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Catchment dynamics under climate change and the impact on rainfall losses and flooding

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Abstract: Climate change is expected to affect both the frequency and severity of floods, which has implications for how flood risks are assessed and managed now and into the future. To date, changes to design flood magnitudes due to climate change have largely focused on projections of rainfall under climate change that are used to inform continuous simulation models and subsequently develop non-stationary flood probability models. While continuous simulation models are widely used for water resources assessment they are not well suited to flood estimation for many practical applications, particularly for rare and extreme events (around 1% annual exceedance probability and rarer). In contrast to continuous simulation models, event-based rainfall-runoff models are widely used in industry and are more suited to estimating flood risks over a wide range of exceedance probabilities (10% annual exceedance probability and rarer) through to extreme events used in the design of critical infrastructure and emergency flood planning. A key set of parameters in event-based rainfall-runoff models are rainfall losses, which represent the amount of rainfall that is intercepted, stored, or infiltrated into the catchment and do not contribute to the runoff during the flood event. These rainfall losses are commonly separated into initial rainfall loss amounts, which occur prior to the generation of runoff, and continuing rainfall loss rates, which occur following the commencement of runoff.

Ensuring that the estimates of rare through to extreme design floods can accommodate climate change impacts thus requires projections of rainfall losses for future climatic conditions. Here, we quantified the impact of climate change on rainfall losses as represented in event-based runoff models, specifically initial and continuing losses. We quantified how these losses have varied by examining runoff responses to independent 5 EY rainfall events occurring in largely unimpaired catchments in Australia containing hydrological reference stations. These events were calibrated using event-based rainfall-runoff models at an hourly time scale. We identified significant dependencies between both the initial and continuing losses and antecedent soil moisture in over 200 catchments. These dependencies were used to project changes in rainfall losses under different scenarios of climate change using projections of soil moisture from the Bureau of Meteorology's National Hydrological Projections dataset (Wilson et al. 2022). We found near unanimous increases in both initial losses and continuing losses across the continent of Australia, and also an increase in their variance, indicating that future flood responses will also be increasingly variable. For frequent flooding, where rainfall losses are a significant proportion of the total rainfall, our results indicate that increased rainfall losses could offset the impact of increased rainfall for events, or conversely magnify the impact of decreased rainfall intensities. This means, for the same amount of rainfall, in the future we may see less runoff generated and increasing water stress in our already water limited continent.

REFERENCES

Ho, M., el al. 2023, Changes in flood-associated rainfall losses under climate change, Journal of Hydrology, in review.

Wilson, L., et al. 2022. A national hydrological projections service for Australia. Climate Services 28, 100331. doi: 10.1016/j.cliser.2022.100331.

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