Exploring the Spatial Variation Characteristics and Influencing Factors of $PM_{2.5}$ Pollution in Nairobi City, Kenya: A preliminary Analysis

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Background

- The existence of AQ monitoring stations in cities would enable the tracking of population exposures and assessment of health effects of AP.
- However, AQ monitoring requires significant human, technical and financial resources.
- In Kenya, reliable continuous AQ monitoring stations and the technical capacities to run such facilities is low.
- To address this gap, the Global Environmental and Occupational Health (GEOHealth) Hub for Eastern Africa is undertaking research and capacity building through funding from the NIH (USA) and IDRC (Canada).

Background

- If exposure to air pollution varies spatially, this may lead to significant inequality in related health risk.
- Since air pollution combines with other aspects of the social and physical environment, a likely scenario would be a disproportional disease burden in less affluent parts of society.
- An anecdotal study suggested that fine particulate matter ($PM_{2.5}$) in Nairobi spatially varied between 10.7 and 98.1 $\mu g/m^3$ as a mean daytime concentration.
- Comparability of that data with many others is difficult due to use of low-cost sensors with no calibration with a reference monitor.

Aims

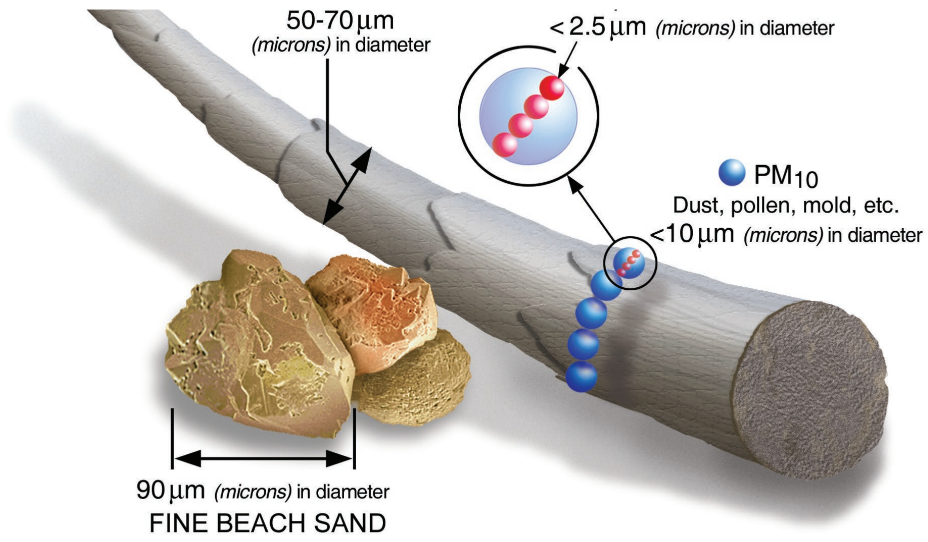
- **The main purpose of the GEOHealth project involves research, training, and capacity building in human health and air pollution risks by:**
- Measuring and defining temporal and spatial variation in outdoor and indoor levels of $PM_{2.5}$ in eight planning zones in Nairobi City County;
- Developing and validating exposure assessment models; and
- Determining the chronic effects of ambient $PM_{2.5}$ on childhood lung function and respiratory symptoms in Nairobi.
- **Here we report on how we are systematically establishing the long-term population exposure to $PM_{2.5}$ pollution in eight planning zones of Nairobi.**

Methods

- Fine particulate matter
- BAM – gold standard reference monitor
- Nephelometers (E-samplers) – low cost sensors

