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Biogeosciences Discussions

Interactive comment on "Organic and inorganic carbon in the topsoil of the Mongolian and Tibetan grasslands: pattern, control and implications" *by* Y. Shi et al.

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In this paper, Shi et al. studied comprehensively the natural factors that impact the organic and inorganic fractions of carbon in soil across the grasslands of Inner Mongolia and the Tibetan Plateau. The authors examined the relative effect of several factors, including climatic conditions, physical and chemical features of the soil, and characteristics of vegetation. The obtained results are clearly presented, the discussion is thoughtful and profound, and the conclusions are convincing. Therefore, this contribution is of high merit and could also be relevant for other grasslands throughout the world. Nevertheless, the main limitation of this study stems from ignoring the livestock

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grazing factor, which may have a considerable impact on total soil carbon in the A horizon. Previous studies showed that grazing livestock modify the pools and distribution of soil carbon to a spatial scale's resolution of tens of centimeters. This may be especially important for large-scale and regional studies, where modifications in physical features of soil (e.g., bulk density, aggregation) and characteristics of vegetation (plant community and cover percentage) following different stocking regimes, could result in large deviations in the calculated total carbon pool of the soil.

Previous studies from other semi-arid regions revealed that livestock movements on hilly rangelands are not evenly distributed on the hillslopes but rather, are spatially-heterogeneous. In some of these regions, concentrated movements of livestock along certain trails have led to the formation of clearly visible routes (e.g., Trimble S.W. and Mendel A.C. (1995) Geomorphology, 13, 233-253). In one region, it was reported that the routes' cover has been $\sim$ 20% of the hillslopes' area. The heavy stocking density in the routes results in the compaction of their surface and modification of features of their soil. Compared with the remainder of the area, soil of the routes was reported to have significantly larger bulk density and concentration of calcium carbonate and smaller mean weight diameter of aggregates, gravimetric moisture content, and concentration of organic carbon. The spatially-heterogeneous livestock densities could be attributed to small changes in micro-topography, and to the fact that animals prefer relatively moderate slopes to step on. This affects the grazing land's net primary productivity to a tremendous extent. First, the modified soil in the routes becomes an inhospitable microhabitat, resulting in its becoming completely barren of herbaceous vegetation (Stavi I. et al. (2012) Arid Land Res. Manage., 26, 79-83). Second, since the consumption of herbaceous vegetation is positively related to its proximity to the routes, its cover tends to follow an increasing trend with increased distance from the routes (Coughenour M.B. (1991) J. Range Manage., 44, 530-542). These modifications in herbaceous cover, distribution, and density result in concordant adjustments of the physical and chemical characteristics of soil in a similar spatial pattern. It is reasonable to assume that such spatially-heterogeneous impact of livestock occurs in many grazing lands throughout the globe.

Therefore, Shi et al. are requested to insert a short paragraph in the section "Uncertainty of prediction" (4.4) that refers to the exclusion of the impact of the livestock factor on their model and to the importance of this factor. Future studies may choose to consider the livestock factor through observations of herds' behavior and detailed monitoring of modifications of the surface soil caused by the grazing animals. This could help in better representation of the spatial complexities characterizing the distribution and pools of the organic and inorganic fractions of carbon in soil.

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