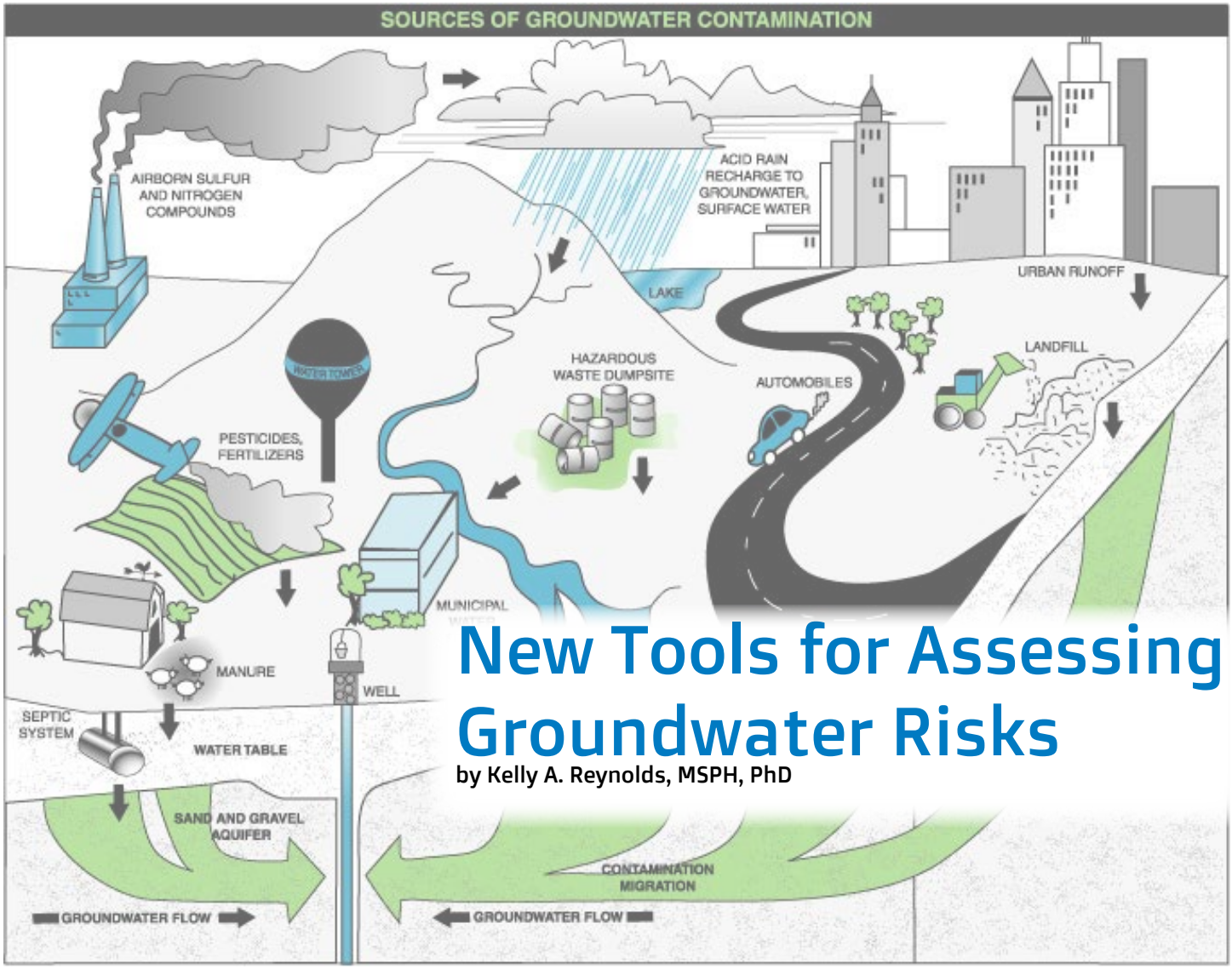

New Tools for Assessing Groundwater Risks

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Groundwater is often thought of as being protected, pristine and the perfect private water source. Contaminant sources, including septic tanks, storage tanks, hazardous waste manufacturers, landfills and environmental runoff (i.e., road salts, fuel residual, etc.) commonly impair groundwater quality, leading to both acute (respiratory and stomach ailments) and chronic (cancer, nervous system problems, reproductive and developmental disorders) human health effects. Researchers, municipalities and regulators recognize groundwater vulnerability and are working collectively to develop better monitoring and management tools, some of which might utilize your own cell phone.

Reducing Outbreaks in Municipal Sources

History has shown that groundwater is not free of microbial contaminants. In the most recent waterborne outbreak report from the Centers for Disease Control and Prevention (CDC), groundwater accounted for 34.4 percent (n=32) and over half of the cases of illness (n=431) from 2011-2012. Drinking untreated groundwater was the second most common cause of the outbreak and the number-one predominant source of illness cases.

