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Analysis of satellite VEGETATION NDVI time series for estimating Post Fire vegetation recovery

Rosa Coluzzi, Tiziana Montesano, Antonio Lanorte, and Fortunato De Santis
CNR, IMAA, tito scalo (PZ), Italy (coluzzi@imaa.cnr.it)

In this paper we compared Hurst exponent as results from aggregate variance and Detrended fluctuation analysis to evaluate the estimation of the self similarity coefficients in satellite time series to assess post fire recovery.

1. The Hurst exponent for a data set provides a measure of whether, the data is a pure random walk or has underlying trends. The Hurst exponent was computed using the aggregate variance which is a time domain method useful for non-stationary time series. It obtains the multi-scale analysis with the aggregation of adjacent points and measures the similarity in terms of variance. If H=0.5, the signal is uncorrelated; if H>0.5 the correlations of the signal are persistent, where persistence means that a large (small) value (compared to the average) is more likely to be followed by a large (small) value; if H<0.5 the correlations of the signal are antipersistent, which indicates that a large (small) value (compared to the average) is most likely not be followed by a large (small) value.

2. DFA is the well-known estimator with detrend, working in the time domain. It is effective both with stationary and non stationary time series. The scaling exponent α quantifies the strength of the long-range power-law correlations of the signal: if α=0.5, the signal is uncorrelated; if α >0.5 the correlations of the signal are persistent, if α <0.5 the correlations of the signal are antipersistent.

Such methods were applied to the most widely used index for monitoring post fire recovery, the normalized difference vegetation index (NDVI) obtained from the visible (Red) and near infrared (NIR) by using the following formula NDVI = (NIR_Red)/(NIR + Red). The value of remotely sensed data for operational vegetation assessment depends on the ability to accurately, efficiently and cost-effectively retrieve key parameters, useful for the characterization of structural properties and temporal dynamics of vegetation. The vegetation indices operate by contrasting intense chlorophyll pigment absorption in the red against the high reflectance of leaf mesophyll in the near infrared. In order to eliminate the phenological fluctuations, for each decadal composition, we focused on the normalized departure NDVIdn = (NDVI-NDVIm)/σndvi where NDVIm is the decadal mean and σndvi is the decadal standard deviation. The decadal and the standard deviation are calculated for each decade, e.g., first decade of January, by averaging over all years in the record. Our analysis provided the following results:

1. α around 0.7 for fire affected areas and α around 0.5 for fire unaffected areas,

2. H around 0.7 for fire affected areas and α around 0.3 for fire unaffected areas,

The estimated scaling exponents of both classes suggest a persistent character of the vegetation dynamics. But, the burned sites show much larger exponents than those calculated for the unburned sites, and the Hurst exponent enables us to well discriminate between fire affected and fire unaffected areas, and in turn to well capture and vegetation the vegetation recovery attitude.