

# Challenges of Water Provision in Zambia

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# Overview

- Infrastructure matters for growth and welfare - but technology alone is often not sufficient
- We explore two barriers to individuals benefiting from public infrastructure:
  1. **Last mile problem:** to connect the end-user requires the right institutions
    - We provide historical evidence from New York
  2. **Infrastructure maintenance and supply consistency:** impacts welfare of the end-user
    - We provide evidence from water interruptions in Lusaka

# 1. “Last mile” problem

- **Infrastructure investments alone are not enough** to solve critical public health problems.
- Despite substantial infrastructure investments, some urban residents choose not to connect to because of **high connection costs**.
- An individual’s failure to adopt => externalities on other residents
- Ability to implement policies to combat this problem depends critically on strength of local **institutions**

# Infrastructure, Incentives and Institutions

Professor Nava Ashraf, Professor Ed Glaeser and Professor Giacomo Ponzetto

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# A model of the complementarity between infrastructure and institutions

- **Externalities** associated with health-related infrastructure imply that the total social benefits of infrastructure are greater than the aggregate private willingness to pay
- Externalities suggest a role for **government intervention**
- Standard economic theory implies that either **penalties** or **subsidies** can induce people to internalize the social benefits and pay for connections

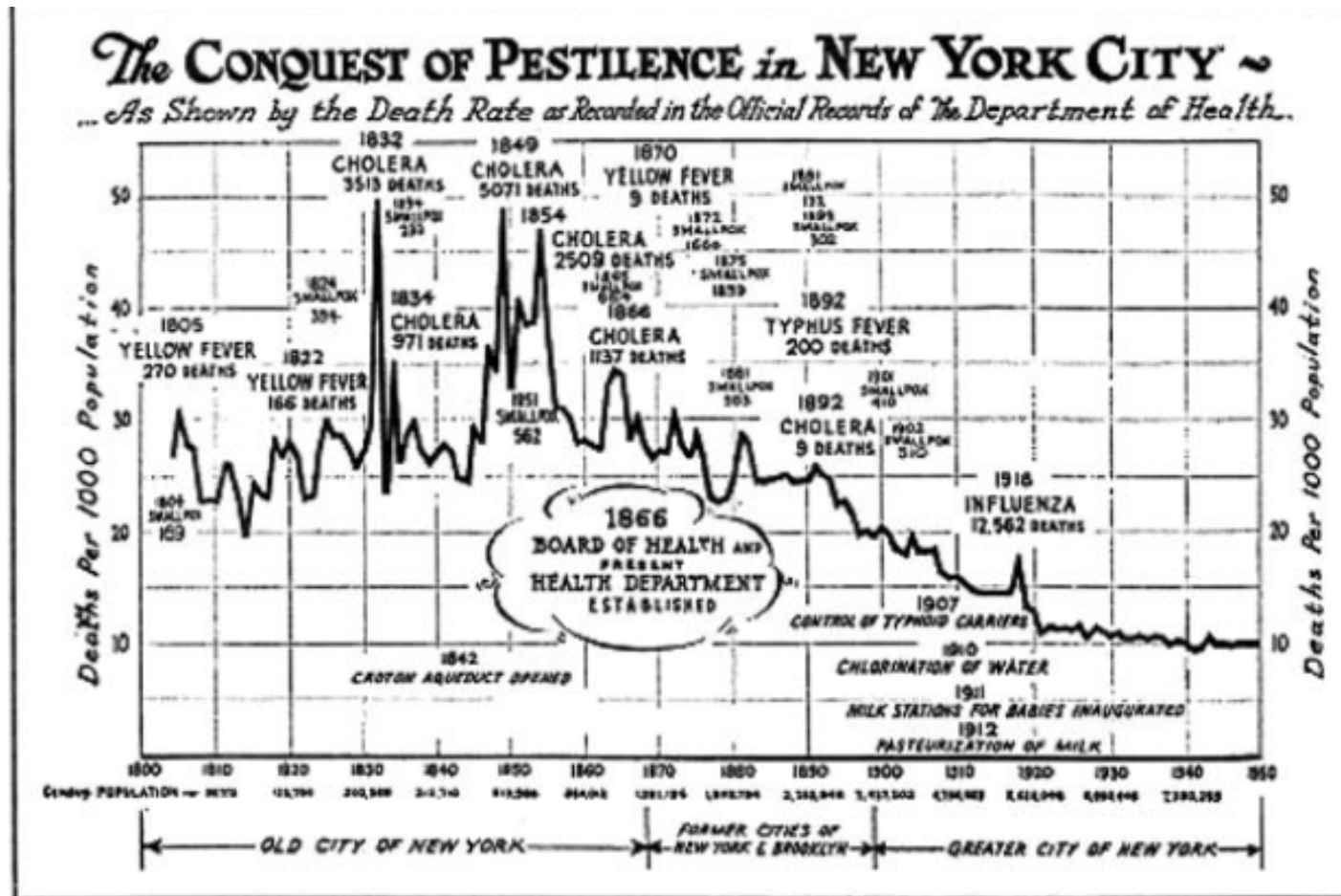
# Solving the last mile problem: 19<sup>th</sup> Century New York

