SMOKE EPISODES EMISSIONS CHARACTERIZATION AND ASSESSMENT OF HEALTH RISKS RELATED TO DOWNWIND AIR QUALITY - CASE STUDY, THAILAND

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INTRODUCTION

With abnormally dry conditions from the 1997-98 El Niño/Southern Oscillation (ENSO) episode, widespread uncontrolled forest fires (originally as part of land clearing operations) occurred since June 1997 in Irian Jaya, Kalimantan (Borneo), Sulawesi, and Sumatra of Indonesia, a country in the South-East Asia region (1). Approximately one million hectares of forest were ablaze when most of the fires subsided three months later in November. From September, the thick haze due to fine particles suspended in the air from smoke and soot had darkened skies across the region—Malaysia, Indonesia, Singapore, Brunei, southern Thailand and parts of the Philippines. Indonesia declared a state of national emergency in September 1997. The Malaysian Government also declared a state of emergency in Sarawak on Borneo Island on 19 September. All private and public offices and schools in Sarawak were closed and the people advised to stay indoors.

An increase in the number of people who required clinic (outpatient) visits or hospital admissions for various haze-related illnesses was reported from Malaysia, Singapore, and Thailand. More than 20,000 cases were reported from Malaysia, a surge of 20 percent was recorded in Singapore, and several thousands cases were estimated to have occurred in Thailand. Most of the cases complained of upper respiratory symptoms, bronchitis, asthma, conjunctivitis, and eczema. The haze was responsible not only for health problems, but visibility as well, making airlines cancelling flights to several airports in the region. Poor visibility was implicated as a factor in the crash of a commercial aircraft in Sumatra on 26 September 1997, that killed all 234 people aboard, and was blamed for a series of fatal ship collisions in that period.

The spreading of the smoke to the Malayan peninsula, including southern Thailand, was helped by the prevailing synoptic scale winds, as indicated by the low-level southerly wind circulation in that period. Transboundary transport of smoke, causing the haze effects to the Malayan peninsula in 1997 was, in fact, not the first occurrence of this type of episode. Similar phenomena occurred sporadically in the past (2).

This paper reviews the situation and activities carried out in response to the haze event in Thailand during and after the late September–October 1997 period. At the same time, a retrospective study on health and environmental impacts from the haze in southern Thailand and its findings are described (3). Data collected and analysed involved health statistics in terms of out-patient visits and hospital admissions, air quality monitoring, and local meteorological conditions that have been recorded in the southern provinces of Thailand. An assessment of the past activities as well as recommendations on what more could be done to better protect public health in terms of mitigation and prevention measures in the next haze episode are presented in the last section of this paper.

SOUTHERN THAILAND

Thailand is located in the heart of the mainland of South-East Asia, covering an area of 513,115 km^2. The current population is 60.6 million (4). The country consists of 4 natural regions: the North, the Central plain, the Northeast, and the South or Southern peninsula. Thailand is a warm and rather humid tropical country. Its climate is monsoonal, marked by a pronounced rainy season lasting from May to September and a relatively dry season for the remainder months of the year.

The Southern region occupies an area of 70,715 km^2 with a population of 8.6 million (Figure 1). 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 per cent), and lower average temperature (27.5 °C) than the rest of the country. Administratively, the region is divided into 14 provinces; each has its own governor appointed by the central government. Densely populated areas (>200 per km^2) are concentrated in the east coast on the gulf of Thailand, in Nakhon Si Thammarat, Songkhla, Pattani and Narathiwat, except Phuket, a small island province in the west.

The health service systems in the southern region are mainly under the public sector (5); each province has general hospitals in large cities, community hospitals at the district level, and health centres in sub-districts (6). However, services provided by the private sector (clinics and hospitals) are common in urban areas. Computerized data processing based on the International Classification of Diseases (ICD-10) has just been introduced into a few city hospitals, and are serving only a portion of daily in- and out-patients. Data processing in medium/small hospitals and health centres is still being done manually.

