Contrasting Pattern of $PM_{2.5}$ Concentrations in Urban-Rural Pair Sensors from Nepal

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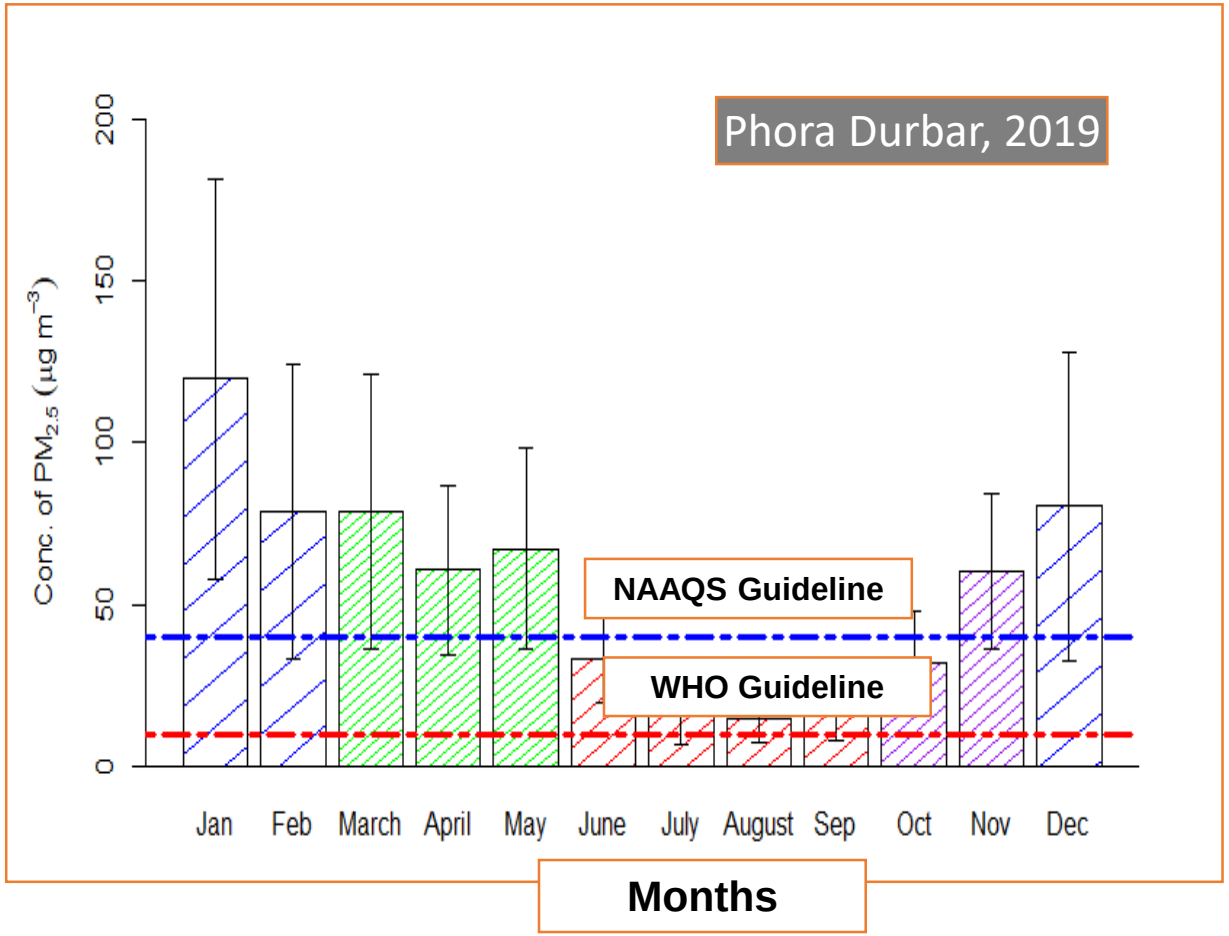
April 25, 2022

Presentation Outline

- Introduction – Context
- Objectives
- Materials and Methods:
  - Sampling Sites
  - BlueSky Air Quality Monitor
- Results
- Conclusions

Introduction

Area: 147,516 km²
Population: 29.19 million (2021) CBS-Nepal
Capital: Kathmandu (population density= 5108 persons/km² ,Terai = 461 persons/km²)
Urbanization rate: 6.4%



Nepal among countries with *highest* $PM_{2.5}$ exposure

Nepal is ranked as a second most polluted country in the world in terms of $PM_{2.5}$ concentration (i.e., annual average of 83.1 ug/m^3) for the year 2019 (HEI, 2020).

