Health and Social Impacts of Air Pollution in Bishkek, Kyrgyzstan

Acknowledgements

Additional Project Team

- M-Vector
  - especially Aida Beishekeeva, Nail Khaibulin
- Rahat Sabyrbekov, American University of Central Asia
- Ajay Pillarisetti, University of California, Berkeley
- UNICEF Kyrgyzstan staff
  - especially Nazgul Sharshenova, Tomoya Sonoda

Outdoor Air Quality Data

- Asian Development Bank
  - Jules Hugot, Kristian Rosbach
- KyrgyzHydromet
  - Begaim Alipova, Lyudmila Nyshanbaeva
- Clarity Movement Co.
  - Levi Stanton, Sean Wihera

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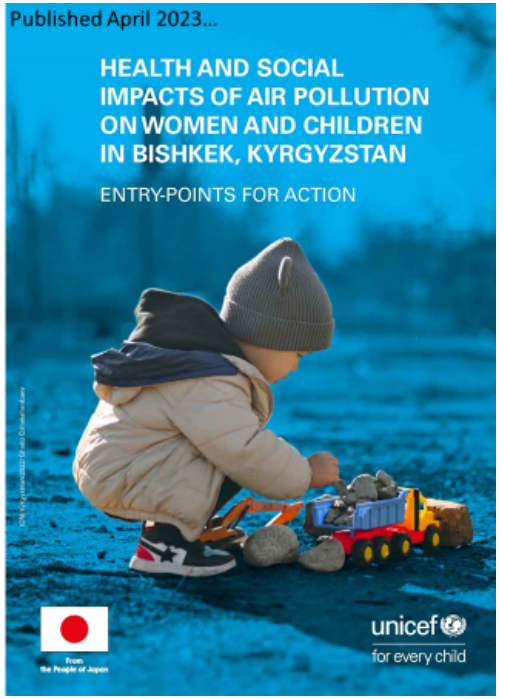

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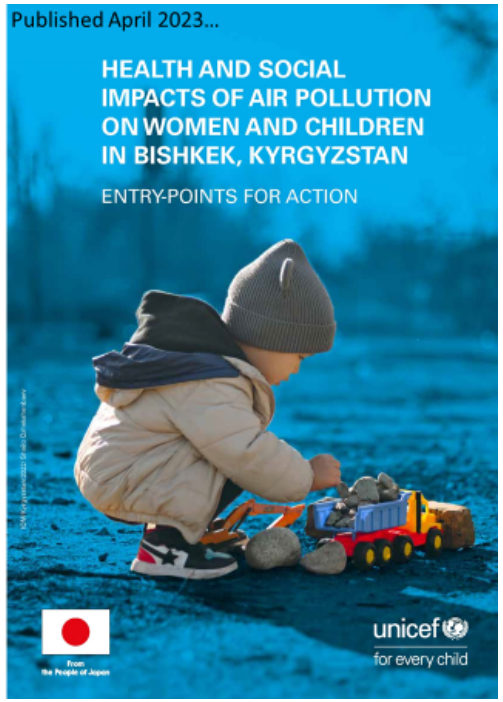
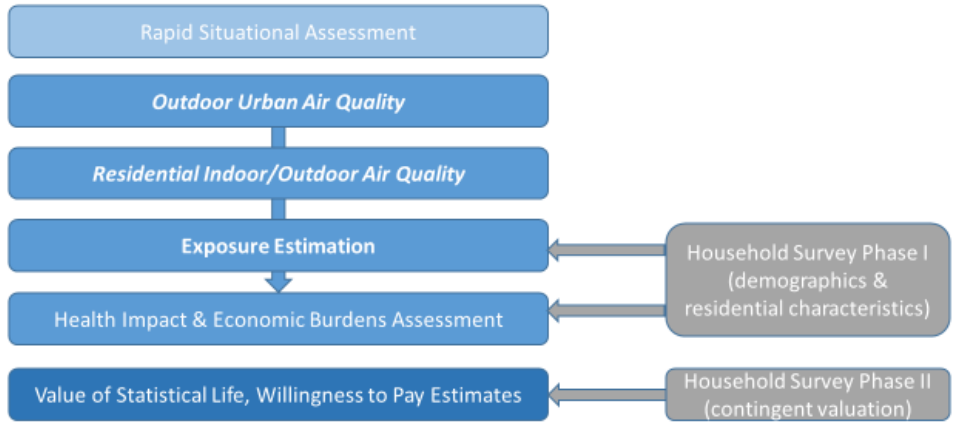


