Evaluation of Submarine Groundwater Discharge along the Gulf Shores of Alabama
Using Coupled Numerical Modeling and $^{222}$Rn Mass-balance Methods

It has been recognized that submarine groundwater discharge (SGD) may be one of the principal mechanisms for delivering nutrients to surface water bodies. A multifaceted study of the coastal aquifers of Gulf Shores, Alabama was conducted to assess SGD fluxes and associated nutrient loading to coastal areas by utilizing a three-dimensional density-dependent numerical model combined with field-based radon ($^{222}$Rn, $t_{1/2}$=3.82 d) isotopic tracer techniques. Two numerical SGD methods were developed to determine localized and entire-shoreline SGD after calibration from the radon lake seepage flux. The radon method utilizes a mass-balance approach where the main assumption is that an excess radon flux detected in surface waters is due to groundwater discharge. To constrain the groundwater end-member in the model, fifty groundwater samples from 32 wells from different depths within the study area were collected. An analysis of the data shows that the radon concentrations in groundwater from the A1 and A2 Aquifers are statistically identical, an indication for direct connection between the two aquifers. Groundwater seepage calculated through the radon mass-balance model resulted in a maximum groundwater flux to Lake Shelby of 18.3 cm/day, which was used to calibrate the numerical model surficial aquifer zone. Final shoreline seepage fluxes of 6.41 and 8.62-cm/day were obtained for the multi-cell and shoreface numerical model techniques, respectively. The two numerical SGD methods display a reasonable agreement with the $^{222}$Rn-derived methods, and provided an effective approximation technique that can be inexpensively duplicated in other similar shoreline areas.

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