Filling in the air quality data gap and enabling air quality management in LMICs using low-cost sensors

Assessment of Traffic-derived Air Pollutants by Smart Sensors: Comparison of Pollutants at Street Levels

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Background

- In cities and towns across the globe, Traffic-Related Air Pollution (TRAP) is the major source of air pollution.
- Change in traffic flow in a city can cause increased, decreased, or no change in overall air pollution.
- Most of the studies evaluating air pollution after introducing new traffic plans into a city measured only ambient air pollution.
- However, they did not measure air pollution on different street segments.

Background

- The standard air pollution monitors are expensive.
- Developing countries like Sri Lanka do not have the funds to establish the required number of monitoring stations to measure air pollution.
- The developing small sensor technology is a new area where air pollution measurements can be done at a low cost.
- These sensors have benefits over standard monitoring stations.

Objective

- This study aimed to monitor and evaluate traffic-related air pollution on the roads of Kandy city, Sri Lanka, before and during a new traffic plan.
- To the best of our knowledge, there has been no traffic-related mobile air pollution monitoring study published in Sri Lanka to date.

Study Area

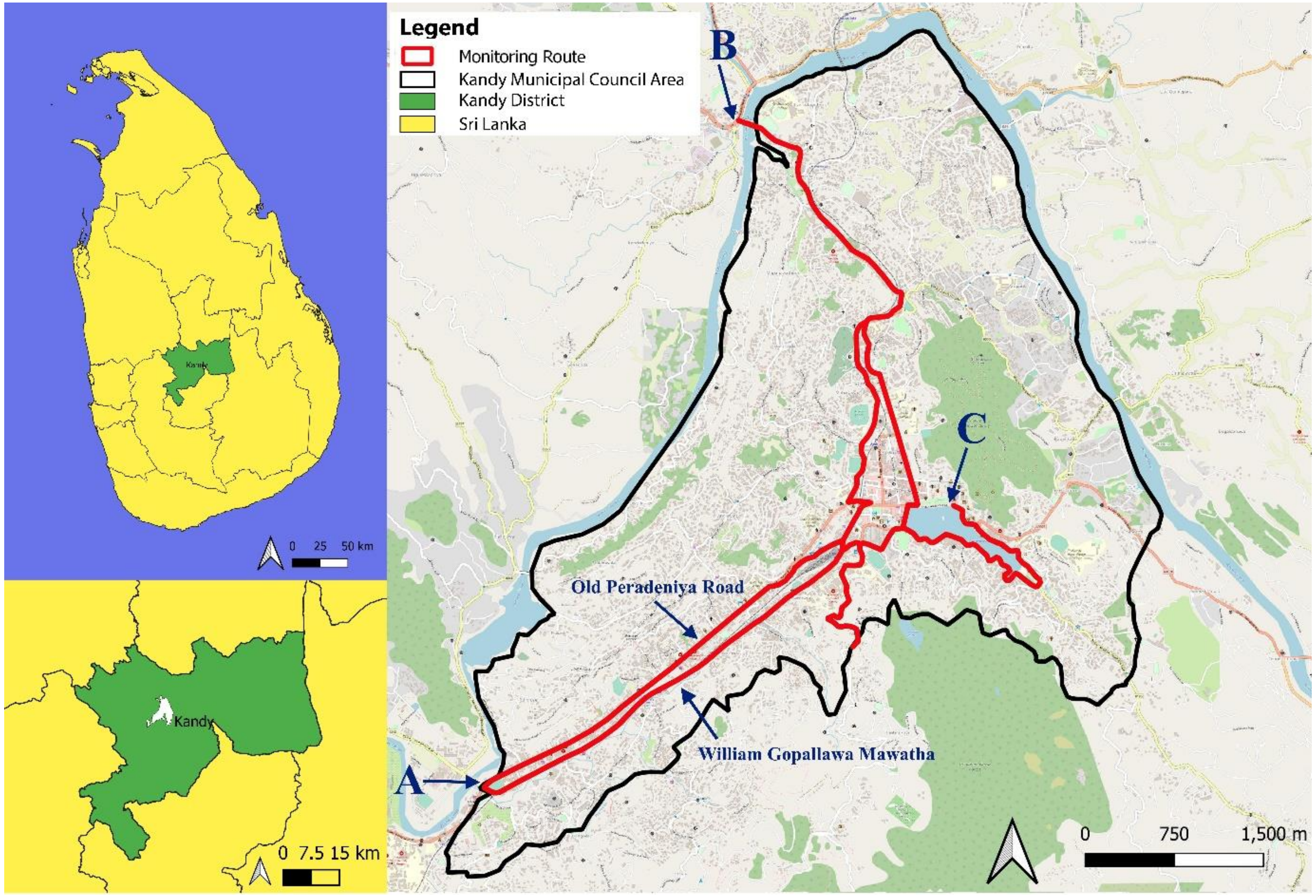

Fig 1. Study Area; Study area was in and around the Kandy city roads. A- via Peradeniya, B – via Katugastota, and C- via Tennekumbura: three main traffic access to Kandy city

- We measured air pollution on the main roads of the city, including the three main traffic access routes to the Kandy Municipal area (total area of 28.53 Km^2)

Methods

Fig 2. Sniffer4D air quality device

Fig 3. Sniffer 4D sensor mounted on a police traffic motorcycle

- In this study, we used a small law-cost mobile air quality measuring device called“Sniffer4D”.
- Data were collected using a “Sniffer4D” device mounted to a traffic police motorbike before and during the one-way traffic plan, along the major roads in the city of Kandy, in March 2019.

Methods

- The motorcycle's speed was maintained at less than 20 km per hour at all times.
- When moving along the roads, sniffer4D provides a geographic location (longitude, latitude, and elevation), temperature, humidity, PM2.5, and NO_2 concentration at each point in every second.
- Monitoring was conducted at regular time intervals
  - Morning (7.00 am – 10.00 am)
  - Mid-day (10.00 am – 1.00 pm)
  - Afternoon (1.00 pm – 4.00 pm)
  - Evening (4.00 pm – 7.00 pm).