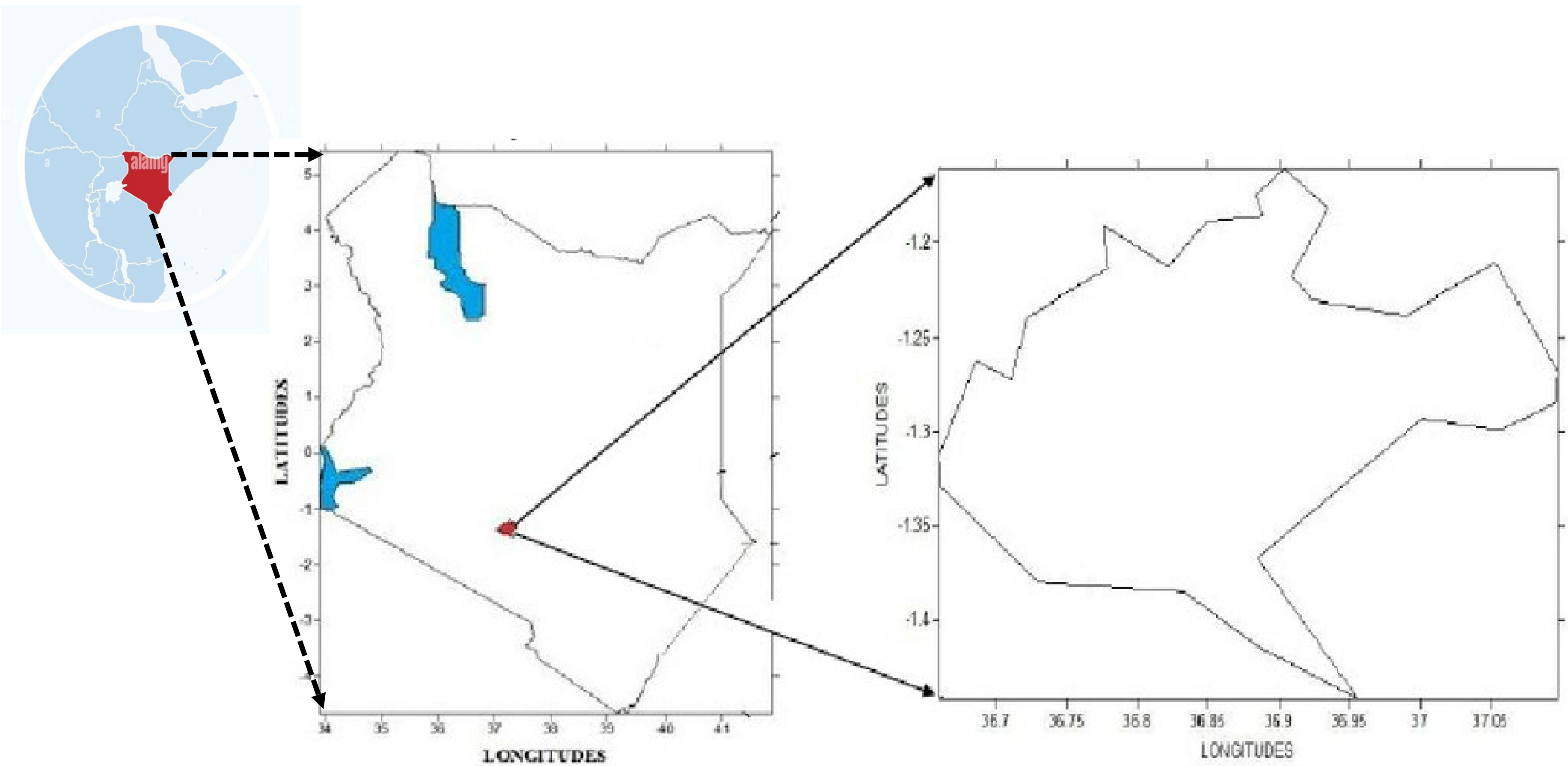
Why the fine particulate matter ($PM_{2.5}$)? Because of its impacts on human health

- $PM_{2.5}$ concentration is characterized by urbanization, industrialization, burning of wastes and use of biofuels (Balakrishnan et al., 2019; Liu et al., 2019; Morelli et al., 2019).
- A recent findings in Ethiopia show a daily mean $PM_{2.5}$ concentrations of 42.4 μg^{-3} leading to 502 deaths in 2020 (Kumie et al., 2021).



