Evidence from Two Cities in India
Kyle Onda

Editors’ Note: Every year, faculty from the Department of City and Regional Planning at UNC-Chapel Hill determine the best master’s paper developed out of the graduating class. Below is an extended abstract of the project. To obtain the original full-length document, please visit the “Electronic Theses and Dissertation Collection” at http://dc.lib.unc.edu.

This study served as both the Master’s Project for the MCRP and the Technical Report for the MSPH in Environmental Sciences & Engineering at UNC.

Almost all urban water systems in South Asia provide intermittent water supply (water that comes less than twenty-four hours per day, every day). Intermittent supply can impair water quality and cause users to waste water and to adopt costly coping mechanisms such as storage, treatment, pumping, and collection of water from alternate sources. Given these deficiencies, many water engineers and policy makers in the water sector recommend conversion of intermittent systems to continuous or “24x7” systems in order to realize benefits such as improved water quality and public health, elimination of household coping costs associated with treatment and storage, and reduced water wastage from households that would no longer have to hoard water under conditions of uncertainty of supply hours.

This study implemented a mixed-methods approach to investigate how upgrading from intermittent to continuous water supply (CWS) impacts domestic water demand as well as coping behaviors. To understand these impacts, fieldwork was conducted in two Indian cities, Nagpur (pop. 2.5 million) and Amravati (pop. 700,000), where pilot neighborhoods have been receiving continuous water supply over the past three years.

Kyle Onda received his dual Master’s of City and Regional Planning with a specialization in Land Use and MSPH in Environmental Sciences & Engineering at the Gillings School of Global Public Health in May, 2014. He is currently continuing his studies as a first year Ph.D. student at DCRP.
detailed causal impact evaluation of introducing continuous water supply was conducted. Using water meter data and a natural experimental design in Amravati, water consumption by households was tracked for households before and after continuous water supply was implemented in the city, for households that did and did not receive the improved service. Using a two-way fixed-effects regression linear regression model that included imputing missing data and matching continuous water households with similar counterparts with intermittent supply, the effect of continuous water supply on demand was estimated for every time period for which data was available. The results are shown in the figure below. The results indicate a consistent increase in water demand due to the introduction of continuous water supply, with up to a ten percent increase in per capita water demand during peak months.

As for coping behaviors including the storage and treatment of municipal water and pumping of groundwater, 100 household interviews were conducted (fifty in each city, split between twenty-five households with continuous water supply and twenty-five with intermittent water supply). Generally, consumers reported continuing to incur coping costs under the improved service.

Interviews with households in both cities indicated that moving from intermittent water supply to continuous water supply does not result in a change in storage behavior, either from overhead or underground storage cisterns or from storing drinking and cooking water in pots (See Figure 3). This is important because many other findings from developing countries have shown that water delivered clean at the tap is often contaminated in in-home storage. Respondents who had continuous water supply (and thus no theoretical need to store water to time-shift water demand) gave many explanations as to why they continued storage (See Figure 4).

All respondents in both cities with CWS continued to store water in vessels in the kitchen for drinking and cooking purposes, citing that water from overhead storage tanks was likely to be somewhat stagnant and unsuitable for such uses. A few households used metal or plastic vessels with integrated filters and spigots, but the vast majority used metal or clay pots from which water was abstracted with a utensil or directly with drinking cups, introducing a possible contamination pathway. Two of the main purported benefits of continuous water supply for households are removing the need to store water in the home, and improving water safety due to eliminating the stored water recontamination pathway. However, this study found that storage practices are not necessarily linked with service reliability in the Indian context.

Figure 2. Average treatment effects.
In addition, CWS for the most part did not seem to affect routine treatment behavior (including use of cloth filters, chemical additives, and UV-light treatment devices) or the use of borewells to pump groundwater, despite respondents noting better water quality from the tap. While this finding is at odds with the purported CWS benefit of reducing treatment costs, this result is not surprising, as evidenced by the markets for bottled water and domestic water filtration devices in higher-income countries with continuous and high-quality tap water.

Overall, the findings of this research indicate that many of the proposed benefits of CWS do not accrue automatically to the consumer. Many assumptions about consumer responses to water service improvements that are used to guide investment may not always bear out in practice. In order for the water conservation benefits of CWS to be realized, water utilities and their regulators should design water tariffs and non-price water demand management approaches that effectively incentivize water conservation while still allowing the poorest to afford sufficient quantities of water for health and hygiene. Uncertainty in the magnitude and direction of coping cost changes as a result of water supply improvements should be incorporated into formal evaluations such as cost-benefit analyses of water supply investments. Storage and treatment-related cost reductions need to be more rigorously evaluated by those implementing water supply improvements before being considered an economic benefit to households that justifies water supply investments.