A comprehensive study of $PM_{2.5}$ characterization in Ho Chi Minh City

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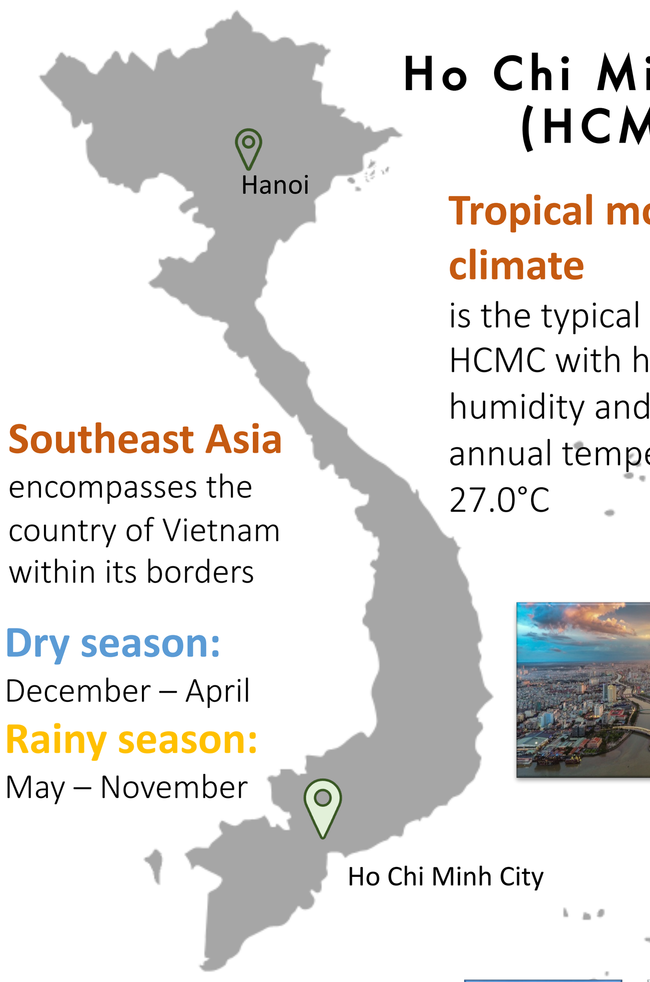
Highlights

1. $PM_{2.5}$ level in HCMC exceeded WHO recommended level
2. $PM_{2.5}$ conc. reduced during the lockdown period
3. Main emission sources of $PM_{2.5}$ in HCMC were: Char-EC/Soot-EC ratio
   - **Anthropogenic-rich source** of biomass burning, coal combustion, and transportation (36%)
   - Secondary ammonium sulfate (18%)
   - Sea salt (14%), road dust (10%)
4. Biomass burning emissions were from crop residues, leaves, and grass burning

Vietnam



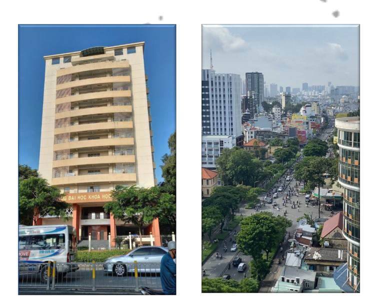
Ho Chi Minh City (HCMC)

Tropical monsoon climate is the typical climate in HCMC with high humidity and average annual temperature is 27.0°C

Southeast Asia encompasses the country of Vietnam within its borders

Dry season: December – April

Rainy season: May – November



1 is attributed to HCMC, Vietnam, for both population and economic growth in 2023.

15 is the global ranking assigned to Vietnam's population for the year 2023.

Objectives

Problems
- Complex $PM_{2.5}$ sources
- $PM_{2.5}$ reduced by COVID-19 effects (lockdown)
- Lack of long-term observation data
- Lack of monirtoring station

Curcumstances and solution
- High concentration of $PM_{2.5}$
- Reduce public health quality

