Modelling sensitivity to desertification with multi-temporal Landsat imageries in a semi-arid region on the Atlantic coast of Morocco

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Desertification, defined as land degradation (LD) in arid and semi-arid areas, is a significant environmental issue as the arid biomes represent 40% of the emerged surfaces and are home to millions of people. Desertification is neither a simple forward march of the desert, nor does it originate from it. It rather occurs on disseminated points or stripes of lands, thus LD can be monitored by using the vegetation as a proxy of habitat status. Remote sensing offers an adequate approach to retrieve this parameter on a large scale and observe its evolution over several years.
The objective of this research is to assess the process of LD in the semi-arid province of Safi on the west coast of Morocco over the last decade and to develop a model of sensitivity to desertification as it presents signs of desertification such as sand encroachments and rocky karstification. We used a dataset consisting of twelve Landsat TM and ETM+ scenes, acquired between 2002 and 2014. The sensitivity model, based on the MEDALUS project (Mediterranean Desertification and Land Use), relies on datasets such as the Harmonized World Soil Database (HWSD) of the FAO, SRTM Digital Elevation Models (DEM) and weather recordings for the years 2007 to 2012.
The Landsat scenes were normalized by using the method of Improved Dark Object Subtraction. A simple and efficient classification model was developed for mapping LD. The negative linear correlation between the Short-Wave Infrared (TM Band 7) and the NDVI determines the gradient of land vitality with a complete vegetation coverage on one extremity and a bare soil on the other. The images were reclassified with a Vegetation Abundance Index (VAI) calculated from the slope of the linear regression, enhancing the separability of the vegetation classes. Multi-temporal comparison was achieved by computing the difference between each classification.
The sensitivity model relies on the Soil, Vegetation, and Climate Quality Indexes (SQI, VQI, CQI) and results in a Desertification Sensitivity Index (DSI). The classification of vegetation was used as input for the VQI while the SQI was calculated using the HWSD and DEM grids. The weather measurements allowed the calculation of the CQI. As a result, a map of environmentally sensitive areas to desertification was produced.
The differences in vegetation coverage indicate abrupt annual changes before the year 2011. Correlating these findings with the precipitation patterns, we assume that these intense fluctuations are a direct function of rainfall amounts. Small areas have been subject to ongoing vegetation decline or gain, nevertheless a trend toward desertification or vegetation growth cannot be concluded on the regional scale. After 2011, the proportion of each VAI class has remained stable. Currently, the DSI model is still under development.