

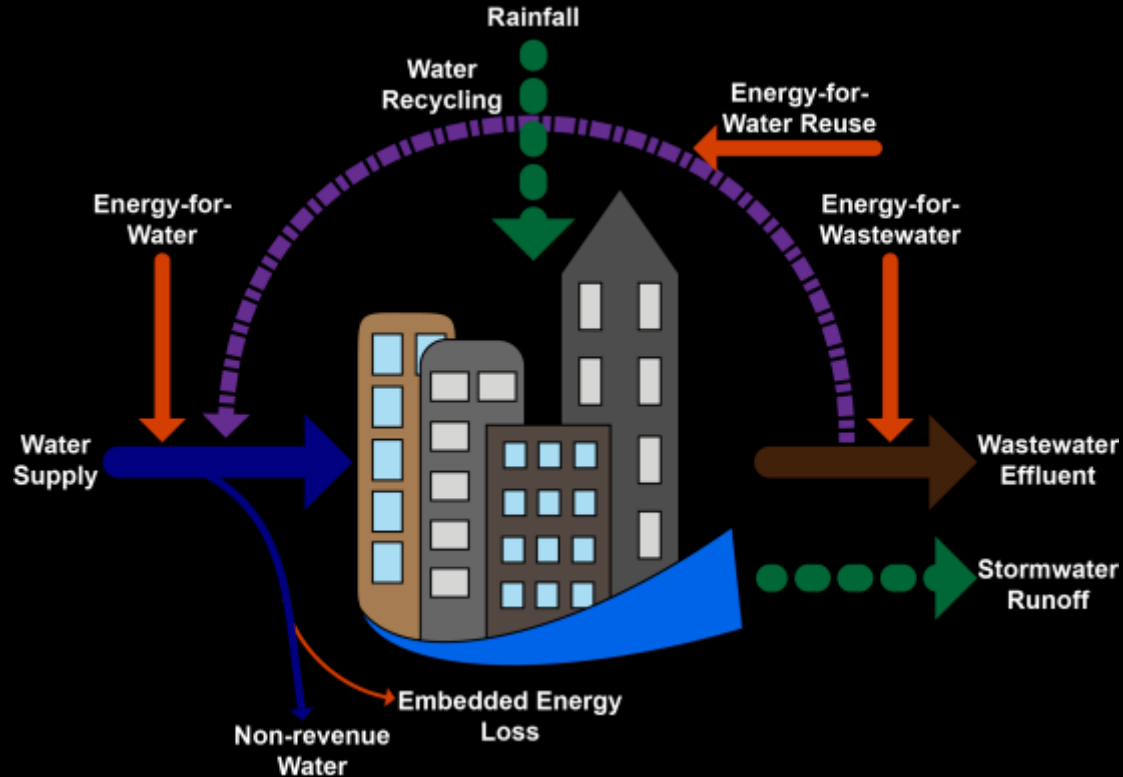
Historic Data for an Uncertain Future: Sustainable Management of Water, Energy, and Food

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There are many components of the water sector in cities.



How can we characterize urban water systems in U.S. cities?

How does energy relate to water and other material flows in and out of U.S. cities?

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What current urban water data are available?



USGS National Water Census



Circle of Blue



Benchmarking Performance
Indicators for Water and Wastewater
Utilities

Some State Level Data:

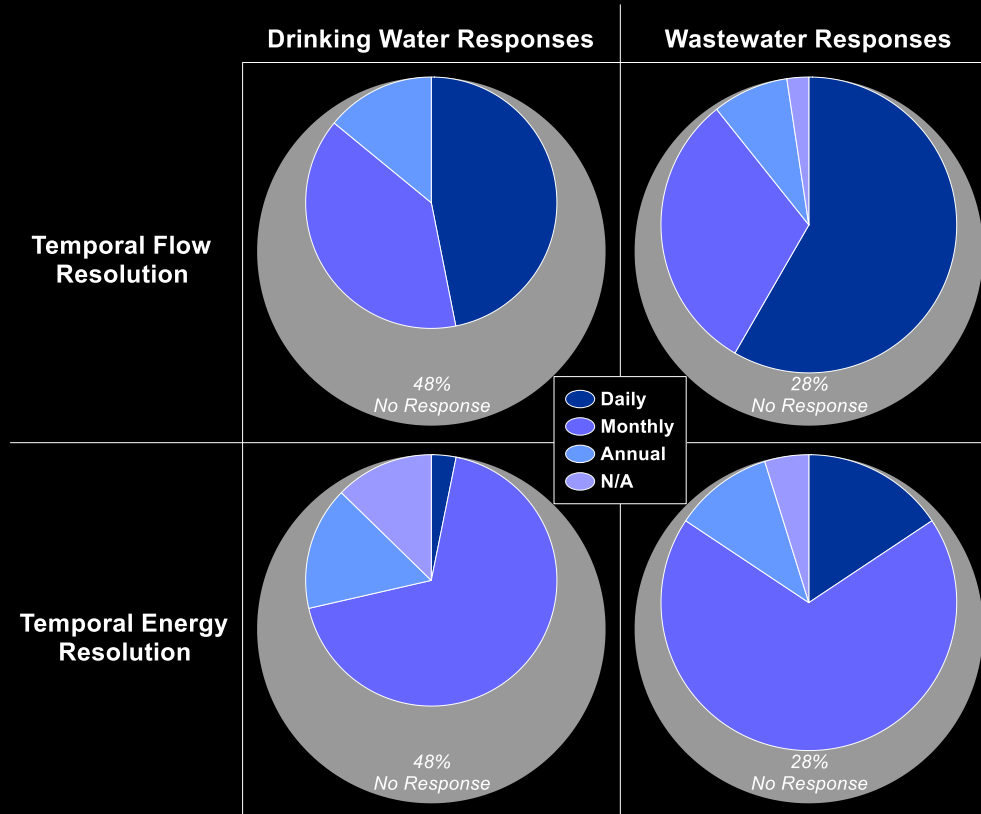
California Water Resources Control Board

