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GROUND, STEMS AND FOLIAGE: FOREST ABOVE-GROUND BIOMASS MAPPING FROM COMBINED SYNTHETIC APERTURE RADAR AND MULTISPECTRAL IMAGERY

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THEME: Forests, Biodiversity and Terrestrial Ecosystems: Monitoring forest cover and biomass; understanding forest contribution to the carbon cycle; tropical deforestation; forestry and forest management.

KEY WORDS: Biomass, Carbon Cycle, Forest Monitoring, Deforestation, Data fusion, REDD+,

ABSTRACT:

With the launch of ALOS-2, Sentinel-1 and other forthcoming satellite missions, a new generation of sensors is emerging. While historically many remote sensing studies have analysed single sensors for specific purposes, the added value of data integration and data fusion is increasingly recognised. Several global forest cover maps and some large-scale forest biomass maps from satellite have recently been published. The objectives of our study were to analyse the relative importance of Synthetic Aperture Radar (SAR) and multispectral satellite data in conjunction with digital elevation data for estimating forest above-ground biomass; to evaluate the accuracy of the approach in different forests; and to devise a strategy for a global biomass observatory. Our method uses a maximum entropy algorithm to integrate different datasets. It estimates $f_1(z)$ as the conditional probability density function (pdf) of the remote sensing variables at sites with a specific biomass range, and f(z) as the unconditional pdf of the variables across the whole study area. $f_1(z)/f(z)$ is the conditional probability of occurrence of a given biomass class. The distance from f(z) is the relative entropy of $f_1(z)$, known in machine learning as the Kullback-Leibler divergence. The probability maps for all biomass classes are merged into one forest biomass map and an uncertainty map. ALOS-PALSAR, MODIS and SRTM DEM data at 250m spatial resolution were analysed and compared to the national forest inventory of Mexico. The results show that PALSAR is most important for low biomass mapping and MODIS for medium biomass, while the DEM was a good predictor of high biomass because high mountains tend not to be logged. Similar results were obtained using ALOS-PALSAR, Landsat, and SRTM at 50m spatial resolution in Spain. Additional studies of automated forest change mapping of the Congo Basin from ALOS-PALSAR and biomass mapping in Siberia are discussed. We conclude that global forest above-ground biomass mapping delivers more accurate spatial datasets when radar and multispectral data are integrated with each other and with an external digital elevation model, and describe an approach towards the new European Space Agency project GLOBBIOMASS that started in 2015.

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