SOIL Discuss., 2, C552–C557, 2015
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Interactive Comment

Interactive comment on "On the rebound: soil organic carbon stocks can bounce back to near forest levels when agroforests replace agriculture in southern India" *by* H. C. Hombegowda et al.

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POINT-BY-POINT REPLY TO THE REVIEWS:

RESPONSE TO REFEREE 1:

General comments Referee: In this article the author presents an analysis of soil organic carbon stock changes associated with conversion from forest or agriculture to agroforestry. They identify significant predictor variables of SOC stock and present a large and useful data set that highlights some of the impacts of agroforestry on carbon stocks. In addition to specific comments below regarding soil texture, the nature of the

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precipitation that falls in this region may have significant impacts on carbon cycling. Mean annual precipitation, although a simple variable available to measure at many sites, does not always capture the underlying drivers for soil carbon cycling, see Knapp et al. (2002). Overall this manuscript presents interesting information and analysis and after addressing minor comments, is suitable for publication in SOIL.

Authors: We would like to thank the reviewer for his or her critical yet constructive comments. We have tried our best to address the issues raised and incorporate further explanations into the text to bolster and improve the manuscript. Mean annual precipitation. While we recognize that MAP is a simple metric for soil moisture and may not fully capture the underlying drivers for SOC stocks, especially seasonal patterns, it is nevertheless a good predictor of regional scale SOC cycling. To detect some of the intra-annual / seasonal variability we examined precipitation seasonality (coefficient of variation of monthly precipitation) from the same Worldclim dataset during our data analysis. We opted not to include these results in the paper as seasonality was auto-correlated with MAP and showed similar trends: higher MAP – higher precipitation seasonality. While we do not use this seasonality data, we nevertheless have included a discussion on how precipitation seasonality (namely the monsoon), affects SOC stocks (page 11, lines 22-25): "Both the decrease in SOC stocks and basal area at high precipitation could be explained by the torrential monsoon rains. Although the overall rainfall amount may be higher, its intensity and distribution over time causes much of it to runoff, which is then not available to plants when they need it."

Specific comments: Referee: Experimental Design: Section 2.3: The author states that no wood is removed from the forest. Is there any history of fire in these forests? If so, is there any evidence of char or ash in the soils once they undergo conversion to agriculture/agroforestry?

Authors: Most of the studied forests are community managed forests where both wood removal and burning for the purpose of grass production is prohibited and no char or ash was found. Additionally, we did not find any char or ash in the agriculture or

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agroforestry systems. Unlike slash and burn practices in the humid tropics, in this region when forests are cleared for agriculture or agroforestry plantations the sites are not burnt as most of the aboveground biomass is removed and used (leaves for animal fodder or for compost material; and wood for fuelwood). To clarify the land clearing practices we have added two sentences to briefly describe this (see page 7: lines 1-2).

Referee: Results: Section 3.1: The author assumes that land use change does not affect soil texture, but there appears to be evidence to the contrary. If across plots there is a +2.3(+-0.4)% and a -5.5(+-0.5)% change in clay content with the conversion from agriculture to agroforestry, and the conversion from forest to agriculture, respectively, this appears to be a significant effect on soil texture. The author contradicts their own assumption by highlighting the importance of clay fraction as a predictor of SOC stock (Table 2). Also, changes in soil texture, particularly in clay content, can have significant impact on the soil water retention (Gupta et al 1979).

Authors: The reviewer is correct and there are indeed significant differences between the clay contents, albeit small. We attribute these differences in soil clay content to the continuous cultivation where clay particles are lost when freshly tilled soil is exposed to high intensity rainfall and are carried away in suspension in the surface runoff (Gonzalez and Laird, 2003). This explanation is found in the text page 12, line 12-15. Considering the small differences in clay percent (2% and 5%), measurement errors may also play a role in explaining the discrepancy. The pipette sedimentation method is quite sensitive to measurement errors in the lab and values can deviate between lab technicians.

