A GEOCHEMICAL STUDY TO DETERMINE THE SOURCES OF NITRATE IN THE GROUNDWATER OF SUFFOLK COUNTY, LONG ISLAND, NY

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Introduction

Groundwater is the only source of potable water in Suffolk County, Long Island, NY. Nitrate-nitrogen levels have become a concern due to the urbanization of Long Island. In 1998, 12 % of wells tested were greater than 10 ppm nitrogen as nitrate and 7.4% of private wells tested (1972-1994) showed levels greater than10 ppm. Drinking water with nitrate concentrations above this limit can be toxic to young infants leading to the blood disorder methemoglobinemia or blue baby syndrome. Ten ppm nitrogen as nitrate is currently the standard for drinking water. The most cost efficient way to prevent nitrate contamination is to determine its source and reduce it there. This study is evaluating possible geochemical tracers to determine if the nitrate in the groundwater is due to turf grass fertilization (organic or chemical) or wastewater derived via cesspool leaching or sewage treatment plant effluent. Other possible sources leading to excess nitrates include past or present agriculture land use, landfill leaching and acid rain.

Possible tracers that may help determine the sources of excess nitrates include boron, carbon and nitrogen isotopes, boron concentrations, halide ratios, as well as some major cations and metal complexes. Nitrate is an anion thought to be conservative in groundwater, that is it is not retarded by or sorbed onto minerals as it travels with the groundwater. Thus, the best elements to use as tracers are other conservative elements that travel along with the nitrate from its source. Boron, chloride, bromide and iodide are also thought to be conservative. Boron isotopes have been useful in determining anthropogenic influences on the groundwater (Barth, 1998; Barth et al., ; Bassett et al., 1995; Eisenhut and Heumann, 1997; Leenhouts et al., 1998; Vengosh, 1998; Vengosh et al., 1999; Vengosh et al., 1994).

Boron is suited for use as a conservative tracer because of its high solubility in aqueous solution, presence in nearly all water, and its insensitivity to evaporation, volatilization, oxidation-reduction reactions, or mineral precipitation or dissolution in all but extremely saline water.

Chloride, bromide and iodide are believed to be among the most conservative of groundwater constituents and therefore reflect water origins with less ambiguity than other dissolved species. Chloride to bromide and iodide ratios have proven useful in other groundwater studies such as Davis et al., 1998; and Fabrykamartin et al., 1991.

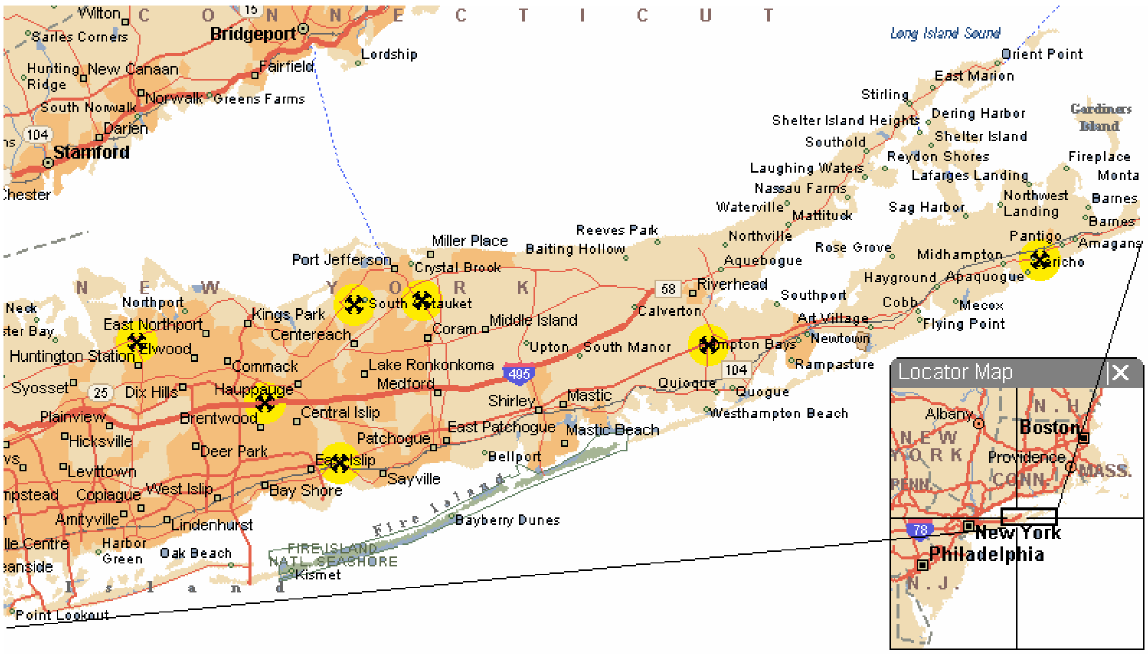
Bleifuss *et al.*, 2000 utilized nitrogen and oxygen isotopes in nitrate and major cations to distinguish between residential and agriculture land use in Long Island