Methods

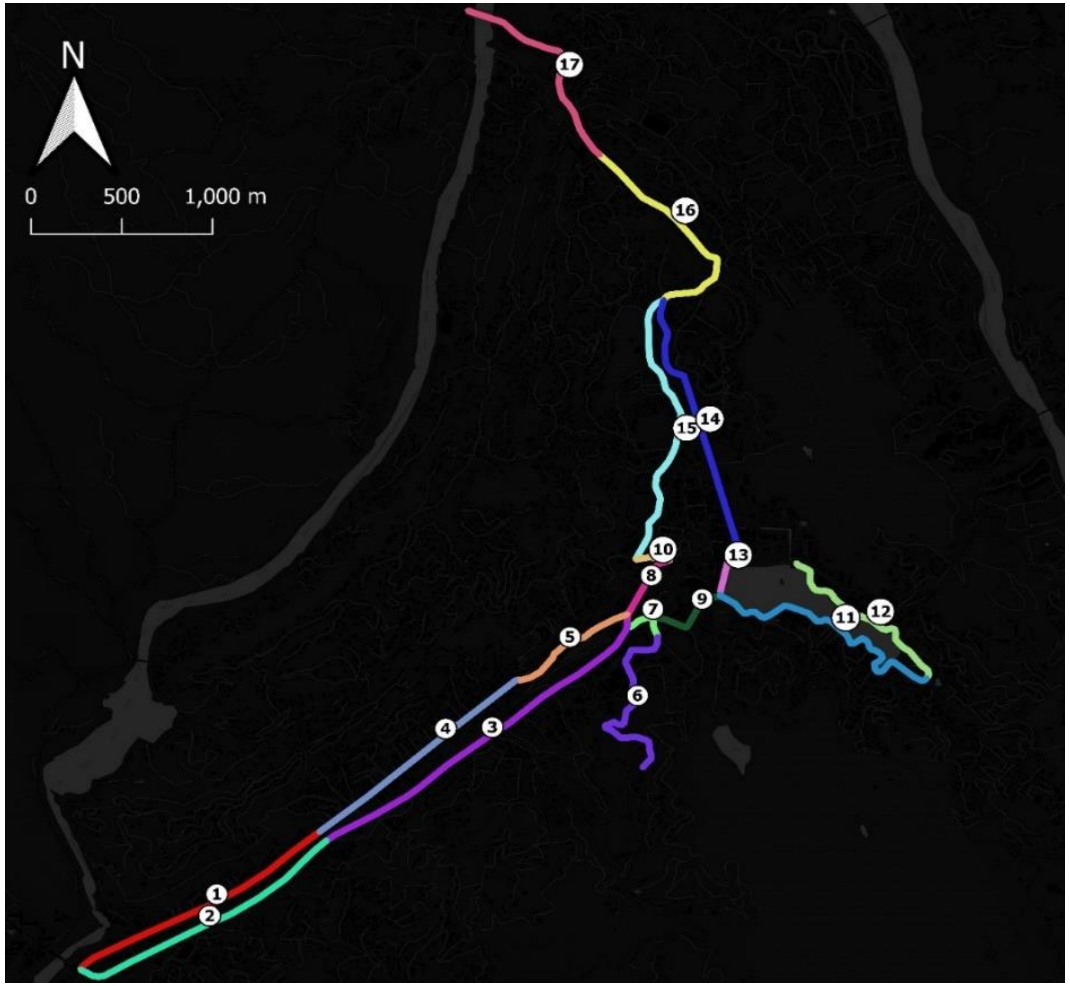

Fig 4. Categorization of road segments in Kandy city

Road Segment ID	Details of the road segment
1	Getambe Junction- Mulgampola Junction (Old Peradeniya Road)
2	Getambe Junction - Mulgampola Junction (New Kandy Road)
3	Mulgampola Junction - Kandy Railway Station
4	Mulgampola Junction – Girls' High School
5	Girls' High School – Kandy Railway Station
6	Hantana Road
7	Baladaksha Mawatha + Keppetipola Road
8	Kandy Railway Station - Clock Tower
9	Bogambara Road
10	Clock Tower - Kandy Police Station
11	Lake Round - EL Senanayake Children's Park
12	EL Senanayake Children's Park - Dalada Maligawa
13	Dalada Maligawa – Lake Round
14	Kandy Jaffna Road – Welikanda Railway Station
15	Kandy Police Station – Welikanda Railway Station
16	Welikanda Railway Station – St. Anthony's Boys College
17	St. Anthony's Boys College – Katugasthota

