Perspectives of SPARTAN from Dhaka, Bangladesh: Atmospheric Pollutions, Monitoring and Characterizations

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Background

- Bangladesh is a Southeast Asian country with very high population (about 200 million) within very small active land area. Economy has shifting from agriculture to industries.

- Megacity Dhaka is also the topmost polluted city in the world causing serious health problem. The estimated costs is up to 7.4% of GDP growth (about $14 billion loss and 96,000 premature deaths annually).

- Air quality during wintertime in Dhaka is extremely poor, where the levels of $PM_{2.5}$ is frequently exceeding the WHO 24-hour guideline value (5 μgm^{-3}) by a factor of up to 100.

- Sea level rise due to 1.5^{o}C increase of global temperature will result into inundation of a large area of Bangladesh, soon forcing rehabilitation of about 41 million people from the southern coastal areas.

Rapid Urbanization with Insufficient Planning, Modern Lifestyle, Changes the economy Changes from Agriculture to Industries.

Which country has the poorest air quality in 2021?

Rank		Country/Region	2021	2020	2019	2018	Population
1		Bangladesh	76.9	77.1	83.3	97.1	164,689,383
2		Chad	75.9	-	-	-	16,425,859
3		Pakistan	66.8	59	65.8	74.3	220,892,331
4		Tajikistan	59.4	30.9	-	-	9,537,642
5		India	58.1	51.9	58.1	72.5	1,380,004,385
6		Oman	53.9	44.4	-	-	5,106,622
7		Kyrgyzstan	50.8	43.5	33.2	-	6,524,191
8		Bahrain	49.8	39.7	46.8	59.8	1,701,583
9		Iraq	49.7	-	-	-	40,222,503
10		Nepal	46	39.2	44.5	54.1	29,136,808

What about 2020, 2019, 2018 and so on?

Major Sources of Air Pollution in Bangladesh

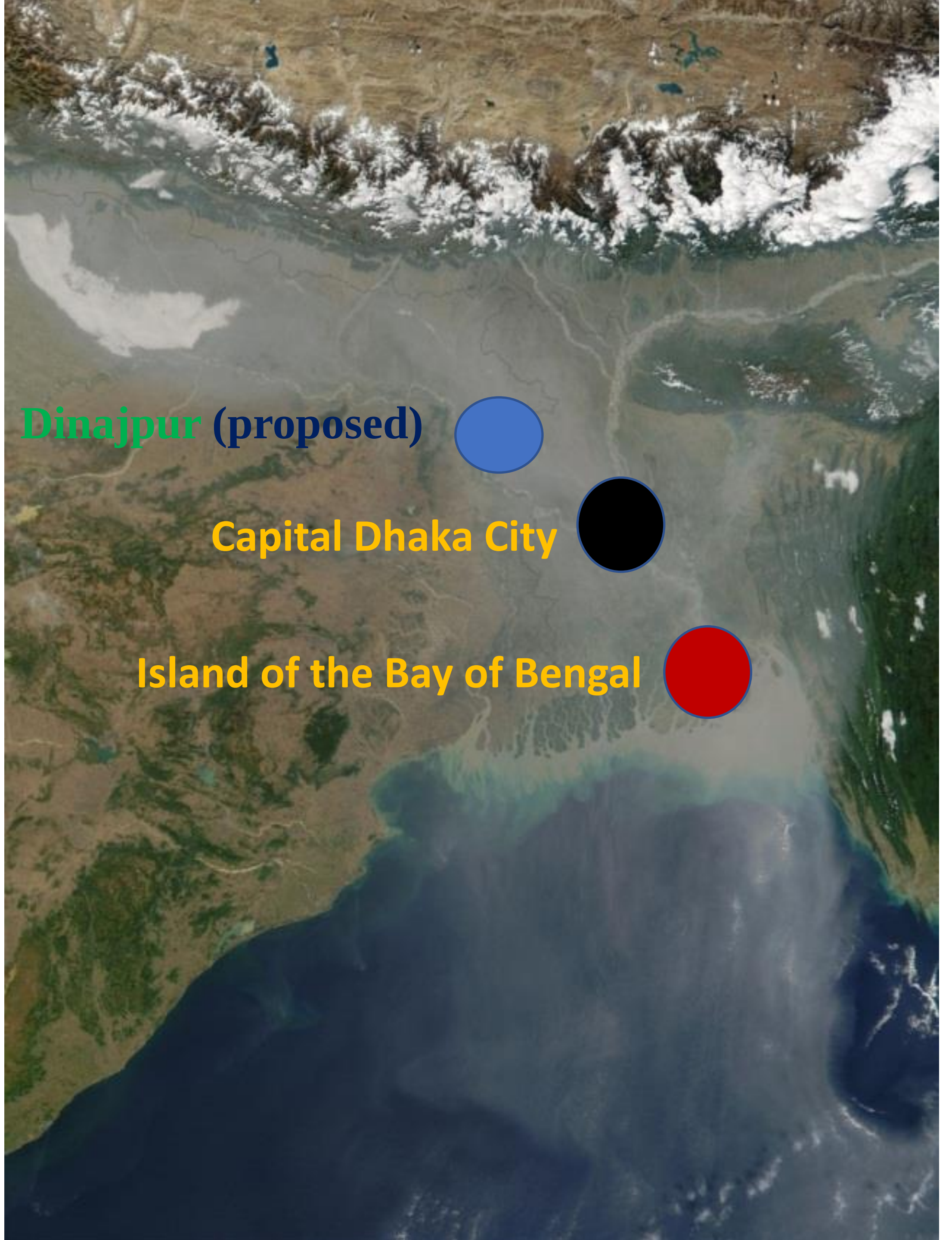
1). Traffice emission
2). Indoor cooking – Natural gas or biomass
3). Garbadge or agricultural waste burning
4). Industrial Emission – Brick kilns and others
5). Construction activities
6). Regional transported pollution
7). Street dusts

Atmospheric Chemistry Research Group, Department of Chemistry, University of Dhaka, Bangladesh.

Operating two observatories (Urban Dhaka and regional background coastal Island of the Bay of Bengal - Bhola).

25 People (PhD/MS/4th Year Projects students/research associates/faculties) are working in our group on different aspects of atmospheric chemistry and air Quality.

