CHARACTERIZATION OF $PM_{2.5}$-BOUND POLYCYCLIC AROMATIC HYDROCARBONS (PAHs) AND HEALTH RISK ASSESSMENT IN CHIANG MAI, 2025

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Abstract

Chiang Mai is located in Upper Northern Thailand and has been annually affected by air pollution for over a decade, primarily due to open burning, particularly during the dry season. One of the most toxic pollutants is the $PM_{2.5}$-bound polycyclic aromatic hydrocarbons (PAHs), which have the potential to cause cancer through inhalation exposure. This study aims to 1) characterize the $PM_{2.5}$ -bound PAHs in samples collected in Chiang Mai in 2025 and 2) assess the associated health risk. Samples were collected on the rooftop of Science Complex Building 1 (SCB1), Faculty of Science, Chiang Mai University, using a high-volume air sampler operated at a flow rate of 1,130 L/min. Based on $PM_{2.5}$ concentrations, samples were classified into two periods: the smoke haze period (1 March–9 April 2025) and the non-smoke haze period (12 April–14 June 2025), in which the average $PM_{2.5}$ concentrations were 68.2 ± 23.92 μg/m³ and 35.30 ± 4.25 μg/m³, respectively. All samples were extracted and analyzed using gas chromatography–mass spectrometry (GC–MS). The average concentration of total PAHs during the smoke haze period (1.70 ± 0.44 ng/m³) was approximately 1.5 times higher than that during the non-smoke haze period (1.16 ± 0.20 ng/m³). A moderate correlation between $PM_{2.5}$ and PAH concentrations was observed (r = 0.62). In both periods, carcinogenic PAHs accounted for a higher proportion than noncarcinogenic PAHs, by approximately 1.6–1.8 times. For the health risk assessment, the inhalation cancer risk (ICR) values ranged from 6.41×10^{-6} to 6.84×10^{-5}, indicating a low to moderate health risk. However, carcinogenic PAHs were more prominent than the non-carcinogenic PAHs in Chiang Mai, 2025, and may pose potential health concerns to the population.

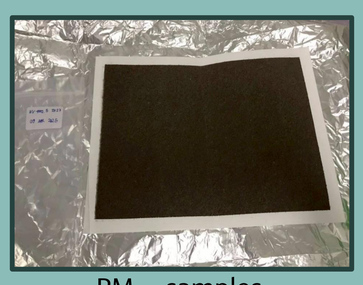
Introduction

Chiang Mai is the largest city in Upper Northern Thailand (UNT), located in the Chiang Mai-Lamphun Basin, surrounded by mountains with deciduous forest. The city has faced air pollution problems every year due to biomass burning, which is enhanced by these geographical features (Thepnuan et al., 2020). $PM_{2.5}$-bound polycyclic aromatic hydrocarbons (PAHs) are toxic contaminants, where some are found to be carcinogenic to humans; therefore, health risk assessment is important to understand the effect of PAHs inhalation through ambient air.

Objectives

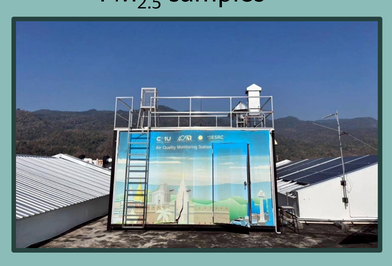
- To characterize the $PM_{2.5}$ -bound PAHs from the samples collected in Chiang Mai, 2025, by the GC-MS method.
- To do a health risk assessment of the $PM_{2.5}$ samples collected in Chiang Mai, 2025

Methodology



$PM_{2.5}$ samples

Samples were collected from March to June of 2025 using High-volume air sampler (HV-RW) with a flow rate of 1,130 L/min for 23 – 24 hours



Rooftop of Science Complex Building 1



HV-RW

Extract sample solution

GC-MS Analysis

Calculate toxicity equivalent concentration (TEQ) and inhalation cancer risk (IUR) to assess health risk

Results And Discussions

PAHs characterization from Chiang Mai, 2025 samples

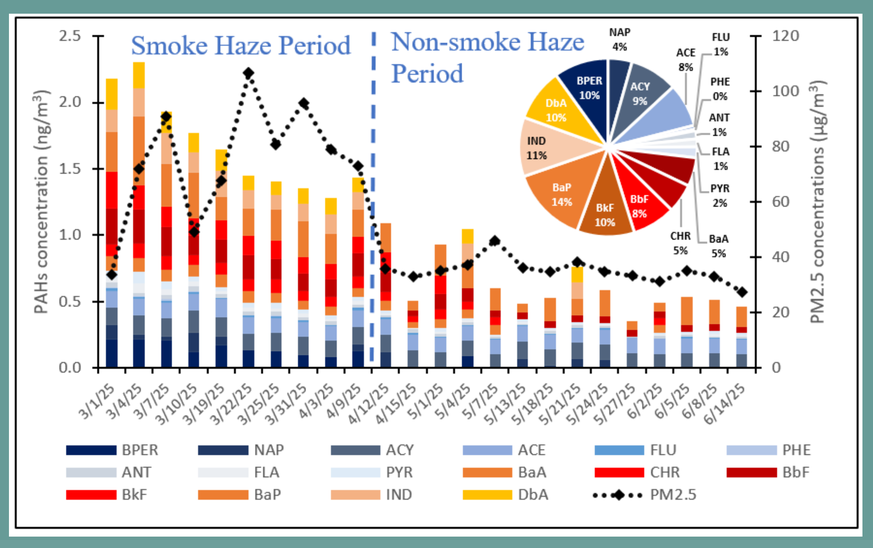


Fig 1. $PM_{2.5}$ and 16 PAHs concentration profile from the samples

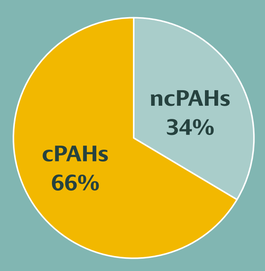
Average total PAHs = **1.46 ± 0.06 ng/m³**

