Multi-year impacts of sedimentation during managed aquifer recharge

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Abstract. The spatial and temporal distribution of surface water infiltration during managed aquifer recharge (MAR) is largely controlled by the movement, distribution and properties of sediment through which infiltration and recharge occurs. We use a variety of tools, techniques and analytical methods to assess and quantify the impacts of sedimentation on the operation of a 3 ha MAR infiltration pond in central coastal California over multiple seasons. In previous work, we used temperature records to derive infiltration rates at individual measurement locations; we combined these results with pressure records to quantify changes to saturated soil hydraulic conductivity (K) with time. In this study we add detailed surveys of sediment properties, including suspended load, surface accumulation, and changes in grain size distribution at depth, to provide a physically based explanation for the observed spatial distribution and temporal evolution of infiltration rates and soil properties. At the start of infiltration, observed increases in K are attributable to the removal of grains <125 μm diameter from the upper 2 m of soil beneath the pond. Subsequent order-of-magnitude declines in K result from the settling and accumulation of suspended sediment at the base of the pond. One dimensional sediment accumulation models for individual measurement locations indicate that the growth of this comparatively thin (1-20 mm) low-K layer ($K \sim 10^{-7} - 10^{-8}$ cm/s) is sufficient to account for observed decreases in K. Repeated sampling and analysis of pond soils for total carbon content indicate no systematic change in carbon concentrations as a result of MAR operation, suggesting that biofouling may play a less important role than fine sediment accumulation in governing infiltration rates. In practical and economic terms, the impact of sedimentation on MAR operations is significant, reducing by >50% the quantity of surface water that might otherwise be infiltrated and recovered during any given year. In addition to more careful control of sediment at its source, data suggest that keeping fine particles in suspension via deliberate agitation of pond water might increase MAR operational efficiency.

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