

Stable Isotope Mixing Models as a Tool for Tracking Sources of Water and Water Pollutants

One goal of monitoring pollutants is to be able to trace the pollutant to its source. Here we review how mixing models using stable isotope information on water and water pollutants can help accomplish this goal. A number of elements exist in multiple stable (non-radioactive) isotopic forms that differ in the number of neutrons in the nucleus, e.g., ^{14}N and ^{15}N , ^{16}O and ^{18}O , ^2H and ^1H . Various physical, chemical, and biological processes operate at slightly different rates on molecules containing these “light” and “heavy” isotopes because of their differences in mass. As a consequence, different materials (e.g., fertilizer versus manure sources of nitrate, precipitation versus groundwater sources of water) often have distinctive isotopic compositions that can be useful for environmental tracking. One common use of this isotopic information is in quantifying the contributions of multiple sources to a mixture, using isotope data along with available chemical data. Given the isotopic compositions of the sources and the mixture, isotopic mixing models can be used to calculate the relative source proportions. We will review basic mixing models, how they work, and their further development over the last decade. To demonstrate how they may be helpful in water quality monitoring, we will discuss several examples of their application to quantifying water sources to stream flow and nutrient sources to nutrient loads in water bodies.

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