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Predictive spatial modelling for mapping soil salinity at continental scale

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Soil salinity is a serious limitation to agriculture and one of the main causes of land degradation. Soil is considered saline if its electrical conductivity (EC) is > 4 dS/m. Maps of saline soil distribution are essential for appropriate land development. Previous attempts to map soil salinity over extensive areas have relied on satellite imagery, aerial electromagnetic (EM) and/or proximally sensed EM data; other environmental (climate, topographic, geologic or soil) datasets are generally not used. Having successfully modelled and mapped calcium carbonate distribution over the 0-80 cm depth in Australian soils using machine learning with point samples from the National Geochemical Survey of Australia (NGSA), we took a similar approach to map soil salinity at 90-m resolution over the continent. The input data were the EC1:5 measurements on the < 2mm fraction at 1315 georeferenced points across the continent at two depth intervals (TOS, 0-10 cm, and BOS, 60-80 cm) (see http://www.ga.gov.au/energy/projects/national-geochemical-survey/atlas.html) were log-transformed and combined with values for climate, elevation and terrain attributes, soil and lithology classes, geophysics, and MODIS vegetation indices extracted at the same locations which were used as predictors in decision tree models. The machine learning software 'Cubist' (www.rulequest.com) was used as the inference engine for the modelling, a 90:10 training:test set data split was used to validate results, and 100 randomly sampled trees were built using the training data. The results were good with an average internal correlation (r) of 0.88 between predicted and measured logEC1:5 (training data), an average external correlation of 0.48 (test subset), and a Lin's concordance correlation coefficient (which evaluates the 1:1 fit) of 0.61. Therefore, the rules derived were mapped and the mean prediction for each 90-m pixel was used for the final logEC1:5 map. This is the most detailed picture of soil salinity over Australia since the 2001 National Land and Water Resources Audit and is generally consistent with it. Our map will be useful as a baseline salinity map circa 2008, when the NGSA samples were collected, for future State of the Environment reports.