Report of the Forum on the Impact of Haze on Human Health in Malaysia

by the Medical and Health Sciences Discipline Group, Academy of Sciences Malaysia

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Foreword

The Academy of Sciences Malaysia (ASM) has been entrusted with the mandate to be a "Thought Leader" in the science, technology and innovation (STI) arena and we consider this an immense responsibility to our society and nation. The Academy translates this mission into action by undertaking strategic STI studies and delivering programmes that mobilise a wide spectrum of expertise not only within the Academy but also its network of prominent international and local linkages. ASM is committed to providing the highest quality of scientific, intellectual and strategic input concerning global challenges and national priorities.

Haze is not a foreign issue in Southeast Asia. Years of illegal forest burning in Indonesia have created a haze epidemic that has become a serious problem for more than breathability. The issue has taken a massive toll on development in much of Southeast Asia. This annual man-made disaster has affected Malaysia and Singapore for more, since 1997. Exposure to haze may cause a variety of adverse health effects. The small particles that cause haze are composed of microscopic solids or liquid droplets that are so small that they can get deep into the lungs and cause serious health problems. The particulate size ranges from <1mm, 1–2.5mm, 2.5–4mm and 4–10mm. In tackling this issue, strategic intervention and efforts from all parties; policy makers, industry, academia and public is vital.

This report is yet another important initiative of ASM to highlight the need for concrete action towards enhancing research and development on the health impact of haze.

In developing this advisory report, ASM has engaged various experts and stakeholders from the public and private sectors. I would like to thank the Academy of Sciences Malaysia's Medical and Health Sciences Discipline under the leadership of Academician Professor Dato' Dr Khairul Anuar Abdullah FASc, all experts and stakeholders for their contribution to at this forum.

Professor Datuk Dr Asma Ismail FASc
President, Academy of Sciences Malaysia

Preface

This report by ASM aims to provide input in the form of a reality check and policy recommendations towards addressing the issue of the impact of haze on human health in Malaysia. This report is borne from a forum initiated by the ASM Medical and Health Sciences Discipline entitled "Forum on the Impact of Haze on Human Health in Malaysia", held on 15 April 2017.

The Academy has always endeavoured to address the nation's highest concerns from the STI perspective. Recently, ASM conducted a study on Local and Transboundary Haze with the aim to provide policy inputs and recommendations on the local transboundary haze issue to the Government of Malaysia and its relevant authorities, particularly on Legal-Policy Framework; Institutional Arrangements; Socio-Economics; and STI interventions.

The ASM Medical and Health Sciences Discipline Group saw this as an opportunity to provide related input on the health impact of the haze phenomenon. However, there seems to be a lack of consolidated data on the impact of haze on human health in Malaysia. Such data is crucial for evidence-based, information decision making. Credible, timely and relevant data would facilitate strategic interventions to mitigate or better respond to the effects of haze on human health.

On behalf of ASM, I would like to thank the ASM Medical and Health Sciences Discipline members for their valuable input and commitment towards making this report possible. It is hoped that this report would catalyse concerted efforts and synergistic action towards determining the impact of haze on human health.

Academician Professor Dato' Dr Khairul Anuar Abdullah FASc
Chair, ASM Medical and Health Sciences Discipline

Acknowledgement

ASM wishes to thank all members of the ASM Medical and Health Sciences Discipline for their participation and contribution in the Organizing Task Force for the Health Impact of Haze Forum.

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ASM also would like to acknowledge Young Scientist Network (YSN-ASM) members and ASM Analysts for being the rapporteurs of the forum.

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Executive Summary

Haze in Malaysia is transboundary in nature and is impacted highly by seasonal wind flow. Transport of air mass studied via the Hysplit backward trajectory model has noted that the wind circulation, hotspots and gradient of pressure suggest that the impact of transboundary pollution is predominant during the southwest monsoon (June to August).

The adverse effect of haze to humans are dependent on several factors such as concentration of major pollutants or particles in the haze, the level of exposure due to frequency, duration and route as well as certain personal factors that predispose a person to health risks. Susceptibility factors also include those related to life stage, pre-existing disease and socioeconomic status.

At present, there is little evidence to link haze to diseases in Malaysia. There has been no conclusive study in Malaysia that is able to prove neither an association nor a causation of haze to burden of disease in the country. However, there were several ill-health conditions discussed that may be affected by haze.

The first is respiratory diseases. No studies have found direct associations between mortality caused by respiratory illness with haze. However, epidemiological studies have demonstrated relationship between wildfire smoke exposure, declines in lung function and increases in physician visits for respiratory problems, respiratory emergency department visits and respiratory hospitalisations.

Similar trends have been observed in cardiovascular disease conditions. Associations between cardiovascular outcomes and wildfire smoke exposure are inconsistent. However,a substantial increase in the occurrence of out-of-hospital cardiac arrest and also hospitalisation of acute myocardial infarction has been recorded during period of haze.

It is also suggested that haze could impact society psychologically which may affect self-control with a potential range of conditions such as insomnia, feelings of anxiety and in some cases depression. It is also shown that air pollution can cause individuals to be less engaged at work. Despite these signs, less is known about the psychological effects.

These potential hazards of haze on health also lead to economic complications such as impact on health tourism, increased healthcare cost, and loss of productivity. Estimated total economic losses during haze episode in 2013 were RM1.5 billion (0.48% of 2013 GDP).

The most effective measures in mitigating these health impacts are to step up on haze prevention rather than medical treatment. Current efforts from the Malaysian government include health education, public advisory, disease management and surveillance. Other than that, several policies and guidelines have also been published to assist in this issue, which include the National Haze Action Plan, the Haze Management Action Plan, and the Health Action Plan.

There are several gaps and challenges faced despite the continuous efforts towards reducing health impacts due to haze, including methodology for assessment of impact to facilitate important decisions. This is very important for evidence-based, informed decision making.

