

Tracking urban progress towards climate and environmental goals

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HAQAST Massachusetts

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Milken Institute School
of Public Health

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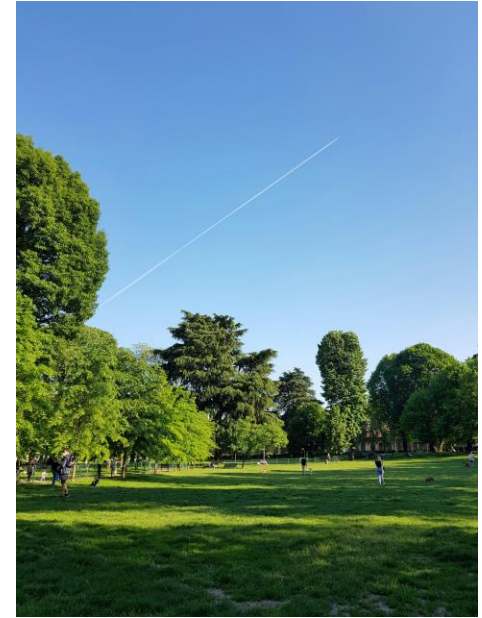
Urban climate and environmental goals



Greenhouse gases
Urban climate action plans



Air pollution
Ambient air quality standards
WHO guidelines



Natural spaces
C40 Urban Nature Declaration

Air pollution in 13,000 cities: Research to action

Long-term trends in urban NO₂ concentrations and associated paediatric asthma incidence: estimates from global datasets

Susan Caenenberg*, Arash Mohegh*, Daniel L Goldberg, Gaige H Kerr, Michael Brauer, Katrin Burkart, Perry Hyatt, Andrew Larkin, Sarah Wornik, Luk Lamsal

Summary

Background Our We aimed to es 1996–2019 at a 13189 cities from

Methods We sca model (based on from satellite an response functi incidence.

Findings We est were attributable 0–66–1–8 million from 19–8% (2– of 7–73 million America and the Asia, and Ocean East (+5%) and the change in NO₂ a

Interpretation E important contri a crucial elemen

Funding Health

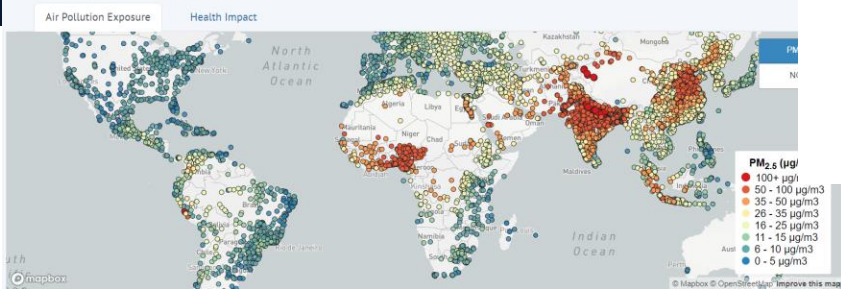
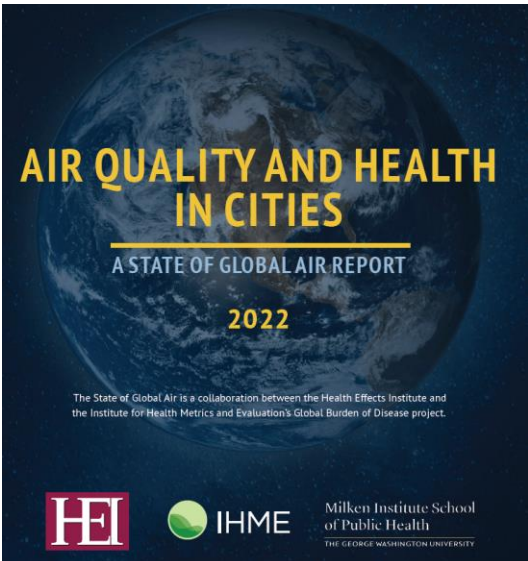
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Introduction Nitrogen dioxide is a pervasive air level ozone an leading contri Major anthropo non-road trans heavy, indium, aviation), power agriculture? "NI fuel combusti especially in urb be used to val regulations, as changes (eg, po and COVID-19) of diseases, including disease, lung cancer, a PM_{2.5} is now the leading global burden of dise leading contributor an in 1990, in part drive pollution and statu estimates of PM_{2.5} at global, regional, and nat the city scale where 55% a figure that is expect makers and non-gover Cities and ICII–local can benefit from inform

Funding NASA, Health and Air Quality Applied Sciences Team, the National Institute for Occupational Safety and Health, and the NOAA Co-operative Agreement with the Cooperative Institute for Research in Environmental Sciences.

