# WRA Bulletin 50

October 2018


## OVERSEAS WORK

### Rainfall estimation over the Kagera river basin, East Africa

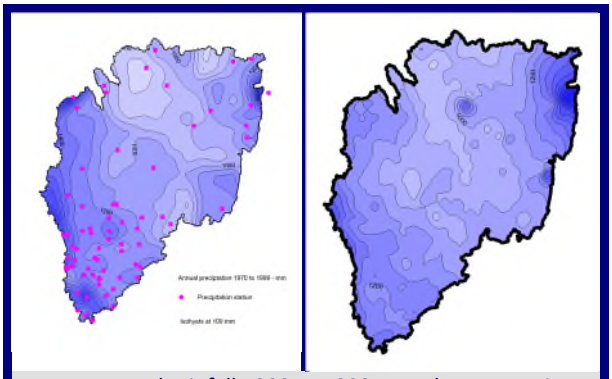
It is always interesting to return to a river basin where you have worked previously, writes Partner Ron Manley. WRA had worked on a water resources study of the Kagera river basin, which flows into Lake Victoria, in 2011/12. This time WRA was reviewing a potential hydropower scheme at Kakono, located near the downstream end of the same river basin. The river basin lies mainly in Rwanda and Burundi but also in parts of Uganda and Tanzania.


The Kagera river basin, showing the location of the Kakono hydropower scheme

In the earlier study an extensive data base of rainfall and climate had been provided. This was sufficient to develop a rainfall/runoff model of the whole basin covering the period 1970 to 1999. Attempts at that time to extend the period of data past 1999 were not successful as the number of operating meteorological stations had fallen considerably.

Returning to work in the basin in 2018 it was discovered that data situation was, if anything, worse and by 2015 there were only a handful of rainfall stations in the whole of the 40,000 km$^2$ basin. It was therefore decided to examine alternative sources of data. One of these for precipitation is produced by the 'Climate Hazards Group InfraRed Precipitation with Station data' (CHIRPS). This has daily, pentad and monthly data for the whole world from 50°N to 50°S and on a 0.05° grid. For Africa it also has data at a 6-hour time step but at a 0.1° grid. CHIRPS grid data combines satellite derived observations with real time climate measurements, topographic information and long-term precipitation averages.

To assess the accuracy of CHIRPS data it was compared with the data produced during the earlier study. This latter study had merged monthly data from meteorological stations with a data set produced by the Climatic Research Unit (CRU) of the University of East Anglia. This data set has values of the average precipitation for the period 1961 to 1990 for each month for the whole earth on a 10-minute grid. A time series of monthly data for the whole basin was produced using observations from meteorological stations and for each grid point, in that case based on the nearest observation and long-term average. The isohyets of annual rainfall for period 1971 to 1999 are shown below for the CRU data in plot (a), together with the locations of the meteorological stations. A similar plot (b) is also shown for the CHIRPS derived gridded data.



Average annual rainfall 1980 to 1999 over the Kagera river basin, from source (a) observed rain gauges and CRU grid (b) CHIRPS grid

There is general agreement between the two plots in that they both show higher rainfall to the west (high elevation) and the east (proximity to Lake Victoria), and lower rainfall in the central basin. A separate plot (not shown here) of monthly time series data for the whole basin also showed good month-to-month agreement and no bias in the average values. The CHIRPS data showed that there had been no systematic change in precipitation in the basin in the period from 2000 (after the end of the previous data set) to the present.

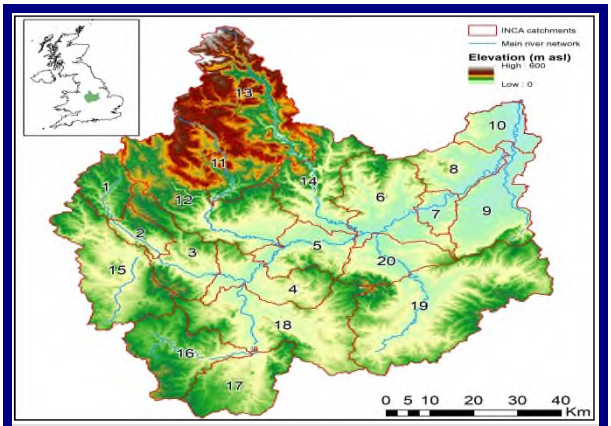
Whilst the comparison of the two isohyet maps appears to suggest that the CHIRPS data produce similar values to station based data, a word of caution

is justified. Rainfall data from the same subset of climate stations was used in both of the estimates – the one produced in the earlier WRA project and the CHIRPS data. It is difficult to assess, from the present study, how accurate the CHIRPS data would be when fewer meteorological stations are operating in the region under investigation.