Correlations between PAHs and $PM_{2.5}$ concentration = **0.62**

BaP is the most prevalent PAH, with a concentration of **0.21 ± 0.10 ng/m³**

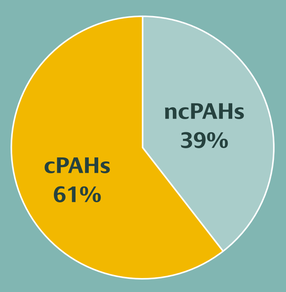
PAHs proportion

Smoke Haze Period



Average total:
ncPAHs = 0.61 ± 0.15 ng/m³
cPAHs = 1.10 ± 0.29 ng/m³

Non-smoke Haze Period



Average total:
ncPAHs = 0.43 ± 0.07 ng/m³
cPAHs = 0.73 ± 0.13 ng/m³

Fig 2. Proportion of carcinogenic PAHs (cPAHs) and non-carcinogenic PAHs (ncPAHs) from the samples

Health risk assessment

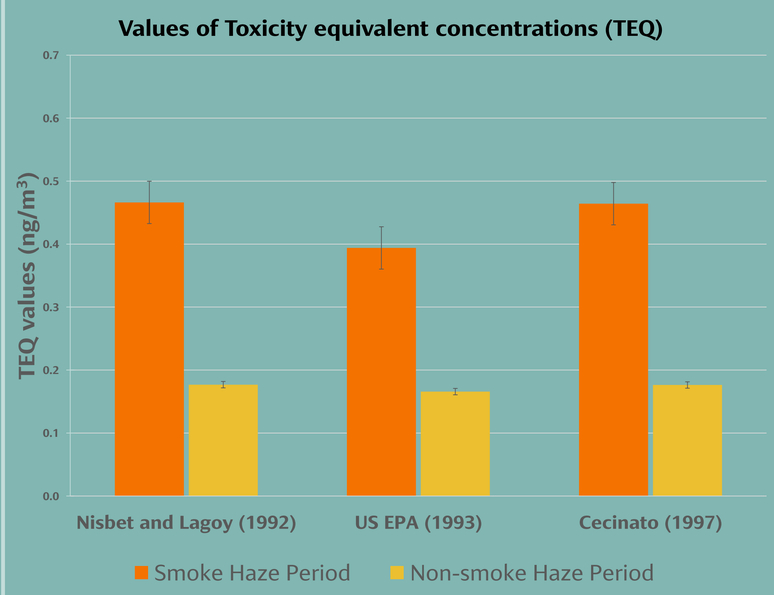


Fig 3. Toxicity equivalent concentrations (TEQ) of the samples

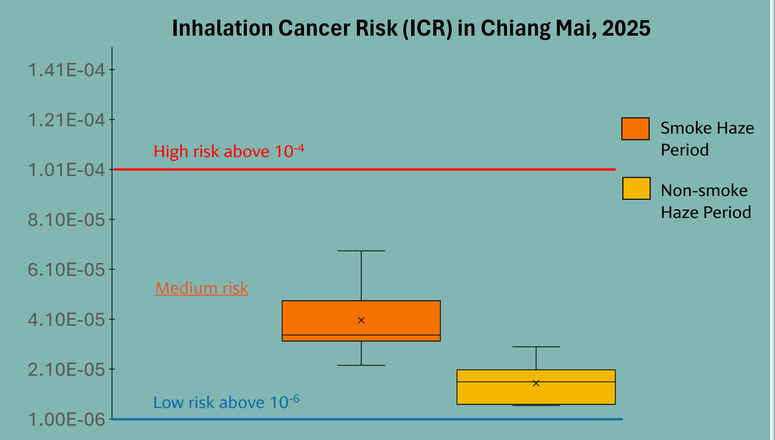


Fig 4. Inhalation cancer risks (ICR) of the samples

Conclusion

- Average total of PAHs concentration is 1.46 ± 0.06 ng/m³
- The result of the health risk assessment can be interpreted as follows: 1-5 in 100,000 people may have a chance of cancer development if they were exposed to TEQ at 0.18-0.63 ng/m³ for 70 years.
- There may be health concerns due to more prominent carcinogenic PAHs in Chiang Mai, 2025.

Acknowledgement

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References

Thepnuan, D., Yabueng, N., Chantara, S., Prapamontol, T., & Tsai, Y. I. (2020). Simultaneous determination of carcinogenic PAHs and levoglucosan bound to PM2.5 for assessment of health risk and pollution sources during a smoke haze period. *Chemosphere*, *257*, 127154. https://doi.org/10.1016/j.chemosphere.2020.127154