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Above-ground bole carbon stock estimation using forest inventory and remote sensing data for secondary forest ecosystem in Ibadan, Nigeria

Aghimien Ehimwenma Victor
Federal College of Forestry, Ibadan, Nigeria

Secondary forest ecosystem contributes to global climate change mitigation through carbon sequestration. Above-ground bole biomass (AGBB) is the major component for monitoring and estimating carbon stocks (CS) and fluxes in tropical forests. Integrating remote sensing (RS) with forest inventory (FI) techniques had also been reported to provide accurate estimation of above ground bole carbon stock (AGBCS). However, information on AGBCS for the International Institute of Tropical Agriculture (IITA), which hosts relics of the undisturbed secondary forest ecosystem in south-western Nigeria, has not been documented. Therefore, AGBCS of the secondary forest ecosystem was estimated using remote sensing and forest inventory techniques. Forest inventory and remote sensing data were used for this study. One hundred and forty plots of 50 m x 50 m were laid in IITA secondary forest using systematic sampling technique at 10% sampling intensity. Trees in each plot were enumerated and identified to species level. The total height (TH) and diameter at breast height (DBH) of trees ≥10 cm were measured to determine tree volume (TV). Sixty wood core samples were randomly collected from dominant trees species at breast height for wood density (WD) estimation. The TV and WD were used to determine AGBB, which were converted to CS using standard forest inventory method. Pleiades satellite imagery was acquired using RS technique and spectral data for each sample plot extracted. The spectral indices used for AGBB estimation were: normalized difference vegetation index (NDVI), difference vegetation index (DVI), infrared percentage vegetation index (IPVI), optimized soil adjusted vegetation index (OSAVI) and renormalized difference vegetation index (RDVI). The RS data were integrated with FI data to develop regression equations for the prediction of AGBB from where the total CS estimate was obtained. Data were analysed using descriptive statistics and regression analysis at α¬¬0.05. A total of 9,985 individual trees comprising 121 tree species and 30 families were recorded. The highest and least frequency of species recorded were *Funtumia elastica* (61/ha) and *Cordia alliodora* (1/ha) respectively. The TH and DBH ranged from 4.70 to 39.30 m and 10.76 to 74.50 cm, respectively, while TV ranged from 129.57 to 167,186 m^3/ha. The WD of tree species ranged from 0.23 to 0.89 kg/cm^3. The AGBB and CS ranged from 101.06 to 881,834.92 kg/ha and 50.53 to 440,917.46 kg/ha, respectively. The DVI had the highest AGBB value which ranged from 187 to 15,577 kg/ha, followed by IPVI, RDVI and OSAVI which ranged from 7,561 to 12,324 kg/ha, 64.0591 to 133.178 kg/ha, 0.0134 to 0.5621 kg/ha, respectively, while NDVI had the least values which ranged from -0.01 to 0.48 kg/ha. The best AGBB estimation model was AGBB = *exp* (3,496.61 +0.99x(RDVI) $^{1/2}$); (Coefficient of determination = 0.93, root mean square error = 31.39, Bayesian information = 2129.34). The total carbon stock ranged from 11,035 to 18,774 kg/ha. Model with renormalized difference vegetation index was most suitable among other indices for estimating above-ground bole carbon stock when integrated with forest inventory data.

aghimien4@yahoo.com

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