EASTERN AFRICA GEOHealth Hub
Global Environmental & Occupational Health

Study site: Nairobi City County



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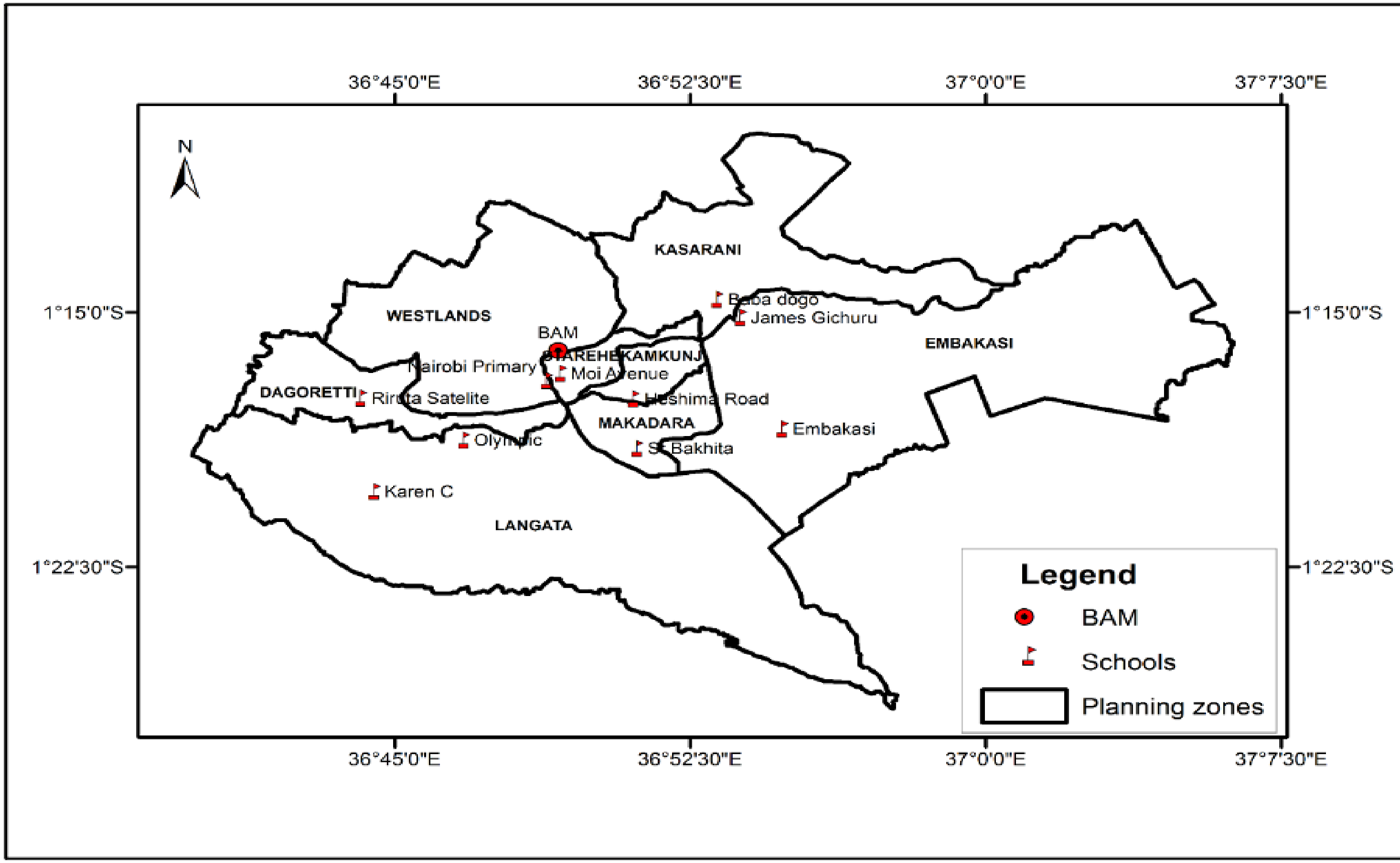
10 E-samplers in 8 planning zones