## UK WORK

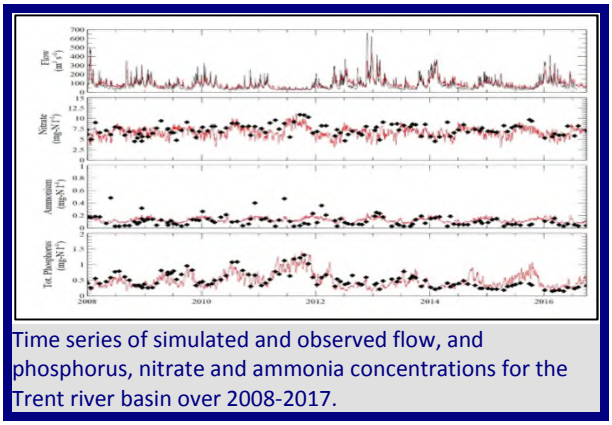
### River Trent Power Stations

As part of the NERC-MARIUS Drought Project (see http://www.mariusdroughtproject.org/), a water quality modelling study has been undertaken on the river Trent by Partner Paul Whitehead and a colleague. The aim has been to assess the potential impacts of drought on water intakes for power stations located close to this river. The Integrated Catchment (INCA) flow and water quality model has been set up for the whole of the Trent river basin to simulate daily flow, and corresponding concentrations of nitrate, ammonia, phosphorus, sediments, dissolved oxygen and biochemical oxygen demand.

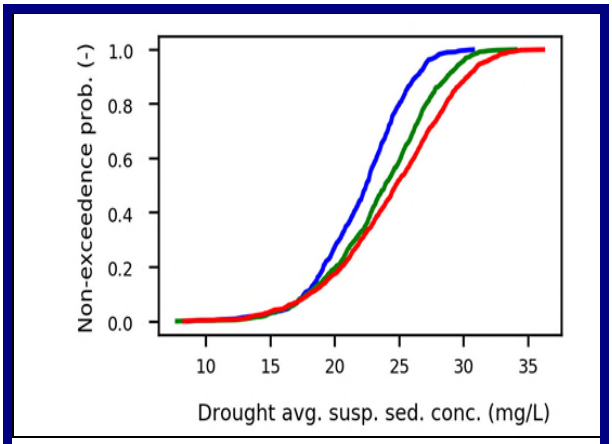



River Trent topography, with INCA model reach boundaries added

A set of drought scenarios was derived from the global climate models at Oxford University, where the Weather@home system runs thousands of simulations on a global network of computers (see http://www.climateprediction.net/weatherathome/). The drought sequences of rainfall and temperature are then used to drive the INCA flow and quality models to create low flow water quality conditions at key locations adjacent to the power stations along the Trent. Statistical analyses of these conditions can then be used by Energy UK to assess drought risks and plan for the future.



Time series of simulated and observed flow, and phosphorus, nitrate and ammonia concentrations for the Trent river basin over 2008-2017.




Distributions of the estimated average concentration of suspended sediment during droughts

A paper entitled *Impacts of droughts on low flows and water quality near power stations*, by Gianbattista Bussi and Paul G Whitehead, is under review for the journal Science of the Total Environment.

## BHS 2018 Symposium

Associate Nick Mandeville attended the latest BHS biennial symposium on 12-13 September 2018. This year's event had been compressed into a two day programme, and was held at the University of Westminster in central London. The occasion was overshadowed by the sad death of the organiser, Prof Geoff Petts, a month before the event.

Nick gave a presentation in the Advances in Modelling Session on 'Estimating storm inflow volumes for a sequence of multiple peaks of the quick-flow hydrograph'

## WRA Board Meetings

Friday 25th January 2019, 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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