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Introduction Decades of scientific literature have shown an association between exposure to tropospheric ozone, a harmful air pollutant, and short-term and long-term respiratory and cardiovascular diseases^{1–3}. The recent availability of fine resolution ozone surface estimates^{4,5} has enabled the estimation of ozone concentrations and ozone-attributable mortality burdens at global, regional, and national scales, along with their temporal trends.^{6–9} A study published in 2021 by DeLang and colleagues⁶ reported the first (0–1°) resolution estimates of global ozone season daily maximum 8 h mixing ratio (OSDMAR) concentrations from 1990 to 2017. The study applied Maximum Entropy and Bayesian Maximum Entropy Data Fusion (BME)¹⁰ in sequence to fuse ozone ground measurement data from the Tropospheric Ozone Assessment Report¹¹ and the Chinese National Environmental Monitoring Center Network, representing 8834 monitoring sites globally, with nine chemical transport model estimates. Authors subsequently examined temporal and spatial trends globally and found that ozone exposure is increasing worldwide. A positive trend in global population-weighted OSDMAR concentration over the period of 1990 to 2017 was attributed, in part, to strong positive trends in highly populated and polluted regions of Asia and Africa. Estimates of OSDMAR concentrations from the study by DeLang and colleagues were included in the Global Burden of Disease (GBD) 2019 study and were used to estimate ozone-attributable chronic obstructive pulmonary disease (COPD) burdens worldwide (865000 deaths).



Global burden and strength of evidence for 88 risk factors in 204 countries and 811 subnational locations, 1990–2021: a systematic analysis for the Global Burden of Disease Study 2021

GBD 2021 Risk Factors Collaborators*

Summary

Background Understanding the health consequences associated with exposure to risk factors is necessary to inform public health policy and practice. To systematically quantify the contributions of risk factor exposures to specific health outcomes, the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2021 aims to provide comprehensive estimates of exposure levels, relative health risks, and attributable burden of disease for 88 risk factors in 204 countries and territories and 811 subnational locations, from 1990 to 2021.

Methods The GBD 2021 risk factor analysis used data from 54561 total distinct sources to produce epidemiological estimates for 88 risk factors and their associated health outcomes for a total of 631 risk–outcome pairs. Pairs were included on the basis of data-driven determination of a risk–outcome association. Age–sex–location–year-specific estimates were generated at global, regional, and national levels. Our approach followed the comparative risk assessment framework predicated on a causal web of hierarchically organised, potentially combinative, modifiable risks. Relative risks (RRs) of a given outcome occurring as a function of risk factor exposure were estimated separately for each risk–outcome pair, and summary exposure values (SEVs), representing risk-weighted exposure prevalence, and theoretical minimum risk exposure levels (TMRELs) were estimated for each risk factor. These estimates were used to calculate the population attributable fraction (PAF); ie, the proportional change in health risk that would occur if exposure to a risk factor were reduced to the TMREL. The product of PAFs and disease burden associated with a given outcome, measured in disability-adjusted life-years (DALYs), yielded measures of attributable burden (ie, the proportion of total disease burden attributable to a particular risk factor or combination of risk factors). Adjustments for mediation were applied to account for relationships involving risk factors that act indirectly on outcomes via intermediate risks. Attributable burden estimates were stratified by Socio-demographic Index (SDI) quintile and presented as counts, age-standardised rates, and rankings. To complement estimates of RR and attributable burden, newly developed burden of proof risk function (BPRF) methods were applied to yield supplementary, conservative interpretations of risk–outcome associations based on the consistency of underlying evidence, accounting for unexplained heterogeneity between input data from different studies. Estimates reported represent the mean value across 500 draws from the estimate's distribution, with 95% uncertainty intervals (UIs) calculated as the 2.5th and 97.5th percentile values across the draws.