Setup of the AQ sensors

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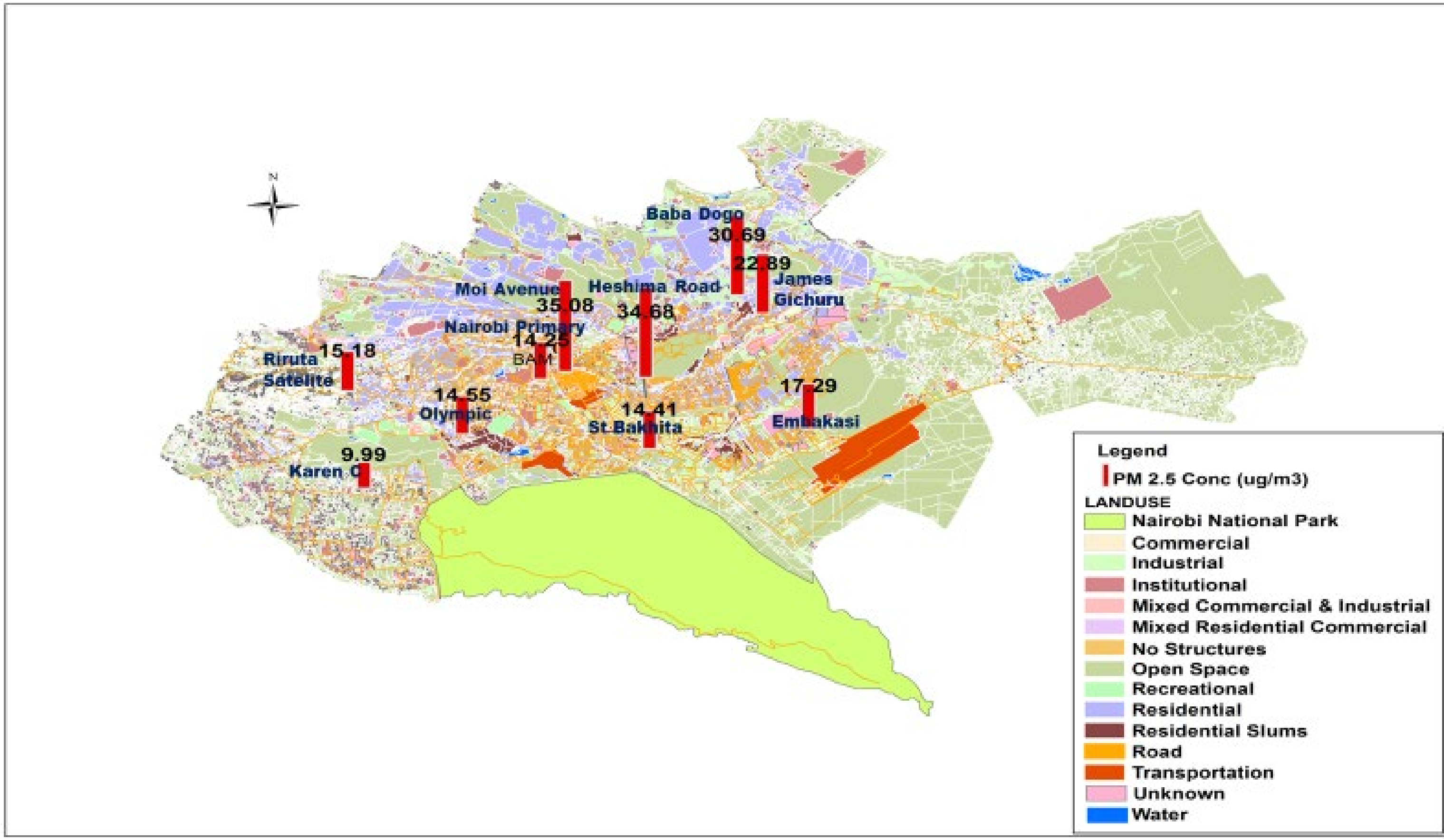
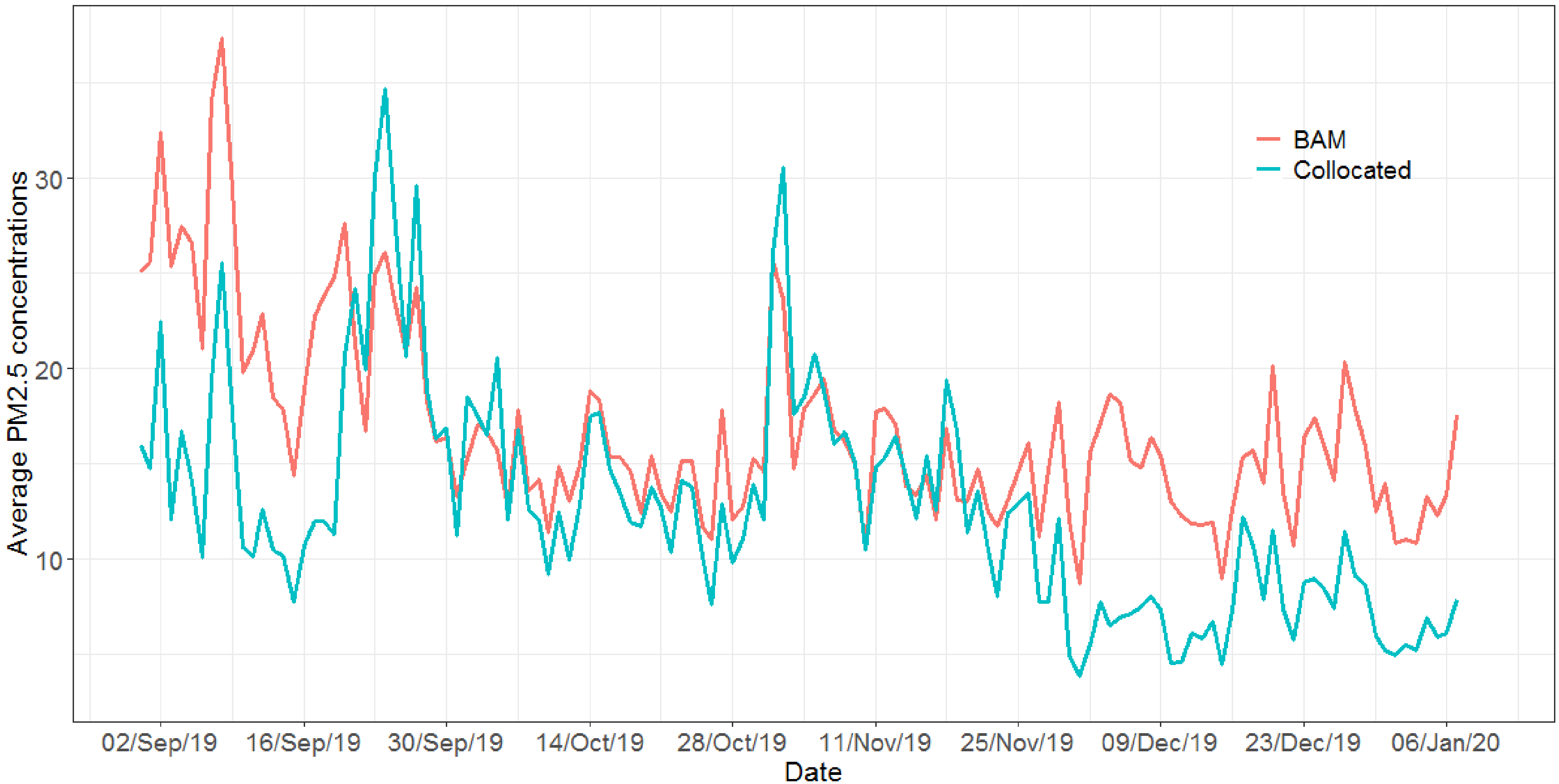
Some preliminary findings