➔ **Reduce $PM_{2.5}$ by characterizing and identifying emission sources**

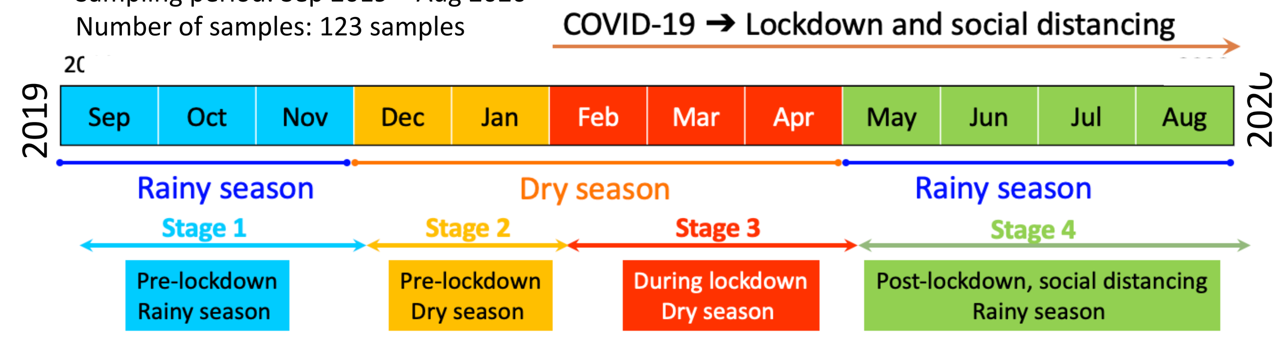
Study 1
- ✓ **Solve:**
- Chemical characterization of $PM_{2.5}$
- Variation by seasonal and lockdown impact
- ❑ **Remain problemS:**
- Unclear sources contributions
- Complex sources locations

Study 2
- ✓ **Solve:**
- Idenfidied sources contributions
- Described sources locations
- ❑ **Remain problem:**
- Unclear types of biomass burning

Study 3
- ✓ **Solve:**
- Analyze biomass burning tracers
- Identified types of biomass burning

