Revisiting Urban Water Distribution in the Twenty-First Century

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Here is how water is distributed in most cities. After being treated, water is sent through thousands of kilometers of pipes. The pressure in those pipes is generally closely monitored so it does not go below a certain minimum value. In the world, the average pressure that is generally sought is around 25 to 30 meters and the minimum value allowed is around ten meters for fire safety and to prevent any potentially contaminated groundwater from infiltrating the water distribution systems.

Making sure that a water distribution system is always under pressure can require an excessive amount of energy. While it is not a problem in hilly regions that use gravity to maintain water distribution system under pressure, most cities use pumps that generally run on electricity (but gas-powered pumps exist as well). In his book *Water 4.0*, David Sedlak wrote that, on average, about 80 percent of all the energy used by water utilities is used simply to run water distribution pumps (the rest is mostly for treatment). Personally, I recall talking with employees from ComEd, the Chicago electricity utility company, who told me that the City of Chicago Department of Water Management was their largest consumer. We are therefore talking about enormous amounts of energy. And in ageing pipe systems that are more prone to leakage and breaks, safely operating a water distribution system is like walking on eggshells. In fact, many water utilities go to great lengths to ensure that water pressure does not vary significantly since sudden pressure changes can create water hammers[1] that can more easily lead to breaks. And if a break happens, emergency teams must be dispatched the change the pipe.

Finding solutions to address these issues is not obvious, but we can learn about one alternative by looking at how water is distributed in Hanoi, the capital of Vietnam. I had the chance to live in Hanoi for several months in 2019 as part of a sabbatical, where I was a visiting professor at the University of Transport Technology (a young and impressively dynamic place where I met many colleagues and made lifelong friends). Hanoi is a bustling and bubbling city that is developing very fast. I am grateful to have had the chance to live there during its transformation. Plus, as a foody, I devoured delicious Vietnamese food every day and I still regularly crave many Vietnamese dishes, including phở cuốn and cá bông lau kho tộ[2]. I was also impressed by how resilient the Vietnamese people were and how creative they were to tackle some of the challenges they had to face. In particular, I was amazing how water was distributed in Hanoi.

The largest change in the Hanoi water distribution model does not come from the water utilities itself but from customers. For a long time, water utilities in Hanoi could not collect and

[1] Water hammers are pressure waves that are sent through pipe walls because of a sudden increase in water pressure. Like sometimes when you close your tap and you hear a bang in the wall and might even see a pipe vibrating a little. Aging pipes systems have more leaks and cracks and fractures can develop in these cracks with water hammers.
[2] Phở cuốn are rolls of beef and other ingredients typically used in phở (Vietnamese soup), wrapped in rice noodles. Cá bông lau kho tộ is caramelized catfish in claypot, I would eat it nearly every day in a restaurant close to the University of Transport Technology where I had an appointment.

treat enough water to service all buildings all the time. Therefore, water distribution was interrupted regularly, rotating between neighborhoods. To have sufficient water during service interruptions, every customer installed a large water tank in their basement that could store water for several days. The basement offered a strategic location because it is at the bottom of a building (i.e., lowest elevation), and therefore the tank can fill up even if water pressures are low. Moreover, every customer installed a smaller water tank on its roof and pumped water from the basement tank to the rooftop tank so that gravity alone was used to distribute water in the house (and it also means that water remains available even during power outages).

Since then, more water treatment plants have been built and all buildings are now constantly supplied with water, but the practice remains. As a result, the average water pressure in Hanoi tends to be closer to the minimum pressure required for fire safety. Plus, a lower pressure exerts less wear on pipe walls, making them less likely to leak and break. Moreover, when I lived in Hanoi, one water utility was contaminated and had to shut down for several days. Many customers isolated themselves from the network and were not severely affected by the disruption.

While water that comes out of the water treatment plants is safe to drink, it may get contaminated during the distribution process, in the pipes, especially in low pressure zones where groundwater may infiltrate the system. Therefore, Hanoians do not drink tap water, but many have installed a secondary treatment process at some of their taps (e.g., in the kitchen) to make it potable.

The Hanoi model is not without flaws. First, it adds an extra cost to building owners since they need to install and maintain extra infrastructure. Second, water quality can worsen if it stays too long in a water tank, especially in rooftop tanks as temperatures get higher. But the Hanoi model does offer one alternative. I was so impressed by the Hanoi model that I co-authored with Vietnamese colleagues the scientific publication "Learning from Hanoi to imagine the future of water distribution" published in Nature Urban Sustainability. I invite you to read since it has some figures to illustrate the model and it is available free of charge at https://www.nature.com/articles/s42949-020-00001-x.

In the end, I am not sure how we will do it, but I am convinced that the current water distribution model adopted by high-income countries can be improved. While I do not know whether the Hanoi model offers the answer or part of the answer, I would not be surprised if solutions came from places like Hanoi that had to be creative to solve its challenges.

Bio

Sybil Derrible is an Associate Professor in the Department of Civil, Materials, and Environmental Engineering and the Department of Computer Science (by courtesy), a Research Associate Professor at the Institute for Environmental Science and Policy, and the Director of the Complex and Sustainable Urban Networks (CSUN) Laboratory at the University of Illinois at Chicago. His research is at the nexus of urban metabolism, infrastructure planning, data science, and complexity science to redefine how cities are planned, designed, and operated for smart, sustainable, and resilient urban systems. He is the author of the textbook Urban Engineering for Sustainability (MIT Press, 2019) and he an Associate Editor for the ASCE Journal of Infrastructure Systems and for Cleaner Production Letters.