- How reliable are exposure readings from low-cost sensors?
- What we found from co-locating an e-sampler with the BAM

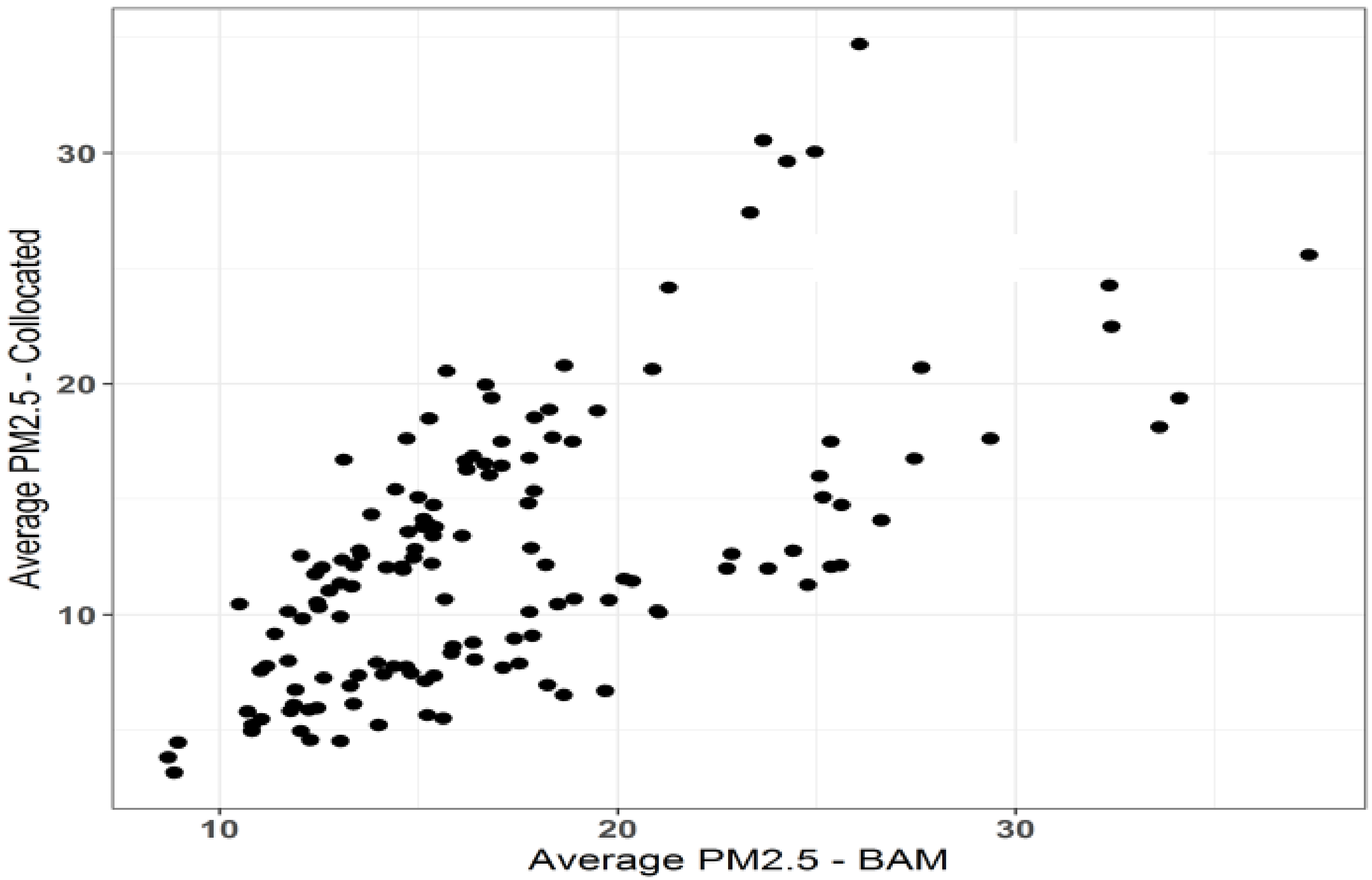