Objectives and Approach

- Examine the health and social impacts of fine particulate matter ($PM_{2.5}$) air pollution on children and women in Bishkek
- Assess entry points for action to reduce air pollution exposures

unicef
for every child



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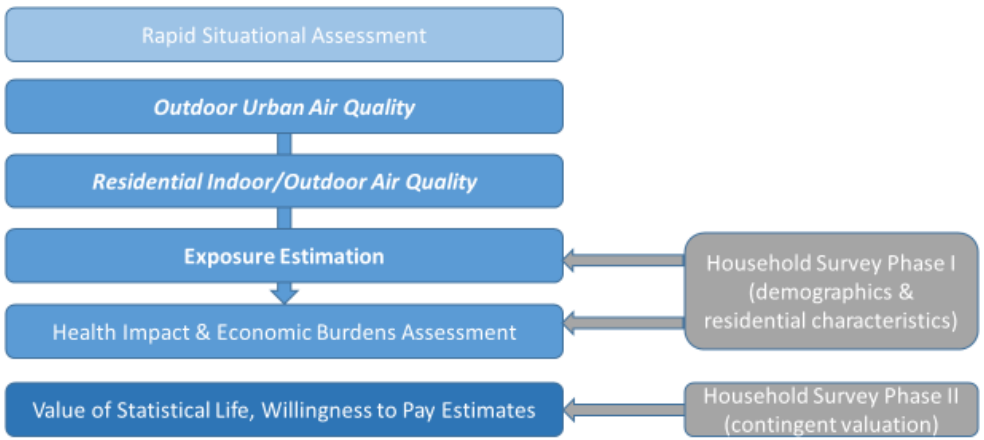
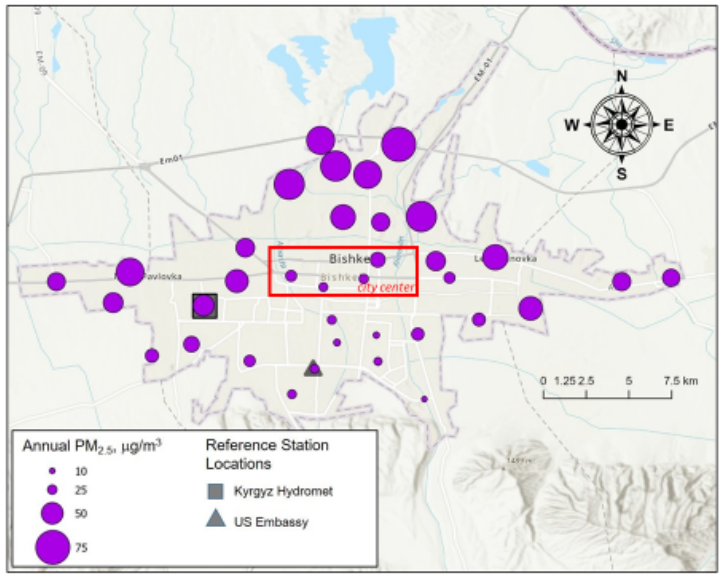
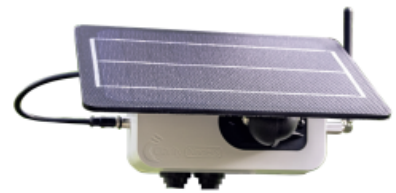


$PM_{2.5}$ 12-month average ("annual"), July 2021-June 2022

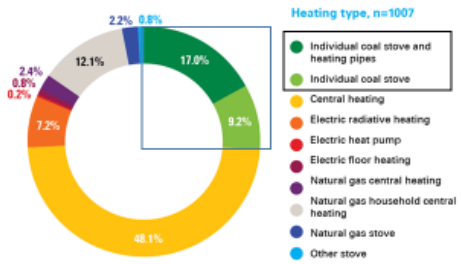




Clarity Movement Co.

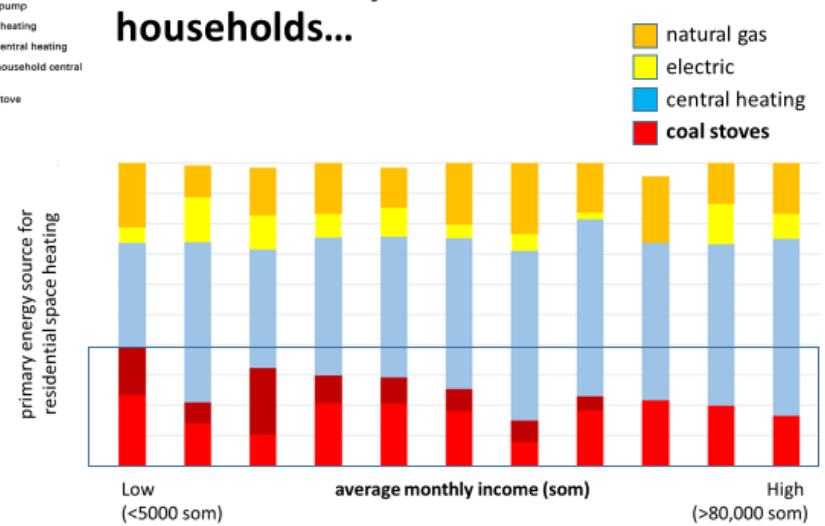
- ~400% difference in outdoor concentrations across Bishkek
- Where you live/work/play matters!

