Using satellite-derived $PM_{2.5}$ exposure estimates to assess neighborhood-scale health impacts

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Acknowledgements: HAQAST Hi-Res Tiger Team

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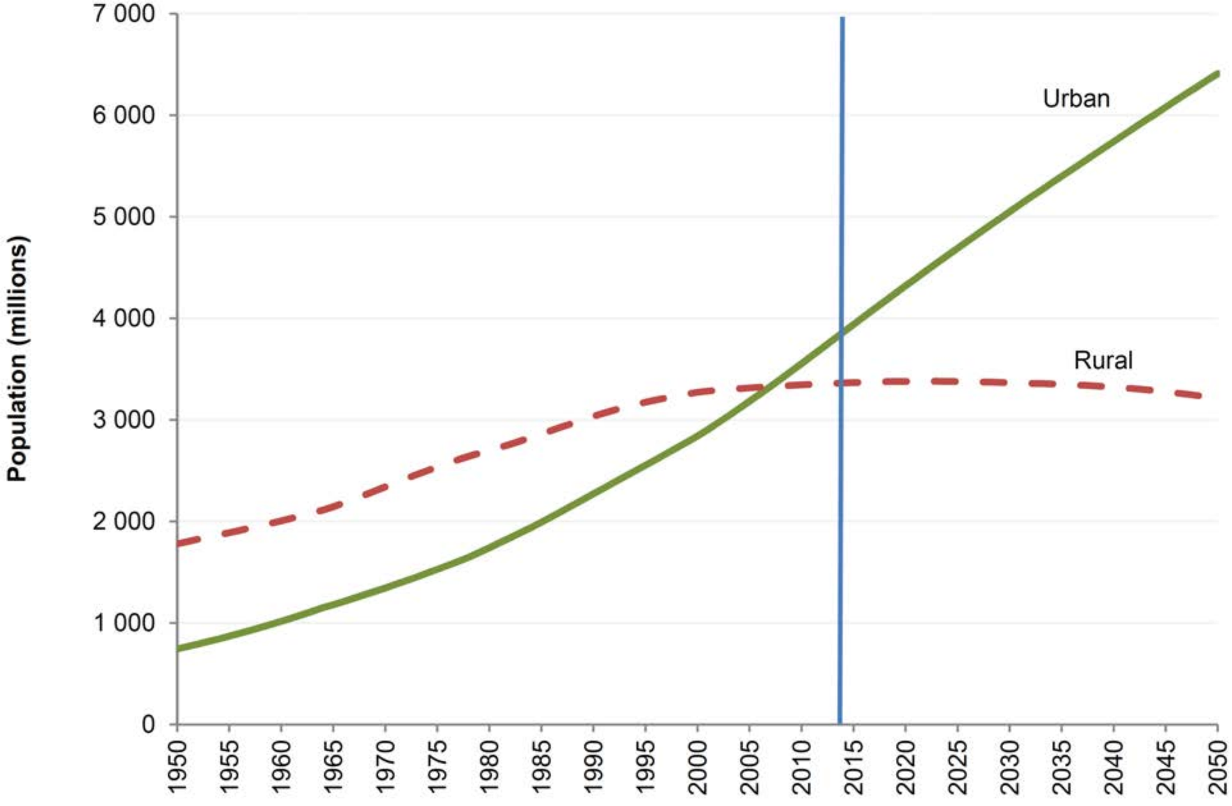
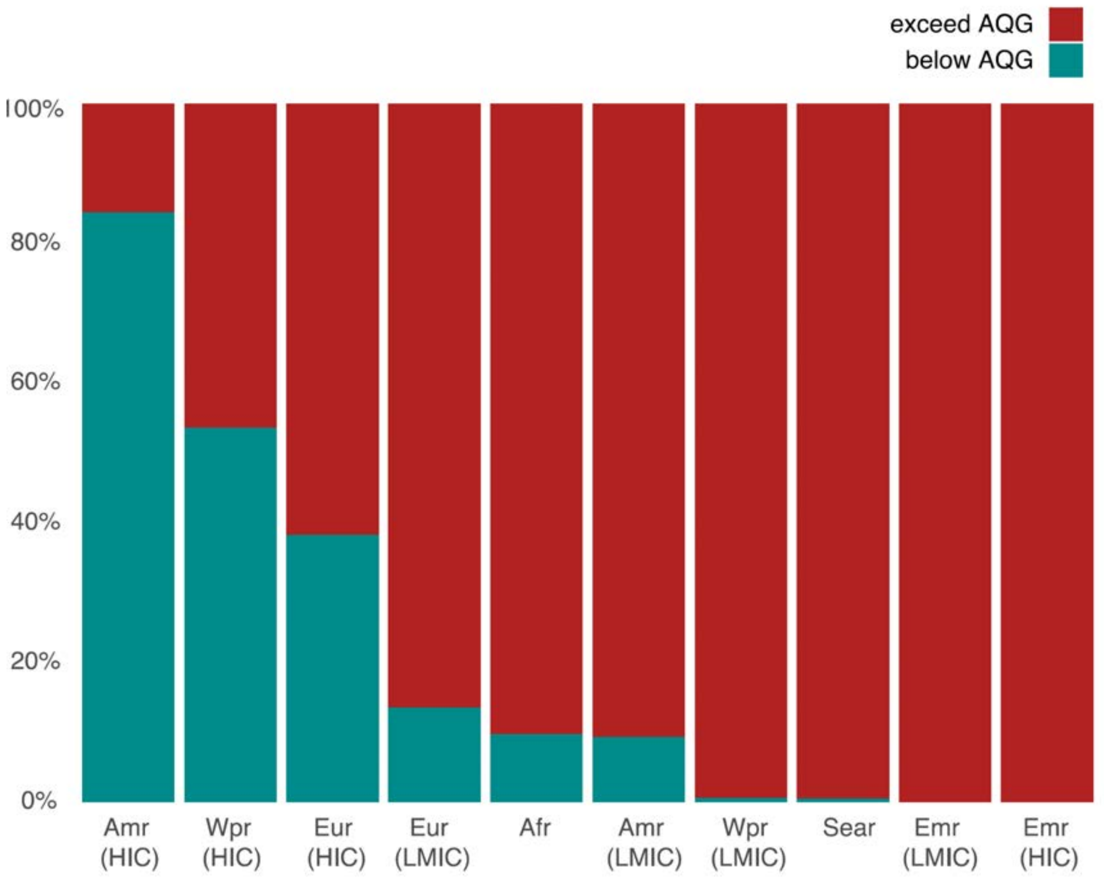
Growing importance of information on air pollution and health impacts in cities

2/3 of global population could live in urban areas by 2050, 90% of this increase in Asia and Africa



UN World Urbanization Prospects (2015)

Only 18% of the global urban population lives in cities where PM falls below WHO Air Quality Guideline (AQG)

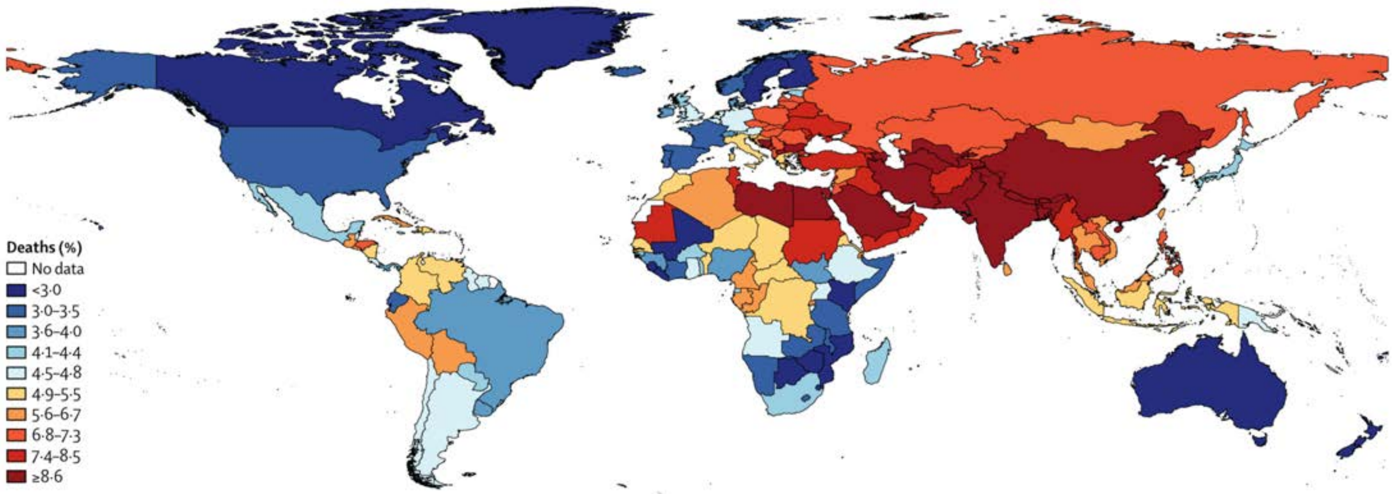


WHO Air Quality Database (2018)

