POLICY BRIEF

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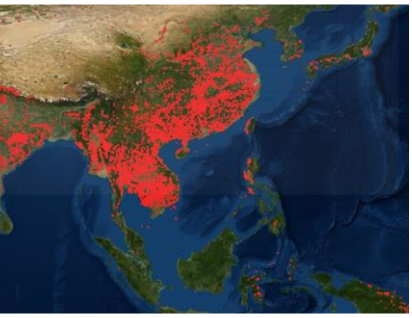

Actions needed to reduce open biomass burning and associated $PM_{2.5}$ pollution in Southeast Asia countries

Contents

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Key messages

- Significant impacts of both local and regional biomass burning sources on $PM_{2.5}$ measured in Hanoi, Vietnam and Chiang Rai, Thailand during the high season (Jan, Feb, Mar, and Apr) in 2021;
- Integrated approach of in-situ measurement, modelling techniques, and advanced satellite remote sensing could enhance the ability to supervise the occurrence and assess the contribution of local and regional biomass burning sources to the local air quality;
- Actions need to be implemented at both national and regional scales to reduce the impacts of open biomass burning on $PM_{2.5}$ pollution during the high season in Southeast Asia countries.

Introduction

Southeast Asia (SEA) has been reported as one of the largest biomass burning source regions in the world. The regional haze known as "Asian Brown Cloud" resulting from biomass burning sources occurs almost every year in SEA, which has strong impacts on human health, environment, and global climate variations (Chen et al., 2017). There is always an argument about sources of air pollution during haze episodes, specifically the contributions of transboundary and local open biomass burning sources.

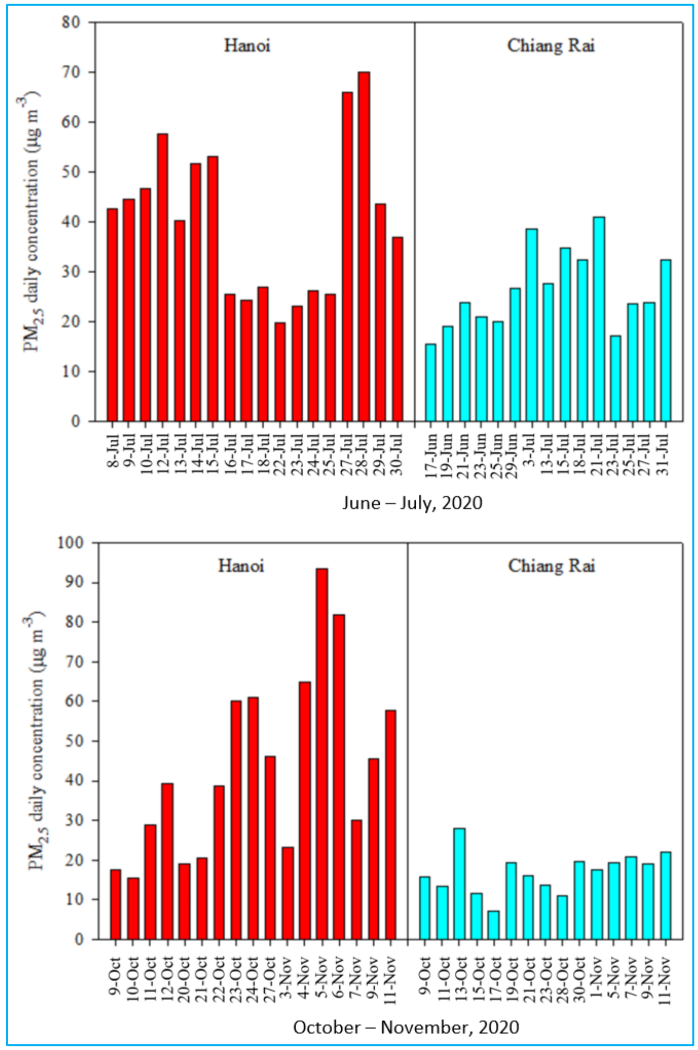
In most of the SEA countries where economic development based largely on agricultural sector, actions to slow adverse impact of poor air quality caused by biomass burning is stalling in the face of intense economic imperatives and the pace of development. In addition to the impact of biomass burning, the increased air pollution, especially fine particle ($PM_{2.5}$) pollution, in the SEA countries has been also significantly influenced by a number of local emission sources such as transport, industry, construction, and long-range transported air pollutants from regional sources. In order to provide strong evidences on the impacts of diverse sources (including biomass burning) to the local $PM_{2.5}$ pollution for supporting policy- and decision-making activities in the SEA countries, there is a critical need to carry out studies employing different technical tools for exploring and assessing the contribution of different emission sources to the local air quality.