Introduction contd…

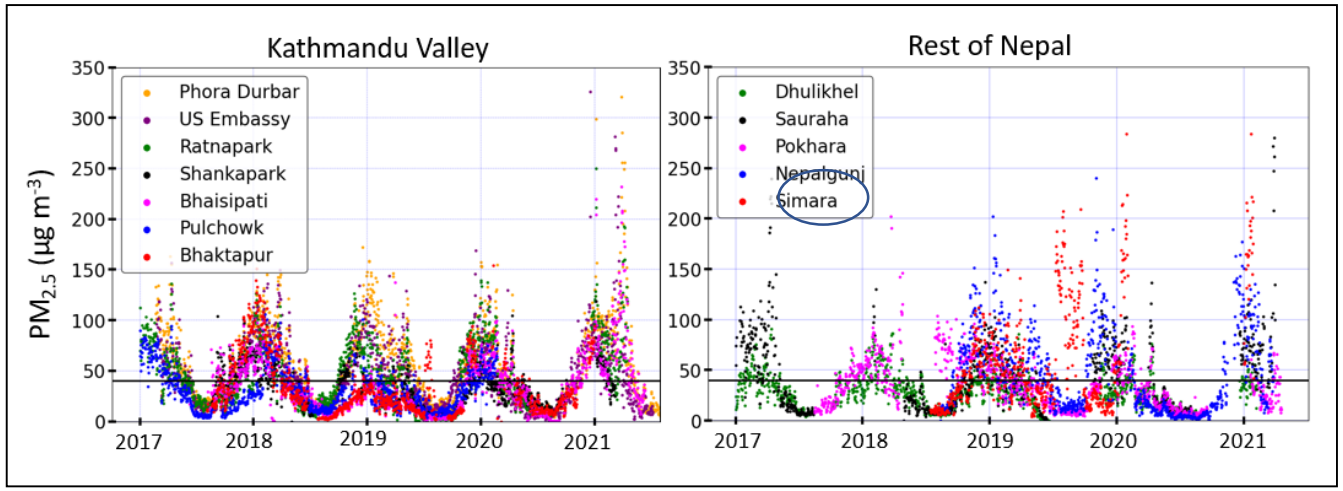
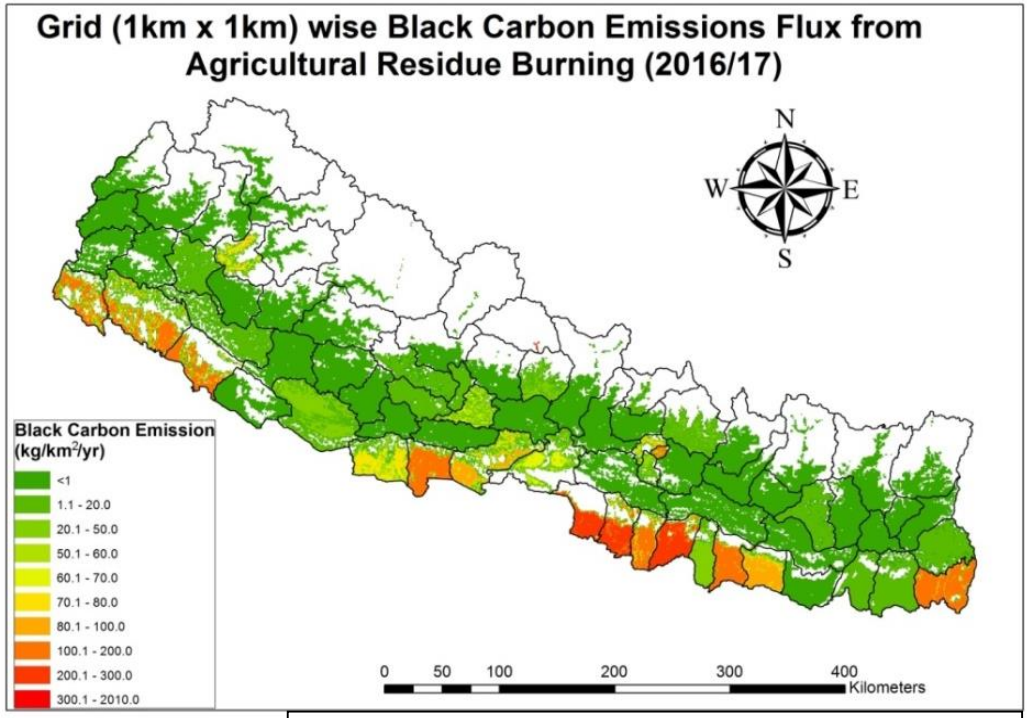


