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Measuring dynamic infiltration rates during rainfall of fluctuating intensity: an approach using affine Horton equations.

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It is important to develop methods for determining infiltrability and infiltration rates under conditions of fluctuating rainfall intensity, since rainfall intensity rarely remains constant. During rain of fluctuating intensity, ponding deepens and dissipates, and the drivers of soil infiltration, including sorptivity, fluctuate in value. This has been explored on dryland soils in the field, using small plots and rainfall simulation, involving repeated changes in intensity as well as short and long hiatuses in rainfall. The field area was the Fowlers Gap Arid Zone Research Station, in western NSW, Australia.
The field experiments used multiple 60 minute design rainfall events that all had the same total depth and average rainfall intensity, but which included intensity bursts at various positions within the event. These were based on the character of local rainfall events in the field area. Infiltration was found from plot runoff rates measured every 2 minutes, and rainfall intensities that were adjusted by computer-controlled pumps at 1 second intervals. Data were analysed by fitting a family of affine Horton equations, all having the same final infiltrability (about 6-7 mm/h) but having initial infiltrabilities and exponential decay constants that were permitted to recover during periods of very low intensity rain, or rainfall hiatuses. Results show that the terms in the Horton equation, f0, fc, and Kf, can all be estimated from field data of the kind collected. This is a considerable advance over ‘steady-state’ rainfall simulation methods, which typically only allow the estimation of the final infiltrability fc. This may rarely be reached owing to the occurrence of short rainfall events, or to changing intensity under natural rainfall, that prohibits the establishment of steady-state infiltration and runoff. Importantly, this method allows a focus on the recovery of infiltrability during periods of reduced rainfall intensity. Recovery of infiltrability is shown to proceed at rates of up to 1 mm/h per minute of hiatus time, or by 20 mm/h during a 20 minute period of low rainfall intensity.