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Belowground carbon allocation patterns in a dry Mediterranean ecosystem: a comparison of two models.

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Total belowground C allocation (TBCA) represents a large fraction of gross primary production; it can exceed aboveground net primary production, and provides the primary source of detrital C to mineral soil. Here, we measure soil respiration, water erosion, litterfall and estimated annual changes in C stored in mineral soil, litter and roots, in three representative land uses in a Mediterranean ecosystem (late-successional forest, abandoned agricultural field, rain-fed olive grove), and use two C balance approaches (steady-state and non-steady-state) to estimate TBCA. Both TBCA approaches are compared to assess how different C fluxes (outputs and inputs) affect our estimates of TBCA within each land use. In addition, annual net ecosystem productivity is determined and C allocation patterns are examined for each land use. We hypothesized that changes in C stored in mineral soil, litter and roots will be minor compared to soil respiration, but will still have a significant effect on the estimates of TBCA. Annual net ecosystem productivity was 648, 541 and 324 g C m^{-2} yr^{-1} for forest, abandoned field and olive grove, respectively. Across land uses, more than 60 % of the C was allocated belowground. Soil respiration (F_S) was the largest component in the TBCA approaches across all land uses. Annual C losses through water erosion were negligible compared to F_S (less than 1%) and had little effect on the estimates of TBCA. Annual changes in C stored in the soil, litter layer and roots were low compared to F_S (16, 24 and 10 % for forest, abandoned field and olive grove, respectively), but had a significant effect on the estimates of TBCA. In our sites, an assumption that $\Delta[C_S + C_R + C_L]/\Delta t = 0$ will give biased estimates of TBCA, particularly in the abandoned agricultural field, where soil C storage may be increasing more rapidly. Therefore, the steady-state model is unsuited to these Mediterranean ecosystems and the full model is recommended. The results from this study provide useful information for those studies analyzing global patterns in belowground C flux and partitioning in ecosystems, in which water-limited ecosystems are under-represented.