Data categories

Sampling period: Sep 2019 – Aug 2020
Number of samples: 123 samples



Study 1

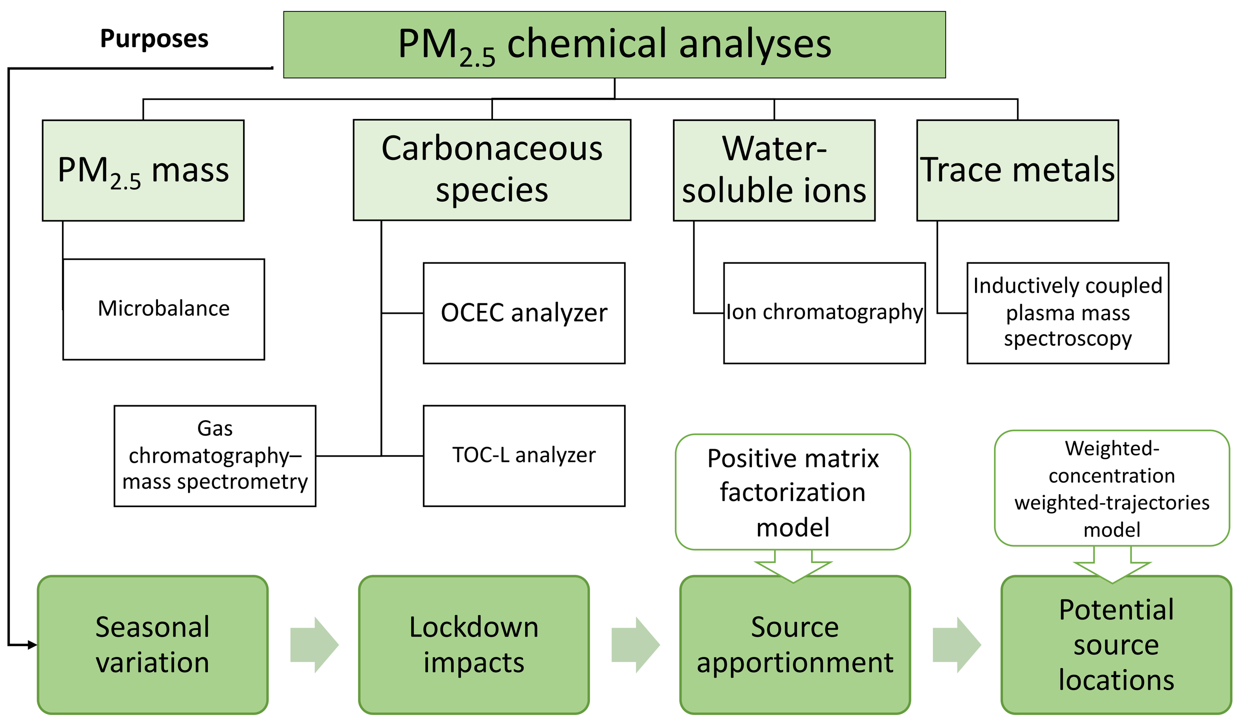


Fig. 1 Diagram of this study

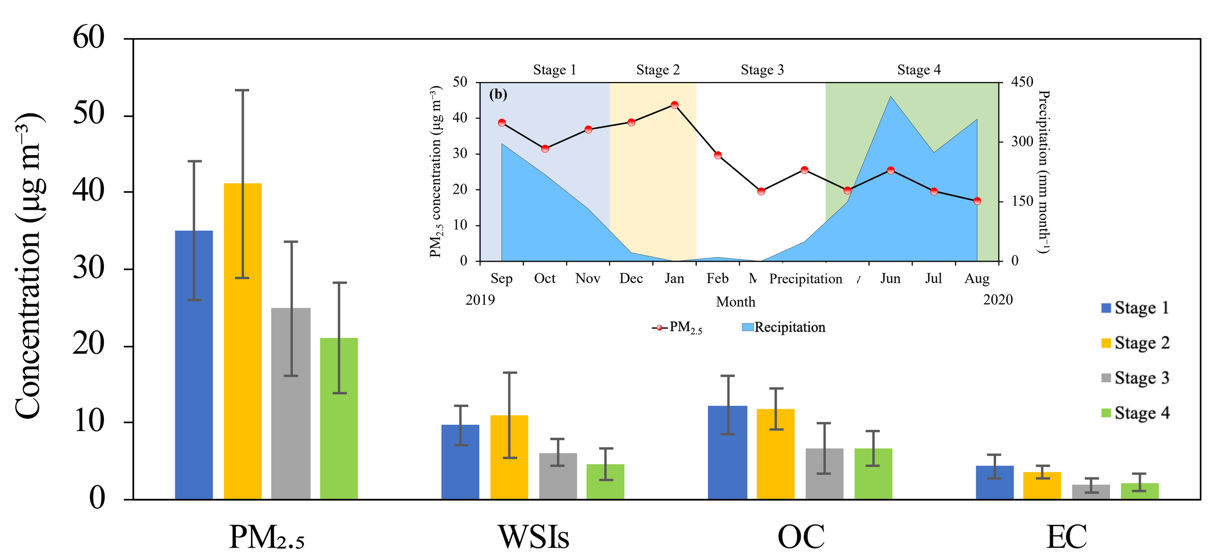


Fig. 2 Variation of $PM_{2.5}$ mass and their chemical compositions by stages

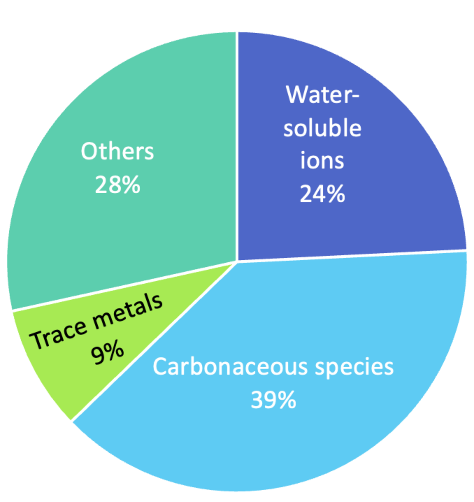


Fig. 3 Compositions of chemical species to $PM_{2.5}$ mass

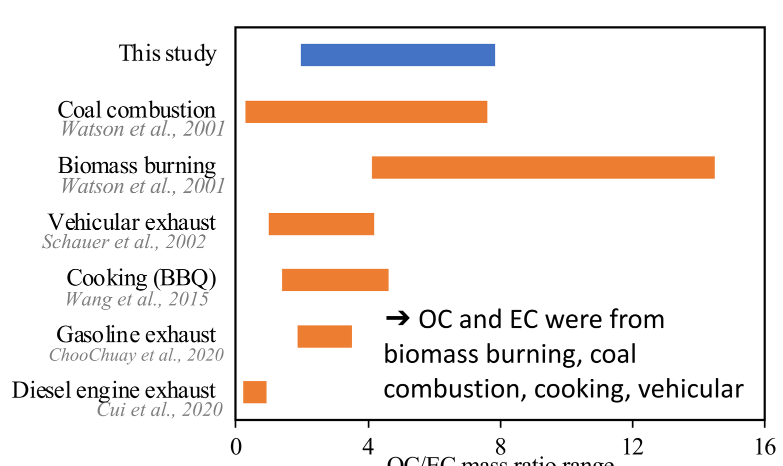


Fig. 4 Diagnostic ratios of carbonaceous species to identify potential sources

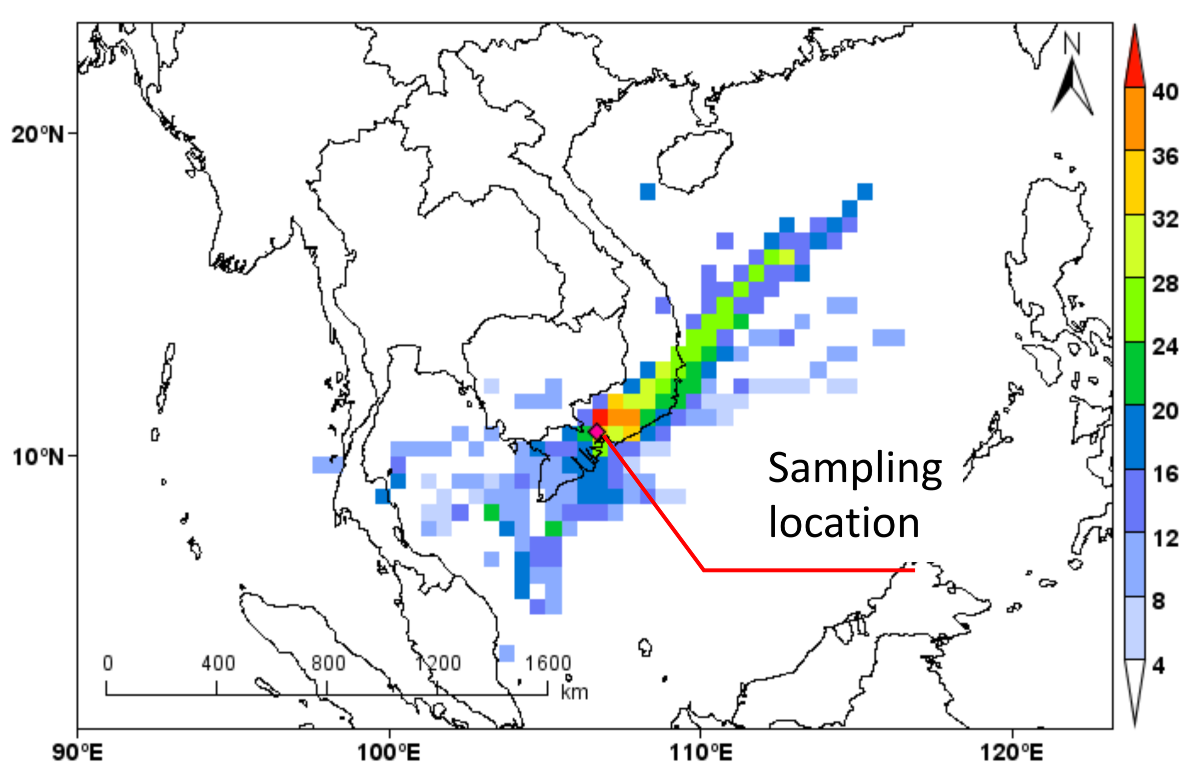


Fig. 5 Potential source locations of $PM_{2.5}$ in HCMC

- $PM_{2.5}$ concentration in HCMC exceeded the limit of Vietnam National Technical Regulation (50 μg m⁻³) and WHO recomendation
- Carbonaceous species dominantly comprised to $PM_{2.5}$ in HCMC
- Wet deposition play an important role in reducing $PM_{2.5}$ level
- $PM_{2.5}$ level were significantly reduced during the lockdown period
- Potential sources of $PM_{2.5}$ were biomass burning, coal combustion, transportation, and cooking activities
- Dominant sources located in urban HCMC and scattered to the southwest/northeast HCMC

