Exploring health outcomes as a motivator for low carbon cities: Implications for infrastructure interventions in Asian cities

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INTRODUCTION

Our IGERT focuses on the design, analysis, and diffusion of sustainable urban infrastructures of the future, through participatory community efforts and integration across the disciplines of engineering, architecture, planning, public affairs, health and behavioral sciences.

TRAINEE RESEARCH: Infrastructure Development for Healthy & Low Carbon Cities

• **Rationale:** Asian cities will dominate future urbanization and global greenhouse gas (GHG) emissions. Accompanying rapid urbanization is even faster growth in populations residing in slums (currently double the growth rate of overall urban population).

• **Current infrastructure condition in Asian cities is poor.** In Delhi, India: 16% of households lack access to drinking water taps; 6% lack access to latrines; 8% use solid fuels for cooking.

This picture (left) depicts children in a slum area of Delhi, India playing in a blackened waterway filled with open sewage. This area lacks many basic amenities such as garbage disposal facilities, adequate water and sanitation infrastructure, and access to urgent health care services.

• **Urban air quality and water quality is also bad**. Delhi average pollutant concentrations can be up to four times higher than national outdoor air quality standards for residential areas; and up to eighteen times higher than drinking water quality standards.

• **Public Opinion** surveys in China suggest current local health risks from infrastructure and infrastructure-related environmental factors may directly motivate low-carbon development, even without future (uncertain) climate considerations.

OBJECTIVES

My overall thesis explores the intersection between human development aspirations (e.g. reduced mortality) and low-carbon infrastructures in cities and aims to develop a decision tool that helps prioritize infrastructure interventions based on public health benefits while also computing the level of carbon mitigation that may be achieved (or not) as a result. To address this objective, we begin by exploring the extent to which current civil infrastructures (i.e., water, sanitation, energy, transport and building infrastructures) and environmental factors (e.g. air and water quality) associated with these infrastructures shape health outcomes in Asian cities using Delhi, India as a case study.

References

Sperling, J.B. & Ramaswami, A. 2012. Exploring health outcomes as a motivator for low-carbon city development: Implications for infrastructure interventions in Asian cities, Habitat International.

Ramaswami, A., & Dhakal, S. (2011). Low-carbon policies in the USA and China: why cities play a critical role. Carbon Management, 2(4), 359e362.

All other references available upon request.

METHODS

A case study of Delhi was conducted to explore the extent to which current urban health outcomes are shaped by infrastructure and infrastructure-related environmental factors:

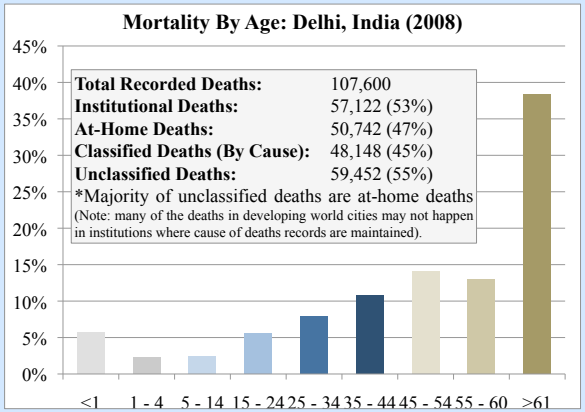
• First, **baseline annual mortality data** from multiple data sets are collected and analyzed to assess data quality and to understand how the various sources of data are different.

• Next, **associations between infrastructure and health** are identified through a combination of literature review and survey of local expert opinion.

• Third, **estimates of excess mortality were computed for the case of air quality where infrastructure/environment associations are well-understood** to demonstrate the scale of excess cardiovascular disease (CVD) deaths related to just a single environmental/infrastructure factor (particular matter or PM10), similar to other recent studies estimating excess mortality.

RESULTS

Baseline Annual Mortality:



Key Findings:

- 8% of deaths were of under-5 children, 54% of deaths were between ages of 5 and 60, and 38% were of those above 61
- Under-5 mortality rates per 1000 live births is quite high for Delhi at 25.7 relative to high income OECD countries at 5.6
- Additional comparisons across Delhi, Mumbai, and India below:

Comparative health indicators for Delhi, Mumbai, and India.

Health indicators	Delhi	Mumbai	India
Est. Annual Mortality Rate (Per 100,000 population)	629	689	989
Average Life Expectancy	72	71	69

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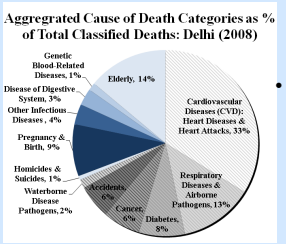
RESULTS CONTINUED…

Associations Between Infrastructure and Health:



Key Findings:

- The hatched portions (left) represent health outcomes with potential infrastructure-related linkages .
- As presented in table below, local experts were surveyed and made "best guesses" that 19% of classified deaths in Delhi, India could be related to infrastructure or infrastructure-related environmental factors.

Summary of local expert opinion on 2008 deaths.

Infrastructure & Environment-related health risk category *(% of classified deaths)*	Median % of deaths attributed to infrastructure & environmental factors by local expert opinion	Estimated % of All Classified Deaths in Delhi That May Be Related to Infrastructure
Heart Diseases & Heart Attacks *(32.9%)*	25%	8.2%
Airborne Disease Pathogens *(12.7%)*	25%	3.2%
Transport Accidents *(3.2%)*	100%	3.2%
Diabetes *(7.8%)*	35%	2.7%
Waterborne Disease Pathogens *(1.5%)*	50%–100%	0.35%–0.7%
Cancer *(6.4%)*	25%	0.7%

Estimating Excess CVD Mortality due to PM10 Reductions:

Mortality Reduction = Pollution Change x Effect Estimate x Incidence Rate x Population

→Pollution Change = annual change in PM10 in micrograms per meter cubed ($\mu g/m^3$)
→Effect Estimate = percent change in mortality from a certain effect per $\mu g/m^3$ of PM10
→Incidence Rate = baseline # of deaths / person / year from that effect
→Population = number of persons in a specific age group.

Sample Calculation for Cardiovascular (CVD) Deaths:

Mortality Reduction = 300 $\mu g/m^3$ x (0.043 / 100 $\mu g/m^3$) x (12,949 deaths/ 17,115,000pers) x 17,115,00 = **1670 excess deaths/year.** Note: this represents a 13% reduction in CVD deaths.

Reducing PM10 to levels in line with the national ambient air quality residential standard is estimated to reduce overall mortality by almost 4%.

CONCLUSIONS & IMPACT

"To develop low-carbon cities of the future, carbon mitigation potential must be combined with quantitative analysis of other benefits and co-benefits, including energy security & public health, suited to the overall goals of society." -Ramaswami & Dhakal, 2011

- Infrastructure intervention in the present time can reduce mortality by ~4% even in one action (i.e. reducing PM10)
- While further exploration using rigorous epidemiology data and methods is still needed, preliminary results suggest infrastructures can have a significant impact on health outcomes for developing country cities (estimated at 19%).
- Ongoing work is the development of a comprehensive decision tool that can help cities prioritize infrastructure interventions that can have significant impacts on improved health and low-carbon development in Asian and global cities.

FUTURE RESEARCH

- **Literature review and community study** to fill knowledge gaps and identify how access to healthcare affects health outcomes.
- **Final Product**: A decision-support tool for quantifying health benefits and GHG co-benefits of various urban infrastructure interventions.