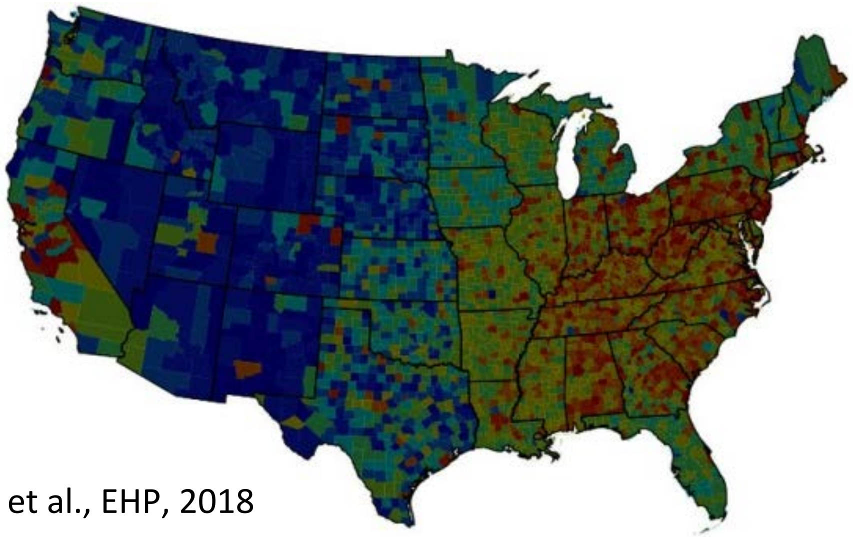
$PM_{2.5}$ disease burden estimated at different spatial scales

- How can cities use information on air pollution health impacts?
  - Evaluate against other risk factors
  - Assess health benefits of actions to reduce air pollution, greenhouse gases

- City-specific air pollution health impact estimates not widely available
  - Global burden of disease estimates reported at national scale
  - County level usually used in US
  - Some city-specific burden of disease estimates, but not globally consistent



Cohen et al., Lancet, 2017

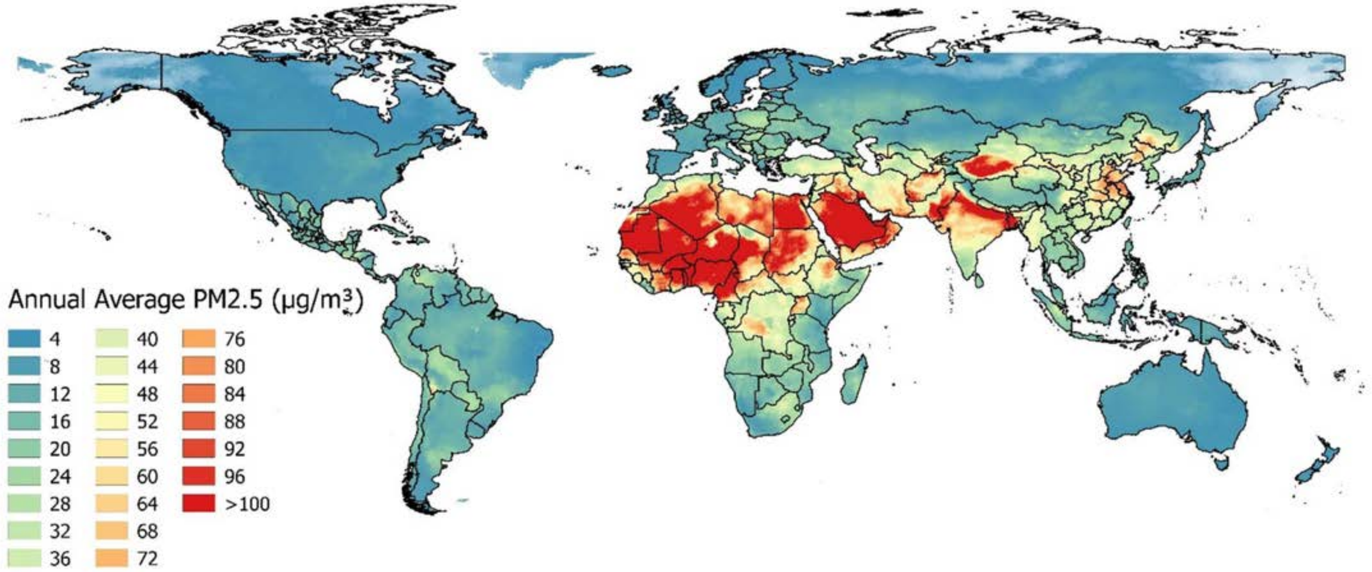


Fann et al., EHP, 2018

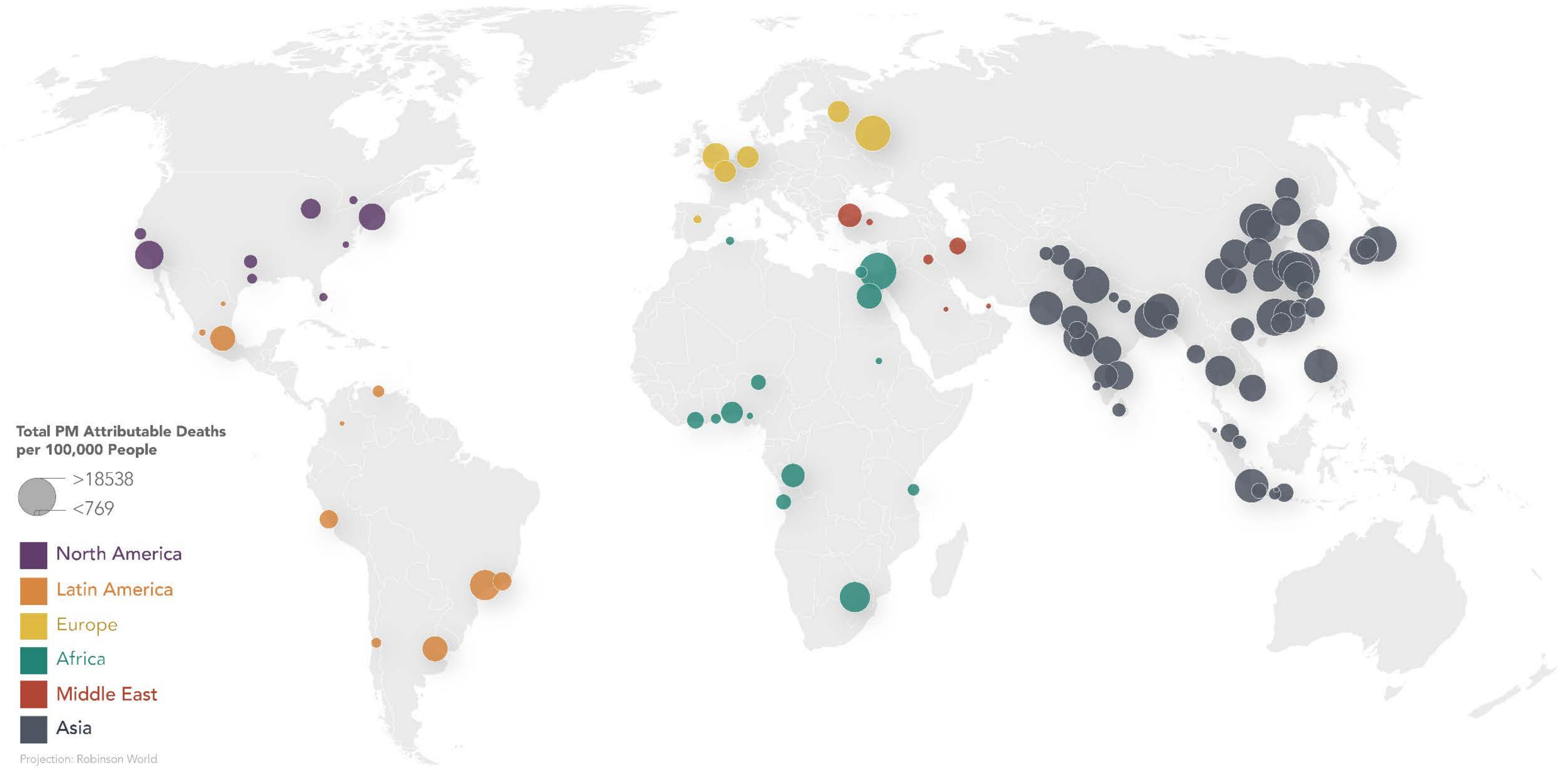
$PM_{2.5}$ burden of disease in cities globally

