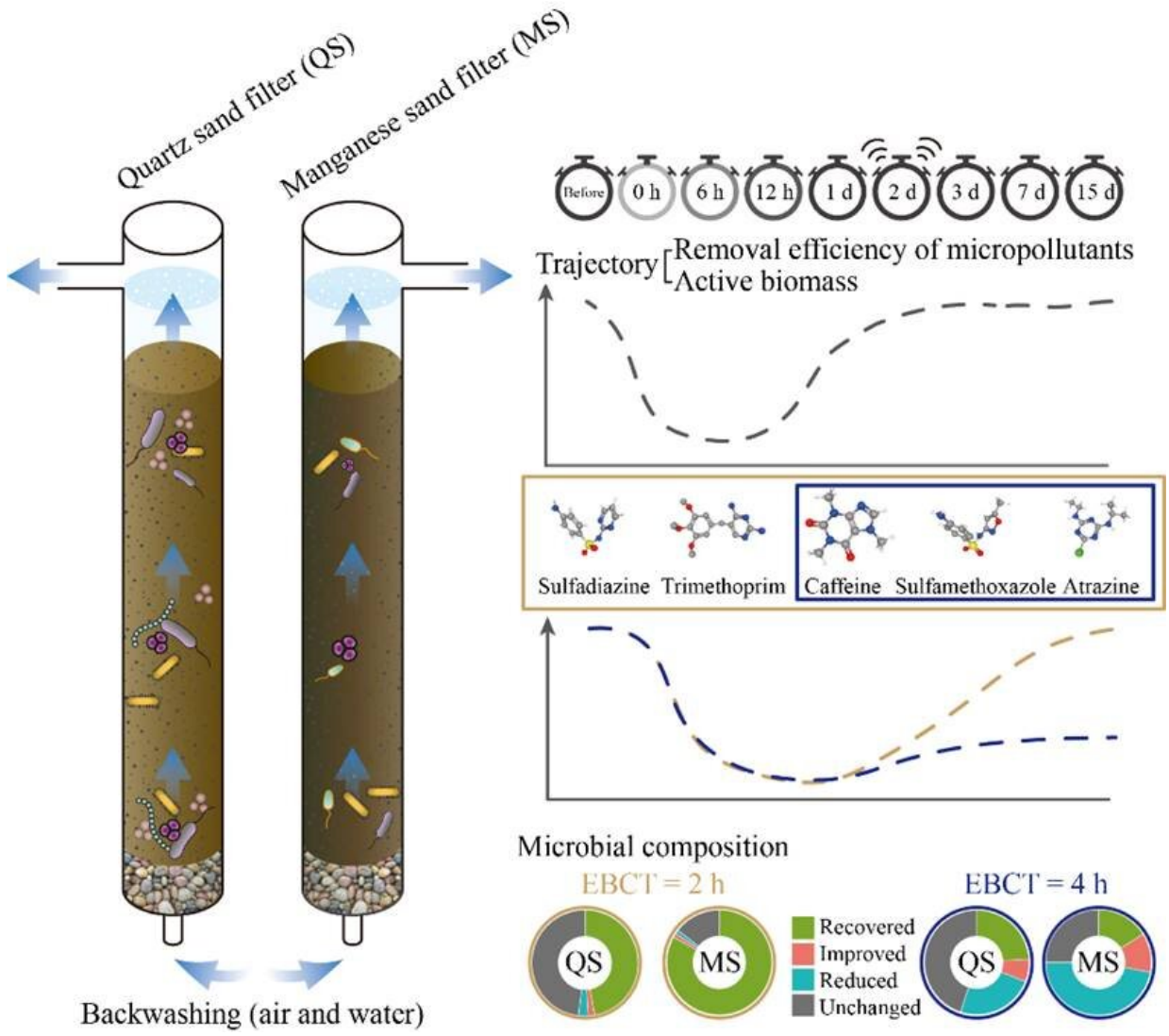
Backwashing affects the removal of micropollutants and the dynamic changes in the microbial community in sand filters

April 26 2023



None. Credit: Higher Education Press Limited Company

Sand filters are commonly applied in drinking water treatment and can efficiently remove suspended solids, organic matter, and microorganisms from source water. During the process, particulate matter and microbes can attach to filter sands and develop a thick biofilm in both rapid and slow sand filters. To prevent clogging and restore pollutant removal efficiency, backwashing using air, water, or a combination of both is usually required for sand filters.

