

Integrating Low-Cost Sensor Data and Satellite Imagery Using Machine Learning for High-Resolution Wintertime PM_{2.5} Mapping in Mongolia

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Model: Joint Random Forest–CNN–LCN
Time period: November 2024 – February 2025

Using tools & software from:   

Background



PlanetScope imagery of Ulaanbaatar, showing dense winter haze layers (Jan 2025)

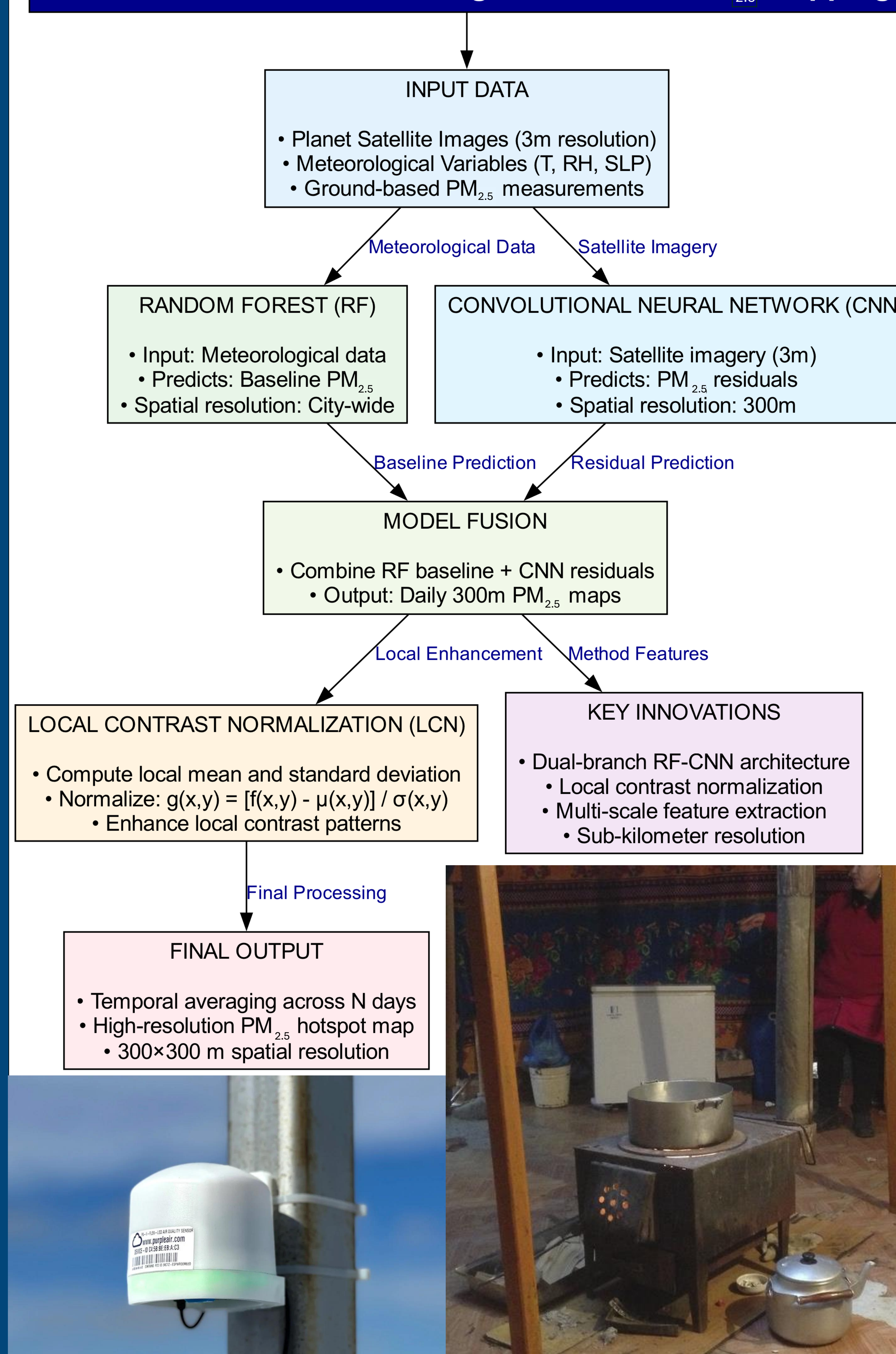
Ulaanbaatar, Mongolia, experiences some of the world's highest wintertime fine particulate matter (PM_{2.5}, particles <2.5 μm) concentrations. This is primarily attributed to coal combustion in ger districts under stagnant atmospheric conditions. Exposure to PM_{2.5} contributes to respiratory and cardiovascular diseases, affecting the most vulnerable populations.