Methods

To evaluate the long term effects of various lawn maintenance procedures lysimeters (soil water samplers) have been installed in maintained lawns at eight locations; Figure 1, to depths up to 150cm, throughout Suffolk County. Two of these locations are undergoing chemical turf grass treatment while the other six are treated organically. Chemical sites are treated by either Scotts® brand fertilizers or LESCO® Brand. Treatment of Scotts® brand fertilizers began in 2000 by Schuchman, 2001 on new sod. The other sites are lawns established at least 10 years ago.

Treatment of LESCO® Brand fertilizers commenced in 2003 with a granular grade fertilizer. Organic treatment is maintained by a contract landscaper utilizing athletic turf mix composed of compost, lime and a granular fertilizer Pro-Grow manufactured by North County Organics. Treatment started in spring of 2002. Fertilizer regimes are representative of typical applications on Long Island. Soil water samples from lysimeters are acquired monthly.

Figure 1: Turf grass sites in Suffolk County



Water samples from cesspools and sewage treatment plants (STP) are being acquired through Suffolk County Public Works. Cesspool samples are from both residential and industrial sources. Currently 1/3 of the Suffolk County population is served by cesspool systems. One hundred and sixty seven sewage treatment plants are in operation in Suffolk County. They range in size, treatment and disposal method. All plants perform secondary treatment of waste and most denitrify waste before disposal. A majority of these plants dispose their effluent to the groundwater while 15 dispose their effluent to surface waters. Sewage treatment plants generally serve a limited clientele such as a housing community, a shopping mall, a college, a nursing home or a small community.

Early Results

Presented here are data on vadose zone samples influenced primarily by chemical or organic turf grass fertilization and residential cesspool samples. Figure 2 exhibits the distribution of soil water and residential waste on a ternary plot. These fields are similar to (Bleifuss et al., 2000) with residential having higher sodium and potassium concentrations and lower magnesium concentrations. Our samples represent sources while Bleifuss plotted groundwater samples from previous studies. The residential field in her study includes more than wastewater but runoff as well. These similarities of our study to hers show that although cations tend to bind to soil and organic particles the fields do not change significantly from the source with depth.