Texas Water Development Board

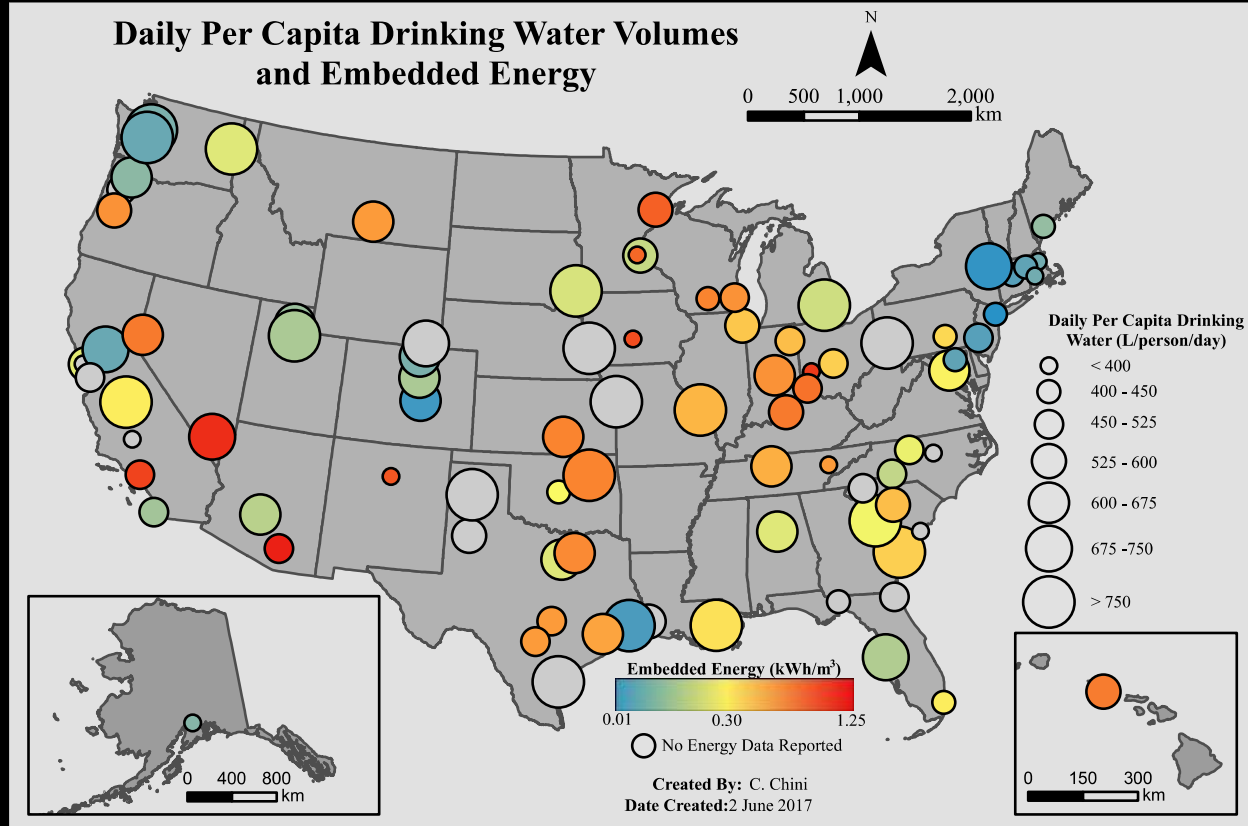
The current means to create a comprehensive database requires extensive open records requests.