The Ministry of Science, Technology and Environment (MOSTE) maintains a network of air quality monitoring stations in three southern cities: Hatyai, Phuket, and Surat Thani since 1996. Each site monitors a number of specific pollutants (hourly and 24-hourly) as well as local weather conditions using the following methods: beta attenuation for particulate matter equal to or less than 10 μm in diameter (PM_{10}), gravimetry for total suspended particulate (TSP), atomic absorption spectrometry for lead, non-dispersive infrared detection for carbon monoxide (CO), chemiluminescence for nitrogen dioxides (NO_2) and ozone, and UV-fluorescence for sulphur dioxide (SO_2) (7). A monitoring station at Prince of Songkhla University (PSU) in Hatyai supplements this network. The ambient air quality standards for Thailand are shown in Table 1.

The Meteorological Department has an extensive network of weather stations in both the east and west coasts of the region and at all airports (8). These 14 stations report 3-hourly data of local wind speed and direction, pressure, rainfall, relative humidity, temperature, cloud cover, and visibility. Meteorological variables are measured according to the World Meteorological Organization's guidance (9).

Surface wind direction is read from a wind vane or from the records of Dine pressure-tube anemograph. Wind speed is read from either anemograph or pressure-plate or cup anemometer. Wind instrument is set at approximately 10 metres above ground. Upper-level winds are measured by the sounding equipment, such as a radiosonde or rawindsonde. Only Phuket Airport and Songkhla operate the upper-air radiosonde sounding. Wind speed is reported in 0.5 ms^{-1} or in knots to the nearest unit, and represents, for synoptic reports, an average over 10 minutes. Wind direction is reported in degrees to the nearest 10 degree, and represents an average over 10 minutes. Wind direction is defined as the direction from which the wind blows, and is measured clockwise from geographic north. The wind category "calm" is reported when the average wind speed is less than 1 knot.

Surface pressure is obtained from mercury barometer and given in hecto-pascal (hPa) corrected for temperature, latitude, and mean sea level. Relative humidity (per cent) is obtained from wet and dry bulb thermometers. Rainfall is measured from a cylindrical rain-gauge with brass rim of 20.3 cm in diameter. A visibility value is obtained by visual observation with the reference to the well-marked landscape within the radius from the station. The lowest visibility within the observing circle is reported. In practice, a report of the visibility of 10 km or greater is considered as "good visibility", and the stations at the airport are generally more concerned with the visibility within 10 km.

RESEARCH ON AIR POLLUTION AND HEALTH IN THAILAND

Research on air pollution and health in Thailand using modern study design and methodology has just begun in the last few years with support of the World Bank (10, 11). The Hagler Bailly and Radian International studies were intended to assist policy-makers in setting priorities among many competing environmental and public health issues. Specifically, these were attempted to find out whether health effects of particulate matter are occurring in Thailand as have been observed in other cities worldwide. They also presented options for the government's action plan in reducing air pollution from particulate matter in Bangkok.

Although there were problems and limitations in data collection and analyses, the Hagler Bailly study (10) was the first attempt to quantitatively evaluate health effects and characterize certain exposure aspects of Bangkok population to particulate matter. Time-series analysis showed that a 30 $\mu g/m^3$ increase in PM_{10} was associated with a 3 per cent increase in daily mortality, or between 1,000 and 2,000 premature deaths each year. As for hospital admissions, a 30 $\mu g/m^3$ change in PM_{10} was associated with 18 per cent and 11 per cent increase in respiratory admissions for elderly and all-age patients, respectively. Based on a study on diary records of acute daily respiratory symptoms maintained by an adult population group, a 30 $\mu g/m^3$ increase in PM_{10} was associated with a 19 per cent increase in lower respiratory symptoms (Table 2). In non-airconditioned premises with some indoor sources of pollution, such as cigarette or charcoal smoke, the indoor PM_{10} concentrations were as high or even higher than those measured outdoors. In locations where there was some air conditioning and with no notable indoor sources of pollution, indoor PM_{10} concentrations were between 50 per cent and 100 per cent of those outdoors.

