agropolis fondation

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Analysis and prediction of the spatio-temporal variability in vine water status at a microregional scale using local measurements and spatial covariate datasets

ABSTRACT

Two broad, inter-linked research domains were undertaken within this project. These related to a) the spatial and temporal evolution of vine water stress on the Languedoc viticulture plain and b) how information relating to vine water stress can be used to digitally map sub-soil properties at a regional scale.

The first year of research concentrated primarily on the first domain - with an indepth analysis of what environmental factors drive or indicate vine water stress and how the spatial variation in vine water stress is affected by the scale or 'footprint' of measurement (point, field, vineyard etc). This showed that data related to the vegetative expression of the vine were the best indicators mid season and soil type became predominantly more important as the season progressed. We also demonstrated that the variation within a field was significant enough to be considered for differential (site-specific) management. Two spatial models were proposed and published. These models, based on either absolute or relative values, were able to effectively 'spatialise' the variation in vine water stress at a field-scale from a real-time point reference value at an accuracy that was ~50% of the error currrently accepted by growers.
Temporal modelling of the evolution in vine water stress was performed in the second year and was aimed at reducing or eliminating the need for the reference measurement in the spatial model. Previously observed linear relationships between points at a sub-field scale were demonstrated to occur at the inter-field scale, even when fields are not contiguous. Thus, if a reference measurement is taken, the data can be extrapolated to other fields, thereby minimising sampling requirements. These linear inter-field relationships were strongest between fields on common soil types but appeared to be sufficiently strong between fields on different soil types for management purposes, provided there were no external soil moisture effects in one of the fields e.g. access to a water table or preferential sub-surface flow. Season water stress evolution was also modelled directly from climatic data at the research site (Gruissan, Aude, France). A model such as this may remove the need for any physical measurements. Prediction accuracies from the temporal model over 6 seasons (2003-2008) were again considerably less than current accepted industry standards. Such a model is dependent on soil conditions, meso-climatic effects and measurement, which are all location specific. Preliminary work has shown that transfer of the temporal model to two other distant (~100 km away) locations was possible with an easily derived local linear calibration co-efficient.
The different spatial and temporal models are currently being combined and analysis is underway to determine the sensitivity and accuracy of the different spatio-temporal models and in particular if the prediction errors of a combined model are sufficient for industry adoption.

Research in the second domain - digital soil mapping - was primarily carried out in the second year. This research built on a novel approach developed at UMR LISAH for mapping evapotranspiration (ET) at a regional scale. Modelling exercises demonstrated that the addition of the ET data, which indicates plant functioning, improved predictions and mapping of soil depth (avaliable soil water capacity) over modelling with conventionally used environmental and topographic covariates. This modelling was performed at the cathment scale (the Peyne catchment, Herault, France) and demonstrated that in monoculture situations, plant growth covariates are able to improve the accuracy and resolution of predictions of subsoil properties that are not themselves directly measured by remote sensors. In particular, ET, which is an indicator of plant water stress but not widely available or used for mapping, is useful for modelling and mapping soil depth/available water capacity.

In addition to this work, Dr Taylor was also involved in several collaborations with partners located at SupAgro as well as overseas. These were predominantly in the realm of Precision Agriculture/Horticulture. Details of the different research streams and topics are given in the attached figure.

Keywords : Agroecosystem, Operation/adaptation, Abiotic stress, Drought, Landscape, Model, Soil, Vigne et vin, 1. Exclu de la photothèque

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PERSPECTIVES

In the short-term (1-2 years), Dr Taylor is continuing to work with Drs Tisseyre and Lagacherie on several journal articles arising from the research undertaken during the Post-doctoral Fellowship. He is also working on a second article with collaborators in UMR ITAP and ASB regarding the published segmentation algorithm. In the medium term (3-5 years), the project partners are planning to submit funding applications at a European level to further develop the work undertaken on digital soil mapping with vegeative covariates. Dr Taylor is also invloved in an on-going project with Dr Tisseyre and IFVV which is investigating water stress issues at the Syndicat level within an AOC defined terroir. All parties hope that in the longer term (+5 years) there will continue to be an association between Dr Taylor and UMR LISAH and UMR ITAP.