Service Delivery (Water and Sanitation): the Connected City Part 2

BREAD-IGC PhD course on urban economics

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Introduction I

- We are more productive working at higher densities (and with different people) than the densities at which we want to live. Cities are how we solve this problem.
- This leads to three questions,
  - How much more productive, and why?
  - How does the cost of commuting affect the way cities are organized?
  - What determines our willingness to tolerate density?
- The first two are central questions in urban economics. They have been studied extensively.
- The third question has received less attention.

Introduction II

- This lecture describes what we know about how sewage and sanitation service affects the organization of cities.
- *We know that the ability to move workers to the center has important effects on the structure of cities. Could it be that the ability to disperse their sewage is equally important?*

Introduction III

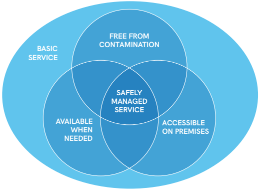
- There are many related policies that also affect our willingness to tolerate density. For example;
  - drinking water delivery and quality,
  - law and order,
  - sewer service
  - vaccination,
  - trash collection,
  - fire protection,
  - noise and pollution.

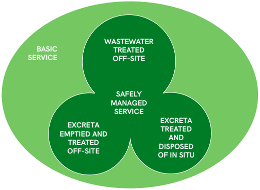
  The impact of these services on the organization of cities is also not well studied. My prior is that their importance corresponds approximately to their listed order.

Introduction IV

- This lecture will describe the state of knowledge about the relationship between water and sewer infrastructure and the organization of cities. It is in three parts,
  - Evidence for the importance of public health for the organization of cities.
  - Evidence for the importance of sewage and sanitation services for public health.
  - Evidence for the importance of sewage and sanitation service for the organization of cities.
  - Suggestions for further research.

World availability of water and sewer I



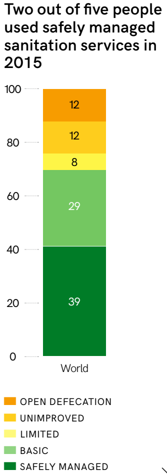


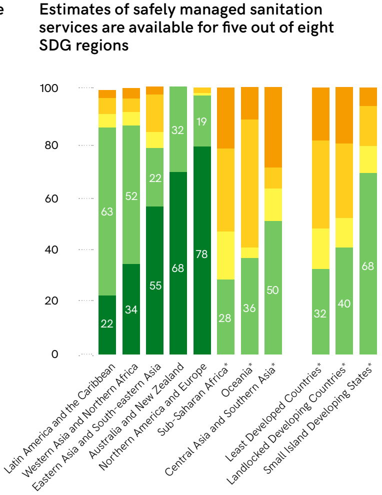
SERVICE LEVEL	DEFINITION
SAFELY MANAGED	Drinking water from an improved water source that is located on premises, available when needed and free from faecal and priority chemical contamination
BASIC	Drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip, including queuing
LIMITED	Drinking water from an improved source for which collection time exceeds 30 minutes for a round trip, including queuing
UNIMPROVED	Drinking water from an unprotected dug well or unprotected spring
SURFACE WATER	Drinking water directly from a river, dam, lake, pond, stream, canal or irrigation canal
Note: *Improved sources include: piped water, boreholes or tubewells, protected dug wells, protected springs, rainwater, and packaged or delivered water.*	

SERVICE LEVEL	DEFINITION
SAFELY MANAGED	Use of improved facilities that are not shared with other households and where excreta are safely disposed of in situ or transported and treated offsite
BASIC	Use of improved facilities that are not shared with other households
LIMITED	Use of improved facilities shared between two or more households
UNIMPROVED	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines
OPEN DEFECATION	Disposal of human faeces in fields, forests, bushes, open bodies of water, beaches or other open spaces, or with solid waste
Note: *improved facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, composting toilets or pit latrines with slabs.*	

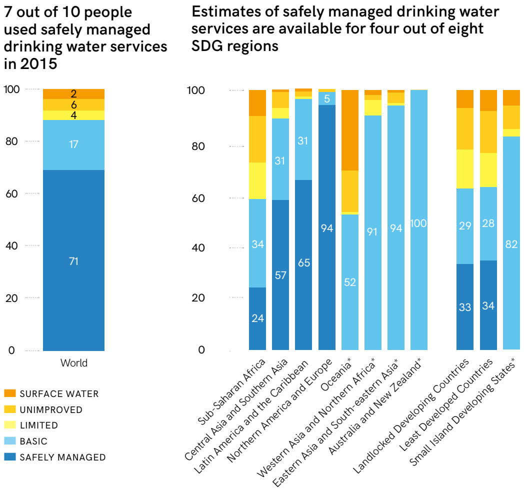
World Health Organization (2017)

World availability of water and sewer II





World availability of water and sewer III

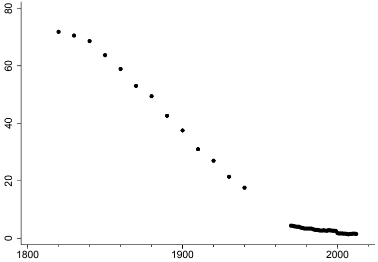


World availability of water and sewer IV

Water and sewer service is in short supply in much of the world, especially developing country slums. Sewers are scarcer than piped water.