Based on the chemical analysis of ambient and source samples and chemical mass balance receptor model, the Radian International study (11) indicated that mobile source emissions and reentrained road dust accounted for majority of PM_{10} levels in Bangkok. The source samples covered power plants, steel mills, road dust, motorcycles, light-duty diesel vehicles and heavy-duty diesel vehicles. In the study, a comprehensive list of emission sources and activity factors for the major pollutants in the area were developed and compiled. Air dispersion modelling was employed in evaluating alternative control measures and their effectiveness in improving air quality. Several cost-effective control measures were recommended for each major source category. These included complete changing over from 2-stroke to 4-stroke motorcycles, improving fuel quality such as use of natural gas for all city buses, ensuring an effective inspection and maintenance programme, covering open trucks, chemical spraying on unpaved roads and construction areas, and vacuum sweeping of streets.

ACTIVITIES AND MITIGATION MEASURES DURING AND AFTER THE 1997 ASEAN HAZE

Activities and mitigation measures implemented at the local and central levels by all related agencies during and after the 1997 haze are described below.

During the haze event

Early response at local and central levels

Because of the abrupt nature of the haze and the lack of previous experience, the response occurred relatively late. Songkhla responded first with a press conference on air quality levels and health advice on 30 September, followed later by the other provinces. One consequence was a great demand on local air quality data. Emphasis tended to be placed on air monitoring stations (both mobile and permanent) rather than mitigation and prevention measures for the public or on how to deal with the root cause of the problem; ie. uncontrolled forest fires in Indonesia. Some conflicting information was generated from different agencies in this early period; eg interpretation of air quality and rainfall acidity data. At the central level, the Cabinet in Bangkok had ordered the Ministry of Public Health to set up a coordinating centre for public assistance during the haze event and a committee was appointed on 3 October 1997. The Ministry distributed 140,000 masks that are protective against particles larger than 3 microns to all 14 southern provinces in early October 1997.

Coordinating Center for Public Assistance during the haze

The Coordinating Center for Public Assistance during the haze convened its first and only committee meeting on 3 October 1997, and appointed a subcommittee on information which also had the first meeting on the same day.

The name of the subcommittee reflected previous conflicts and confusions and the need to coordinate air quality, health risk communication and public advice on protective measures. The subcommittee produced a set of guidelines for public assistance during the haze in late October 1997.

Guidelines for public assistance during the haze

The contents of the guidelines are as follows:

- Air quality monitoring and upper respiratory symptoms reporting during the 1997 haze.
- Review of impacts on visibility and health.
- Health risk communication and public advice on protective measures.
- Role and functions of each agency in public assistance during the haze.
- Air quality monitoring guidelines.
- Rainwater quality monitoring guidelines.
- Press conference and public information suggestions.
- Reporting of respiratory diseases

An effort to set up a reporting system of respiratory diseases from southern provinces, in addition to the routine reporting system, worked partially only for the first month—September 1997. Ten of 14 provinces reported 500-800 cases of upper respiratory diseases in September. There was no any subsequent report after October. The data coming in were too crude and incomplete for any conclusion to be drawn on health impacts of the 1997 haze.

Health risk communication and public advice on protective measures

The protective measures are generally similar to those of other ASEAN countries, covering suggestions for the susceptible population groups (asthmatics and chronic bronchitis, elderly, infants and children, persons with underlying lung or heart disease, and smokers) and the general population. These include avoiding strenuous activities and smoking, staying indoors, drinking clean water and temporarily refraining from rainwater, seeking care when having symptoms or attacks, and wearing protective masks outdoors in severe haze.

Assessment of public health impacts from the 1997 haze

To assist the Coordinating Center in producing guidelines for assessing public health impacts that can be conducted locally in each province, the Health Systems Research Institute convened a technical meeting on 10 October 1997. The meeting included participants with expertise or interest in air pollution and health research, health information system and meteorology. The guidelines were produced and distributed in mid-October. So far, there are only two local studies from Songkhla looking at the number of outpatients and in-patients with respiratory and/or cardiovascular diseases in September 1997.

Post-haze activities

Coordinating Center for Public Assistance during the Haze

The Coordinating Center's subcommittee had another meeting on 9 April 1998 to update activities and information from its members. The Pollution Control Department of the Ministry of Science, Technology and Environment and the Meteorological Department will continue to supply the Center their air quality monitoring and meteorological data for haze warning system.