Certainly, more research is needed to determine if wildfire smoke exposure is consistently associated with cardiovascular effects, specific causes of mortality, birth and mental health outcomes. Current recorded estimations are based on modelling and calculations associated between disease and death during haze. It is difficult to determine whether haze is the causative factor due to the complicated nature of medical conditions and lack of accurate records in epidemiology statistics.

Research on which populations are most susceptible to health effects from wildfire smoke exposure is also needed to facilitate public health planning for future wildfires. Furthermore at present, there are very few local studies on health economic impact of haze. Clearly, there is a gap in a conclusive understanding on how haze affects human health and psychology. Hence, a lot more work is needed to elucidate the health impact to humans.

To close the gap and challenges, it is important to scientifically document trends of haze and healthcare utilisation in Malaysia so that steps can be taken to combat haze as well as to allocate appropriate resources to meet the healthcare demand associated with haze.

1.0
Presentations

Overview of Public Health Action, Gaps and Challenges to Protect the Public

by Datuk Dr Lokman Hakim Sulaiman FASc

Impact of Haze on Health

Haze in Malaysia is transboundary in nature and is impacted by seasonal wind flow depending on the climate in Malaysia, particularly during the southwest monsoon (June to August). Impact of haze on human health is dependent on several factors such as the hazard i.e. concentration of major pollutants or particles in the haze multiplied by the level of exposure due to frequency, duration and route as well as certain personal factors that predispose a person the health risk. Major air pollutant concentration during haze is PM2.5 (>=75%). It is important to note that size of particles do matter as fine particles can be suspended longer and transported further, and therefore, can cause exposure to a larger population. In addition, the size of particles that are smaller than PM2.5 can easily bypass body defence system and penetrate into the alveoli of the lungs.

Gaps Related to Impact on Haze on Health

Haze can cause acute and long-term health effects. However, long-term effects require long-term or longitudinal studies. The most common health impact is mild but the cause is often multifactorial and this makes it difficult to attribute association, much less causality to haze. Therefore, there is a need for more in-depth surveillance and research.

Gaps and Challenges to Protect the Public

It was emphasised that the best way to mitigate health impact is to step up haze prevention rather than treatment. Therefore, Ministry of Health (MOH) plays an active role in giving health education to the public to face haze. Several gaps and challenges to protect public health were highlighted as follows:

- The most common public advisory is to stay indoors, reduce outdoor physical activity, and wear a mask during outdoor activities. However, MOH faces more difficult decisions on when to provide advisory to close schools, cancel public events or stop outdoor activities.
- The role of MOH to monitor the disease management and surveillance with aim to raise awareness, reduce exposure and impact is gruelling. Disease surveillance is carried out by sentinel health clinics located within 5km radius from the Continuous Air Quality Monitoring Stations (CAQMS). Based on this, no obvious link to conjunctivitis, asthma, etc. was found.
- The Department of Environment (DOE) has produced a National Haze Action Plan that spells out the roles of each relevant agency during haze including the MOH. The MOH has a Haze Management Action Plan as well as Disaster and Crisis Management Plan in place. These plans provide detailed actions to be

taken before, during and after any crisis in the event that the haze condition is declared as a national crisis. In addition, the Health Action Plan was said to have been revised several times towards a better response. However, it was pointed out that there was still a need for standard guidelines that are continuously updated.

- The methodology for assessment of impact to facilitate important decision making such as on school closure to be made by MOH and Ministry of Education (MOE) remains a challenge. MOH needs better assessment tools to help in the decision-making.
- MOH conducted risk assessment and found that an Air Pollutant Index (API) level of 200 is the most appropriate level for decision on school closure due to unacceptable health risk. Risk assessment also showed that when the API is >100, having outdoor games / activities should be limited to 15 minutes only.
- It was stressed that the decision-making is extremely challenging because the API can change overnight and because of the complex nature of diseases. This raise the question on whether in the development of current API warning system there would be a possibility to forecast API.
- Another challenge is advice on the types of mask to be used as most surgical masks are not effective in filtering PM2.5 particulates in the haze.

Summary

Overall, there is not much evidence to link haze to diseases in Malaysia due to the lack of solid evidence pertaining to each category of gaps. This has tremendous impact on decision making and communication of risk. As such, there is a need for more in-depth and long term research.

Question:
Explanation was sought on the chart shows the proportion of inhaled dose to planned physical activity intensity at school environment and risk on Slide 17.
Answer:
The total inhaled dose per day is substantially lower among children who stay at home when exposure at school environments is not accounted (when school is closed). The inhaled dose further reduced when children stay at home ventilated with air conditioning system. Further analysis on inhaled dose by specific physical activity intensity at school environments shows that a large proportion of potential inhaled dose (47%) is contributed by a short duration of moderate and high physical activity intensity. HRA indicates school shall be closed when API reaches 200; that however, we do not know for sure whether this intervention is effective or not. We assumed that when school is closed, the children are expected to stay indoors at their home. Research is needed not only to study the behaviour of school children when their school is closed but more important is to study the impact of such intervention on the health outcome using population data.

Question:
What are some of the existing policies governing the assessment and monitoring of health impact caused by haze?
Answer:
MOH responds to the situation and makes sure that all facilities are prepared to face the issue. However, not much can be done by MOH to prevent haze.

Question:
Is the impact of haze on health in Malaysia an association or causation?
Answer:
No evidence whatsoever. Even association cannot be established.

Question:
What is the burden of health caused by haze in this country?
Answer:
We do not know. There is a need for more in-depth studies.