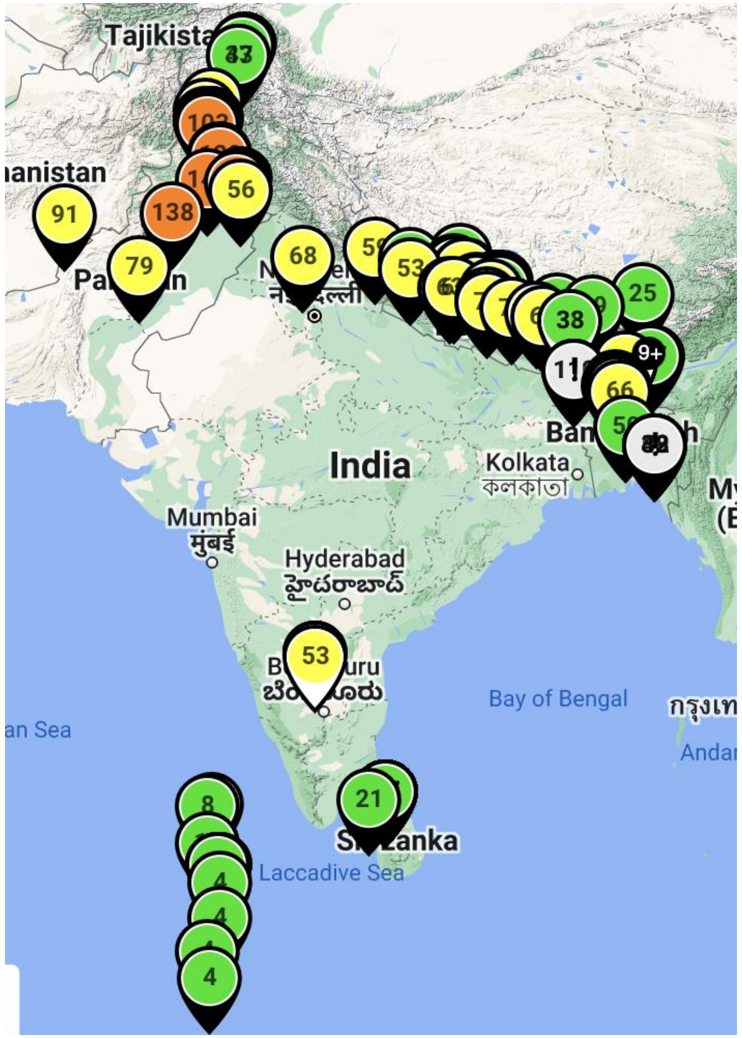
Planning to establish one more station at the most northern part of the country - Dinajpur.

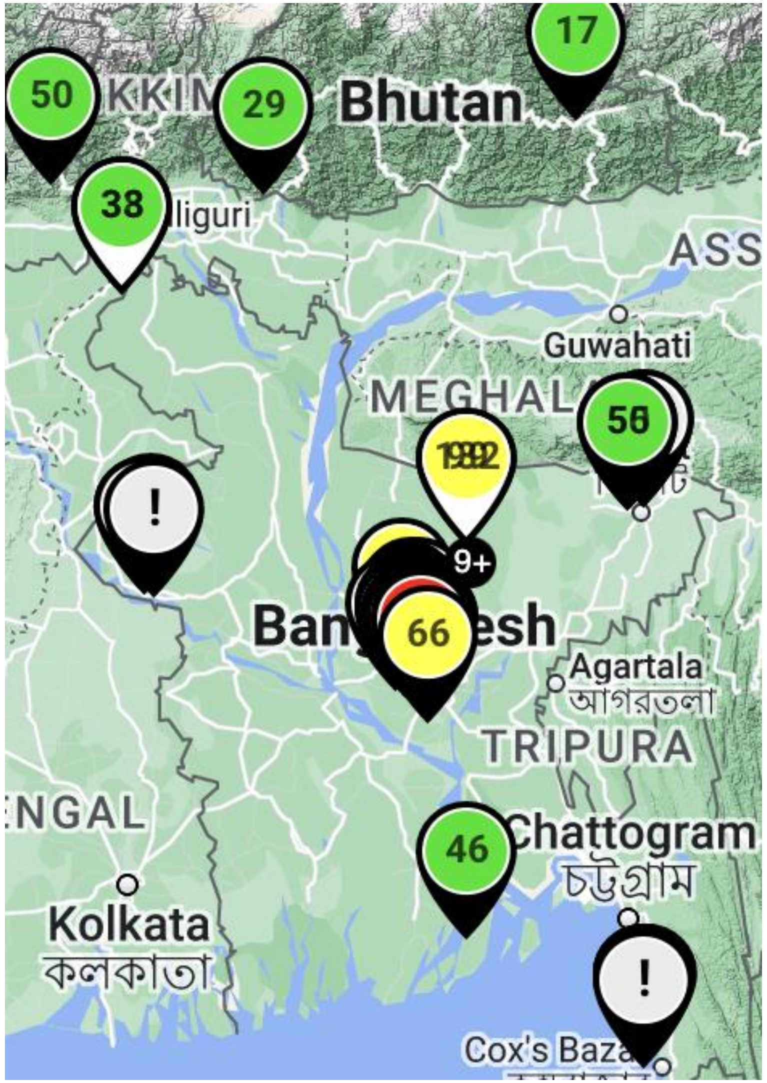


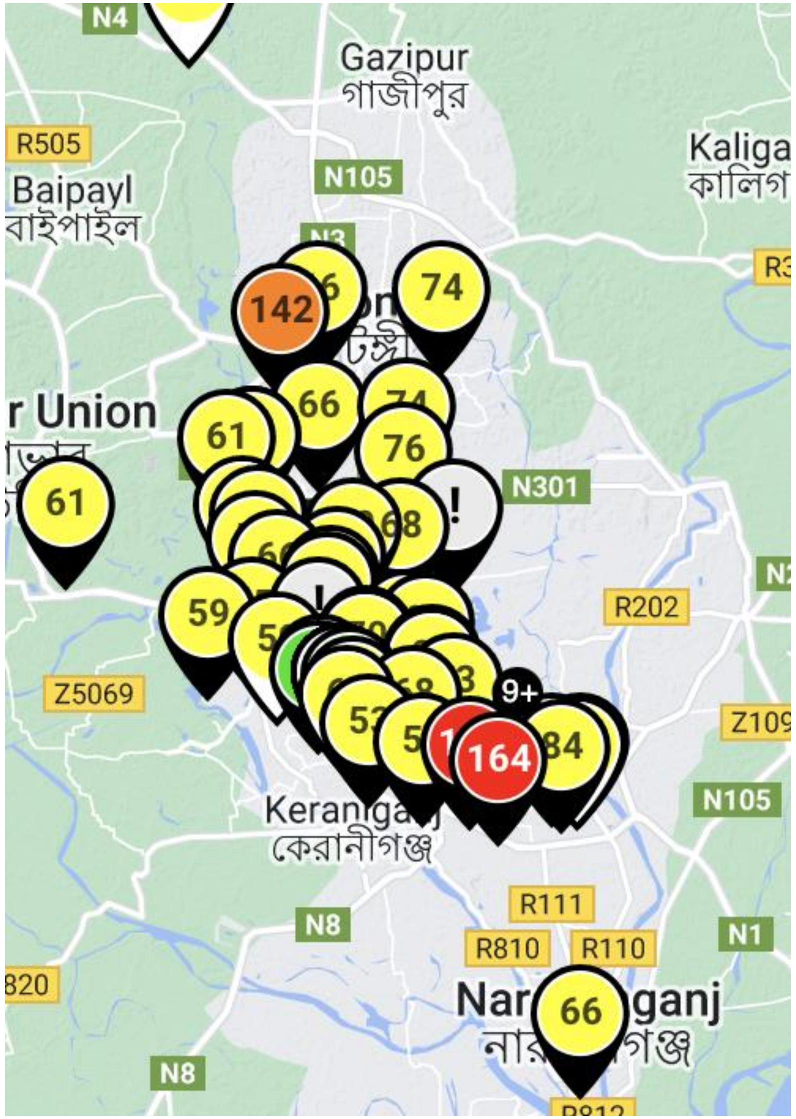
Bhola Observatory - Island of the Bay of Bengal Observatory

