Stabilization of soil aggregates along a plant community succession: indirect positive effects of root biomass and root heterogeneity

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Soil aggregate stability is a major component of soil functioning. This research aimed at tracking variations of soil aggregate stability along succession and to unravel how root characteristics contribute to drive these variations. Forty-eight plant communities on embankments along roadsides were selected in the French Mediterranean region, aged from 6 to 69 years-old, and ranging from graminoïd dominated plant communities to shrub/trees dominated communities. From methodological perspective, we measured soil aggregate stability and several soil and plant community characteristics, focusing on root characteristics (*e.g.* root morphology, root chemistry and mass density). Beyond the usual community average root traits, we adapted methods generally used for aboveground traits to calculate root morphological heterogeneity. The results show that soil aggregate stability varied significantly along the successional gradient, from unstable in early successional communities to very stable in late successional ones. Along the gradient, the accumulation of soil organic carbon, related to plant community dynamic, appeared as the major factor driving the stabilization of soil aggregates (Figure 1).

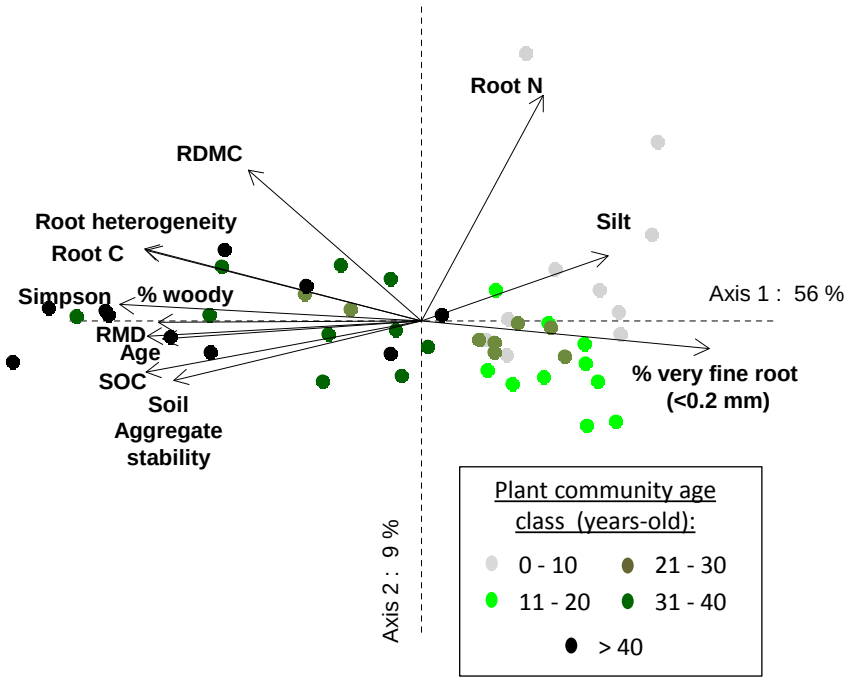

Figure 1: Principal component analysis of soil, plant community and root characteristics along the succession. Root C & Root N: carbon and nitrogen contents in fine (<2 mm) roots; RMD: Root mass density; SOC: Soil organic carbon; % woody: percentage cover of woody species; Simpson: taxonomic diversity

Structural equation models revealed that the increase in root mass density and root morphological heterogeneity along the succession contributed equally to the accumulation of soil organic carbon, stabilizing soil aggregates (Figure 2).

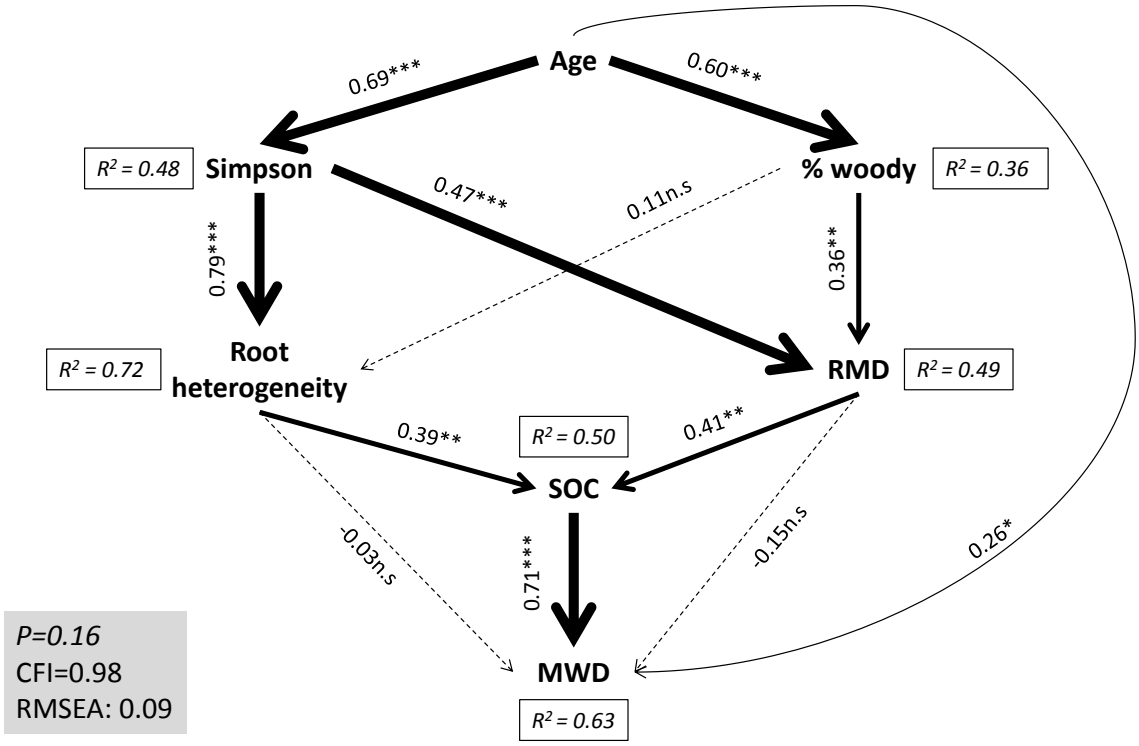

Figure 2: Direct and indirect effects of age, plant diversity, woody coverage, root heterogeneity and root mass density on soil aggregate stability. Structural equation models are shown. Numbers adjacent to arrows are indicative of the effect-size and P-value of the relationship. Continuous arrows indicate positive and significant relationships. The width of arrows is proportional to the significance of path coefficients. Dashed arrows indicate non significant relationships. Level of significance are *: P<0.05; **: P<0.01; ***: P<0.001; n.s: P>0.5. R^2 denotes the proportion of variance explained. RMD: Root mass density; SOC: Soil organic carbon; % woody: percentage cover of woody species; Simpson: taxonomic diversity

Finally, the research reveals that root compartment appeared as central to indirectly drive soil aggregate stabilization along the succession.