- New York's Croton Aqueduct was finalised in 1842 and brought clean water to the city
- However, many households were unwilling to incur the connection fee and the city continued to suffer from regular outbreaks of waterborne diseases.
- The city subsidized some connections – but these were not sufficient to cover most residents

# Solving the last mile problem: 19<sup>th</sup> Century New York

- Mortality rates only began to improve after a policy shift and institutional reform after 1866.
- This reform changed **incentives**: Policy shifted from subsidies to fines on wealthy property owners who did not connect their properties to the mains
- These fines were overseen by trusted **institutions**: enforcement was carried out by a newly established and independent health board

# Bad Contagion: The Spread of Disease



New York City's Department of Health shows the timeline of the city's mortality rate, which sharply dropped with the provision of clean water in the nineteenth century.

*New York City Department of Health and Mental Hygiene*



# A model of the complementarity between infrastructure and institutions

- In weaker institutional environments:
  - It maybe difficult to allocate **subsidies** without waste
  - **Penalties** maybe difficult to levy fairly and effectively
- These costs must be considered when designing the optimal policy response

# Optimal policy response depends on institutional constraints

- If **executive institutions are strong** and can run a subsidised water and sewerage programme without too much waste, **subsidies** may be optimal
- Alternatively, if the **judicial institutions** are strong (e.g. can limit risks of bribery and extortion), a **pure penalty system** may be preferred

# Optimal policy response depends on institutional constraints

- When **both the judicial** and **executive** institutions are weak, a **mixed system** may maximise the social net benefit
  - Penalties low enough to avoid extortion, with subsidies providing the remaining incentive.
- Finally, if both types of institutions are **extremely weak**, it may be necessary and socially optimal to **focus on improving institutions** before attempting to implement a solution to the last mile problem.

# Lessons for Lusaka

- If institutional capacity is limited in Zambia, subsidies alone cannot solve the last mile problem
- The optimal policy response to the last mile problem in Lusaka may therefore require a **mix of subsidies and penalties**
- There is also scope to improve **institutional capacity**:
  - Improving legal framework to protect water infrastructure
  - Protecting water provision from electricity outages
  - Cost-reflective tariffs and meeting operational costs of utility
  - More emphasis on enforcement of Public Health Act
  - NWASCO's role in enforcing health standards in communities
- Caveats:
  - Imposing rules on **landlords as opposed to tenants** may be more feasible
  - **Poorly defined property rights** may make it difficult to impose regulation

## 2. Infrastructure maintenance and supply consistency

- ‘Last mile problem’ on the extensive margin: Large infrastructure projects do not end at construction; maintenance is critical in order to ensure impact
- Evidence from experience of western cities - but robust empirical evidence is lacking—leading to an opportunity for Lusaka to serve as a learning city
- Measuring the impact of reliable municipal water supply is challenging:
  - Requires plausibly *exogenous* source of water supply interruptions
  - Requires high frequency outcome data

# Water, Health and Wealth

Professor Nava Ashraf, Professor Ed Glaeser, Professor Bryce Steinberg and Abraham Holland

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# Context

- Institutional constraints impede water supply in Lusaka:
  - Cost recovery difficult for LWSC due to water theft, loss and delinquent bill payments
  - Link between electricity outages and water outages
  - Inadequate legal framework to protect water infrastructure
- Theft and loss common to infrastructure projects in many countries – impedes ability of companies to provide consistent service
- We explore the welfare impacts when infrastructure providers are required to operate in second-best environments

# Research Question

- **What is the short-term impact of unexpected interruptions to piped water access on health outcomes and economic activity?**



