Title: **Sources and Extent of Atrazine Contamination of Groundwater at a Grade A Dairy Farm in Dane County, Wisconsin**

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Background/ Need: Groundwater quality surveys by the Wisconsin Department of Agriculture, Trade and Consumer Protection (DATCP) have indicated widespread contamination of private drinking water wells by atrazine residues. Several questions remain unanswered: does atrazine contamination result from point or nonpoint source; is it the result of applications when use was more widespread and application rates were generally higher; and what is the extent of contamination at a site where atrazine is found in a single drinking water well. Little site-specific atrazine research has thus far been performed outside the lower Wisconsin River valley and the sand plains of central Wisconsin. Concern over the extent of contamination by potentially harmful atrazine metabolite residues and lack of understanding of what circumstances contribute to metabolite contamination also prompted this research.

Objectives: 1) To investigate and characterize the extent and distribution of atrazine and metabolite residues in shallow groundwater overlying a bedrock aquifer over a 2-year period by observing their spatial and temporal patterns. 2) To determine whether the contamination is mainly due to point or nonpoint sources and whether the concentrations display a seasonal variability that can help establish the time of transport through the unsaturated zone. 3) To predict the time of transport of atrazine residues through the groundwater system and relate residue concentrations to groundwater residence times.

Methods: The site selected was in the vicinity of the private well which had the highest measured groundwater concentration of atrazine in Dane County. The shallow aquifer in the study area is a sandy-loam glacial till underlain by Cambrian sandstone and overlain by silt loam soils. In a 4.1 km^2 area, 55 groundwater sampling points were installed at 25 locations. Nested piezometers and multilevel samplers were used to measure water quality with depth. The private well at the site was also monitored. Samples were taken either monthly or bimonthly and were analyzed for atrazine and metabolite concentrations. Five additional private wells in the area were tested three times. Samples were also periodically checked for nitrate, chloride, specific conductivity, temperature, dissolved oxygen, pH, P, K, Ca, Mg, S, Zn, B, Mn Fe, Cu, Al and Na. Water-levels were measured to determine hydraulic gradients. Hydraulic conductivity and discharge rates into Six-mile Creek were estimated by slug tests. Soil samples were taken for atrazine and metabolite residue analysis to help determine relative mobilities of the compounds and rates of transport to the water table. Water samples were analyzed for tritium content to help verify the residence times predicted by hydraulic gradient and conductivity measurements.

Results: Atrazine residues were detected at 19 of the 25 piezometers and at 5 of the 6 private wells monitored in the area. Desethylated atrazine was the only atrazine metabolite detected in quantifiable amounts and occurred at 19 of the 25 monitoring well locations and 4 of the 6 private wells. Highest atrazine and metabolite concentrations were found near an equipment shed and the area where pesticide handling is most likely to occur. The ratio of metabolite to parent compound concentrations was lowest at that site. Total atrazine and metabolite concentrations were generally < 1.0 ppb, with metabolite:parent compound ratios generally > 1. At some water-table wells with shallow depths to groundwater, evidence exists that pesticide fronts arrive 3 to 7 months after pesticide application. Where downward vertical hydraulic gradients exist, the travel time and the zones of contribution to various monitoring wells was predicted, indicating that the zones of contribution to many wells are very small. Small zones of contribution were also indicated by water chemistry similarities between groundwater and nearby standing surface water and a septic field. Time of travel predictions and tritium analyses indicate that water at many contaminated wells may be a decade or more old. Concentrations of atrazine and desethylated atrazine decrease with time spent in the aquifer. The metabolite:parent compound concentration ratio increases slightly with time of travel in groundwater.

Conclusions/ Implications/ Recommendations: Although some evidence of point-source pollution exists, most groundwater residues detected probably result from normal field applications. Contaminant distribution reflects pesticide application practices by the three farmers in the area. Though the metabolite:parent compound concentration ratio indicates that some atrazine is being degraded to desethylated atrazine, dilution through dispersion is probably the dominant cause of atrazine (and metabolite) dissipation. If the distribution and extent of contamination at this site is typical of other areas of Wisconsin, revising groundwater standards for total atrazine to include metabolite concentrations will lead to a dramatic increase in the number of groundwater standard violations due to the widespread occurrence of desethylated atrazine in groundwater at concentrations most often exceeding those of the parent compound. Regulatory agencies should be prepared to take appropriate action. It may be many years before the effect of reduced application rates or atrazine bans will be noticeable. The efficacy of atrazine use restrictions may not be measurable in the first few years after policy implementation. The domestic well at the center of this site was probably contaminated in part from pesticide handling near the well. Atrazine use restrictions will not contribute to a lessening of such point-source contamination problems. Further investigations are needed to determine how many private wells have been contaminated by point vs. nonpoint sources.

Related Publications:

Levy, J., G. Chesters, H.W. Read, and D.P. Gustafson (1991). Atrazine breakdown, movement and the importance of metabolites. Proceedings of the 1991 Fertilizer, Aglime and Pest Management Conference, Madison, WI, p. 115-126.

Key words: atrazine, metabolites, desethylated atrazine, glacial sediments

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Project Report: A report on this project is available for loan from Wisconsin's Water Library, University of Wisconsin - Madison, 1975 Willow Drive, Madison, Wisconsin 53706.