MULTIPLE CROP YIELD PREDICTION USING DUAL-POLARIMETRIC TERRASAR-X STRIPMAP IMAGERY

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1. ABSTRACT

The TerraSAR-X X-band high-resolution SAR system was launched in June 2007 and became operational in January 2008 and since a few days after its launch has been providing unprecedented SAR imagery of land and sea surfaces. Vegetation analysis with SAR has been a widely researched topic. Different wavelengths are suitable for different scales of vegetation, L-band has found application in forestry, C-band in forestry as well as agriculture, X-band on the other hand has only been studied from various once-off airborne campaigns. X-band due to its shorter wavelength is sensitive to small scale growth of crops, development of heads and reduction of moisture during hard ripening stages. With the availability of high temporal frequency coherent dual-polarimetric high resolution data from TerraSAR-X, paddock level crop growth monitoring and even yield prediction at a 10m scale can be performed. This increases the relevance of SAR as a monitoring system to end users. The time series information has also been demonstrated to be of high value in identifying any growth anomalies.[1]

To rigorously test the application of X-band dual-pol systems to crop growth monitoring a test site was established in the University of Adelaide Roseworthy Agricultural College. This site was previously used for crop studies with L-band ALOS-PALSAR by Zhou et. al.[2] The college has a small group of paddocks growing a variety of crops including barley, a few varieties of wheat, canola, beans, lentils and peas. These crops have highly varied structure and growth patterns. This site is especially suitable since the farms are experimental and all the machinery used here has telemetry systems for recording in situ moisture, elevation and during harvesting yield in weight and volume per square meter. Crop phenological stages are monitored by the farm management and this information is available to corroborate any remote sensing findings. Additional information such as soil types, irrigation and spraying regimen are readily available.

In 2008 Australian spring (October-November) a short TerraSAR-X data acquisition campaign was carried out with the view to derive relationships between the SAR returns and the yield of 2008 winter crops. 3 dual-polarization (HH/HV) stripmap scenes were collected at the same viewing angle and orbit over a 22-day period leading up to the harvest. Field visits were carried out on the collection day to record the soil and vegetation gravimetric moisture and height of the crops. Most of the crops at this time are fully developed and are in the dry ripening stage. One of the collection days experienced moderate rainfall and variations in soil and vegetation moisture unrelated to the crop development. These values were recorded and were used form a per crop yield derivation with adjustment for rainfall bias. The coherent dual-polarimetry was used to derive entropy and alpha values (H2a decomposition)[3] and estimate contributions from the ground and vegetation, the vegetation contributions were then used in the yield prediction with greater success.

This study is planned to be extended to season-wide monitoring of the crops for the 2009 growing season with collections every 11-days (TerraSAR-X repeat cycle) or more frequently. X-band coherent scattering models[4] for the different crop types will be developed independently to validate the observations.

2. REFERENCES

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