Space-Time Observation System for Soil Moisture

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A confluence of scientific and technological developments in soil moisture sensing, remote sensing, and geospatial data have made it possible to parameterise the components of the soil water balance equation in space and time;
soil moisture = precipitation + irrigation – evapotranspiration – deep drainage – runoff.
In this work, we present results on the development of an approach to predict soil moisture at a spatial resolution of 90m on a daily time step using readily available geospatial data. Three types of water balance models were examined; (1) single layer model with the saturated flow (2) multi-layer model with the saturated flow (3) multi-layer model with the unsaturated flow. Five layers were considered; 0-5, 5-15, 15-30, 30-60 and 60-100 cm, which coincide with the layers of the Soil Grid of Australia which is available at ~90m spatial resolution. Soil properties such as clay at each grid point were used as inputs to a pedotransfer function to predict the saturated water content for each layer. Precipitation and evapotranspiration are estimated by gridded SILO rainfall data (5km, 1 day) and the MODIS 16 ET product (1km, 8 days), respectively. Soil moisture predictions were tested with two soil moisture networks own by FarmLink Research and the Department of Environment and Primary Industries (DEPI), Victoria. The multi-layer model with the unsaturated flow was the best in term of predicting soil moisture for the whole profile (0-1m) with a median correlation coefficient of 0.7 across all sites, however, the deep layer (60-100cm) gave the worst predictions (median correlation = 0.4) compared to other layers. To understand the relative importance of the model predictions as compared to other environmental properties, a random forest model was fitted to a suite of variables e.g. soil order, month, temperature and etc., that vary in space, time or both space and time. Soil moisture predictions were the most important variable after slope, aspect and solar radiation index for FarmLink network, however, it was the most important variable for the DEPI network. This may indicate the water balance model could be improved if it includes processes such as lateral flow, hill slope orientation and its impact on evaporation. Further work will consider how to incorporate other estimates of soil moisture, such as in situ soil moisture probes into the modeling approach.