# Investigation of PM 2.5 Concentration in the Wet Season of Bangkok, Thailand

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## INTRODUCTION

- Air pollution levels in Bangkok, Thailand are critical issues throughout the year. The mean concentrations of both pollutants, particulate matters (PM) $PM_{2.5}$ and $PM_{10}$, are over the limitation as announced by the Pollution Control Department (PCD). The daily mean standard Particulate Matters in Thailand's capital changes during the transition period from rainy season to dry season (December and January) over the national standard every year. Sources of particulate matters are regularly exacerbated by smoke (haze) from nearby sources and regional transboundary effects. In addition, air pollution from traffic is also a major contributor in Bangkok. Previous studies shown that $PM_{10}$ most commonly occurs in the environment. However, studies had been proven that $PM_{2.5}$ is more harmful to the health of people due to a consistent amount of harmful chemicals such as PAHs (Polycyclic Aromatic Hydrocarbons). There are no studies published regarding $PM_{2.5}$ concentrations during wet non-haze episodes.

## OBJECTIVE

This project aims to investigate the $PM_{2.5}$ concentration during non-haze episode (rainy season).

## Methodology

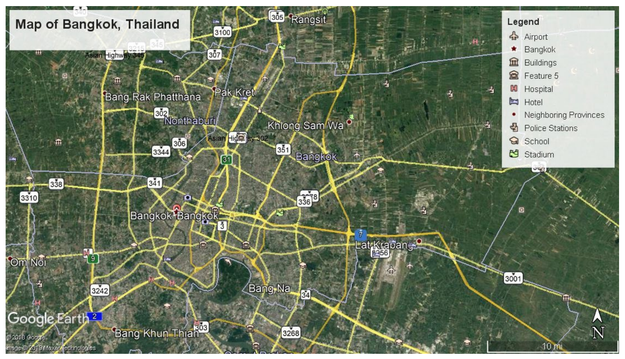


**Figure 1: The image illustrates the map of Bangkok, Thailand along its surrounding provinces.**

- Data were collected using AirBeam 2, Aslung, and Plume devices.
- AirBeam 2 automatically measures $PM_1$, $PM_{2.5}$, $PM_{10}$, relative humidity, temperature in Fahrenheit, time, date and distance. The gathered data are automatically recorded in a download application in a mobile Android Operating System, AirCasting. AirCasting also has the capacity to record observational notes and pictures.
- Aslung was used a backup for AirBeam 2. Aslung automatically measures $PM_1$, $PM_{2.5}$, $PM_{10}$, Relative humidity, temperature in Celsius, Carbon Dioxide, time, and date. Recorded samples were stored in a memory stick inserted inside Aslung device.
- Routes, time, distance, and speed were tracked by a downloaded application in a mobile Android Operating System, GPS Tracker.
- Plume automatically measures Nitrogen Dioxide ($NO_2$), volatile organic compounds (VOC), $PM_{2.5}$, and $PM_{10}$.
- Chosen samples were from specific places in the central, north, south, east, and west locations of Bangkok.
- PM absorption by average speed were measured via usage of various modes of transportations.
- Statistical analysis regarding PM comparisons were analyzed by descriptive statistics and illustrated by a bar graph.
- Vehicle average speed and $PM_{2.5}$ concentrations were illustrated in a table format.
- $NO_2$ and VOC were analyzed by linear correlation to determine their significance to $PM_{2.5}$.

**There is a high concentration of air pollutant $PM_{2.5}$ in slow moving ferry boats surrounded by water located in West Bangkok**

## Results

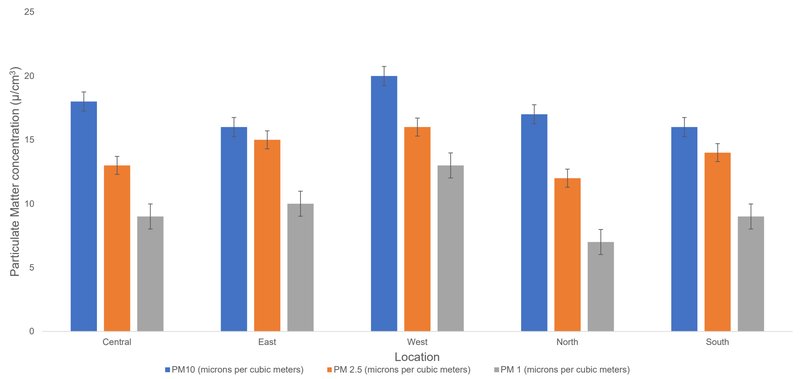


**Figure 2:** The graph illustrates the comparative analysis of $PM_{10}$, $PM_{2.5}$, and $PM_1$ concentration measured by microns per cubic meters

