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Identification of homogeneous regions in regional flood frequency analysis under changing climate

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ABSTRACT

In water resources management and design of hydraulic structures, regional flood frequency analysis (RFFA) is needed as this can provide design flow estimation for ungauged catchments. In RFFA, the identification of homogeneous region is a primary step. Flood characteristics are changing due to varying climate conditions. This is a result of the change in rainfall, snowmelt, groundwater flow and land characteristics. Previous studies examined use of flood and catchments characteristics to delineate homogeneous regions. Although abundant scientific literatures are available in identifying homogeneous regions, none of this examined the implication of climate change on identification of homogeneous regions. The main objective of this study is to identify homogeneous regions using physiographic and hydrologic variables and incorporating climate change impacts. This project will address the following research questions:

1. What does homogeneity mean in RFFA?
2. Is there any link between homogeneous regions in the space of flood statistics and in the space of catchment characteristics?
3. Does increased heterogeneity reduce the accuracy of flood quantile estimation in RFFA?
4. How effective are different measures of statistical homogeneity?
5. If homogeneous regions cannot be identified, should we use index flood method or quantile regression technique?
6. How climate change affects regional homogeneity in RFFA?

METHOD

For this study, 201 gauged catchments are selected from NSW and VIC states of Australia. These catchments are unregulated and have catchment areas in the range of 3 km^2 to 1010 km^2 with a mean value of 334 km^2. The annual maximum flood data length ranges from 25 to 89 years (average of 46 years). Preliminary analysis based on Hosking and Wallis method shows that few stations are discordant when a single region comprising of 201 stations is formed. Heterogeneity measures also indicate that the regions are highly heterogeneous (H values in the range of 14 to 33), but discordant values are not that higher. Using this data, the available region identification approaches (both linear and nonlinear), as well as the most recently proposed statistical homogeneity test (say flood regime variability test, fuzzy logic and multivariate L (Linear) moments homogeneity test), will be applied to propose new homogeneous region identification methods that incorporate climate change indices.

This research was commenced in July 2021 and is expected to be completed by June 2024. A scoping review paper is under preparation, which is expected to be submitted for publication by March 2022. A total of five journal articles will be written based on this research.