Methods designed for global consistency and compatibility with Global Burden of Disease (GBD) Study

- GBD 2016 global $PM_{2.5}$ estimates at 0.1°x0.1° - MODIS, MISR, SeaWIFS, CALIOP, GEOS-Chem, AERONET, ground measurements (Shaddick et al. 2018)
- GBD 2016 baseline disease rates (Institute for Health Metrics and Evaluation)
- GBD 2016 Integrated Exposure Response curves for $PM_{2.5}$
- NASA SEDAC Gridded Population of the World
- GHS-Pop urban built-up area

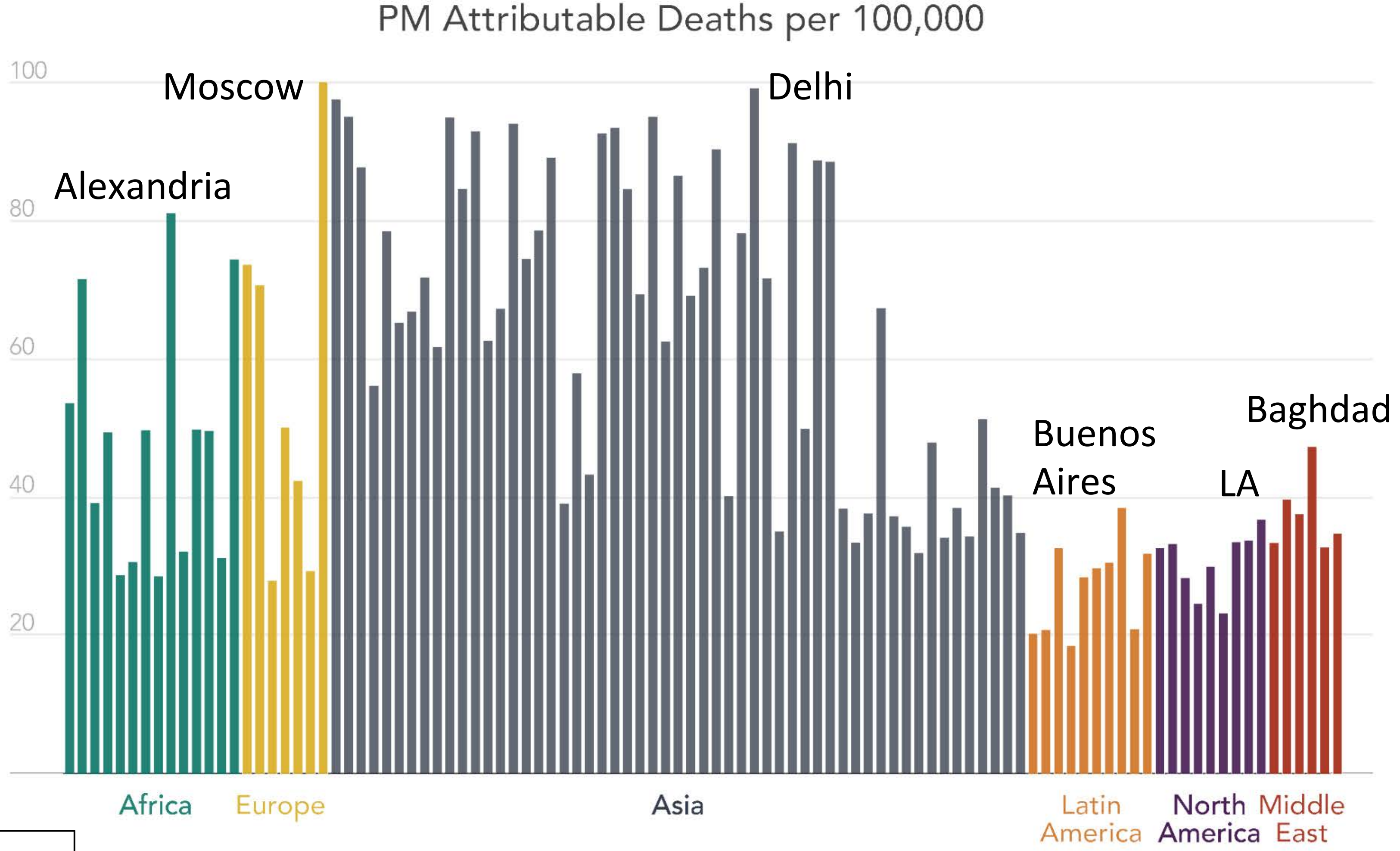


PM$_{2.5}$ mortality burden in 100 most populated cities



Preliminary results. Do not cite or quote.

Factor of 5 difference in rate of $PM_{2.5}$-attributable deaths among 100 most populated cities globally



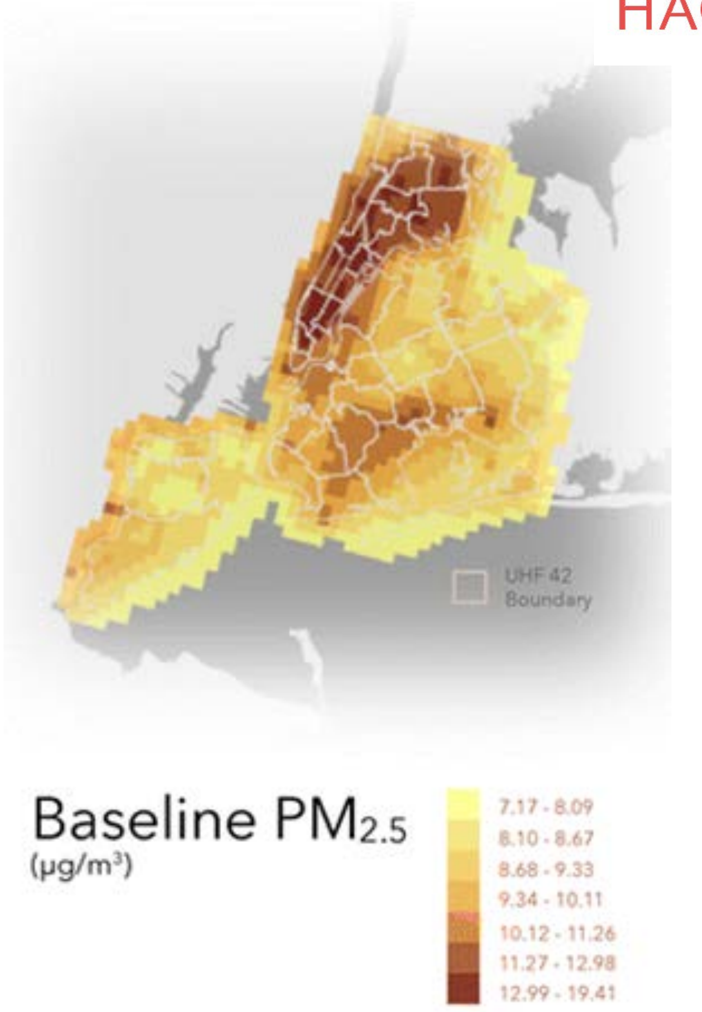
Ratio of highest to lowest

Africa	Europe	Asia	Latin America	North America	Middle East
2.8	3.6	3.1	2.1	1.6	1.4

Preliminary results. Do not cite or quote.