Review of the Literature on Haze and Health in Asia-Pacific Region

by Professor Dr Awg Bulgiba Awg Mahmud FASc

Due to nature of the health risks imposed by the haze and the available scientific data, the impact of haze was mainly discussed on two ill-health conditions, namely respiratory and cardiovascular diseases. The influences of haze on both respiratory and cardiovascular diseases were further deciphered based on the following criteria:

- Morbidity (physician & emergency department visits and hospitalisation)
- Mortality

Based on published data from other countries and limited data from Malaysia, the reported health outcomes are very much influenced by:

- The particle size of the haze
- The period of exposure
- Vulnerable population

The following important epidemiological studies had delineated the association of haze particle size, PM10 and its related health hazards:

- The epidemiological study from Sastry et al. (2002) which included the Malaysian data revealed particle size of PM10 had a direct association with increased mortality rate due to haze formed by wildfire in 1997.
- A cross-sectional analysis of cardiovascular mortality among people over 65 years old in the Brazilian Amazon, where the predominant source of air pollution is from wildfires, found a significant association between the percentage of hours of PM2.5 over 25 µg/m3 and cardiovascular mortality (Nunes et al., 2013).
- A study of 13.5 years of data including 48 days affected by wildfire smoke in Sydney, Australia, demonstrated a significant increase in mortality associated with smoke-affected days (Johnston et al., 2011). An earlier study of mortality in Sydney, using 8 years of data, found a suggestive increase in mortality associated with wildfire-related PM10 (Morgan et al., 2010).
- A meta-analysis of data from 2003 to 2010 in 10 cities in southern Europe found increases in cardiovascular mortality associated with PM10 that were stronger on smoke-affected days than on non-affected days, but smoke was not significantly associated with respiratory mortality (Faustini et al., 2015).
- In Madrid, mortality, but not specifically respiratory or cardiovascular mortality, was associated with PM10 on days with advection events related to biomass burning (Linares et al., 2015).

The Mortality and Morbidity Due to Haze in Respiratory Diseases Condition

Based on three studies, no significant direct association was noted between mortality caused by respiratory illness in association with haze (Johnston et al., 2011; Morgan et al., 2010 & Faustini et al. 2015). Epidemiological studies have demonstrated the significant associations between wildfire smoke exposure and declines in lung function among non-asthmatic children and increases in physician visits for respiratory problems, respiratory emergency department visits and respiratory hospitalisations. Amongst, the occurrence or exacerbation of asthma, chronic obstructive pulmonary diseases (COPD), upper and lower respiratory infections, pneumonia and bronchitis were studied in association with haze.

In the case of asthma, lung function of the individuals was not affected by haze. However, the frequency of medication especially inhalation therapy had significantly increased. The increase in frequency of medication for asthma is influenced by the duration of exposure and the total content of suspended particles.

The number of the emergency visit and hospitalisation were increased significantly among asthmatic patients during the haze period. For COPD patients, the visit to physician and emergency department; hospitalisation showed a strong association. The number of cases admitted to a hospital, visiting physician and emergency department demonstrating a general increase in respiratory infections, pneumonia and bronchitis cases. Consistent evidence of associations between wildfire smoke exposure and respiratory morbidity in general, and specifically for exacerbations of asthma and COPD. Growing evidence suggests associations with respiratory infections and all-cause mortality.

The Mortality and Morbidity Due to Haze in Cardiovascular Diseases Condition

Results from studies of associations between cardiovascular outcomes and wildfire smoke exposure are inconsistent. Many studies of wildfire smoke exposure have found no associations with grouped cardiovascular disease outcomes, although a few have documented evidence for specific endpoints. Too few studies and too many inconsistencies in findings exist to determine whether wildfire smoke exposure is associated with specific cardiovascular outcomes, despite evidence that exposure to ambient PM is associated with increased risk of cardiovascular morbidity.

Cardiovascular morbidity that is gauged in term of the frequency of physician visit, emergency department visit and hospitalisation showed no significant association. However, when the cardiovascular diseases are confined to a specific disease type, the morbidity seems to vary from disease to disease. Although the number of emergency department visits is not changed, yet a substantial increase in the occurrence of out-of-hospital cardiac arrest and also hospitalisation of acute myocardial infarction was recorded.

Patients with hypertension did not record any changes in physician visit. However, the number of hospitalisation had increased significantly. The number of dispensations of fast-acting nitroglycerin and emergency visit increased in angina patients without affecting the hospitalisation rate. Based on three studies, cardiac arrhythmias did not score any changes in a number of emergency visit or hospitalisation. From five studies, two had indicated a strong correlation of mortality in cardiovascular disease in association with haze (Nunes et al., 2013; Faustini et al., 2015; Johnston et al., 2011). Cardiovascular disease and acute myocardial infarction rates were increased significantly due to haze (Nunes et al., 2013).

The Mortality and Morbidity Due to Haze in Other Diseases Conditions

The increase in hospitalisation was weakly noted in cerebrovascular disease but not in terms of emergency department visits. Lower birth weight is noted during the haze period where a reduction in 9.7g of birthweight was recorded when the expose take place in the second trimester.

Vulnerability of Population towards Haze

Few epidemiological studies have investigated whether specific populations are more susceptible to wildfire smoke exposure than the general population. Susceptibility factors investigated include those related to life stage, pre-existing disease, socioeconomic status, and ethnicity. However, most of the subgroup differences are based on observed changes in the magnitudes of point estimates, not on significance tests. The findings for differential effects by age are inconclusive.

- A study of PM10 exposure in Malaysia from the 1997 South-east Asian wildfires found higher rates of mortality among people 65–74 years old compared to others; a smaller suggestive effect was found among those ≥ 75 years old (Sastry, 2002).
- People ≥ 65 years old had higher rates of respiratory hospitalisations compared to younger adults exposed to biomass burning in the Brazilian Amazon (Ignotti et al., 2010) and wildfire smoke in Australia (Morgan et al., 2010).
- Such older adults were also found to have higher rates of hospitalisation for asthma than their younger counterparts during California wildfires (Delfino et al., 2009), and higher rates of out-of-hospital cardiac arrests and hospitalisations for IHD in Victoria, Australia (Haikerwal et al., 2015).
- Other studies, however, have found higher effects for younger adults than for older adults.
- Wildfire PM-related respiratory admissions during Indonesian wildfires exceeded predictions for 40 to 64 years old but not for those ≥ 65 years old (Mott et al., 2005).
- Similarly, emergency departments visits for COPD, pneumonia and acute bronchitis were more strongly associated with peat fire smoke among people < 65 years old compared to people ≥ 65 in North Carolina (Rappold et al., 2011).
- Although respiratory physician visits were associated with PM10 among people 60–70 years old and among those ≥ 80 in a British Columbia wildfire, younger adults exhibited stronger associations (Henderson et al., 2011).
- Children with asthma did not experience increased respiratory symptoms or medication use during Australian wildfires, whereas adults did (Johnston et al., 2006).
- Similarly, the highest PM-related increase in physician visits for asthma during a wildfire in British Columbia was found for adults (Henderson et al., 2011), as was true for emergency department visits for asthma on

smoke-affected days in Australia (Johnston et al., 2014).

