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Developing a peaks-over-threshold based flow estimation method

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RESEARCH SUMMARY

Flood is one of the worst natural disasters, which cause billions of dollars of damage globally each year. Due to climate change, flood severity is increasing. Flood frequency analysis (FFA) is widely adopted to estimate design floods, which are needed to design hydraulic structures. Traditionally, FFA adopts the annual maximum (AM) model. However, criticisms have been made on its limited flexibility, in particular for frequent design flood estimates. An alternative to AM model is the Peaks-Over-Threshold (POT) model, which can overcome some of the drawbacks associated with the AM model. The POT model is currently underemployed worldwide due to its modeling complexity and determining statistical sound threshold for fitting the probability distributions. The POT model is also not as well-studied as the AM model.

This research aims to develop a POT-based flow estimation method using Australian data and is expected to be completed by 2024. This project firstly reviews the existing literature on the POT-based FFA and identifies the relevant research gaps. A journal paper of scoping review on POT model has been prepared, which is currently under review. This article reviews the existing literature on POT model, which includes aspects of at-site and regional FFA and stationarity.

Based on the identified research gaps, this study then explores the applicability of POT model in both at-site and regional FFA. A journal paper is published based on 188 gauged catchments in southeast Australia, which compared design flood estimates between the AM and POT models. This article also links the differences between the two models with relevant catchment characteristics. Currently, this research is concentrating on a regional flow estimation technique in southeast Australia for very frequent to frequent flows, considering the baseflow factor as a predictor. Ordinary least squares and weighted least squares are used for developing the regression models. Upon completion of this stage, POT based regional FFA will be extended to artificial intelligence-based methods such as supervised machine learning. This study also aims to assess the impacts of climate change on POT based FFA. Finally, this study aims to perform a quantitative assessment of uncertainties on POT based FFA.

At present, Australian Rainfall and Runoff (ARR) recommends using POT based FFA for floods more frequent than 0.2 average events per year. However, with the recent advances of POT based FFA, it is not yet accommodated into ARR. Regarding regional FFA and nonstationarity, POT based approach is not well explored in depth internationally. It is expected the outcomes of this doctoral research will benefit not only the Australian engineering hydrology practice, but also the international one. Furthermore, a software will be developed that can be used by practicing hydrologists to implement POT modeling covering flow estimates at both gauged and ungauged catchments under stationary and non-stationary conditions.