Quantifying groundwater inputs to the East River, CO using ^{222}Rn measurements and Xe reaeration

JOHN N. CHRISTENSEN[1*], ATE VISSER[2], ALEXANDER NEWMAN[3], EMILY BURT[4], MICHELE E. NEWCOMER[1], ROSEMARY W. H. CARROLL[6] AND KENNETH H. WILLIAMS[1]

[1]Lawrence Berkeley Natl. Lab, Berkeley, CA 94720 USA (*corespondance: jnchristensen@lbl.gov)
[2]Lawrence Livermore Natl. Lab, Livermore, CA 94550 USA (visser3@llnl.gov)
[3]Rocky Mt. Biol. Res. Lab., Crested Butte, CO 81224 USA (alexnewman760@gmail.com)
[4]Univ. of Southern Calif., Los Angeles, CA 90007 USA (eburt@usc.edu)
[6]Desert Reseach Inst., Reno, NV 89512 USA (Rosemary.Carroll@dri.edu)

Groundwater exports from alpine watersheds are a variable fraction of river flow through the water year and are important components of river discharge during low flow periods. During these periods, groundwater helps to maintain ecosystem health while also contributing dissolved metals and nutrients to rivers. Earlier, shorter, or attenuated peak snowmelt release may affect baseflow volume and timing through changes to groundwater recharge, and may affect water quality. Groundwater influx to streams is an important component of watershed models, however it can be difficult to quantify due to its distributed nature. ^{222}Rn, a noble gas with a half-life of 3.8 days, enters groundwater from the decay of rock/sediment-hosted ^{238}U, its ultimate parent. We use ^{222}Rn measurements of river water samples to quantify the flux of groundwater to reaches of the East River. To properly interpret ^{222}Rn concentrations, it is necessary to have knowledge of the Rn gas loss (reaeration) rate from the river, which is a function of hydrologic and geomorphic conditions. As an alternative to empirically based formulations to estimate gas exchange rates, we use controlled Xe tracer experiments in the river to measure reaeration directly [1] and relate the result to Rn loss in calculating groundwater inputs [2]. For two contrasting reaches of the river, we obtained Xe reaeration rates of 28 day^{-1} (relative low flow) and 65 day^{-1} (higher flow). Along with its use in ^{222}Rn interpretation, Xe measured gas exchange is also useful in constraining the budgets and modeling the behavior of N_2, CO_2, O_2 in the East River in support of the LBNL Watershed Function Science Focus Area (SFA).

[1] Benson et al. (2014) *Water* **6**:1013-1027. [2] Avery et al. (2018) *Water* **10**:100; doi:10.3390/w10020100.