Air quality information

After the air pollution episode throughout southern Thailand from the Indonesian forest fires, the Pollution Control Department has set up an Internet homepage called Air Quality in Southern Thailand to inform the public of air quality within the region, especially from particulate matter (PM_{10}). The URLs for accessing the information are: http://www.pcd.go.th and http://www.aqnis.pcd.go.th.

Meteorological information

The Meteorological Department was involved in several committees set up by the Thai government to deal with the Indonesian haze and other forest fires. It also took part in seminars or technical meetings concerning the phenomenon. The department was represented at various international meteorological meetings on Indonesian haze problems and was involved in establishing a more efficient co-ordination among meteorological services in the region.

NATIONAL HAZE ACTION PLAN

The experience of the haze impacts from Indonesian forest fires in 1997 has stimulated the response of the public sector. The Prime Minister directed the Ministry of Science, Technology and Environment to formulate the National Haze Action Plan to prepare for and mitigate the impacts from future forest fires in the region. The Thai Committee on ASEAN Haze Mitigation (TAHM) was then set up and chaired by the Deputy Permanent Secretary of the Ministry of Science, Technology and Environment. The TAHM consists of the following government agencies:

- Royal Thai Army, Royal Thai Navy, and Royal Thai Air Force, Ministry of Defence
- Public Relations Department, Office of the Prime Minister
- Bureau of the Royal Rain Making and Agricultural Aviation Division, Ministry of Agriculture and Cooperatives
- Royal Forestry Department, Ministry of Agriculture
- Department of Health, Ministry of Public Health
- Meteorological Department, Ministry of Transport and Communications
- Ministry of Foreign Affairs

- Department of Public Welfare, Ministry of Labor, Social and Welfare
- Pollution Control Department, Ministry of Science, Technology and Environment

The role of the TAHM is to formulate the plan for immediate response and to accelerate necessary actions to mitigate/minimize impacts from the ASEAN forest fires. The National Haze Action Plan has already been prepared and is currently in the process for approval from the Cabinet. Actions under the Plan are activities inside the country (local action plan) as well as the potential cooperation that can be provided to other ASEAN member countries (ASEAN coordination) in case of the occurrence of the forest fires.

ASOEN TASK FORCE ON TRANSBOUNDARY POLLUTION AND ASEAN MINISTERIAL MEETING ON HAZE

The regional haze events of 1991 and 1994 triggered a series of regional measures towards cooperation in fire and smoke management. In 1992 and 1995, regional workshops on transboundary haze pollution were held in Indonesia and Malaysia, respectively. This was followed by the establishment of a Haze Technical Task Force (HTTF) during the sixth meeting of the ASEAN Senior Officials on the Environment (ASOEN) in September 1995. The task force is chaired by Indonesia and comprises senior officials from Brunei Darussalam, Indonesia, Malaysia and Singapore. The objective of the work of the task force is to operationalize and implement the measures recommended in the ASEAN Cooperation Plan on Transboundary Pollution relating to atmospheric pollution, including the problem of fire and smoke (1). In response to the ASEAN Environment Ministers' Jakarta Declaration on Environment and Development on 18 September 1997, the Asian Development Bank (ADB) has provided funds through a Regional Technical Assistance (RETA) grant to assist ASEAN in strengthening cooperation among the fire- and smoke-affected countries.

The first two ASOEN HTTF meetings were limited to only four countries: Brunei Darussalam, Indonesia, Malaysia, and Singapore. The other ASEAN members, such as Thailand and Philippines, were invited to participate in the third meeting in November 1997 in Kuala Lumpur, Malaysia, to review the steps and measures taken to deal with the haze pollution affecting the region. Singapore hosted the fourth meeting and the first ASEAN Ministerial Meeting on Haze (AMMH) in December 1997. The fourth ASOEN HTTF meeting had finalized the Regional Haze Action Plan (RHAP) and the proposal for support from the ADB, and submitted both to the AMMH on the following day. At this meeting, the ASEAN Ministers endorsed the RHAP. The Plan mainly focussed on the development of three programmes: (i) preventive measures (Malaysia as the focal point); (ii) establishment of operational mechanisms and monitoring measures (Singapore); and (iii) strengthening of forest fire-fighting capability and other mitigating measures (Indonesia).