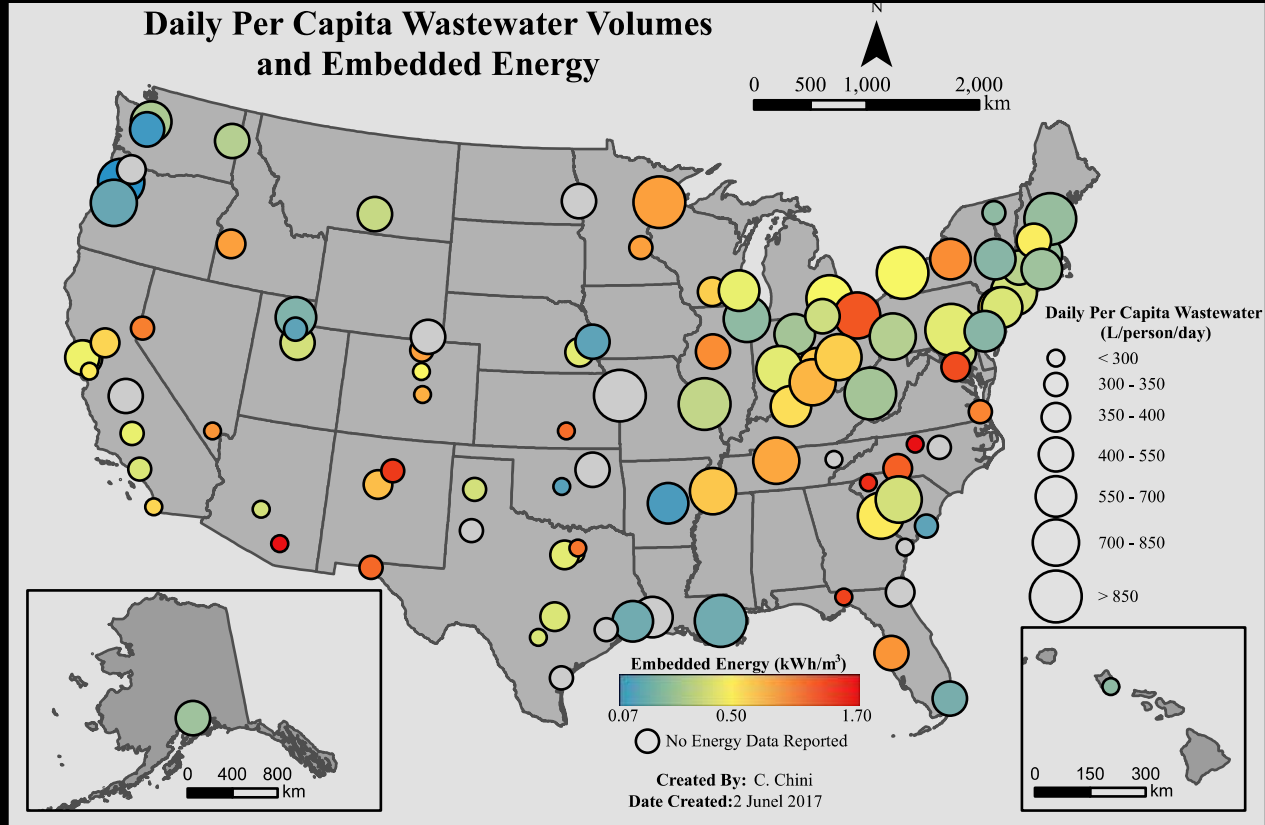
Wastewater utilities responded at a higher rate than drinking water utilities.