Raw data from KyrgyzHydromet/ADB Clarity sensor network; validated, adjusted and analyzed by the UNICEF project team



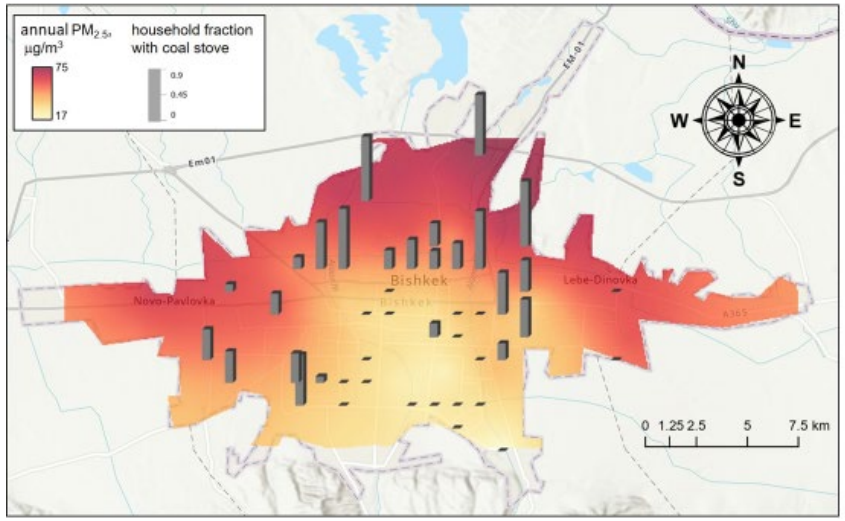
Coal Stoves are used by ~25% of surveyed households…

… and Coal Stove use broadly distributed across all income brackets



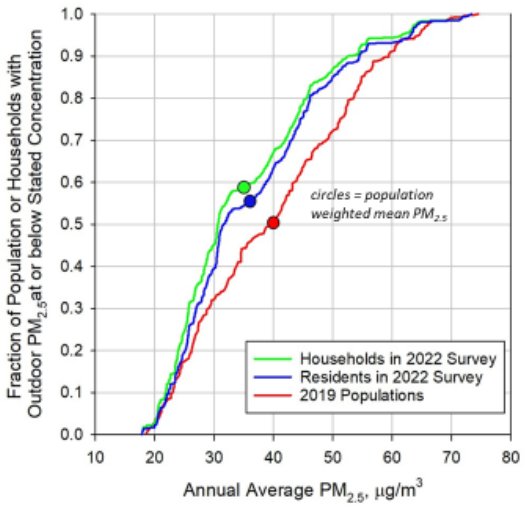
$PM_{2.5}$ Outdoor Concentrations Strongly Correlated with Residential Coal Use

(July 2021-June 2022; same pattern using winter average $PM_{2.5}$)

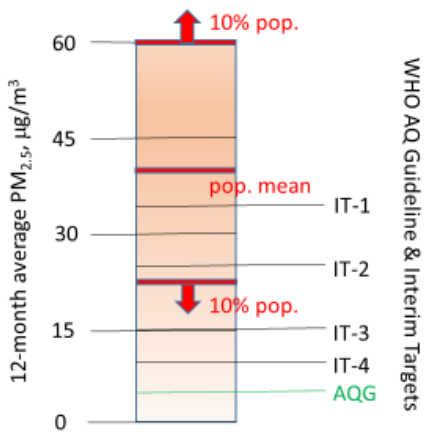


Distribution of Outdoor $PM_{2.5}$ at Residences

Combining $PM_{2.5}$ spatial map (previous slide) and spatial (1km^2) population data…