$PM_{2.5}$ exposure levels in Nairobi



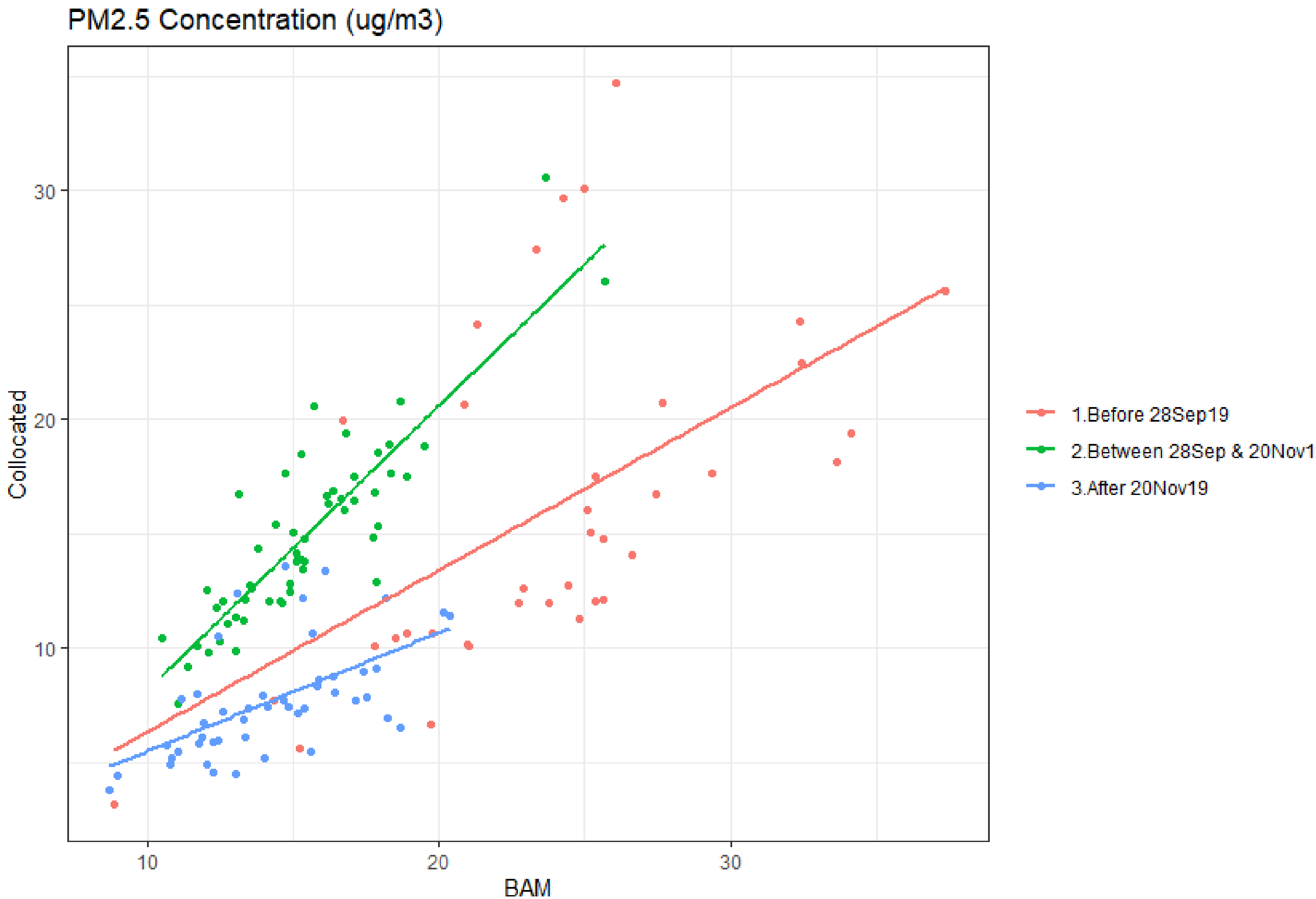
How $PM_{2.5}$ measures from BAM and a the co-located E-sampler varied over time