Figure: Time series of diurnal average of $PM_{2.5}$ (µg m^{-3}) concentration at different places in Nepal



Highest emissions flux occurred in the Terai region (90.7%) Das et al. (2020)

18% of pollutants from the low laying plain region advected to Kathmandu as background pollution during 2015. Mahapatra et al. (2020)

Episodes of transboundary air pollution in the central Himalayas

Atmospheric Pollution Research 13 (2022) 101270

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https://doi.org/10.5194/acp-17-11041-2017

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Received: 8 May 2018 / Accepted: 17 January 2020

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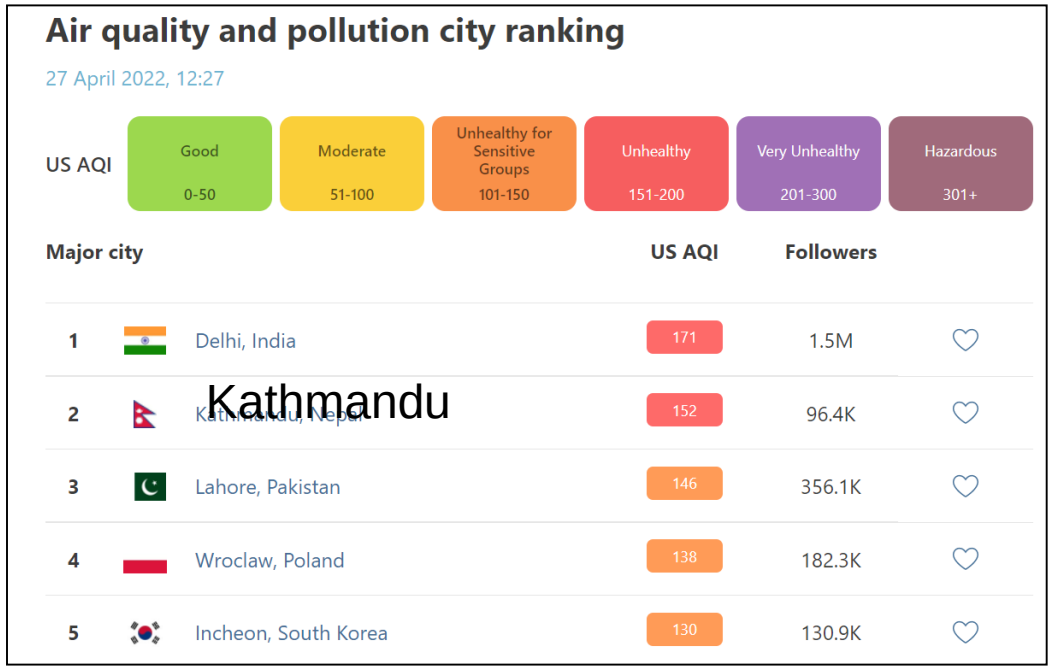


