

Inferring Spatiotemporal Soil Moisture Anisotropy at the Catchment Scale II

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Abstract

The Tarrawarra (southeast Australia) dataset (*Western & Grayson, 1998*) contains twenty time series of soil moisture data observed at spatially distributed locations within a 10 ha catchment. With every series containing fifty-three temporally distributed neutron moisture meter (NMM) measurements, the NMM data may be visualised as a set of spatially distributed series that progress simultaneously in time (*Fig. 1*). The NMM data are complemented with thirteen spatially high-resolved time domain reflectivity (TDR) surfaces irregularly distributed along the time-axis. Since these surfaces cover the complete catchment with a 10×20 m grid (*Fig. 1*), they comprise the NMM sites and may be regarded as spatial realisations of the scenarios repeatedly sampled with NMM technique. In order to utilise the combined NMM/TDR dataset in inferring complete soil moisture surfaces at every NMM occasion, Kriging with external drift is applied (*Wackernagel, 2003*). This method offers quite robust estimates of the error associated with soil moisture modelling, but requires a spatiotemporal covariate that continuously compensates for varying soil moisture anisotropy.

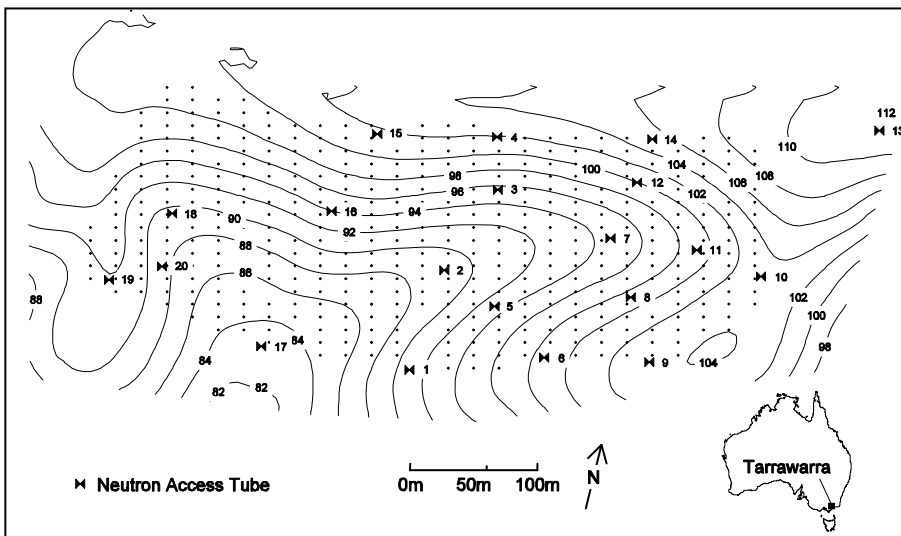


Figure 1: The 10 ha Tarrawarra catchment with NMM access tubes (▶◀), TDR measurement locations (●), and 2 m equidistant elevation contours.

The resulting time series of Kriged soil moisture surfaces may again be considered as simultaneously progressing, spatially (pixel-wise) distributed time series. These series are analysed in a state-space ARMAX approach in order to identify the auto- and cross-covariance structures that define spatiotemporal soil moisture anisotropy at the catchment scale (*Thierfelder et al., 2003*). Since the anisotropy information is required when Kriging parameters are estimated, ARMAX-conditioned Kriging is methodologically implied. The resulting inferential loop is implemented via a Kalman-filter designed to address the Kriging-ARMAX analogy, where respective residual statistics are compatible and, in fact, analogous (*Wackernagel, 2003*).

As a result of the analysis performed, topography-dependent anisotropy structures are assessed at the landscape scale, together with auto- and cross-correlative characteristics of generic soil moisture. Based on this information, a distinction can be made between physically introduced observational effects and effects introduced by random processes. Such distinction is a necessary prerequisite for determining the location of Catchment Characteristic Soil Moisture Monitoring (CASMM) sites, i.e. a set of non-redundant monitoring sites that together capture the variance components of generic soil moisture at the catchment scale (*Vachaud et al.*, 1985, *Grayson & Western*, 1998).

References

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