

The Changing Face of Water

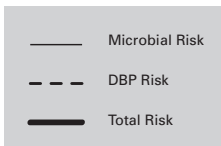
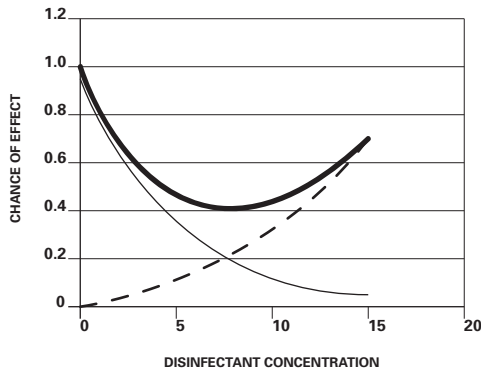


THE UNIVERSITY
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For millennia, water was THE environmental issue. Civilizations developed along waterways. Agriculture flourished and people lived well when water could be counted on; those same societies collapsed as rainfall disappeared. The health of children hinged on keeping microbes out of the water supply. It's hard to remember that water-borne disease was rampant in the United States as recently as the turn of the last century, or to recall the immense effort that went into sanitary engineering to save the public health.

And yet, population growth and development in watersheds is stressing our ability to keep water clean and to extract enough for homes, agriculture and industry. New microbial threats are becoming evident, either because they have evolved from the older microbes we fought off so successfully, because we never before had the tools to see them,

because our own overuse of antibiotics has made treatments less effective, or because increased use of antibiotics in livestock has allowed the growth of new, antibiotic resistant, strains. In any event, it's evident that *Cryptosporidium parvum*, *Giardia*, *Norwalk virus*, *Salmonella* and a host of other microbes are present in our water supplies, with water treatment facilities our one line of protection.



Microbes and Disinfectant

We're fortunate in this country to have first-rate utilities that provide protection against microbes through disinfection at a reasonable cost. The concentration of microbes in our drinking water is maintained at safe levels, with only irregular outbreaks when a treatment system fails or is overwhelmed by something like a hurricane. Recent scientific studies have suggested that some of the disinfectants, particularly those involving chlorine, react with organic material in the water to produce chemicals that may be capable of producing health effects. These disinfection by-products (DBPs) present us with a unique challenge: balancing risks

from the microbes against risks from the DBPs. Increasing the concentration of these disinfectants reduces the chance of microbial disease, but at the expense of increasing the concentration of the DBPs. This is shown in the figure to the left. Notice that low concentrations of disinfectants produce high risk of microbial disease but low risk from the DBPs, and high concentrations reverse this pattern. Somewhere in the middle is a concentration of disinfectant that produces the lowest overall risk (in the "valley" of the dark line).

Utilities and regulators are struggling to find where this point of "best" disinfection lies. The EPA is in the process of finalizing new Long Term Surface Water Treatment Rules, as well as regulations on DBPs. Two points are of interest here. First, it must be remembered that the risks from microbes are well established historically, even if we have forgotten them here in the U.S. They lie ready to re-emerge if we aren't diligent in treatment. The risks from DBPs are much less well established. Our decisions must reflect this difference, and they currently don't.

Second, the costs of the new treatment rules may be significant in some cases. While the exact numbers are not in, the EPA estimates that the rules will increase water costs by about \$200 to \$300 per household per year in some homes using small water supplies. Since these supplies tend to be found in poor rural areas, there may be a disproportionate impact on groups least able to absorb the new costs. This is a common problem facing new regulations for drinking water, with the economic burden often falling disproportionately on those who can least afford it. Society must find a way to deal with this issue of social justice.

Pollutants of the Day

With microbial disease off the radar for most people, society is focusing on substances in water such as arsenic, radon and perchlorate. There is little doubt that these are capable of producing significant health effects when people are exposed at high levels, but the question is whether they produce these effects at levels found in the water

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> more

we drink, and whether the cost to treat for them is worth the investment relative to other ways in which health might be improved.

