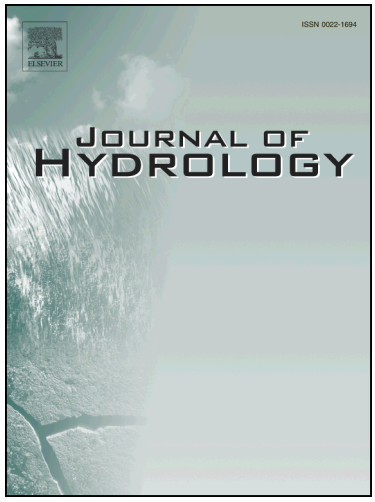

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Dependence properties of spatial rainfall extremes and areal reduction factors

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Abstract

Areal reduction factors (ARFs) transform an estimate of extreme rainfall at a point to an estimate of extreme rainfall over a spatial domain, and are commonly used in flood risk estimation. For applications such as the design of large infrastructure, dam safety and land use planning, ARFs are needed to estimate flood risk for very rare events that are often larger than the biggest historical events. The nature of the relationship between ARFs and frequency for long return periods is unclear as it depends on the asymptotic dependence structure of rainfall over a region, i.e., the extent to which rainfall from a surrounding region is extreme as rainfall at a point becomes more extreme. Miscalculating this for very rare events could lead to poor design of infrastructure. To investigate this, spatial rainfall processes are simulated using asymptotically dependent and independent models, and the implications for ARFs of the asymptotic assumptions are explored in a synthetic study. The models are then applied to a case study in Victoria, Australia, using 88 daily rainfall gauges with 50 years of data. The analysis shows that the observed data follow the behaviour of an asymptotically independent process, leading to ARFs that decrease with increasing return period. The study demonstrates that the use of inverted max-stable process models to simulate ARFs can provide a rigorous alternative to empirical approaches, particularly for long return periods requiring significant extrapolation from the data.