HAQAST Hi-Res Tiger Team: $PM_{2.5}$ health impacts

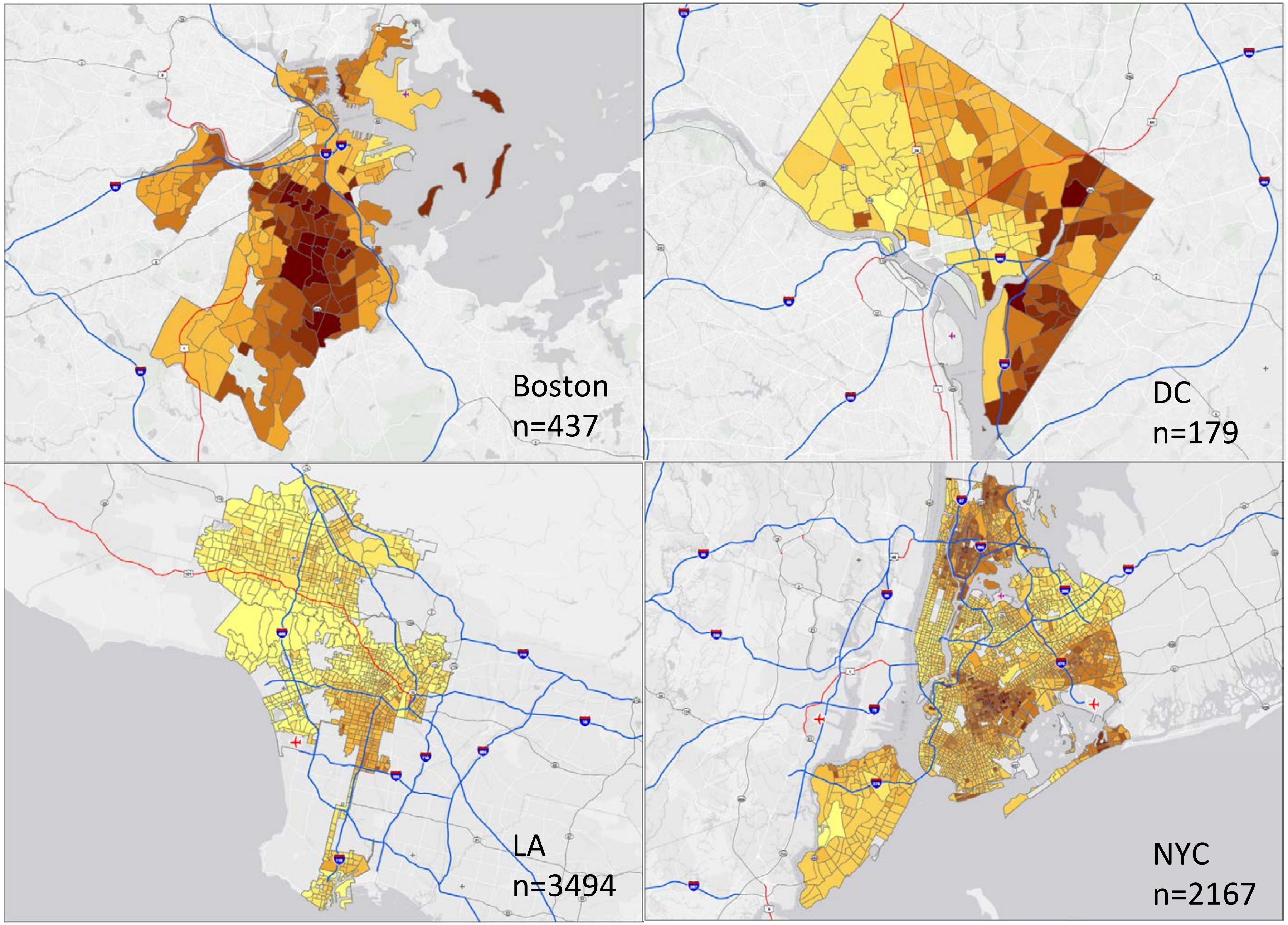
- Resolving $PM_{2.5}$ variation within cities can influence estimated health impacts
- Objective: $PM_{2.5}$ health impacts at neighborhood scale
  - Boston, Los Angeles, New York City, and Washington DC
  - Existing satellite-derived $PM_{2.5}$ concentrations at 0.01°x0.01° from van Donkelaar et al. (2016) for all cities (MODIS, MISR, SeaWIFS, CALIOP, GEOS-Chem, AERONET, ground measurements)
  - New MAIAC-derived $PM_{2.5}$ concentrations at 100m for NYC, scaled up to 250m
  - Census-tract level baseline disease rates from CDC
  - Block level population allocated to census tracts using PopGrid software
  - Health impact functions in BenMAP-CE software



Kheirbek et al., *Env. Health*, 2016
1km data from combining CMAQ with monitor values