APN funded project: “*Impact of biomass burning sources during high season on $PM_{2.5}$ pollution observed at sampling sites in Hanoi, Vietnam and Chiang Rai, Thailand*”

This project aims to develop and apply an integrated approach of in-situ measurement, receptor and trajectory modelling techniques, and advanced satellite remote sensing for assessing the impacts of local and regional biomass burning sources to the fine particle ($PM_{2.5}$) pollution in Hanoi, Vietnam and Chiang Rai, Thailand. For this purpose, four field measurement campaigns (representing four seasons) are conducted concurrently at the studied sites in Hanoi and Chiang Rai during 2020-2021. The USEPA Positive Matrix Factorization (PMF) receptor model is applied for evaluating the contribution of different sources to the measured $PM_{2.5}$ at the studied sites. Meanwhile, the active fire data provided by the MODIS satellite (FIRMS website: https://firms.modaps.eosdis.nasa.gov) is used to explore biomass burning activities occurring in the SEA region during the study periods. The three-day backward trajectories of air masses arrived at the studied sites which generated using the HYSPLIT model (Draxler and Rolph, 2003) are analysed to identify the most likely biomass burning source regions influencing $PM_{2.5}$ measured at the studied sites in Hanoi and Chiang Rai.

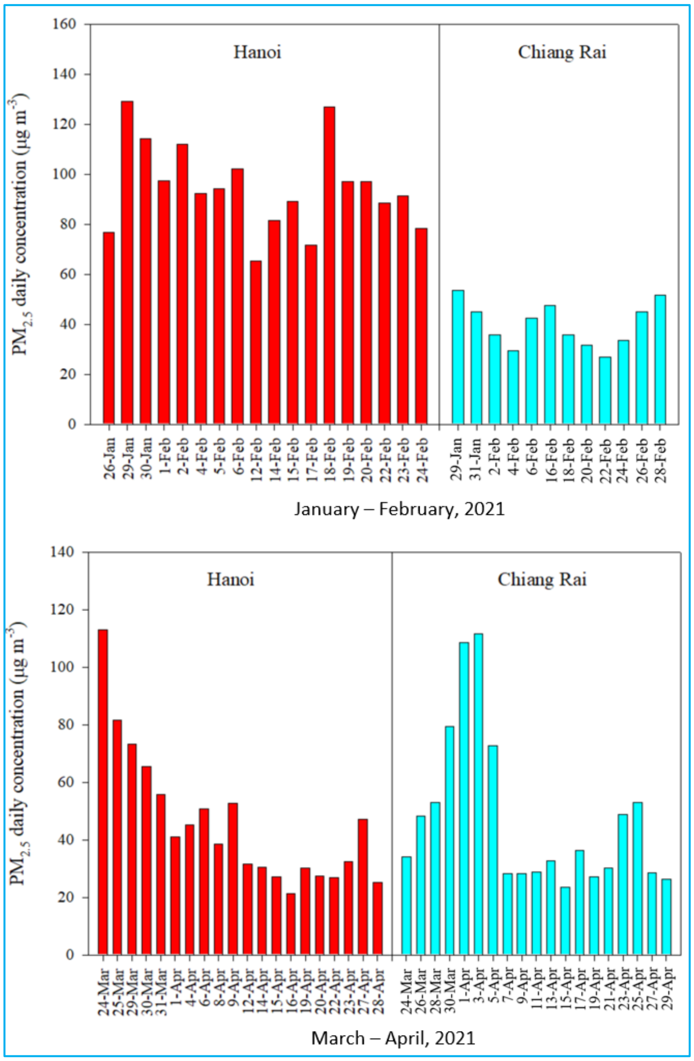
Project results

The measurement periods in June-July and October-November, 2020 are considered as the low season (with less biomass burning activities). Meanwhile, the measurement periods in January-February and March-April, 2021 are considered as the high season (with intensive biomass burning activities). The results show that during the low season, the daily mean concentrations of $PM_{2.5}$ measured in Hanoi are generally higher than those measured in Chiang Rai. While the daily mean concentrations of $PM_{2.5}$ measured in Hanoi exceed the Vietnamese 24h-average ambient air quality standard for $PM_{2.5}$ (50 µg/m^3) in several sampling days, all of the values measured in Chiang Rai are lower than the Thai 24h-average ambient air quality standard for $PM_{2.5}$ (also 50 µg/m^3).



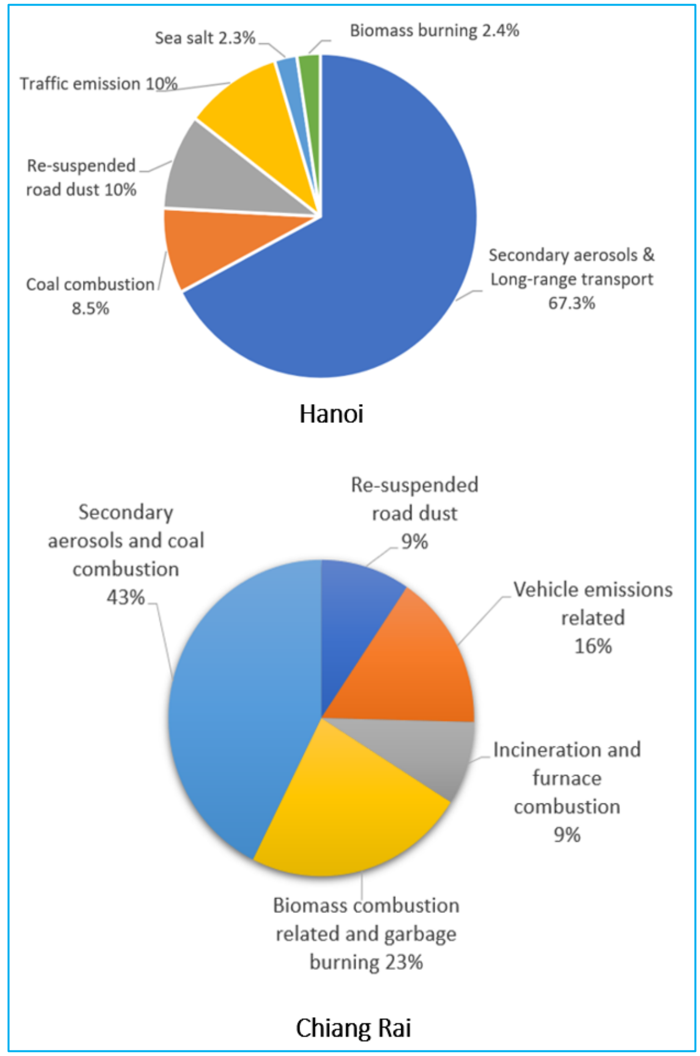
Daily mean $PM_{2.5}$ mass concentration measured during the low season

