

Potential Impact of Biomass Burning on Urban Air Quality : Case-study of Chiang Mai

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Abstract:

1. Introduction

Chiang Mai is the second largest city in Thailand covering an area of 20,107 km². Its population amounts to 1.6 million inhabitants. It is located in the North of Thailand and is situated 310 meters above sea level. The city is surrounded by hills covered with trees (forest type of vegetation). As a result of the topographical characteristics of Chiang Mai as well as meteorological conditions, urban activities and seasonal vegetation fires, air pollution has become a major issue in this area. Every year, Chiang Mai is faced with major problems of high particulate matter concentration in particular during the dry season. PM₁₀ concentrations can largely exceed the ambient air quality standard of 120 µg/m³ (24 hours average concentration) during the months of January to April.

In this work air quality in Chiang Mai was investigated to assess the potential contribution of biomass burning to air pollution in the city, in particular with regard to PM₁₀.

2. Methodology

In these investigations the base-year 2002 was selected due to the completeness of the data available. Air pollutants concentrations and meteorological data were collected from two monitoring stations in Chiang Mai. One is located in the city center and the other at a sub-urban site. Information on forest fires and agricultural burning were also collected for the year 2002. Times series analyses, diurnal characteristics, and correlations between specific pollutants at both sites were performed. The data obtained were then analyzed in combination with information on forest fires and agricultural burning as well as meteorological data.

3. Results and conclusive discussion

From the investigations undertaken it was found that CO, NO_x and O₃ are likely to be of traffic origin. They show typical diurnal characteristics (c.f. figure 1) and a relatively high correlation between CO and NO_x is found at the urban site (0.83) and sub-urban site (0.62). On the other hand, the lower correlation observed between CO and PM₁₀ at both the urban (0.33) and sub-urban site (0.56) indicates that their source of emission is likely to be different. This suggests that PM₁₀ is therefore not mainly of traffic origin.

Information on wind direction and wind speed indicates that calm conditions of wind dominate during the months of January to March and October to December, a period during which PM₁₀ concentration is

considerably higher at both air quality monitoring stations and in particular at the urban site with an average monthly value of almost $160 \mu\text{g}/\text{m}^3$ observed in February 2002 (c.f. figure 2). This also coincides with a period of low rainfall in particular for the months of January to March (no wet deposition) and high biomass burning activities (c.f. figure 3).

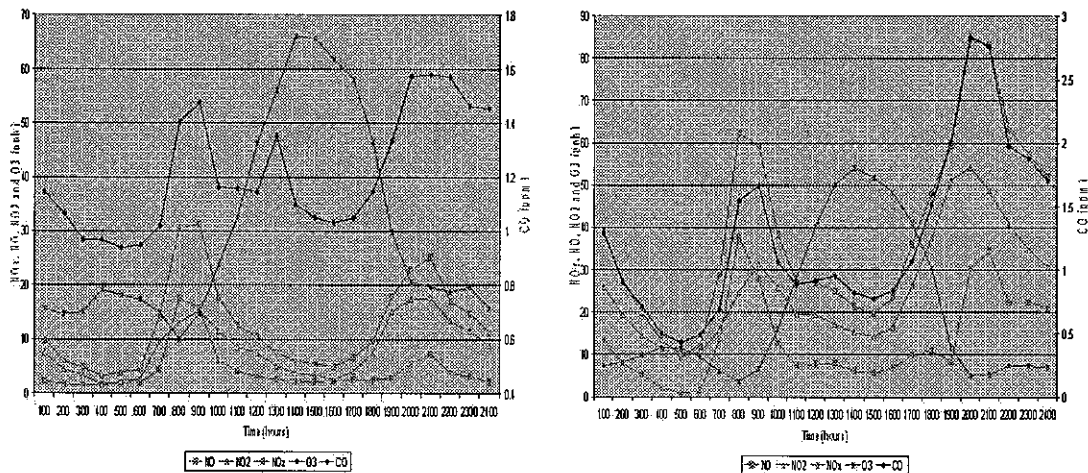


Figure 1: Diurnal characteristics at the urban site (right) and sub-urban site (left) in 2002

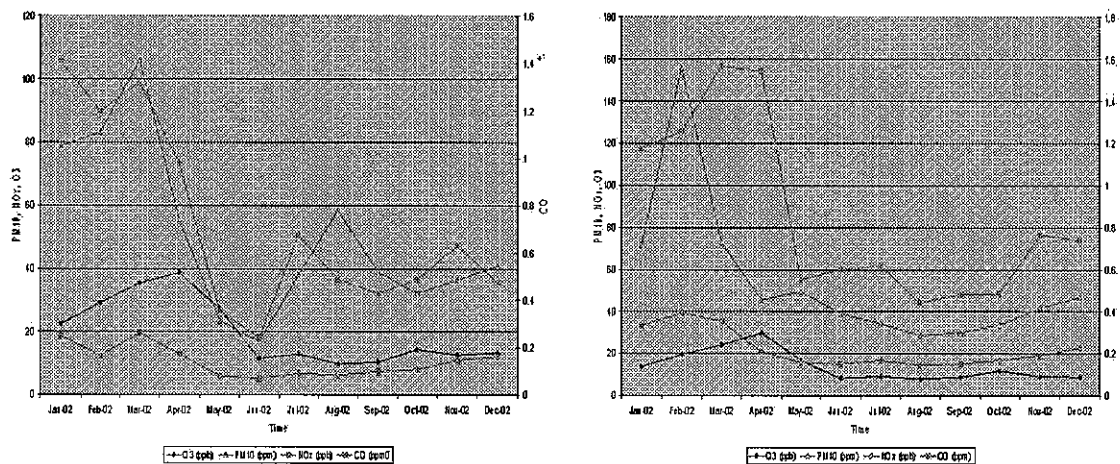


Figure 2: Air pollutant concentration at the urban (left) and sub-urban site (right) in 2002

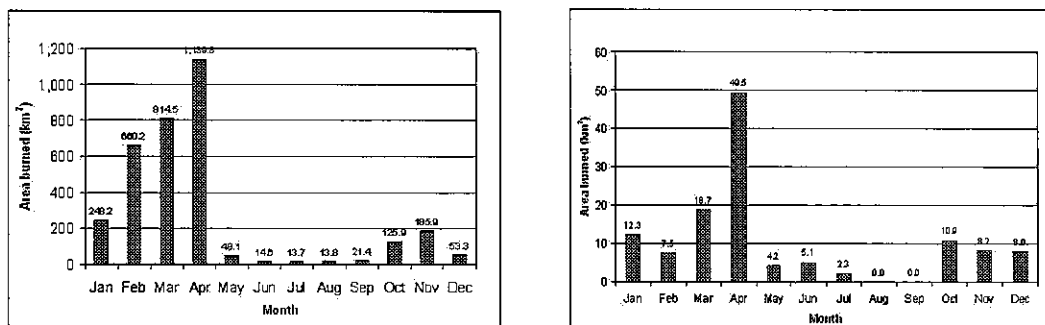


Figure 3: Area of forest (left) and paddy fields burned in 2002

Polar plots of PM_{10} with wind direction were drawn using data collected from both air quality monitoring stations. The plots obtained indicate that for both sites particulate matters are mainly from the south, scattered between the South-East and South-West directions. Chiang Mai is surrounded by forests on the west side and paddy fields on the east side. The closeness of the two ambient air quality monitoring stations to the forest, especially the sub-urban site, and the high peaks of PM_{10} observed during the period of vegetation fires strongly suggests that biomass burning and in particular forest burning is an important contributor to particulate matter pollution in Chiang Mai during the dry season (January to April).