Results And Discussion

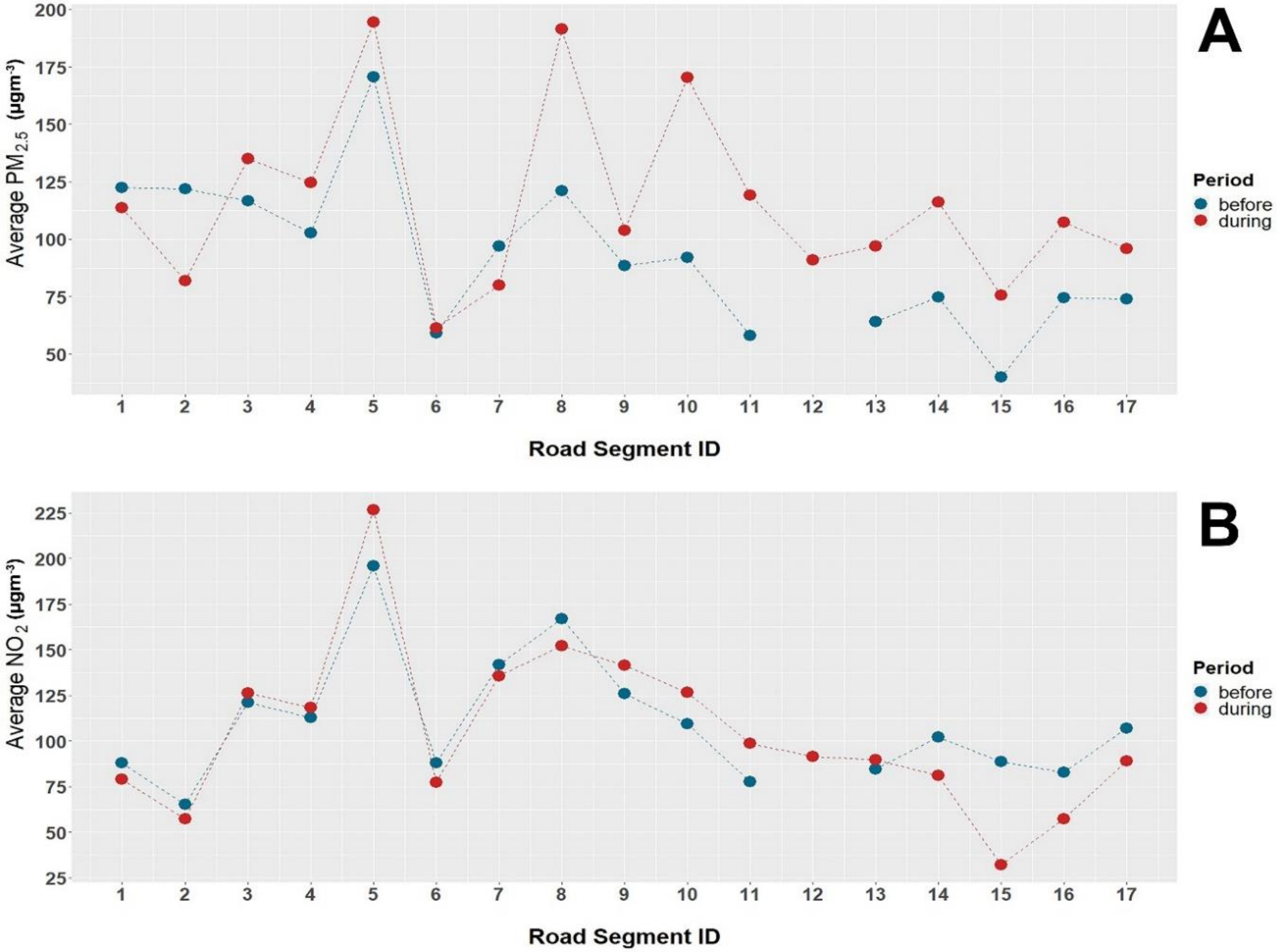

Fig 5. $PM_{2.5}$ (A) and B) NO_2 (B) level by Road Segment ID before and during the new traffic plan

- $PM_{2.5}$ concentrations during the New Traffic Plan (NTP) means were statistically significantly higher than the before NTP ($p=0.0067 < 0.05$).
- Mean NO_2 concentrations were not significantly different before (109.87 ppb) and during NTP (104.73 ppb).