- Asthma hospitalisations among children aged 0–5 years more strongly associated with wildfire PM2.5 exposure than asthma hospitalisations for both older children and adults < 65 years old during a California wildfire; but the highest association was found for people ≥ 65 years (Delfino et al., 2009).
- Few studies have investigated how socio-economic status influences responses to wildfire smoke exposure.
  - Henderson et al. (2011) noted findings of no effect modification by neighbourhood socio-economic status on associations between wildfire smoke exposure and physician visits in British Columbia, Canada, but detailed results were not presented.
  - In contrast, during a North Carolina peat fire, North Carolina counties with lower socio-economic status had higher rates of emergency department visits for asthma and CHF compared to counties with higher SES (Rappold et al., 2012).
  - Similarly, in Indonesia, districts with lower food consumption demonstrated more significant adverse associations between smoke exposure and survival of birth cohorts than those with higher household food consumption (Jayachandran, 2009).
- A recent study found that body mass index modified the association of wildfire smoke exposure on exacerbations of asthma, as measured by the prevalence of physician-dispensed short-acting beta-agonists for children with asthma in southern California (Tse et al., 2015).
- Only one ethnic subgroup has been studied in relation to differential health outcomes associated with wildfire smoke exposure. Indigenous people in Australia experienced higher rates of hospitalisation for respiratory infections (Hanigan et al., 2008) and Ischemic heart disease (IHD) (Johnston et al., 2007) associated with exposure to bushfire smoke than non-indigenous people. This effect may be explaine explained by underlying health status, access to medical services, or other social characteristics in this group (Martin et al., 2013).
- Vulnerable populations (age group, social-economic status) showed an association, but research showed variable findings and inconclusive.

Gaps Related to Impact on Haze on Health

More research is needed to determine whether wildfire smoke exposure is consistently associated with cardiovascular effects, specific causes of mortality, birth outcomes, and mental health outcomes. Research into which populations are most susceptible to health effects from wildfire smoke exposure is also needed to inform public health planning for future wildfires.

Question:
What is your view on the Harvard and Columbia study estimating 90 thousand deaths in Indonesia due to haze?
Answer:
The number is produced by model and calculation. There is of course uncertainty on the accuracy and reliability. It is difficult to associate diseases and deaths during the haze as the nature of medical conditions is too complicated and may not be accurately recorded in epidemiology statistics. The studies he reviewed were reported on acute exposure such as wildfire but not on long-term exposure and long-term health impact. It is difficult to conclude on the long-term exposure, and it is very challenging to study the health impact. There is a need for data and research on the long-term health impact of haze in Malaysia.

Question:
Among the 10 ASEAN countries, why is there no studies on haze?
Answer:
Haze issue has a different degree of priority in different countries.

Impact of Haze on Health in Malaysia
by Professor Dr Mazrura Sahani

According to World Health Organization (WHO) (2016), by reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma. Substantial studies on the health effects of ambient air pollution were published internationally. These studies ranged from mortality, morbidity effects to molecular epidemiology. Both animal and human studies provide evidence for respiratory and cardiovascular effects associated with exposure to ultrafine particulates (UFPs). Observed effects in selected studies include lung function changes, airway inflammation, enhanced allergic responses, vascular thrombogenic effects, altered endothelial function, altered heart rate and heart rate variability, accelerated atherosclerosis, and increased markers of brain inflammation (HEI, 2013). A paper that provides an overview of studies on impact of haze on health in Malaysia shows chronic long-term effects of haze exposures are not well studied or established locally, more need to be done (Sastry, 2000; Afroz et al., 2003).

In 2013, globally, 88% of the world's population lived in areas exceeding the WHO annual Air Quality Guideline of 10 µg/m3 PM2.5. Between 1990- 2013, 20.4% increase in global population-weighted PM2.5 driven by trends in South Asia, Southeast Asia, and China. Concentrations of PM2.5 were higher during the haze period compared to the guideline annotated using the lines. Haze occurred during the SW monsoon.

Haze usually occurs during the south-west monsoon in Malaysia. In this plot, the transport of air mass was demonstrated using Hysplit backward trajectory model. The above simplified illustration of the wind circulation, hotspots, gradient of pressure suggests that the impact of transboundary pollution was predominant during the SW monsoon. The more common health symptoms following high exposure to air pollutants during the haze include throat irritation, coughing, difficulty in breathing, nasal congestion, sore eyes, cold attacks and chest pain (Mohd Shahwahid & Othman, 1999).

During the 1997 haze, Kuala Lumpur General Hospital recorded a substantial increase in cases of upper respiratory tract infections, conjunctivitis, and asthma, with a 2-day delayed effect for asthma incidences. For example, in June there were only 912 cases of asthma recorded in Selangor while in September, more than 5000 cases were recorded (Awang et al., 2000). Brauer and Hisham-Hashim (1998) investigated haze-related illnesses during the 1997 haze period (August – September) and reported significant increase in asthma and acute respiratory infections in Kuala Lumpur hospital.

In Kuching, Sarawak, outpatient visits increased between 2 to 3 times during the peak 1997 haze period while respiratory disease outpatient visits to Kuala Lumpur General Hospital increased from 250 to 800 a day (WHO, 1998).