AirPhoton Devices from SPARTAN Network in Dhaka, Bangladesh

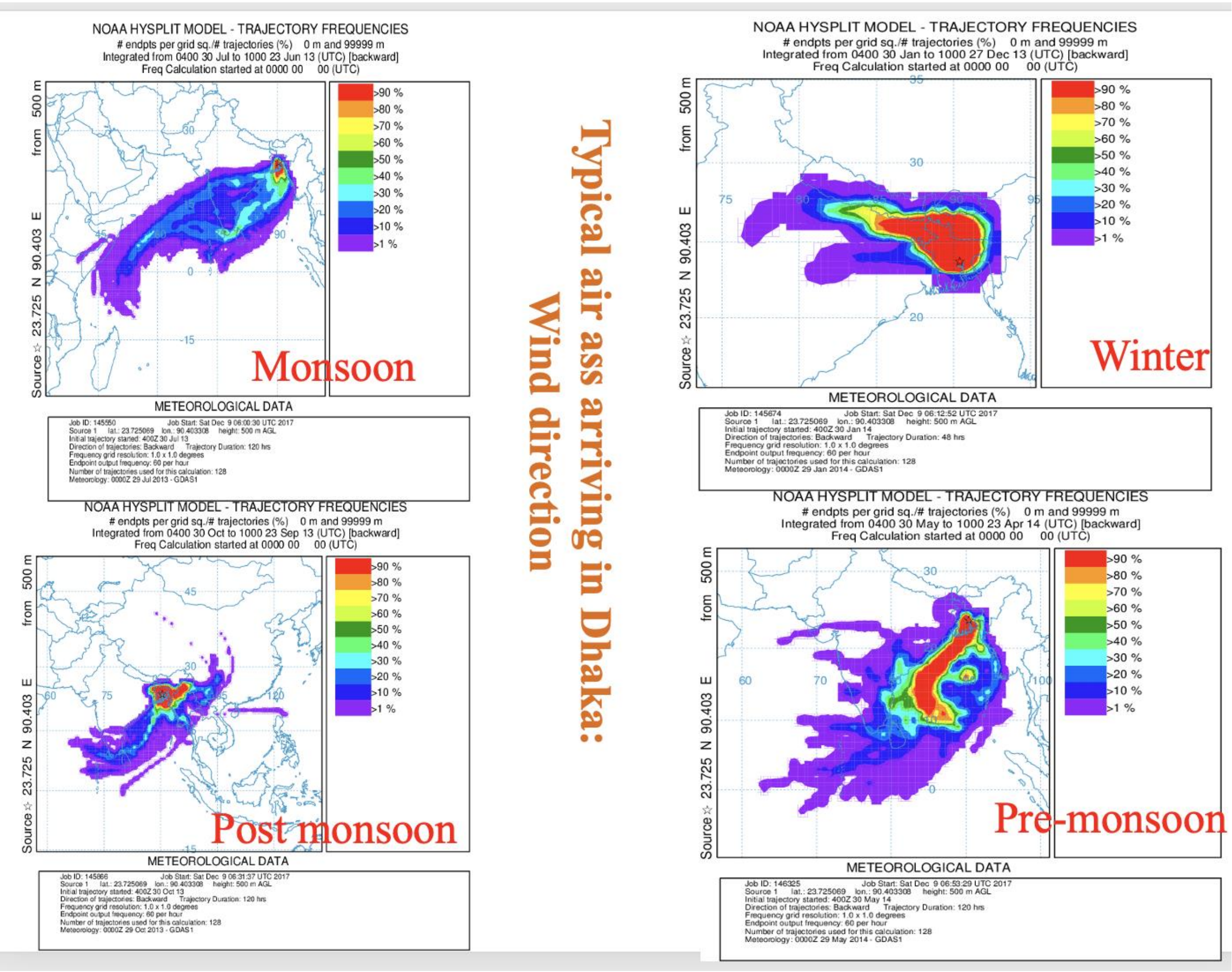
Air quality monitoring Network in Bangladesh and Southeast Asia with Duke University supported by US State Department

