NDORMS
NUFFIELD DEPARTMENT OF ORTHOPAEDICS, RHEUMATOLOGY AND MUSCULOSKELETAL SCIENCES

UNIVERSITY OF OXFORD

Foundation Models for Mapping Emission Sources and Acute Respiratory Infection (ARI) Hotspots

Usman Nazir, Sara Khalid

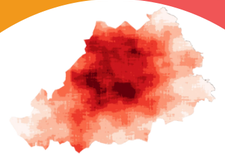
Email: usman.nazir@ndorms.ox.ac.uk

For more details visit our website: https://www.ox.ac.uk/climate-and-environment/planetary-health

Problem Statement

20–30% ↑
hospital admissions for respiratory issues

15% ↑
asthma cases among school children



Impact on Public Health in

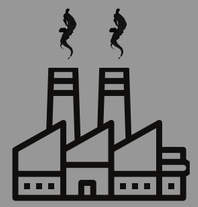
Lahore

CM Punjab Smog Mitigation Plan 2024

50%
Pediatric patients due to respiratory issues

500 ↑
people were hospitalized in a single day in govt hospitals of Lahore

9%
Non – combustion Industrial Processes



24%
Industry

16%
Energy

39%
Transport

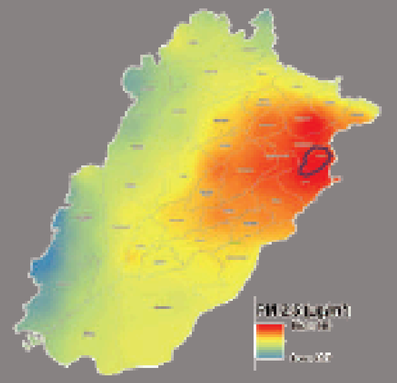
11%
Agriculture

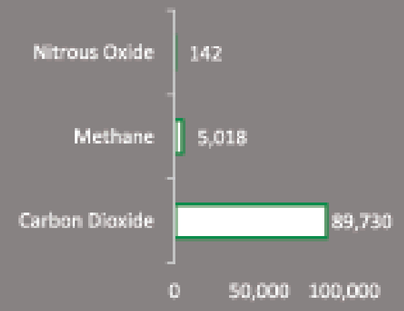
1%
Others

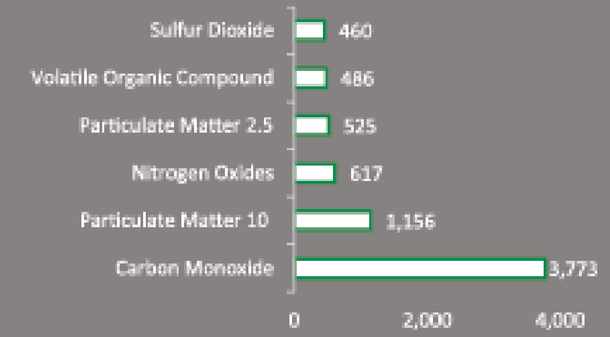
EMISSION SHARE OF PUNJAB

94,890 Kilotonnes/year (kt/y)
Total GHG Emissions
CO2, CH4 and N2O

7,017 Kilotonnes/year (kt/y)
Total Air Emissions
PM10, PM2.5, SO2, NOx, CO, VOC

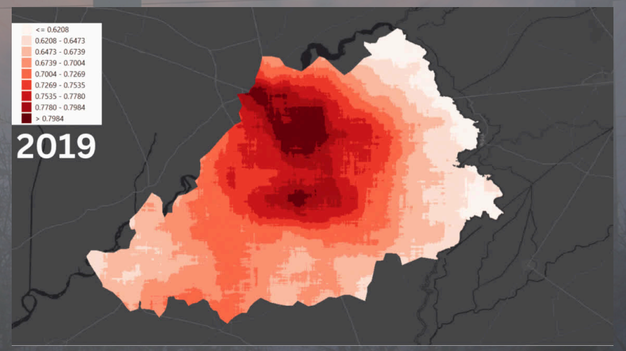






Source: Integrated Assessment of Air Pollution and Climate Change Mitigation in Pakistan 2022 (ccacoalition.org)