Psychological Effects of Haze and Pollution
by Professor Dr Hussain Habil

Pollution describes the presence of a diverse and complex mixture of chemicals particulate matter (PM) or biological materials in the ambient air which can cause harm or discomfort to humans or other living organisms. Sources of air pollution can be either natural or manmade.

Gap and challenges

A lot more works are needed to elucidate the health impact to human. Therefore, we should not confine ourselves only on the direct impact of haze but also the indirect impact such as the psychological effects due to haze. It is not being included in the systematic review and consideration during the study on haze. There is a gap in understanding how haze affects psychologically. This is an opportunity for research and it is suggested that more studies need to be conducted to understand the perception of public towards haze incident and its effects psychologically rather than just clinical psychiatric symptoms.

Psychological Effects of the Haze and Pollution

Haze incident affects health, socioeconomic and political stability. Haze may affect self-control and has the potential to cause range of conditions such as insomnia, feelings of anxiety and in some cases depression. Less is known about the psychological effects. A study showed that air pollution can make individuals less engaged at work. According to ego depletion theory, both the direct physiological impact of air pollution and the individual's own perception of its severity act to deplete resources affecting self-control. How individual perceive and understand the impact of haze will affect the emotional impact on individual but will definitely affect the quality of life. Psychological and toxic effects of air pollution can lead to psychiatric symptoms, including anxiety and changes in mood, cognition, and behaviour. Psychological stress can cause symptoms similar to those of organic mental disorder. Different people have different way to cope with haze due to their own perception and acceptance of risk, the impact could be potentially challenging to assess. Reactions to stress depend on cultural, individual, and situational variables and thus it is imperative to understand the factors in order to be able help prevent trauma.

Economic Impact of Haze on Health
by Professor Dr Maznah Dahlui

Gap and challenges

There are only three local studies on health economic impact of haze. It is important for us to scientifically document the trend of haze and healthcare utilisation in Malaysia so that steps can be taken to combat haze as well as to allocate appropriate resources to meet the healthcare demand associated with haze.

Economic Impact of Haze on Health

Financial implication of haze on health could affect health tourism, the use of self-protection devices, and increase cost to healthcare providers and patients including direct medical as well as indirect and intangible cost. Therefore, increase disease burden lead to increase cost, loss of productivity including absence from work and school. Socially, haze could impact limitation and restriction of daily activity (social networking) and disruption of peaceful mind. Four SR/MA concluded that for every increase in PM10-2.5, there is 0.3% to 3.7% increase in hospital admission and outpatient visit rate due to haze-related illnesses. Valuing the damage caused by haze will help policy makers appreciate the scale of the problem as the values can be readily compared with other losses or the merits of alternative resource use.

Assessment on the economic impacts of haze to health starts with measuring the increment of the related diseases. Total incremental COI for Malaysia during 1996 haze incident was estimated at RM9,562,466. For 2006 haze incident, incremental COI for Malaysia was estimated at US$6 million (2.6% from total damage cost or 0.21% of GDP). Estimated total economic losses during haze episode in 2013 were RM1.5 billion (0.48% of 2013 GDP).

2.0
Breakout Session

Methodology

1. Participants were asked to list down known evidence of the impact of haze on health that was not mentioned by the speakers from their own expertise/experience.

2. In deducing the list of strategies (non-policy related) on how different parties (government, industry academia, NGOs, public) or individuals can play a role in reducing the impact of haze on health, the participants were guided with three key elements; Think, Share and Review. They -were asked to brainstorm on what are the possible strategies to mitigate the issue and suggested studies that should be conducted in Malaysia to ensure the impact of haze in Malaysia is conclusive. The participants will then share the strategies among their groupmates and review them together. They were asked to finalise the list and choose three strategies of greatest importance before presented their finding.

Proposed strategies

Followings are proposed strategies gathered during the breakout session.

Governance

i. Increase monitoring interval and implementation process of environmental impact assessment (EIA) in the industries (manipulation of the regulations)
ii. Promote self-compliance Occupational Safety and Health Administration (OSHA) 1994
iii. Strict enforcement on open burning
iv. Develop joint KPI for different departments and ministries to encourage collaboration
v. The hospital or emergency departments should monitor the patients' health complaints during haze, followed by proper documentation
vi. Provide evidence-based advice and advocacy to government and stakeholders

Awareness and Communication

i. Public awareness to prevent source of haze
ii. Awareness of impact on health economics
iii. Awareness on danger of haze and what they should do to take care of their health
iv. Utilise social media to spread information to public
v. Develop effective communication strategy to convey haze related information to the public (e.g. phone alerts)

Infrastructure and Technology

i. One stop centre government agency to consolidate all the data as it involves more than one agency
ii. Big data analytics to ensure robustness and trustworthiness
iii. Provide transparent, accurate and timely information of application programming interfaces (API)
iv. Collection and sharing of relevant data
v. Increase facilities to curb open burning, haze and any activities that contributed to haze problem
vi. Environmental health risk assessment to be carried out

Empowering the Quadruple Helix (Government – Industry – Academia – Public)

i. Dialogue between the quadruple helix on haze or air pollution
ii. Ensure translation from research to action (e.g.: by developing health intervention include psychological aspect and encourage transdisciplinary collaboration of the quadruple helix)
iii. Government incentives for public, industry and contributors in reducing haze
iv. Industry to involve in research or policy through funding or donation (foundation/ trust)

3.0
Panel Discussion

Moderator:
Academician Professor Dato' Dr Khairul Anuar Abdullah FASc

Panellists:
1. Professor Dr Mohamad Hussain Habil
2. Professor Dr Mazrura Sahani
3. Professor Dr Maznah Dahlui

Q1: Did government or policy maker use all the papers to make policy?

A1: MOH is using a lot of evidence in decision making, for example, risk assessment to decide the closure of schools during haze period. MOH collaborates with scientists to collect scientific evidences and information.

A2: Professor Dr Mohamad Hussain Habil highlighted that there was a concern that research info does not go beyond the academic world. He expressed a concern on the use of public funding for research but the finding is not shared with public. Ways needed to disseminate research findings to public.

