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Tropical cyclone effects on rapid runoff responses: quantifying with new continuous-time transfer function models

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Abstract The South Creek Experimental Catchment (Queensland, Australia) was the first forest hydrological study established within cyclone-affected areas of the humid tropics to address runoff processes or surface–groundwater interactions. From the outset it was believed that the very flashy nature of the responses within this area of Queensland was at least partly attributed to rainfall characteristics associated with tropical cyclones. This study quantifies the impact on the dynamic response characteristics of very flashy streamflow responses to rainfall from a sequence of tropical cyclones relative to those associated with local convective events. To achieve this we have applied state-of-the-art time-series modelling methods to South Creek data and to that from a basin not directly affected by tropical cyclones but where the soils and slopes are comparable. For both data sets our analyses best captured the rainfall–runoff responses with second-order continuous-time transfer functions where 60% of the streamflow was associated with a fast pathway. While the recession time constant (*TC*) of this fast pathway was 75 minutes for the basin with rainstorms produced by local convective events (namely the Baru Experimental Catchment in Malaysian Borneo), the *TC* was only 21 minutes at South Creek. With an identical model structure and an identical value describing the rainfall–runoff nonlinearity, this shows quantitatively that for a unit rainfall input (sampled on a sub-hourly basis), the basin affected by tropical cyclones produced flashier stream responses in comparison to that only affected by localised tropical thunderstorms.

Key words continuous-time model; data-based mechanistic model; experimental catchment; surface–groundwater interactions; tropical cyclone