Chapter 21

Sentinel SAR Data and In-Situ-Based High-Resolution Above-Ground Carbon Stocks Estimation Within the Open Forests of Ramgarh District

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ABSTRACT

The present study deals with an approach to estimate the above ground biomass (AGB) to assess the total carbon stock of forest cover present in Ramgarh district using remote sensing and GIS techniques. Due to the fact that biomass estimation is one of the most influential biophysical parameters in traditional carbon sequestration techniques, satellite remote sensing plays an important role in AGB and carbon stock estimation. Presently, AGB is estimated using Sentinel1A SAR data in conjunction with in-situ field data, which is conducted in 20 different sites within the forest area. Biomass is calculated for each plot, and a correlation analysis is performed with the backscatter value obtained from SAR data to generate an allometric equation that is used to calculate the AGB and carbon stock for the entire forest cover. Both Polarization VV and VH are correlated with field data in which cross-polarized backscatter value shown a stronger correlation of 0.75 (R2 Value). C-band is proved to be the best band for the estimation of biomass and carbon stock in tropical mixed forests.

1. INTRODUCTION

Forest on the earth covers nearly one-third of total surface area and plays a vital role in the global carbon cycle changes (Franklin, 2001). Forest biomass which is also expressed as dry weight per unit area is one of the most influencing factors of the forest ecosystem, accurate estimation of Above Ground Biomass

DOI: 10.4018/978-1-6684-5678-1.ch021

(AGB) is a critical component for carbon stock quantification, suitability analysis, analyzing fuels for forest fires etc. (Bhatt, Bisht, Rawal, & Dhar, 2007; Gorte, 2009). The estimated standing biomass in India is 8375 million tons in year 1986 whereas the carbon stock is estimated to be 4178 million tons (Dadhwal, Sehgal, Singh, & Rajak, 2003). The first ever woody biomass estimation is done in India by the Forest Survey of India (FSI) in 1995 in which they have used field inventory data, forest cover and various thematic maps as input, afterwards they carried out another survey to estimate the total carbon stock of Indian forests using remote sensing data and sample plot data during 2008-2010 (Gilbert, 2012). Presently, the scenario is at an alarming rate due to the deforestation and declining condition of mixed forest within the growing cities and it is continuously increasing (Pandey, Anand, & Srivastava, 2019; Ranjan, Anand, Vallisree, & Singh, 2016).

The most common method for biomass estimation is through allometric equations which is applied to the field inventory data to estimate biomass and carbon stock of forests. Many generalized allometric equations are generated by a number of researchers for different tree species, in a generalized allometric equation the relation between various physical parameters such as height of the tree, diameter at breast height, wood density, crown diameter, tree species etc. are established (Huang, Ziniti, Torbick, & Ducey, 2018; Montes, Gauquelin, Badri, Bertaudiere, & Zaoui, 2000; Navar, 2009; Nelson, 1999; Xiao & Ceulemans, 2004). (Kim et al., 2011), focused their study towards the site specific allometric equations and predicted forest biomass for a regional level whereas (Vieilledent et al., 2012) stated a universal approach towards biomass and carbon stock estimation in which a simple allometry of height and diameter is required from field inventories which is applicable for given forest sites where biomass allometric models are not available.

Carbon stock means the total carbon stored in living biomass that are present in the ecosystem, the carbon sequestration by tree in the forest are the source of carbon in the forest whose quantity varies with the forest type (Lucht, Schaphoff, Erbrecht, Heyder, & Cramer, 2006; Winjum, Dixon, & Schroeder, 1992). According to (Eggleston, Buendia, Miwa, Ngara, & Tanabe, 2006), there are five carbon pools in the ecosystem that include above ground, below ground, litters, woody debris, and organic matters present in soil, in which the carbon present above the ground are dominant. (S. Brown, 1997; Lugo & Brown, 1992)stated that the total carbon sequestration is approximately half of the forest biomass whereas the total carbon sequestration of the forest is inferred from its total biomass accumulation. Numerous studies are published on biomass and carbon sequestration that mainly focuses on boreal and temperate forests (Le Toan et al., 2011; Santos, Lacruz, Araujo, & Keil, 2002) however study on tropical forests are limited due to the complex species composition and structure (Sinha, Jeganathan, Sharma, & Nathawat, 2015).

Due to its ability of measure the reflectance at broad spectral bands having precise information, the multispectral images are widely used to perform classifications. There are several image classification techniques used for the classification of land use land cover which are broadly of two types, supervised classification technique and unsupervised classification techniques. The supervised classification technique is broadly consists of decision tree (Friedl & Brodley, 1997), support vector machine (Furey et al., 2000), neural nets (Weiss, Kapouleas, & Shavlik, 1990), maximum likelihood classification (Paola & Schowengerdt, 1995) etc. whereas the unsupervised classification techniques consists of k-means (Rollet, Benie, Li, Wang, & Boucher, 1998), spectral clustering (Kamvar et al., 2003), ISODATA (Irvin, Ventura, & Slater, 1997) etc. In present study, the maximum likelihood classification technique is used to do the classifications.

The role of remote sensing technology for the assessment of biomass and carbon sequestration has been found as a better alternative against the conventional methods (Anand, Singh, & Kanga, 2018).

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