Nitrate, a critical agricultural nutrient, is a common groundwater contaminant across Wisconsin. Analysis conducted over the past decades in Dane County, Wisconsin, indicate that roughly 25 percent of private, domestic wells contained nitrate in excess of the state and federal drinking water standard of 10 ppm. As an nitrogen — well above Wisconsin’s statewide average of 5 ppm. While nitrate contamination is widespread, it is often challenging to quantify its spatial and temporal distribution. This is partly because it is difficult to track the fate and transport of such non-point source groundwater contaminants. Our research seeks to improve our understanding of the spatial and temporal distributions of nitrate in groundwater by combining GIS mapping, groundwater modeling, and statistical analysis. Using historical databases, we compiled approximately 67,000 private nitrate analyses from Dane County and evaluated them spatially using ArcGIS. The distribution of all groundwater nitrate concentrations was evaluated based on sampling date and location. A trend of nitrate, which is expected to increase, was observed across all periods of time.

Methods

1. Collection of a groundwater nitrate database: The database consists of 38,000 records, including historical nitrate analyses from private and public wells, and newly collected water samples from private homeowners. Roughly 25,000 records contained detailed well information, including well identification, depth to water table, and depth to water table.

2. GIS-based analysis of well nitrate records to identify spatial and temporal trends.

3. Groundwater modeling and particle-tracking analysis to estimate the travel time and source of groundwater.

4. Statistical modeling of nitrate concentrations across time to estimate historical nitrate loading to the groundwater system. Well nitrate data and modeled groundwater age suggest that spatial trends of nitrate concentrations are largely influenced by groundwater flow. Trends observed over the past 20 years, as documented in Figure 12, suggest that although maximum nitrate concentrations appear to be decreasing, minimum background concentrations continue to rise, leading to an increased equilibrium level of nitrate in groundwater. This trend closely mirrors the historical pattern of nitrogen fertilizer use in Dane County since the 1940s. If reduced nitrate loading was to occur, areas with younger groundwater may show faster nitrogen concentrations decreasing than areas with older groundwater where nitrate has accumulated over time.