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Abstract. Geographically weighted regression (GWR) procedures can be adapted to enhance the spatial features of low spatial resolution maps based on higher resolution remotely sensed imagery. This operation relies on the assumption that the GWR models developed at low resolution can be proficiently applied to higher resolution data. An example of such an application is presented for downscaling a forest growing stock map which has been recently produced over the Italian national territory. GWR was applied to a Landsat Thematic Mapper image of Tuscany (Central Italy) for downscaling the growing stock predictions from a 1-km to a 100-m resolution. The accuracy of the experiment was assessed versus the measurements of a regional forest inventory. The results obtained indicate that GWR can enhance the spatial features of the original map depending on the spatially variable correlation existing between the forest attribute and the ancillary data used. A final ecosystem modeling exercise demonstrates the utility of the spatially enhanced growing stock predictions to drive the simulation of the main forest processes.
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Keywords: growing stock; geographically weighted regression; Landsat Thematic Mapper.

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1 Introduction

Maps of forest attributes (e.g., tree density, basal area, growing stock, etc.) are important data sources for many scientific and practical tasks such as carbon sink evaluation, land suitability assessment, timber management, and landscape biodiversity estimation.[1,2] Conventionally, statistical assessments of forest attributes are obtained through inventories based on ground sampling, which are expensive and time consuming to perform.[3,4] Moreover, the data collected are generally unsuitable to produce wall-to-wall maps of forest attributes having high spatial detail.[5]

Satellite remote sensing techniques are a valuable alternative source of information about forest attributes at various spatial and temporal scales. Information on forest biomass can be derived from both passive and active sensors, such as optical, SAR, and LiDAR imagery.[6–8] In regard to optical images, several studies have been conducted on the integration of ground and satellite data to map these forest attributes over both Europe[9–11] and North America.[12,13]

Based on the results of these and similar studies, an effort was conducted by Gallaun et al.[14] to map main forest attributes all over the European continent. These authors produced low resolution (500 m) maps of growing stock and above-ground woody biomass for broadleaves and conifers through the combination of ground and Moderate Resolution Imaging Spectroradiometer (MODIS) data. Such maps are a step forward for the characterization of European forests, but are affected by relevant shortcomings which may limit their operational utilization. A recent research effort by Maselli et al.[15] produced an improved version of these maps for the Italian national territory through the combination of ground inventory data and remote sensing products derived from different satellite sensors [MODIS, Geoscience Laser Altimeter System, and Landsat Thematic Mapper (TM)/Enhanced Thematic Mapper Plus

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