# Empirical Strategy

- We explore how **unexpected**, temporary shocks to water supply affect:
  - Health outcomes
  - Economic Activity
- **Identification strategy:** We control for time invariant characteristic of the water districts (district fixed effect) as well as seasonal effects (month or week fixed effects)
  - Assumes that conditional on district and month/week fixed effects, timing of outages is random

# Data Sources in Lusaka

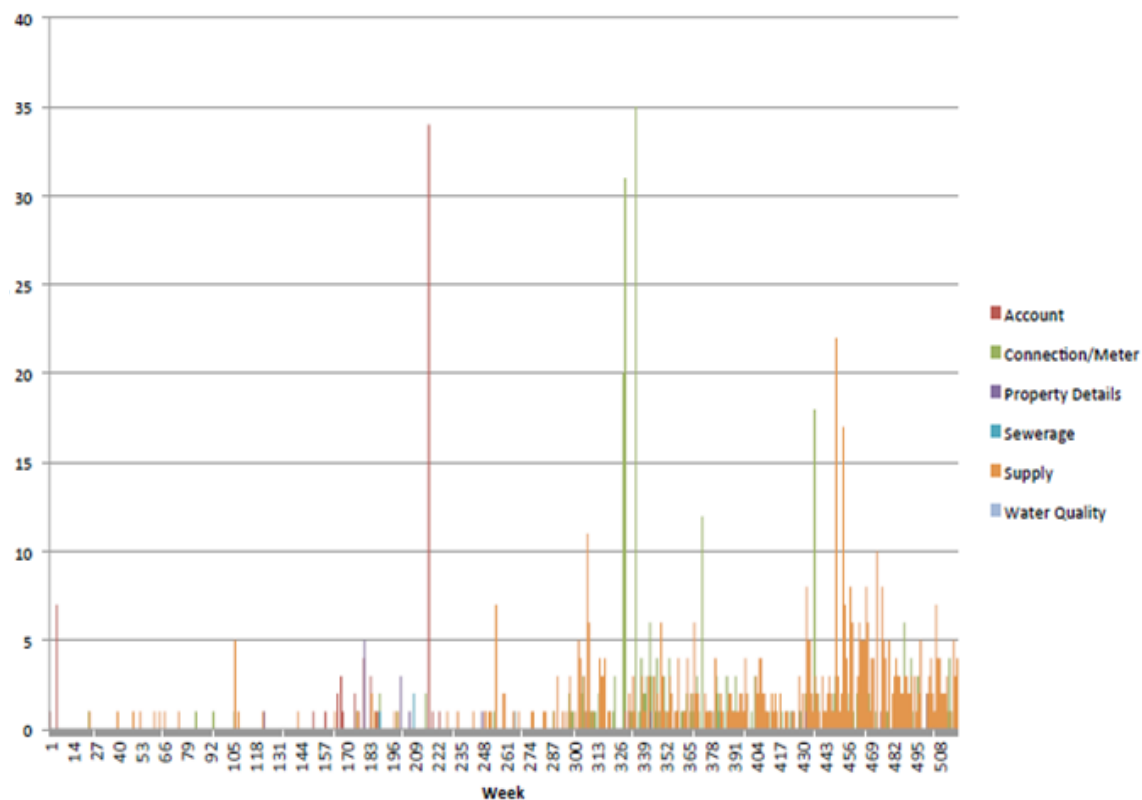
- Water
  - Lusaka Water and Sewerage Company (LWSC, est 1988) Call records from 70 (38) water service districts in Lusaka
- Health
  - Monthly clinic data on disease incidence and treatment from 21 health facilities across Lusaka
- Economic activity / Financial transactions
  - Zoonaa money transfer data
- All geocoded
- This project:
  - Compares places that all have access to piped water; use timing of temporary interruption among those with access
  - Geocoded data on health and financial transactions

# Water Supply Complaints Data

- Universe of recorded supply complaints from Lusaka Water and Sewerage Company
- 2000-2015
- Location, date, time, nature of interruption
- Used as a proxy for water interruptions
- Calculate the **total number of household-days with supply issues** per week/month:
  - The number of outstanding water supply complaints in each district per day, aggregated to the month or week level.