**Table 1:** The table illustrates a descriptive analysis of all Particulate Matters' numeral differences

| PM 10 | | PM 2.5 | | PM 1 | |
|---|---|---|---|---|---|
| Mean | 17.4 | Mean | 14 | Mean | 9.6 |
| Standard Error | 0.748331477 | Standard Error | 0.707106781 | Standard Error | 0.979795897 |
| Median | 17 | Median | 14 | Median | 9 |
| Mode | 16 | Mode | 14 | Mode | 9 |
| Standard Deviation | 1.673320053 | Standard Deviation | 1.58113883 | Standard Deviation | 2.19089023 |
| Sample Variance | 2.8 | Sample Variance | 2.5 | Sample Variance | 4.8 |
| Kurtosis | 0.535714286 | Kurtosis | -1.2 | Kurtosis | 1.744791667 |
| Skewness | 1.088511769 | Skewness | 0 | Skewness | 0.846307424 |
| Range | 4 | Range | 4 | Range | 6 |
| Minimum | 16 | Minimum | 12 | Minimum | 7 |
| Maximum | 20 | Maximum | 16 | Maximum | 13 |
| Sum | 87 | Sum | 70 | Sum | 48 |
| Count | 5 | Count | 5 | Count | 5 |
| Confidence Level(95.0%) | 2.077701267 | Confidence Level(95.0%) | 1.963243161 | Confidence Level(95.0%) | 2.720349523 |

**Figure 3:** The image illustrates the background of Chao Praya river located in west Bangkok


## RESULTS

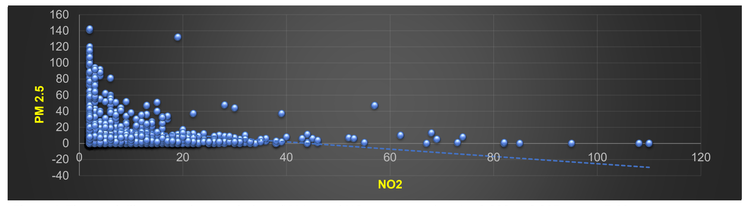


**Figure 4:** The graph illustrates the correlation of $PM_{2.5}$ and $NO_2$. concentrations (p=0.000; r=0.225; t-stat=7.83; $t_{critical}$ (0.05)=1.96; df=880)

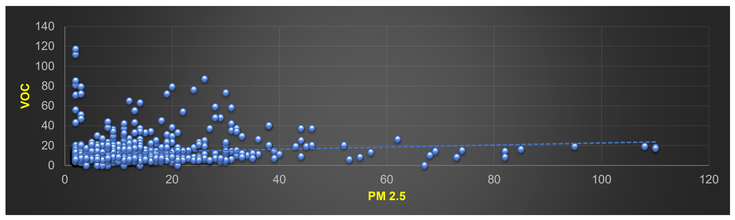


**Figure 5:** The graph illustrates the correlation of $PM_{2.5}$ and VOC. concentrations (p=0.001; r=0.114;t-stat=3.40;$t_{critical}$ 0.05)=1.96; df=880

**Table 2:** $PM_{2.5}$ concentration measured in microns per cubic meters and describes the air ventilation, whether it is closed air or open air in wheeled vehicles

| Vehicle | PM 2.5 (µ/m³) | Closed or Open Air? |
|---|---|---|
| Motor-cycle | 12 | Open Air |
| Tuk-tuk | 20 | Open Air |
| Car | 2 | Closed Air |

**Table 3:** $PM_{2.5}$ concentration measured by microns per cubic meters and average speed measured in miles per hour in water vehicles.

| Vehicle | PM 2.5 (µ/m3) | Average Speed (mph) |
|---|---|---|
| Khlong Sansaep (ferry boat) | 42 | 5 |
| Large Shuttle Boat | 20 | 7 |
| Orange Express | 15 | 10 |

**Table 4:** $PM_{2.5}$ concentration measured by microns per cubic meters and average train speed measured in miles per hour in train.

| Vehicle | Average speed (mph) | PM 2.5 (µ/m3) |
|---|---|---|
| BTS | 24 | 8 |
| MRT | 28 | 8 |
| ARL | 22 | 15 |

## Discussion

- $PM_{10}$ is prominent in Bangkok, during non-haze episode although variance suggested a small difference between $PM_{10}$ and $PM_{2.5}$. The results suggests that $PM_{2.5}$ are still in high capacity despite non-haze episodes in Thailand. $PM_{2.5}$ results support the previous studies regarding the health hazard for humans.
- Results show that $PM_{2.5}$ is common in areas where there is are slow-moving vehicles located in West Bangkok. This suggests that average speed might be associated with high concentrations of $PM_{2.5}$. Lack of statistical analysis and further data set that could support the high concentration of $PM_{2.5}$ in the west of Bangkok, becomes the limitation of the study.

## Conclusions

Despite non-haze wet seasonal episodes, $PM_{2.5}$ is still prominent in all areas of Bangkok. Results of this study can be used as baseline for future studies regarding the health impacts of $PM_{2.5}$ in human health.

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