The fifth ASOEN HTTF meeting was held in Indonesia in January 1998 to discuss the progress of implementation of the three programmes in the RHAP. The meeting also discussed the proposed scope of ADB's RETA project. Malaysia hosted the sixth ASOEN HTTF meeting in Kuching on 24 February 1998, followed by the second AMMH on 25 February 1998. During the second AMMH, the progress of the RHAP and ADB's technical assistance project in support of the RHAP was reported. The ASEAN Specialized Meteorological Center (ASMC) has also informed the Ministers of the regional meteorological forecast activities. The seventh ASOEN HTTF meeting and the third AMMH were arranged and hosted by Brunei Darussalam from 3-4 April 1998. The eighth ASOEN HTTF meeting and the fourth AMMH were held in Singapore from 18-19 June 1998.

HEALTH AND ENVIRONMENTAL IMPACT ASSESSMENT

A multidisciplinary retrospective research to assess the environmental and public health impacts from the 1997 haze in the southern provinces of Thailand has been carried out since early 1998. The main objective was to evaluate the relationship between changes in meteorological and air quality conditions and their health impacts in order to prepare better mitigation and preventive measures in the future.

Methods

For the purpose of health and environmental impact study, data on morbidity and mortality, air quality, and meteorology including visibility in 14 southern provinces during 1996-1997 were collected and analyzed. The focus was on the identification of changes in air quality and meteorological conditions, and the related impacts on morbidity and mortality during the haze event. Hatyai, the largest city of the region, was selected for a more detailed study as its health, air quality and meteorological data were the most complete.

Meteorological data

Meteorological data from the archives of all 14 stations south of 11°N latitude covering southern Thailand were used in the study. These included weather charts, digitized data, and satellite images. Weather charts, and surface and upper-air data were used in investigating the synoptic situation, especially during the critical period.

The 3-hourly data of pressure, wind speed and direction, temperature, relative humidity, rainfall and visibility were included in the analysis. The data for the years 1996 and 1997 were used in comparing each meteorological variable at each station. Time series data of the daily mean of each variable were plotted and compared between the two years.

The GMS-5 Japanese geostationary meteorological satellite visible images were used as a supplement in identifying the affected areas. These images were available only during the daytime.

Air quality monitoring data

The daily air quality levels of PM_{10} and other criteria pollutants from three permanent stations in the south maintained by the Ministry of Science, Technology and Environment were collected and analyzed. Similar analysis was carried out for the air quality monitoring data of Prince of Songkhla University.

Health data

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

A more detailed time-series study of both outpatient visits and admissions was carried out in two public hospitals that serve Hatyai City (Hatyai Hospital and Prince of Songkhla University Hospital). The 1996 and 1997 data were analyzed by month or day and by diagnosis.

The Hatyai hospital mortality and death registration data were also collected and analysed. Nationwide electronic data processing of death certificates is now carried out centrally at the Information Technology Center, Ministry of Interior (MOI), with a lag-time of 4-6 months. Although the Hatyai hospital mortality data are readily available, the 1997 death registration data have not yet been completed and are not available for analysis.

The morbidity studies were focussed on the following disease conditions:

- accidents (ICD-10: V01-V99);
- respiratory diseases (upper respiratory tract infection, pneumonia, asthma, bronchitis, and others, ICD-10: J00-J99);
- cardiovascular diseases (ischemic heart diseases and others, ICD-10: I00-I99); and
- irritation and infection of eye and skin (ICD-10: H10-H13, and L20-L30, L50-L54).

RESULTS

Meteorological findings

Monthly surface meteorological observations, daily surface meteorological observations in September and October 1996 and 1997, and 10-day wind rose analysis in September–October 1997 for Hatyai are shown in Figures 2 to 4. Examples of wind circulation at 600 metres above sea level and satellite images are shown in Figures 5 and 6.

The synoptic weather of southern Thailand in 1996 and 1997 did not differ much from each other. The effects of the 1997 El Niño phenomenon to the weather pattern in southern Thailand, as well as other parts of the country in 1997 were not very distinctive from the normal dry year. Rainfall pattern for the year 1997 did not indicate a large deviation from the 30-year mean and the year 1996 values. Temperature as well as relative humidity did not show much difference between the two years. The average daily wind speed and direction from 1997 to 1996 were relatively similar. A large number of calm winds were reported at each station. All monthly mean visibility reported at the stations in southern Thailand showed marked deterioration, deviation or shift from the patterns of previous months as well as the values in 1996. This pattern coincided with the reports of other air quality parameters.

