Spatial variation of $PM_{2.5}$ in urban locations of Nepal

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Introduction

Around 66% of Nepal's population lives in urban areas (CBS, 2021), and the country aims to reduce the 24-h ambient $PM_{2.5}$ concentration in cities to less than 30 (µg /m^3) within the next 25 years (NPC, 2020). Regular $PM_{2.5}$ monitoring is crucial for assessing progress towards that goal. Given the difficulties in installing expensive federal-grade monitors across all urban locations, low-cost sensors are an excellent alternative, particularly in developing countries, where air pollutants have significant spatial gradient (Giordano et al., 2021).

Objective

Assess the spatial variation of $PM_{2.5}$ in urban centres of Nepal

Methodology

We used TSI BlueSky air monitors to measure $PM_{2.5}$ (µg/m^3) in seven municipalities of the Terai lowland region in southern Nepal. In the valleys of Kathmandu (1,400 m) and Pokhara (822 m), we considered the average of the $PM_{2.5}$ from the urban locations, as shown in the study area map. The study period was April 2022 to March 2023. Before deployment, we collocated BlueSky monitors with each other at CDES and federal-grade equipment at ICIMOD for calibration.

Discussion

- We found a similar rise and fall pattern of $PM_{2.5}$ across the country. However, there is a noticeable variation in the diurnal $PM_{2.5}$ concentration at different urban locations. The variation seems to follow a similar pattern in similar geographic regions.
- The $PM_{2.5}$ concentration is higher in Terai cities particularly during winter, probably because of local open burning events in the evening and the influence of regional pollution. Elevated evening peaks indicated night-time industrial emissions. Polar plots of $PM_{2.5}$ at Dhangadhi also indicated multiple sources.
- We observed locally sourced $PM_{2.5}$ in Kathmandu Valley, with the highest concentration of pollution possibly due to westerly winds (~10m/s).
- Pokhara Valley has lower $PM_{2.5}$ concentrations compared with other cities. However, some local festival events appear to raise the $PM_{2.5}$ concentration during December end.
- Low-cost sensors are useful in tracking $PM_{2.5}$ concentrations at both local and regional levels. This helps in developing a baseline for informed decision making in air quality management.

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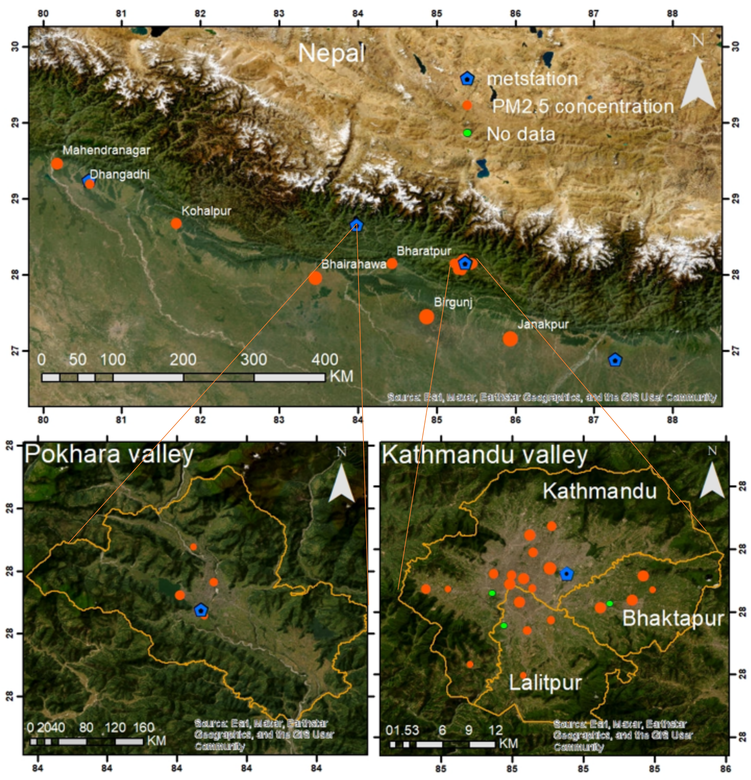
Study area



