When to Use Hydrologic Lump and Semi-Distributed Approach to Determine Critical Duration and Storm Pattern

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Overview

With the introduction of the Australian Rainfall and Runoff 2016 (ARR 2016), there has been a change in the modelling of the hydrologic processes contributing to floods for design events. The most significant is the inclusion of ensemble events, which has increased the number of temporal patterns from 1 in ARR 1987 to 10 in ARR 2016. A typical approach with ARR 1987 was to utilise the hydrologic model to determine the critical storm duration for a particular average reoccurrence interval (ARI) event. It is suggested a similar approach can be used for the ARR 2016 hydrological assessment. This paper will explore different catchments and modelling tools to assess the reliability in adopting this approach using ARR 2016 methods.

Objectives

The main objective of this paper is to explore various catchments and modelling tools to determine if a lumped or semi-distributed hydrologic approach is appropriate for using the ARR 2016 updated temporal patterns. The rationale is to explore in what cases is it appropriate to utilise the hydrologic tool to discern the critical storm pattern and duration when estimating the peak design flood levels in a hydraulic model.

Method

The approach taken was to select 3 different catchments located with Queensland (Weipa, Mackay and Warwick) each with slightly different catchment shapes and response times. The hydrologic catchments were set-up in XPSWMM and WBNM considering both a lumped catchment and semi-distributed catchment approach. The hydrologic models were used to determine the appropriate critical duration and storm patterns for each catchment and each AEP event in accordance with ARR 2016. This resultant critical duration and storm pattern was compared between the different models.

The XPSWMM model hydrologic outputs were tested in the hydraulic model to determine the peak flood levels for the chosen storm patterns for each AEP event. The resultant predicted flood levels were compared.
The XPSWMM model for the Weipa catchment was assessed in the hydraulic model for the full range of storms and this output was compared.

Results

Outputs indicated that whilst a clear storm critical duration and storm pattern could be determined from the hydrologic assessment, this did not always translate into the hydraulic model peak flood levels. With more frequent AEP events at times producing higher levels than less frequent events.

Conclusions

The conclusion of the testing indicated that the adoption of different approaches of lumped and semi-distributed modelling would yield different outputs using the hydrologic assessment. When this was tested in the hydraulic model more frequent AEP events can at times produce higher levels than less frequent events. This required more consideration of the catchment parameters and specifically consideration of how the catchment storage is accounted for in distributed and semi-distributed modelling approaches.