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Health status diagnosis of chestnut forest stands using Sentinel-2 images

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Context - Objectives
Health status diagnosis of chestnut forest stands is a crucial concern for forest managers. These stands are made vulnerable by numerous diseases and sometimes unadapted forestry practices. Moreover, since last years, they were submitted to several droughts. In Dordogne province (France), the economic stakes are important. For example, about 2/3 of the chestnut forest area are below the optimal production level, and most of this area shows forest stands with a high proportion of dry branches. The actual extent of chestnut forest decline remains still unknown. Sentinel-2 time series show an interesting potential to map declining stands over a wide area and to monitor their evolutions. This study aim to propose a method to discriminate healthy chestnut forest stands from the declining ones with several levels of withering intensity over the whole Dordogne province.

Method
The proposed method is the development of a statistical model integrating in a parsimonious manner several vegetation indices and biophysical parameters. The statistical approach is based on an ordered polytomous regression to which are applied various technics of models’ selection (A. Agresti, 2003).

1- Remote sensing variables : About 36 vegetation indices were calculated from THEIA-MAXA L2A products and 5 biophysical parameters were processed from ESA level 1C product. These last parameters have been obtained with the Overland software (developed by Airbus DS) by inverting a canopy reflectance model. This software couples the PROSPECT leaf model and the scattering by arbitrary inclined leaves (SAIL) canopy model.

Remote sensing variables

- 10 spectral bands (resampled at 10m spatial resolution )
  - B2, B3, B4, B5, B6, B7, B8, B8a, B11 et B12
- 36 vegetation indices
  - NDVI, EVI, NDBI, NDVI2, MCARI, DVI, Cigreen, CRI2, NBR, NBR, PSRI …
- 5 Biophysical parameters
  - Bc1 : Cover fraction of brown vegetation
  - Gc1 : Cover fraction of green vegetation
  - Fap1 : Fraction of Absorbed Photosynthetically Active Radiation
  - Gla1 : Green Leaf Area Index
  - Wau1 : Leaf water content

Results

1- The best remote sensing variables according to AIC and cross validation :
  - Vegetation Red Edge and NIR spectral bands : B8a, B8, B6, B8
  - Vegetation indices : NDVI (B8-B4)/(B8+B4), NDBI (B8-B6)/(B8+B6), NDVIR2 (B8a-B6/B8a+B6), DVI (B7-B5), IRECI (B6 - K3)/(B6+K4), NBR (B8-B2)/(B8+B2)
  - Biophysical parameters : GLAI and GLCV

2- Calibration and validation of the predictive models are based on health status data. About 50 plots have been surveyed by foresters describing the chestnut trees health status by using two protocols (ARCHI and expert knowledge).

3- Maps from the 12 best models :
  - Linear prediction maps,
  - Maps of probability of belonging to a class of decline value,
  - Expected classification maps.

In progress :
- Spatial analyses of the 24 selected models
- Validation of the selected models with additional plots of expert knowledge observations (spring 2018)