Findings Among the specific risk factors analysed for this study, particulate matter air pollution was the leading contributor to the global disease burden in 2021, contributing 8.0% (95% UI 6.7–9.4) of total DALYs, followed by

High SDI
Both sexes, 5–14 years, DALYs per 100,000
2021 rank

1 Low birth weight

2 Short gestation

3 Bullying

4 Iron deficiency

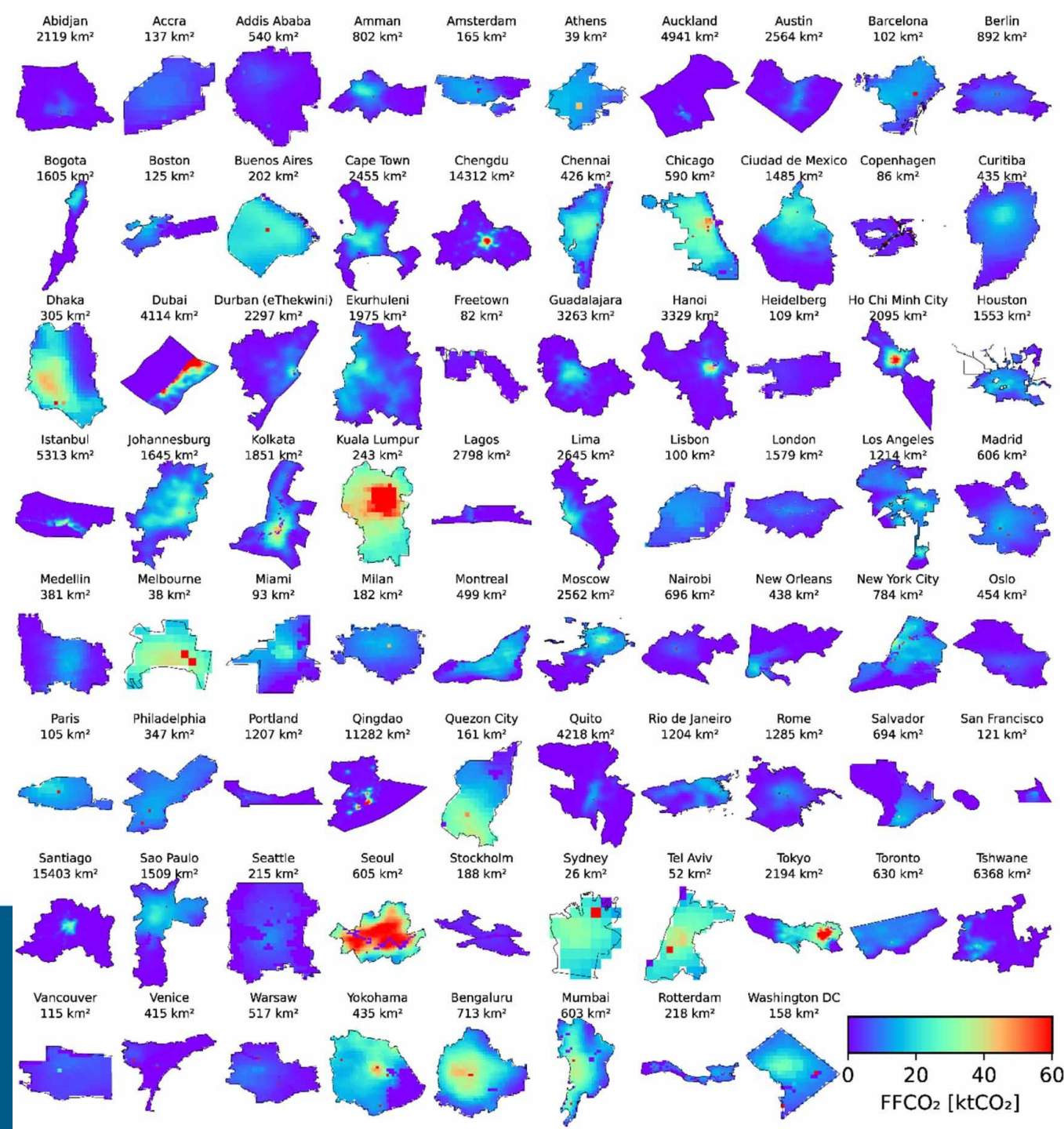
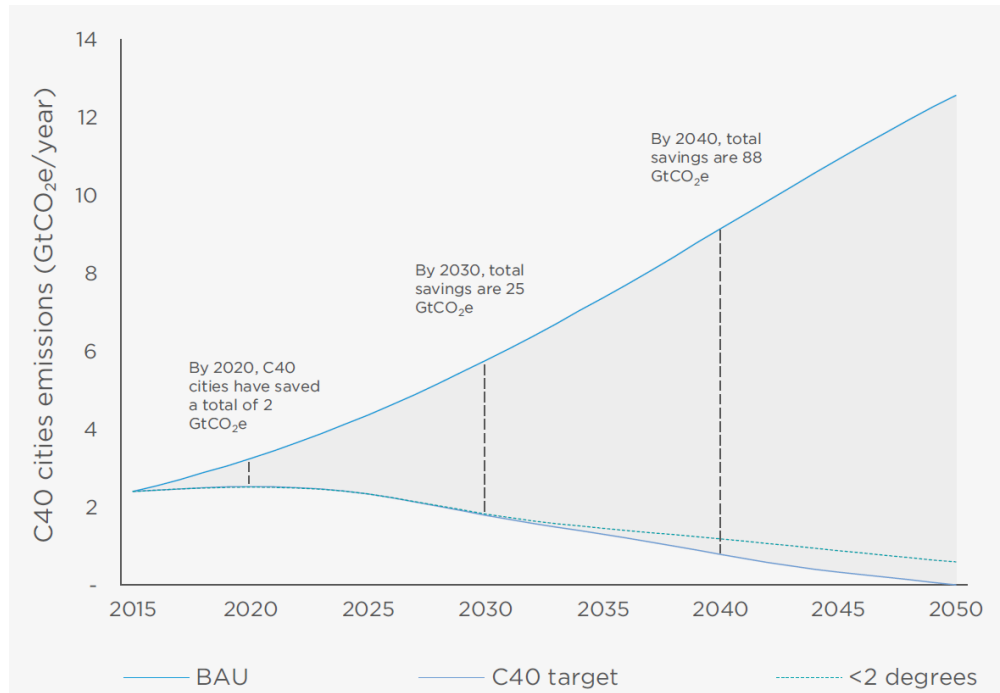
5 High body-mass index

