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Supporting Online Material for

Old-Growth Forests Can Accumulate Carbon in Soils

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This PDF file includes:

Materials and Methods
References

Sites and Methods

Monsoon Evergreen Broadleaved Forests. This long-term research was conducted at the Dinghushan Man and Biosphere (MAB) Reserve (23°09’21”N–23°11’30”N, 112°30’39”E–112°33’41”E**)** in Guangdong Province, China. The Reserve covers an area of 1,155 ha and has a subtropical monsoon climate. The Reserve was established in 1950 to protect a remnant of undisturbed natural monsoon evergreen broadleaf forests in the subtropics, and was accepted as the first MAB reserve in China in 1978. It has 2,054 recorded native species of higher plants. Annual mean precipitation is 1,678 mm, concentrated from April to September. Annual mean relative humidity is 78 percent and annual mean temperature is 22.3° C. Elevation in the reserve ranges from about 14 m to 1,000 m above sea level. The bedrock is typically sandstone and shale. Soils, with serious natural acidification and pH 4.0–4.9, are classified as hydration laterites.

A 200 m by 400 m plot, representative of the monsoon evergreen broadleaf forests in the region, was established in 1979 at an altitude of about 300 m above sea level on a south-facing slope. The forest at this site has not been disturbed for more than 400 years, according to ^{14}C dating (*S1*). The aboveground community can be divided into five layers: three arbor layers, one shrub layer, and one grass layer. In addition, the aboveground community has many kinds of interlayer plants (liana and epiphytes). The upper canopy is dominated by species with high importance values but few individuals. Evergreen plants are predominant and most often natives of the tropics and subtropics, such as *Castanopsis chinensis*, *Canarium pimela*, *Schima superba*, and *Engelhardtia roxburghiana*. The sub-canopy layer is mainly composed of *Cryptocarya concinna* and *Machilus chinensis*. The aboveground biomass of this community is about 380 Mg ha^{-1}.

Soil Organic Carbon (SOC) and Bulk Density Measurements. The data set used for this study was compiled from four major field campaigns spanning 24 years. Field measurements were consistently collected during the study period to a depth that included the entire top 20 cm soil layer, which did not reflect the change in soil thickness presumably caused by bulk density change. Substances of the organic layers (O horizons) were excluded. The first field campaign was conducted in 1979 with 96 composite soil samples collected using an auger 30 mm in diameter. During this campaign, the plot was divided into 800 subplots of 10 m by 10 m. A composite sample of five soil cores was taken from each of the 96 randomly selected subplots. The second campaign started in 1983 and ended in 1986. During this campaign, the plot was divided into 200 subplots of 20 m by 20 m. Thirty-three subplots were sampled in the same way as in 1979, except 10 soil cores were taken for each composite sample. The purpose of the third field campaign was to investigate the vertical distribution of SOC. During this campaign, one composite sample of 20 soil cores was collected from the plot. During the last campaign, an ongoing effort to monitor the long-term dynamics of SOC since 1998, 20 composite samples (10 soil cores for each composite) from 20 randomly located subplots were collected each year.

Sampling was carried out primarily in September, at the end of the rainy season and the beginning of the dry season. The soil samples were bulked, mixed, and air-dried. Plant residues, including roots, were discarded. The soils were then milled to pass a sieve of 93,000 openings m^{-2}. Soil organic carbon was determined using the wet oxidation method (*S2*).

Roughly in parallel, soil bulk density was determined by samples taken from 12, 8, and 6 subplots in 1979, 1983, and 1986, respectively, and from 20 subplots between

1999 and 2003. Undisturbed soil cores were taken from five randomly selected locations within each subplot using a stainless steel corer (5.65 cm in diameter, 4 cm in depth, and 100 cm^3 in volume). All of the sample cores within each subplot were pooled together and oven-dried at 105° C to constant weights. Soil bulk density was calculated as the ratio of total dry weight to total soil volume.

Calculation of Soil Carbon Stock Change. SOC stock is the product of SOC concentration, layer thickness, and bulk density (*S3*, *S4*). The determination of the temporal change of SOC stock becomes challenging when these three factors change over time. In this study, two extreme values, representing the upper and lower limits of the possible SOC change, were used to define the uncertainty introduced by the lack of observations on soil thickness dynamics. The upper limit of SOC change was defined based on mass conservation. A decrease in bulk density will be compensated by an increase in soil thickness in the calculation of SOC stock change under mass conservation. Nevertheless, decreased bulk density, as shown by our field measurements, would result in an expansion of the original top 20 cm layer under mass conservation. Consequently, the SOC concentration measured using samples collected from the top 20 cm layer would be higher than that of the expanded soil column, because the relatively low carbon-bearing portion of the expanded column at the bottom was not included in the samples. The change in SOC concentration measured by this sampling strategy would represent the maximum change possible, because the SOC change rate usually decreases with soil depth and the relatively slow changing part of the expanded column was not included in the samples. The upper limit of the change of SOC stock can be calculated as follows:

$$SOCu = 0.2*D_{1979}*(SOC_{2003}-SOC_{1979}) \quad (1)$$

where 0.2 and D_{1979} are soil sample thickness (m) and bulk density (Mg mass m^{-3}) in 1979, respectively, SOCu is the upper limit of SOC stock change (Mg C ha^{-1}) from 1979 to 2003, and SOC_{1979} and SOC_{2003} are SOC concentration in the top 20 cm layer (Mg C Mg^{-1} mass) in 1979 and 2003, respectively.

The lower limit of SOC stock change is defined using the assumption of constant thickness and calculated as follows:

$$SOC_l = 0.2*(D_{2003}*SOC_{2003} - D_{1979}*SOC_{1979}) \quad (2)$$

where D_{2003} is soil bulk density (Mg mass m^{-3}) in 2003, and SOC_l is the lower limit of SOC stock change in the top 20 cm layer (Mg C ha^{-1}) from 1979 to 2003. In essence, it is assumed in equation 2 that the expanded part of the original top 20 cm soil layer, resulting from decreased bulk density, did not contain SOC. Therefore, equation (2) gives the lower limit of SOC stock change.

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