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Groundwater Vulnerability Assessments: Prioritizing Water Safety in Times of Austerity

Mansoor A. Baloch, PhD, LEED-AP, EIT

Private Wells—Public Health Risks

For communities using private or unregulated drinking water wells, groundwater vulnerability to microbial contamination poses a significant public health risk. Historically, a significant number of drinking-water-associated waterborne illness outbreaks and contamination events have been attributed to unregulated water systems (Craun & Calderon, 2003; DeSimone, Hamilton, & Gilliom, 2009; Yoder et al., 2008). Although many environmental health programs are required to inspect and test private wells only at the time of permitting (when a new well is constructed or repaired), illnesses and problems associated with these systems constitute a major part of water safety initiatives pursued by these programs.

In the wake of government austerity measures, many environmental health permitting programs will curtail services associated with private wells. In its efforts to support local environmental health programs, the Centers for Disease Control and Prevention's Environmental Health Specialists Network (EHS-Net) Water Program has developed a groundwater vulnerability assessment tool, Land-use Hydrology and Topography (LHT), piloted in 18 counties in the state of Georgia to assess the effectiveness of this approach for identifying unregulated wells for prioritized intervention (Baloch & Sahar, 2011). This column presents a case for using a groundwater vulnerability mapping approach to prioritize intervention programs for those private or individual wells most vulnerable to contamination.

Groundwater Vulnerability Assessment Approach

The U.S. Environmental Protection Agency (U.S. EPA) defines a public water system (PWS) as a water system serving a minimum of 15 connections or 25 persons for at least 60 days in a year (U.S. EPA, 2003 U.S. EPA, 2004). Unlike unregulated or private wells, wells supplying water to PWSs are protected by state wellhead programs (WHPs). These programs provide a localized approach to protection by focusing on the critical surface and subsurface areas surrounding a well connected to the PWS known as wellhead protection areas (WHPAs). This exact approach is not a viable option for unregulated or private wells because identifying and delineating WHPAs for every private well in a jurisdiction is not practical given the large number and sparse locations of these systems. Furthermore, budget

Corresponding Author: Mansoor A. Baloch, Consultant Hydrologist/Environmental Engineer, EEHS/NCEH, 4770 Buford Highway, MS F58, Atlanta, GA 30341. MBaloch@cdc.gov.

cuts across government agencies necessitate sound planning and project prioritization to direct limited funds available for environmental health programs to projects that can have the most positive public health impacts. Elements of the WHPs can be adapted, however, to a groundwater vulnerability approach to help identify, priori-tize, and protect private wells in contamination-prone areas.

Groundwater vulnerability or susceptibility is a system property that refers to "groundwater sensitivity to contamination and describes the relative tendency or likelihood for contaminants to reach a specified position in the ground water system after introduction at some location above the uppermost aquifer (Ligget & Talwar, 2009; National Research Council, 1993)." A groundwater vulnerability assessment approach may help prioritize groundwater protection measures and direct limited resources to the most vulnerable locations for further investigation, protection, and monitoring. Groundwater vulnerability assessments use a systems theory approach that considers the entire watershed hydro-logic system to understand the influences of variability in the watershed conditions and events on the groundwater. This approach can thus identify the root causes leading to contamination of the groundwater system.

With the use of GIS, complex hydrogeological and environmental data are processed to create a single vulnerability map by using an index and overlay method. Such methods are well suited to produce regional scale screening tools for use in decision making and for prioritizing focus areas and site assessments. In a GIS, digital data layers of variables of concern are rated and assigned weights and then combined into a vulnerability score (Rahman, 2008). Based on the score, a given study area is classified into contamination risk categories (e.g., high, medium, and low) depicting the relative vulnerability of groundwater in that region on a simple map (Figure 1). Vulnerability maps are inexpensive to produce, easy to implement, and often use readily available data. Furthermore, a vulnerability map is easy to understand and can be used as a powerful educational tool for raising public awareness about groundwater contamination issues (Ligget & Talwar, 2009).

Summary and Further Information

Groundwater vulnerability assessments provide meaningful tools to identify areas that are more likely than others to become contaminated. Such tools are particularly relevant in the absence of site-specific monitoring and process-based evaluation. With budget reductions, environmental health practitioners can use vulnerability assessment maps to identify areas for prioritized intervention. This information can also be used during water outbreak investigations as an indicator in the environment for possible sources of contamination and may assist in tracing back to identify the source of the outbreak.

EHS-Net Water Program's LHT, a groundwater contamination vulnerability assessment tool, can be replicated and used in other areas of the country. Further details regarding the LHT tool, its input data requirements, and technical support can be obtained by contacting the EHS-Net Water Program at CDC (www.cdc.gov/nceh/ehs/ehsnet/).

Biography

Mansoor A. Baloch

References

Baloch, MA.; Sahar, L. Environmental vulnerability assessment tool development for water pollution. Paper presented at URISA GIS in Public Health Conference; Atlanta, GA. 2011 Jun.

Craun, GF.; Calderon, RL. Waterborne outbreaks in the United States, 1971–2000. In: Pontius, FW., editor. Drinking water regulations and health. New York: John Wiley & Sons; 2003. p. 40-56.

DeSimone LA, Hamilton PA, Gilliom RJ. The quality of our nation's waters: Quality of water from domestic wells in principal aquifers of the United States, 1991–2004—Overview of major findings. US Geological Survey Circular. 2009; 1332 Retrieved from http://pubs.usgs.gov/circ/circ1332/includes/circ1332.pdf.

Liggett JE, Talwar S. Groundwater vulnerability assessments and integrated water resource management. Streamline Watershed Management Bulletin. 2009; 13(1):18–29.

