RUNOFF, REEF, REGULATION... and reality checks

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Probabilistic Categorisation of Storm Temporal Patterns for Runoff Modelling

Mr Evan O'Brien[1], Mr Andrew Barker[1]
[1]*CDM Smith*

Biography:
Evan is an RPEQ-certified engineer with 15 years of experience in the consulting industry. He has worked on a wide range of projects including hydrological and hydraulic studies for urban infrastructure planning and flood risk assessments; detailed drainage design for road, rail and airport projects; and site-based roles as the designer's representative for civil construction and flood mitigation projects. Most recently he has led the surface water modelling component of the Bundaberg Ten Year Action Plan – a suite of proposed flood mitigation options to protect that town against flooding from the Burnett River.

It is widely understood that the temporal distribution of rainfall within a storm event can have a large influence on the shape of the resultant runoff hydrograph (Nathan et al. 2016), a fact that has many implications for risk managers and designers of urban infrastructure. The industry guideline Australian Rainfall and Runoff 2016 (ARR16) moved towards addressing this inherent natural variability through the provision of a suite of temporal patterns (selected from observed storm events) for design event modelling. However, this presents a conundrum for practitioners wishing to assess risk on a probabilistic basis, because whilst rainfall and loss inputs are defined probabilistically, the temporal patterns advanced by ARR16 are not. They are hand-picked excerpts from real storms and as such, their properties cannot be known a priori. Instead, for any given storm duration ten possible runoff hydrographs are produced and only limited statistical analysis can be carried out after the fact. A typical method is to select the "median" hydrograph by peak discharge and carry this forward for hydraulic analysis and design tasks.
This raises important questions: Are the properties of the sample (ie. the ten-pattern ensemble) the same as those of the population from which they are drawn? And if so, how can the temporal pattern that produced a particular hydrograph be classified beyond simple descriptors such as "front end loaded" or "relatively uniform"?
In this paper, the authors present case studies on design runoff modelling using probabilistic temporal patterns derived from at-site data. Combining the powerful data analysis and visualisation capabilities of the "R" software language, with an overarching data science workflow, an interactive web tool was developed (Barker & O'Brien, 2018), which is now put to use in deriving rainfall probability isopleths for design event modelling. Event filtering can be performed to build patterns based on seasonality, historic period, minimum depth threshold, and dominant rainfall quartile, among other things.
This approach has the key advantage of allowing a practitioner to explicitly define the properties of the temporal distribution of rainfall prior to carrying out the analysis, so something previously as vague as "front end loaded" now becomes "the 90th percentile accumulation curve for all first-quartile-dominant, summer storm events". Similarly, extreme edge cases can be developed for late onset bursts, which are important to dam managers. Results are compared against those from the ARR16 methodology, with the goal of furthering our understanding of hydrologic risk.