**Impact of dispersal networks on contaminant biodegradation at varying water potentials**

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Bacterial population dispersal is a prerequisite for efficient biodegradation in soils because it increases the contact probability of bacteria and contaminants. However, in terrestrial environments bacterial surface motility is usually restricted due to a limited thermodynamic availability of water. In the porous soil matrix the osmotic (Ψo) and the matric potential (Ψm) constitute the main descriptors of the water potential and both are described to decisively affect bacterial motility behavior. Experimental studies and a spatially explicit microbial simulation model have proven that fungal mycelia facilitate bacterial dispersal in water unsaturated environments, which resulted in an enhanced contaminant degradation. Nevertheless, poor knowledge exists on the beneficial effects of mycelia at varying Ψo and Ψm. We therefore established experimental microcosms to investigate the effect of mycelia-like dispersal networks on the spatiotemporal dynamics of *Pseudomonas putida* KT2440-gfp at ΔΨo and ΔΨm between 0 and -1.5 MPa (i.e. water potentials representing completely saturated or plant permanent wilting point conditions) and determined their benefit for the biodegradation of benzoate as a model substrate. We found that a decrease of the osmotic potential slowed down bacterial dispersal and growth in the system. Consequently, biodegradation rates dropped by 50 % at ΔΨo -0.5 MPa and by 90 % at ΔΨo -1.5 MPa. In contrast, matric stress completely repressed bacterial movement already at ΔΨm -0.25 MPa, which leads to a drop of the degradation rates by 40 %. Dispersal networks accelerate bacterial movement in all treatments and thus markedly improve the biodegradation performance by up to a factor of 4 and 1.8 for osmotic and matric stress treatments, respectively. We propose that dispersal networks may act as an important buffer mechanism for fluctuating water regimes in soils and hence support bacterial contaminant degradation.