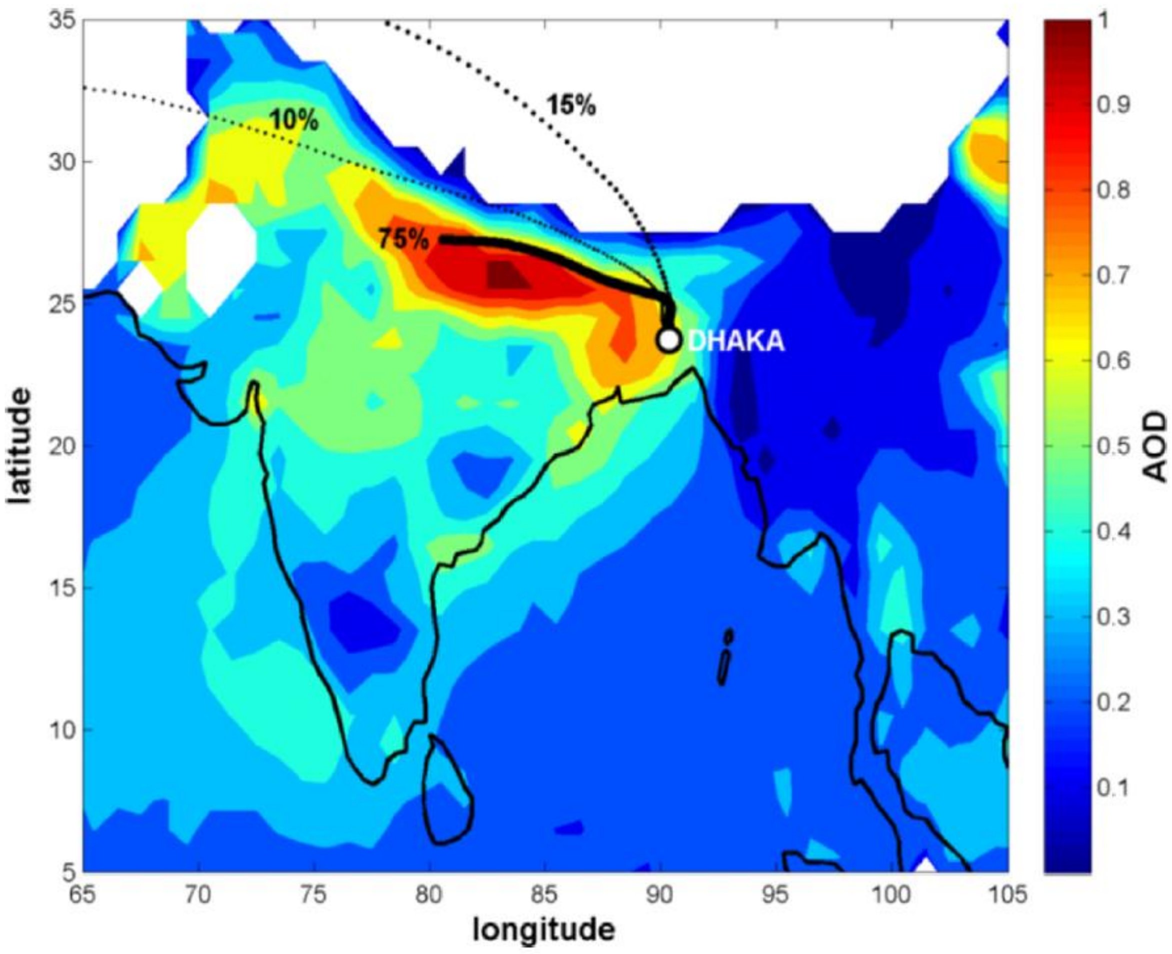






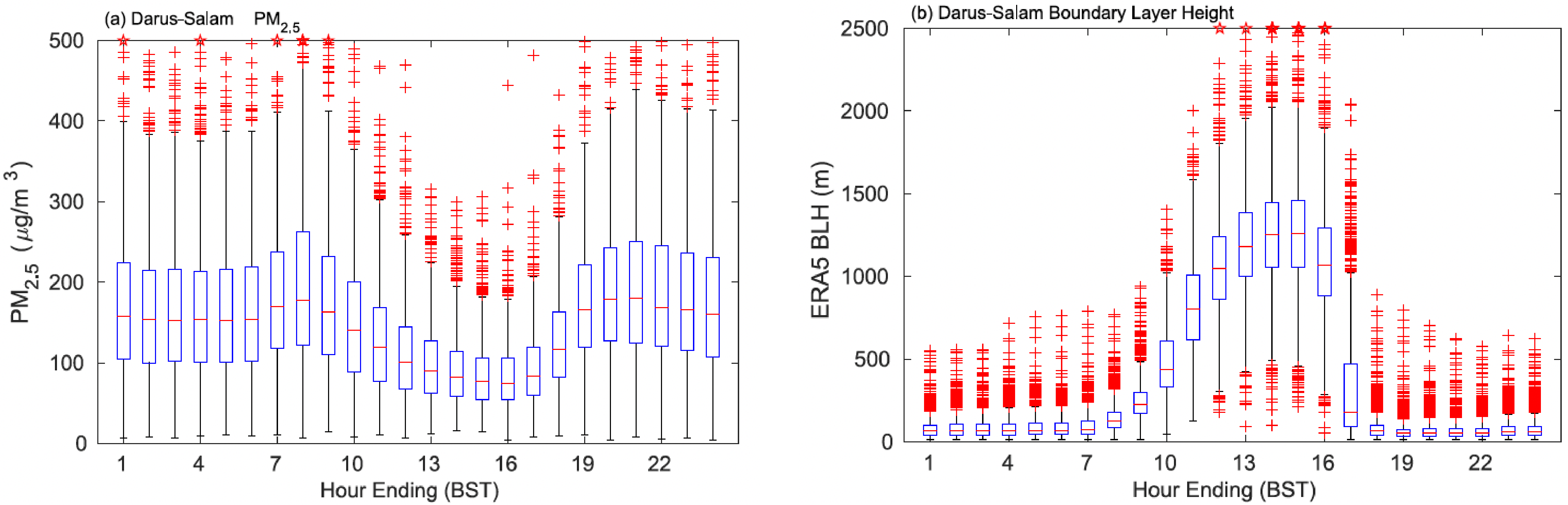
Transported airmass strongly affect the air quality in Bangladesh





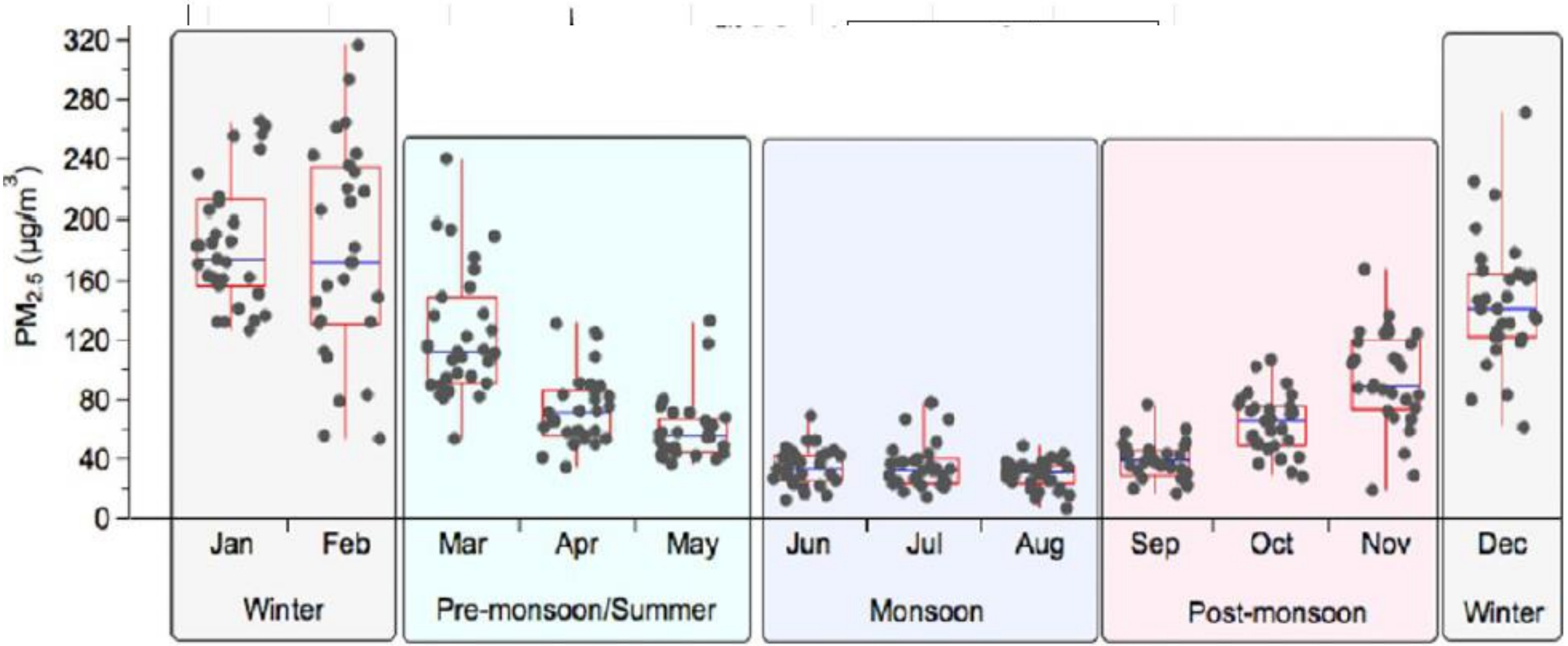
During winter period from November to February - regional haze transported from IGP region to the Bay of Bengal passing over Bangladesh. Sometimes $PM_{2.5}$ goes up to 500 μgm^{-3}.

