WRA Bulletin 42

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Celebration of WRA's 21stAnniversary

Back in 1994 a small group of established individual consultants with world-wide experience of water issues came together to form a company that they decided to call Water Resource Associates (WRA). Strangely, one of the originators of the idea was none other than Dr Jim McCulloch, the first Director of the Institute of Hydrology, where several of the original and current WRA partners had worked. The company has prospered over the years and our combined international experience now spans over more than 120 countries covering Western and Eastern Europe, Africa, Asia and the Middle-East**.**

To celebrate these 21 successful years WRA hosted an anniversary lunch for current and former staff and selected clients at the Beetle and Wedge Hotel on the banks of the Thames on 17th July 2015. Almost 60 people enjoyed drinks and an excellent meal on one of the few sunny days last year as shown below. We now look forward to the next 21 years!

HYSIM is 40 years old!

The twenty-first anniversary of WRA in 2015 overshadowed another important milestone – HYSIM was forty years old. The date of HYSIM's creation is linked to the submission of Ron Manley's MSc to Birmingham University. The MSc by research was basically about the development of HYSIM. Ron celebrated HYSIM's fortieth anniversary by demonstrating its flexibility. He simulated the Mekong river from its source in the Himalayas down to Kampong Cham in Cambodia, and area of 657000 km^2. He has recently, in HYSIM's 41st year, extended its range in the other direction by simulating the Pago stream in Samoa, and area of 1.52 km^2

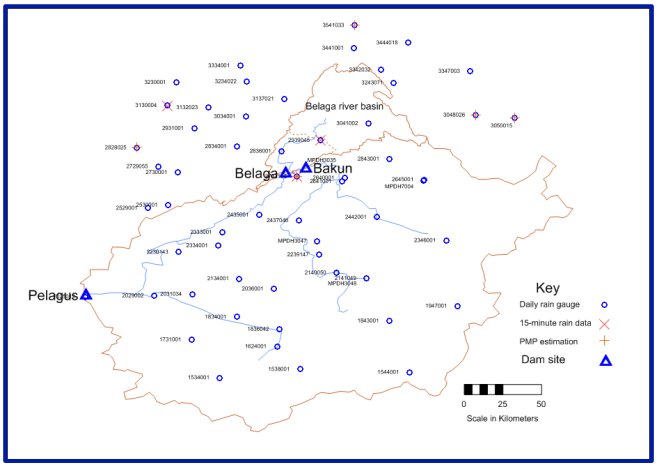
In terms of the hydrology and hydraulics incorporated in the model little has changed since then. The only significant change was to allow for extended droughts - when HYSIM was originally used to simulate the 18-month drought of 1975/6 the initially recovery was too rapid. Previously HYSIM had allowed for evapotranspiration from crops; the modification allowed for continuing evaporation even through crops had wilted.

Whilst the science has remained stable the computing environment has not. Originally HYSIM was developed in FORTRAN on the computer with 8k of 17 bit words. Even when it was translated to Visual Basic a couple of decades ago computer memory still imposed limitations on data storage capacity. Recently, as a preliminary step to producing a completely new version of HYSIM, Ron has been removing some of the constraints. In particular, he has increased the number of river reaches that can be modelled from 10 to 100 and made changes to the routing algorithm to make it more stable. These changes were used for the simulation of flows for the River Belaga.

Belaga Dam, Sarawak

The River Belaga is a tributary of the Rajang river basin in Sarawak, Malaysia. There is a proposal to develop the site for hydropower. WRA were contracted by Norconsult to examine the hydrology of the dam site. WRA has

previously worked with Norconsult on the Pelagus dam site. The following map shows the Belaga basin located in the upper Rajang Basin upstream of the previously studied Pelagus dam site.



There were two main objectives: to produce a long-term flow record for hydropower analysis and to estimate the Probable Maximum Flood (PMF). The location of the daily rainfall measuring stations is shown on the above map. Few of the stations had data before 1962 and this was taken as the starting point for flow simulation, though many of the stations only started in the 1980s so much of the early data was infilled. There was one flow measurement station, a short distance upstream of the proposed dam and for PET estimation one station outside but near to the basin was used.

Probable Maximum Precipitation (PMP) and using HYSIM to calculate the maximum flood. The PMP was calculated using the Hershfield method and the stations used for the calculation are shown above. Rainfall records at a 15-minute interval were provided for 3 stations, also shown above, which were used to establish storm profiles of different durations, from 3 hours to 3 days. These were used with estimates of the PMP to create a data set for HYSIM.

One feature of HYSIM, which had always been available even though little used, is to use data of a time step shorter than a day. In this case the channel hydraulics were simulated at an hourly time step using rainfall data at the same time step.

The following photograph is a typical view of the Belaga river. What is interesting in this case is the form of the channel. Most rivers have an incised channel and a flood plain. Here, and this was observed elsewhere, there is no flood plain with the channel deeply incised and having steep banks.