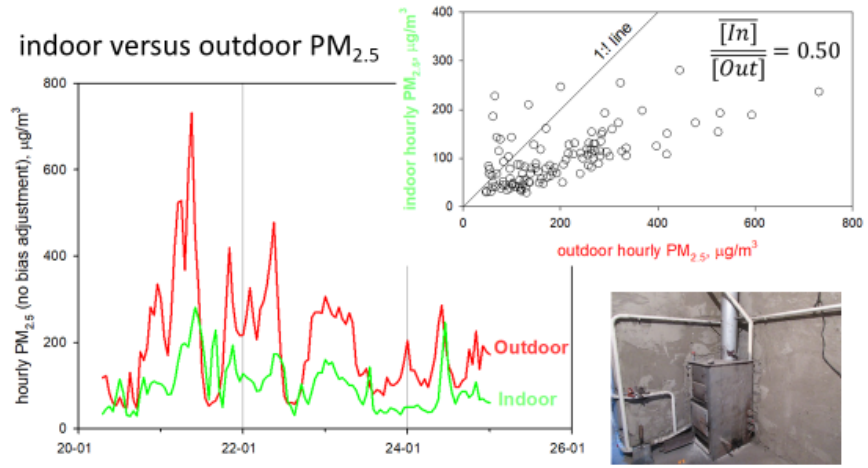


Using 2019 population data…



But people spend most of their time indoors…

outdoor $PM_{2.5}$ concentrations, $PM_{2.5}$ indoor/outdoor ratios, and time-activity data → exposures



Mean Household Indoor/Outdoor (I/O) $PM_{2.5}$ Ratios Similar for All Heating Types

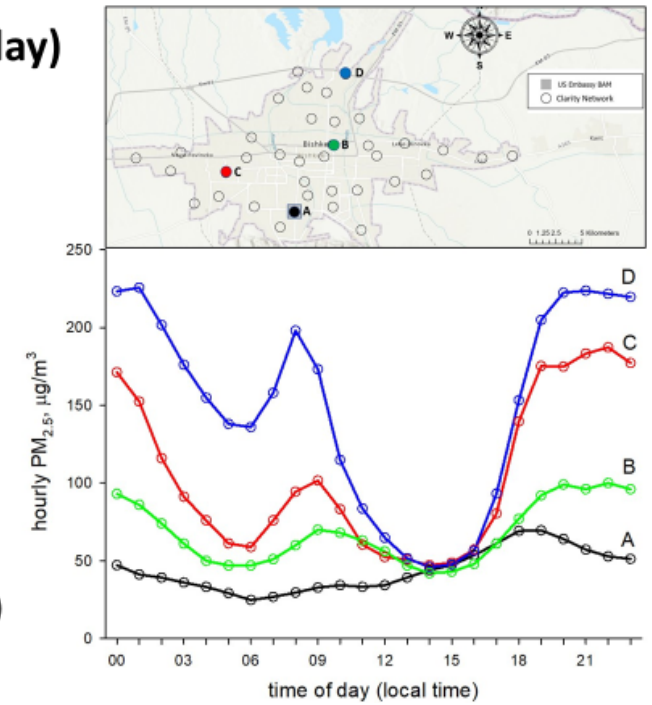
	stove with pipes	stove without pipes	central heating	pipeline gas	ALL DATA
Count	8	30	6	4	48
Mean	0.47	0.55	0.42	0.55	0.52
St. Dev.	0.17	0.23	0.11	0.37	0.22

I/O ratio ~0.5 across all heating types…

Consistent with infiltration of neighborhood-scale outdoor PM

Winter Diel (time of day) Profiles

Across the city, best time to be outdoors is early- to mid-afternoon (in some areas, all hours are similar)



Part I Summary (Jay)

- **Moderately dense low-cost sensor (LCS) network (~5km^2/LCS)**
  - Identified high $PM_{2.5}$ spatial variability (factor of four) across Bishkek
  - Enabled $PM_{2.5}$ exposure estimation at 1km^2 resolution
  - Determined influence of mountain-valley airflow on $PM_{2.5}$
- **$PM_{2.5}$ network and household survey**
  - Highlighted residential coal stoves as the dominant source of wintertime $PM_{2.5}$
- **Simultaneous Indoor/Outdoor Monitoring**
  - Generated relationships needed for $PM_{2.5}$ exposure modeling
  - Identified indoor $PM_{2.5}$ dominated by infiltration of ambient air

Part I Summary (Jay)

- **Key Messages**
  - Large differences in $PM_{2.5}$ exposures across the city
  - Interventions to reduce **$PM_{2.5}$ emissions** must be at the neighborhood or larger scale to reduce household-level exposures
  - Absent (or in addition to) emissions reductions, there are household-level actions to reduce **$PM_{2.5}$ exposures** (e.g. air purifiers)
  - Large spatial differences in $PM_{2.5}$ time-of-day profiles; across the city $PM_{2.5}$ air quality is best in the early- to mid-afternoon

- **Part II (Rufus) propagates this work forward to the health and economic impacts analysis**

For more information, contact **Jay Turner, JRTURNER@WUSTL.EDU**