Diurnal Variation and Boundary Layer Height in Dhaka

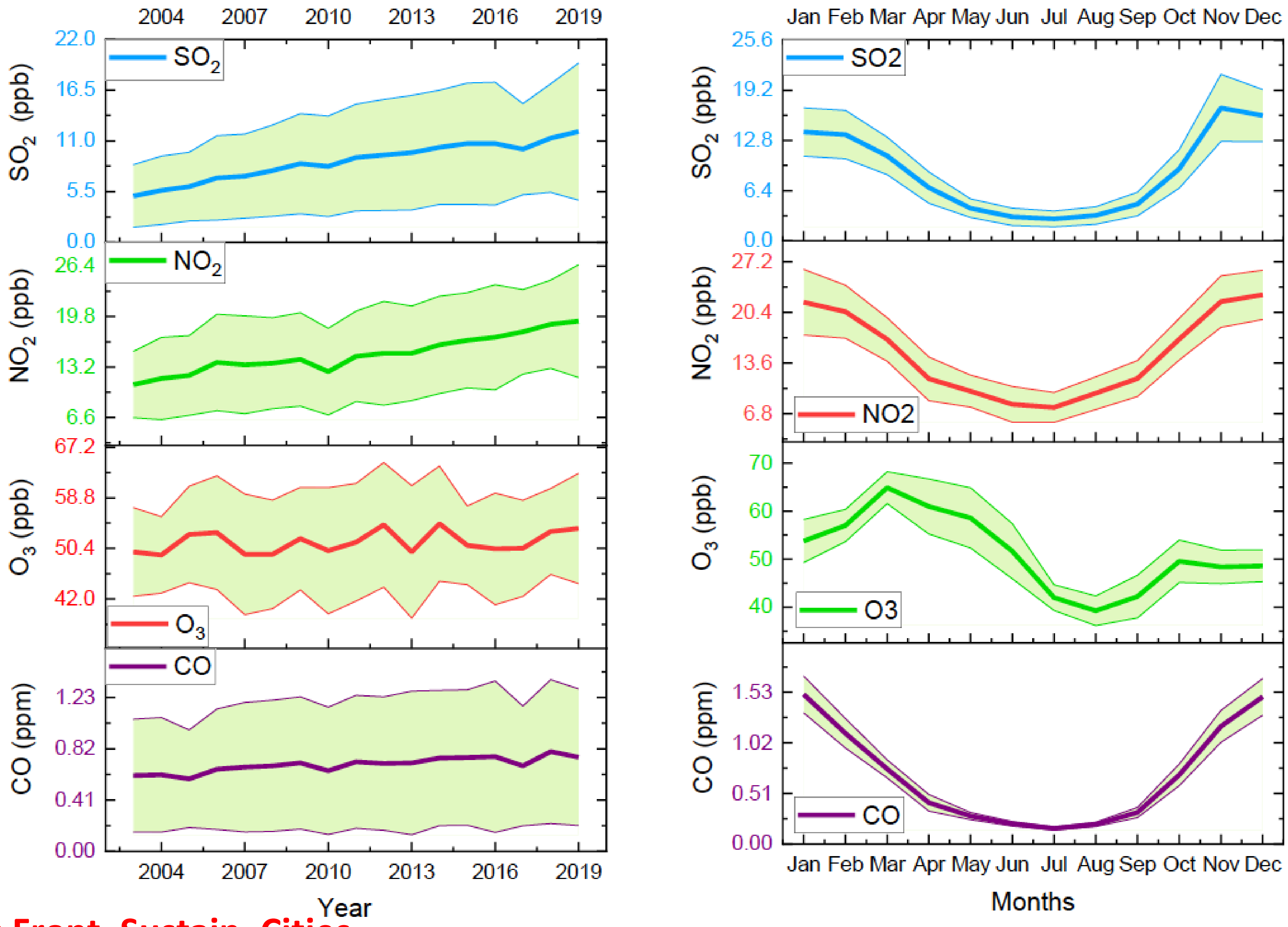


Diurnal profiles at Darus-Salam for November to March: (a) PM2.5 concentrations and (b) ERA5 boundary layer heights. The box plots show median, interquartile range, data range, and outliers. Stars show hours with values above the y axis (7 for $PM_{2.5}$, 14 for boundary layer height)

Trend of $PM_{2.5}$ with strong seasonal variation



Long-term Trends of Gaseous Pollution in Dhaka



Pavel et al 2021: Front. Sustain. Cities

SPARTAN Network

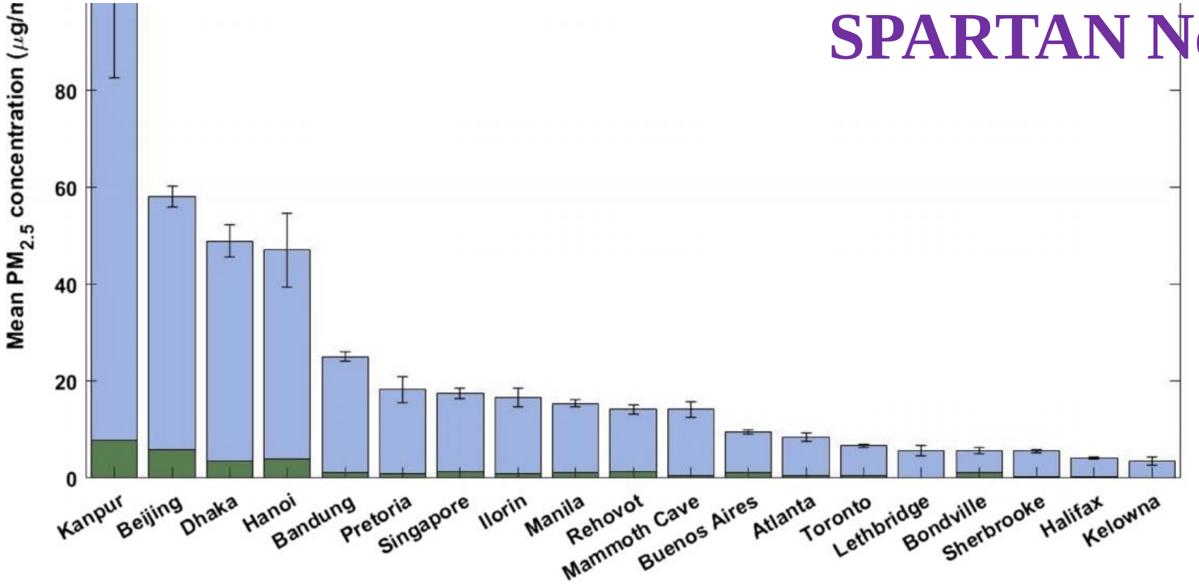


Figure 1. Mean $PM_{2.5}$ mass concentrations at SPARTAN sites with standard error bars shown. Overlaid green bars show total measured trace metal mean mass concentrations for each site.