# Water Complaints Data

Complaints by week, Kalingalinga



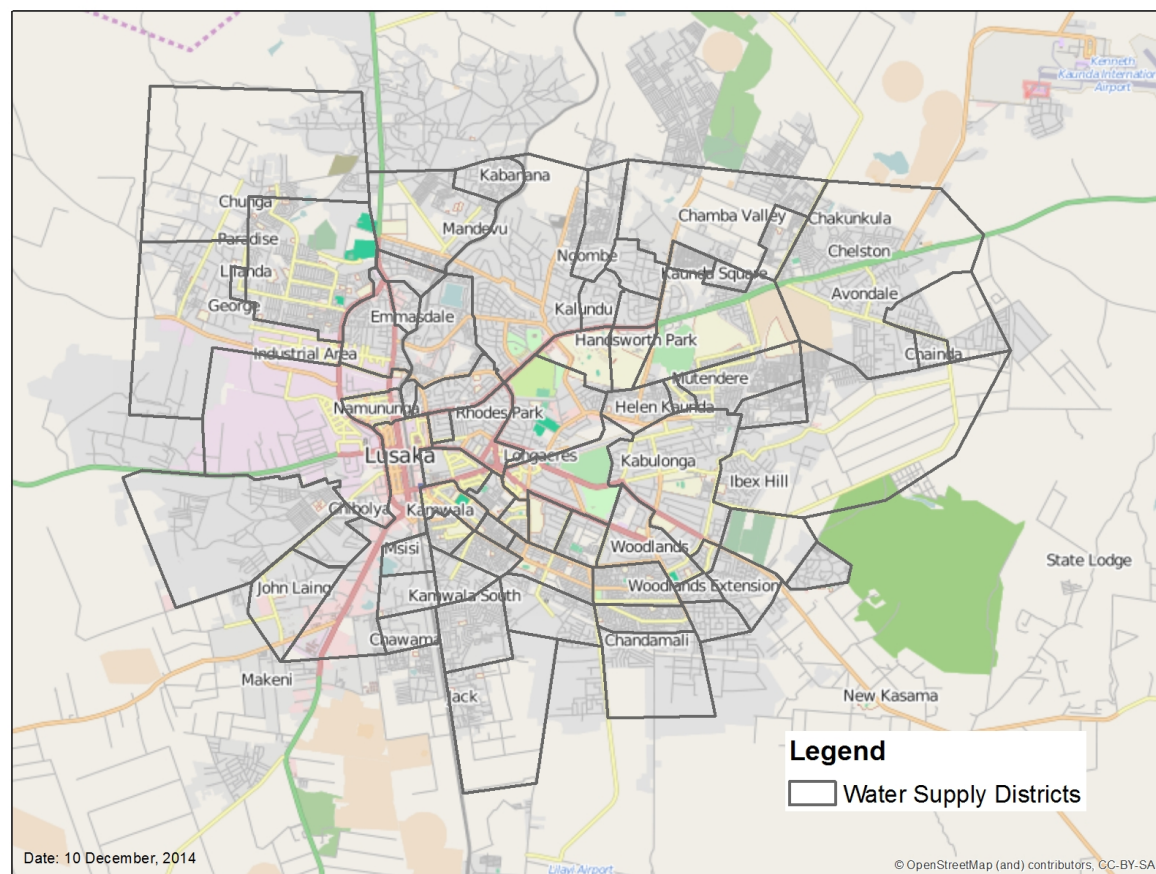
# Health Data

- Administrative data from Zambia Health Management Information System (HMIS)
- January 2009 -June 2014
- 21 geo-coded health facilities
- Collected by staff members at the health centers and clinics in Lusaka District
- Outcome Variables:
  - Diarrhea, typhoid fever, measles, upper respiratory infections – associated with contaminated water
  - Malaria – mosquitos
  - Intestinal worms – soil contamination

