A Model to Assess Groundwater Inflows to Lakes via a Rn-222 Mass Balance

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Radon in the water column of lakes can typically be derived from the following sources: production by decay of dissolved Ra-226 (parent of Rn-222); diffusion from sediments; inflow from streams or rivers (especially if these "surface" inputs are groundwater derived); and direct groundwater inputs. Losses of radon include radioactive decay; evasion to the atmosphere; and outflows of lake water either by surface flow or recharge to underlying aquifers. We have examined the radon budget of several small lakes in Florida and observed that inputs are often dominated by groundwater and losses via atmospheric evasion. This prompted us to develop a simple mass balance model to allow for rapid estimations of groundwater flow into lakes.

Our model requires the following assumptions: (1) the lake is well-mixed both horizontally and vertically; (2) the only radon inputs to the lake are by advection of groundwater and diffusion from sediments; and (3) the only losses of radon are via decay and loss to the atmosphere. Preliminary studies of several "seepage" lakes in Florida has shown that they are indeed well-mixed, i.e., no significant gradients in radon concentrations. The assumptions regarding inputs and outputs of radon also seem to hold, at least for lakes without significant surface water inflows or outflows.

In order to evaluate the groundwater-derived radon flux, we monitor the Rn concentration in lake water over time for a period long enough (usually 1-3 days) to observe changes likely caused by variations in atmospheric exchange (primarily a function of wind speed). We then attempt to reproduce the observed record by accounting for decay and atmospheric losses and by evaluating the total Rn flux using an iterative approach. Once the Rn flux is evaluated, we estimate groundwater discharge by dividing this value by the measured groundwater radon concentration.

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