Whereas, the measurement results are found to be different at two studied sites for the high season. The daily mean concentrations of $PM_{2.5}$ measured during January-February in Hanoi are significantly higher than those measured in Chiang Rai. In the contrast, the daily mean concentrations of $PM_{2.5}$ observed during March-April in Chiang Rai are comparable to or higher than those measured in Hanoi. During January-February, in Hanoi, all of sampling days display the much higher values of the $PM_{2.5}$ daily mean concentrations than the national standard. Whereas, in Chiang Rai, the $PM_{2.5}$ daily mean concentrations exceed the national standard just in a few sampling days. However, during March-April, there is an increase in the number of sampling days with the daily mean concentrations of $PM_{2.5}$ higher than the national standard in Chiang Rai. The highly increased $PM_{2.5}$ pollutions in Hanoi during January-February and in Chiang Rai during March-April could be largely influenced by the local and/or regional biomass burning sources.



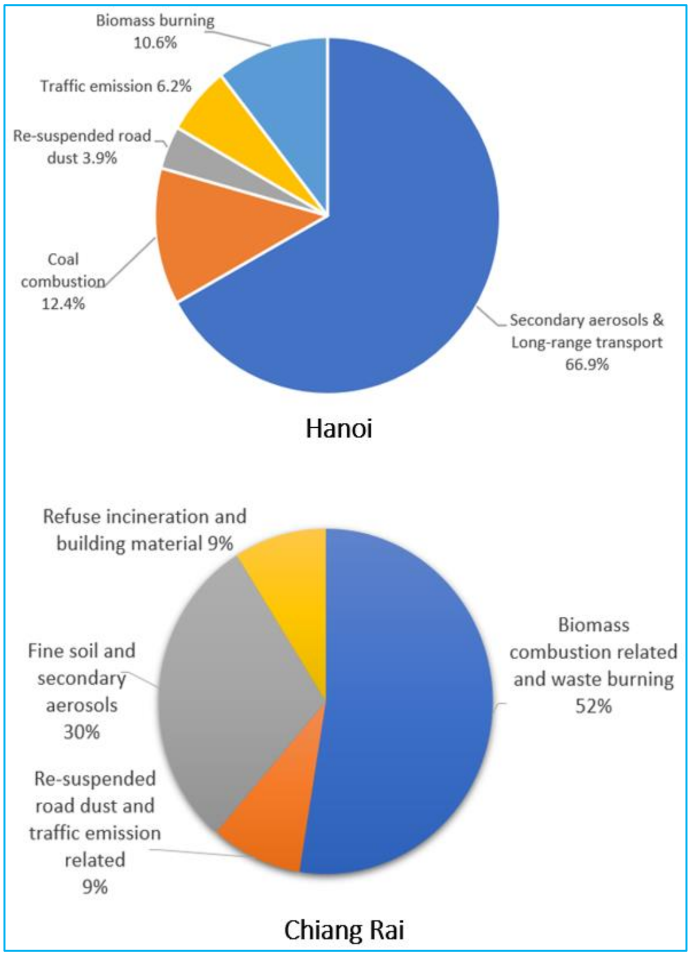
Daily mean $PM_{2.5}$ mass concentration measured during the high season

The PMF receptor model based $PM_{2.5}$ source apportionment results show that the secondary aerosols and long-range transport are the largest source contributing to the measured $PM_{2.5}$ for the studied site in Hanoi for both the low and high seasons. Meanwhile, the secondary aerosols and coal combustion and biomass combustion related and garbage burning are the largest sources contributing to the measured $PM_{2.5}$ for the studied site in Chiang Rai during the low and high seasons, respectively.