Objectives

- 1 Combine satellite imagery, surface PM_{2.5} measurements, and meteorological data using a Random Forest-CNN joint model.
- 2 Detect wintertime PM_{2.5} hotspots at the neighborhood scale across the city.
- 3 Provide a rapid, scalable, satellite-based approach for fine-scale mapping in heavily polluted megacities.

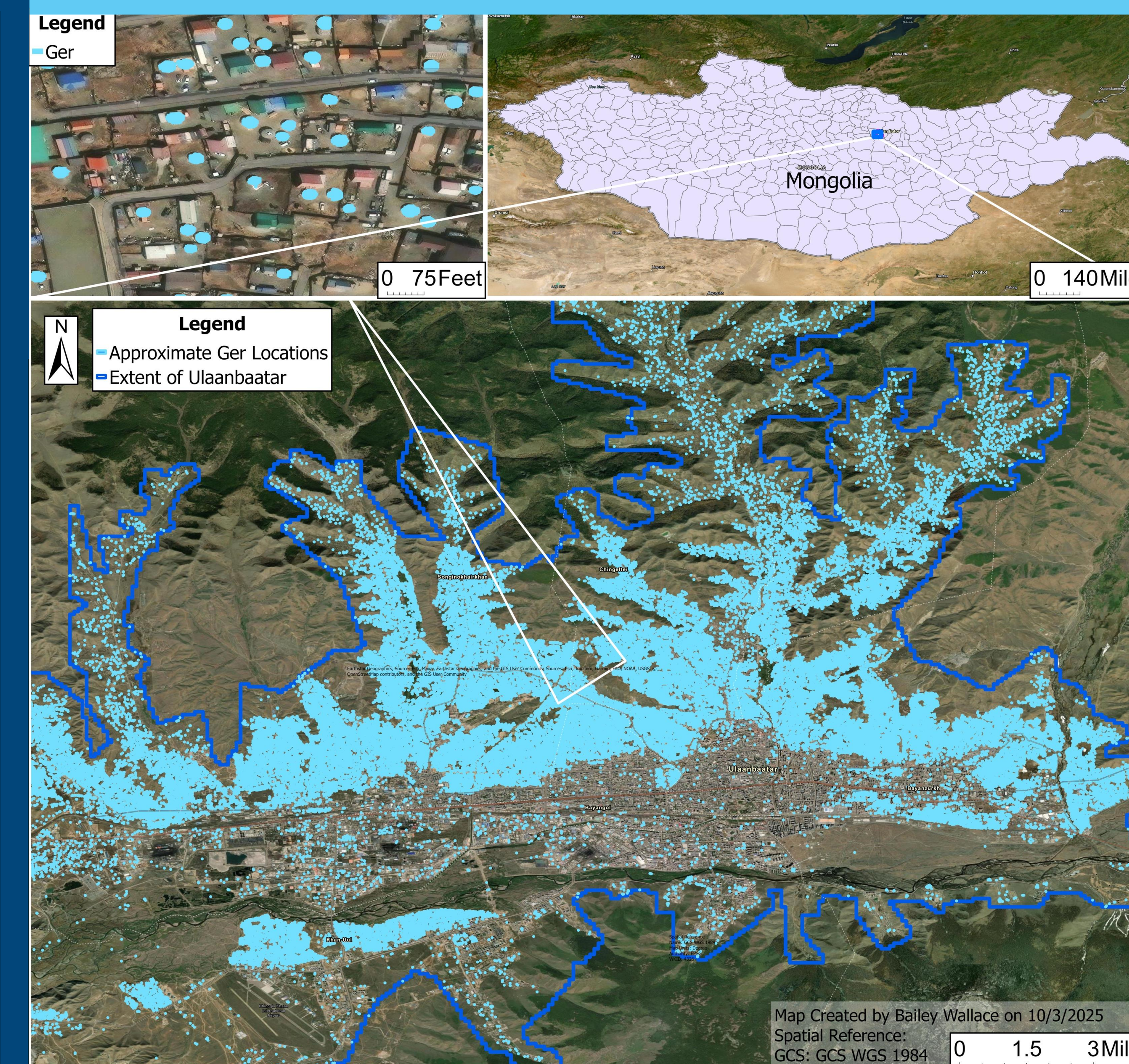
Data Sources & Methodology

RF-CNN-LCN Workflow for High-Resolution PM_{2.5} Mapping






Outdoor air quality monitor (PurpleAir sensor) and traditional Mongolian coal-burning stove

Approximate Ger Locations in Ulaanbaatar



This map shows approximate ger locations in Ulaanbaatar, Mongolia

Implications

-  High-resolution exposure mapping enables identification of pollution hotspots at sub-kilometer scale
-  Policy applications support targeted interventions in ger districts with elevated PM_{2.5} exposure
-  Model generalizability: adaptable for other megacities with limited monitoring networks

