Assessing Total Belowground Carbon and Nitrogen Stocks with Quantitative Pits

Measuring the effects of forest management and other environmental stressors on belowground carbon and nitrogen is critical to understanding subsequent effects on the global climate system. Such measurements must be not only *precise* in the sense that they are repeatable with little variation, to allow statistical confidence in observed changes over time, but also *accurate* in the sense that they avoid systematic error, allowing observed changes to be correctly scaled over wide areas. Furthermore, they should ideally consider not only soil in the strict sense, but also other belowground stocks of organic matter that might respond to change.

In the rocky soils typical of many forests, conventional coring methods for measuring C and N stocks are subject to systematic error in that they cannot sample in certain locations. In some soils, such as bouldery granite tills, even rotary corers powered by a gasoline engine have this limitation.

In the November–December 2012 issue of the *Soil Science Society of America Journal*, researchers working in the White Mountain National Forest in New Hampshire updated an intensive quantitative soil pit method to measure belowground C and N stocks in 14 northern hardwood stands that varied in forest age. Quantitative pits have been used in more than 40 studies worldwide since 1980 and involve excavating a pit of fixed area (in this case 0.5 m^2) down through various soil layers and then weighing and subsampling everything removed from each layer.

This direct measurement of mass per unit area by depth increment avoids propagating the errors in separate estimates of rock volume and bulk density, and the excavation process provides samples that accurately represent large volumes. The researchers measured not only soil (particles

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Quantitative Pits

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smaller than 2 mm), but also important non-soil pools, including buried wood and bark fragments, live and dead roots, soil adhering to rocks, the rocks themselves, and the top 50 cm of the C horizon, which are not typically sampled or distinguished by conventional soil-sampling methods.

The researchers found that non-soil stocks accounted for a surprisingly large fraction of belowground C in White Mountains, including roots (10% of soil C, on average), wood and bark (4% of O horizon C), soil adhering to rocks (5% of soil C), the rocks themselves (7% of soil C), and the C horizon (17% as much C content in its top 50 cm as the B horizon). Together, these non-soil components of total belowground C together add 35% on average to soil C as typically measured. Relative N contents were similar in magnitude. The researchers conclude it is important that such pools not be overlooked in projects accounting for changes in ecosystem C and N, and at minimum, they must be treated consistently over time.

Excavating a quantitative soil pit in Campton, NH.

Adapted from Vadeboncoeur, M.A., S.P. Hamburg, J.D. Blum, M.J. Pennino, R.D. Yanai, and C.E. Johnson. 2012. The quantitative soil pit method for measuring belowground carbon and nitrogen stocks. Soil Sci. Soc. Am. J. 76(6). View the full article online at https://dl.sciencesocieties.org/publications/sssaj/tocs/76/6