AMBIENT $PM_{2.5}$ AIR POLLUTION IN BISHKEK

KEY MESSAGES

IOM/Kyrgyzstan/2022/ Shailo Dzhekshenbaev

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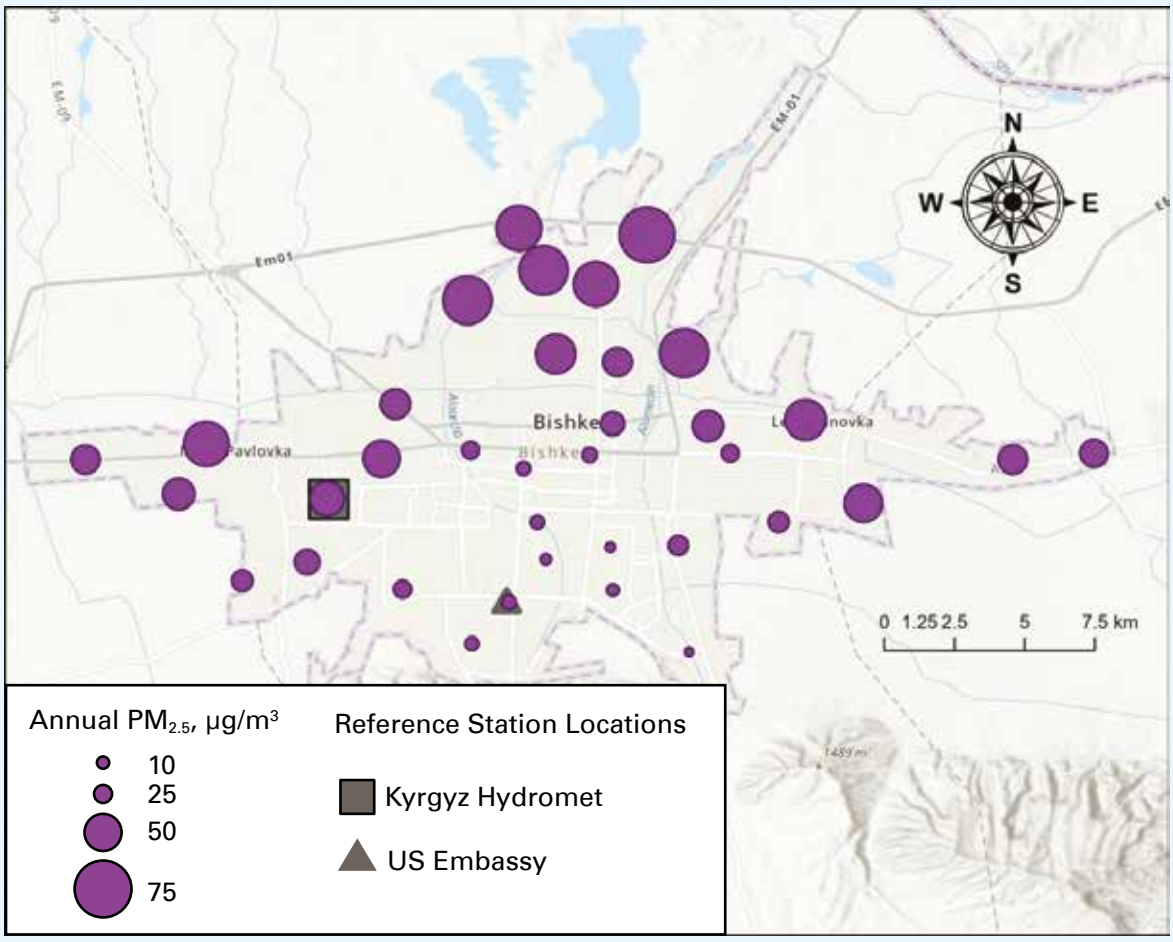
AMBIENT $PM_{2.5}$ AIR POLLUTION IN BISHKEK – KEY MESSAGES

Audience: all

Ambient $PM_{2.5}$ Air Pollution in Bishkek

Small air pollution particles ($PM_{2.5}$), that are at least 30-200 times smaller than the width of a human hair, are the best indicator for health impacts of air pollution in urban populations. Modernization of ambient air quality and emissions standards to reflect this current understanding will be helpful in developing effective strategies to reduce the impacts in the population.

