Project Database of ICP Forests
PROJECT DESCRIPTION

PROJECT INFORMATION

Project title: Very high resolution monitoring of EU forest ecosystems: understanding advancements now possible by means of new satellite remote sensing data

Project ID: 95

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PROJECT DESCRIPTION

Remote sensing data are fundamental to upscale the information collected by in situ survey and to increase the monitoring frequency. In the last two years, the availability of open access spaceborn remote sensing data has dramatically increased, thanks to the launch of the ESA Sentinels 1, 2 and 3 and the opening of NASA Aster data archive.
Specifically, the Sentinel-2 (S2) multispectral imager offers now 13 spectral bands, with 3 of them in the red-edge region, at very high resolution (10-60 meters), with large swath (290 km) and frequent coverage (up to 5 days). The S2 mission is in pre-operational status with imagery available since few months and very limited use yet in forest monitoring (Immitzer et al. 2016).
The Aster instruments produce 14 spectral bands from the visible to the thermal region, collected in a large swat at 15 to 90 meters spatial resolution, and with a 4 to 16 days revisiting time. Aster data have been used for land monitoring purposes since years (Yuksel et al. 1998) but only very recently (April 2016) they were made available at no cost to the public.
The Sentinel-1 SAR instrument provides microwave polarimetric information at C-band, with 5 x 20 meters ground sampling (range x azimuth) in not-emergency mode, and is characterized by a large swat and very high revisit frequency (up to 2 days). C-band SAR can provide relevant information for forest monitoring, especially if joined with multispectral data, due to the backscattering sensitivity to water content, volume, and surface roughness (Reiche et al. 2016).

These massive datasets can bring enormous innovation in the way we monitor our forests resources. However, a sound experimental testing phase is needed to understand these new opportunities in forest monitoring and the accuracy obtained when using these innovative sensors, and to develop methods and tools for optimal data usage, also considering data fusion.

To perform a testing phase, the forest level II in-situ information from the ICP Forest network is requested, to be jointly used with remote sensing data for training, testing and validation purposes.
In order to understand additional details on the parameters or classes to be monitored, the availability of in-situ data examples is preliminary requested: a first assessment will allow to provide additional technical details related to the following project aims:

i. To test the retrieval of different forest crown variables using the new freely available Sentinels and Aster data, at very high spatial resolution.

Hypothesis: the advanced spectral features of S2 and Aster, and complementary S1 microwave information, are able to detect specific foliar and crown chemistry compositions and phenology status in selected forests species or species assemblages.

Statistical and analysis methods: In situ information will be screen and organized according to crown chemistry and phenological relevant parameters. Image processing techniques will prepare imagery for data extraction over selected in situ areas. Advanced regression techniques (i.e. Partial Least Square Regression) and machine learning tools (i.e. Random Forests, Neural Networks) will be employed to evaluate the ability of the remote sensing datasets to accurately retrieve selected foliar chemistry and phenology measures. New vegetation indices will be also tested for this purpose.

ii. To develop methods for very high resolution forest type classification

Hypothesis: based on their ability to detect specific crown characteristics related to functional groups (chemistry composition and phenological behaviors), the Sentinels and Aster datasets allow to carry out fine scale forest functional classification

Statistical and analysis methods: In situ information will be screen and grouped according to crown chemistry, traits, and phenology. Image processing techniques will prepare imagery for data extraction over selected in situ areas. advanced classification techniques (i.e. Multivariate Adaptative Regression Splines) and machine learning tools (i.e. Random Forests, Neural Networks) will be employed to classify at fine scale forests according to functional characteristics. New vegetation indices and textural features will be also tested.

iii. To test the early detection of changes in forest conditions

Hypothesis: the frequency and variety of the remote sensing acquisitions allow to early detect changes in forest crown conditions, caused by atmospheric agents (pollutants), climate-induced events (i.e. severe droughts), pests.

Statistical and analysis methods: the notification of anomalies observed in the field during project execution, will allow to collect and retroactively investigate the occurrence in remote sensing images of changes in spectral and microwave response from the crowns, or changes in phenological behavior. This will help to understand the ability of Sentinels and Aster data to monitor and predict forest stresses.
Further data: were available, additional GIS layers on vegetation and topography, as well as metereological and flux data, will be tested as additional regression/classification model inputs.

Project leader previous experience:
In direct relation to the present proposal, G. Vaglio Laurin has experience in classification of forest types with joined optical and SAR sensors (Vaglio Laurin et al. 2013a and 2013b); in the retrieval of forest structural (Vaglio Laurin et al. 2014a) and biodiversity (Vaglio Laurin et al. 2014b) characteristics with hyperspectral information; in the use of Sentinel-2 data for forest functional guild mapping (Vaglio Laurin et al. 2016); in atmospheric nitrogen deposition in forests (Bertolini et al. 2016). She presently work in the Forest Ecogy Lab at University of Tuscia under the supervision of Prof. Dario Papale, and participates in the H2020 EO-1-2014 project 'Detecting changes in essential ecosystem and biodiversity properties – towards a Biosphere Atmosphere Change Index: BACI'

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