TSI BlueSky monitors

FIGURE 1: Sensor locations at different urban centres of Nepal

Results

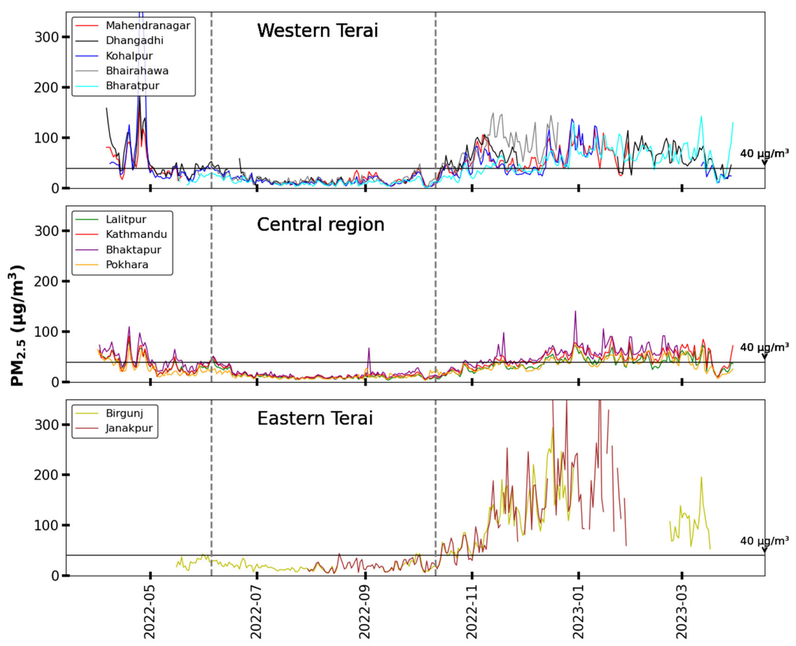


TABLE 1. Data summary of dry months from November 2022 to March 2023

Location	Days	Mean ± std (µg m^{-3})	Days > NAAQS (%)
Mahendranagar	91	64±23	84
Dhangadhi	92	65±22	87
Kohalpur	92	53±28	62
Bhairahawa	50	92±28	98
Bharatpur	150	59±24	74
Lalitpur	150	39±13	45
Kathmandu	150	48±15	72
Bhaktapur	119	57±17	87
Pokhara	150	37±13	38
Birgunj	84	124±52	98
Janakpur	77	156±77	99

Figure 2: Variation of 24-h average of $PM_{2.5}$ (µg/m^3) at different urban centres in Nepal (April 2022 to March 2023)

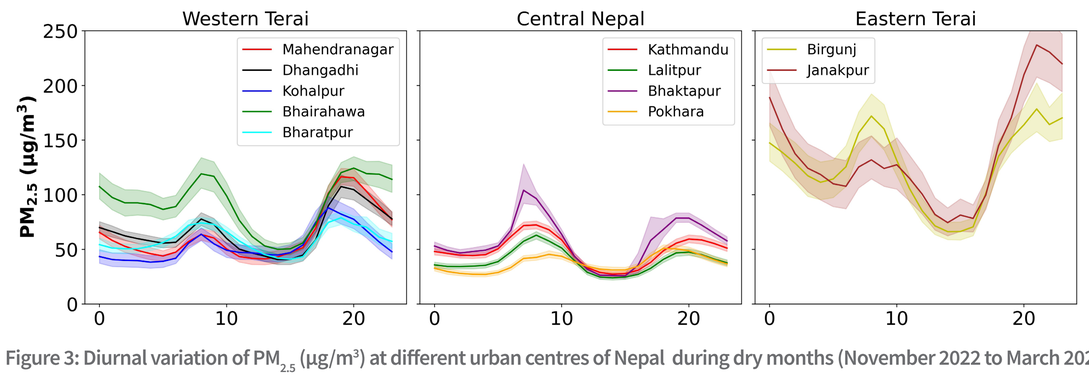


Figure 3: Diurnal variation of $PM_{2.5}$ (µg/m^3) at different urban centres of Nepal during dry months (November 2022 to March 2023)

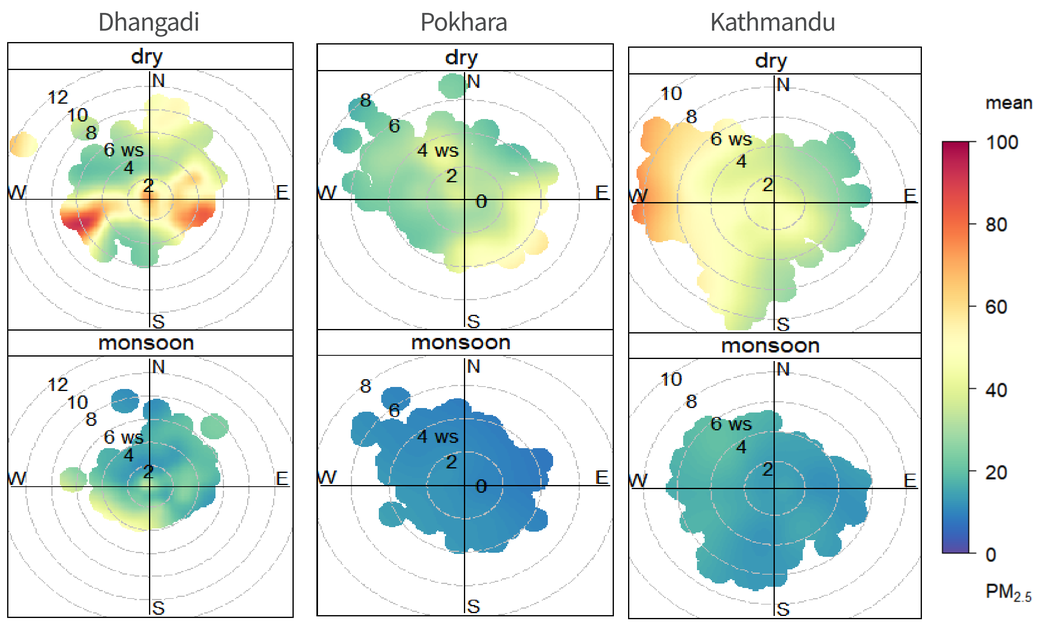


FIGURE 4: Polar plots of mean concentration of $PM_{2.5}$ (µg/m^3) at Dhangadhi, Pokhara, and Kathmandu (April 2022 to March 2023)

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