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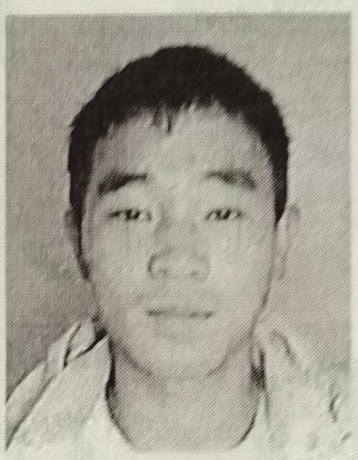

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Comparison of variable extraction methods using surface field data and its key influencing factors: A case study on aboveground biomass of *Pinus densata* forest using the original bands and vegetation indices of Landsat 8

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ABSTRACT

Insufficient sample data is a challenge when estimating forest aboveground biomass (AGB) using large-scale remote sensing. Extracting remote sensing information from sub-compartments could rectify such defects, but the corresponding method, its accuracy, and influencing factors still need to be clarified. We combined Landsat 8 data with a *Pinus densata* forest sub-compartment to extract remote sensing information that matched the sample plots. Six sub-compartment based methods, including the centroid point extraction method, and the minimum, mean, maximum, majority, and median statistic extraction methods were used to extract sub-compartment remote sensing information and compare the differences between each method and the true values. For each method, structural equation modelling (SEM) was used to explore the effect of sub-compartment topography, shape, and forest stand factors on the extraction error. Mean statistic was the best extraction method, with the highest consistency index, and the lowest mean relative error, between the extracted and true values. All three factors affected extraction accuracy, with forest stand being the dominant one. When sub-compartment data are sufficient, but sample plots are insufficient, it is an effective extrapolation method for large-scale AGB estimation.

1. Introduction

Forest aboveground biomass (AGB) is not only a key forest ecosystem parameter but also directly reflects forest carbon sequestration capacity (Lindner and Karjalainen, 2007; Miura and Jones, 2010; Pan et al., 2011; Valbuena et al., 2013). Thus, it is of great importance to accurately estimate forest AGB for calculating global carbon reserves and meeting climate change requirements (Baccini et al., 2008; Kankare et al., 2013).

To date, remote sensing images combined with survey data has been a popular approach for large-scale forest AGB estimation (Fayad et al., 2016; Zhang and Shao, 2020; Zhao et al., 2009) because it can overcome intensive and time-consuming traditional biomass acquisition methods, and provides a reliable solution for accurately estimating AGB on a grand scale (Wulder et al., 2010; Yan et al., 2015). Meanwhile, optical remote sensing data, especially Landsat 8 operational land imager (OLI), has been widely used in AGB estimation due to its free access, appropriate resolution, as well as its strong sensitivity to vegetation types (Lu et al., 2012; Naik et al., 2021; Patenaude et al., 2005; Saatchi et al., 2011; Wulder et al., 2010; Yan et al., 2015). However, during forest AGB estimation, uncertainty caused by biased sample plot selection, forest stand condition variation and evaluation models is still a challenge, especially in forests with dense cover and high heterogeneity (Lu et al., 2014; Réjou-Méchain et al., 2019; Weisbin et al., 2014). Therefore, for extracting remote sensing information, it is essential to select a reliable method to improve remotely-sensed AGB estimation.

Estimating forest AGB in "pixels" is becoming popular, and most forest AGB estimation models are constructed based on remotely sensed variables extracted from sample plots (Nguyen et al., 2019). Moreover, sample plot size is typically matched to a pixel on the image, such as a field survey or a permanent plot. However, this method is more demanding when matching remote sensing image "pixels" with field plots (Dube and Mutanga, 2015; Koju et al., 2019; Loveland and Irons,

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