Initially the estimates of the PMF were very high, much higher than earlier estimates. This did not, of itself, mean the new estimates were wrong but it did justify a more detailed examination. It was concluded that the routing of the flows was a significant factor and the channel network was redefined in much more detail. In all 25 reaches were used, a feature only possible with the new version of HYSIM, and an envelope of maximum floods, for rainfall of different durations, was produced. These were closer to earlier estimates

Modelling the Impacts of climate Change on India and Bangladesh

As part of the NERC funded ESPA Delta Project Assessing Health, Livelihoods, Ecosystem Services And Poverty Alleviation In Populous Deltas (see www.espadelta.net) Paul Whitehead has applied the INCA model to the Ganga,

Brahmaputra and Meghna river systems, as shown in Figure 1. This has involved using the multibranch version of INCA N to simuate over 26 tributaries and 85 reaches of the river systems. The UK Met Office has provided 3 climate scenarios based on the Regionally Coupled Model liked to the HadCM3 Global Circulation Model, and the simulations have been downscaled to a 25km grid across the catchments. The modelling of the climate indicates increased trends in temperature in all three climate scanarios as well as increased precipitation with temperature increases from 2.6 ^{o}C by mid century to 4.3 ^{o}C at the end of the century. Precipation is modelled to increase by between 10% by mid century and 15% by the end of the century. The effects on the flows in the Ganga River system at Furraka in the lower Ganges is shown in Figure 2 and indicates increased flows in the monsoon period by the mid century, with the potential for increased flooding.

The water quality has also been modelled with nitrate reducing into the future as increased flows dilute discharges and also the Ganga Management Plan delivers improved water treament of effluents from the major cities. The downstream flow and water quality time series are being transferred to a range of other modellers in the project simulating the estuary systems, the Bay of Bengal, agriculture, fisheries and the impacts of of change on poverty alleviation in Bangladesh.

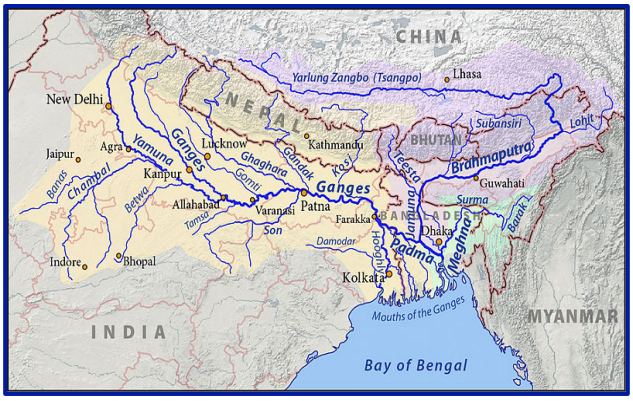


Figure 1 Map showing the GBM River Systems draining into India and Bangladesh

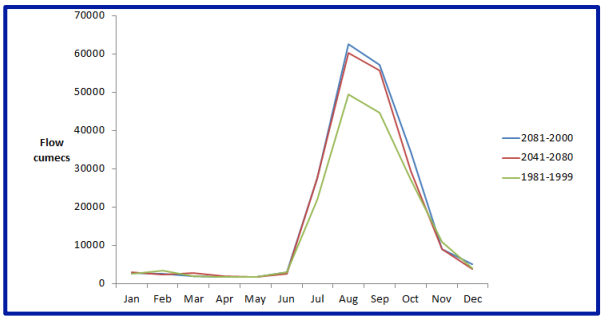


Figure 2 Monthly Flows in the lower Ganga River System for current and future climate conditions

Papers published

Whitehead, P.G., Sarkar, S., Jin, L., Futter, M.N., Caesar, J., Barbour, E., Butterfield, D., Sinha, R., Nicholls, R., Hutton, C. and Leckie, H. D., 2015, Dynamic modelling of the Ganga river system: impacts of future climate and socio-economic change on flows and nitrogen fluxes in India and Bangladesh , Environ. Sci.: Processes Impacts, 17,6 1082-1097, DOI: 10.1039/C4EM00616J

Whitehead, P.G., Barbour, E., Futter, M.N., Sarkar, S., Rodda, H., Caesar, J., Butterfield, D., Jin, L., Sinha, R., Nicholls, R. and Salehin, M., 2015, Impacts of climate change and socio-economic scenarios on flow and water quality of the Ganges, Brahmaputra and Meghna (GBM) river systems: low flow and flood statistics, Environ. Sci.: Processes Impacts, 2015,17, 1057-1069, DOI: 10.1039/C4EM00619D

Futter, M.N., Whitehead, P.G., Sarkar, S., Rodda, H. and Crossman, J., 2015, Rainfall runoff modelling of the Upper Ganga and Brahmaputra basins using PERSiST, Environ. Sci.: Processes Impacts, 2015,17, 1070-1081 DOI: 10.1039/C4EM00613E

Jin, L., Whitehead, P.G., Sarkar, S., Sinha, R., Futter, M.N., Butterfield, D., Caesar, J. and Crossman, J., 2015, Assessing the impacts of climate change and socio-economic changes on flow and phosphorus flux in the Ganga river system, Environ. Sci.: Processes Impacts, 2015,17, 1098-1110, DOI: 10.1039/C5EM00092K

Next WRA Board Meeting

22nd January 2016, Blewbury

The WRA Bulletin is a quarterly publication, and relies on contributions submitted by Directors, 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 Frank Farquharson: frank@watres.com
Water Resource Associates LLP, PO Box 838, Wallingford, Oxon OX10 9XA. Tel: +44(0) 1491 838 190, www.watres.com