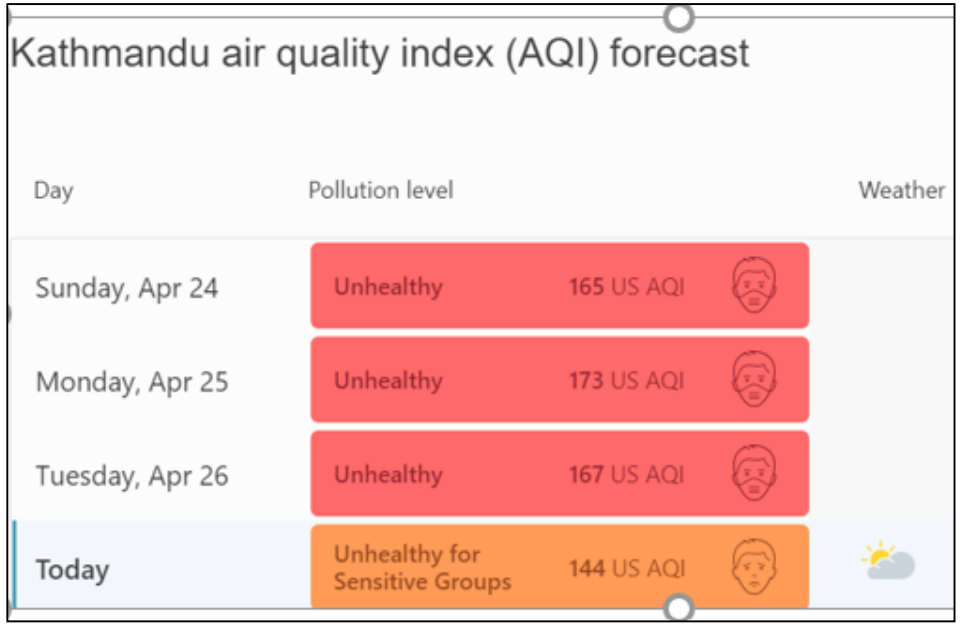
Air quality and pollution city ranking

27 April 2022, 12:27

US AQI	Good 0-50	Moderate 51-100	Unhealthy for Sensitive Groups 101-150	Unhealthy 151-200	Very Unhealthy 201-300	Hazardous 301+

	Major city	US AQI	Followers
1	Delhi, India	171	1.5M
2	Kathmandu, Nepal	152	96.4K
3	Lahore, Pakistan	146	356.1K
4	Wroclaw, Poland	138	182.3K
5	Incheon, South Korea	130	130.9K

Kathmandu



Kathmandu air quality index (AQI) forecast

Day	Pollution level	Weather
Sunday, Apr 24	Unhealthy 165 US AQI	
Monday, Apr 25	Unhealthy 173 US AQI	
Tuesday, Apr 26	Unhealthy 167 US AQI	
Today	Unhealthy for Sensitive Groups 144 US AQI	

A coordinated South Asian effort is necessary to better understand the processes governing transboundary air pollution and severity of the regional air pollution (ICIMOD, 2019)

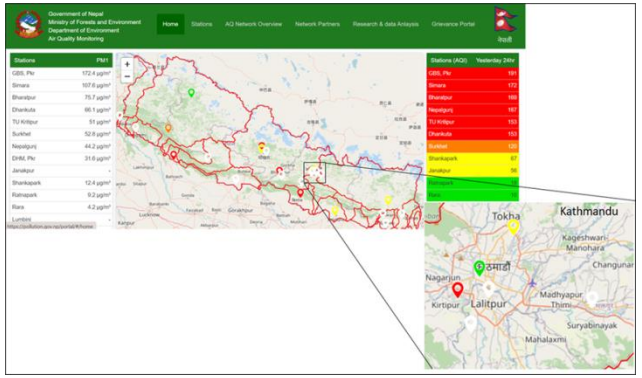
Source: IQAir

- Air quality management in the Terai is encumbered by a lack of ambient measurements and significant uncertainty in the local vs. transboundary pollutant contributions.

- The Government of Nepal is expanding its air pollution monitoring network to the Terai but faces technological limitations to keep their expensive equipment calibrated and fully operational.

DoEnv Monitoring Data

Dept. of Env.



- Regulatory-grade monitors (e.g. GRIMM EDM) are a challenge to maintain.

