OPINION

Hydrology in India – a practitioner's perspective

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In his Guest Editorial 'Impetus to hydrology', Mujumdar[1] has opened up an important topic. The extent of neglect of hydrology can be gauged from the fact that he found it necessary to start his article explaining to the readers of a science journal, what exactly is hydrology. This note is not a response to the Mujumdar's Editorial. There is no disagreement with what he wrote. This is an attempt to examine the state of hydrology, but from the perspective of a practitioner.

India has come to a stage where hydrology has almost become irrelevant. Hydrologists are now consulted only for the assessment of water availability and design flood for large projects. But society seeks guidance on how to manage our water resources from 'water experts' who have a background in anything but hydrology. These 'experts' dominate not only the media and internet, but also various Government committees. As a result, a lot of non-science has entered our water discourse, and the so called 'wisdom of the centuries' concept dominates over modern, scientific hydrology.

The hydrology community in India, of which I am also a member, needs to ask itself some hard questions. Why have 'hydrologic quacks' come to dominate the water discourse and why have the trained hydrologists become almost redundant?

Hydrology is a rather sedate discipline. The unit hydrograph concept was proposed by Sherman in 1932. After 83 years it is not only still in use, but is in fact the backbone of design flood studies. The Nash model for derivation of the instantaneous unit hydrograph for a natural watershed dates back to 1957, and that too is still in use. In the 36 years that I worked in the Central Water Commission (1976–2012), I saw only one significant change in the practice of hydrology. The computation of design flood changed from empirical formulae to flood frequency studies and probable maximum flood studies.

Flood forecasting, a crucial activity for a nation where 33.5 mha area is flood-prone, continues to be done by an obsolete gauge-to-gauge correlation, i.e. a correlation between a high flow observed at some upstream location and the flood some hours later at a downstream location. This makes a prediction of only the very high flows and restricts the lead time of the forecast to travel time of flow between the two stations. Extended hydrologic predictions (EHP) refer to increasing the lead time by computing the flood forecast before rainfall has even occurred, based on quantitative precipitation forecast. But EHP requires prediction of the continuous hydrograph, not just the peak flows. And that requires use of advanced conceptual models. The developed nations are all already well into EHP, and many nations that are ranked lower than India on the S&T ladder, are also attempting EHP. India is yet to start.

In the early era of computers, the hydrology practitioners used to write FORTRAN programs themselves for hydrologic computations. But that era is now long over. Advances in computer hardware and software technology have made it possible to provide an algorithm as ready-to-use software package that not only incorporates the hydrologic computation, but also interacts with standard database formats for data I/O, and interacts with a GIS to provide spatial analysis, like demarcating the area likely to be flooded and its visual representation on a map.

However, all the hydrologic software used in India is imported. A couple of decades ago India purchased several copies of Mike 11, a software package initially intended for dam break analysis and later modified for flood forecasting also. Mike 11 is developed by a European consultancy group. And this package and its later variants continue to be the only software for attempting flood forecasting with conceptual models. Another recent package that is becoming popular, the SWAT model for study of land management practices, is also imported. Under a World Bank project called Hydrology Project-2, it was envisaged to develop hydrology software for many different purposes, and all the software was developed by foreign consultants.

I am perplexed by this absence of Indian software for hydrology. Because the hydrologic know-how in a typical flood forecasting package, or a reservoir simulation package, is rather simple. In the sense it is not in the same complexity league as hypersonic wind tunnel modelling, or computation of a MRI scan. The algorithms for rainfall–run-off models, channel routing models, reservoir simulation, etc. are neither secret nor complex. And India is a leader in programing expertise. After C-DAC developed the Param, even supercomputers have become accessible to hydrologists. But hydrologists do not seem to have any use for tera-flop computing. And not a single usable software package for hydrology has emerged from any hydrology R&D group or institution in India.

I envy the meteorologists who study the other half of the hydrologic cycle, the atmospheric phase. Taking advantage of advances in computing technology, the meteorologists have made huge progress in climate modelling. Amongst civilian users they were probably the first to seek a supercomputer, the Cray X-MP, some 15 years ago. In contrast, except for the GIS part – which is not hydrology – the hydrologic computations currently in use can do with a PC-XT with 640 K RAM.

Whenever such issues are brought up in seminars on hydrology, the research community complains about Government not providing the data, an essential input for R&D. It is true that obtaining hydrologic data in India is not easy. However, that as the reason for absence of usable R&D output, or hydrology being stuck with the unit hydrograph, is not convincing. And for three reasons.

One, the data of only the trans-boundary rivers, namely the Ganga, Brahmaputra and Indus are classified. For other basins that are entirely within India, the data are not classified and can be obtained, though it does take some efforts.

Two, whatever data are denied to the Indian R&D community, it is also denied to foreign R&D community. However, that has not deterred the foreign groups from developing software for use in India.

Three, it is also not the case as if some R&D group has developed an algorithm to the extent where it is now only waiting for the data, and as soon as the data become available, the model can be verified and released for use.

Unless someone has a more convincing explanation, the only one I can think of for the stagnation of hydrology is the academician versus practitioner divide. In medicine, the academicians are also practitioners. A professor of surgery does not limit to lecturing in medical colleges. He actually performs surgery, every day. In contrast, in engineering there is very little interaction between the academicians and practitioners. And this divide is particularly severe in the case of hydrology.

The one change mentioned in the foregoing, from empirical formulae to flood frequency and PMF studies, was not driven by any hydrology R&D institution in India. In seminars and journals, we the practitioners keep hearing about many different types of stochastic and deterministic models, artificial neural networks, etc. But none has been developed to a stage where it can be offered to the practitioners as a 'ready to use' package.

With the above analysis as background, the following suggestions are offered for consideration as corrective measures:

(a) Do not expect the practitioners to make advances in hydrology. And the academicians also cannot do it sitting only in academic institutions. They need to be enabled to participate in the practice of hydrology. Water resources departments should be opened for lateral entry, say on deputation for a limited period, to academicians. There is talk of lateral entry in administration. Why not in S&T also? Of course, the onus of making this happen is on the practitioners. They will have to get above the concerns of 'losing some posts'.

(b) In India, hydrology usually means surface water hydrology. The compartmentalization of surface water and groundwater is actually an administrative and legal division. But it has unfortunately percolated down to science as well. This must end.

(c) There is absolutely no justification to restrict hydrology only to civil engineers. Graduates in mathematics or in atmospheric physics can certainly take PG courses in hydrology. Open-channel hydraulics is the only topic they need to learn from the domain of civil engineering.

(d) In many countries, the rainfall forecasts and run-off forecasts are both done by the same department. Now that we have a Department of Earth Sciences, at least some part of hydrology, say river-flow forecasting, should be shifted from the water resources departments to earth sciences. Meteorology, surface water hydrology and groundwater hydrology should all be integrated into one.

(e) Taking this a step further, at the UG level itself an 'earth sciences programme' should be considered that includes meteorology, all hydrology, and also some environmental sciences, into one package.

1. Mujumdar, P. P., *Curr. Sci.*, 2015, **109**, 235–236.

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