Results And Discussion

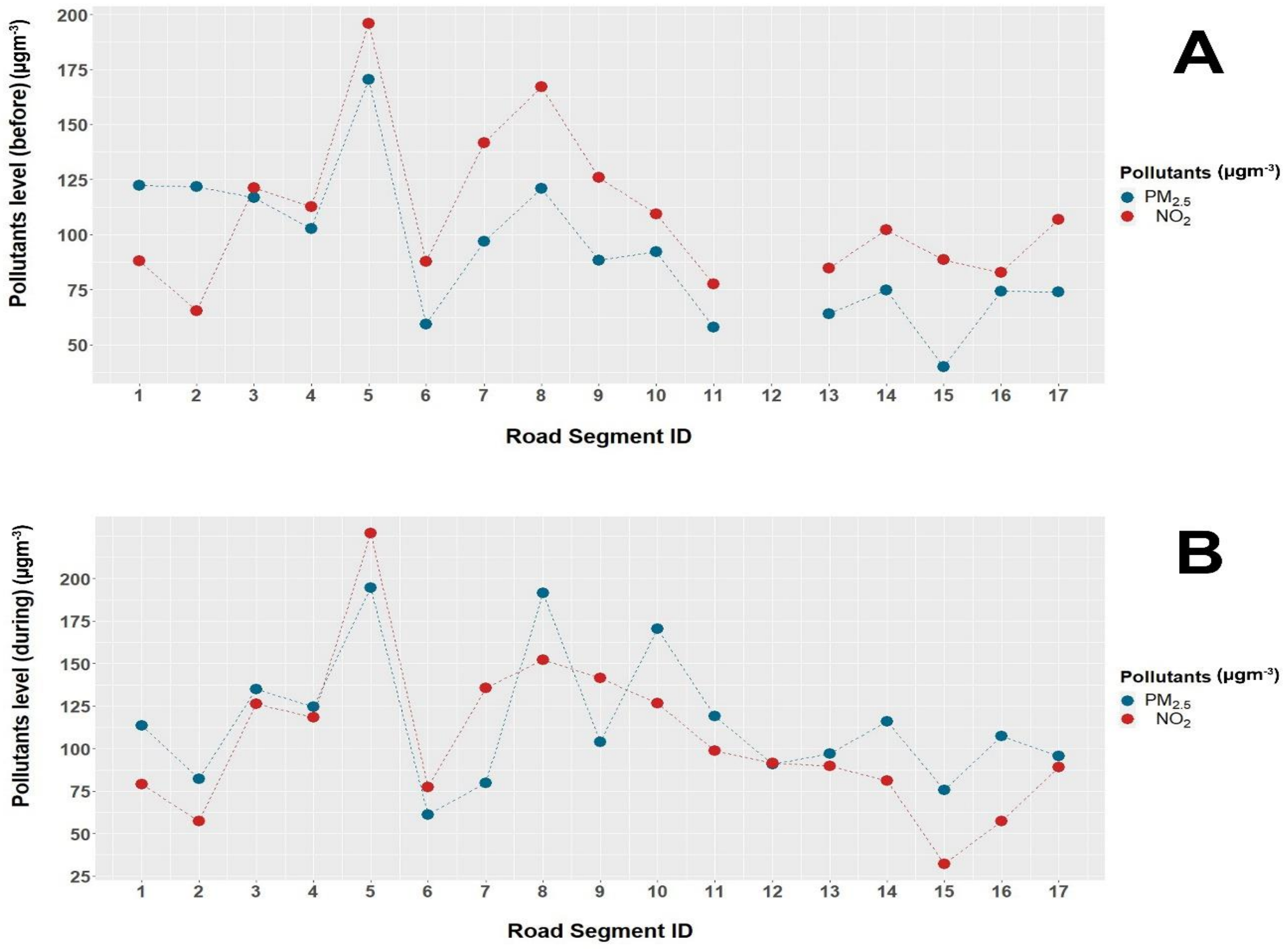

Fig 6. Average NO_2 and $PM_{2.5}$ levels in different street segments before (A) and during (B), the new traffic plan)

- The PM2.5 concentrations were moderately correlated with NO2 and positively correlated with PM10, before and during the NTP.

Results And Discussion

- During the new traffic plan, the average $PM_{2.5}$ was the highest in the morning (131.24 µg m^{-3}), followed by evening (111.67 µgm^{-3}), afternoon (110.27 µg m^{-3}) and midday (106.28 µg m^{-3}).