Disease rates vary within cities: Asthma prevalence (2014) at census tract level

Similar data/maps available for other diseases



https://www.cdc.gov/500cities/

Identifying high risk areas: $PM_{2.5}$-attributable cases per 100,000 people

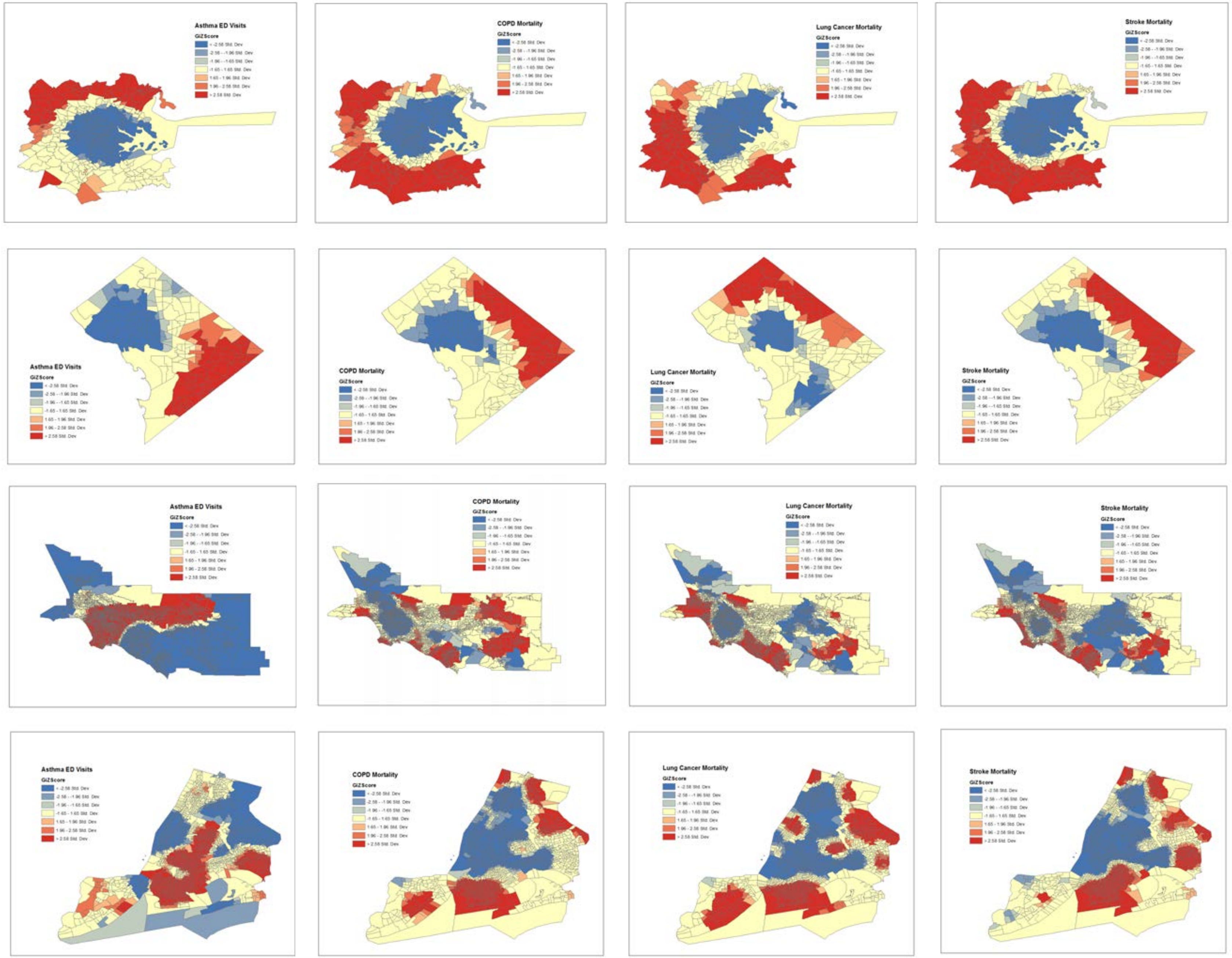
Asthma | COPD | Lung cancer | Stroke

Boston

DC

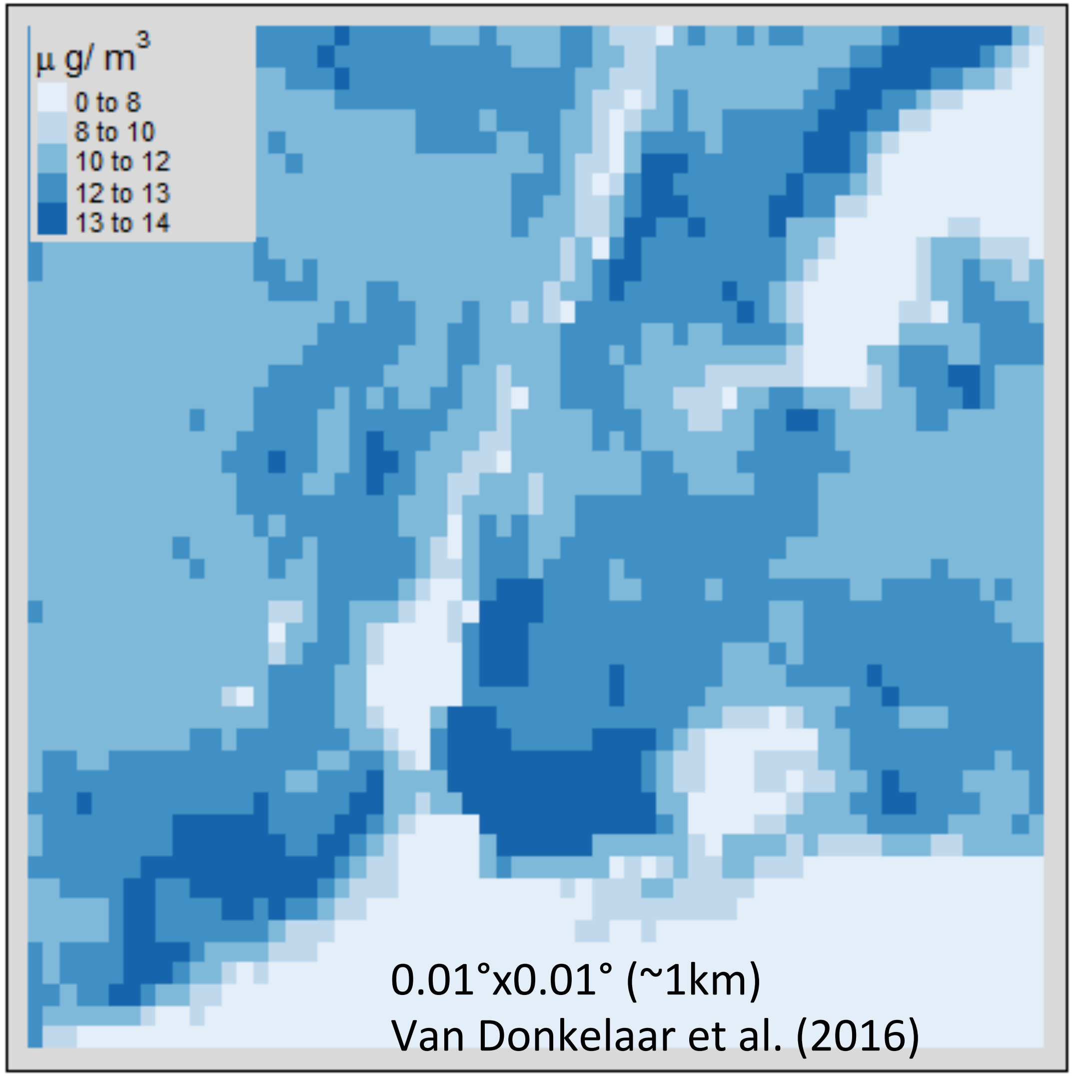
LA

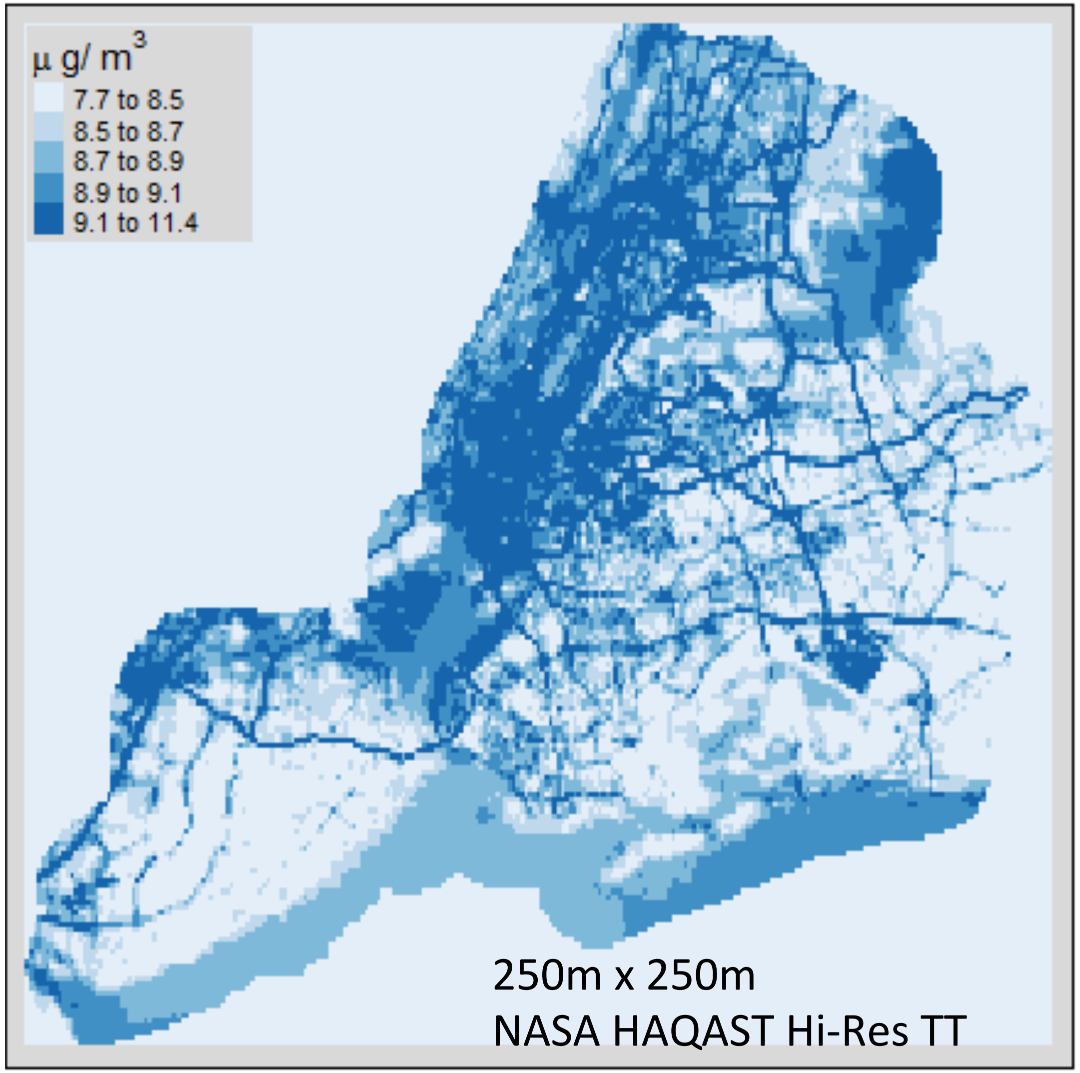
NYC



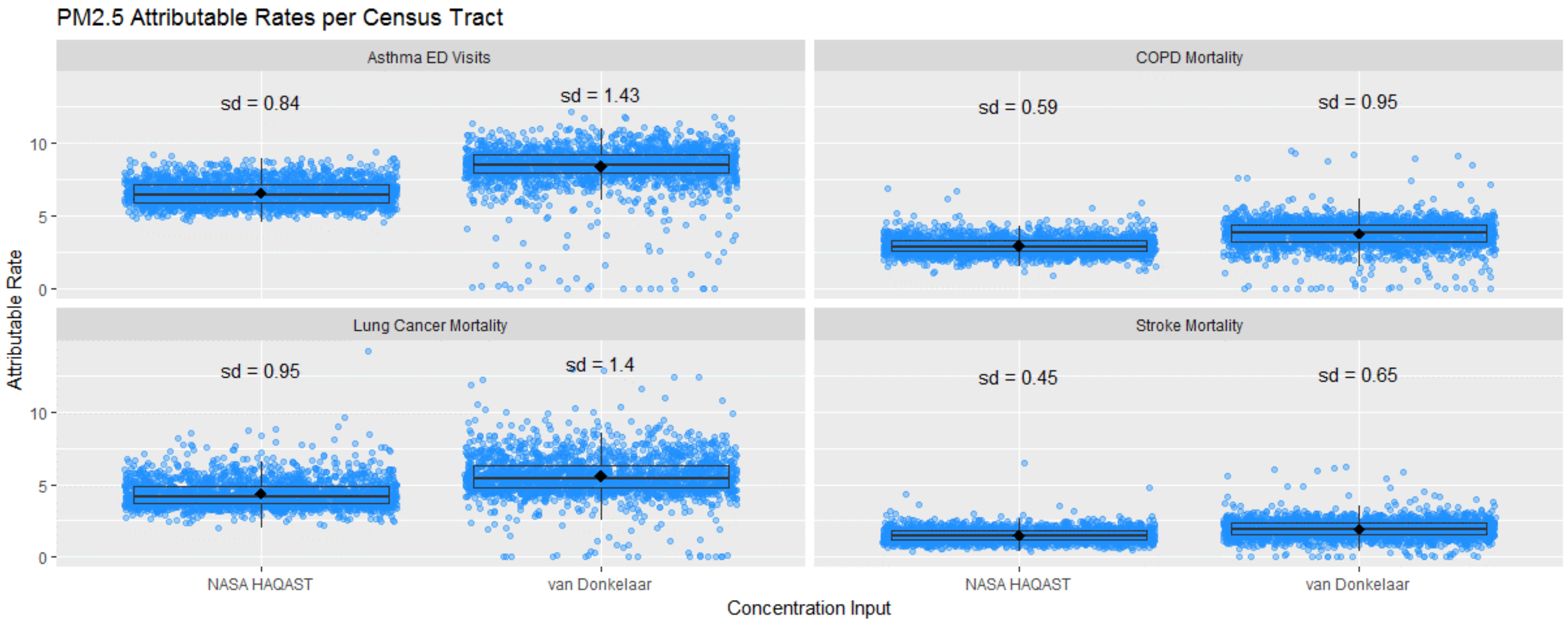
Preliminary results. Do not cite or quote.

Health impacts using two satellite-derived $PM_{2.5}$ estimates in NYC





Comparison of health impact results using HAQAST Hi-Res TT satellite-derived $PM_{2.5}$ estimates in NYC



HAQAST $PM_{2.5}$ (250m) | Van Donkelaar et al. (2016) $PM_{2.5}$ (1km) | HAQAST $PM_{2.5}$ (250m) | Van Donkelaar et al. (2016) $PM_{2.5}$ (1km)

Preliminary results. Do not cite or quote.

Conclusion

- These works in progress demonstrate how satellite-derived $PM_{2.5}$ estimates can be used to assess city-level burden of disease
  - Globally consistent estimates by city, compatible with GBD 2016 estimates
  - Neighborhood-scale impacts within cities, highlighting high risk areas
- Methods can be applied in any other city
- We are piloting results with stakeholders to determine the ways in which results can be used
  - Local governments
  - Air quality and health co-benefits of greenhouse gas mitigation (e.g. C40)
  - Track global progress on urban air pollution and health risks (State of Global Air, Lancet Countdown, Lancet Commission on Pollution and Health)
- Future improvements
  - Extend to ozone and potentially NO_2
  - New satellite-derived concentration estimates (MAIAC MODIS, TROPOMI)
  - Temporal trends

Thank you!