Acknowledgment

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Study 2

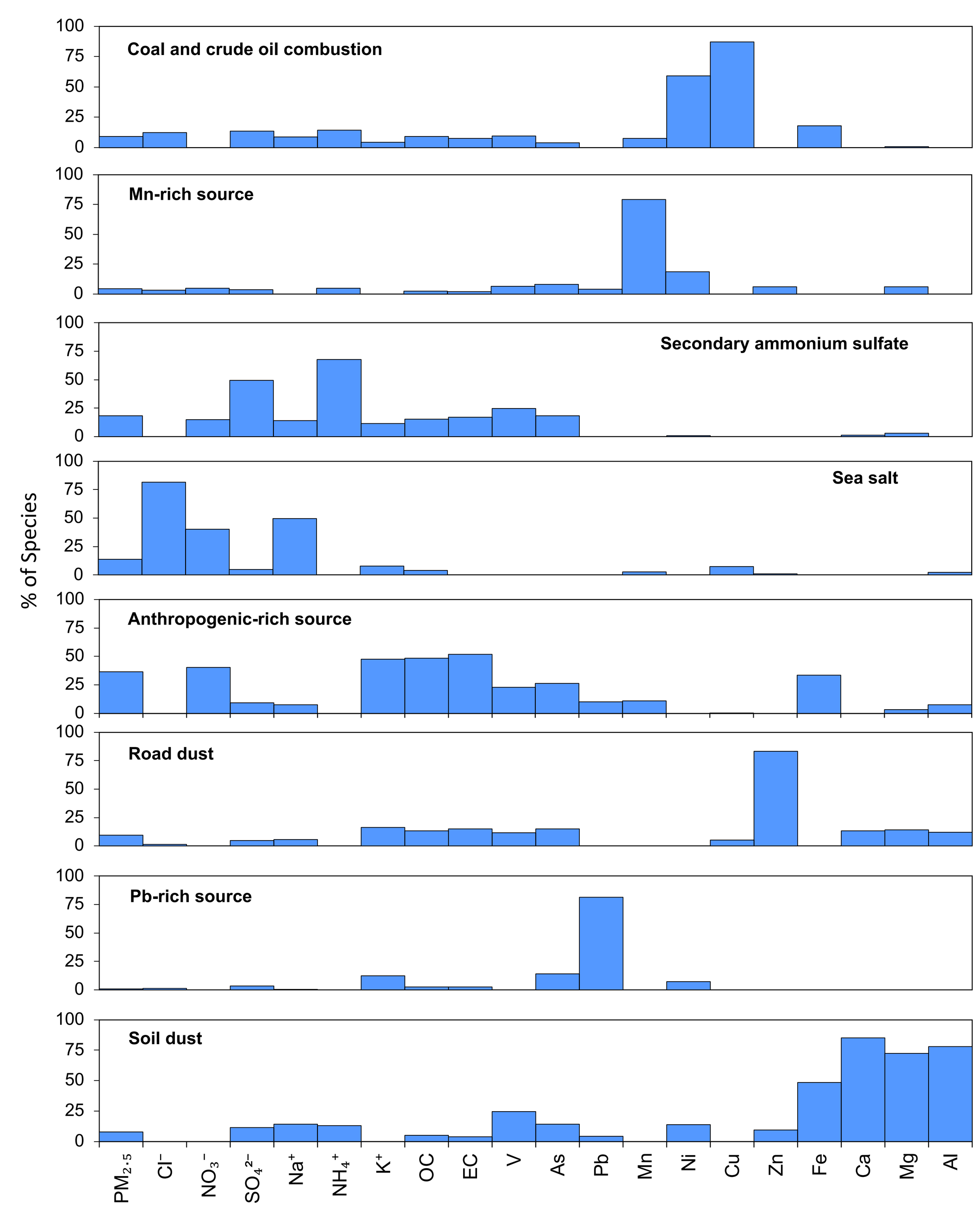

Fig. 2 Profiles of eight factors extracted by PMF

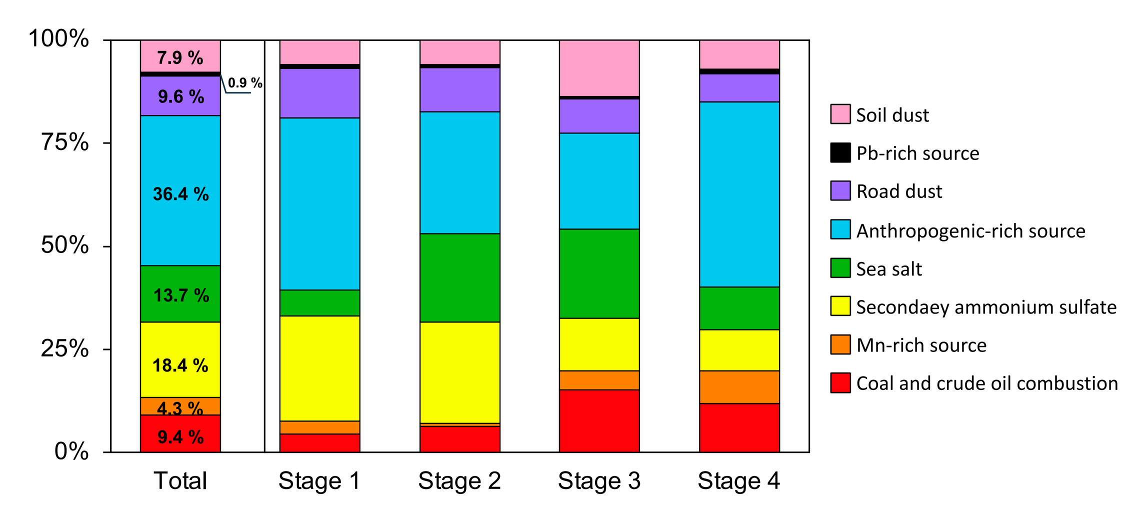

Fig. 2 The contribution of each source to $PM_{2.5}$ by percentage

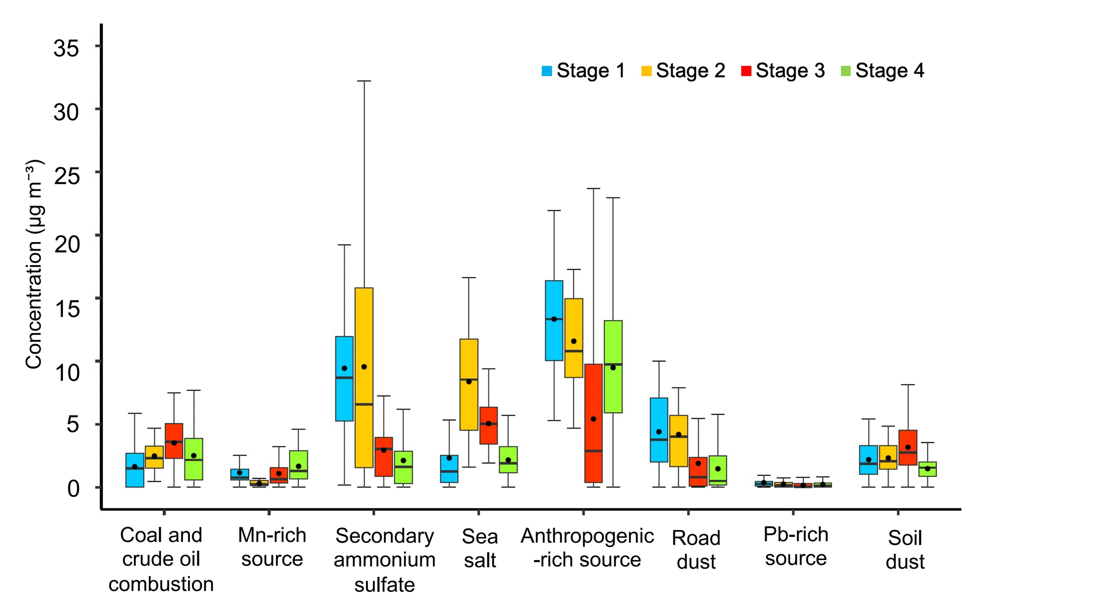

Fig. 3 The contribution of each source to $PM_{2.5}$ by concentration

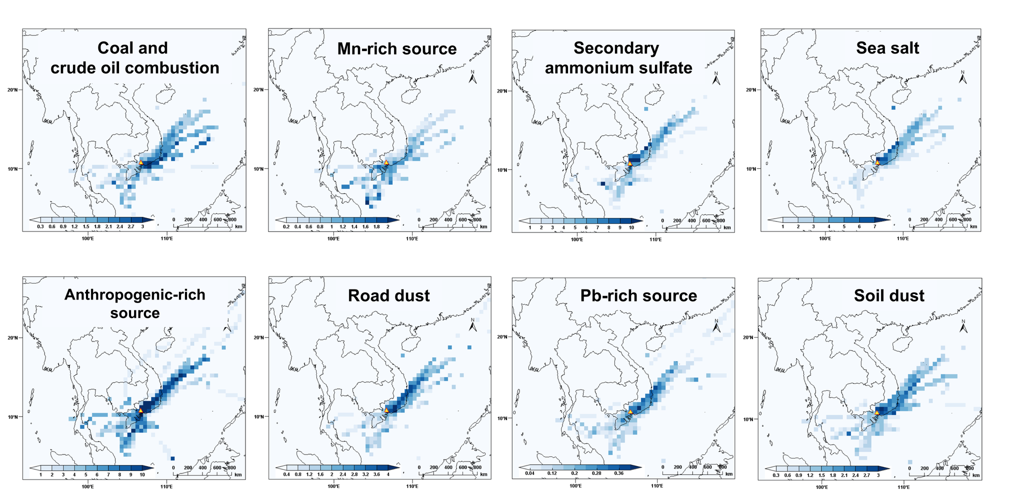

