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The spatial and temporal distribution of point scale soil water in a semi-arid catchment and some implications for catchment scale predictability

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In humid catchments it is generally assumed that soil moisture is systematically spatially distributed following, at least to first order, the topographic index. In semi-arid catchments, however, it is generally assumed that the spatial distribution is spatially random, despite potential controls from the systematic spatial effects of aspect, soil catena and vegetation. Recent advances in Time Domain Reflectometery (TDR) instrumentation have made large scale spatially-distributed, continuous-time, point-scale measurements of soil moisture both cheap and easy. Using data from the SASMAS field region with 26 permanent monitoring sites NW of Sydney, Australia we explore the spatial and temporal statistical properties of soil moisture measurements using data from a network of permanently installed TDR probes with spacing of the order of 0.1-10 km supplemented by a series of hand-held transects at a variety of resolutions from 100mm to 1m. We find a range of correlation scales that suggest strong random variability at the short length scales as well as strong correlations of time varying soil moisture over distances of several kilometres. The latter large-scale results are suggestive of spatial organization. The paper explores the implications of these results for (1) the potential to use a single permanently installed probe for continuous time monitoring of regional scale soil moisture status (e.g. for agricultural soil moisture estimation and initialisation of hydrology and climate models), and (2) methodological constraints on the use of hand-held measurements.