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Soils need to be considered when assessing the impacts of land-use change on carbon sequestration

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In a recent analysis of the effects of land-use change (LUC) on carbon (C) sequestration and biodiversity, Marques et al.[1] conclude that the impacts of forestry on C sequestration are probably much larger than for other types of land-use transition. This conclusion, and the policy recommendations that flow from it, are based solely on considerations of aboveground biomass or (more specifically) "harvest volumes and typical rotation times for managed forests". If instead soils and soil C are considered, then a completely different set of conclusions and policy recommendations would have emerged.

The effects of LUC on aboveground C and net C sequestration are transient[2]. Net ecosystem C sequestration varies strongly with stand age, as is shown for recovering forests, which capture more C at young stand ages than mature forests (the land-use category that stores the largest amount of C in aboveground biomass)[3]. In forestry operations, foresters can practice techniques such as selective logging and/or take care to ensure that tree falls do not damage non-target trees, which can minimize impacts on carbon sequestration[4]. But a more important oversight by Marques et al.[1] was the failure to consider soil organic C, which is essential for the delivery of soil-based ecosystem services, but is also vulnerable to LUC[5]. Soils hold more C than the vegetation and the atmosphere combined[6]. The first 3 m of the soil profile may contain up to 2,344 PgC versus 600 PgC in aboveground plant biomass[7]. The impacts of LUC on soil C stocks have been widely analysed at both local and global scales. Early[5], as well as more recent[8], meta-analyses have demonstrated that the transition to cropland results in much greater losses of soil C than the transition to forestry.

When the largest and most important terrestrial C reservoir is considered, a completely different picture emerges to the conclusions of Marques et al.[1]: a transition to industrial-scale cropping emerges as the LUC that leads to most C loss. The need to focus on soils and soil C is difficult to overstate. Soils and soil C are critically important providers of ecosystem services[9] and recovering soil C is a difficult process that may take decades to millennia. It is even possible that in some cases soil C levels will never recover to levels observed before LUC[10]. While this type of economic and policy analysis is urgently needed, future analyses need to include soil C.

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Author contributions

S.D.-G. and B.L. wrote the first draft, P.L.P. and N.B. reviewed and edited the manuscript.

Competing interests

The authors declare no competing interests.

Additional information

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