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CHARACTERIZING CULTIVATED AREA IN WEST AFRICA USING MODIS TERRA 250m IMAGERY

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Remote sensing plays an important role in delivering accurate and timely information about crops for early warning systems. Multi-temporal imagery is generally used to monitor vegetation. Typically, vegetation indices dynamics are used to monitor the cropping season, so as to distinguish one crop type from another, or for detecting the planting date, harvesting date, and growing period etc. But West African rural landscapes are complex, with small-scale farming, numerous trees in the fields, and synchronized phenology for crops and natural vegetation due to the rainfall regime and farmers' strategies. However, the intermediate spatial resolution (250 m) and temporal (daily) coverage of MODIS data offers potential for detecting and characterizing crops in a fragmented landscape (Doraiswamy et al., 2004).
Apart from the possibility of tracking landscape phenology using the NDVI, we assumed that a rural landscape can also be characterized by a particular structure, meaning that the texture of an image has to be taken into account. Thus, we used spectral, spatial and textural indicators of moderate-resolution images to i) build a common and effective method for estimating the areal coverage of cultivated domain in Mali and ii) investigate the applicability of MODIS, in combination with external data, for characterizing this cultivated domain and producing maps of crop production systems. This methodology is being tested in Mali, with the objective that these maps could be subsequently used as inputs for crop models to forecast yield. Part (i) was the subject of a previous paper (Vintrou, 2010)and part (ii) is the subject of the present one.
We conducted surveys in farms of 100 villages of South Mali in order to better understand the farmers' practices (Soumare, 2008). A preliminary census of all farms in the villages was first carried out. Then, we monitored the practices on the farm plots sampled. Each village is therefore described by indicators such as the number of farmers, their main productions, the number of cattle etc. We hypothesize that these "ground indicators" can be correlated with remote-sensing indicators in order to characterize Malian rural landscapes in the studied villages, such that the latter indicators could be used for extrapolation to all other villages in the area.
First, we started with an a priori classification of the villages surveyed based on expert knowledge. Each village was assigned to a class, considering its main production(s) and the intensification of the production. Then, we extracted from the crop mask of NDVI MODIS time series (2007) different indicators for each village. To characterize crops phenology, we extracted the sum, the standard deviation, the maximum of NDVI, and the percentage of crops area coverage. To characterize the cultivated domain structure, we extracted different textural indices (contrast, variance and dissimilarity), a fragmentation index (the Mean Patch), and the number of crops patches.
Finally, the resulting table, composed of ground and remote-sensing indicators was analysed with the multiple additive regression tree (MART) method. The MART method (Friedman, 2001; Friedman, 2002) is known to inherit most of the advantages of regression trees, such as the possibility of working with qualitative as well as quantitative variables, handling missing data and correlated predictor variables, and being robust with outliers, while surmounting their main disadvantage which is inaccuracy (Friedman and Meulman, 2003). Other applications in remote sensing (Lawrence et al., 2004) or in ecology (Lo Seen et al., 2010) have highlighted the superiority of such methods compared with commonly used regression models when analysing complex real-world data.
A statistical model was thus developed based on the ground and remote sensing indicators table, with 80% of the 100 village samples used as the training set and the rest for external validation. The model obtained was then applied with the remote sensing indicators in order to predict the class to which each of the remaining villages in the area belongs to. The a priori village classification was then iteratively adjusted as a trade-off between model prediction accuracy and pertinence of the village class definitions. Results are currently being analysed and will be presented in the paper and at the conference.

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