Referee: It would be helpful in this section to see the results of the t-test for the 10-30cm clay content in the appendix.

Authors: In the text we have included the p-values of the T-test, indicating that there are significant differences in clay contents. Accordingly we felt that adding the t-test results in the appendix did not add any additional information.

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Referee: It is not stated clearly whether the difference in clay content occurs throughout the profile, but if the difference is within the upper 10cm it is likely that change to/from tillage, and aeolian and hydraulic erosion/deposition are all potentially significant drivers of soil texture changes and cannot be discounted. If the upper 10cm of the soil with 1600 kg m-3 bulk density and 20% clay content by mass has a change in 5% of the clay content, this results in a change of 16 Mg ha-1 of clay. If the potential for this clay to associate carbon is assumed to be 3.9% by mass (Gonzalez et al 2003) that results in a potential change of 0.480 Mg ha-1 of carbon associated with the clay fraction when these clay particles form aggregates. This amount of carbon, although below the error of 0.7-1.6Mg ha-1 associated with SOC stock changes in the upper 10cm (Figure 3), is still worth mentioning as a part of the mechanism for change in SOC stock. It is also worth noting that loss/gain of the clay fraction could contribute more significantly to the amount of carbon stored in areas of higher erosion/deposition due to its outsize role in physical and chemical stabilization of organic matter.

Authors: We agree with the reviewer. The difference in clay content in the topsoil is most likely due to tillage and subsequent erosion – especially if the soils are tilled before the monsoon. As the reviewer states, not only is the organic carbon lost directly through erosion, but the loss of soil clay particles also reduces the capacity of the soil to hold and store carbon. This mechanism has now been included in the revised text (see page 12, line 12-18).

Referee: Discussion Section 4.2 P 883 lines 17-18: The author states that erosion is of little importance. Judging from the losses in clay fraction from the soils upon land use change, this is not necessarily an aspect of land use change that can be overlooked at all sites. Dourte etal (2012) reports rainfall rates for Andhra Pradesh and has made calculations showing that high rates of runoff are possible. Using Dourte's data for monsoonal rainfall intensity as a proxy for nearby areas, of similar rainfall quantity, runoff, and therefore erosion of surface fines and associated fine-grained surface organic matter cannot be dismissed, especially for the agricultural sites without the

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protection of a closed canopy for diffusion of the rainfall energy. Including this in the discussion would also help make this data more interpretable in areas where steeper slopes and high rainfall energies are present.

Authors: Erosion is no doubt an important way in which carbon and clay particles are lost. Accordingly we have removed the phrase where we state that “soil erosion is of minor importance”. Considering that all our plots were located on flat or gentle slopes and that we only did a one-time sampling we could not quantify the magnitude on SOC and clay losses from erosion. Instead we have bolstered this section by citing the findings from Dourte et al. (2012) and Gonzalez and Laird (2003) (see page 12, line 12-18).

Technical Corrections

Referee: P872 line 4: remove “however”

Authors: corrected

Referee: P 874 Line 16: “stocks” should be “stocks”’ or “: : :and changes to SOC stocks along a forest: : :”

Authors: corrected

Referee: P880 line 19 “: : :soil SOC: : :” should be “SOC”

Authors: corrected

Referee: P876 lines 8-9 “cinnamom” should be “cinnamon”

Authors: corrected

Reference list: Dourte, D., Shukla, S., Singh, P. and Haman, D.: Rainfall intensity-duration frequency relationships for Andhra Pradesh, India: changing rainfall patterns and implications for runoff and groundwater recharge, Journal of Hydrologic Engineering, 18(3), 324-330, 2012.

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Gonzalez, J. M. and Laird, D. A.: Carbon Sequestration in Clay Mineral Fractions from C-Labeled Plant Residues. Soil Science Society of America Journal, 67(6), 1715-1720, 2003.

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