Geophysical Research Abstracts
Vol. 20, EGU2018-370, 2018
EGU General Assembly 2018

Future Water Availability and Demand in the Tana River Basin, Kenya, with Climate and Land Use Changes

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The Tana River Basin is the largest and one of the most economically important basins in Kenya, which is a country that has been continually challenged by water stress in recent decades. Changing climate, more frequent droughts and issues arising from planned socio-economic development are likely to increase the problems of water stress in the future, which will, in turn, impair food security and economic prosperity. Increased irrigated agriculture, new economic centres and additional dams are planned for this semi-arid region, which also contains already-threatened ecosystems, as well as endemic and endangered species. Management of the limited water resources is made particularly difficult by these multiple, often conflicting, water uses within the basin. Agricultural and urban needs must be balanced with resources required by natural ecosystems and biodiversity to ensure sustainability.

This research combines projections of climate and land use change in order to help inform water resources management and policy in Kenya. The WaterWorld Policy Support System (http://www.policysupport.org/waterworld) was used to develop projections of changes to key hydrological variables by the 2050s. This physically-based model was designed for use in data-poor areas, such as East Africa. The full range of available Coupled Model Intercomparison Project Phase 5 (CMIP5) global climate models (GCMs) was used with the four representative concentration pathways (RCPs) to show the variation in the potential outcomes for future water availability in the basin. Using a multi-model approach, the uncertainty in the hydrological projections can be evaluated.

Results show a general trend towards increased precipitation, and therefore runoff, in the Tana River Basin, but there are large discrepancies between GCMs. This variation in anomalies of projected precipitation demonstrates the uncertainty in CMIP5 GCM outputs for the area. Robust management decisions will need to be made in the face of this considerable uncertainty, so policies that allow for adaptability and a wide range of possible future outcomes are paramount.

These projected changes in water availability were then combined with data on changes to water demand, such as crop yield projections and terrestrial biodiversity distribution data to further examine changes to water resources. Crop yields were extracted from the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) database and terrestrial species distribution changes were determined using data from the Wallace Initiative (wallaceinitiative.org/). These results were then compared to policy documents set out by the Government of Kenya in order to produce integrated maps of water availability and demand.

Developing countries like Kenya must face the task of improving socio-economic conditions while responding to a changing climate and also protecting their ecosystems. By combining projections of land use change in the basin with spatially explicit projected changes to water availability, it is possible to identify the extent of conflicts or synergies between differing land uses in a climate-changed future.