During the last week of September 1997, all stations south of 10°N latitude reported a steep decline in visibility. The patterns differed significantly from the visibility report for the corresponding period in the previous year. Daily values indicated some of the synoptic weather patterns that could favour the spreading of the smoke haze from the area south of Thailand. From 20 September 1997, the general synoptic weather over Thailand was under the influence of the active low-pressure trough over central Thailand, with the quite active low-pressure cell off the coast of Vietnam at approximately 15 °N and 100 °E. This active low-pressure cell was later transformed into a tropical depression, followed by tropical storm "Fritz" (9722) on 23 September 1997. The presence of the low-pressure cell or tropical storm near the coast of Vietnam often causes the cross-equator flows in the direction feeding into the centre of the storm. In this case, the low-level flows (i.e. at 850 hPa) during that time has a southerly direction for stations south of Surat Thani, and veering to southeast for stations at Surat Thani on the north.

On 22 September 1997, the sounding analysis at Songkhla Station indicated the low-level inversion layer up to 850 hPa. This indicated the existence of a stable layer close to the ground, favourable to the building up of smoke concentration. Later, on 23 September 1997, the anticyclonic circulation was found at 600 metre above ground covering the area between Songkhla and Surat Thani. Again, the presence of the low-level anticyclonic circulation could induce the subsidence of the air favouring accumulation of the smoke concentration.

During the first week of September 1997, the surface wind pattern of all the stations throughout southern Thailand had the south-southwest, west, and northwest directions. The 10-day wind roses indicated that during the period 11-20 September 1997, the stations in the east coast of southern Thailand, except Narathiwat, had the southerly or southwesterly wind components while the west coast stations had more components in southwest or west direction. Phuket stations (downtown and airport) had mostly west direction. In the following week (21-30 September 1997), the surface winds had more northerly direction. At most of these periods, the stations in Malaysia reported calm or southerly winds. The daily wind-rose for Hatyai in September indicated the southerly wind component most of the time prior to 21 September when the visibility was reported to be worsening.

Air quality levels

PM_{10}

After reports in international news media and warning from the Meteorological Department, the Indonesian forest fires haze was first visibly observed in the southern provinces of Thailand on 22 September 1997, with a 20 $\mu g/m^3$ increase in PM_{10} from the previous day in Hatyai. The first peak of this episode occurred between 22 and 29 September with a maximum during 24-25 September, followed by the lower second peak during 6-8 October 1997 (Figures 7). However, the highest 24-hour average PM_{10} observed at Prince of Songkhla University station was 218 $\mu g/m^3$ 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 was no other transboundary haze event in Thailand after this.

The monthly 24-hour average of PM_{10} in Hatyai in both 1996 and 1997 do not differ much and indicate the relatively clean background levels in the city (43 $\mu g/m^3$). The abrupt but short duration of haze and air quality deterioration in late September 1997 resulted in a moderate increase of PM_{10}, 69 $\mu g/m^3$, compared to the same month in 1996 (Table 3). Even though the 24-hour average close to or more than 200 $\mu g/m^3$ were observed for 3 days in late September 1997, this dilution effect suggests the need to pay more attention at the daily 24-hour average. PM_{10} levels in the south seem to increase from June to August, a pattern different from what has been observed in Bangkok (the capital city) where air pollution is higher from December - February.

Other gas pollutants (CO, NO_2, and SO_2)

The monthly 24-hour average of NO_2 in Hatyai for both 1996 and 1997 were not different (Table 4, Figure 8). Similar trend was observed for SO_2. Only CO showed a two-fold increase of monthly 24-hour average in September and October 1997 compared to the same period in 1996. However, all their concentrations were much lower than the national and US air quality standards. The US standards for these pollutants using the same volumetric units are: 9 ppm (8-hour maximum) for CO; 53 ppb (annual average) for NO_2; and 140 ppb (24-hour average) for SO_2 (mixed units are shown in Table 1).