A3: Professor Dr Maznah Dahlui commented that most of the economic evaluation study conducted is being used in policy formulation. ASM needs to play a role as a platform to bring all stakeholders together to strategise, particularly in communication and dissemination of research findings.

Q2: Do you have equipment to measure PM2.5?

A1: Pn Nur Aziah from the DOE mentioned that DOE just started PM2.5 monitoring and full dataset on PM2.5 will be available in a month (continuous air monitoring). PM10 has been measured.

A2: Professor Dr Mazrura Sahani added that the centre has equipment to sample and measure PM2.5 and PM10. However, they are using manual measurement.

Q3: Is there any studies have been done on biomarkers?

A1: Professor Dr Mazrura Sahani commented that research is mainly conducted on biomarker in biological samples, for example, heavy metals. Other molecular biomarkers are also been conducted to do cytotoxicity and genotoxicity at cellular level.

Q4: What kind of policy needs to be in placed can be used to reduce the health impact of haze?

A1: Professor Dr Maznah Dahlui commented that most strategies given by the participants are related to policy. Economy assessment is needed to have budget to implement the policy and increase public's awareness on this issue.

A2: MOH also emphasised on the need of a firm policy to prevent production of haze, for example, policy that put pressure on the contributor of haze (such as the transboundary haze).

A3: Pn Nur Aziah added that Malaysia already has a clean air action plan. Many efforts have been done to address transboundary haze. Progress has been made at regional level, but it is impossible to prevent transboundary haze. Haze pollution by locals is manageable as it is within the control but the transboundary haze requires a larger platform such as ASEAN to mitigate. For example, Haze free ASEAN by 2020 was implemented. Moreover, the Indonesian government has taken many steps to prevent haze (forest fire) and is committed to solve the issue in 3 years' time.

Q5: How do we actually make policy to reduce haze?

A1: Dr Maizatul from the Kulliyyah of Law, International Islamic University Malaysia (IIUM) commented that the law/policy already in place but the real issue is the implementation. On the transboundary haze issue, Malaysia does not have jurisdiction to act against the Malaysian-owned companies that responsible for open burning practices in Indonesia. Indonesian government needs to take actions against these companies. There are long- and short-term policies related to haze issue. Short-term policy deals with issues such as how to compensate the public affected by haze; while long-term policy deals with preventive measures. Preventive measures need to be in placed only then punishment can be given to the parties committed to air pollution.

Q6: Is there any gaps being identified that we can fill in after listening to the presentations from the five groups?

A1: Professor Dr Maznah Dahlui stressed on the need to enhance the cross-sectoral collaboration and break the silo cultures. She suggested that ASM creates a platform to bring all parties together.

A2: Professor Dr Mazrura Sahani touched the importance of developing the capacity and called for younger generation's participation. ASM needs to take up the challenge to recruit more young scientists in this topic.

Q7: What are the kinds of policies we need to put in for different stakeholders to work together?

A1: MOH felt the need to improve and continuously update data related to haze, where implementation is the focus. But, it is challenging to attract more people to work on this topic. There is a lack of genuine parties such as NGOs and other stakeholders to collaborate with MOH.

A2: Professor Dr Mohamad Hussain Habil said that it is a big issue which involves multiple agencies and ministries. First step is to identify all the stakeholders involved in this topic, only then we can come up with a more conclusive approach on what to do next.

Q8: Can we do a time series study on vulnerable populations from different areas in Malaysia?

A1: Professor Dr Mazrura Sahani answered that Universiti Kebangsaan Malaysia (UKM) currently doing a research in hospital populations in Klang Valley.

Summing Up

There is not enough research or studies to correlate the impact of haze on human health. Hence, in order to monitor and mitigate this issue, it is crucial for Malaysia to do a nationwide study on the impact of haze towards human health. This effort must be carried out by all parties, i.e the quadruple helix to ensure the validity of the data gathered.

References

Adar SD, Filigrana P a, Clements N, Peel JL. Ambient Coarse Particulate Matter and Human Health: A Systematic Review and Meta-Analysis. Curr Environ Heal reports. 2014;1:258–74.

Anaman KA. Urban Householders7 Assessment of the Causes , Responses , and Economic Impact of the Air Pollution Episode in Brunei Darussalam. 2017;18(2):193–205

Atkinson RW, Kang S, Anderson HR, Mills IC, Walton H a. Epidemiological time series studies of PM2.5 and daily mortality and hospital admissions: a systematic review and meta-analysis. Thorax. 2014;69(7):660–5.

Calderón-Garcidueñas, L., Calderón-Garcidueñas, A., Torres-Jardón, R., Avila-

Choudhury HK, Saikia J: Factors influencing farmers' adoption of slash and burn agriculture in North East India. For Policy Econ. 2012, 15: 146-151.

Gadit AAM. Ecology and mental health: time to understand Eco psychiatry. J Pakistan Med Assoc. 2009;59:56–57.

Gao M, Guttikunda SK, Carmichael GR, Wang Y, Liu Z, Stanier CO, et al. Health impacts and economic losses assessment of the 2013 severe haze event in Beijing area. Sci Total Environ. Elsevier B.V.; 2015;511 (January 2013):553–61.

Ho, R. C., Zhang, M. W., Ho, C. S., Pan, F., Lu, Y., & Sharma, V. K. (2014) [3] [4]. Impact of 2013 south Asian haze crisis: study of physical and psychological symptoms and perceived dangerousness of pollution level. BMC Psychiatry, 14, 81. http://doiorg/10.1186/ 1471-244X-14-81
Secretariat ASEAN: Media release: 6th meeting of the conference of the parties to the ASEAN agreement on transboundary. 2010, Jakarta: Association of Southeast Asian

Kochi I, Loomis J, Champ P, Donovan G. Health and economic Impact of wildfires : literature review and impact assessment. In: González-Cabán A, editor. 3rd International Symposium on Fire Economics, Planning, and Policy: Common Problems and Approaches. Colarado, United States of America; 2009. p. 1–14.