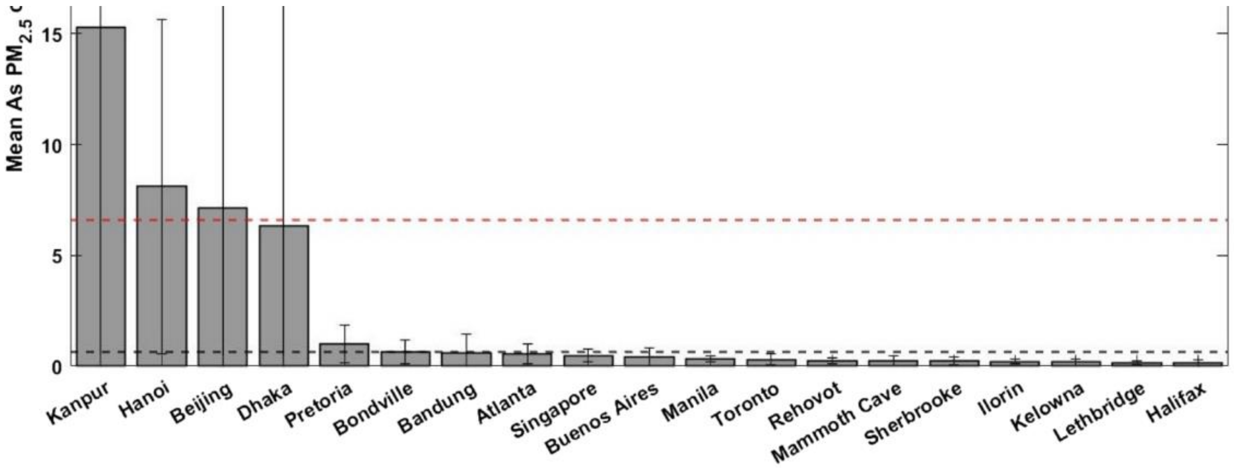
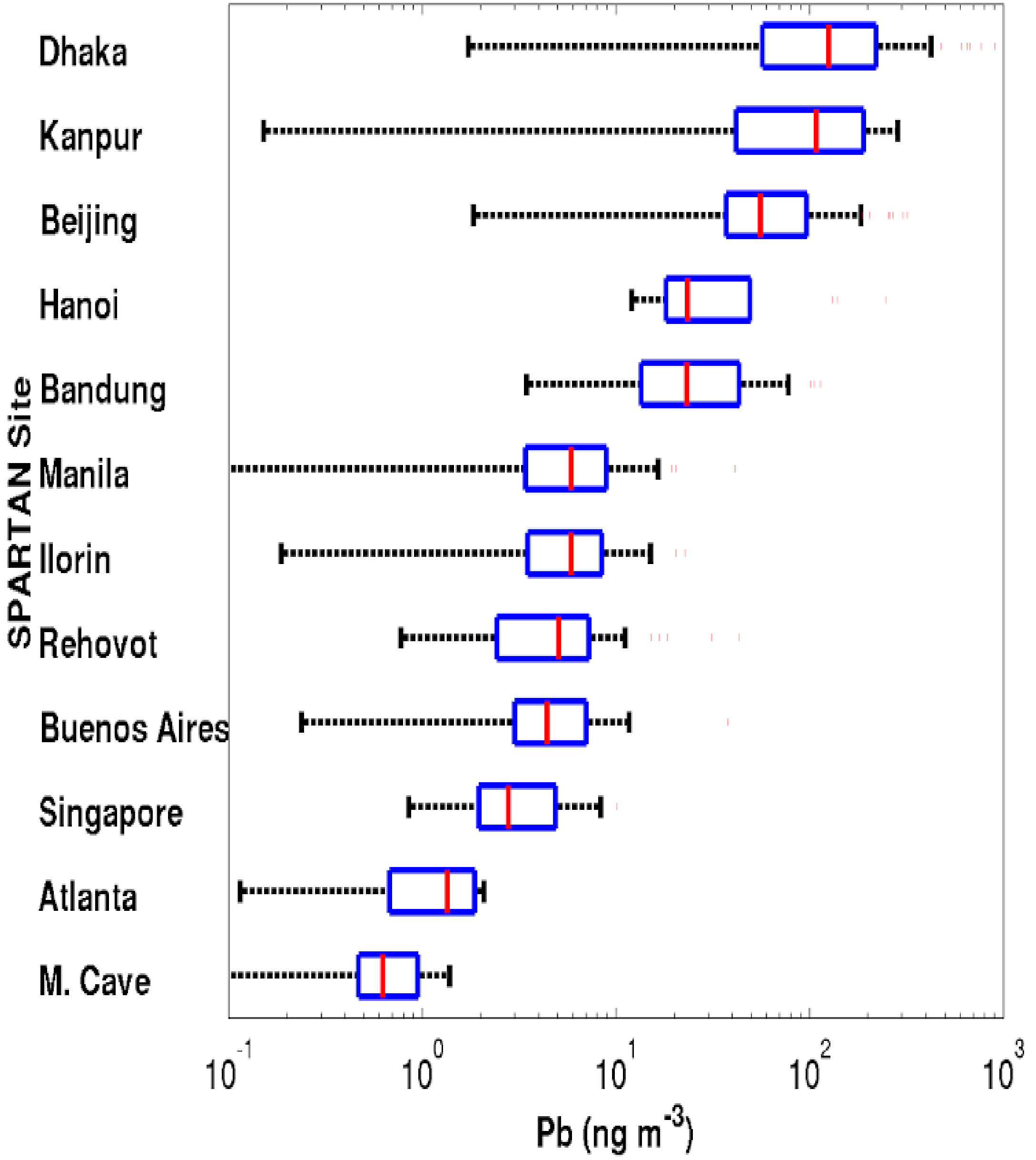


Figure 4. Concentrations of As in $PM_{2.5}$ samples taken from SPARTAN sites, with standard deviation bars shown. Dotted red line represents 1:100,000 excess lifetime risk of cancer due to As exposure (6.6 ng/m^3). Dotted black line represents 1:1,000,000 excess lifetime risk of cancer due to arsenic exposure (0.66 ng/m^3).



