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Biological framework for soil aggregation: Implications for ecological functions.

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Soil aggregation is heuristically understood as agglomeration of primary particles bound together by biotic and abiotic cementing agents. The organization of aggregates is believed to be hierarchical in nature; whereby primary particles bond together to form secondary particles and subsequently merge to form larger aggregates. Soil aggregates are not permanent structures, they continuously change in response to internal and external forces and other drivers, including moisture, capillary pressure, temperature, biological activity, and human disturbances. Soil aggregation processes and the resulting functionality span multiple spatial and temporal scales. The intertwined biological and physical nature of soil aggregation, and the time scales involved precluded a universally applicable and quantifiable framework for characterizing the nature and function of soil aggregation. We introduce a biophysical framework of soil aggregation that considers the various modes and factors of the genesis, maturation and degradation of soil aggregates including wetting/drying cycles, soil mechanical processes, biological activity and the nature of primary soil particles. The framework attempts to disentangle mechanical (compaction and soil fragmentation) from in-situ biophysical aggregation and provides a consistent description of aggregate size, hierarchical organization, and life time. It also enables quantitative description of biotic and abiotic functions of soil aggregates including diffusion and storage of mass and energy as well as role of aggregates as hot spots of nutrient accumulation, biodiversity, and biogeochemical cycles.