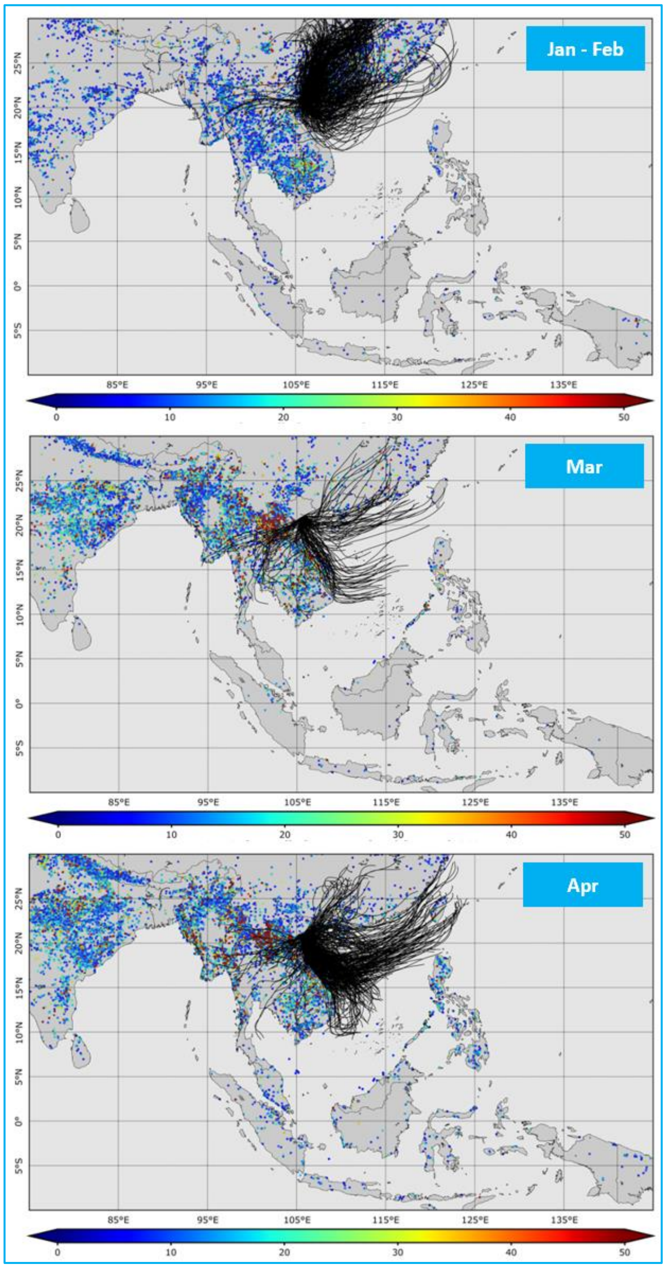
Source apportionment for the $PM_{2.5}$ measured during the low season

Clearly, in the high season, the contributions of biomass burning (10.6 % in Hanoi) and biomass combustion related and garbage burning (52% in Chiang Rai) to the measured $PM_{2.5}$ significantly increase, compared to those in the low season. These results suggest the large impact of biomass burning sources to the measured $PM_{2.5}$ in the studied areas, especially those in Chiang Rai, during the high season, which explain for the increased $PM_{2.5}$ concentration in Chiang Rai during the period of March-April.