SN	Station Name	2016	2017	2018	2019	2020
1	Pulchowk					
2	Ratnapark					
3	Bhaisipati					
4	Kirtipur					
5	Shankapark					
6	Bhaktapur					
7	Dhulikhel					
8	Sauraha					
9	DHM, Pokhara					
10	PU Pokhara					
11	Lumbini					
12	Nepalgunj					
13	Simara					
14	Dang					
15	Phohara Durbar					
16	US Embassy					
17	Dhankuta					

Percent of monthly missing data for $PM_{2.5}$

<25% | 25-50% | 50-75% | >75% | No data

Objectives

- To determine the difference in $PM_{2.5}$ concentrations across the Terai which includes urban sites that are each paired with a nearby rural sites.
- Assess transboundary contributions of $PM_{2.5}$ concentrations in the Terai.

Materials and Methods

BlueSky Air Quality Monitor

- Real-time Particulate Matter (PM) sensor that provides **accurate measurements of $PM_{2.5}$ mass** concentration, temperature and humidity
- Can be **used at altitudes** up to 3000 m (10,000 feet)
- Designed to be used outdoors in highly polluted areas where **particulate concentrations can be as high 1000 ug/m^3**
- Helpful for **air quality model evaluation** (e.g., WRF-Chem or CMAQ)

Sampling Sites

12 urban-rural pairs in Terai - transboundary

Sampling Duration: Nov 1 2021-Feb 1 2022 (Urban)

Nov 1 2021-Jan 2 2022 (Rural)

April 2022- two weeks Mahendra.

Mahendranagar (Urban)

Mahendranagar (Rural)

Birgunj (Urban)

Birgunj (Rural)

