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An artificial neural network approach to estimate watertable depths in space and time over a cultivated mediterranean region

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The knowledge of the distribution of the shallow water table depths both in time and in space allows to improve the understanding and the prediction of several processes happening at the catchment scale (e.g. Guix et al, 2005). Since the fluctuations of these water tables can only be measured at a limited number of well sites and over limited periods, it is important to develop procedures able to estimate these fluctuations from surrogate data such as soil data, topographic variables, reference wells and climatic data (Bierkens, 2001).

Such a procedure is proposed in the context of mediterranean areas characterised by highly contrasted climatic conditions, marked relief, discontinuous aquifers and high densities of artificial stream networks. To capture the non-linearities of the water table fluctuations in this specific context an artificial neural network approach is selected (Vila *et al.*, 1999). The approach is tested in a 60 km^2 vine production area, namely the lower Peyne valley (Languedoc – France).

Watertable depths were measured weekly between november 11th 2002 and july 19th 2004 at 41 four meters-well-sites sampled within the study region. At these sites, a set of easy-to-collect indicators were calculated in view of representing the temporal and spatial variations of watertable depths. Temporal indicators are cumulated rainfall, potential evapotranspiration and a set of reference wells that must be monitored during the prediction period. Spatial indicators are mainly relief indicators derived from a DEM - e.g. slope gradient, distance to the nearest stream, contributive area -

. Some additional spatial indicators that are still not mapped in the study area were also determined at each site, e.g. impermeable layer depth, distance to ditch and ditch depth.

A two step approach was undertaken. The sites were first classified into four classes according to the shape of the fluctuations, one of these class being sites at which watertable are seldomly observed (11 sites). We showed that these classes can be successfully discriminated (10% misclassification) from the available spatial indicators by means a set of simple boolean criteria combined in a classification tree. A 1-hidden layer feedforward neural network predicting time series of watertable depths was calibrated over the remaining set of 30 sites showing watertable fluctuations. Several data configurations were tested, i.e. using reference sites or not, using classification of sites or not. For each data configuration, the best neural network - i.e. the optimal number of neurons and connectivity parameters - was found by applying a cross-validation approach (one site removed at each trial).

The results showed that the watertable depths can be predicted with acceptable errors (RMSE = 0.52 m). The best performances are obtained by using watertable depths variations at reference sites as indicator of temporal variations and by calibrating separately neural networks for each of the defined classes.

References

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