A Multi-Tracer Approach for Determining Sources of Nitrate Contamination of Ground Water and Springs, Lafayette County, Florida

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Wastes from animal farming operations (milk and beef cows, poultry, and swine) can potentially contribute large quantities of nitrogen (N) to ground water in Lafayette County, a rural area in northern Florida and one of the leading producers of milk and broiler chickens in Florida. During 1955-95, N inputs estimated from animal wastes (not corrected for losses due to volatilization and waste-handling practices) accounted for 28 to 53 percent of the estimated total N inputs (1.4 to 4.6 million kilograms per year) from all sources of N (fertilizers; atmospheric deposition; wastes from cows, poultry, and swine; and septic tanks). A multi-tracer approach, which consisted of the analysis of spring-water and shallow ground-water samples for naturally occurring chemical and isotopic tracers ($\delta^{15}N$, $\delta^{18}O$, δD, $\delta^{13}C$, CFCs, tritium) was used to determine sources and chronology of nitrate contamination of ground water in Lafayette County and other parts of the Suwannee River Basin. Water samples from six springs in Lafayette County [flows greater than 280 liters per second (L/s)] had $\delta^{15}N\text{-}NO_3$ values ranging from 5.4 to 9.1 per mil, likely indicating a mixture of inorganic and organic sources of nitrogen. Nitrate-N concentrations in spring waters ranged from 1.7 to 5.5 milligrams per liter (mg/L). Springs integrate ground water from large parts of the aquifer and mixing of waters from various convergent flow paths is reflected by the separation in apparent ages determined from measured concentrations of CFC-11 and CFC-113. Estimated residence times for ground water discharging to springs range from 15 to 77 years, based on CFC concentrations and the use of different flow-system models. Increases in nitrate concentration in water samples from Troy Spring (flow greater than 2,800 L/s) during 1960-98 track the increase in estimated fertilizer N inputs through the early 1980's followed by the increase in estimated N inputs from animal wastes during the mid-1980's to 1998.

In contrast, water from wells in the Upper Floridan aquifer (sampled zones were 7-13 meters (m) and 26-32 m depth below land surface) had $\delta^{15}N\text{-}NO_3$ values of 10.2 to 12.8 per mil, indicating an organic source of N. Ground-water ages ranged from 8-16 years based on measured CFC-113 concentrations and a piston-flow model. Nitrate-N concentrations in ground water were 18-20 mg/L during low-flow conditions (July 1997) in the Suwannee River, but decreased to 10-13 mg/L after a period of prolonged rainfall (March 1998). Slightly elevated concentrations of N_2 gas indicate that denitrification reactions may account for some of the decrease in NO_3 concentrations during high-flow conditions. Future studies in this area would benefit from the analysis of animal pharmaceuticals and their metabolites in ground water in an attempt to discriminate among various animal-waste sources of nitrogen, which cannot be done using nitrogen-isotope data alone.

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