WRA Bulletin 54

October 2019

OVERSEAS WORK

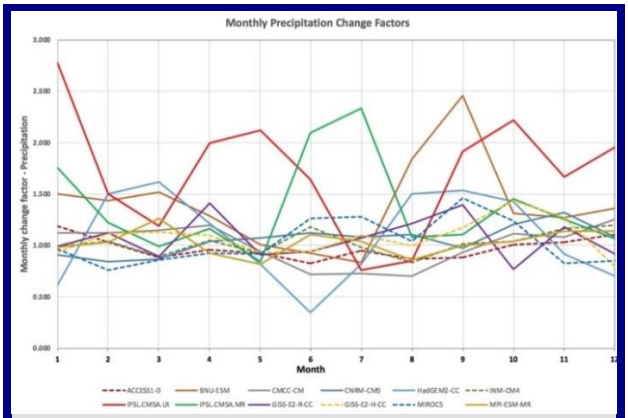
Lake Victoria levels under climate change, East Africa

WRA worked with the UK Centre for Ecology and Hydrology and North Carolina State University in the USA on a project to study the potential impacts of climate change on water levels of Lake Victoria in East Africa. The WRA part of the study was led by Partner Frank Farquharson, with a major contribution from Associate David Plinston and a minor one from Associate Nick Mandeville.

Map showing areal extent of surface water of Lake Victoria together with the boundary of its contributing basin.

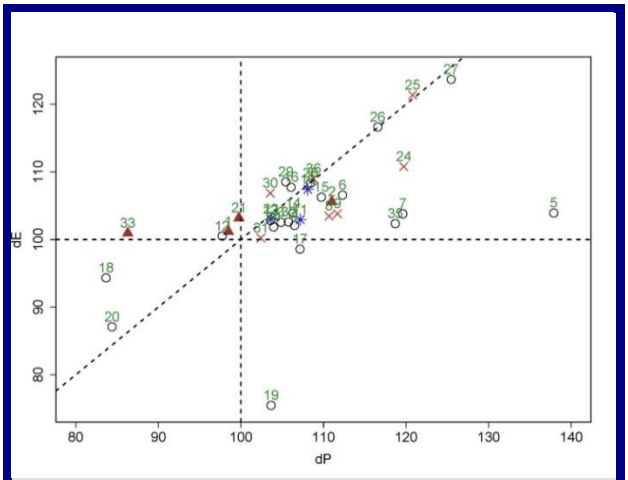
The study was jointly funded by the World Bank and Department for International Development, and was part of a study of how climate change might impact navigation on the lake. WRA have undertaken two investigations on Lake Victoria previously, as reported in WRA Bulletins Nos 23 and 30.

Past and future climate data from an ensemble of 36 global climate models from the CMIP5 (Coupled Model Inter-comparison Project Phase 5) were assembled, with the period 1950-1999 representing the 'present climate' and 2000-2049 being 'future climate'. Spatial rainfall and evaporation estimates for the Lake Victoria basin and the lake surface were derived and change factors (future climate/present climate) were computed for rainfall (dP) and evaporation (dE) for each model. Unfortunately, not all models had been 'validated' over East Africa and inspection of the seasonal rainfall patterns demonstrated significant variation between models, and showed that some models tended to overestimate the short (Oct-Dec) rains and underestimate the long (Mar-May) rains.



Comparison between the monthly precipitation change factors resulting from different climate models

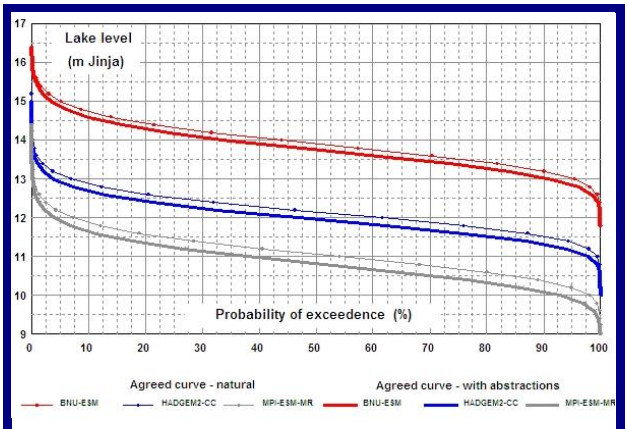
There was also considerable variation in model grid sizes, and, generally, higher resolution models (grid size <1.5 degrees) performed better than coarser models. Only some models explicitly considered the very large lake area, which plays a dominant role in the water balance with some 85% of the outflow generated by net-rainfall over the lake itself. Annual change factors varied dramatically between models.