HEALTH IMPACTS FROM THE 1997 HAZE

The Ministry of Public Health monthly morbidity study

Monthly outpatient visits (OPD) reported from all 14 southern provinces during 1996-97 were in the range of 700,000-800,000, or almost 10 per cent of the regional population. Of these visits, respiratory disease was the most common and accounted for about one third, followed by digestive ailments and skin plus eye diseases (Table 5). Monthly inpatient admissions (IPD) reported from all 14 southern provinces were between

50,000-60,000 or almost 1 per cent of the population hospitalized each month. Respiratory disease was the second most common at 14 per cent of all admissions (Table 5). Other regions of Thailand also showed similar pattern (11).

Among outpatient visits, there seemed to be a seasonal trend of respiratory diseases in early rainy (June-July) and colder (December-January) seasons in the south (Figure 9a). This trend changed in 1997 with respiratory illness rising in August and peaking in September when the haze hit the area. Compared with the control area in the far north, respiratory disease visits showed an increase in September 1997 but peaked a month later in October (Figure 9b). Among IPD admissions, a similar seasonal trend of respiratory illness in early rainy season (June-July) was observed in the south (Figure 10a). This trend changed in 1997 with respiratory diseases rising in August and peaking in September when the haze hit the area. In the control area in the north, IPD respiratory disease category showed an increase in September 1997 but continued to peak in October (Figure 10b).

For respiratory disease admissions, a seasonal trend of pneumonia can be observed during the months of September to October for both the south and the upper north regions (Figures 11a and 11b). Reported monthly pneumonia admissions displayed a sharp increase in September 1997 when the haze appeared in the south, followed by smaller peaks of bronchitis/chronic obstructive pulmonary disease (COPD), and asthma in the same month. For the control area in the north, which was not affected by the haze, smaller peaks of pneumonia and bronchitis/COPD were observed a month later in October 1997.

This common mode of surging in respiratory diseases in both the south and the north suggested that there might be some widespread respiratory tract diseases not related to the haze occurring in Thailand during that period. Therefore, in southern Thailand, the haze event was not a sole cause but an additional cause for these respiratory illnesses.

Other than respiratory diseases, reported outpatient eye and skin diseases as well as cardiovascular diseases and accidents did not show a marked increase in the south during the haze episode in September-October 1997. For inpatient cases, these diseases also did not reveal any obvious increase; all remained rather stable during the same period (Figures 9 - 11). Consequently, the analysis of health impact from the 1997 haze focused only on respiratory effects.

During the 2-month period covering the haze episode from September-October 1997, a substantial increase in respiratory morbidity of both OPD visits and IPD admissions was observed in the study area of southern Thailand. The differences in OPD visits/IPD admissions between the southern and the northern (control) regions were: 26 per cent vs 18 per cent for all respiratory disease visits, 33 per cent vs 26 per cent for all respiratory disease admissions, 36 per cent vs 18 per cent for pneumonia admissions, 40 per cent vs 28 per cent for bronchitis/COPD admissions, and 12 per cent vs 9 per cent for asthma admissions (Table 6). Hence, the net health impacts from the 1997 haze are 8 per cent and 7 per cent increases in respiratory disease visits and admissions, respectively. It is interesting to observe that the percentage of net haze impacts is higher in two specific respiratory diseases, pneumonia and bronchitis/COPD. From this finding and the monthly report of respiratory disease morbidity, the increase during the 1997 haze would be approximately 45,000 visits and 1,500 admissions in southern Thailand.

Regression analysis demonstrates significant associations between almost all categories of monthly respiratory disease admissions and monthly PM_{10} levels (Table 7). For each 1 $\mu g/m^3$ increase in the monthly PM_{10}, there were about 85, 28, 13, and 13 monthly admissions for all respiratory illness, pneumonia, bronchitis/COPD, and asthma, respectively. Relative humidity is the only weather variable significantly associated with pneumonia admissions. For each percentage change in the monthly relative humidity, there was 178 pneumonia admissions. The R^2 or the proportion of variance of illness that is accounted for by the predictor variables of the models, varied from 0.45 in bronchitis/COPD to 0.80 for pneumonia cases.