Fig. 4 WCWT analysis based on PMF 5.0 results. The unit of the WCWT value: μg m⁻³

- Al, Mn, V, Mg, Ca, and Fe mainly contributed by Earth's crust. Cu, As, and Zn has substantial anthropogenic contributions. Ni and Cu were ~10 were from both anthropogenic emissions and the Earth's crust.
- $PM_{2.5}$ main sources were **anthropogenic-rich source** of biomass burning, coal combustion, and transportation (36%), secondary ammonium sulfate (18%), sea salt (14%), and road dust (10%)
- A significant drop in $PM_{2.5}$ from human activities was observed during lockdown period, emphasizing the substantial impact of direct emissions in urban $PM_{2.5}$ levels in HCMC.

Study 3

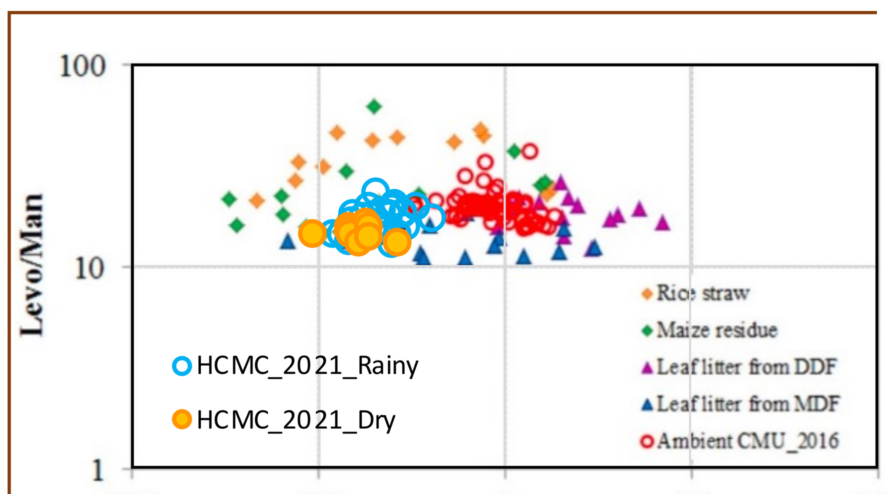

Fig. 1 Scatter plot of biomass markers to potassium from different types of biomass burning (Thepnuan et al., 2019)