6 NO2 pollution

Led by Veronica Southerland, Arash Mohegh, Danny Malashock

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Tracking urban CO₂ emissions



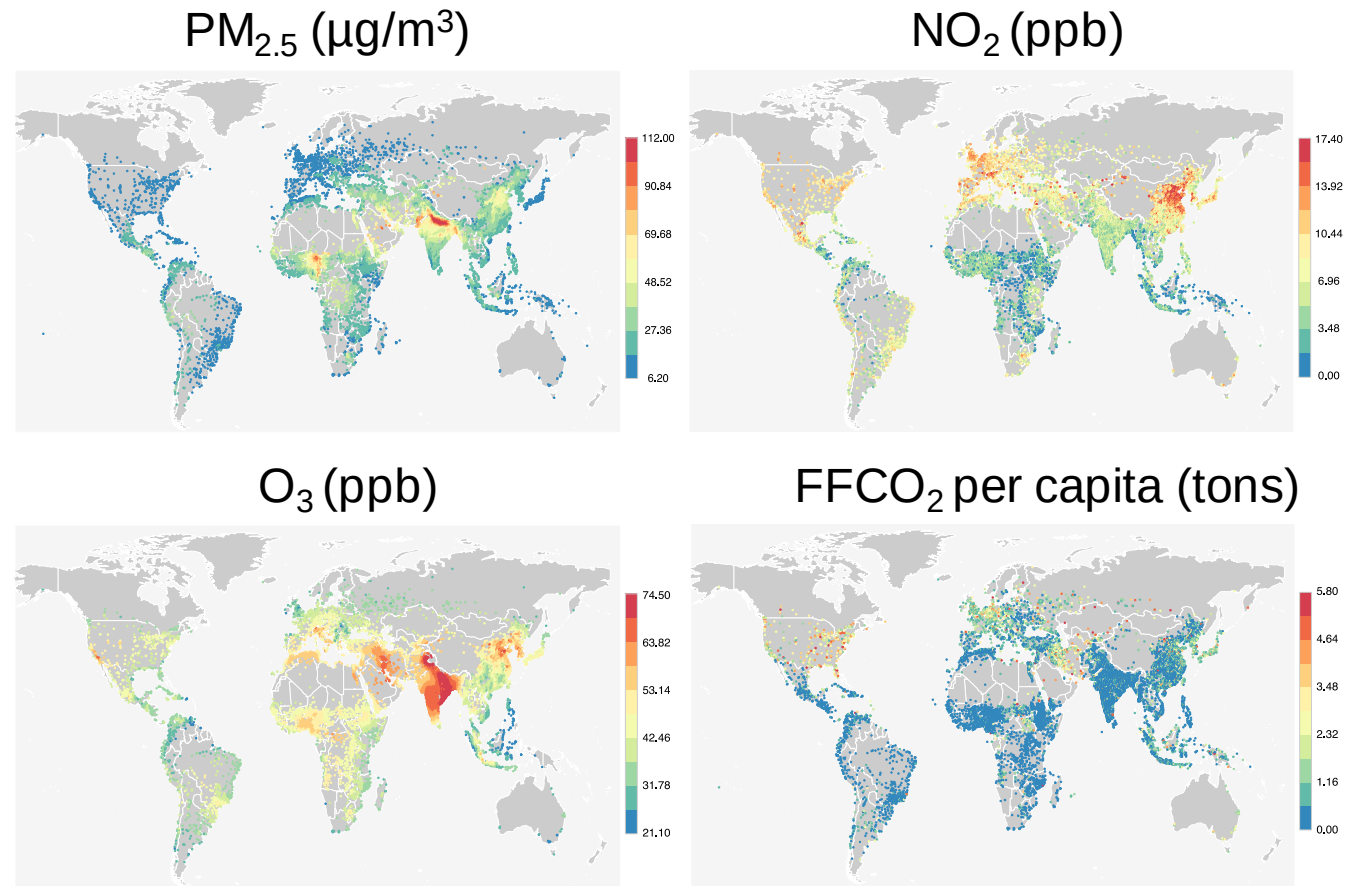
Led by Doyeon Ahn
Co-mentorship by Dan Goldberg
Ahn et al., Environ. Res. Lett., 2023

