Improving sewer infrastructure should reduce rain-related disease risk

Critical need to identify greatest infrastructural and geographic vulnerabilities

Key Message
Impending hydrological changes in Wisconsin due to climate change combined with vulnerabilities due to failing infrastructure pose a public health threat, with increasingly extreme precipitation and leaky pipes promoting waterborne diseases that hit children hardest.

More than half of the documented waterborne disease outbreaks in the United States have followed heavy storms.

Acute diarrhea is responsible for 10% of all U.S. hospital admissions, the death of 300 American children, and $1 billion in costs to society per year.

Contaminated drinking water is responsible for between 6% and 40% of diarrhea-related illness.

In Wisconsin, climate change is expected to drive increased precipitation overall as well as more frequent and more intense storms.

We can reasonably expect that more precipitation and extreme weather will place greater stress on aging sewer and water infrastructure. This will lead to a greater risk of rain- and runoff-related disease.

Compromised Pipes Facilitate Pathogen Transport

Even under non-extreme conditions, our conveyance systems are vulnerable to the waterborne transport of the viruses that cause diarrhea. Extreme weather events will exacerbate this problem.

Sewer pipes are not supposed to connect with water pipes, but robust evidence suggests that they often do, though we lack comprehensive knowledge of where.

Viruses from human fecal matter flushed down our toilets migrate into surface waterways, groundwater that supplies drinking water, and directly into public water distribution pipes when system pressure drops.

Diarrhea's Impact on American Society

10% of hospital admissions

300 children's deaths

$1 billion annual costs to society

Policy Recommendation
A statewide inventory of sewer and water infrastructure vulnerabilities should help prioritize capital improvements and alert communities to local health risks.

Health Risks Unquantified but Increasing

The human health risk posed by waterborne disease in Wisconsin has only begun to be quantified.

Our understanding is incomplete because much diarrhea goes unreported; few large-scale epidemiological studies have been done; and we lack a comprehensive understanding of where our failing infrastructure (leaky pipes) intersects with geographic, hydrological, and demographic vulnerabilities.

Even if the climate predictions prove wrong, we still expect rain-related disease risk to increase.

Children under age five are at greatest risk because they have not yet acquired immunity to diarrhea-causing viruses.

The immunocompromised are also at risk.

Unless our disintegrating sewer and water infrastructure is repaired, patching the systemic vulnerabilities to rain-related disease, the health of our most vulnerable will remain at risk.

This risk is highest for small communities that do not disinfect drinking water systems and large, aging distribution systems with many vulnerabilities.

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Supporting literature

Borchardt, Mark A.; Nathaniel L. Haas; and Randall J. Hunt. 2004. Vulnerability of drinking-water wells in La Crosse, Wisconsin, to enteric-virus contamination from surface water contributions. Applied and Environmental Microbiology 70: 5937-5946.

Borchardt, Mark A.; Kenneth R. Bradbury; Madeline B. Gotkowitz; John A. Cherry; and Beth L. Parker. 2007. Human enteric viruses in groundwater from a confined bedrock aquifer. Environmental Science & Technology 41: 6606-6612.

Borchardt, Mark A.; Susan K. Spencer, Burney A. Kieke Jr.; Elisabetta Lambertini; and Frank J. Loge. 2012. Viruses in nondisinfected drinking water from municipal wells and community incidence of acute gastrointestinal illness. Environmental Health Perspectives 120: 1272-1279.

Bradbury, Kenneth R.; Mark A. Borchardt; Madeline Gotkowitz; Susan K. Spencer; Jun Zhu; and Randall J. Hunt. 2013. Source and transport of human enteric viruses in deep municipal water supply wells. Environmental Science & Technology. DOI: 10.1021/es400509b.

Curriero, Frank C.; Jonathan A. Patz; Joan B. Rose; and Subhas Lele. 2001. The association between extreme precipitation and waterborne disease outbreaks in the United States, 1948-1994. American Journal of Public Health 91: 1194-1199.

Elliott, Elizabeth Jane. 2007. Acute gastroenteritis in children. BMJ 334: 35-40.

Gaffield, Stephen J.; Robert L. Goo; Lynn A. Richards; and Richard J. Jackson. 2003. Public health effects of inadequately managed stormwater runoff. American Journal of Public Health 93: 1527-1533.

Lambertini, Elisabetta; Susan K. Spencer; Burney A. Kieke, Jr.; Frank J. Loge; and Mark A. Borchardt. 2011. Virus contamination from operation and maintenance events in small drinking water distribution systems. Journal of Water and Health 9: 799-812.

Lambertini, Elisabetta; Mark A. Borchardt; Burney A. Kieke, Jr.; Susan K. Spencer; and Frank J. Loge. 2012. Risk of viral acute gastrointestinal illness from nondisinfected drinking water distribution systems. Environmental Science & Technology 46: 9299-9307.

Marsalek, Jiri and Quintin Rochfort. 2004. Urban wet-weather flows: sources of fecal contamination impacting on recreational waters and threatening drinking-water sources. Journal of Toxicology and Environmental Health, Part A: Current Issues, 67: 20-22, 1765-1777.

McLellan, Sandra L.; Erika J. Hollis; Morgan M. Depas; Meredith Van Dyke; Josh Harris; and Caitlin O. Scopel. 2007. Distribution and fate of Escherichia coli in Lake Michigan following contamination with urban stormwater and combined sewer overflows. J. Great Lakes Res. 33: 566-580.

McLellan, Sandra; Michael Hahn; David Lorenz; Gabriella Pinter; Istvan Lauko; Elizabeth Sauer; David Bennett; David Perry; and Julie McMullin. 30 August 2011. Impact of climate change on CSOs and SSOs in Milwaukee watersheds.

Morss, Rebecca E.; Olga V. Wilhelmi; Gerald A. Meehl; and Lisa Dilling. 2011. Improving societal outcomes of extreme weather in a changing climate: an integrated perspective. Ann. Rev. Environ. Resour. 36: 1-25.

Patz, Jonathan A.; Stephen J. Vavrus; Christopher K. Uejio; and Sandra L. McLellan. 2008. Climate change and waterborne disease risk in the Great Lakes region of the U.S. Am J Prev Med 35: 451-458.

Reynolds, Kelly A.; Kristina D. Mena; and Charles P. Gerba. 2008. Risk of waterborne illness via drinking water in the United States. Reviews of Environmental Contamination and Toxicology. 192: 117-158.

Richardson, Hopi Yip; Gordon Nichols; Chris Lane; Iain R. Lake; and Paul R. Hunter. 2009. Microbiological surveillance of private water supplies in England—The impact of environmental and climate factors on water quality. Water Research 43: 2159-2168.

Sauer, Elizabeth P.; Jessica L. VandeWalle; Melinda J. Bootsma; and Sandra L. McLellan. 2011. Detection of the human specific Bacteroides genetic marker provides evidence of widespread sewage contamination of stormwater in the urban environment. Water Research 45: 4081-4091.

Vavrus, Steve and Jeff Van Dorn. 2009. Projected future temperature and precipitation extremes in Chicago. Journal of Great Lakes Research 36: 22-32.

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Quick Stats: Elliot 2007.