Results

Birgunj

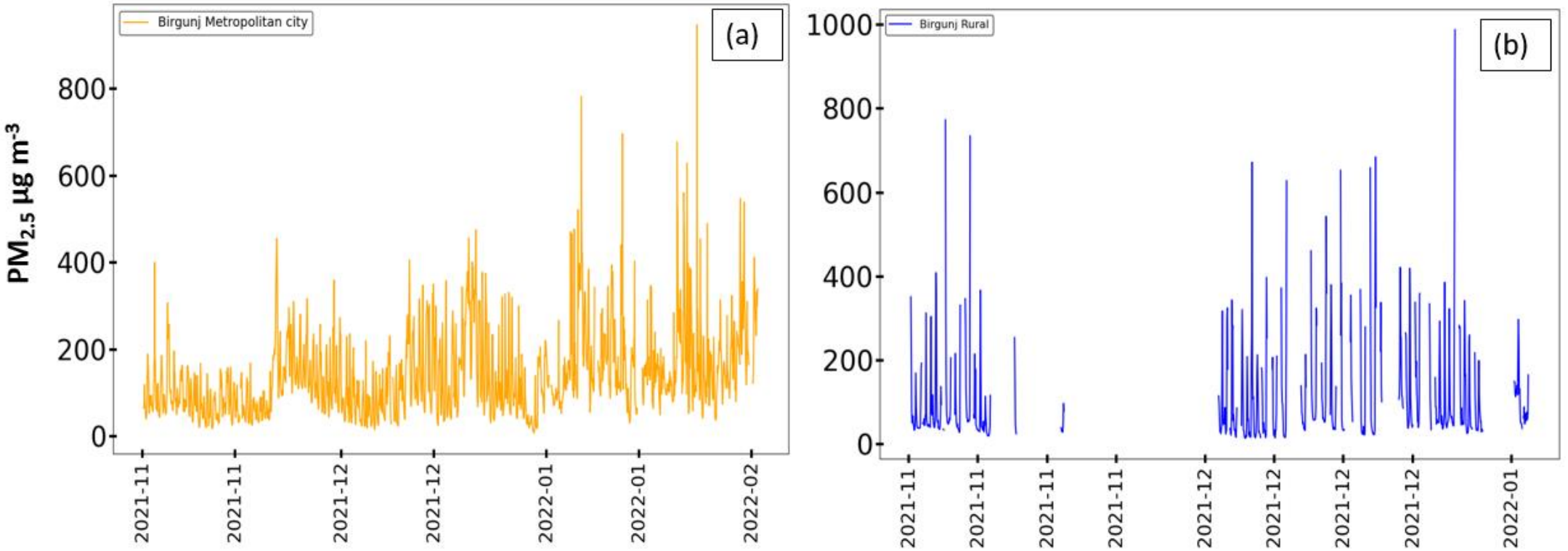


Fig: Hourly average $PM_{2.5}$ at (a) Urban and (b) Rural Birgunj

Results

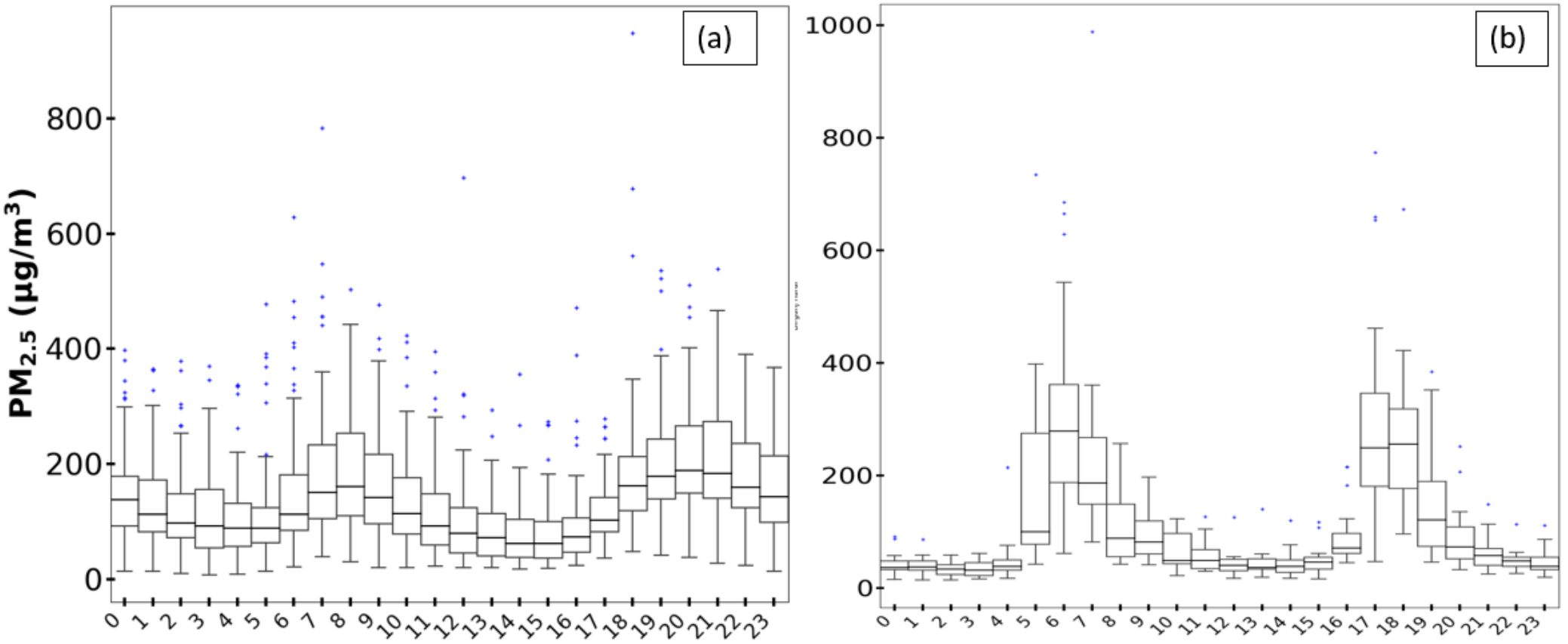
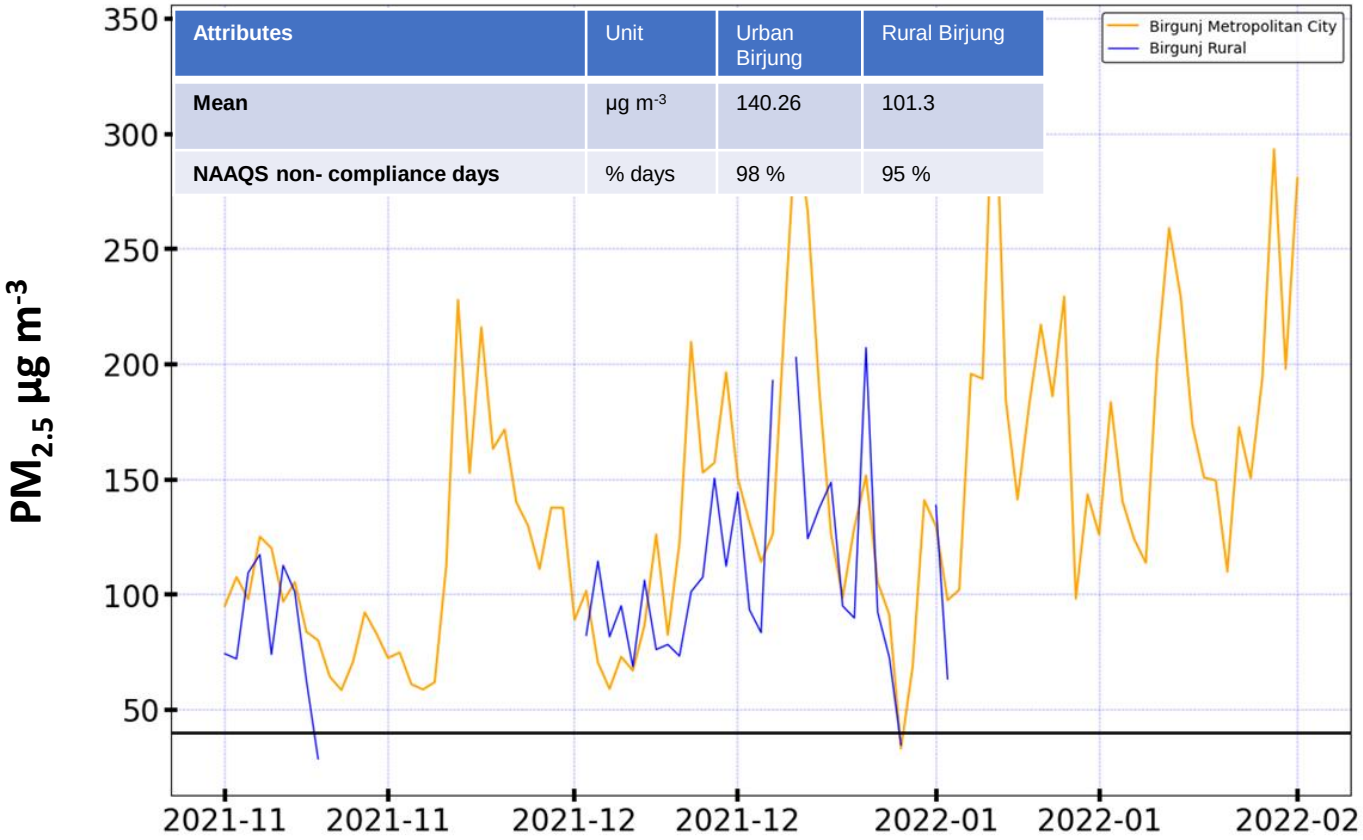