About 15% and 40% of the world's urban population does not have access to safely managed water and safely managed sanitation (Coury et al., 2024).

Public health and the organization of (US) cities



% US Employment in Ag. (FRED)

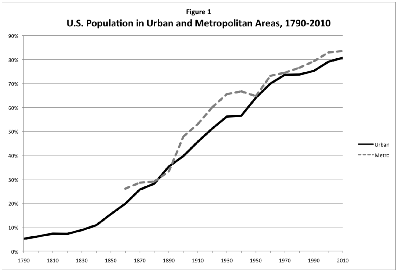
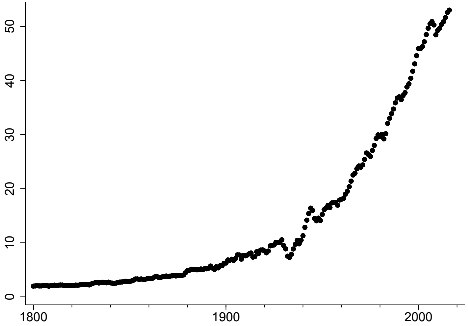


Figure 1: Before 1950, the urban share only includes residents living in incorporated places. From 1950 onward, the urban share includes residents living in both incorporated and unincorporated places. Data on urban population shares are from the U.S. Census Bureau. Metropolitan area population shares were calculated using data and the contemporaneous definitions provided by IPUMS in each year.

Boustan et al. (2013).



Real per capita GDP in constant 2011 dollars from Bolt and Van Zanden (2014). From 1800 to 2016, US incomes increased from 1980$ to 53015$, a factor of about 27.

Fig. 2 *Crude Death Rate*
Boston, MA, 1811-1920

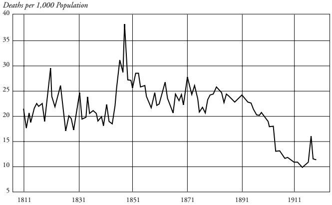


Fig. 3 *Crude Death Rate*
Philadelphia, 1802-1920

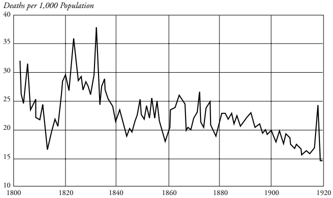


Fig. 1 *Crude Death Rate*
New York City, 1804-1900

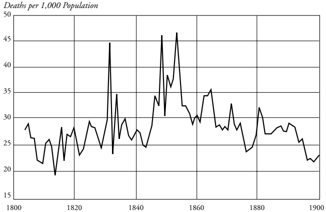
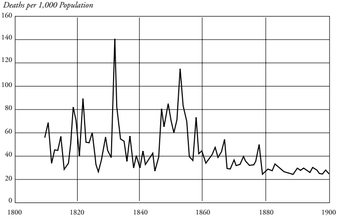
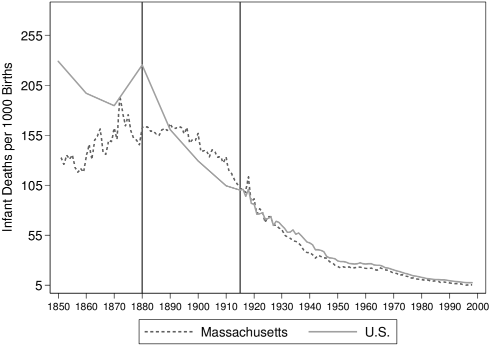


Fig. 5 *Crude Death Rate*
New Orleans, 1810-1900



Crude death rates were 20-80 in 19th century US cities, and fell in the 20th century (Haines, 2001).

Figure 1: Infant Mortality in the United States and Massachusetts: 1850 to 1998



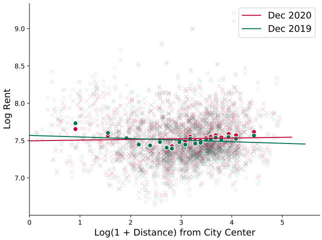
Infant mortality in the US and Massachusetts in the 19th century was terrifyingly high (Alsan and Goldin, 2019). Current US rates are about 5 per 1000.

