# Carbon sequestration as influenced by climatic, plant and soil parameters, their dynamics and control of selected Sri Lankan forests

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## Abstract

Understanding forest C sequestration of the tropical region is of paramount importance to reduce atmospheric $CO_2$ levels for mitigating global warming. Present study investigated changes of floristic, soil and climatic parameters and their control on C sequestration in two selected wet and dry zone forests of Sri Lanka. Floristic surveys were conducted to collect vegetation parameters. Permanent sampling plots of 2 x 2 m were set up for litter and soil sampling to cover a full annual cycle. Collected samples were analysed to characterize basic physicochemical composition. Climatic data were collected from the nearest meteorological stations to the forests. Regression models were formulated from a global tropical forest database to predict the above ground biomass increment of the two forests. Simple mathematical models were developed to calculate litter decomposition and root turnover rates. Principal factor analysis, multiple and simple regression analyses and descriptive statistical methods were used to analyse the data.

The wet zone forest contained higher plant biomass C (249 t C/ha), annual biomass increment (4.85 t C/ha/yr), soil C stock (108 t C/ha) and litterfall C stock (5.73 t C/ha) than those of the dry zone forest of which the corresponding values were 77.0 t C/ha, 4.72 t C/ha, 93.6 t C/ha and 4.72 t C/ha, respectively. Higher amounts of fine root and floor litter C stocks (2.7 t C/ha and 2.36 t C/ha, respectively) were present in the dry zone forest than the wet zone forest (2.4 t C/ha and 2.01 t C/ha, respectively). Higher species richness (25.3 ± 1.7) was recorded in the wet zone forest than the dry zone forest (17.3 ± 2.1). Macintosh distance (U) that determines species diversity and distribution was comparable in the dry zone (1.12) and wet zone (1.11) forests. Out of soil organic matter fractions analysed, fulvic fraction represented ca. 50% of soil total C, humic fraction ca. 30% and the balance by free soil litter fraction of both dry and wet zone forests. Stable humic fraction was relatively constant, while the free soil litter

fraction was accumulated and the fulvic fraction declined in both dry and wet zone forests during the study period. Maximum air temperature influences soil N in the dry zone forest as well as free litter fraction in the wet zone forest, possibly through microbial activities. Fulvic and free litter fractions in the dry zone and wet zone forests respectively were determined by total litterfall. An atmosphere-floor litter-soil continuum controlling soil moisture from rain fall and maximum relative humidity (i.e. night time) during wet and dry seasons, respectively was identified in the dry zone forest. It is apparent that during the dry season of the dry zone forest, soil moisture deficiency during five months' dry spell may have induced fine root growth for the uptake of water, possibly as a survival mechanism of the dry zone forest. The fine root growth seemingly has been fuelled by the N supply from low C/N soil organic matter through the microbial growth and action utilizing labile soil C and the water supply through the atmosphere-floor litter-soil continuum. This mechanism has possibly supported to an unusual greening-up of the canopy with the new flush during the dry spell of the dry zone forest.

Plant C sequestration was influenced by free litter and humic fractions, soil moisture and Macintosh distance (U). Thus, it is clear that labile and stable soil organic matter fractions, moisture and plant diversity and distribution are important factors which should be considered in plant C sequestration of the forest management programs. Soil fulvic fraction was found to act as a focal point of interacting with or influencing the other variables such as soil N, free litter fraction, humic fraction etc., thus determining soil C sequestration of the wet and dry zone forests. On the whole, the wet zone forest showed a higher total ecosystem C sequestration than the dry zone forest. Under future climate change scenarios, the dry zone forests are seen to be more climatic sensitive and vulnerable than the wet zone forests.