However, backwashing can induce a loss in biomass, thus decreasing the pollutant removal efficiency of sand filters. Slow sand filters, whose empty bed contact times (EBCTs) are typically longer than one hour, have a higher removal efficiency of micropollutants than rapid sand filters, however, their clogging issues are more severe.

Slow sand filters can remove a fraction of the dissolved organic carbon, ammonium, and manganese through microbial transformation and degradation. Additionally, recent evidence suggests that some organic micropollutants can be removed by sand filters, which is at least partly attributed to the biofilm formed in the filter sands.

Owing to the limited micropollutant adsorption onto sand material, biodegradation of micropollutants by indigenous microbial populations is the most crucial removal mechanism of micropollutants in slow sand filters. During backwashing, the water and air used can expand the volume of the filter media, and thus strip and remove the biofilm from the filter sands. Therefore, biofilm formation occurs periodically in the slow sand filter, and microbial community dynamics are crucial for pollutant removal in the sand filter after backwashing. However, few studies have focused on microbial biofilm community dynamics after backwashing.

To solve this problem, Dr. Yaohui Bai from the Chinese Academy of Sciences and his team members have worked together to reveal the temporal dynamics of both the concentration of micropollutants and the microbial community after backwashing and to indicate the optimal intervals for backwashing slow sand filters for micropollutant removal. They conducted a laboratory column experiment to track the dynamics and resilience of the microbial biofilm community and the corresponding micropollutant removal after backwashing with slow sand filters.

Two types of filter materials, manganese and quartz sand filters, were used to fully compare the influence of backwashing on the microbial community in slow sand filters under two different empty bed contact times (EBCTs). The research team's study, titled "Impacts of backwashing on micropollutant removal and associated microbial assembly processes in sand filters," is published online in *Frontiers of Environmental Science & Engineering*.

In this study, the temporal dynamics of micropollutant removal and microbial community composition after backwashing were tracked, and the removal efficiencies of caffeine, sulfamethoxazole, sulfadiazine, trimethoprim, and atrazine gradually recovered within two days in both sand filters at two-hour EBCT, whereas declining trends in sulfadiazine and trimethoprim degradation were found at four-hour EBCT. After backwashing, the removal efficiency of atenolol in the manganese sand filter increased rapidly but remained at a high level (almost 100%) in the quartz sand filter for both EBCTs.

Correspondingly, the active biomass recovered within two days under all conditions. Microbial community composition gradually recovered to the pre-backwashing level at two-hour EBCT, and the recovered microbes accounted for 82.76 % ± 0.43 % and 46.82 % ± 4.34 % in the manganese and quartz sand filters, respectively, at two-hour EBCT. In

contrast, at four-hour EBCT, the community composition in sand filters did not recover to the pre-backwashing level (R

This study explored variations in micropollutant degradation and temporal dynamics of the microbial community after backwashing for the first time. It is indicated that a two-day optimal interval for the recovery of micropollutant removal after backwashing should not affect the operation of slow sand filters with a short EBCT. It has deepened our understanding of the effect of microbial biofilm community on the removal of pollutants in sand filter, and provides a new perspective for the removal of pollutants in drinking water.

More information: Donglin Wang et al, Impacts of backwashing on micropollutant removal and associated microbial assembly processes in sand filters, *Frontiers of Environmental Science & Engineering* (2022). DOI: 10.1007/s11783-023-1634-z

Provided by Higher Education Press