 'model parameterisation generally imparts little additional uncertainty to climate change projections '. First of all, it is very unlikely that the combined uncertainty would be additive; and secondly, the parameter uncertainty might be important for individual climate change scenarios with low annual flow

anomaly, i.e. for scenarios given by HadCM3, IPSL, MPI, and HadGEM – the anomaly here seems to be below 10%."

=> We acknowledge these points and will re-phrase the text accordingly.

8. "In discussion, the authors say that 'confidence can be placed in the assertion that irrespective of precipitation magnitude or direction of future changes in precipitation, the proportion that contributes to Mitano river discharge via groundwater flow will decrease as a result of increasing temperature '. This is based on one climate model (HadCM3) inputs for hydrological predictions. But HadCM3 predicts very moderate rainfall changes, and predicts one of the most extreme temperature changes (Fig.7) – because of that the conclusions could be not valid for other GCMs."

=> Temperature increases for all GCMs and so will result in increased PET for all GCMs. The PET increase will serve to decrease the proportion of precipitation contributing to groundwater flow as more precipitation will evaporate before reaching the groundwater system. However, the influence that this will have on river flow will depend on inter-GCM variation in (1) the magnitude of temperature increase (which is relatively high for HadCM3) and (2) the direction and magnitude of precipitation change. The text will be re-phrased to clarify this conclusion.

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