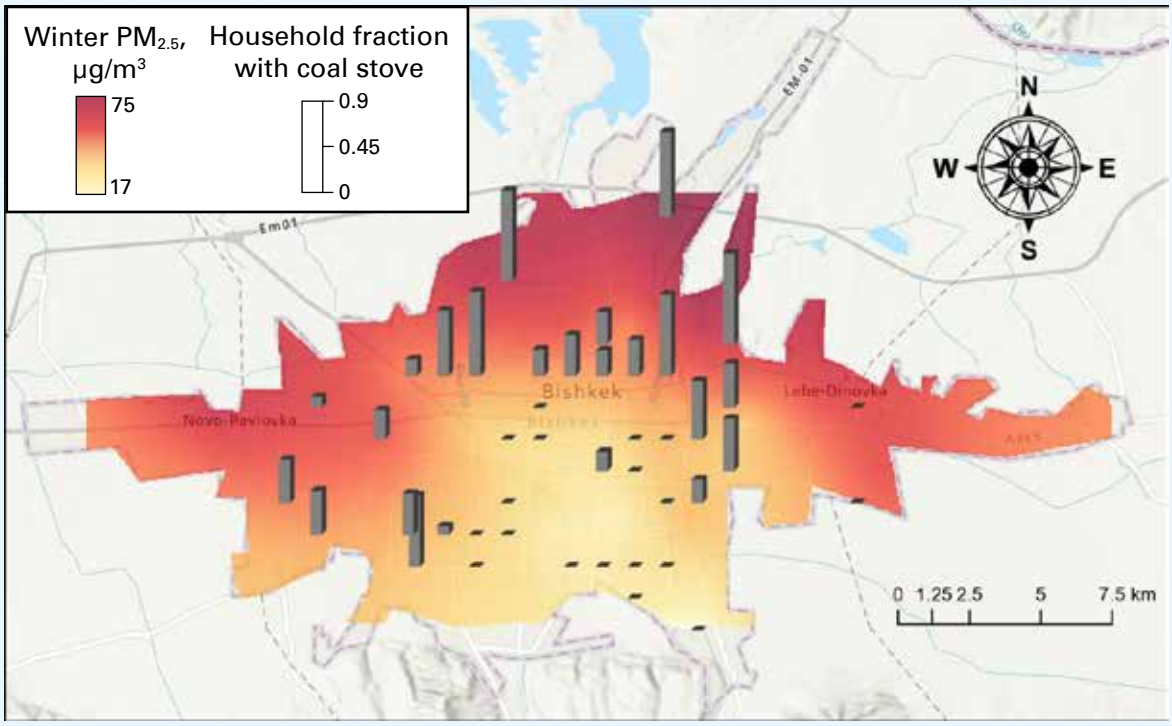


Annual average PM2.5 concentrations (July 2021-June 2022) for the Kyrgyzhydromet/ Asian Development Bank Clarity low-cost sensor network, bias adjusted.