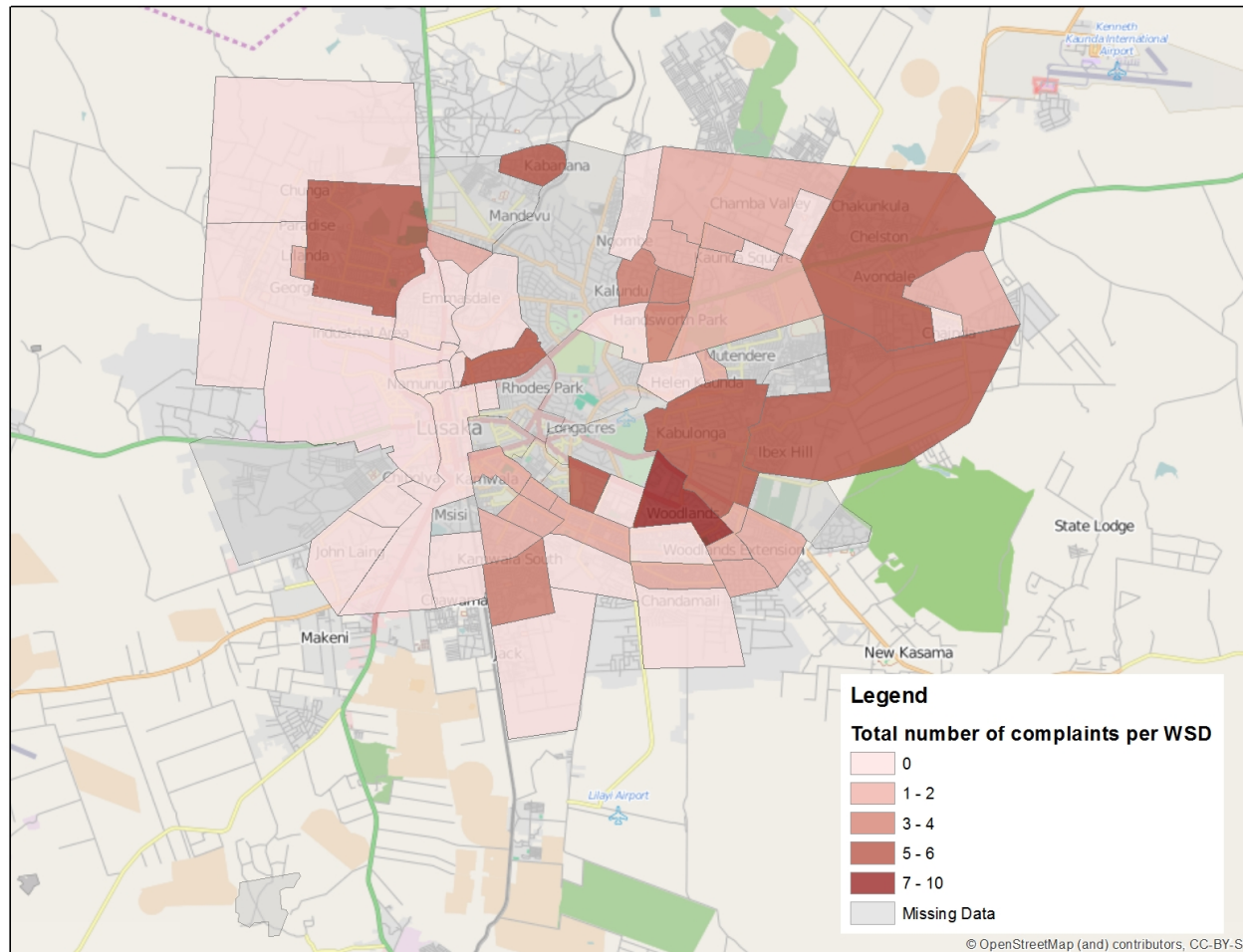
# Financial Transactions Data

- We use Zoonat transactions as a proxy for economic activity
- Zoonat is major platform for electronic money transfer in Zambia: on a monthly basis, Zoonat transfers 200,000 transactions valued at \$14 million.
  - Its prevalence and frequency make it an attractive source of data on financial activity
- We use the universe of transaction records from Zoonat, 2009-2015
  - 180 geo-coded Zoonat booths in Lusaka
  - 200,000 Lusaka residents used Zoonat in 2013-15