Lu F, Xu D, Cheng Y, Dong S, Guo C, Jiang X, et al. Systematic review and meta-analysis of the adverse health effects of ambient PM2.5 and PM10 pollution in the Chinese population. Environ Res. Elsevier; 2015;136:196–204.

Lundberg, A. (1996). Psychiatric aspects of air pollution. Otolaryngology--Head and Neck Surgery, 114(2), 227-231.

MB, Jaafar AB, Abdullah AM, Ismail MB, Hassan MN, Abdullah R, Johan S, Noor H: Air quality in Malaysia: impacts, management issues and future challenges. Respirology. 2000, 5: 183-196. 10.1046/j.1440-1843.2000.00248.

Mohd Shahwahid H.O. The Economic Value of the June 2013 Haze Impacts on
Peninsular Malaysia. Laguna, Philippines; 2016.

Polluted Work: A Self-Control Perspective on Air PollutionR Fehr, KC Yam, W He,
JTJ Chiang, W Wei Academy of Management Proceedings 2015 (1), 11610

Ostermann K, Brauer M. In: Forest fires and regional haze in southeast Asia. Eaton P, editor. New York: Nova Publishers; 2001. Air quality during haze episodes and its impact on health.

Othman J, H.O MS. Cost of Trans-boundary Haze Externalities. J Ekon Malaysia. 1999;33(33):3–19.

Othman J, Sahani M, Mahmud M, Sheikh Ahmad MK. Transboundary smoke haze pollution in Malaysia: Inpatient health impacts and economic valuation. Environ Pollut. Elsevier Ltd; 2014;189:194–201.

Ramírez, J., Kulesza, R. J., & Angiulli, A. D. (2015). Air pollution and your brain: what do you need to know right now. Primary health care research & development, 16(04), 329-345.

Reid, C. E., Brauer, M., Johnston, F. H., Jerrett, M., Balmes, J. R., & Elliott, C. T. (2016). Critical Review of Health Impacts of Wildfire Smoke Exposure. Environ Health Perspect, 124(9), 1334-1343. doi:10.1289/ ehp.1409277

Schiffman SS. Introduction: health and ecological linkages. Environ Int. 2003;29:351. doi: 10.1016/S0160-4120(02)00168-X.

Schweithelm J, Glover D, Jessup T. Indonesia's Fires and Haze : The Cost of Catastrophe. Indonesia's Fire and Haze: the Cost of Catastrophe. 2006. 1-13 p.

Appendix

Programme

9.00 am	Breakfast and Registration
9.30 am	**Welcome Remarks** by Academician Professor Dato' Dr Khairul Anuar Abdullah FASc (Chairman of ASM Medical & Health Sciences Discipline Group)
9.40 am	**Scene Setting: Haze: Overview of Public Health Action, Gaps and Challenges to Protect the Public** by Datuk Dr Lokman Hakim Sulaiman FASc, Deputy Director General of Health (Public Health), Ministry of Health Rapporteur: Dr Abhimanyu (YSN-ASM), Sharmila & Alia (ASM Officers)
10.20am	Tea Break
10.40 am	**Review of the Literature on Haze and Health in Asia-Pacific Region** by Professor Dr Awg Bulgiba Awg Mahmud FASc Deputy Vice Chancellor (Academic and International), UM Rapporteur: Assoc Prof Dr Rajesh (YSN-ASM), Nitia Samuel (ASM Analyst), Hazrul (ASM Officer)
11.00 am	**Impact of Haze on Health in Malaysia** by Professor Dr Mazrura Sahani Faculty of Health Sciences, UKM Rapporteur: Dr Tham Chau Ling (YSN-ASM), Sharmila & Katrina (ASM officers)
11.20 am	**Psychological Impact of Haze** by Professor Dr Mohamad Hussain Habil Head of Psychiatric Medicine,Faculty of Medicine, MAHSA University Rapporteur: Dr Chai Lay Ching (YSN-ASM), Hazrul & Asyraf (ASM Officers)
11.40 am	**Economic Impact of Haze on Health** by Professor Dr Maznah Dahlui Deputy Dean, Faculty of Medicine, University of Malaya Dr Manraj Singh (YSN-ASM), Alia & Katrina (ASM Officers)
12.00 pm	**Breakout Discussion Session** *1-2 Rapporteurs assigned to each group
1.00 pm	Lunch
2.00 pm	**Breakout Group Presentation** *1-2 Rapporteurs assigned to each group
2.30 pm	**Panel Discussion** Moderated by Academician Professor Dato' Dr Khairul Anuar Abdullah FASc Rapporteur: Dr Abhimanyu, Dr Tham Chau Ling, Dr Manraj Singh, Dr Rajesh & Dr Chai Lay Ching Asyraf & Nitia
3.30 pm	Hi Tea / End of Forum

Speakers Profiles

Datuk Dr Lokman Hakim Sulaiman FASc
Deputy Director General of Health (Public Health), Ministry of Health

Professor Dr Awg Bulgiba Awg Mahmud FASc
Deputy Vice Chancellor (Academic and International), Universiti Malaya

Professor Dr Mazrura Sahani
Faculty of Health Sciences, Universiti Kebangsaan Malaysia