Since risks at levels found in water are not clear, regulators proceed with precaution. This involves first finding a concentration in water below which effects have been shown to be acceptable. Then, to account for our imperfect knowledge, this concentration is divided by a series of uncertainty factors, just to be sure effects are protected against even if we are wrong in our understanding. This provides a margin of safety.

How much precaution is appropriate? Increasing the margin of safety increases the cost of the regulation. So we must ask: Can we live with a slightly lower margin of safety (while still being reasonably confident health is protected), or do we want to spend even more to be very confident? And rather than focusing on a pollutant once it reaches the drinking water, a more effective approach would be to invest in watershed management, preventing contaminants from reaching water supplies in the first place. The principles of pollution prevention need to find their way into the water arena. This would free utilities to focus once again on the historical and global problem of microbes, health and adequate supply of water.

Records Fall

1998 through 2003 saw drought conditions worsen significantly in North Carolina. Several watersheds had their lowest recorded daily discharge rate during this period, especially in the western and central parts of the state. Similar conditions are found in the west and mid-west states, leading to creation of the National Drought Policy Act in 1998, and the National Drought Policy Commission to craft a national response to this increasing problem.

Municipalities in North Carolina face a critical need: developing plans for sharing water in times of drought. They are no longer able to rely solely on a policy of "one city, one water source". These counties and municipalities are rapidly approaching limits on the available supply of water, which becomes acute when drought has dropped the level of water in lakes and streams, and prevented groundwater aquifers from recharging. One part of an overall plan must include doing a much better job of tying industrial and residential development patterns to the amount of water available in our lakes, rivers and aquifers. At the same time, there is a pressing need to connect water supplies from

different municipalities so water can be shared in times of drought. This will require not only new infrastructure to carry the water, but also a system of governance and pricing that ensures both the burdens and costs are shared equitably among those who need the water. And there is little doubt that wastewater reuse is on the horizon for at least non-drinking uses such as cooling and irrigation; in fact, such a plan is being developed for the UNC-Chapel Hill campus. Such reuse brings microbial protection concerns back to the forefront.

The Challenge of an Equitable Infrastructure

Protecting water quality and quantity is a significant national task, made all the worse by a crumbling infrastructure requiring substantial investment over the coming decades. The complexity of the problem, the potential costs of improvement, and the costs of having inadequate supplies of clean water are so large as to demand national attention and coordinated policies. In fact, this is a global problem, the subject of both a World Water Forum and the attention of the World Health Organization.

The watershed policies of the Neuse River basin in North Carolina stand as examples of what can be accomplished when planning, public health and regulations work hand in hand. Such policies work best when they create a single entity responsible for all aspects of a watershed from the natural features to engineered systems, from distribution and treatment of water during normal times to control of stormwater run-off worsened by the increasing fraction of land covered with impervious surfaces.

The remaining challenge is to ensure that these policies recognize that infrastructure development, including sewers and distribution systems, still is spread inequitably. Too many of the connections to central sewage lines stop at the edge of poor and minority communities. While replacing the systems with connections to municipal sewage lines is not always feasible, there is at least a need for significant improvements in the monitoring and maintenance of septic systems, which can act as potent sources of microbes and nutrients. We must move as a nation towards a comprehensive plan of watershed development that allows population growth and economic development while ensuring that affordable clean water and sanitation are available to everyone.

What needs to be done?

1. Tie development directly to the adequacy of the water supply;
2. Develop organizations to manage all aspects of the water cycle in a watershed;
3. Make access to clean, affordable water a right of citizens in the state;
4. Develop plans, and means, to share water between municipalities; and
5. Develop financing strategies to upgrade our distribution and treatment systems.

Credits

This white paper was produced by Larry Band, Greg Characklis, Doug Crawford-Brown, Jeff Hughes, Phil Singer, and Mark Sobsey of UNC-Chapel Hill.