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A stochastic model of throughfall for extreme events

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Abstract. Although it is well known that forest canopies reduce the amount and intensity of precipitation at the ground surface, little is known about how canopy interception modifies extreme events. The effects of forest cover on intensity-duration-frequency relationships were investigated, using a stochastic model to extrapolate measured rainfall and throughfall to throughfall expected during extreme events. The model coupled a stochastic model of rainfall with stochastic representations of evaporation and precipitation transfer through canopies. Stochastic evaporation was governed by probability distributions sensitive to storm size, and transfer through canopies was governed by a black-box linear system. The modelled reduction of extreme-event intensities by canopies was 5–30%, depending on duration and return interval. The reduction was 15–20% in low return interval events (2 y) at all durations. In contrast, intensities of high return interval events (90 y) were proportionally more reduced at short durations (~30% reduced) than at long durations (~5% reduced). The model suggested that evaporative losses reduced intensity in the frequent events (2 y return interval), but water transfer through the canopy was more important for the reduction in intensity in the rarest extreme events. High return intervals of long duration were least affected by canopies because evaporative losses were the least proportion of rainfall. Extreme events larger than 10- or 20-y return interval probability threshold occurred only 31–69% as often in throughfall as in rainfall.

Keywords: canopy interception, throughfall, stochastic rainfall modelling, rainfall intensity, linear systems, landslides

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