Soil gas dynamics and microbial activity in the unsaturated zone of a regulated river

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ABSTRACT

Over 60% of the world's rivers are dammed, and are therefore regulated. In some river systems, river regulation is the dominant factor governing fluid exchange and soil gas dynamics in the hyporheic region and overlying unsaturated zone of the river banks. Where this is the case, it is important to understand the effects that an artificially-induced change in river stage can have on the chemical, plant, and microbial components of the unsaturated zone. Daily releases from an upstream dam cause rapid stage fluctuations in the Lower Colorado River east of Austin, Texas. For this study, we utilized an array of water and gas wells along a transect perpendicular to the river to investigate the biogeochemical process occurring in this mixing zone. The gas wells were installed at several depths up to 1.5 meters, and facilitated the continuous monitoring of soil gases as the pulse percolated through the river bank. Water samples collected from the screened wells penetrated to depths below the water table and were analyzed for nutrients, carbon, and major ions. Additionally, two soil cores were taken at different distances from the river and analyzed for soil moisture and grain size. These cores were also analyzed for microbial activity using the total heterotroph count method and the acetylene inhibition technique, a sensitive method of measuring denitrifying activity. The results provide a detailed picture of soil gas flux and biogeochemical processes in the bank environment in a regulated river. Previous work found that meter-scale changes in river stage propagate through the bank as significant fluctuations to the water table. We propose that these conditions create an area in the subsurface that is subjected to daily cycles of saturation and drying, supporting enhanced microbial oxidation of soil organic matter. Measured soil CO_2 exhibited periodic variations with the fluctuating water table, with most peak values occurring during water table drawdown. Along the transect CO_2 concentrations increased with increasing depth down to the water table, and with decreased with increasing distance away from the river.