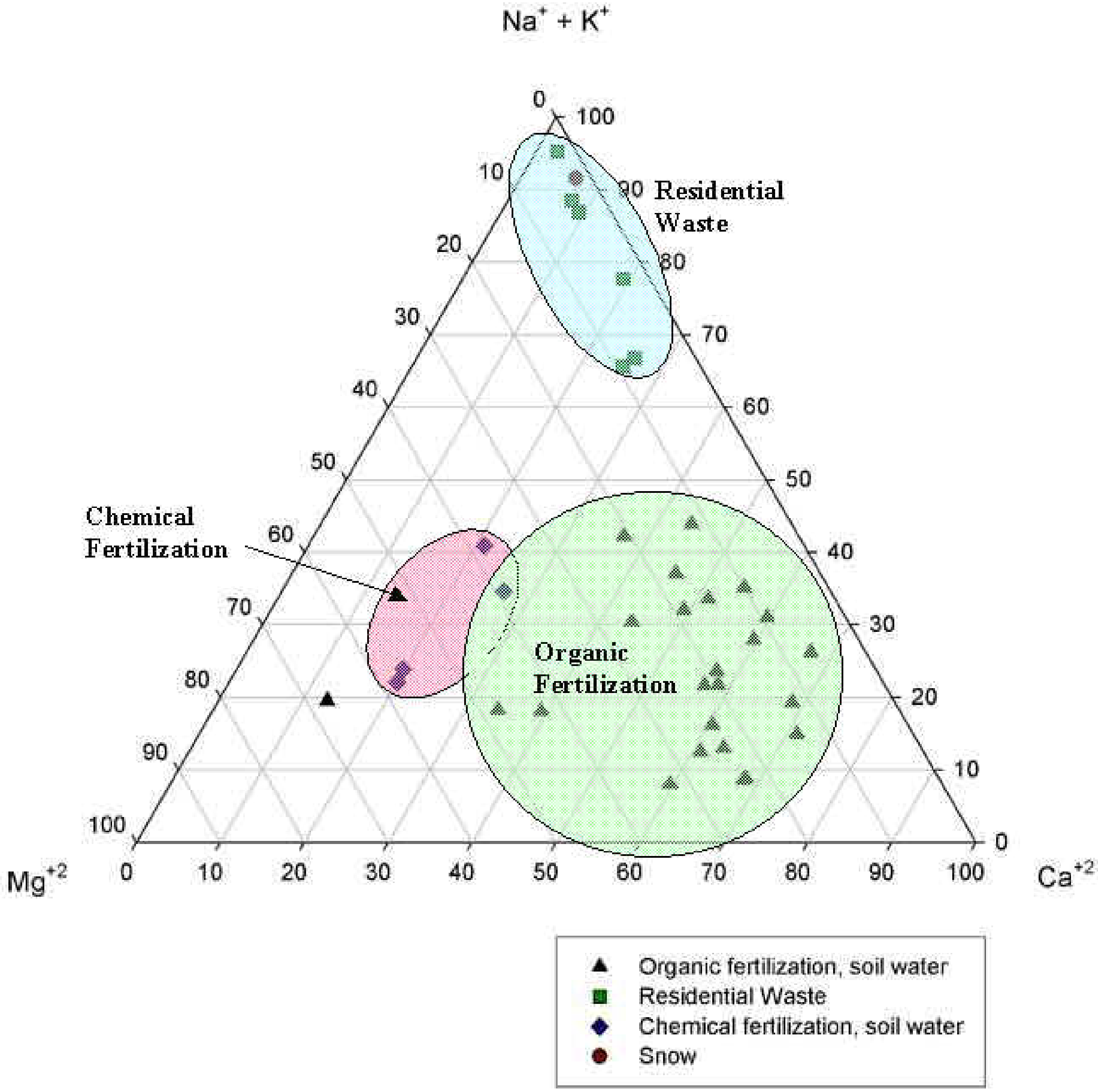


Fig. 2 Ternary plot of Na + K, Mg and Ca for soil water and residential waste water.

Figure 3 is a plot of boron versus phosphorous concentration for soil water and residential waste, the residential waste water has much high phosphorous concentrations. The fate of phosphate has been studied by (Harman et al., 1996; Schuman, 2001). They concluded that phosphorus will migrate in a sewage plume once the soil is saturated or the extractable phosphorous levels are high. In golf greens phosphorous mobility was clearly affected by the rate of application of fertilization.

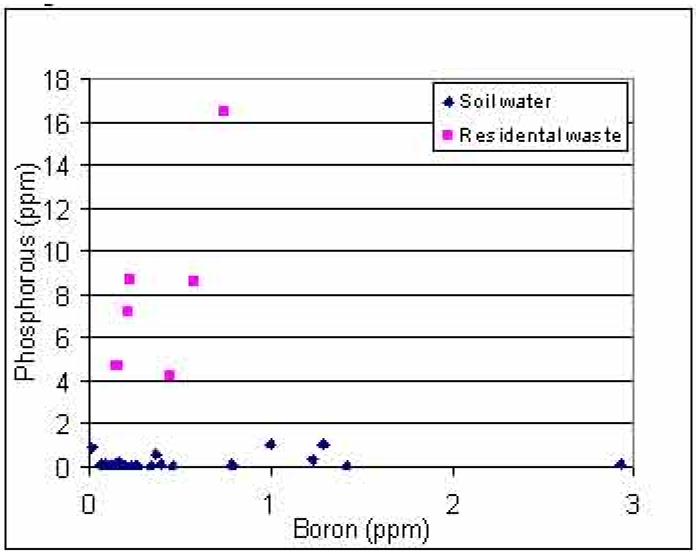


Fig. 3 Boron vs phosphorous concentrations for soil water and residential waste water.

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