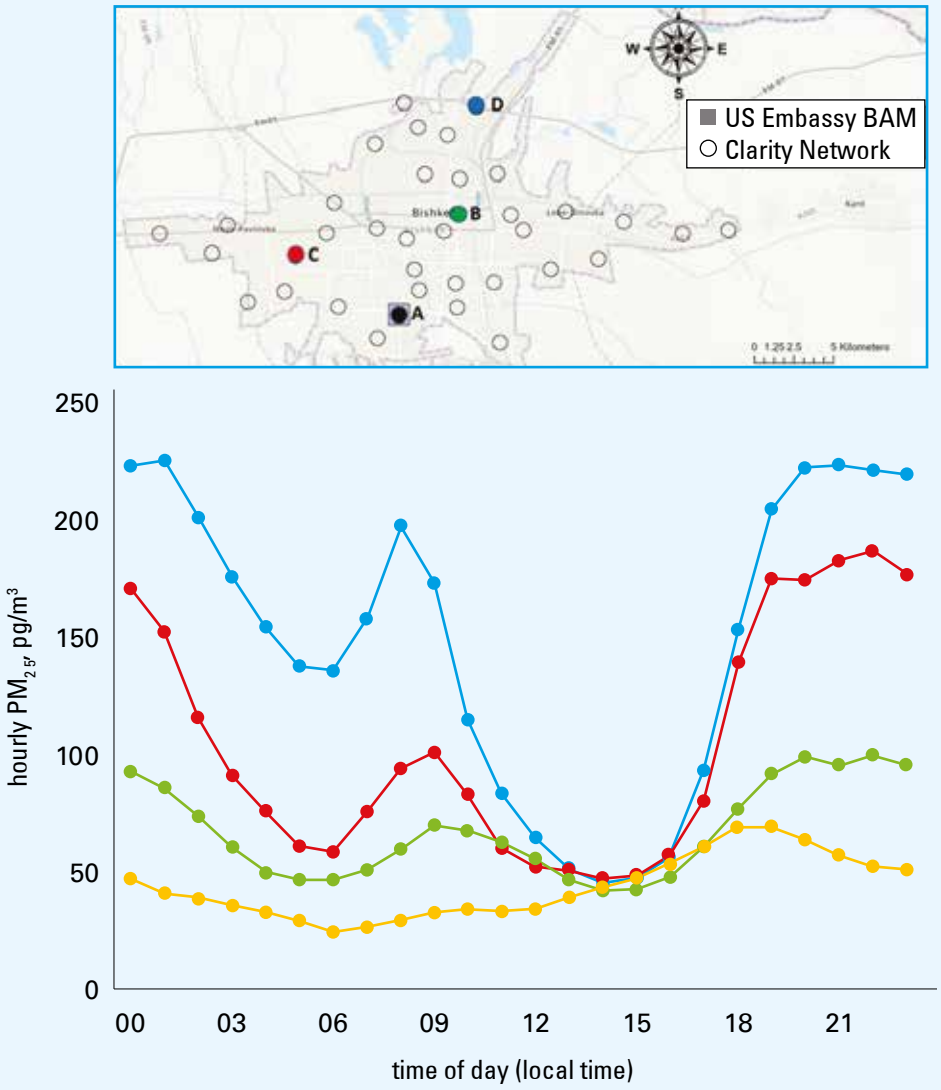
Annual Average $PM_{2.5}$

The recent UNICEF air pollution study shows that in Bishkek for the one year period between 7/1/2021 and 6/30/2022:

- Spatially- and population-weighted annual average $PM_{2.5}$ concentrations across the city were 44 and 40 µg m^{-3}, respectively.
- These ambient $PM_{2.5}$ concentrations are far in excess of those known to cause major health impacts in urban populations.
- $PM_{2.5}$ concentrations were substantially lower in the urban core and the south compared to concentrations experienced by residents in the west, north and east neighborhoods of the city.
- The annual average $PM_{2.5}$ concentration measured at the US Embassy monitoring site was 25 µg m^{-3}, which underestimates the citywide population-weighted average by a factor 1.6



Contours: winter average PM2.5 concentrations (November 2021-January 2022) for the Kyrgyzhydromet/Asian Development Bank Clarity sensor network, bias adjusted. Columns: Fraction of households using raw coal stoves. The two zones to the east with no stoves are apartment areas adjacent to neighborhoods with detached homes using raw coal stoves.



$PM_{2.5}$ time of day profiles for November 2021-January 2022. The map shows the monitoring locations (A-D) from the Kyrgyzhydromet/Asian Development Bank Clarity low-cost sensor network.

Wintertime PM2.5

- Elevated neighborhood $PM_{2.5}$ concentrations during wintertime are strongly impacted by the number of homes using coal stoves for heating.
- Neighborhoods with high coal stoves utilization experience extremely high nighttime $PM_{2.5}$ concentrations, consistent with residential heating.
- $PM_{2.5}$ time of day profiles across all sensors in the low-cost sensor network show that the lowest concentrations are in the early afternoon, which make this the preferred time to maintain benefits from outdoor exercise

Seasonal variability

- Wintertime ambient $PM_{2.5}$ concentrations far exceed those during the summer, highlighting the role of burning coal for wintertime space heating in creating high $PM_{2.5}$ air pollution concentrations.
- Wintertime high concentrations are further exacerbated by weather conditions suppressing dispersion of the emitted pollutants, which demonstrates that wind dispersion and street orientation will not resolve the air pollution issue.
- Summertime $PM_{2.5}$ concentrations are much lower than in winter yet still are higher than those known to cause health impacts

AIR MONITORING

Reference Grade Continuous Ambient Air Monitoring Stations (CAAMS)

- Air quality modeling will inform optimal siting of reference grade continuous ambient air monitoring stations (CAAMS) to capture spatial gradients across Bishkek.
- $PM_{2.5}$ monitors are a priority for estimation of health implications.
- The expensive reference grade CAAMS can be leveraged with $PM_{2.5}$ low-cost sensor networks to improve the understanding of $PM_{2.5}$ levels across Bishkek and evaluate the effective of emissions control programs.

Low-Cost Sensor Networks

While individual devices are low cost (especially compared to reference grade monitors), budgets are necessary for:

- Inter-sensor comparisons and calibration (bias adjustment) to reference grade monitors.
- Data quality screening and sensor performance evaluation (and sometimes replacement) which is necessary on an ongoing basis.