Brick kilns Emissions

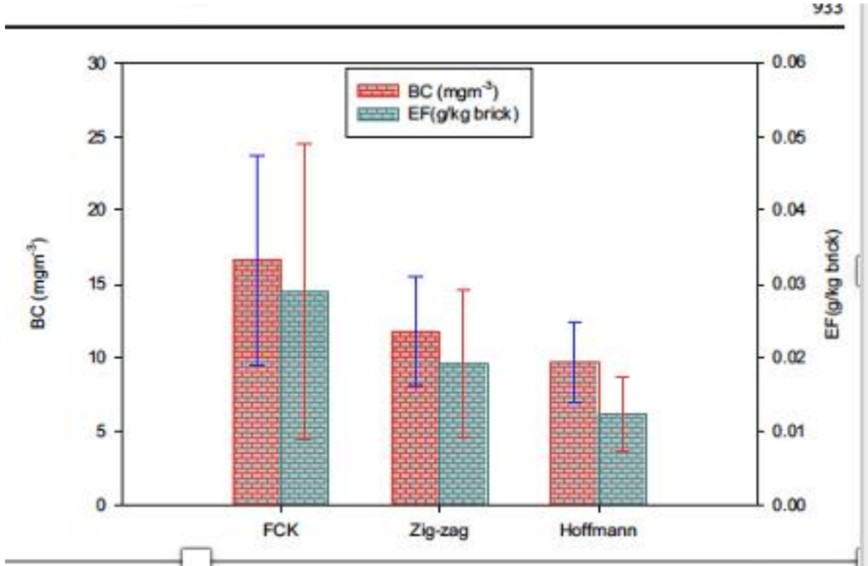


Table 3 Pollutant measurements from stack emission of three types of kilns in Greater Dhaka region, Bangladesh. All units are in mg/m^3

Pollutants	FCK	Zigzag	Hoffmann
BC	16.6 ± 7.1	11.8 ± 4.2	8.9 ± 4.4
$PM_{2.5}$	141 ± 86	128 ± 72	109 ± 53
CO_2	5254 ± 2021	6995 ± 2667	2350 ± 758
CO	264 ± 75	177 ± 81	74 ± 21
SO_2	578 ± 354	332 ± 196	316 ± 219
VOC	23,204 ± 2560	25,266 ± 3563	22,939 ± 2760
NO_x	0.74 ± 0.63	1.6 ± 0.75	1.2 ± 0.58

All samples are presented in their averaged values from specific kilns

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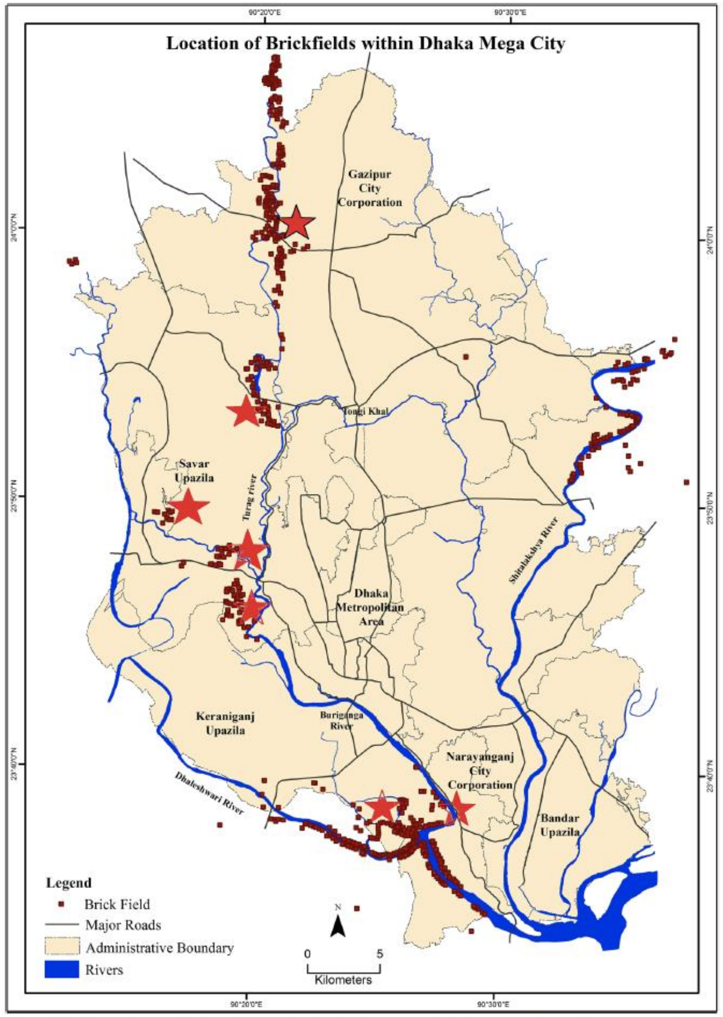
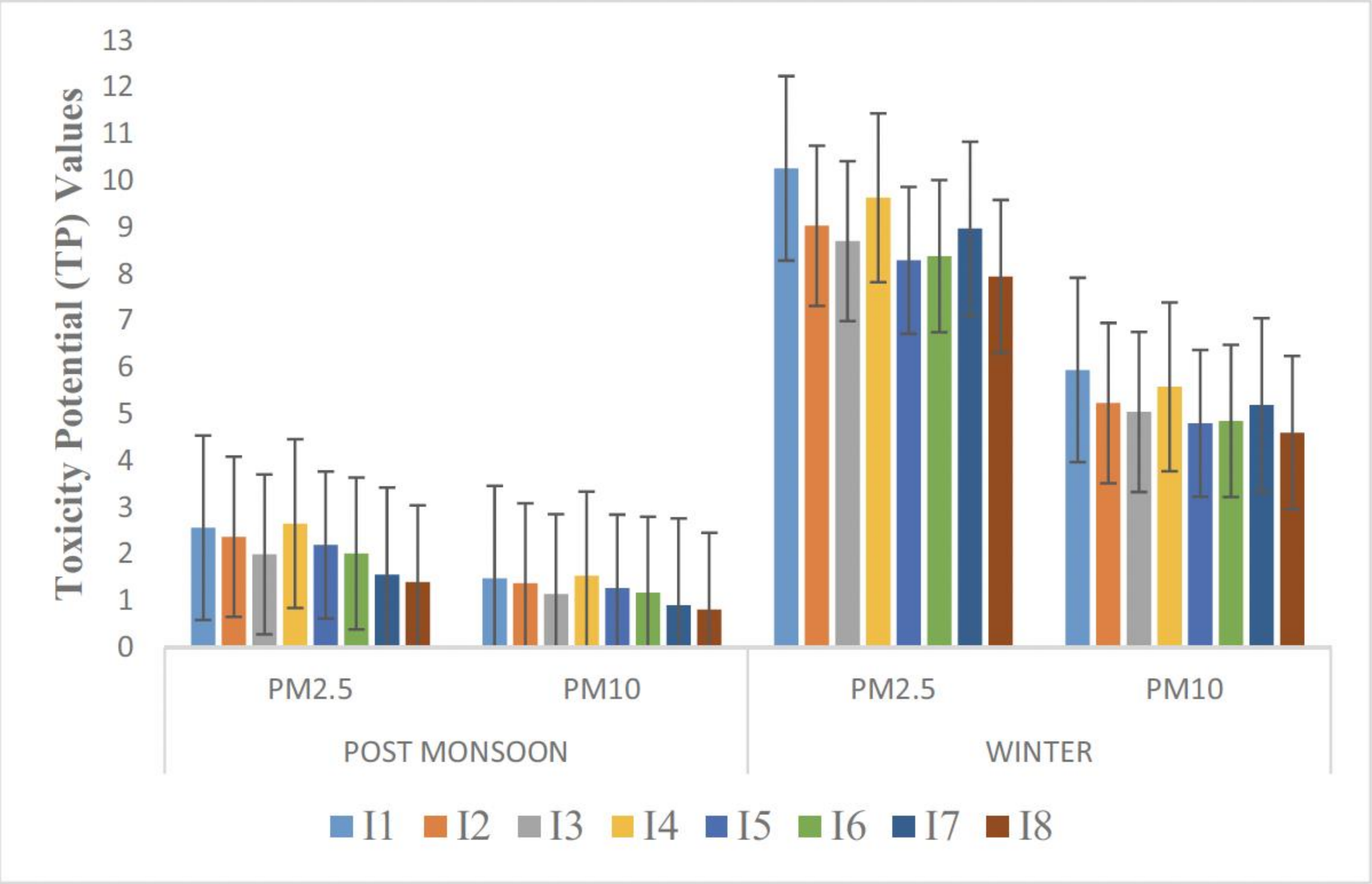


