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Is There a Link Between Space and Time in Soil?

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The pore-scale structure of soil provides the habitat for most of the world's biodiversity and determines the rates of fundamentally important ecosystem processes. Research over the past few decades has highlighted the fact that the structure is not random, but that there exist spatial correlations that have been interpreted using concepts drawn from fractal geometry. Whilst it is relatively easy to derive fractal models for static images of soil structure, there has not been any satisfactory explanation for the origin of non-random structure in terms of the dynamical processes that organise pore-scale structure over time. Given the importance of structure for function, this is an important area of ignorance in soil science since it essentially means we do not understand how and why function might change over time. It also weakens the validity of any model for static structure. Here we present new data and a simple dynamical model for the genesis of pore scale structure. The model incorporates the fact that structure impacts on the distribution of microenvironments in soil and that this, in turn, affects the distribution of microbial activity. Microbial activity impacts on structure by affecting the strength of the binding of soil particles through e.g. the release of extracellular polysaccharides and fungal growth. The feedbacks between structure, activity and binding result in self-organising behaviour that leads to the development of non-random structure over time. We discuss the results of the model with reference to recent data and to the consequences for how we might move forward to understand the link between the temporal evolution, structure and functioning of soil.