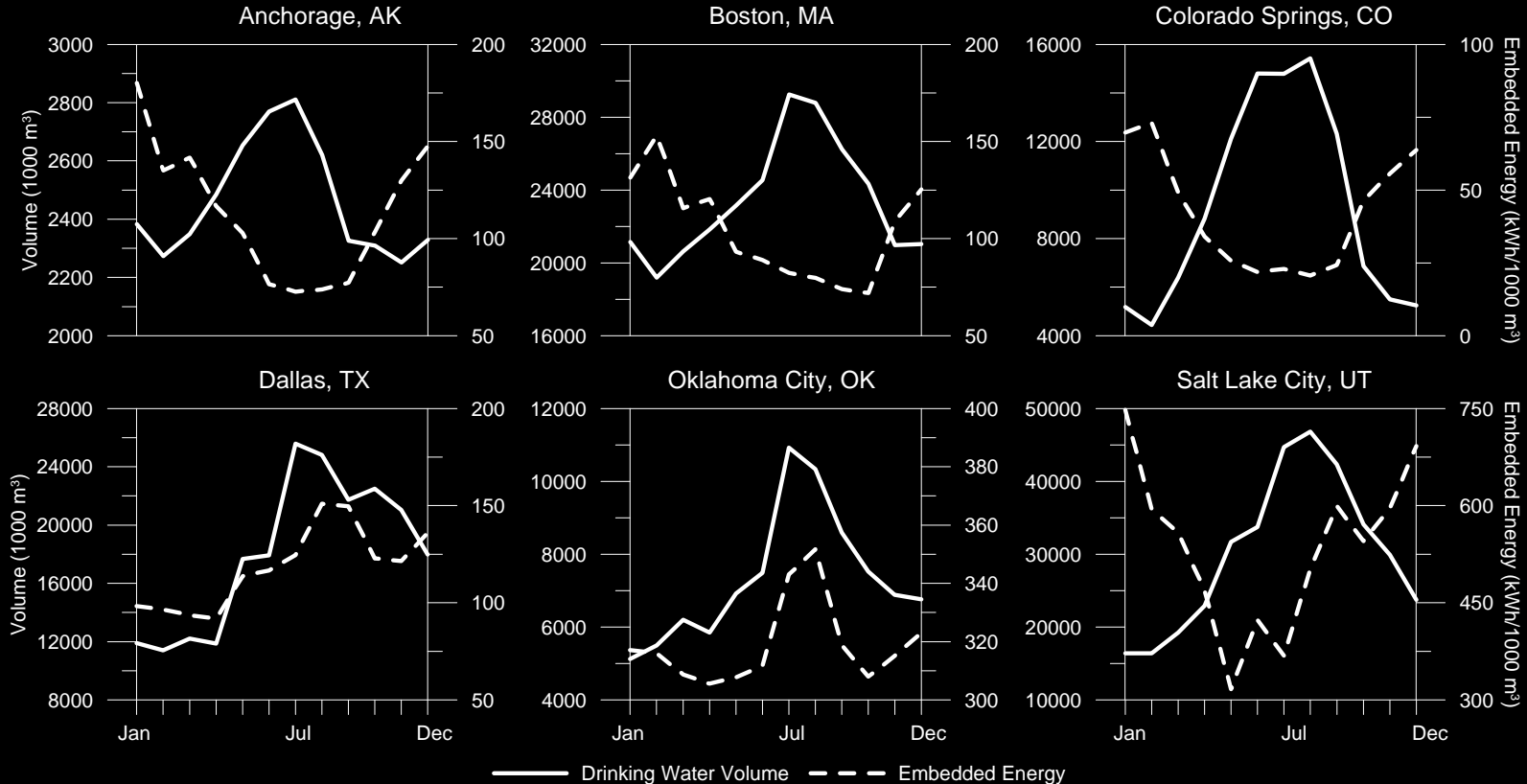
Energy intensity of drinking water varies spatially.



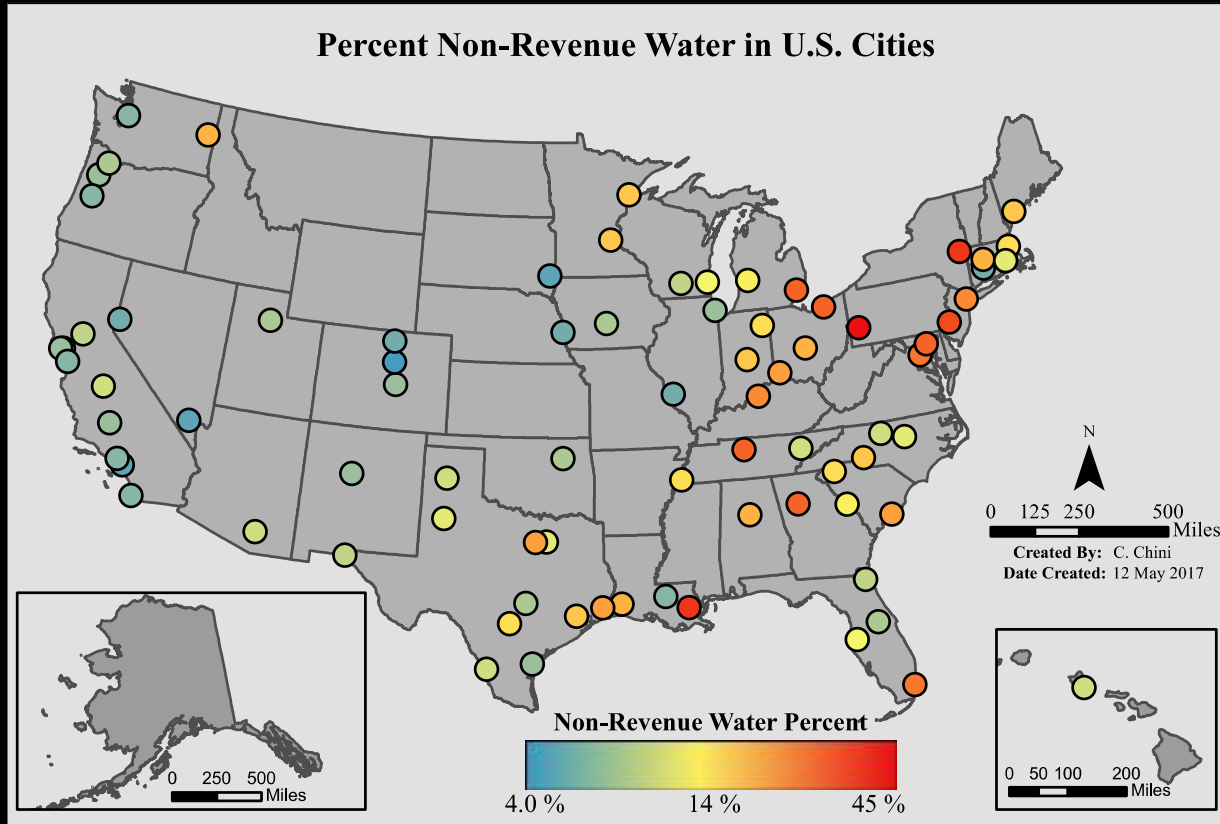
Energy intensity of wastewater varies spatially.



