Comune di Bologna

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA
DIPARTIMENTO DI INGEGNERIA CIVILE, CHIMICA, AMBIENTALE E DEI MATERIALI

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Ordine Geologi Emilia-Romagna

Remote Sensing

12° Workshop tematico di Telerilevamento

IL RUOLO DEI DATI COPERNICUS SENTINEL NEI PROCESSI DI CONOSCENZA E GESTIONE DEL TERRITORIO: STATO DELL'ARTE DEL TRASFERIMENTO TECNOLOGICO AL COMPARTO OPERATIVO

•PROCESSAMENTO •CARTOGRAFIA •ESTRAZIONE INFORMAZIONI •COSTI/BENEFICI

25-26 giugno 2019

BOLOGNA

Oratorio San Filippo Neri - Via Manzoni 5

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Supporting Forest Planning and Management by Sentinel 2 data aimed at forest Basal Area Estimation

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This work is part of a project dealing with the problem of the socio-economic marginality of forest sector for wood production. The Regional Forestry Plan of Piemonte Region (NW Italy) blamed this marginality mainly due to the high costs of wood extraction and its corresponding low market value. Costs could be reduced supporting the forest biomass estimation by remote sensing, limiting the ordinary workflow based on field surveys, thus resulting highly time consuming. Furthermore, in some cases stands of interest can be difficultly accessed inducing additive costs.

Many studies dealing with both climate change and sustainability of forest management based on remotely sensed data can be found in literature (Dube et al., 2016). Many of them propose different methods for the estimation of forest biomass-related features (volume, basal area, above ground biomass and forest carbon stocks). A wide variety of approaches have been used (optical, LiDAR and RADAR are the most frequently used), including parametric (e.g. regression models) and nonparametric algorithms such as K-Nearest Neighbour (K-NN), Artificial Neural Network (ANN), random forest, support vector machine (SVM), and Maximum Entropy (MaxEnt)(Fassnacht et al., 2014; Lu et al., 2016). Nonparametric approaches, in recent years, have become more prevalent because of their higher potential to identify complex nonlinear relationships compared to regression model(Haywood et al., 2018). Optical images are widely employed because of their accessibility and affordability (Dube et al., 2016). In some studies the native spectral bands are used to calibrate a regression model with the biomass (Muukkonen and Heiskanen, 2005; Vacchiano et al., 2018; Zhao et al., 2016); in others vegetation indexes are employed (Freitas et al., 2005; Pandit et al., 2018). There are a lot of cases where optical data are associated to LiDAR or RADAR data (Jiménez et al., 2017; Morin et al., 2018; Wittke et al., 2019).

The quality of the estimation is depends on the error. In literature it is possible to find studies that refer to the absolute error, making difficult any comparison. Others uses rRMSE (Relative Root Mean Squared Error) referring the absolute value of the error to the value of the measure itself, therefore introducing a sort of normalization. rRMSE proves to vary between 8 and 50 %, but these values have to be compared with caution because the validation sets were generated in very different ways (Dittman et al., 2017).

Allometric approaches for biomass estimation based on field measurements are certainly more accurate, but time consuming (Dittmann et al., 2017) and cannot provide a continuous spatial distribution of the data at a large scale(Vacchiano et al., 2018). As a consequence, they are suitable for a small area application only. RADAR based methods appear to be efficient on a large area scale, but suitable for homogenous stands only (Dittmann et al., 2017); they also proved to saturate in forest characterized by a high level of biomass (Dube et al., 2016). LiDAR based approaches appear to be the most efficient and accurate ones for medium sized area applications. Differently, multispectral imagery appears to be appropriate for large area monitoring; unfortunately, in general, they give a coarse estimation of homogeneous stands, and some further limitations can be observed in mountain regions (Dittmann et al., 2017).

This work is aimed at exploring the possibility of defining a methodology for the estimation of the Forest Basal Area (BA) of conifers based on freely available satellite imagery. BA is said to be a good dendrometric parameters to synthesize the structure of the forest stands. The procedure is, in fact, intended to support local forest management in a more effective and economic way with special focus on forest inventory instances. In particular a preliminary and experimental procedure for wood volume estimate (conifers) in the Susa Valley (Piemonte, NW Italy) based on Sentinel 2 Level 2A data and Multi-layer Perceptron (MLP, Rumelhart&Williams, 1985) ANN applications is presented and first results given.

One S2 image per month, along the 2018 main growing season (May – September, table 2), was selected having the minimum cloud cover in the area. NDVI = $(\rho_{NIR}-\rho_R) / (\rho_{NIR}+\rho_R)$, Normalized Difference Vegetation Index, and $NDWI_G=(\rho_G-\rho_{MIR1}) / (\rho_G+\rho_{MIR1})$, Normalized Difference Water Index, were computed from the original bands and used as predictors of BA. Ground observations from 387 plots surveyed in the past years in coniferous stands within the study area were used to train a Multi-layer Perceptron ANN, using the correspondent values of NDVI and NDWIG as inputs. Results showed that accuracy of AB estimates by ANN ranges between about 15% and 25% . A preliminary map of AB for the entire study area was finally generated, masking out all those parts of the valley where conifers were not present.

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