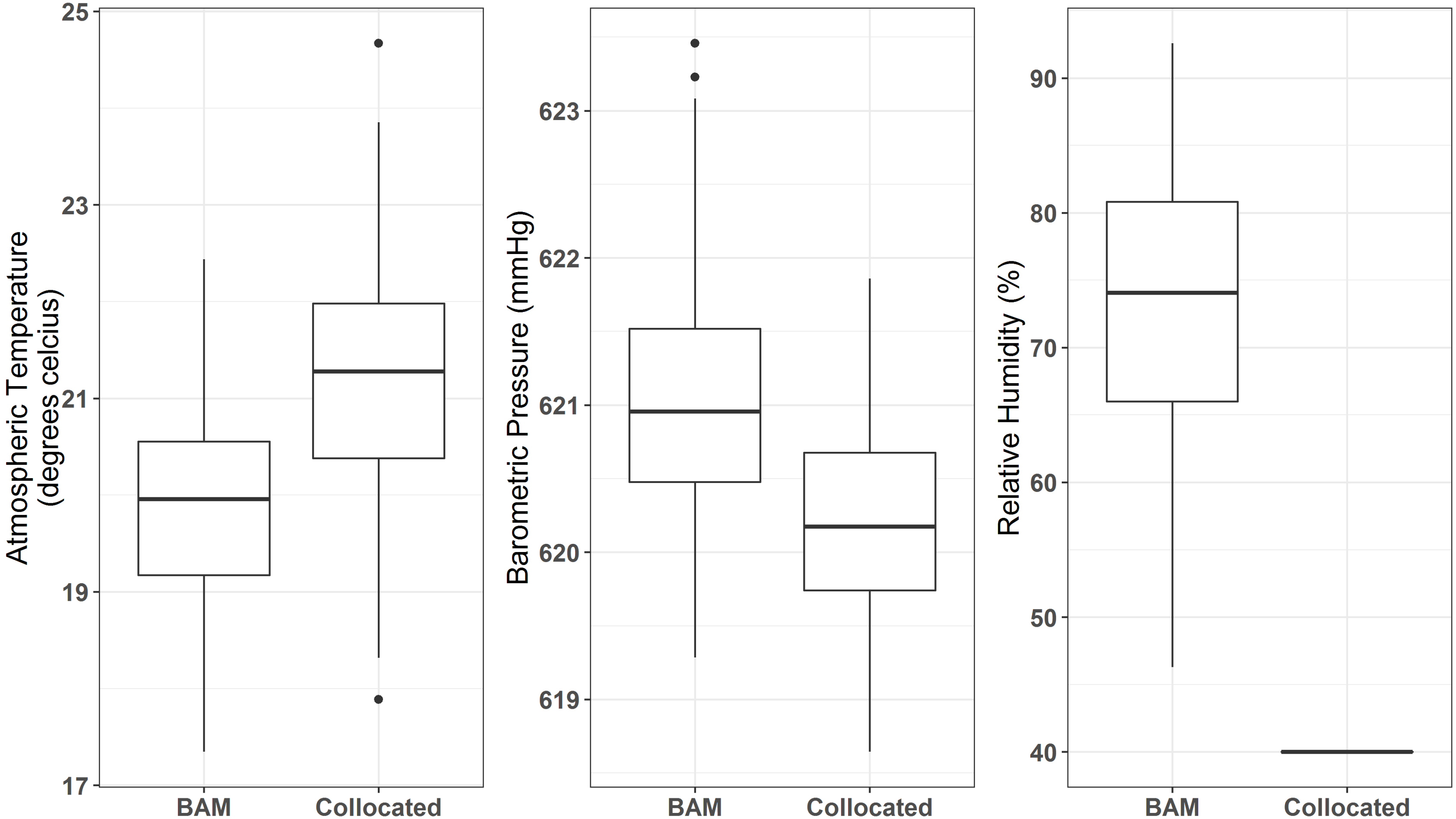
The correlation between $PM_{2.5}$ measures from BAM and nephelometer was low positive (r^2=0.6376, p<0.001)



