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Hydrology and Earth System Sciences Discussions

Interactive comment on "Uncertainty in water resources availability in the Okavango River Basin as a result of climate change" *by* D. A. Hughes et al.

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Reply to questions 1 and 2: Please see Todd et al. (2010) for a full description of the methods used both here and in the other studies comprising this special issue of HESS. To quote from Todd et al. (2010): "Prescribed warming scenarios were generated using the climate impact interface software "ClimGen" (Osborn, 2009), available at: http://www.cru.uea.ac.uk/_timo/climgen/. ClimGen creates climate scenarios through a pattern scaling approach in which climate change patterns as simulated by a suite of GCMs are applied to an observed $0.5^\circ \times 0.5^\circ$ baseline climatology, namely

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the CRU TS3.0 data... By dividing the climate change in a particular variable at each grid cell by global mean temperature change (ΔT) the "standardised" pattern of climate change in that variable per unit global mean temperature increase is defined. This procedure is referred to as "pattern scaling" and allows calculation of the spatial pattern of climate change in any variable, associated with any given global mean temperature change (i.e. prescribed warming), assuming a linear dependence of change in ΔT . These standardised climate change patterns are calculated separately for each month to preserve the seasonal information, and are all interpolated statistically onto the $0.5^\circ \times 0.5^\circ$ global grid. Within ClimGen these patterns are used to create gridded fields of monthly data with which to drive the hydrological models. In essence, the change pattern is used to perturb a historical dataset to ensure minimal bias with respect to observations, a necessary condition for running impact models calibrated with respect to historical observations. In essence though, the climate change field is "added" to the historical data from CRU TS3.0. These data were then used to drive the hydrological impact model in each study catchment."

The paper will be modified to provide a summary of the above.

Reply to question 3: Where simulations indicate large changes either side of zero, measures of central tendency such as the median will inevitably provide a misleading measure of the possible climate change signal. Again, see Todd et al. (2010). The median (or any measure of central tendency) is not ideal because this study hasn't completely sampled the probability-space of possible future climate – instead it is based on a subset of a GCM "ensemble of opportunity". This point can be strengthened in the revised paper.

Reply to question 4: Temperature data used for Hargreaves for baseline were the gridded 0.5x0.5° resolution CRU TS3.0 data. Scenario data comprised the ClimGen derived climate change signal added on to the CRU TS3.0 values. Hargreaves PET is based on both mean temperature and diurnal temperature range – therefore it is not surprising that there are differences between Hargreaves and the simple approach

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used here. The precipitation data used are thought to be the primary source of error in simulated river flow.

Reply to question 5: Initially, it was attempted to calibrate the Pitman model using CRU TS3.0 precipitation data. As noted in the paper, model performance using this dataset was unacceptable, so an alternative baseline precipitation dataset was used: UDEL. As such, future precipitation scenarios for the Okavango were subsequently derived by adding the ClimGen spatial pattern of climate change onto the UDEL baseline instead of the CRU baseline. As the UDEL baseline data were different to the historical data used in the previous calibration of the model it was essential to re-calibrate.

Reply to question 6: The selection of parameters for inclusion in the uncertainty analysis was based on the sensitivity of the model results to different parameter variations as well as the likely range of parameters that would produce behavioural results (based on experience gained from the calibration runs). The uncertainty bands are relativley narrow because observed data are available to ensure that the model is quite well determined. Increasing the uncertainty parameter bands would not result in the observed flow data falling more within the simulated ranges as the main problem with the simulations is related to the imperfections in the rainfall data (see earlier comment and reply).

Reply to question 7: This point is noted and the text will be changed in a revised version of the paper.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 5737, 2010.