



Application of automated methodologies based on digital images for phenological behaviour analysis in Mediterranean species

Carla Cesaraccio (1), Alessandra Piga (1), Andrea Ventura (1), Angelo Arca (1), Pierpaolo Duce (1), and Joel Granados (2)

(1) CNR IBIMET, Institute of Biometeorology, National Research Council, Sassari, Italy (c.cesaraccio@ibimet.cnr.it), (2) IT University of Copenhagen, Copenhagen, Denmark

The importance of phenological research for understanding the consequences of global environmental change on vegetation is highlighted in the most recent IPCC reports. Collecting time series of phenological events appears to be of crucial importance to better understand how vegetation systems respond to climatic regime fluctuations, and, consequently, to develop effective management and adaptation strategies.

Vegetation monitoring based on “near-surface” remote sensing techniques have been proposed in recent researches. In particular, the use of digital cameras has become more common for phenological monitoring. Digital images provide spectral information in the red, green, and blue (RGB) wavelengths. Inflection points in seasonal variations of intensities of each color channel can be used to identify phenological events.

In this research, an Automated Phenological Observation System (APOS), based on digital image sensors, was used for monitoring the phenological behavior of shrubland species in a Mediterranean site. Major species of the shrubland ecosystem that were analyzed were: *Cistus monspeliensis* L., *Cistus incanus* L., *Rosmarinus officinalis* L., *Pistacia lentiscus* L., and *Pinus halepensis* Mill.

The system was developed under the INCREASE (an Integrated Network on Climate Change Research) EU-funded research infrastructure project, which is based upon large scale field experiments with non-intrusive climatic manipulations. Monitoring of phenological behavior was conducted during 2012-2014 years.

To the end of retrieve phenological information from digital images, a routine of commands to process the digital image file using the program MATLAB (R2013b, The MathWorks, Natick, Mass.) was specifically created. The images of the dataset have been re-classified and renamed files according to the date and time of acquisition. The analysis was focused on regions of interest (ROIs) of the panoramas acquired, defined by the presence of the most representative species of the ecosystem. The ROIs are regions of irregular shape and size of about 5000 x 3500 pixels. The areas have been selected with the objective of excluding as much as possible everything that is not framed the species observed.

The color channel information (digital numbers; DN_s) were extracted and the RGB value was correlated with the pattern of phenological development. In particular, was calculated the Excess Green Index, which reveals, through the variation of the green signal during the year, the physiological changes in the state of vegetation. The inflection points of these curves indicate the significant changes of the state of color and the corresponding modifications of the physiological state of the vegetation. In this way, the probable dates of the principal growth stages for Mediterranean species under study were identified, and then were correlated with the dates collected in the field through direct observation.

Preliminary results of this study show that the use of digital images are well-suited to identify phenological pattern of the Mediterranean species.