Modeling Soil Organic Carbon (SOC) using remotely sensed variables in sub-tropical forests of Chitwan District, Nepal

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Now a days the possibility of enhanced carbon storage in soils is of more interest compared to vegetation as it contains more carbon. For this reason, the revised Kyoto protocol includes two new clauses relevant to soil organic carbon sequestration. So, for the countries that have signed the Kyoto protocol, estimation of SOC sequestration is a required strategy. Reliable quantification of carbon held in soil is essential to formulate any kinds of monitoring program. Instead of a traditional laboratory method, estimation of carbon through a model might be an easy alternative. It would save time and remove the tedious task of soil sampling and processing. This study aims therefore to develop a model based on remotely sensed measured variables to estimate SOC in the subtropical forest of Chitwan, Nepal. To develop a model, six variables were selected, above ground biomass (AGB), elevation, species diversity, litter quality, soil bulk density and soil pH to estimate soil organic carbon. Although soil bulk density and pH cannot be measured through remote sensing technology, they were used to test the robustness of model. Soil organic carbon was analysed through Walkley-Black and Loss on Ignition (LOI) methods. Canopy Height Model (CHM) was developed from LiDAR data by subtracting the Digital Terrain Model (DTM) from the Digital Surface Model (DSM) to estimate the height of the trees. This CHM image was segmented based on an Object Based Image Analysis (OBIA) technique using e Cognition software. Segmented CPA further analysed to develop a model for DBH prediction. With the information of DBH, tree height and wood specific gravity, AGB was calculated. Elevation height was extracted from LiDAR derived DEM. A Worldview -2 high resolution image was classified to extract the information of tree species class. The image was classified into two classes Sal (*Shorea robusta*) and non-Sal (mixed species). These two classes were further transferred into a litter quality index by using a dummy variables code. A Stepwise regression procedure was followed to select the best fit model. Results show that there is a positive relationship ($r = 0.79$) between soil organic carbon and above ground biomass ($p<0.001$). Elevation and soil organic carbon is also positively correlated ($r=0.74$). There is no significant relationship between species diversity and soil organic carbon. Based on AIC and p value a regression model with above ground biomass ($p<0.001$) and litter quality ($p=0.07$) was selected to estimate soil organic carbon. ($p=0.07$). Root Mean Square Error (RMSE) for the selected model was 18.14%. Selected variables AGB and litter quality can be measured through remote sensing techniques. Based on AGB (kg/m^2) pixel value and litter quality (0 or 1) pixel value, SOC map was prepared. This model was tested with the field observed SOC value and shows a strong correlation coefficient value ($r=0.82$). Predicted model estimated average 1.77 kg/ m^2 soil organic carbon within 0-10 cm layer in the Chitwan district of Nepal.

Keywords: Soil Organic Carbon(SOC), Biomass, Crown Projection Area(CPA), Lidar, WorldView-2 Satellite Images, Allometric equation.