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The effect of unsteady streamflow and stream-groundwater interactions on oxygen consumption in a sandy streambed

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Abstract:
Streamflow dynamics are often ignored when studying biogeochemical processes in the hyporheic zone. We explored the interactive effects of unsteady streamflow and groundwater fluxes on the delivery and consumption of oxygen within the hyporheic zone using a recirculating flume packed with natural sandy sediment. The flume was equipped with a programmable streamflow control and drainage system that was used to impose losing and gaining fluxes. Tracer tests were used to measure hyporheic exchange flux and a planar optode was used to measure subsurface oxygen concentration patterns. It was found that the volume of the oxer zone decreased when the losing flux declined, and was drastically decreased when gaining conditions were applied. It was also found that unsteady streamflow led to a slight increase in the average volume of the oxic zone, compared to the average volume of the oxic zone under steady streamflow. However, the average oxygen consumption rates were significantly higher under unsteady streamflow compared to steady streamflow under all groundwater conditions with the exception of the highest losing flux. The present study provides the first insight into the interactions between streamflow unsteadiness and losing/gaining fluxes and improve understanding of their impact on microbial metabolism in the hyporheic zone.

Keywords: hyporheic zone, streamflow, exchange flux, subsurface oxygen concentration, planar optodes