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Towards development of a seamless probabilistic flood inundation map for extreme flood events across Australian catchments

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Floods in Australia are among the most costly and deadly natural disasters causing significant material damage, injury, and death. Effective emergency management to reduce the devastating consequences of flooding depends on the accuracy and reliability of forecasts. Effective infrastructure planning for flood mitigation depends on the accuracy and reliability of future projections. Flood inundation mapping is a tool widely used for flood mitigation purposes by providing information on flood event characteristics such as occurrence, magnitude, timing, and spatial extent. However, information derived from flood inundation maps is subject to uncertainties in each step of a complex modelling chain, including uncertainties in hydro-meteorological and observational datasets, digital elevation models and representation of rivers, as well as over-simplification of hydrological and hydraulic processes. Therefore, relying on a purely deterministic representation of flood characteristics may lead to poor decision making. Probabilistic flood maps are capable of accounting for uncertainty by estimating the probability of a certain area being flooded, which is a recommended approach for risk-based decision making. In addition, providing probabilistic flood map information encompassing past, present, and future, will improve Australia's resilience to flood events and target infrastructure spending. Generation of seamless probabilistic flood maps in an operational setting, particularly at a continental scale, needs to be supported with an integrated and consistent set of hydro-meteorological datasets across timescales and catchments.

The aim of this study is to develop a seamless probabilistic flood inundation mapping framework for near-future to far future floods across flood-prone Australian catchments. We take advantage of products from the Australian Water Outlook (AWO: awo.bom.gov.au), a water service that provides nationally consistent water information since 1911 until the present as well as long-term projections out to 2100. In this framework, large rainfall events are detected based on ensemble forecasts or projections from AWO using a threshold analysis. After detection of a potential flood, an event-based hydrological model (URBS) is initialised to generate an ensemble of river reach hydrographs in a Monte Carlo framework where the parameterisation of the catchment wetness is informed by historical flood events for the catchment. This enables uncertainty from ensemble rainfall and catchment losses to be quantified and incorporated within

the hydrograph generation step. Lastly, we combine remotely sensed data with topographic and river network information to map the flood extent, using the height above nearest drainage (HAND) method. This framework will be tested for two major flood events in February 2020 and March 2021 at Hawkesbury Nepean Valley catchment located in New South Wales, Australia, which, due to significantly different antecedent conditions, had dissimilar flood characteristics, thereby demonstrating the suitability of the framework.