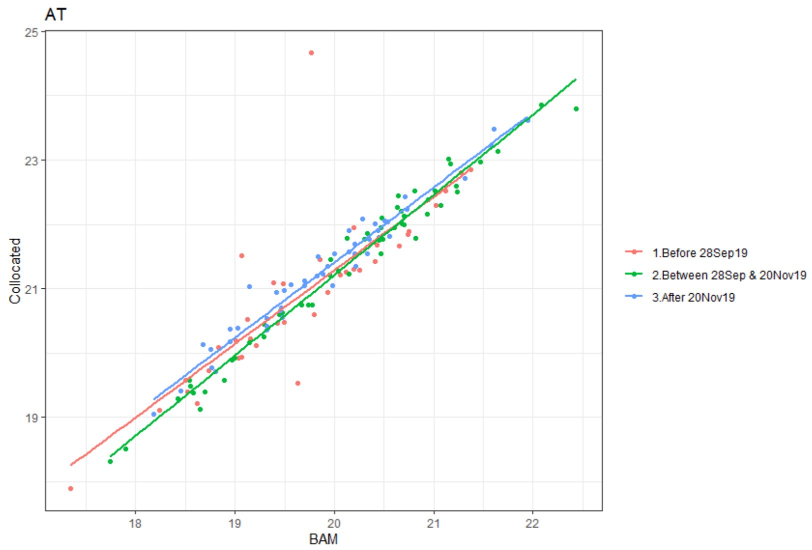
This association varied at different time ranges

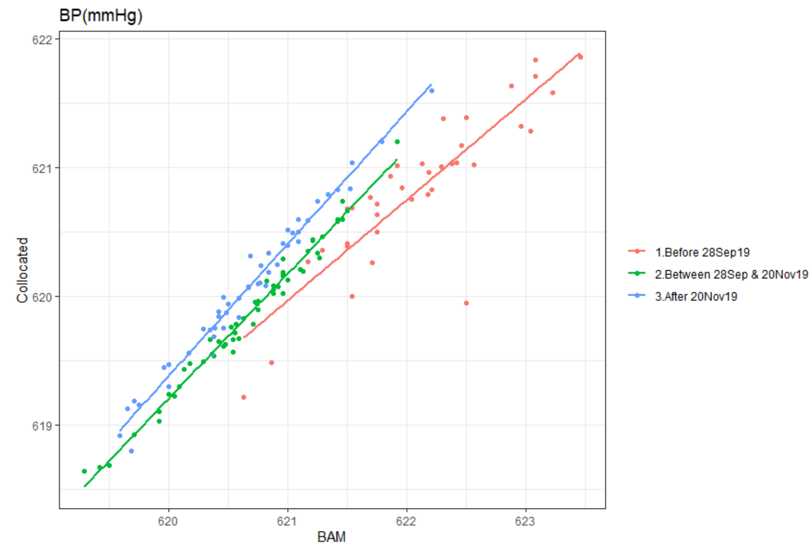


Distribution of environmental factors from the AQ monitors



High Positive Correlations of Environmental factors measures





Correction factor?

- $PM_{2.5}$ in BAM = 9.76 + 0.59 μg/m^3 in co-located nephelometer
- The nephelometers did not measure RH which from the BAM was the most important environmental factor affecting $PM_{2.5}$ concentrations in Nairobi (r^2=-0.32, $p<0.001$)

Inferences

- Low cost sensors remain the most cost effective way of generating rapid spatial AQ data in Kenya.
- However, they require regular caliberation to generate reliable and comparable data.
- Although our study seasonally caliberated the nephelometers using the K-factor, the data generated will require further standardization using the following factor $y = 9.762 + 0.589x$ in order to be comparable with the BAM measurements.

Thank you