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Time-scales for runoff and erosion estimates, with implications for spatial scaling

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Using rainfall data at high temporal resolution, runoff may be estimated for every bucket-tip, or for aggregated hourly or daily periods. Although there is no doubt that finer resolution gives substantially better estimates, many models make use of coarser time steps because these data are more widely available. This paper makes comparisons between runoff estimates based on infiltration measurements used with high resolution rainfall data for SE Spain and theoretical work on improving the time resolution in the PESERA model from daily to hourly values, for areas where these are available. For a small plot at fine temporal scale, runoff responds to bursts of intense rainfall which, for the Guadalentin catchment, typically lasts for about 30 minutes. However, when a larger area is considered, the large and unstructured variability in infiltration capacity produces an aggregate runoff that differs substantially from estimates using average infiltration parameters (in the Green-Ampt equation). When these estimates are compared with estimates based on rainfall for aggregated hourly or daily periods, using a simpler infiltration model, it can be seen that there a substantial scatter, as expected, but that suitable parameterisation can provide reasonable average estimates. Similar conclusions may be drawn for erosion estimates, assuming that sediment transport is proportional to a power of runoff discharge..

The spatial implications of these estimates can be made explicit with fine time resolution, showing that, with observed low overland flow velocities, only a small fraction of the hillside is generally able to deliver runoff to the nearest channel before rainfall intensity drops and runoff re-infiltrates. For coarser time resolutions, this has to be parameterised as a delivery ratio, and we show that how this ratio can be rationally estimated from rainfall characteristics.