Fig. 1 Location of brick kilns in Greater Dhaka region, Bangladesh, with dots and also indicating seven clusters with star in red color. Eighteen bric kilns were chosen for sampling of these seven clusters

Toxicity Potential (CP)

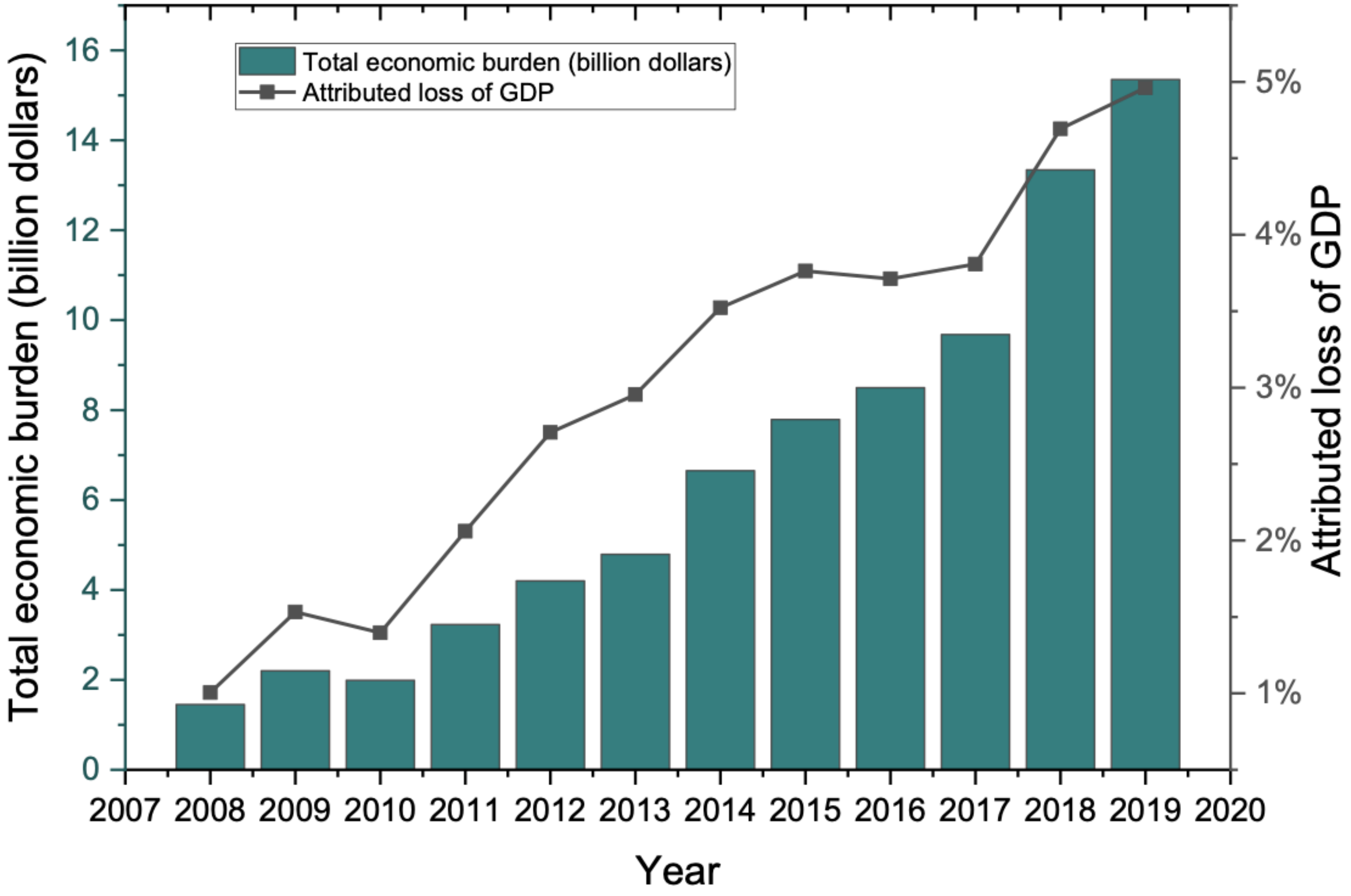
$$\text{Toxicity Potential (TP)} = \frac{Cp}{Sp} \quad (1)$$

Here C_p is the measured concentrations of the pollutants and S_p is the standard guideline value of 25 μgm^{-3} for $PM_{2.5}$ and 50 μgm^{-3} for PM_{10} (WHO 2006).



Toxicity potential (TP) values of indoor air quality indicators of $PM_{2.5}$ and PM_{10} at post-monsoon and winter seasons at three different hospitals in Dhaka, Bangladesh, during 2019/2020.

Economic Burden with Gross Domestic Product (GDP)



Evolution of economic burden (% GDP attributed to ambient air pollution) associated with criteria pollutants $PM_{2.5}$, PM_{10}, CO, O_3, NO_2, and SO_2 in Dhaka for 2008-2019 of people aged 15-64 years.

Research Collaboration/Funding Support

SPARTAN

SPARTAN: A Global Network to Evaluate and Enhance Satellite-Based Estimates of Ground-level Particulate Matter for Global Health Applications

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