Source: Punjab Pollution Inventory, SUPARCO and Urban Unit 2023 https://urbanunit.gov.pk/Download/publications/Files/8/2023/Emission%20Inventory%20of%20Punjab%201990-2020_FD.pdf

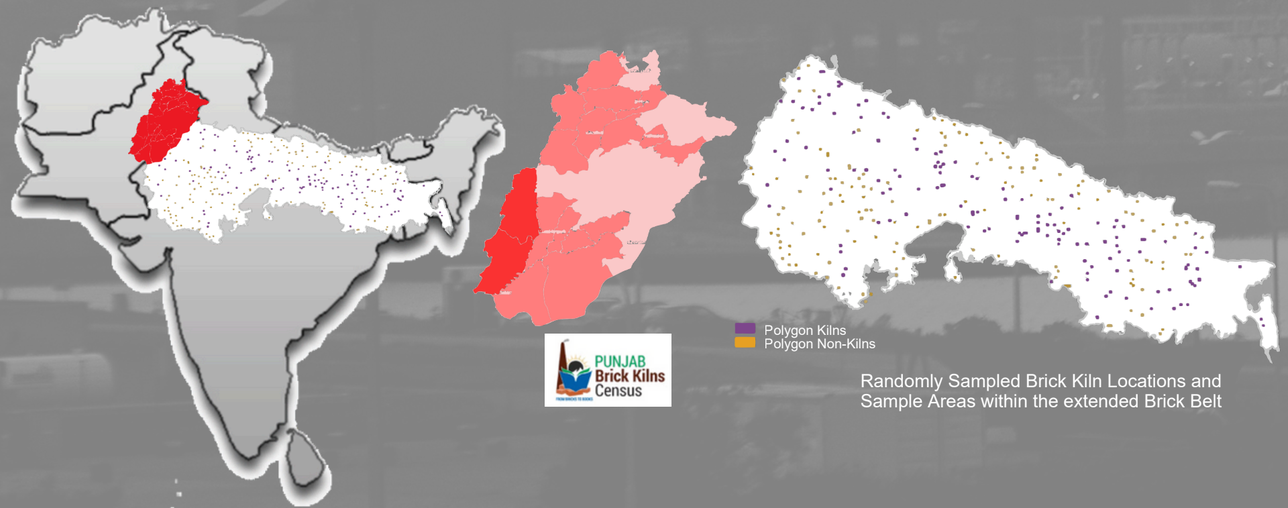


Challenges

- Bottleneck: Absence of spatially explicit data.
- Huge variations in satellite imagery.

Existing Strategies & Limitations

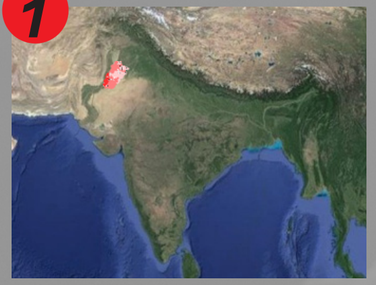
- Field surveys and manual localization are both tedious and lack scalability [2].
- Data obtained manually from satellite imagery is very sparse [3].



Randomly Sampled Brick Kiln Locations and
Sample Areas within the extended Brick Belt

Emission Sources Detection Framework

A classical machine-learning approach to localize brick kilns in remote-sensing imagery.