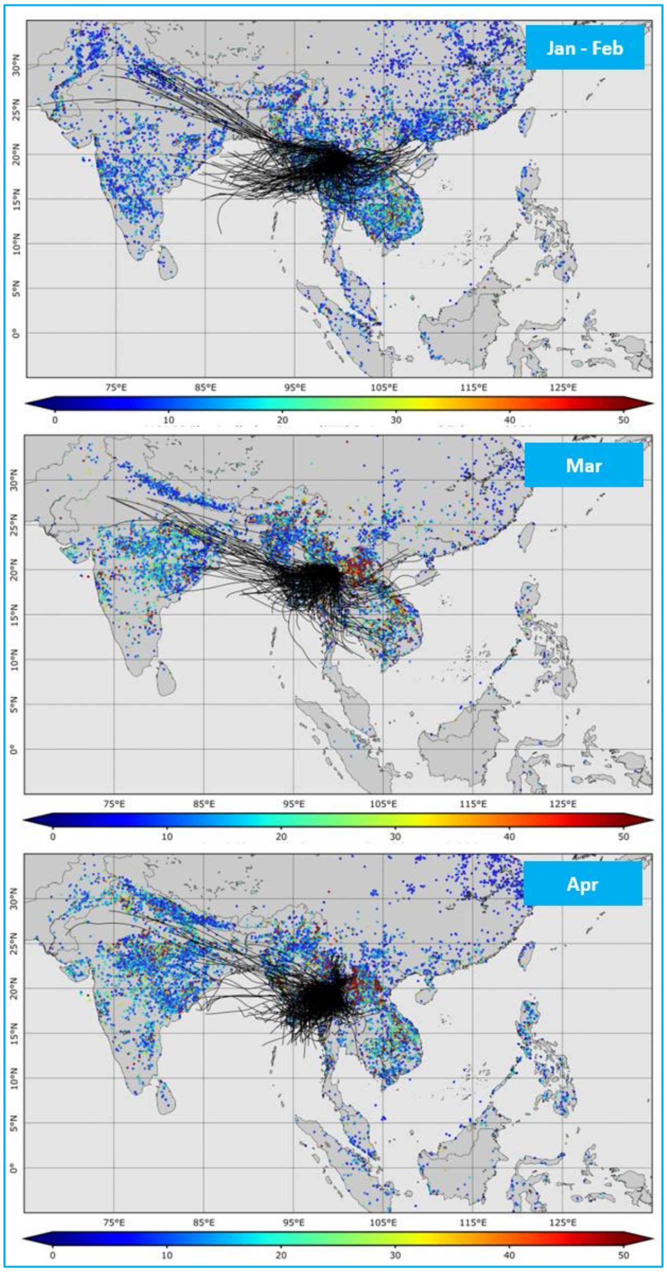
Source apportionment for the $PM_{2.5}$ measured during the high season

In order to further investigate the impacts of biomass burning sources to the measured $PM_{2.5}$ at the studied sites during the high season, the integrated maps of MODIS active fire activities and three-day air masses backward trajectories generated using the HYSPLIT model are analysed. It is generally seen that fire activities occurring in the SEA region and in the southern part of China during the periods in January, February, March, and April of 2021 are numerous. In Hanoi, air masses arrived at the studied site passing over the dense fire regions in the southern part of China (considered as the regional sources, during Jan - Feb) and in the central and northern parts of Vietnam (considered as the local sources, during Mar - April).



Maps of MODIS active fire activities in SEA and three-day air masses backward trajectories arrived at the studied site in Hanoi during the high season

In Chiang Rai, air masses arrived at the studied site travel through the intensive fire regions in the southern part of Myanmar (considered as the regional sources) and the northwestern part of Thailand (considered as the local sources). The impacts of both local and regional biomass burning sources, are recognized as one of the main reasons for the highly elevated concentrations of $PM_{2.5}$ measured during the high season at the studied sites, especially those in Chiang Rai.



Maps of MODIS active fire activities in SEA and three-day air masses backward trajectories arrived at the studied site in Chiang Rai during the high season

Recommendation for actions

1. Reduce open burning of agricultural and municipal wastes

Reducing open burning of both agricultural and municipal wastes through provision and enforcement of regulations prohibiting open burning.

2. Develop alternative options for agricultural waste burning

Promoting reuse and recycling of agricultural wastes through development of incentive policies and treatment/recycling technologies.

3. Improve capacity for supervising open biomass burning and associated air pollution

Using modelling combined with satellite remote sensing as a means to complement the limited capacity of traditional ground-based air quality monitoring network for supervising local and regional fire activities and associated air pollution, and enforcing anti-burning regulations.

4. Enhance regional cooperation for combating open biomass burning and associated air pollution

Enhancing the regional cooperation in both research and policy-making which can help achieve a shared vision of healthier and cleaner air in the SEA region.

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Acknowledgements

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