Energy intensity of drinking water varies temporally.



Non-revenue water varies spatially.



How can we characterize urban water systems in U.S. cities?

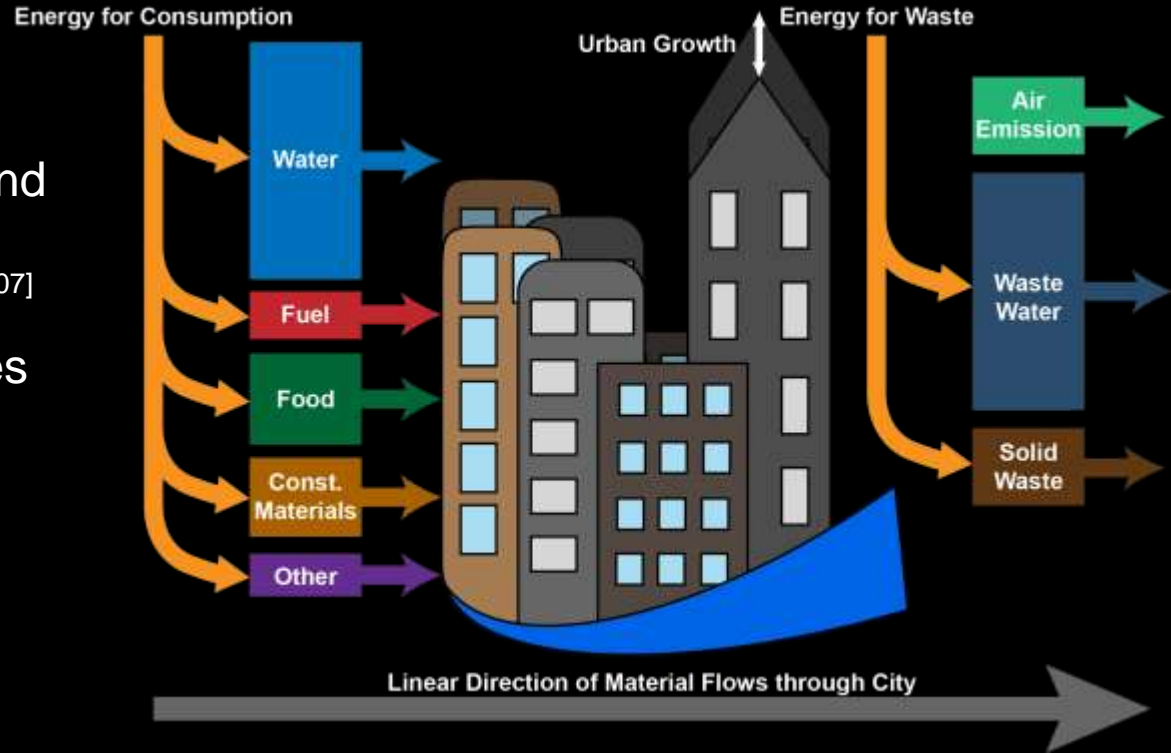
- Water and wastewater utility data are available but not publicly reported in a centralized database
- Energy intensity of water and wastewater utilities includes **both primary and secondary energy sources**, and varies spatially and temporally
- Non-revenue water requires the same energy as **300,000 U.S. homes**

How can we characterize urban water systems in U.S. cities?

How does energy relate to water and other material flows in and out of U.S. cities?

Urban metabolism is the application of material flow analysis (MFA) to the urban scale.