Promulgation of the Groundwater Disinfection Rule in 2006 is credited with increased protection against microbial pathogens and an overall decrease in groundwater associated outbreaks. Annualized cost benefits are estimated at a range of $10 M to $19.7 M (USD) and the prevention of 42,000 cases of illness from rotavirus and echovirus alone.[1] Given that the rule only applies to public systems with groundwater sources or mixed groundwater and untreated surface-water sources, private groundwater supplies remain at risk. Deficiencies in private water supplies are increasingly reported as sources of illness in the CDC outbreak database.

Groundwater Outbreaks—Private Wells

From 1971-2008, private wells were responsible for 67 percent (n=40) of reported outbreaks from groundwater.[2] Cross contamination with septic system wastes due to poor design, maintenance or improper spacing is listed as the primary cause. US EPA provides guidance to homeowners on proper home septic maintenance and design. Nearly one in four US homeowners practice on-site, decentralized septic treatment and approximately 10-20 percent of these systems are estimated to function improperly, resulting in environmental pollution and public health risks.[3]

Vulnerabilities of the groundwater supply are also apparent in regions where hydrogeologic conditions allow for more rapid transport of

contaminants through the soil profile, reaching the groundwater aquifers. Porous media (i.e., karst limestone) accounted for 26.2 percent (n=45) of private well outbreaks from 1971-2008. Contaminant transport is enhanced further by heavy rainfall or flooding events, contributing to 21 percent of the reported groundwater outbreaks.

Changing conditions that impact public health relative to groundwater quality are difficult to monitor and control outside of a municipality, leaving private well-water consumers at increased risk. Improvements in tools to assess and predict groundwater impairment is essential in reducing future outbreaks and chemical exposure events.

Treatment options

The Groundwater Disinfection Rule provides a means for assessing contamination potentials in groundwater sources by guiding municipalities through a process of surveying sanitary impact to drinking-water supplies. Primarily, treatment is focused on protecting consumers against microbial contaminants. Chemical contaminants may result from direct or indirect pollution sources and may be natural or introduced. Successful risk management approaches may include limiting use of a supply until contaminant levels naturally dilute or degrade. Other management goals may require large-scale contaminant removal. Common clean-up methods include pumping and treatment of the groundwater, installation of in-situ filters or reactive materials aimed at specific contaminant removal and the use of active biological cultures capable of degrading or immobilizing contaminants. This process is known as bioremediation.

All groundwater remediation processes are costly. Thus, incentives to prevent contamination from occurring are the preferred risk-management approach. US EPA provides federal oversight on environmental contamination, pollution prevention and remediation. Legislation such as the Water Pollution Control Act, the National Environmental Policy Act, the Comprehensive Environmental Response, Compensation and Liability Act and the Resource Conservation and Recovery Act provides enforceable regulations aimed at source drinking-water protection.

Pollution tracking and assessment

Tools in risk-assessment modeling enable experts to evaluate the vulnerability of groundwater supplies by considering contaminant levels, nearby pollutant sources (i.e., landfills, manufacturing, etc.), contaminant degradation, transport timelines and other critical parameters. Recently this type of tool was applied to assess levels of concern for 30 landfill sites in New Jersey, all of which are no longer in service.[4] A risk model was used to screen landfill sites, looking at specific characteristics of each site and ranking them by level of concern that ranged from high, moderate and low relative to their likelihood of being a source of groundwater contamination. Historical groundwater data, including hydraulic flowrates, were used to inform the model. In the end, 12 of the 30 assessed sites were categorized as a high level of concern for affecting groundwater quality down gradient.

This assessment data will be useful when considering the redevelopment of closed landfills and possible exposure risks or remediation needs. These and other types of mathematical modeling tools are useful for assessing environmental and health risks under a variety of scenarios. Scenarios can include historical data or projected inputs, such as extreme storm events or increased event frequency relative to predicted climate change. Such modeled assessments are more rapid and much less expensive than real-world environmental and human health monitoring but must be routinely validated and improved as real-world data becomes available.

US EPA keeps a list of activities and resources related to groundwater modeling. Current activities include:[5]

- Development of a groundwater flow tool as a dominant mechanism for contamination.
- Assessment of the state-of-the-science of chlorinated solvents transformation in groundwater.
- Development of an advanced groundwater transport model for contaminants from multiple sources with potential impacts on multiple drinking-water wells or other receptors. The model includes transformation of organic subsurface contaminants, source zones for non-aqueous phase liquids (NAPLs), diffusion of contaminants from low permeability layers and assessment of natural attenuation of contaminants in the subsurface.
- Field and laboratory research on treatment technologies including permeable reactive barriers, on-site chemical treatment and monitored natural attenuation.

Water quality assessment—personal apps?

Most of the developed groundwater risk assessment models are not user-friendly and certainly not designed for the layperson to utilize. Expert consultants are available through a variety of commercial, engineering, extension and academic groups to evaluate regional concerns but in the future, such assessment models may be more transparent, user-friendly and individually available. For example, a cell-phone app could be developed where consumers could assess their own risks. Prompted model input parameters derived from specific community or private water supply data could help consumers to evaluate contaminants of primary concern and link them to the appropriate POU system to mitigate their risk. Risk assessment researchers are working on the development of user-friendly mathematical models that can help the water treatment industry evaluate risks and communicate those risks to the public in addition to fostering a better understanding of options for improved health.

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