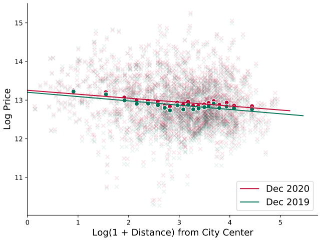
Decade	Ratio
1870-1880	1.38
1880-1890	1.50
1890-1900	1.35
1900-1910	1.33
1910-1920	1.21

Ratio of urban to rural crude death rates in the US, by decade. The urban mortality premium was about 40% in 1780 and declined to 20% by 1920 (Haines, 2001).

- Three events approximately coincided in the late 19th and early 20th century.
  - Urban population increased
  - Productivity increased
  - Urban mortality rates fell
- The conventional wisdom is that the decline in the absolute and relative level of urban mortality was an important contributor to the process of urbanization and growth in the US.

Covid and US cities





Left panel: relationship between log distance from the city center and log rent before (green) and after (red) the pandemic. Right panel reports sale price gradients (Gupta et al., 2021).

- Modern experience with Covid confirms the importance of public health for process of urbanization in the US.
- It would be nice to have more evidence for this story.
- The pattern in modern day Africa is not obviously the same. Henderson and Turner (2020). African cities are not obviously more dangerous than rural regions, so why aren't they growing even faster?

Water and sewer interventions and public health

The effect of late 19th and early 20th century municipal water quality is well studied;

- (Alsan and Goldin, 2019) Interaction of water and sewer main in a municipality gives a 26% decrease in infant mortality, Boston Harbor watershed, 1880 to 1920.
- (Anderson et al., 2018) Sample of 25 US cities between 1900 and 1940. Manage sewage outflows 0% effect on infant mortality, water filtration 11% decline. Joint effect of all water quality related interventions is 4%. Note disagreement with (Alsan and Goldin, 2019).
- (Ferrie and Troesken, 2008) Event study of improved municipal water quality on mortality and future mortality in 19th century Chicago. Improved water quality reduces crude death rate by 18-30% from 1850-1925.

- (Kesztenbaum and Rosenthal, 2017). Completely sewering an unsewered Paris neighborhood between 1880 and 1915 gives 1-3 years of life expectancy at birth.
- (Troesken, 2004) Role that piped water and sewer service played in narrowing the black-white life expectancy gap in the US during the first half of the 20th century.
- Beach (2022) is a useful survey of the history literature.

The effects of improvements to water and sewer infrastructure have also been studied in the context of the modern day developing world.

- Galiani et al. (2005) finds that privatizing Argentina's water supply services lead to an 8% reduction in child mortality, all from a reduction in waterborne disease.
- Bhalotra et al. (2021) looks at the roll-out of municipal water treatment in late 20th century Mexico reduced childhood mortality from diarrheal disease by about half.
- Gamper-Rabindran et al. (2010) finds that roll-out of piped water, but not sewer access, has an important effect on infant mortality in Brazil around 2000.
- Devoto et al. (2012) finds that access to piped drinking water increases time spent at leisure but does not affect childhood incidence of waterborne disease in Morocco in 2007.

- Ashraf et al. (2017) find that more reliable drinking water supplies decreases childhood diarrheal disease and increases the time girls spend at school in urban Lusaka in 2000.

Where does this leave us?

- Interventions to improve municipal water *quality* have been well studied. They have important health benefits in the developing world and the 19th century US. There is disagreement about effect sizes, or treatment/treatment effects are heterogenous in a way that is not understood.
- The provision of household piped water or sewer access is less well studied. There is some evidence that this is also important for health and for many other aspects of life.
- Interventions are diverse, e.g., installation of municipal water and sewer mains, moving intakes to deeper water, chlorination, disruptions of piped water supply, etc. Such estimates do not lend themselves readily to cost benefit analysis of prospective projects.

Water and sewer interventions and cities

- Alsan and Goldin (2019) fail to reject zero effect of interaction of arrival of municipal water and sewer mains on; demographics or population density. Confidence intervals are large.
- Coury et al. (2024) find that land values in 19th century Chicago more than double with access to sewer network.
- Kitagawa, McCulloch, Schaelling and Turner (2024 – in progress) 3% increase in central city share with sewer access often affects density as much as a radial interstate. No evidence of demographic sorting.

Doubling of land prices must result in a big increase in density in 19th century Chicago. This is consistent with Kitagawa et al. There is a lot more here to do.

Suggestions for further research I

- Our present understanding of the effects of water and sanitation infrastructure on health is not conducive to cost benefit analysis of anything except improvements to water quality.
- Many studies of the effect of urban water and sanitation infrastructure on health are DiD designs. It would be nice to have more design based estimates.
- Our understanding of how water and sanitation infrastructure affects the organization of cities is rudimentary. We have evidence that the effects on land use are large, but also some conflicting evidence.
- If sewers affect density, then the literature on public health outcomes understates benefits.

Suggestions for further research II

- As far as I know, we know nothing systematic about the costs of water and sewer infrastructure.
- We are a long way from being able to do a welfare analysis of competing interventions.

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