Satellite Remote Sensing Information

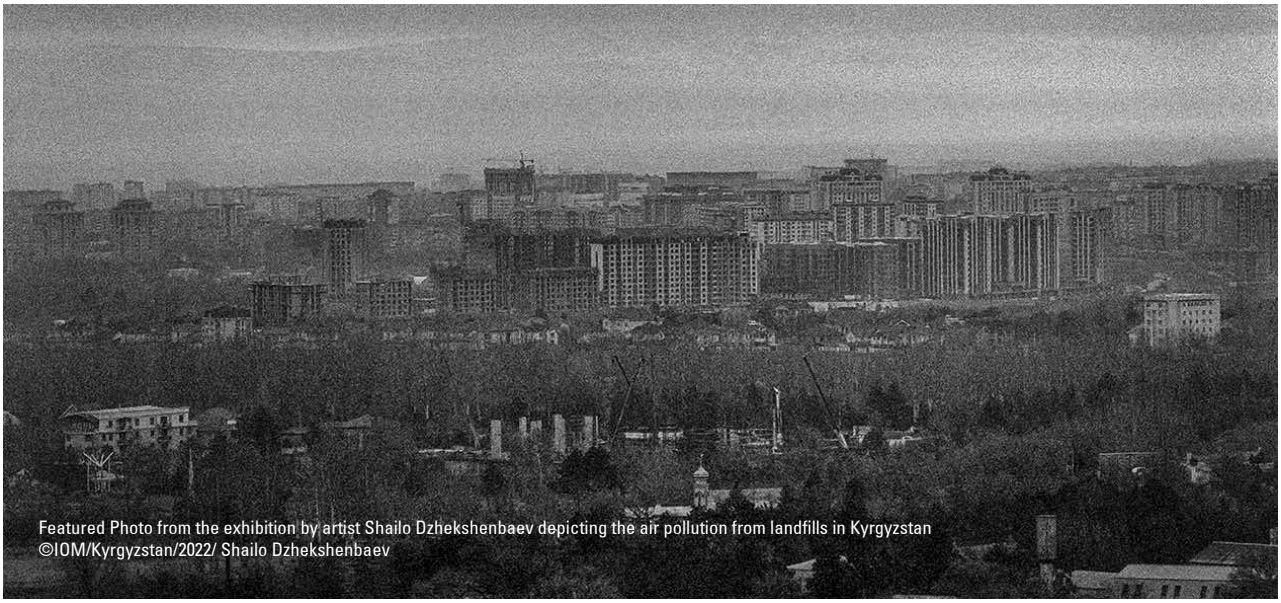
- $PM_{2.5}$ concentrations can be estimated using satellite aerosol optical depth (AOD) measurements referenced to ground level monitors and/or air quality modeling.
- Conventional satellite data streams cannot resolve neighborhood-scale $PM_{2.5}$ levels but a newer generation of small satellite networks shows promise to reach this spatial scale.
- Wintertime heating emissions are poorly resolved due to large emissions at night which are not captured with current AOD measurements

AIR QUALITY PLANNING AND MANAGEMENT

Source Apportionment

Air monitoring alone is insufficient to develop science-based air quality management plans.

- $PM_{2.5}$ source contributions cannot be resolved by source apportionment studies alone, because the many sources using the same coal type are not distinguishable. Furthermore, wintertime $PM_{2.5}$ daily contributions from different emission sources tend to be highly correlated because of the large role played by meteorology and this leads to blurring of contributions across emission source categories.
- Significant effort is needed to develop the emissions inputs needed for robust urban airshed modeling. Current emissions data are inadequate to generate robust source contribution estimates from such modeling.
- Detailed research studies are required to estimate PM condensable (gases that condense into the particle phase as a hot combustion exhaust gas cools), and secondary organic aerosol formation, which add significantly to PM mass estimates.
- Emission testing procedures can significantly impact emission estimates and in-field estimates are required.
- Improvements in stationary and mobile emissions estimates are necessary to better apportion sources.
- Continuous emissions data from large industrial point sources are necessary.



Featured Photo from the exhibition by artist Shailo Dzhekshenbaev depicting the air pollution from landfills in Kyrgyzstan
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Air Quality Index

- Adopt an Air Quality Index (AQI) based on health impacts and actions the public can take to reduce exposures.
- The AQI should reflect the high spatial variability in wintertime $PM_{2.5}$ concentrations across Bishkek, such as an AQI map rather than a single value for the city.

FOR NOTES

For every child
Whoever she is.
Wherever he lives.
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A future.
A fair chance.
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In more than 190 countries and territories.
Reaching the hardest to reach.
The furthest from help.
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And never give up.

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