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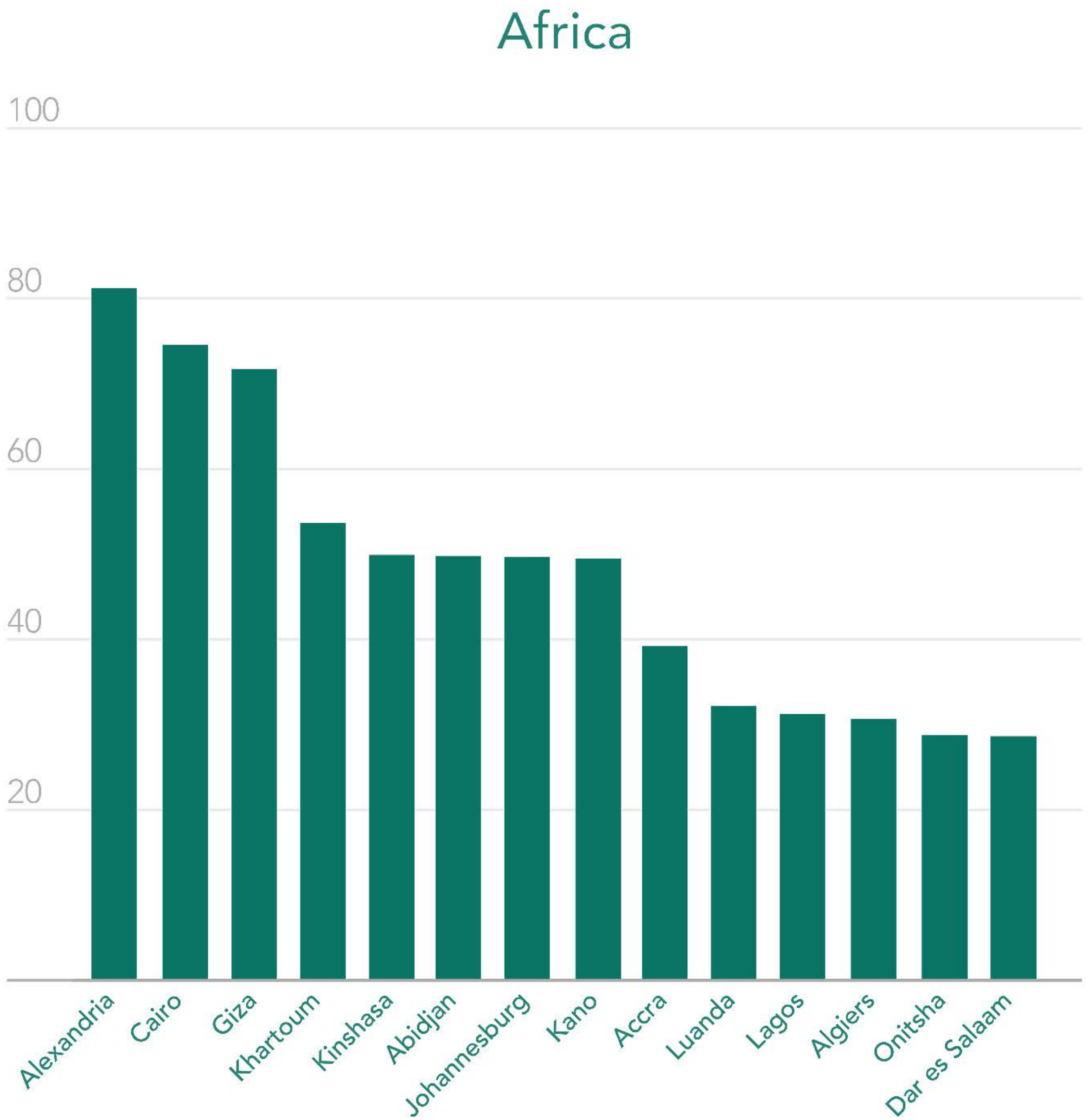
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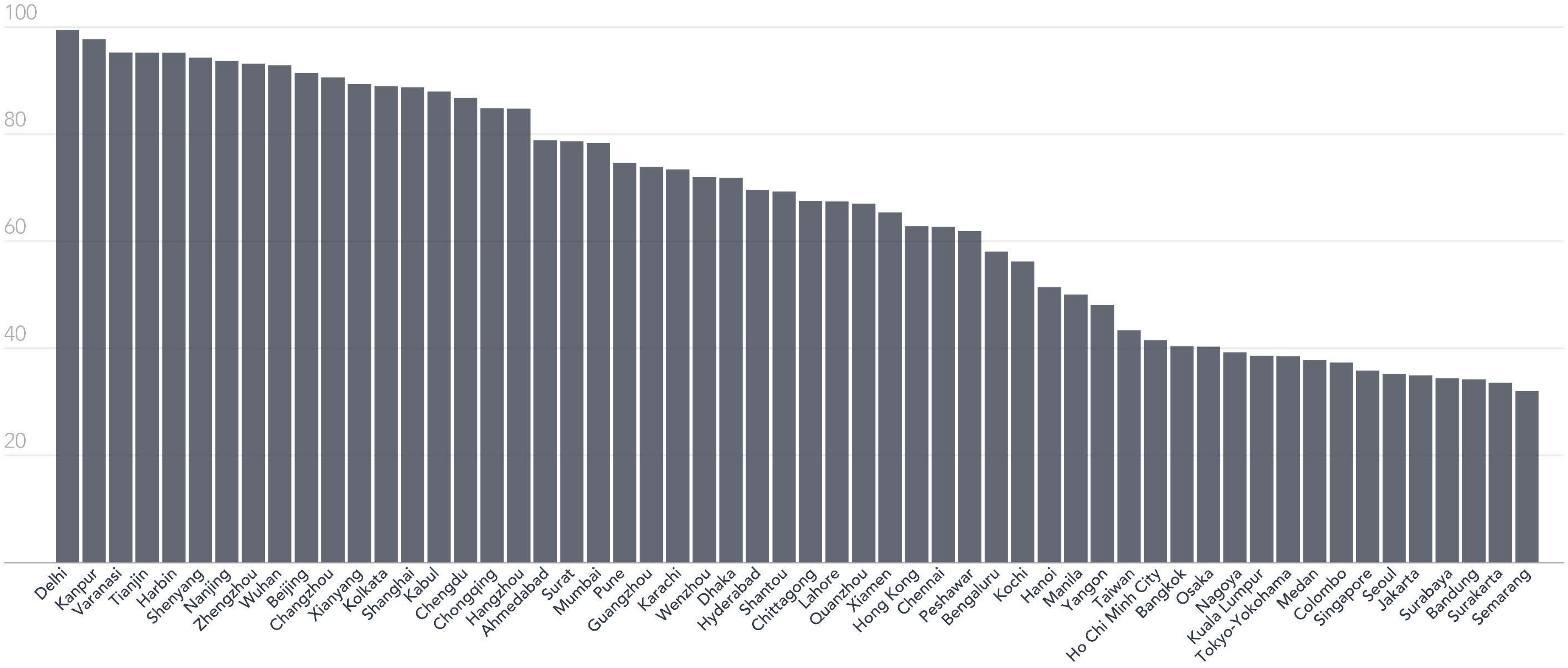
Asia