- Sum of social, economic, and technical processes in city
[Kennedy et al. 2007]
- Few studies in United States and few studies compare multiple cities with same methodology

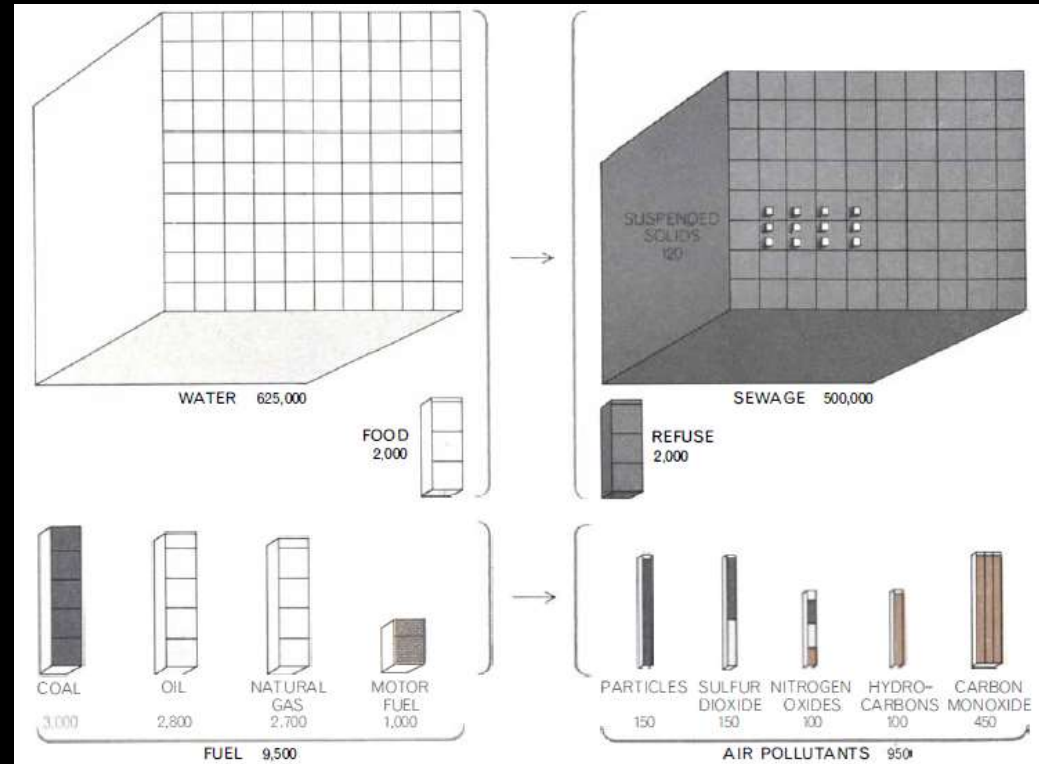


What is the urban metabolism of a typical* U.S. city?

*typical = 1 million people

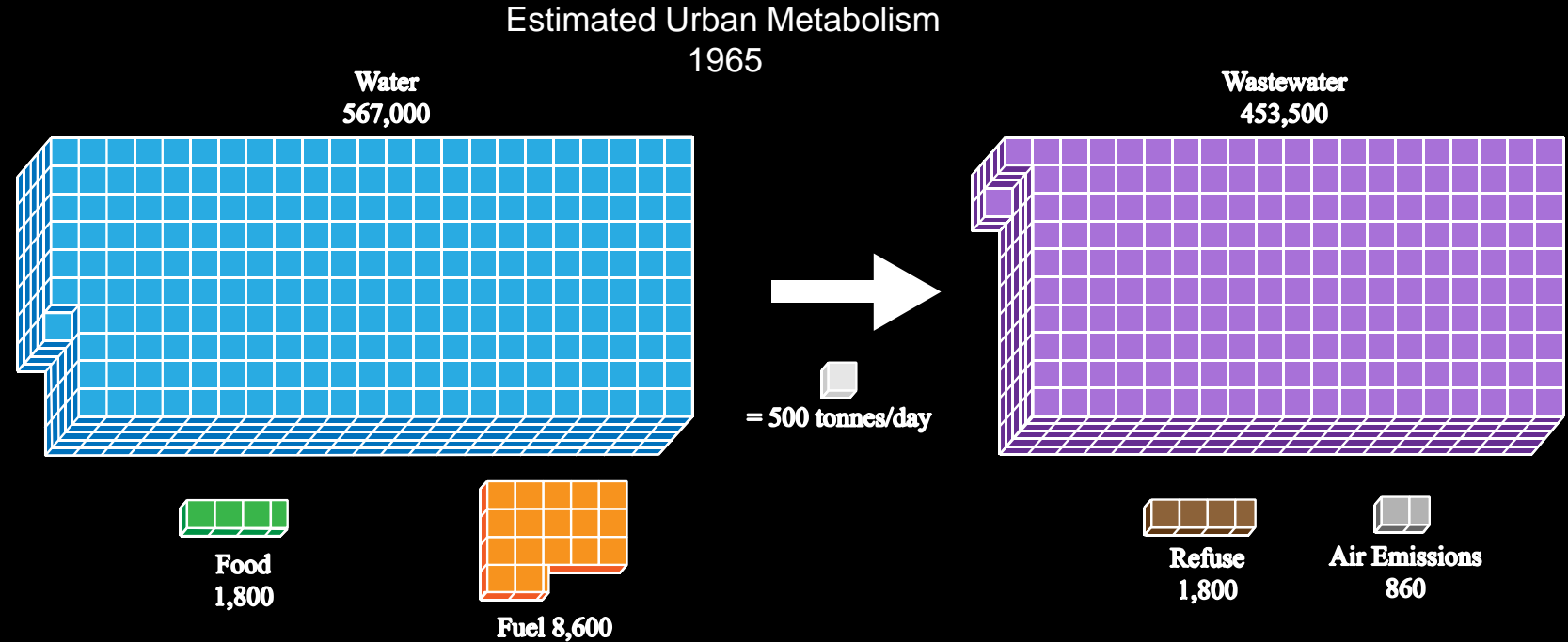
Abel Wolman's 1965 seminal study: "The Metabolism of Cities."
Scientific American

