INTERCONNECTION OF A CROP GROWTH MODEL WITH REMOTE SENSING DATA TO ESTIMATE THE TOTAL AVAILABLE WATER CONTENT OF SOILS

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ABSTRACT

A number of decision support tools used in agriculture for the management of crops production are based on GIS or remote sensing data interfaced with agronomic models [2]. One of their fundamental advantages is to take into account the geographic heterogeneity of the environmental growth conditions.

The total available water content of the soil (TAWC) is one of the determining factors in the crop growth. It depends on the soil depth and soil physical characteristics: the soil water content at permanent wilting point and at field capacity.

The computation of this parameter from laboratory [5] and/or field measurements [3] for large regions is often far beyond the means of agricultural sector stakeholders in emerging countries.

We have developed a simple and robust technique to estimate this parameter from optical satellite images and a dynamic semi-mechanistic crop growth model.

The methodology is based on the inversion of sugarcane crop growth simulations made with the MOSICAS model ([6] [7]) and Normalized Difference Vegetation Index (NDVI) values extracted from SPOT images.

We have applied the technique on a sugarcane-growing area of Reunion Island, a volcanic island located in the Indian Ocean with semi-tropical climate.

We have selected the sugarcane fields of a large farm on the north coast, ranging from 30m to 200m of altitude and resting on brown-reddish cambisols and andic soils with different depths.

We have collected the production data of these fields in 2000, 2007 and 2008, corresponding to: 1-available satellites images for this area and 2- relatively dry years so that the crop growth strongly depends on the soil water retention capacity.

We have chosen the period of the images so that the vegetation is at its full development.

We have configured each of the fields in the MOSICAS model (planting dates, weather data, inter-row spacing, etc.) and simulated the radiation interception efficiency (IE) of the crop at the dates of the images of years 2000 and 2007.

We have iterated the computations for different TAWC values input in the model, ranging from 50 to 200mm, for each field, in order to establish charts of IE-TAWC relations.

The satellite images provided NDVI values translated into IE values via a linear empirical equation, for each of the fields. The TAWC value for each field was obtained by direct reading on the corresponding chart.

The results show a good agreement with bibliographic values on one hand and between-year TAWC values on the other hand. Moreover they show nearly no influence of the sugarcane variety.

The validation of the TAWC values on 2008 show very low EI relative errors between remotely sensed values and modeled values.

This methodology can thus be considered as a very robust and cheap TAWC estimation technique, suitable for large agricultural areas, provided that 1 - a crop growth model is available for the cultivated crop in the area, 2 - production and remote sensing data are available for a couple of years. It would be interesting to test and generalize this technique with other crop models such as CROPSYST [8], CROPGRO [1] or CERES [4].

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