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Assessing the present-day vegetation dynamics in the Sahelian environments using MODIS dataset. A Geostatistical approach

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Vegetation dynamics in anthropized semi-arid environments are assessed at local scale through the geostatistical analyses of MODIS NDVI (15-day resolution product provided at 250m resolution), land cover (Globcover Land Cover –GLC– map, 300m resolution) and runoff percentage data. The study areas are located in three Sahelian sites defined by the ECLIS and AMMA programs in Niger, Mali and Senegal (sites of Dantiandou, Hombori and Tessekré, respectively). The methodological approach consists, in a first step, in using statistical and phenological indicators calculated from annual NDVI time series covering the period 2001-2009 for indentifying vegetation trends of crops, natural herbaceous and perennial vegetations. Among those, variation (CV), symmetry (CS) and kurtosis (CK) coefficients (mean values for the period 2001-2009) revealed to be strongly linked to vegetation types: perennial vegetations are defined by both low CV (0.15-0.24), low CS (0.2-0.7) and high negative CK (varying between -0.7 and -1.4) when cereal crops and natural herbaceous vegetations coincide with higher CV (0.24-0.45) and CS (0.7-1.2) values, and lower negative CK (ranged from –0.7 to 0). Second, local vegetation phenology was studied by modeling annual NDVI time series. Vegetation biomass annual trends correspond to a single growth cycle, occurring during the monsoon period. The annual greenness and senescence periods have been modeled from smoothed NDVI data (3-point moving window) using a 6-parameter double-sigmoid function. The transition dates of vegetation activity analyzed in this study are onset and offset dates, which respectively have been defined as the dates at which the double-sigmoid reaches their half maximum values. These phenological dates have been calculated by finding the day of year (DOY) at the maximum and the minimum of the first derivative of the double-sigmoid function, respectively. Green-up onset and offset dates, as well as maximum and minimum slope values given by the derivative function, also proved to be significant biomass activity indicators: perennial vegetation corresponds to late onset (DOY 190-220) and offset (DOY 270-300) dates, and by low slopes when natural herbs and crops are characterized by earlier phenological dates (DOY of 160-190 and 235-270 for onset and offset dates, respectively) and higher slopes. Third, these statistical and phenological indicators were coupled with runoff percentage data through a collocated co-kriging method. Moderate but significant spatial correlations are shown for natural herbs and crops when low correlations correspond to perennial vegetation. Comparison of the results on the three Sahelian sites revealed that the geostatistical analyses performed on statistical and phenological indicators derived from MODIS NDVI time series can be considered as efficient quantitative tools for improving early warning systems.