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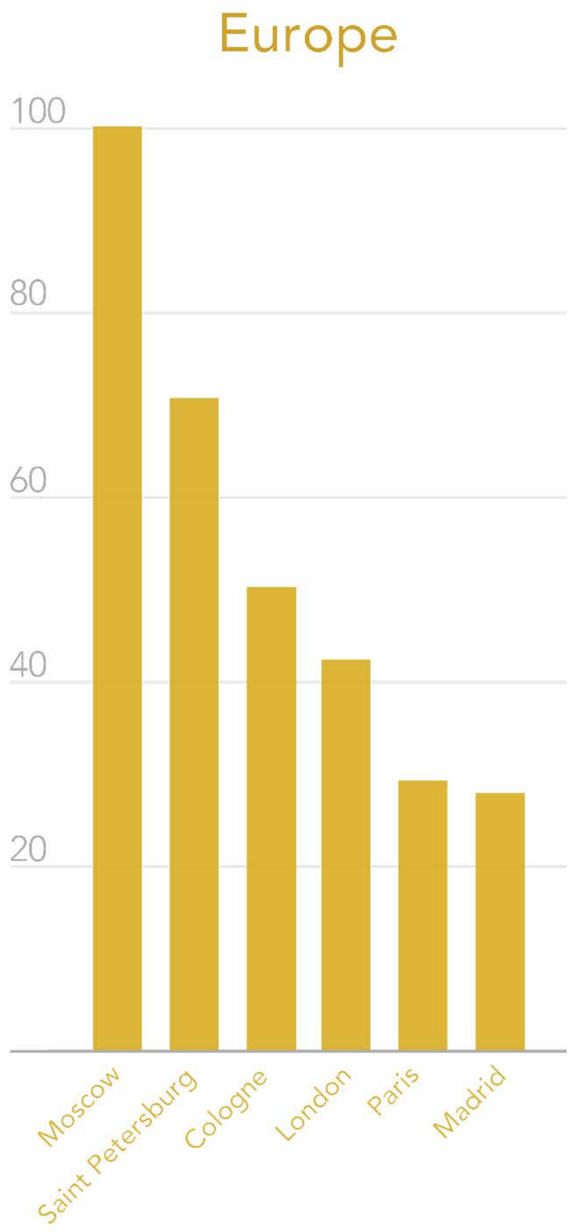
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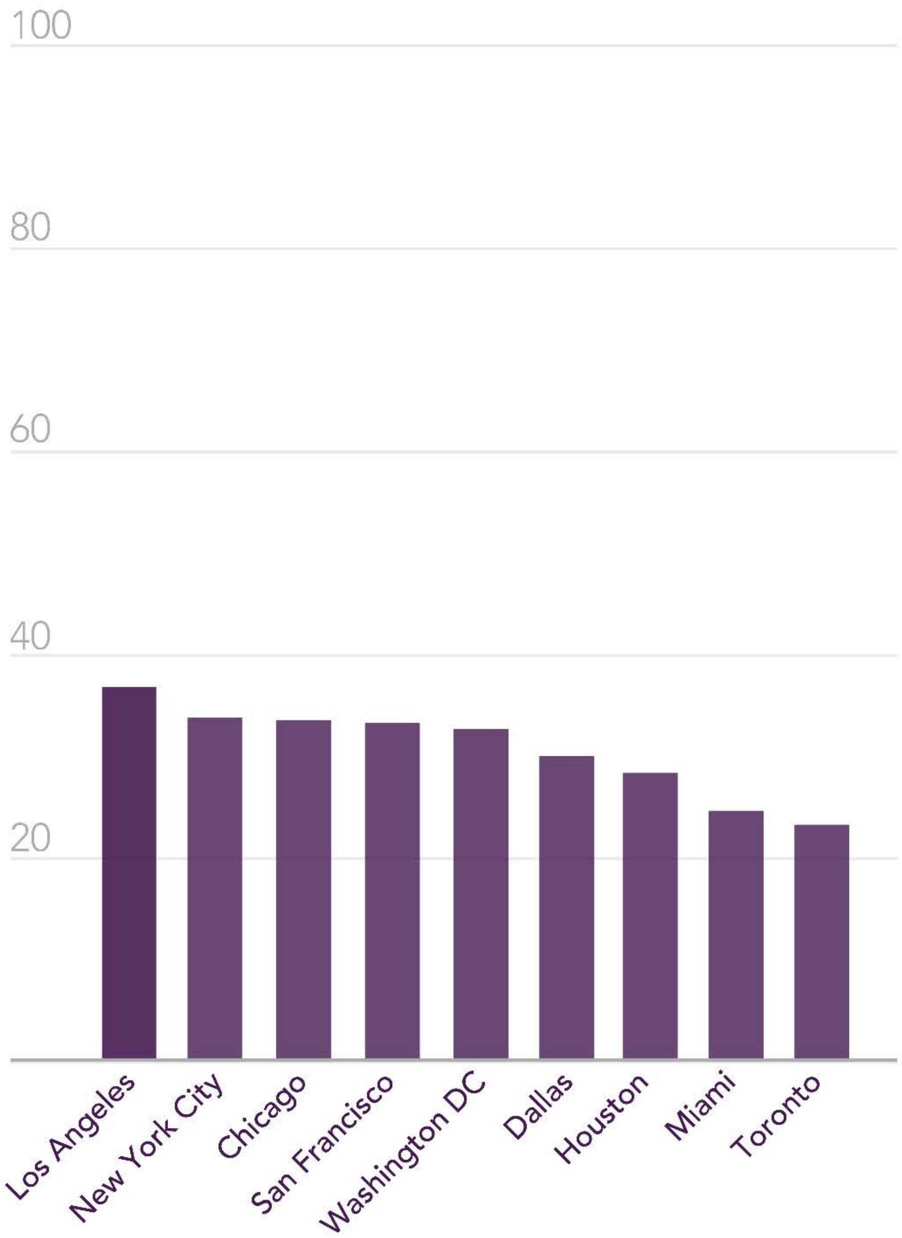
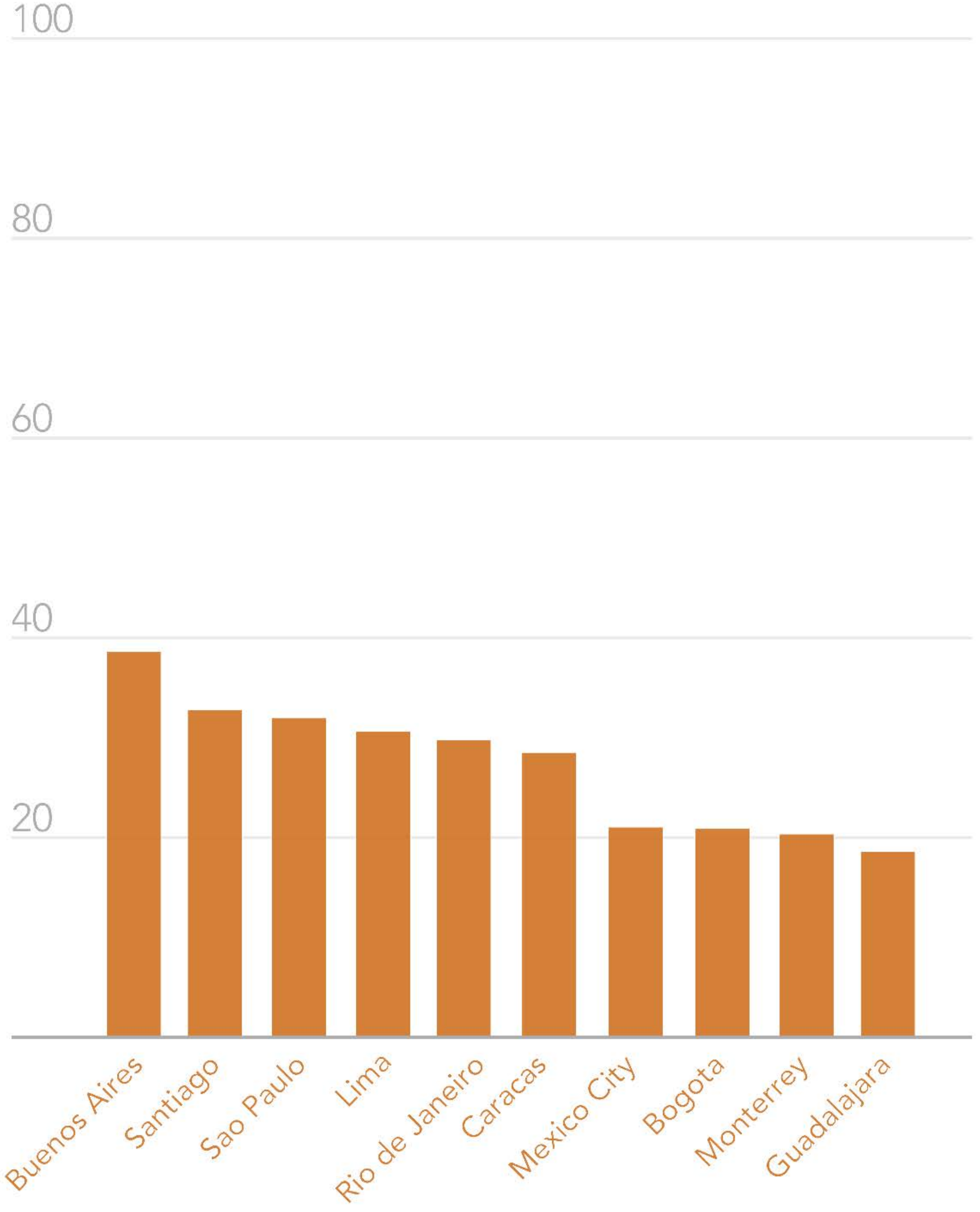
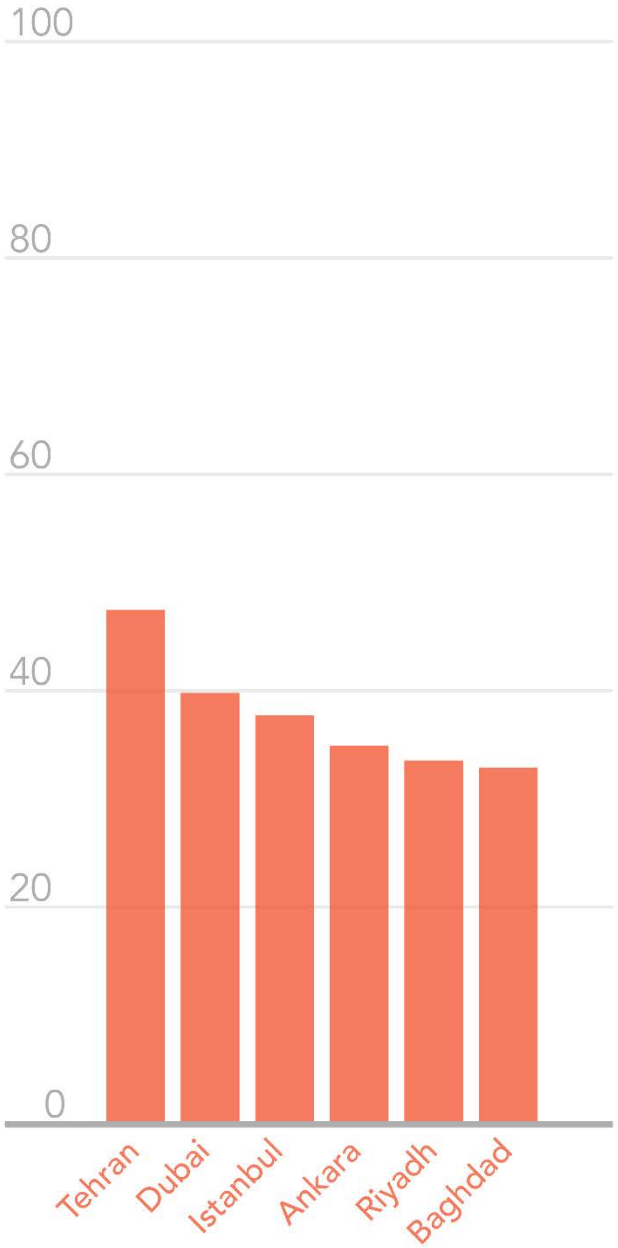


Latin America



Middle East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