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Accounting for Dispersion and time-dependent Input Signals during Gas Tracer Tests and their Effect on the Estimation of Reaeration, Respiration and Photosynthesis in Streams

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The variation of dissolved oxygen (DO) in streams, are caused by a number of processes, of which respiration and primary production are considered to be the most important ones (Odum, 1956; Staehr et al., 2012).

Measuring respiration and photosynthesis rates in streams based on recorded time series of DO requires good knowledge on the reaeration fluxes at the given locations. For this, gas tracer tests can be conducted, and reaeration coefficients determined from the observed decrease in gas concentration along the stretch (Genereux and Hemond, 1990):

$$k_2 = \frac{1}{t_2 - t_1} \ln \left(R \frac{c_{up}}{c_{down}} \right) \qquad (1)$$

with the gas concentrations measured at an upstream location, c_{up}[ML^{-3}], and a downstream location, c_{down}. t_1[T] andt_2 [T] denote the measurement times at the two locations and R [-] represents the recovery rate which can also be obtained from conservative tracer data.

The typical procedure for analysis, however, contains a number of assumptions, as it neglects dispersion and does not take into account possible fluctuations of the input signal. We derive the influence of these aspects mathematically and illustrate them on the basis of field data obtained from a propane gas tracer test. For this, we compare the reaeration coefficients obtained from approaches with dispersion and/or a time-dependent input signals to the standard approach. Travel times and travel time distributions between the different measurement stations are obtained from a simultaneously performed conservative tracer test with fluorescein.

In order to show the carry-over effect to metabolic rates, we furthermore estimate respiration and photosynthesis rates from the calculated reaeration coefficients and measured oxygen data.

This way, we are able to show that neglecting dispersion significantly underestimates reaeration, and the impact of the time-dependent input concentration cannot be disregarded either. When estimated reaeration rates are used to calculate respiration and photosynthesis from measured oxygen data, these effects carry over, leading to higher respiration rates for higher reaeration.

References:

Genereux, D. P., & Hemond, H. F. (1990). Naturally-Occurring Rn-222 as a Tracer for Streamflow Generation - Steady-State Methodology and Field Example. *Water Resources Research, 26*(12), 3065-3075. doi: Doi 10.1029/Wr026i012p03065

Odum, H. T. (1956). Primary production in flowing waters. *Limnol. Oceanogr, 1*(2), 102-117.

Staehr, P. A., Testa, J. M., Kemp, W. M., Cole, J. J., Sand-Jensen, K., & Smith, S. V. (2012). The metabolism of aquatic ecosystems: history, applications, and future challenges. *Aquatic Sciences, 74*(1), 15-29. doi: DOI 10.1007/s00027-011-0199-2