# Environmental and Health Impacts from the 1997 Indonesian Forest Fires in Southern Thailand

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## Southern Thailand Background

Thailand is located in the heart of South-East Asia mainland, covering an area of 513,115 square kilometers (sq km). The Southern region occupies the area of 70,715 sq km and 8.6 million populations. Rainfall generally continues until November or December, resulting in higher average annual rainfall (2741 mm with 176 rainy days and 1697 mm with 147 rainy days in the west coast and east coast, respectively), higher relative humidity (80%), and lower average temperature (27.5 C) than the rest of the country.

## Emissions characterization, Thailand

After reports in international news media and warning from the Meteorological Department, the Indonesian forest fires haze was first visibly observed in southern provinces of Thailand on 22 September 1997, with a 20 mg/m3 increase in PM10 from previous day in Hatyai. The first peak of this episode occurred between 22-29 September with a maximum during 24-25 September, followed by the lower second peak during 6-8 October 1997 (Figure 1). However, the highest 24-hour average PM10 observed at Prince of Songkhla University station was 218 mg/m3 on 26 September, with missing data of the previous 3 days. Although the forest fires in Sumatra and Borneo continued for the next several months, there is no any other transboundary haze event in Thailand after this.
A) Air quality monitoring
Ministry of Science, Technology and Environment (MOSTE) has maintained a network of air quality monitoring in 3 southern cities: Hatyai, Phuket, and Surat Thani since 1996. Each site monitors hourly and 24-hour criteria pollutants including local weather condition.

<table>
<thead>
<tr>
<th></th>
<th>South</th>
<th>North</th>
<th>% net haze impacts</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respiratory OPD visits</td>
<td>$+26$</td>
<td>$+18$</td>
<td>$+8$</td>
<td>$&lt;0.01$</td>
</tr>
<tr>
<td>Respiratory admissions</td>
<td>$+33$</td>
<td>$+26$</td>
<td>$+7$</td>
<td>$&lt;0.01$</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>$+36$</td>
<td>$+18$</td>
<td>$+18$</td>
<td>$&lt;0.01$</td>
</tr>
<tr>
<td>Bronchitis/COPD</td>
<td>$+40$</td>
<td>$+28$</td>
<td>$+12$</td>
<td>$&lt;0.01$</td>
</tr>
<tr>
<td>Asthma</td>
<td>$+12$</td>
<td>$+9$</td>
<td>$+3$</td>
<td>$&lt;0.01$</td>
</tr>
</tbody>
</table>

B) Meteorological data
Meteorological data from the archive of the observation data of all 14 stations south of 11°N latitude covering southern Thailand were used in the study. The data included weather charts, digitized data, and satellite images. Weather charts, surface and upper-air data were used in investigating the synoptic situation, especially during the critical period. (Figure 2 Figure 3).
Assessment of health risks related to downwind air quality, Thailand

A) Health data

1. The Ministry of Public Health monthly morbidity report. A provincial summary of the number of out- and in-patients by diagnosis group is routinely reported every month as part of activity report for health care facilities under the MOPH. There are 21 diagnosis groups for outpatient visits and 75 for admissions. The 1996 and 1997 data were analyzed and compared. Similar data in the upper northern region were also analyzed and used as control group.

2. The time-series study of daily hospital morbidity and mortality in Hatyai. A more detailed study of both outpatient visits and admissions was carried out in 2 public hospitals that serve Hatyai City (Hatyai Hospital and Prince of Songkhla University Hospital—a city hospital and a university hospital). The 1996 and 1997 data were analyzed by month, day, and diagnosis.

3. The death registration mortality study. Nationwide electronic data processing of death certificate is now carried out centrally at the Information Technology Center, Ministry of Interior (MOI), with some lag-time of 4-6 months. However, the 1997 death registration data set is not yet completed and available for analysis. The study is under planned in the next step.
Morbidity studies focused on the following diseases:
1) accidents (ICD-10: V01-V99),
2) respiratory diseases (upper respiratory tract infection, pneumonia, asthma, bronchitis, and others, J00-J99),
3) cardiovascular diseases (ischemic heart diseases and others, I00-I99), and
4) irritation and infection of eye and skin (H10-H13, and L20-L30, L50-L54).

B) Results
Only respiratory diseases showed a marked increase in the affected southern region during September-October 1997, when the haze episode appeared in the area (Figures 4,5). Irritation and infection of eye and skin, cardiovascular diseases, and accident remained rather stable in that period. Of hospitalized respiratory illness, pneumonia showed a clear increase, followed by bronchitis and chronic obstructive pulmonary disease (COPD), and asthma. The common mode of surging in respiratory diseases in both the south and the north suggested that there might be some widespread respiratory tract sickness not related to haze occurring in Thailand in that period. Therefore, in southern Thailand, the haze event was not a sole cause but an additional cause on top for those respiratory illnesses.

Comparison of respiratory morbidity in the south with the control upper north during September-October 1997 revealed an increase (from the same period in 1996) in respiratory OPD visits 26% vs. 18% and in respiratory admissions 33% vs. 26%, resulted in the net health impacts from the haze 8% and 7%, respectively. The net health impacts for pneumonia, bronchitis/COPD, and asthma are 18%, 12%, and 3%, respectively (Table 1).

Regression models are apply to assess the association between monthly PM10 levels, weather variables, and respiratory illness. Among all respiratory conditions, monthly PM10 levels was significantly associated with pneumonia, bronchitis/COPD, and asthma admissions. It suggests that every 1 mg/m3 increase in PM10 is associated with 28, 13, and 13 admitted cases of pneumonia, bronchitis/COPD, and asthma respectively in 1997. Of the weather variables, only relative humidity became significant for pneumonia admissions. Higher relative humidity would increase pneumonia cases. The R2, or the proportion of variance of illness that is accounted for by the predictor variables, of the models varied from 0.32 from respiratory OPD visits to 0.80 in pneumonia cases.

Daily OPD visits of respiratory illness in Hatyai during September-October 1997 showed a marked rise and widening of upper respiratory tract infection (URTI) cases during the haze episode.
between late September to early October 1997. While there seemed to be no increase of acute bronchitis, pneumonia, bronchitis/COPD and asthma visits (Figure 6).

Conclusions and recommendations
Looking back, we can learn much from the past experience and mistakes with the 1997 haze. The root cause of the haze problem is not haze but uncontrolled forest fires due to shortcomings of proper forest management and practice. This phenomenon is still very common in some Southeast Asia countries, including Thailand (ESCAP, 1995).

In light of the low possibility of achieving the goal of forest fires control and emissions reduction in the near future, recommendations on immediate haze-related activities in many fronts are fully needed in order to protect health and quality of life. These include public education on the serious health and socio-economic impacts of uncontrolled forest fires, establishing air quality and meteorology warning system, stock of emergency supplies and equipment, and more research for better and appropriate public and personal protective intervention.

REFERENCE