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Short- and long-term functional recovery of benthic microbial communities from drought

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Increased duration of severe drought progressively causes drying of shore and streambed sediments of temperate rivers with implications for their metabolic performance. Drought is defined as ceasing flow until the streambed becomes entirely dry. Recent work reports the impacts of drying on microbial communities but little is known about processes driving the resilience of communities, their abundance, diversity and metabolism upon flow resumption. Functional recovery of stressed microbial communities can start from cells that are adapted to outlast the dry stress (short-term recovery within minutes to few days) and cells that recolonize the sediments via the flowing water or protected refuges of the still wet hyporheic zone (long-term recovery within weeks to months).
We hypothesized that the benthic microbial community does not recover to pre-disturbed metabolic activity levels in the short-term but reaches metabolic activity levels of non-disturbed river sediments during long-term recovery. In combined laboratory and field experiments with sandy sediments of a lowland river (River Spree, Brandenburg, Germany) we investigated the short-term and long-term functional recovery of benthic microbial communities exposed to 90 days of severe drying. For severe drying, river sediments were left outdoor for drying neither shaded nor wetted. Microbial activity during drying was measured as CO_2 emission from a known sediment volume. Recovery of microbial activity after flow resumption was assessed by measuring O_2 consumption of the sediments. Chl a samples were taken from each microcosm to get a quantitative estimate of primary producers. Dynamics of the functional short-term recovery were measured in microcosms at 6, 12, 18, 42, 66, and 90 h past rewetting. Dynamics of the long-term recovery were measured after exposing the dried sediment back to the river in mesh bags (250 μm). We collected a set of mesh bags 0.5, 1, 3, 6, 15, and 23 weeks after the onset of recovery and measured primary production and community respiration in microcosms.
Short-term recovery after flow resumption was delayed (24 hours) and increased later on to a constant level reaching 50 % of pre-disturbed activity. Within six weeks of long-term recovery, the benthic microbial communities showed increasing respiration reaching 100 % of their pre-disturbed metabolic activity, yet still not reaching that of undisturbed sediments. After drought and before immersion into the river, Chl a was less than 50 % of the concentration of undisturbed river sediments. Within three weeks of long-term recovery in the river, the previously dry sediments approached Chl a concentrations of the non-disturbed river sediments.
In our experiment, we show that despite fast uptake of metabolic activity after drought stress, the biofilm needs several months to fully recover.