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Assessing Future Hydrological Changes in the Tana River Basin, Kenya

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Changes in precipitation will be one of the most significant factors in determining the overall impact of global climate change but are also one of the most uncertain and difficult to project. The reliability of global climate models (GCMs) for predicting changes in rainfall is particularly concerning for East Africa. This research focuses on Kenya's Tana River Basin and aims to project the impacts of climate change upon the hydrology in order to inform national climate change adaptation plans. The Tana basin has been identified as crucial for Kenya's development, with increased irrigated agriculture and additional dams planned. The area is also important for biodiversity and contains already-threatened ecosystems and endemic species. Kenya is already a water-scarce country and demand for water is expected to increase in the future as the country develops. Therefore, examining changes to precipitation with climate change is vital.

The WaterWorld Policy Support System (http://www.policysupport.org/waterworld), a physically-based hydrological model, has been used to determine annual and monthly changes in hydrology. WaterWorld utilises the WorldClim (Hijmans et al., 2005) climate projections for the latest generation of climate models from the Coupled Model Intercomparison Project, phase 5 (CMIP5) to characterise the temperature and precipitation changes. In order to better understand the high uncertainties in projections of climate change, the full range of latest emissions scenarios (the representative concentration pathways or RCPs) were used to force the WaterWorld model. The WorldClim baseline values were evaluated by comparing them to observations and were found to correctly represent the annual cycle of precipitation. In addition, the CRU TS3.22 data (Harris et al., 2014) have also been examined and provide a valuable comparison to the WorldClim dataset.

These simulations encompass a broad range of climate projections, but show a general trend towards increased precipitation in the Tana River Basin. Overall, the multi-model ensemble mean for all RCPs suggests that there will be increases in precipitation by the 2050s, with the annual basin-average rainfall increasing between 112% (RCP2.6) and 149% (RCP8.5). As the precipitation in East Africa is highly seasonal, examining monthly changes is also important. Drying is projected in some months, whereas wetter conditions are projected in others. Average precipitation changes do not vary greatly between the RCPs, but there are large discrepancies between individual GCMs, with some models even disagreeing on the sign of precipitation change (i.e. positive or negative relative to the baseline). Between-model differences in the magnitude of precipitation change are also substantial.

This large variation in anomalies of projected precipitation demonstrates the uncertainty in CMIP5 GCM outputs for the area and has important implications for water resources management and policy. Robust management decisions will need to be made in the face of this considerable uncertainty. Policies that allow for adaptability and a wide range of possible future outcomes are paramount.