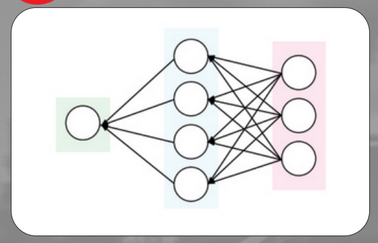
1

Region of Interest

2


Province Punjab, Pakistan

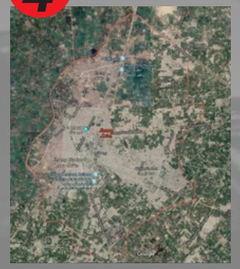
3

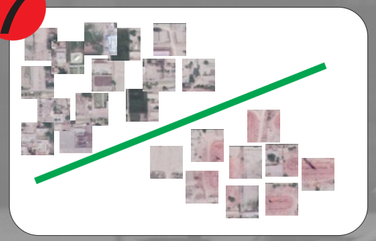

District Jhang, Punjab

6

Deep Neural Network

5

Slicing image patches

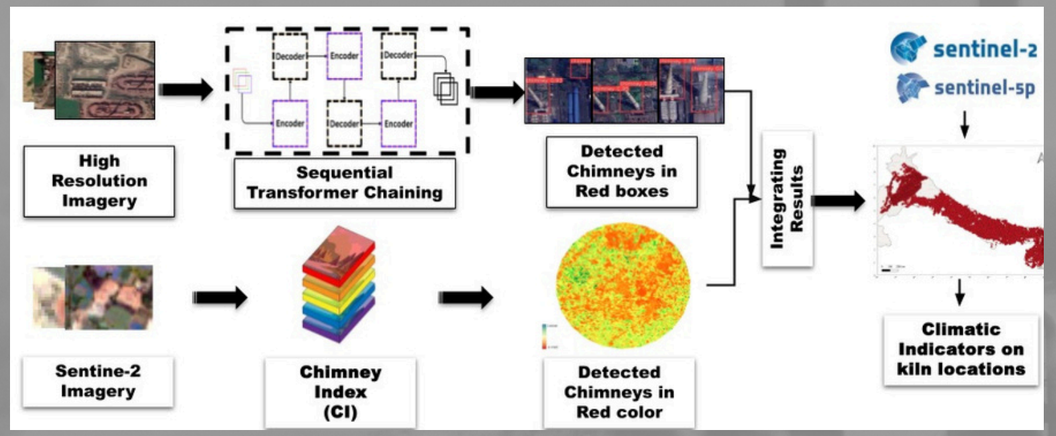
4

Satellite Imagery of the region

7

Classification of Kiln/Non-kiln patches

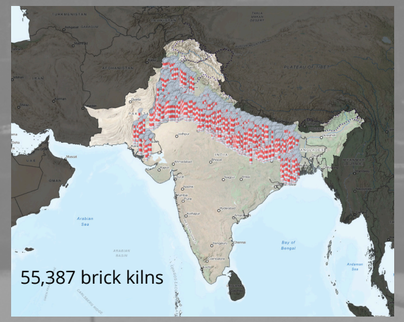
8

Locating possible Brick Kilns

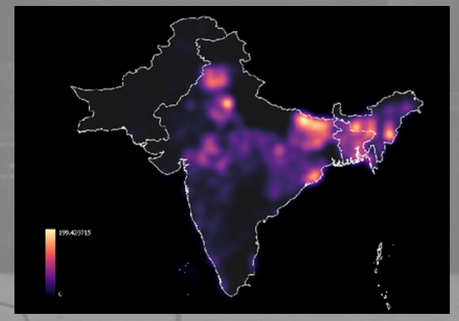
Proposed Architecture



Qualitative Results



Brick kiln Belt of South Asia


DHS Acute Respiratory Infection cases

https://www.nottingham.ac.uk/news/pressreleases/2018/march/using-satellite-images-to-tackle-modern-slavery-across-south-asia's-'brick-belt'.aspx
https:/www.ox.ac.uk/news/2023-06-15-ai-could-help-detect-unregulated-sources-air-pollution-south-asia-new-project-shows

Takeaways & QR

Weak Associations: Emission sources spatially correlate with pediatric ARI, with **SO2** most indicative.
Tooling works: Foundation-model chaining yields a precise, scalable chimney inventory.
Actionable: The pipeline supports targeted health and regulatory interventions in high-risk zones.

References

[1] WorldHealthOrganization.*EnvironmentalRiskFactorsandtheBurdenofDisease*.2018. URL:https://www.who.int/about/accountability/results/2018-2019. Accessed: 2025-08-05.
[2] Punjab Brick Kiln Census, URL:http://202.166.167.115/brick_kiln_dashboard/
[3] Boyd, DoreenS.,etal."Slavery fromSpace:Demonstrating the Role for Satellite Remote Sensing to Inform Evidence Based Action related to UN SDG number 8." ISPRS J. Photogrammetry and Remote Sensing 142, 2018: 380–388.

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