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Biogeosciences Discussions

Interactive comment on "Agropedogenesis: Humankind as the 6th soil-forming factor and attractors of agrogenic soil degradation" *by* Yakov Kuzyakov and Kazem Zamanian

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The comments by Dr. Pal focus on agropedogenesis in the tropics. He emphasized that soil development in the tropics under agricultural practices needs particular attention if we aim at developing a universal concept for agropedogenesis. This argument has been considered in section "2.7. Changes in the attractors by specific land-use or climatic conditions" as the agropedogenesis may stop at some metastable conditions depending on specific land-uses or climatic conditions. Nonetheless, agropedogenesis is a universal process leading to similarities in properties of agricultural soils independent on the climatic conditions or other soil forming factors. This is due to the fact that

human activities dominate over the effects of other soil forming factors. The responses to the three major concerns of Dr. Pal are as follow:

(a) The accumulation of soil organic carbon (SOC) by growing agricultural crops in soils of semi-arid tropical (SAT) climate of India which shows no sign of soil degradation.

→ This is true that agricultural practices may also lead to soil improvement. In Fig. 1 we showed both directions i.e. degradation and improvement in soil condition following cultivation onset. In the text also the degradation is mentioned as the most common (but not always) fate of agricultural soils. However, the main message of our paper was the necessity to recognize human as a soil forming factor. Agricultural managements aim at increasing the yield and human, via management practices, modifies the soil properties in the way which it suits crop growth. This makes human as the main factor who determines the direction of changes in soil properties/developments. In consequence, we hypothesized a steady-state condition for soil development under agricultural practices as it is the case in natural pedogenesis. We defined end-values/attractors for a set of properties i.e. master properties which are most sensitive to land-use/land management. These attractors can be as indicators of achieving steady-state condition under agricultural practices. The Dr. Pal's example on organic carbon (OC) of the Indian SAT soils is well in accordance with our attractor concept. As he mentioned the OC content reached to a plateau and a value about 0.7% after nearly three decades of cultivation on Indian SAT soils. Nonetheless, we will try to emphasize more on soil improvement in the revised version of the manuscript to avoid misunderstanding that agricultural practices may solely lead to soil degradation.

(b) The resilience of SAT sodic soils through anthropogenic activities showing pedogenic processes that are reverse to what was proposed in the conceptual model of agropedogenesis.

→ In Fig. 6 we preliminary proposed/defined the time needed for various soil properties to reach their attractors. The attractor of CaCO3 is defined as 0% i.e. complete

decalcification of soil which takes place over millennial time spans. The improved management (IM) system mentioned by Dr. Pal is applying synthetic nitrogen and phosphorus fertilizers as well as furrow irrigation in contrast to the traditional management (TM) system. He argued that implying IM system in SAT sodic soils improved soil condition for crop growth and subsequently increased the yield. However, this conclusion does not rescind our agropedogenesis concept but rather supports it. The modification of alkalinity in SAT sodic soils after implying IM system was due to one order of magnitude increase in CaCO3 solubility. Such an increase in CaCO3 solubility was enough to provide Ca2+ ions needed to replace exchangeable Na+ (Pal et al., 2012). This process first confirms the determinant role of human on direction of soil development i.e. agropedogenesis. Second, continuous dissolution of CaCO3 leads to decalcification of the top-soil i.e. movement toward the attractor of CaCO3 (0%) although over millennial period.

(c) Compete with the idea that acidification under agricultural crops is a sign of soil degradation in model concept of agropedogenesis.

→ We agree that acid soils under for example forest vegetation can still have high organic carbon content. However, in agricultural soils, the yields decrease by decreasing pH value. Thus acidification should be considered as a sign of degradation for agricultural soils.

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