"In the U.S. today attention is focused on shortages of water and the pollution of water and air. There is plenty of water, but supplying it requires foresight. Pollution calls for public economic decisions."

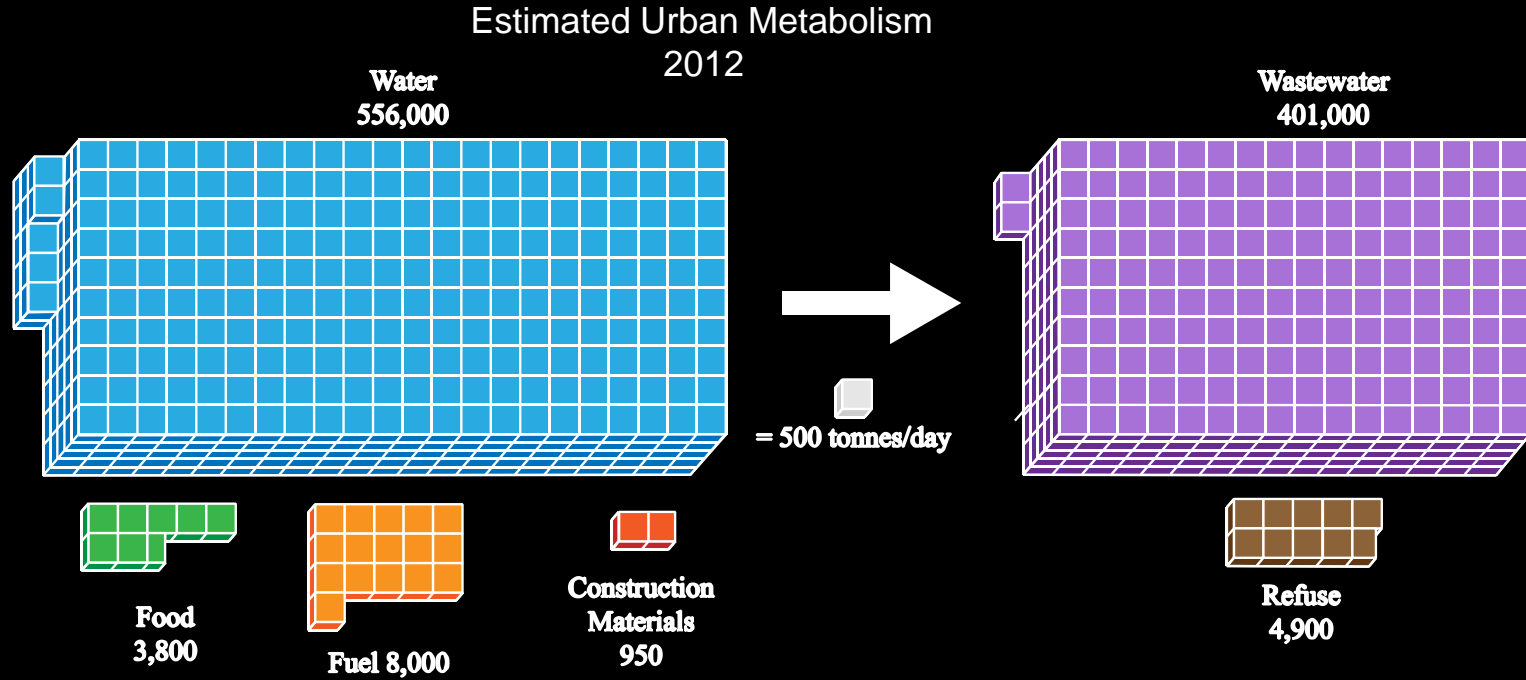


[Wolman 1965]

A sustainable urban metabolism suggests a decrease in energy, water, and material flux over time.



There is an increase in urban metabolism over the past 50 years, especially related to food and solid waste.