Air pollution and CO₂ emissions in 13,000 cities

Updated estimates with new concentrations datasets

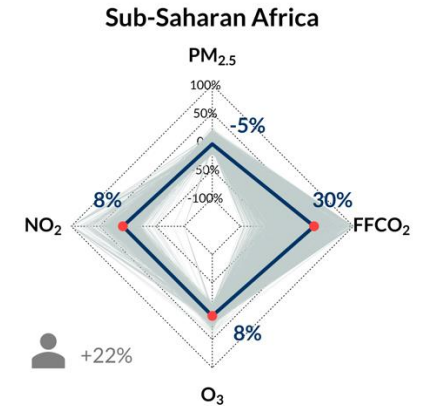
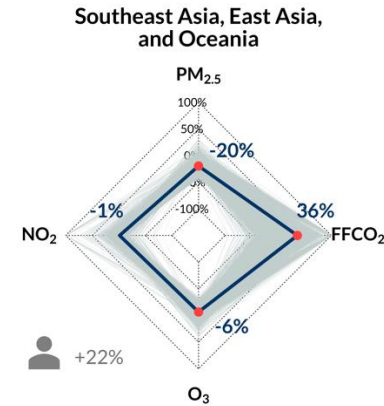
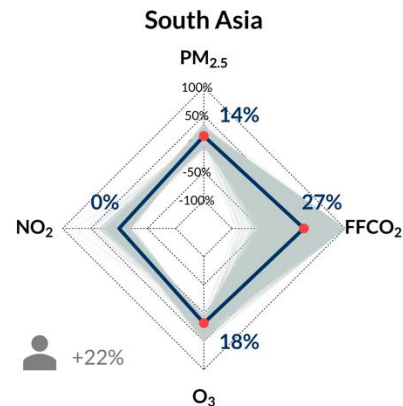
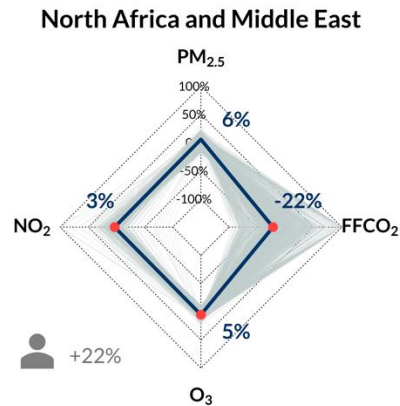
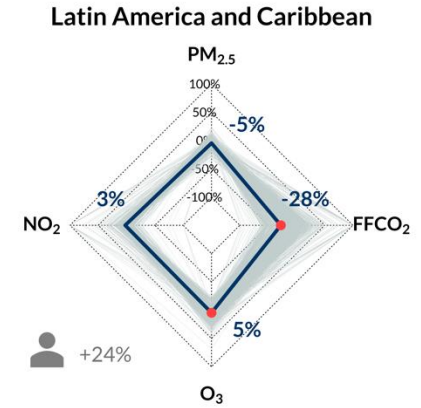
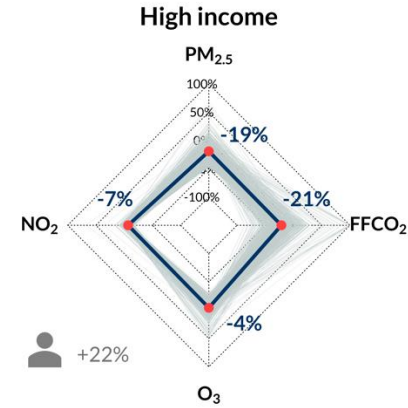
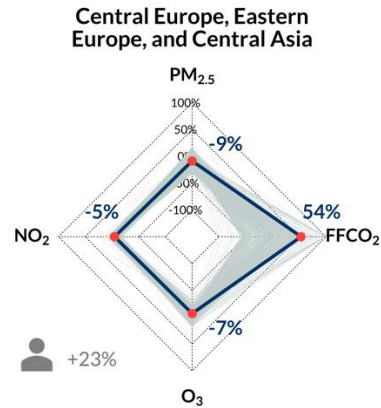
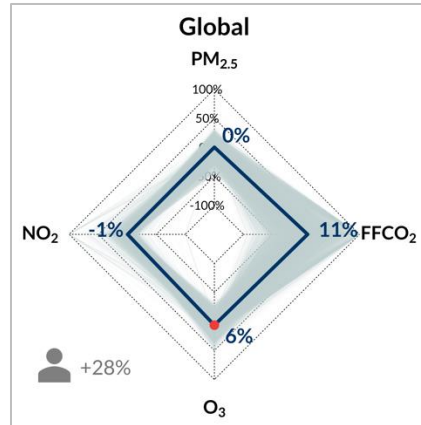
- Van Donkelaar et al. (2021) for PM_{2.5}
- Larkin et al. (2023) for NO₂
- DeLang et al. (2021) for ozone
- EDGAR v7.0 for CO₂

Most recent year for which all datasets were available: 2019



Led by Soo-Yeon Kim, GW PhD student
Co-mentorship by Gaige Kerr

Air pollution and CO₂ emissions in 13,000 cities: Trends 2005 to 2019



Led by Soo-Yeon Kim, GW PhD student
Co-mentorship by Gaige Kerr

C40 Urban Nature Accelerator

PATHWAY 1 QUALITY TOTAL COVER

Heat & Water related risk



30-40% of the total built-up city surface area is:

