

**STATISTICAL MODELING OF PUBLIC ATTITUDES
TOWARDS WATER INFRASTRUCTURE RETOOLING
ALTERNATIVES IN SHRINKING CITIES**

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Outline

- Motivation and Overview
- Study Objectives
- Survey Analyses and Statistical Modeling
- Results and Implications
- Contributions and Summary
- Limitations and Future Work



Motivation: Infrastructure in Shrinking Cities



**Source: Office Oswalt, Tim Rieniets, 2006.

Motivation: Infrastructure in Shrinking Cities

The 'shrinking cities' phenomenon has been **well studied by social and political scientists**

The **impacts on engineering and systems management** are only beginning to be appreciated

- Drivers of urban decline (e.g., Martinez-Fernandez and Wu 2009; Moraes 2009)
- Shifting from growth towards stabilization (e.g., Bontje 2004; Wiechmann 2009; Pallagst 2009)
- Transitioning land uses (e.g., Armbost et al. 2008; Masi 2008)
- Public views evaluating quality of life, abandonment, and vacancies (e.g., Greenberg and Schneider 1996; Bright 2000; Hollander 2010; Hollander 2011)

- Modeling **population dynamics** (Kabisch et al. 2006)
- Incorporating **green infrastructure** in vacant land (Schilling 2009)
- Impact of demographic changes on **service costs** (Schlor et al. 2009)
- Review of possible **infrastructure management** alternatives (Hoornbeek and Schwarz 2009)



Motivation: Infrastructure in Shrinking Cities

Infrastructure Utilization Spectrum

Underutilization

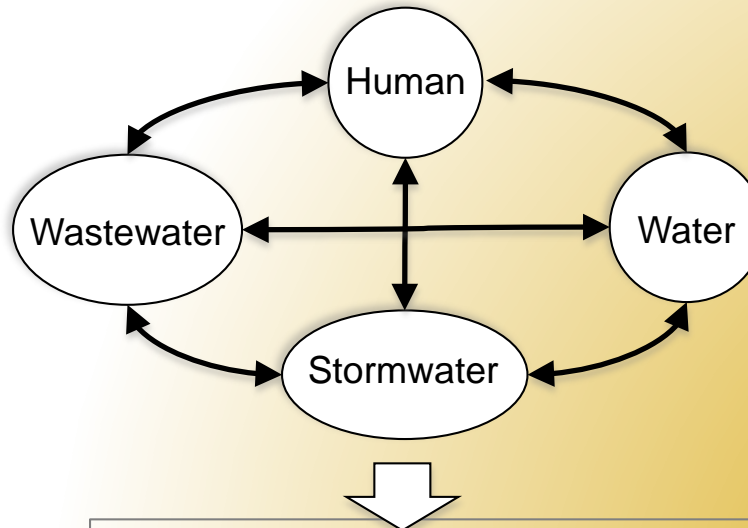
Design Capacity

Exceeding Capacity

Lack of knowledge regarding:

- Underutilization of built infrastructure
- Retooling alternatives
 - Technical viability
 - Performance and interdependencies
- **Public views about infrastructure issues and alternatives**

Assess the impact of urban decline on coupled human and water sector infrastructure systems



Technical viability of retooling alternatives

What are the public views towards different issues and alternatives?

Research Objectives

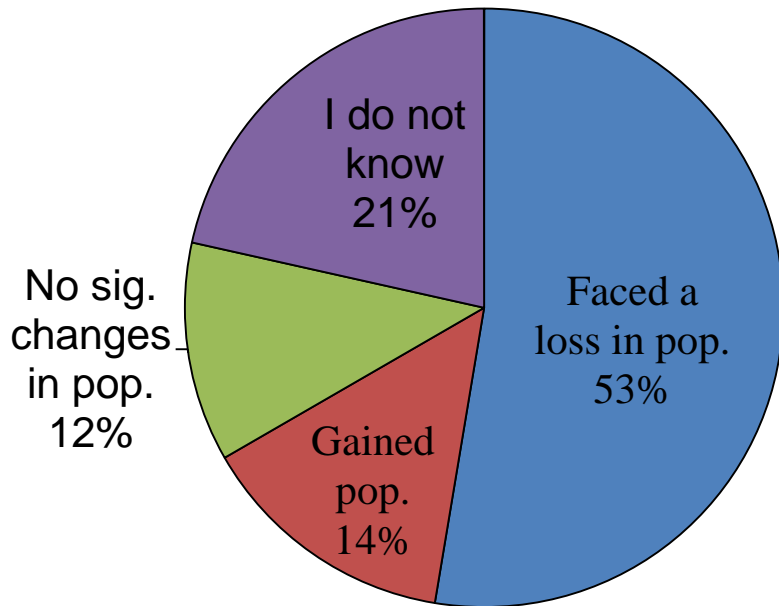
Evaluate the attitude of residents in shrinking cities towards select water infrastructure retooling alternatives