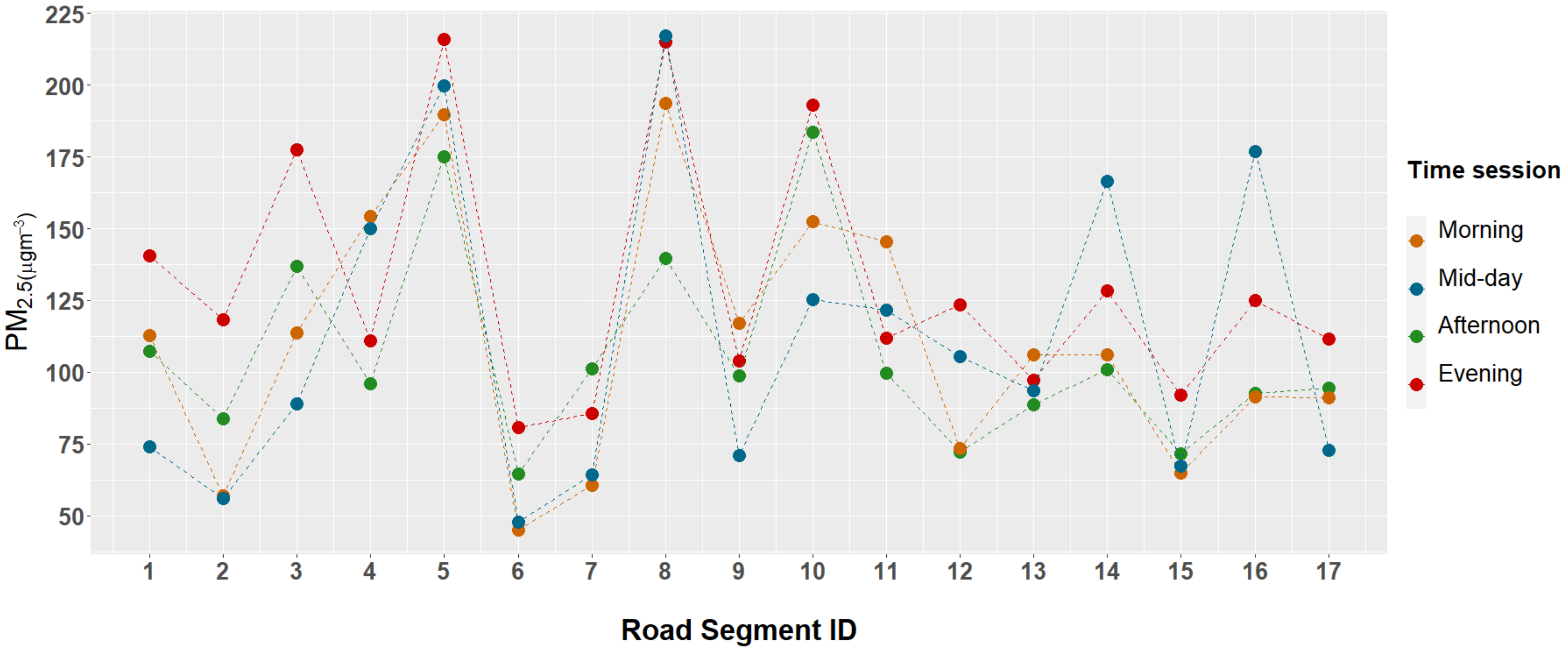

Fig 7. Average $PM_{2.5}$ variations in each time period during the new traffic plan

Results And Discussion

		Highest average concentration at(μg/m^3))	Lowest average Concentration at(μg/m^3))
Before NTP	$PM_{2.5}$	buffer ID 5 (170.52)	buffer ID 15 (40.06)
	NO_2	buffer ID 5 (195.88)	buffer ID 2 (65.42)
During NTP	$PM_{2.5}$	buffer ID 5 (194.47)	buffer ID 6 (61.26)
	NO_2	buffer ID 5 (226.69)	buffer ID 15 (32.22)

Conclusion

- Extensive spatial coverage of air quality monitoring by mobile sensor networks enables to determine the level of population air pollution exposure and considers that in traffic planning.
- A good traffic plan can reduce the $PM_{2.5}$ level in the city. The recent change in the Kandy city traffic plan might have caused an increase in $PM_{2.5}$ levels.
- Proper development of road infrastructure with compatible traffic plans could reduce air pollution in urban areas.

Thank you