Application of Statistical Methods and GIS for Downscaling and Mapping Crop Statistics using Hypertemporal Remote Sensing

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To sustain the management of natural resources, land use and land cover (LULC) should be spatially mapped and temporally monitored using GIS. As areas are large, conventional methods are laborious. Alternatively, remote sensing can be used for LULC mapping and monitoring. Normalized differential vegetation index (NDVI) is the most used vegetation index for crop identification and phenology. For agricultural areas, crop statistics are estimated yearly at regional level following administrative units. However, these statistics are not informing about spatial extent of these crops within administrative units; such information is crucial for crop monitoring. The main objective of this research was to fill the gap, based on statistical methods and GIS, by adding spatial information to crop statistics by analyzing temporal NDVI profiles. The study area covers 1300 km^2. Data consist of 147 decadal Spot Vegetation NDVI images. Crop statistics were compiled on seasonal basis and aggregated to different administrative levels. Images were processed using an unsupervised classification method. A series of classification runs corresponding to different numbers of clusters were used. Results of different runs are compared using divergence separability, a statistical measure of distance; the 'best' number of clusters is the one corresponding to the run having the highest minimum and/or average divergence. Using stepwise multiple linear regression, cropped areas from agricultural statistics were related to areas of each NDVI profile cluster. Estimated regression coefficients were used to generate maps showing cropped fractions by map units. The optimal number of clusters was 18. Similar profiles were merged leading to eight clusters. Results of regression show that clusters 2, 5, and 8 are not included in models. This relates directly to the limited spatial extent of these clusters. Rice was grown, for example, in autumn, on 50% of the area of map-units represented by NDVI-profile group 4 and 75% of the area of group 7 while it was grown, in spring, on 2, 69 and 25% of areas of NDVI-profile groups 2, 6, and 7, respectively. Regression coefficients were used to generate map of crops. This research illustrates the benefit of integrating statistical methods with GIS, remote sensing and crop statistics to delineate NDVI profile clusters with their corresponding agricultural land cover map units and to link these statistics to geographical locations. These map units can be used as a reference for future monitoring of natural resources, in particular crop growth and development and, consequently, for forecasting crop production and/or yield and stresses like drought.
Keywords: Crop Statistics; GIS; Multiple Regression; NDVI; Unsupervised Classification.