Retooling alternative → a physical, managerial, or operational change to the existing infrastructure intended to:

- Stabilize or reduce the cost of service
- Improve services

Final Sample Pool

455 complete responses from 21 shrinking cities



Over the past 4 decades,
my city has...

City	Number of Responses	City	Number of Responses
Akron, OH	16	Gary, IN	11
Baltimore, MD	21	Niagara Falls, NY	14
Birmingham, AL	22	Pittsburgh, PA	37
Buffalo, NY	44	Rochester, NY	26
Camden, NJ	5	Saginaw, MI	14
Canton, OH	10	Scranton, PA	11
Cincinnati, OH	39	St. Louis, MO	38
Cleveland, OH	55	Syracuse, NY	11
Dayton, OH	23	Trenton, NJ	10
Detroit, MI	19	Youngstown, OH	12
Flint, MI	18	Total	456

Impact of Awareness on Parameters Influencing Attitudes

Perception

I would support my city building a new water treatment plant

versus

Attitude

I think my city needs a new water treatment plant bordering my neighborhood

Interested in the attitudes towards the following retooling alternatives:

- Do nothing to the current infrastructure
- Repurpose infrastructure
- Raze or decommissioning infrastructure
- Invest in the maintenance of the current infrastructure
- Investing in more infrastructure

Impact of Awareness on Parameters Influencing Attitudes

Questions were to have binary results → “I think/do not think my city should implement the retooling alternative”

- Avoids decision paralysis
- Forces a decision

Evaluated various econometric and statistical models for the best fit

- Best fit determined by Akaike information criterion (*AIC*) and the Bayesian information criterion (*BIC*)
 - *AIC* → asymptotically efficient, minimizing mean square error → predictive criterion

$$AIC = -2 \ln f(y|\widehat{\beta}_k) + 2k$$
 - *BIC* consistent, identifies the model with most influential factors → descriptive criterion

$$BIC = -2 \ln f(y|\widehat{\beta}_k) + k \ln n$$
- Binary probit model → best fit for all questions