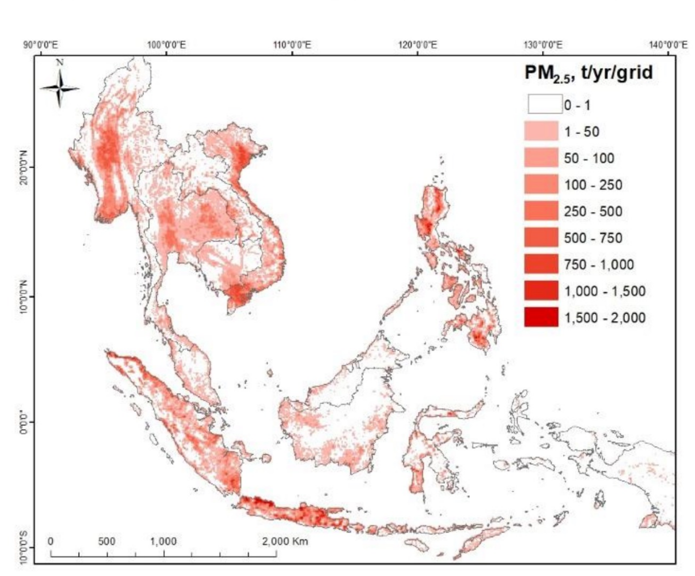

Fig. 3 Spatial distribution of $PM_{2.5}$ emissions (t km⁻² yr⁻¹) in SEA region in 2018 (Kim Oanh et al., 2021)

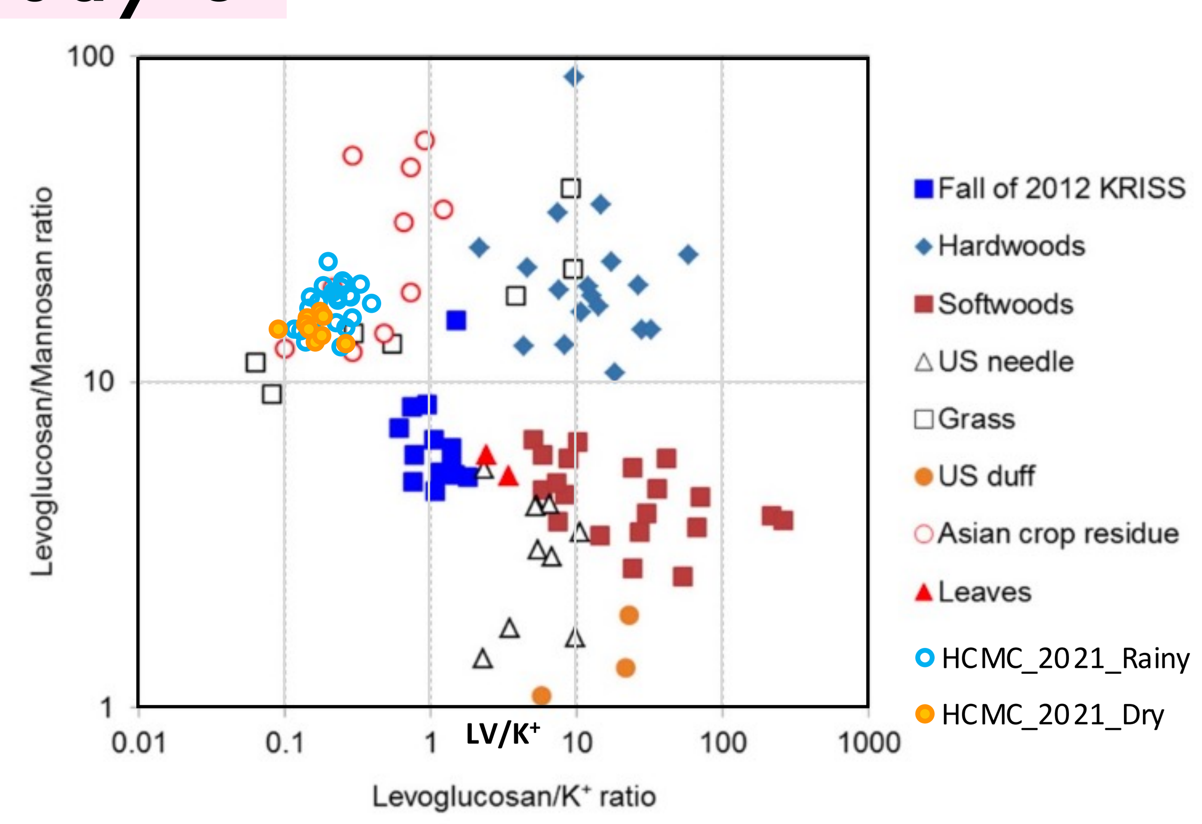

Fig. 2 Scatter plot of biomass markers to potassium from different types of biomass burning (Jung et al., 2014)

- Biomass burning influence the $PM_{2.5}$ in HCMC is associated to tthathe combustion of crop residue (maize and rice straw), leaves, and grass burning.
- Biomass burming contributed a large amount of $PM_{2.5}$ to ambient air which requires appropriate regulation from authorities to reduce its emission.