Annual rainfall (dP) and evaporation (dE) change factors. Symbols show modelled land use: lake = blue asterisk, soggy soil = brown triangle, no lake = red cross, unknown = black circle. NB: Outlier at coordinates 184, 167 (#23, IPSL-CM5A-LR, no lake) not shown, but retained in analysis.

Overall, most models suggested that Lake Victoria basin might become wetter by the 2040s, with evaporation also increasing, although some models (numbers 5, 18, 19 and 33) do appear to indicate rather anomalous predictions.

Because of considerable overlaps in model predictions of future climate, three sub-sets were studied in greater detail: one that suggested much higher future lake levels; one much lower levels; and a third group, which included the majority of models, that suggested little change. Future rainfalls and evaporation were input to a basin water balance model and level-duration curves produced. Results are illustrated in a set of lake level duration curves, where the impacts of both climate change (thin lines) and climate change plus increased basin abstractions are shown (heavy lines).



Lake level duration curves from stochastic modelling for selected CMIP5 models with, and without, abstractions

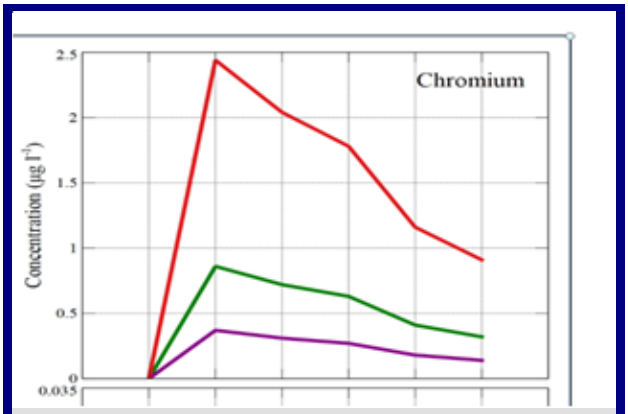
Overall the study illustrated the considerable uncertainty within current global models and their ability to estimate reliably future climates over Africa, partly at least because of the relative paucity of regional climate data for model verification.

Reversing pollution in the Turag, Balu and Buriganga rivers in Dhaka, Bangladesh

As part of the Oxford REACH programme a major modelling study of flow and water quality has been undertaken on the Turag-Balu-Buriganga river system in Bangladesh. Partner Paul Whitehead and Associates Dr Gianba Bussi and Prof Li Jin have used modelling and biosensor technology to assess risk, impacts and restoration measures linked to human health. This work examined new techniques to extend earlier water quality studies in Dhaka described in WRA Bulletin No 48. The major issue is the poor water quality in the river system with toxic water, especially during the festival periods.

Annual festival in Dhaka

There is significant tannery pollution with heavy metals released including Cadmium, Chromium, Lead, Zinc and Copper. The INCA metals model has been employed to simulate tannery pollution control and evaluate different effluent treatment processes.



Chromium concentration levels along the Buriganga river simulated by the INCA metals model, under three different effluent treatment strategies

Also, we have worked with Oxford Molecular Biosensors (see www.omb.co.uk) to apply a new biosensor technology to measure both cytotoxicity and genotoxicity. We have related these measurements to the high metals concentrations.

Two peer-reviewed papers were written about the study results. Further details may be obtained from Prof Paul Whitehead.

Next WRA Board Meeting

Friday 10th January 2020, at Blewbury.

The WRA Bulletin is a quarterly publication, and relies on contributions submitted by Partners, Associates and Consultants. The document is circulated by email, and published on the WRA web-site, aiming to keep the WRA network up-to-date with respect to current activities. Please email contributions for future issues to Nick Mandeville: nick@watres.com

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