$$P_i(YES) = \Phi\left(\frac{\beta_{YES}X_{YESi}}{\sigma}\right)$$

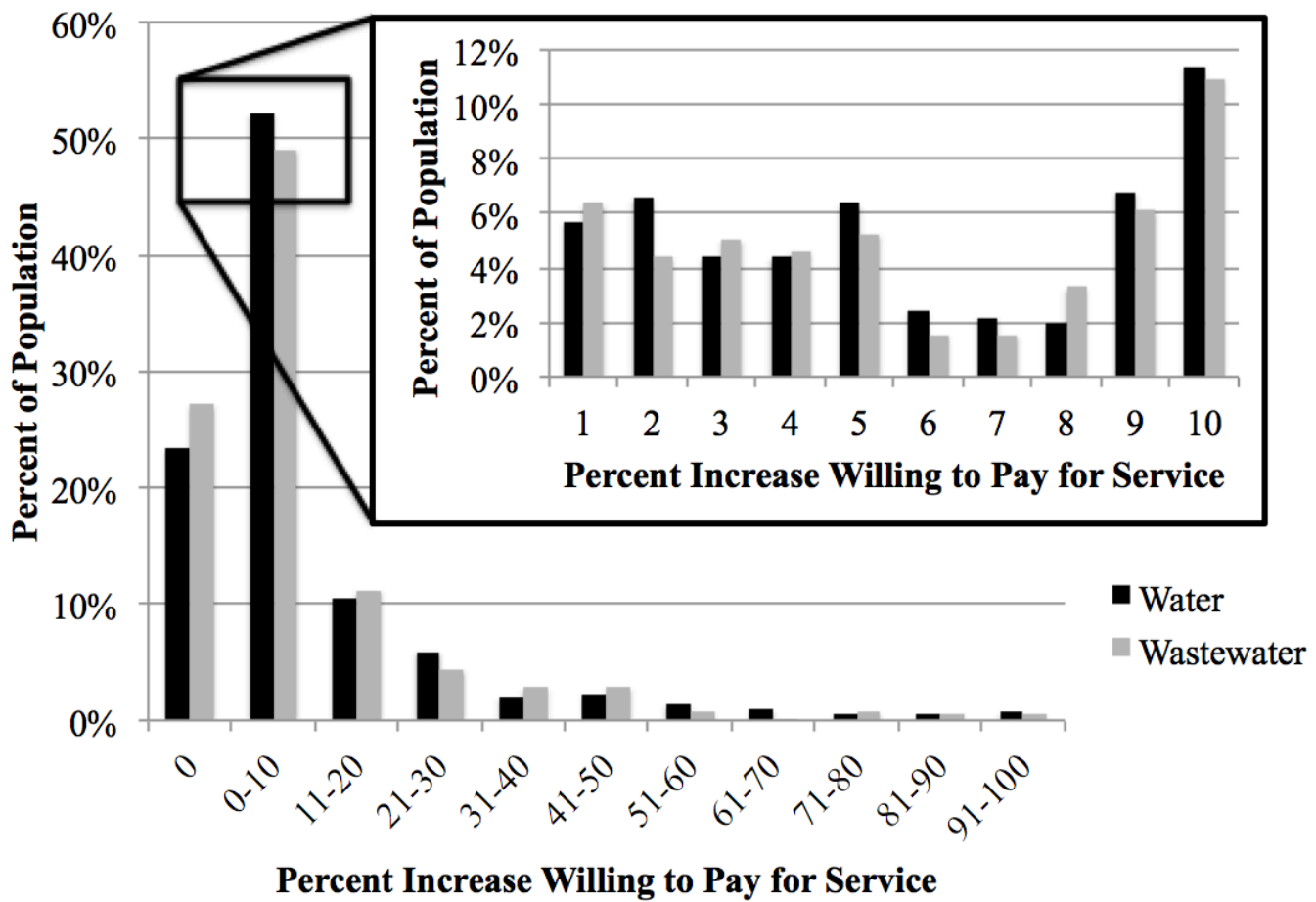
Raw Data

- 18% → no interest in the decision-making process for water infrastructure needs
- Approx. 20% → did not trust their water provider to make appropriate decisions
 - Potential for opposition or unstable relationships with the public in the absence of participatory involvement

Raw data at a glance:

- 61% → male
- 47% → over 50 years old
- 58% → income less than \$35,000
- 60% → grew up in city currently residing in
- 71% → responsible for water bill
- 31% → rent household
- Average number of cars → 1.49

Willingness-to-Pay



Location Parameters

Agree with the implementation of:

Residents of:

- **Cleveland, OH** → invest in **more infrastructure**
- **Gary, IN** → invest in **more infrastructure**
- **Trenton, NJ** → invest in **more infrastructure**
- **Flint, MI** → **raze** or **decommission** infrastructure
- **Scranton, PA** → do **nothing**

Disagree with the implementation of:

Residents of:

- Shrinking cities in **Ohio** → **razing** or **decommissioning** infrastructure
- Shrinking cities in **Pennsylvania** → investing in the **maintenance** of current infrastructure
- **Trenton, NJ** → investing in the **maintenance** of current infrastructure