Fig: Diurnal variation of $PM_{2.5}$ at (a) Urban and (b) Rural Birgunj

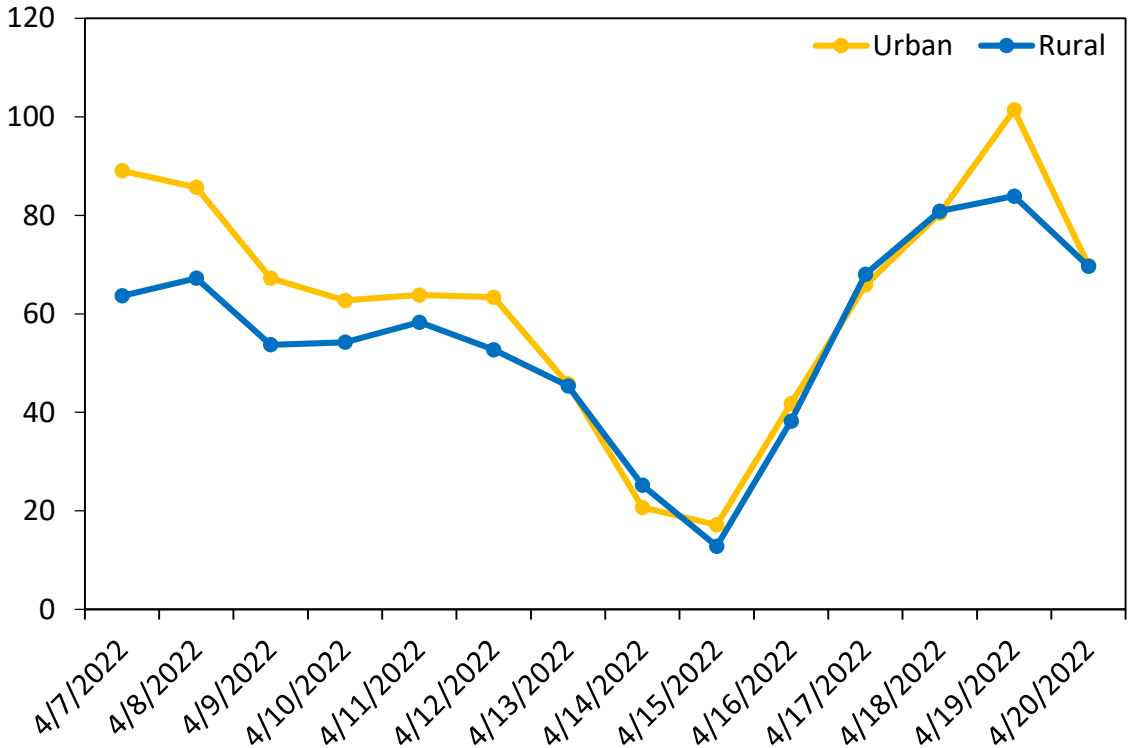
Note: Sharp rise and fall in PM concentration during morning and evening hours is observed in the rural area.

Birgunj

Attributes	Unit	Urban Birjung	Rural Birjung
Mean	µg m^{-3}	140.26	101.3
NAAQS non- compliance days	% days	98 %	95 %



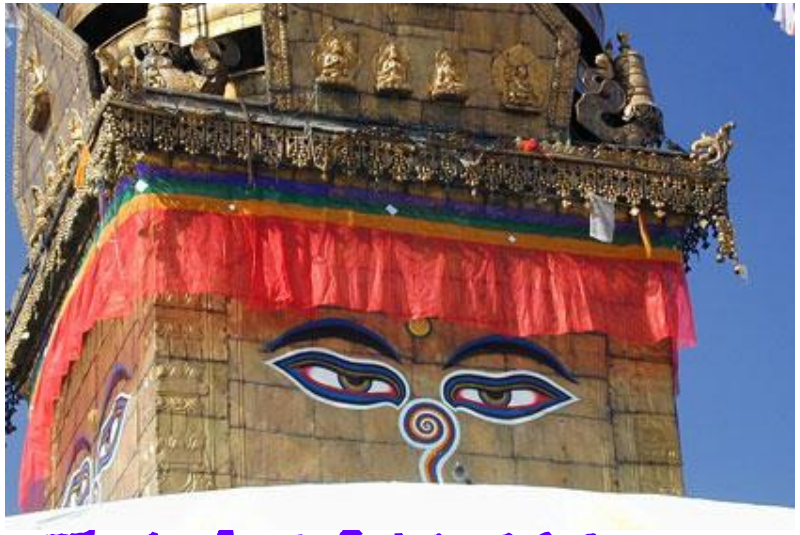
Mahendranagar



$PM_{2.5}$ concentrations at various sites urban and rural Birgunj and Mahendranagar

Conclusions

- Urban sites were prone to higher levels $PM_{2.5}$ exposures, compared to rural sites.
- Higher noncompliance to NAAQS at both Urban and Rural measurements suggests the possible transboundary pollution sources
- Research ongoing: Additional pairs of BlueSky sensors deployed in the Terai will show the trend and pattern of $PM_{2.5}$ and also the status of transboundary pollution.
- Efforts needed in future to reduce concentrations of $PM_{2.5}$ would be discoursed by findings of this research.



THANK You

Acknowledgements

Project-"Building Capacity to Improve Air Quality in South Asia: Reducing $PM_{2.5}$ Through Low-Cost Sensor Network Driven Policy Decisions"

IOST, TU & CDES, TU