# Putting it all together: Water Supply Districts



# Putting it all together: Complaints

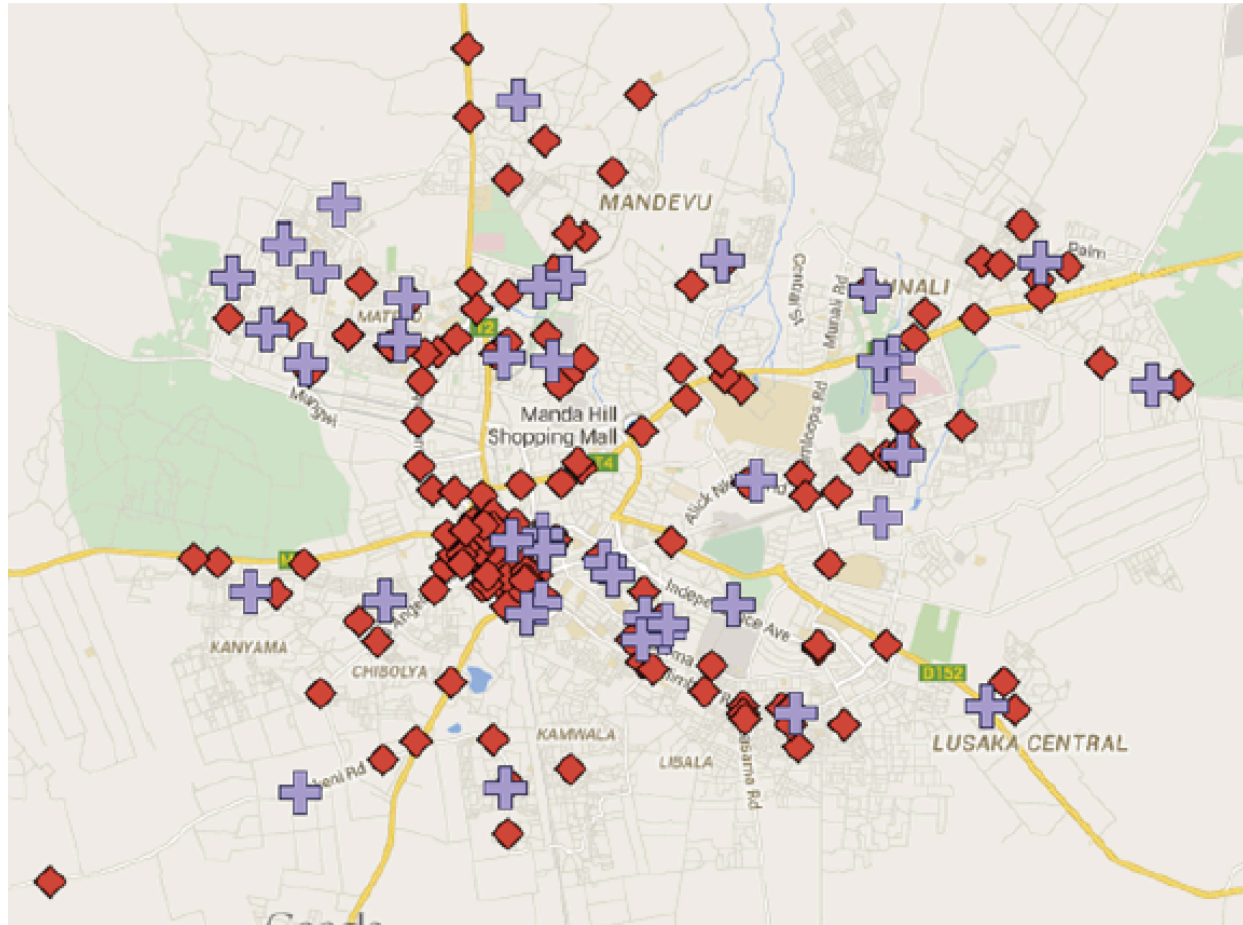




# Putting it all together: Zoon



# Putting it all together: Health Facilities



# Effects of supply outages on health outcomes

- We find outages lead to increased cases of diarrhea, respiratory infections, typhoid fever and measles
- Health impacts of intermittent clean water similar to health effects of not having access to clean water
- **Potential mechanism:** This evidence suggests that **Lusaka's residents cannot perfectly adapt to unexpected water interruptions**, as alternative sources of water seem to be unhealthy.
  - What are the water sources people rely on during unexpected water service disruptions?
  - How does it affect time use, especially of mothers and children?

# Effects of supply outages on financial transactions

- We find that outages cause a reduction in weekly financial transactions
- **Potential Mechanisms:** Based on qualitative interviews we identify two mechanisms behind this decrease in financial transactions:
  - Illness may reduce individual's economic activity
  - Water interruptions have a *time cost* as individual's must travel further to secure water
    - This displaces other household activities

# Effects of supply outages

- Our results highlight that policy makers need to consider infrastructure maintenance in conjunction with infrastructure expansion - both may have substantial welfare effects
- Strengthening institutions may be the path forward:
  - Better enforcement of contracts and policing of theft could facilitate cost-recovery for water providers – enabling and incentivizing them to invest more

# Conclusions

- Water infrastructure is vital to the growth and vitality of cities, but initial investment and technology are not enough
- The **last mile problem** needs to be resolved to realize full impact of infrastructure investment
  - Importance of institutions in determining the optimal policy response
- Policy makers also need to consider **maintenance and protection of existing infrastructure in parallel with planning for new investments** to ensure regular, consistent water access
  - Further inquiry into the mechanisms is needed: benefit of collaboration and co-generation of knowledge

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