Demographic Parameters

Age

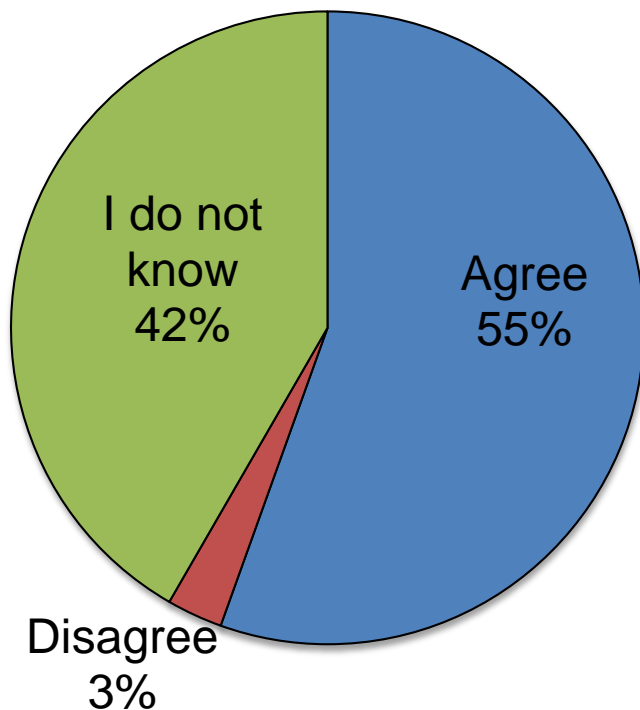
- >35 years old
 - Agree with investing in the **maintenance** of infrastructure
 - Disagree with **doing nothing**
- >50 years old
 - Disagree with **repurposing infrastructure**
- **Men** and **single individuals** → Agree with **repurposing infrastructure**
- **Income < \$35,000**
 - Agree with investing in **more infrastructure**
 - Disagree with **doing nothing**
- **Employment status: Out of work**
 - Agree with investing in the **maintenance** of infrastructure

Demographic Parameters

- **Ownership of cars**
 - Disagree with **doing nothing**
 - 2+ cars in household → agree with **decommissioning** or **razing** infrastructure
 - 1+ cars in household → agree with investing in the **maintenance** of infrastructure
- **Ownership of household**
 - Renters → disagree with investing in **more infrastructure**
 - Own via loan → agree with **doing nothing**
- **Responsible for water bill** → Disagree with **doing nothing**
- **Grew up in the city** → Disagree with **doing nothing**

What Can We Do This Information?

The physical water infrastructure footprint in my city impacts the cost of my water bill...



- Identify communication and knowledge gaps
- Information provided by utilities to consumers
- Identify sources of opposition
- Tailor information for demographic groups
- Narrow decision space to alternatives more likely to be adopted
- Outreach

Summary

- Underground infrastructure are **unseen** → **lack same level of awareness** as other infrastructures
- Consumers are **sensitive to price changes** (price elasticity) → consumer behavior directly tied to service provided
- Retooling alternatives → potential to **reduce/stabilize costs** of service
- Public support critical for **successful implementation** of alternative
- Analyses show factors **influencing attitude**:
 - Understand sources of opposition
 - Tailor information
 - Determine initial viability of retooling alternatives

Contributions

- Illustrate the viability of using **survey analyses** and **statistical modeling**
- Qualitative and quantitative methodology → **insight into residents' knowledge**
- Parameters identified → **agreement/disagreement** towards retooling alternatives

Limitations

- Public attitudes captured for a moment in time → views are dynamic
- Limited number of retooling alternatives evaluated → 4 retooling alternatives + do nothing evaluated

Future Work

- Expand the number of alternatives evaluated
- In depth survey deployment for analysis of specific cities, states, or regions → identify local drivers, such as policy or management structure

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US cities may have to be bulldozed in order to survive

Dozens of US cities may have entire neighbourhoods bulldozed as part of drastic "shrink to survive" proposals being considered by the Obama administration to tackle economic decline.

Disappeared Detroit

Obama to Bulldoze Cities? Shrinking Cities Bulldozed by Obama Detroit Learns Hard Lesson that Shrinking Cities Should Not Build Houses

The New York Times

U.S.

WORLD U.S. N.Y. / REGION BUSINESS TECHNOLOGY SCIENCE HEALTH
POLITICS EDUCATION BAY AREA CHICAGO TEXAS

Razing the City to Save the City

CITIES, TOWNS, TRANSPORT | GO LOCAL | THE GOOD LIFE

The Road to Right-Size Cities

What post-industrial cities can learn from rural America about smart

Should We Bulldoze the 'Burbs?

Obama administration proposes study about shrinking cities by bulldozing emptier area

A debate has ensued about whether to raze neighborhoods that have fallen into economic decay.

Shrinking the City

April 16, 2010 by Sarah

June 30, 2009 | A story last week in the Telegraph, a British paper, describes

Burning Down Detroit (Why razing much of Motor City might help Michigan's economic woes)

The New Yorker | 12/14/2009 | Ben Demme

Thank you! Questions?