- **Green spaces**
(eg., street trees & urban forests, parks, building integrated vegetation)

and/ or

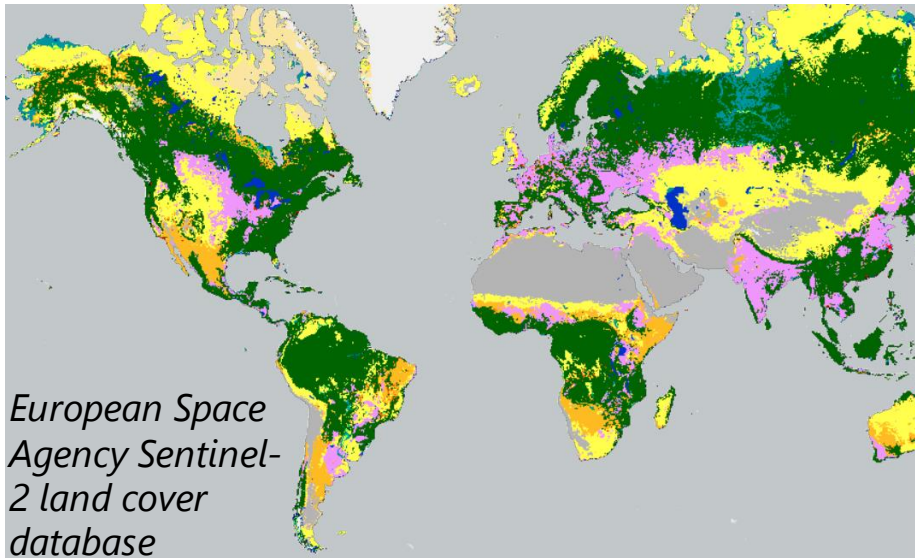
- **Permeable spaces**
(eg., pavements, infiltration trenches, swales, detention basins, regenerative urban agriculture)

PATHWAY 2 EQUITABLE SPATIAL DISTRIBUTION

Accessibility and connectivity



70% of the city population has access to a fit for purpose green or blue space within 15 minutes' - equitably prioritised to maximise accessibility and connectivity to nature for the most vulnerable



European Space Agency Sentinel-2 land cover database

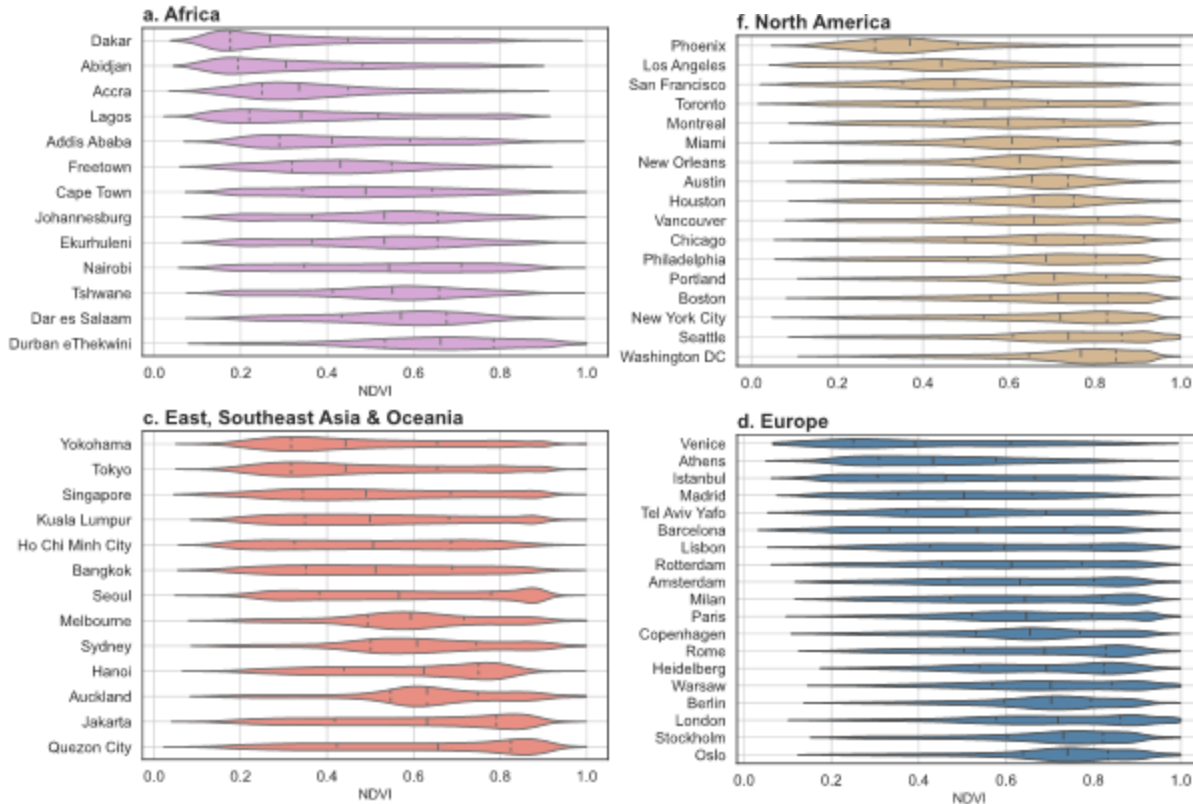
How much does this...