Daily hospital morbidity and mortality study in Hatyai

Daily hospital morbidity and mortality study in Hatyai was based on pooling data from the two city hospitals, Hatyai Hospital and Prince of Songkhla University (PSU) Hospital. Respiratory diseases generally accounted for 15 per cent of OPD visits and 12 per cent of IPD admissions.

Daily respiratory illness visits and admissions in Hatyai city during September-October 1997 are shown in Figure 12. The number of cases fluctuated according to the working hours. It was higher during the weekdays, then dropped during the weekend. The 7-day moving average showed different period of increase; for OPD visits, in early October, while for IPD cases, in late September.

For respiratory illness visits, a rise and widening of upper respiratory tract infection (URTI) cases can be observed during the haze episode between late September and early October 1997, compared to the year before (Figure 13). There seemed to be no increase of other respiratory categories in OPD visits. Of respiratory admissions, some increases of pneumonia and acute bronchitis as well as bronchitis/COPD were observed during the first peak of the haze episode, although the overall numbers were small (Figure 14).

During the 2-month period covering the haze episode in September-October 1997, significant increases in OPD visits for respiratory illness and admissions for bronchitis/COPD were observed in Hatyai city (Table 8). The increases were 11 per cent for outpatient visits and 8 per cent for hospital admissions, compared with the reference of increased trend of hospital visits and admissions, of 4 per cent and 7 per cent, respectively. The net health impacts from the 1997 haze were 7 per cent and 1 per cent increases in respiratory illness visits and admissions, respectively. These increases support the results of the region-wide study described in the previous section. Among OPD visits, the net increase was most pronounced for URTI (15 per cent) and bronchitis/COPD (although not statistically significant), while other categories showed a decrease. For hospitalization, the net haze impacts was highest for bronchitis/COPD (49 per cent), while pneumonia cases increased slightly and asthma cases declined (both not statistically significant). Using this finding and the respiratory illness statistics in both hospitals, the increase in service load during the 1997 haze would be approximately 1,600 outpatient visits for URTI and 40 hospital admissions for bronchitis/COPD in a city with 260,000 population.

Regression analysis was carried out for the category daily visits for all respiratory illness and URTI. Significant association between deviation from daily average visits for all respiratory illness and URTI and daily

PM_{10} levels was demonstrated (Table 9). For each 1 $\mu g/m^3$ increase in daily PM_{10}, there was 0.2 deviation from daily average visits for all respiratory illness and URTI. This conclusion is based on the background information on hospital utilization and practice in Hatyai. No weather variable was found to be significant in the analysis. However, their R^2 or the proportion of variance of illness that is accounted for by the predictor variables of the models, are only 0.08 and 0.12 for all respiratory illness and URTI, respectively.

To identify the vulnerable groups during the haze episode, hospital utilization by age for both outpatients and inpatients were analyzed. For OPD visits, there was a slight increase in those <5 years of age (2 per cent), but a slight decrease in those in the older age group (-2 per cent) during the period September-October 1997 when the haze hit the area, after adjusting for increases in other months (Table 10). On the contrary, among IPD admissions, there was a marked decrease in young patients (-8 per cent), but an increase in older patients (3 per cent) during the haze period, after adjustment with the reference period.

There were 1746 deaths in both hospitals in Hatyai city in 1997. There seemed to be a pattern of higher mortality in the first half of each year. In 1997, a small rise in mortality occurred in July, September and November. The increase in September, which was the month of the haze episode, was due to a rise in the number of deaths from respiratory diseases. No such increase was observed in 1996. During the two-month period September-October 1997, increases in hospital mortality were observed, although all were not statistically significant (Table 11). The highest increase was deaths from respiratory diseases.

CONCLUSIONS AND RECOMMENDATIONS

Widespread uncontrolled forest fires, which originated from agricultural land clearing, occurred since July 1997 in several major islands of Indonesia, under the abnormally dry conditions from the 1997-98 El Niño/Southern Oscillation (ENSO) episode. The fires sent thick smoke haze across the sky of most countries in the region—Malaysia, Indonesia, Singapore, Brunei, southern Thailand and parts of the Philippines in