Drying out the Nile? Regional Climate Change and Water Resources in East Africa with a focus on Lake Victoria and Lake Tana

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Introduction

Famed as the sources of the Nile River, Lakes Victoria and Tana are catchments projected to undergo substantial change in precipitation under future climate change scenarios. Extensive periods of drought are also seen in palaeo-records from the region, which the proposed DACEA project aims to explain with reference to regional and global teleconnections.

Here, we present high resolution (44km, 10km) simulations of the HiRAMS Regional Climate Model (RCM), driven at the boundaries by the CHAMS/MPI-OM coupled GCM under the SRES A1B scenario. The 44km run covers 1950-2100, the 10km run three time-slices (1980-1999, 2046-2065, 2080 – 2099) over East Africa. These indicate a reduction in future precipitation and increase in potential evapotranspiration with important consequences for agriculture and hydropower production in the Nile basin.

Results

Model resolution is very important in capturing precipitation and evaporation variability, the 10km resolution (top row) has significantly more evaporation than the 44km run (lower row). Both models are able to simulate the bimodal distribution of precipitation at the present day with the long and short rains well represented. Note the decline in rainfall and increase in evaporation in the future. Later in the century the short rains in February-March become less reliable and occasionally fail completely.

Hydrometeorology

We use the Penman-Monteith equation to calculate potential evaportranspiration (PEV) in the area around Lake Victoria.

DJF and MAM show the largest increase in PEV, particularly close to the coast, while the Congo basin sees greater increases in PEV in the JJA and SON seasons which may reflect recent observations of drought in the Congo basin (Zhou, L. et al., 2014). The region as a whole sees an increase in PEV through the whole year by the end of the century.

Drivers of Aridity Change in East Africa (DACEA) Project

The DACEA project will investigate regional and global teleconnections that affect aridity in East Africa and their environmental consequences using a combination of climate modelling and palaeoproxies from East African lakes including Lake Tana and Lake Victoria. Model experiments (Figure 5) examining the influence of orbital forcing and ocean circulation on the East African monsoon will be carried out with the EC-Earth GCM. Downscaling to regional and local scale will be carried out with the HIRAMS RCM and the MIKE-SHE hydrological model.

Figure 2 shows precipitation (PEV) for the three models over two timeslices: 2a, the present day (1980-1999) and 2b, the end of the century (2080-2099). CHAMS (1.875 x 1.875°) in brown, HIRAMS RCM at 44km (green) and at 10km resolution (blue). Numbers to the left of the plots indicate 5 year means for each period for each model. Note the substantial differences between the values of the different simulations, reflecting the differing resolutions, in particular during the period of short rains (approximately boreal spring).

References: Stendel et al., in prep.; Mottram et al., in prep.; Thejl et al., in prep.; Marshall et al., 2011; IPCC AR5 WG1 chapter 14; Zhou, L. et al., 2014, Nature