...tell us about this?

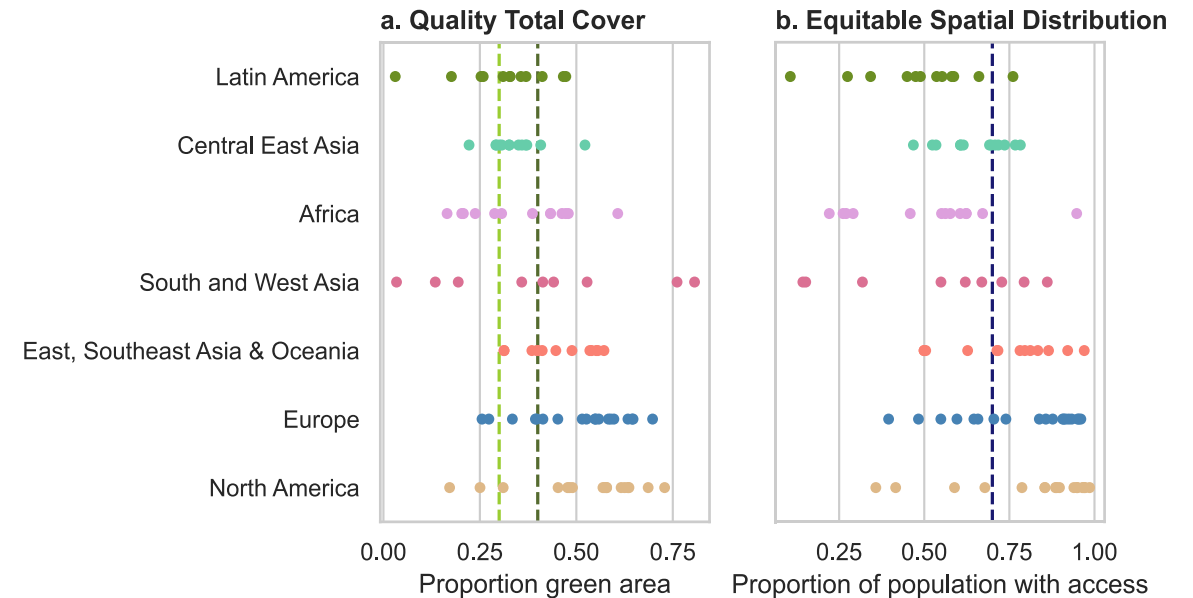


Tracking progress towards urban nature targets

Distribution of urban greenspace (NDVI)



Distribution of urban progress towards Urban Nature Accelerator targets



European Space Agency Sentinel-2 NDVI and WorldCover datasets

Work led by Greta Martin, GW PhD student
Co-mentorship by Kate O'Dell
Martin et al., GeoHealth, 2024

Urban Air Quality Explorer

- Map
- Percent Change
- Data Codebook
- Data Download
- Video Walkthrough
- About

- NO₂
- O₃
- PM_{2.5}
- CO₂

- Concentration
- PAF
- Cases
- Rates

Click to isolate cities

- Non-C40 Cities
- C40 Cities