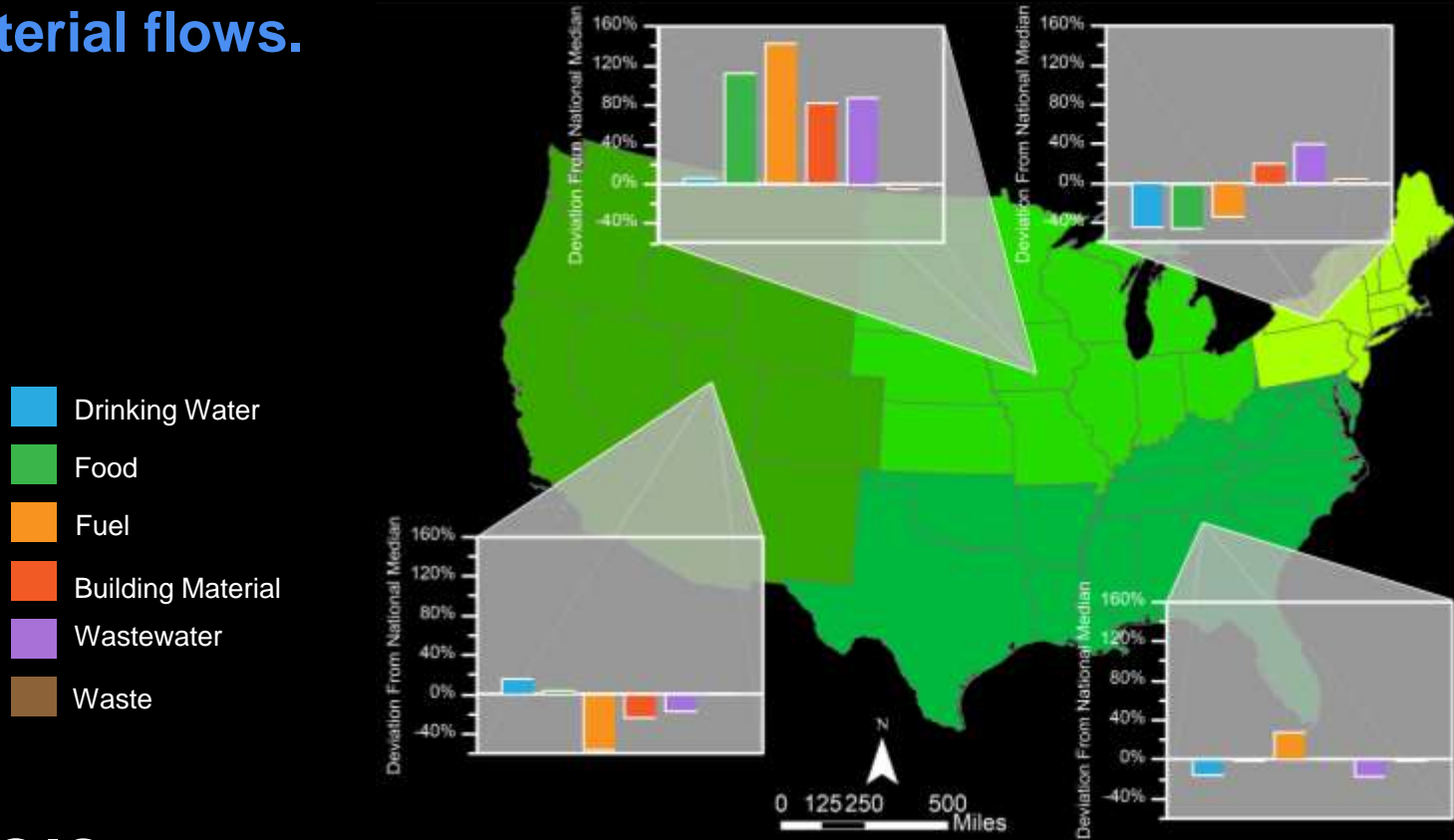


A city of one million people requires almost 3,900 GJ per day to facilitate urban metabolism.

Material flows and their embedded energy for an average U.S. city of 1 million residents



There are regional deviations from the national median values of urban material flows.



How does energy relate to water and other material flows in and out of U.S. cities?

- Water and wastewater dominate the mass flux of materials through cities
- Both **water and food** are energy-intensive city inputs from an urban metabolism perspective
- The metabolism of U.S. cities has increased over time, especially regarding **food and solid waste**
- Regional differences in material flows indicate the importance of the Midwest as a geographic hub

City sustainability extends beyond traditional energy or emissions considerations to also depend on water. Planning for an uncertain future requires better data collection and decision making.

Acknowledgements.



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Publications.

Chini, C.M. and A.S. Stillwell. (2017). "Where Are All the Data? The Case for a Comprehensive Water and Wastewater Utility Database." *Journal of Water Resources Planning and Management*. 143(3), 01816005.

Chini, C.M. and A.S. Stillwell. (2018). "The State of U.S. Urban Water: Data and the Energy-Water Nexus." *Water Resources Research*. 54(3), 1796-1811.

Chini, C.M. and A.S. Stillwell. (2019). "The metabolism of U.S. cities 2.0." *Journal of Industrial Ecology*. In press.

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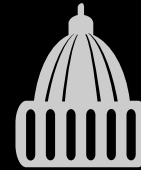
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water



energy



policy