National Research Council. Ground water vulnerability assessment: Predicting relative contamination potential under conditions of uncertainty. Washington, DC: National Academies Press; 1993.

Rahman A. A GIS based DRASTIC model for assessing groundwater vulnerability in shallow aquifer in Aligarh, India. Applied Geography. 2008; 28(1):32–53.

U.S. Environmental Protection Agency. Small systems guide to Safe Drinking Water Act regulations. 2003. Doc. No. EPA 816-R-03-017Retrieved from http://www.epa.gov/ogwdw/smallsystems/pdfs/guide_smallsystems_sdwa.pdf

U.S. Environmental Protection Agency. Understanding the Safe Drinking Water Act. 2004. (Doc. No. EPA 816-F-04-030)Retrieved from http://www.epa.gov/ogwdw/sdwa/pdfs/fs_30ann_sdwa_web.pdf

Yoder J, Roberts V, Craun GF, Hill V, Hicks LA, Alexander NT, Radke V, Calderon RL, Hlavsa MC, Beach MJ, Roy SL. Surveillance for waterborne disease and outbreaks associated with drinking water and water not intended for drinking—United States, 2005–2006. Morbidity and Mortality Weekly Report Surveillance Summaries. 2008; 57(SS09):39–62. [PubMed: 18784643]

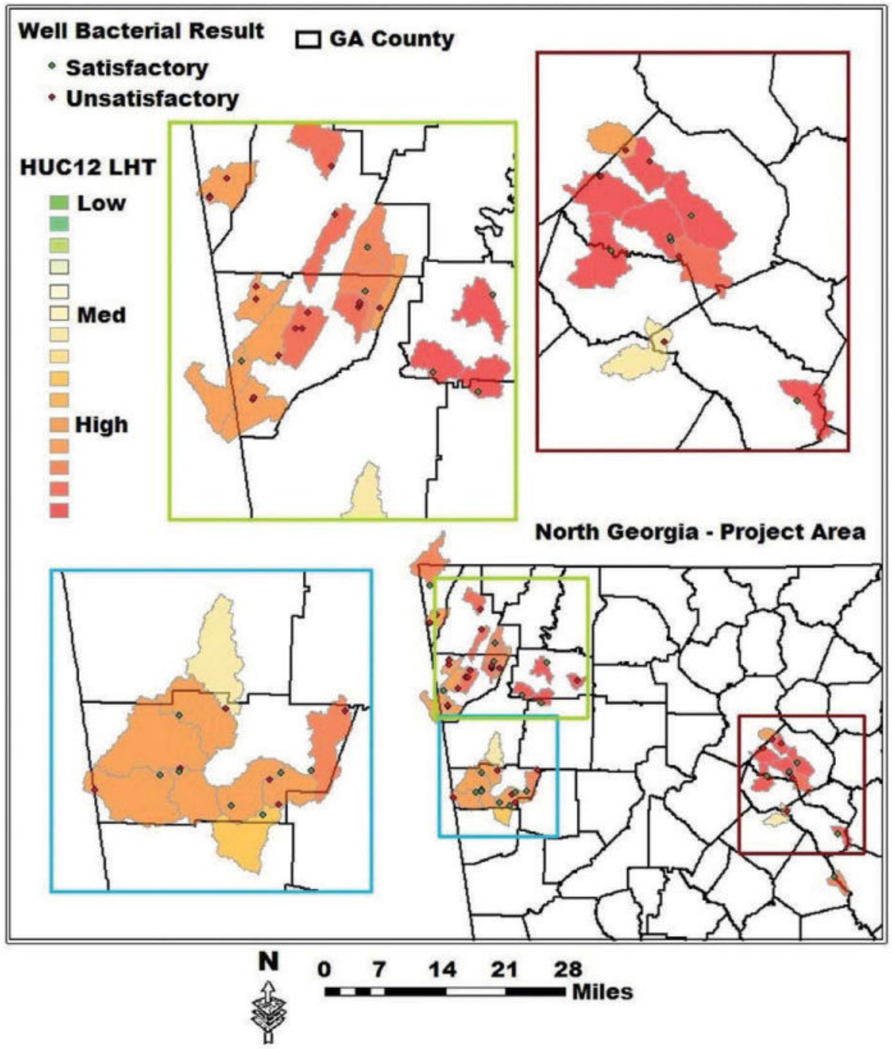
Editor's Note

NEHA strives to provide up-to-date and relevant information on environmental health and to build partnerships in the profession. In pursuit of these goals, we feature a column from the Environmental Health Services Branch (EHSB) of the Centers for Disease Control and Prevention (CDC) in every issue of the *Journal*.

In this column, EHSB and guest authors from across CDC will highlight a variety of concerns, opportunities, challenges, and successes that we all share in environmental public health. EHSB's objective is to strengthen the role of state, local, tribal, and national environmental health programs and professionals to anticipate, identify, and respond to adverse environmental exposures and the consequences of these exposures for human health.

The conclusions in this article are those of the author(s) and do not necessarily represent the views of CDC.

Mansoor Baloch is a consultant hydrologist/environmental engineer with the Environmental Health Specialists Network (EHS-Net) Water Program at EHSB. He has more than 10 years of research and program experience in water resources management, water quality, and environmental engineering.



HUC = hydrologic unit code.

FIGURE 1.

Land-Use Hydrology Topography (LHT) Model Results Identifying Groundwater Vulnerability to Microbial Contamination in Subwater-sheds of Pilot Counties in North Georgia (Baloch & Sahar, 2011)