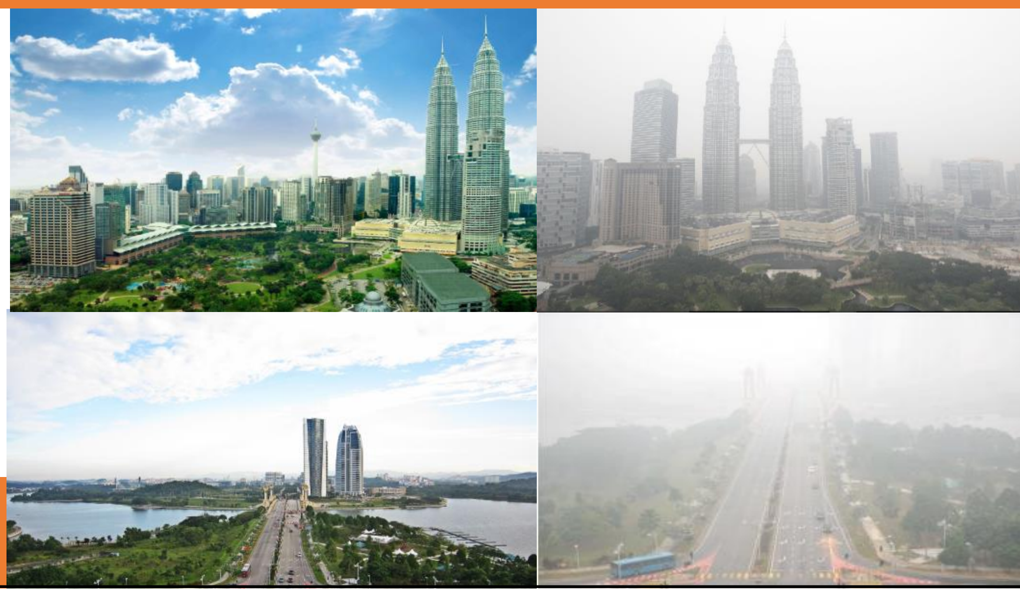
Professor Dr Mohamad Hussain Habil
Head of Psychiatric Medicine, Faculty of Medicine, MAHSA University

Professor Dr Maznah Dahlui
Deputy Dean, Faculty of Medicine, Universiti Malaya

Slide Presentations

HAZE: AN OVERVIEW OF PUBLIC HEALTH ACTION, GAPS AND CHALLENGES TO PROTECT THE PUBLIC

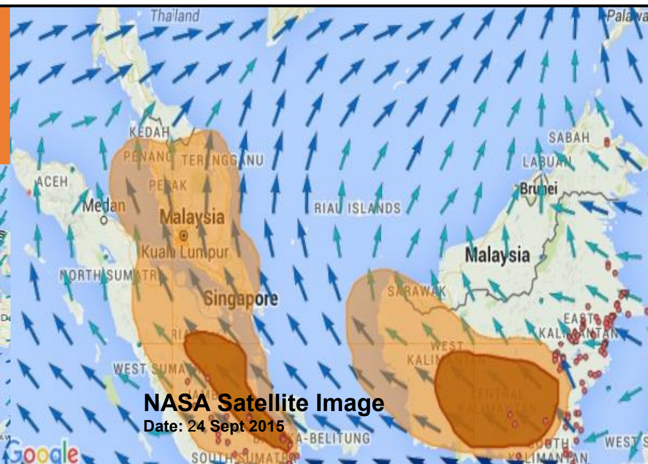
A city with two faces



Outline of presentation

- Introduction
  - Climate in Malaysia
  - History of haze
- Concept of risk on human health
- Major air pollutants during haze
- Health impacts
- MOH's Roles
  - Guiding principles: What do we have?
  - Public advisory
  - Health promotion and education
  - Diseases surveillance
  - Diseases management
- Gaps and challenges

Climate in Malaysia



Haze: Risk on Human Health

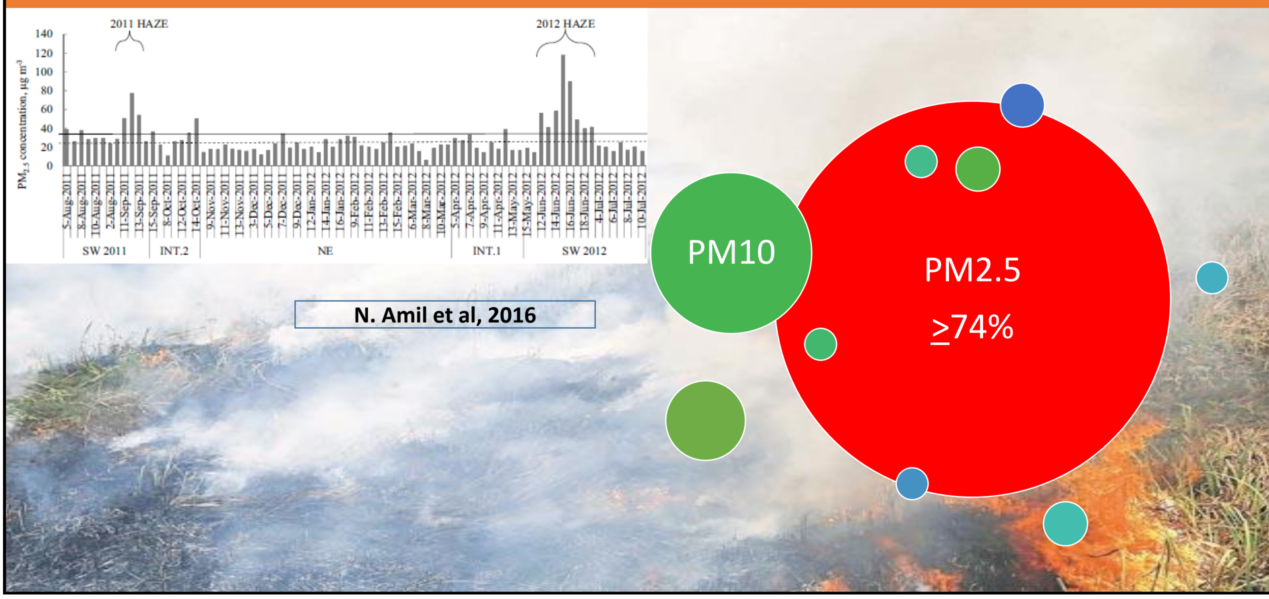
RISK = HAZARD X EXPOSURE

What is inside the haze?

Its toxicity

- **Concentration**
- **Major Pollutants (particle size)**
- **Exposure (Frequency, duration, route)**
- **Personal (Breathing rate)**
- **Protective measures taken by the person**

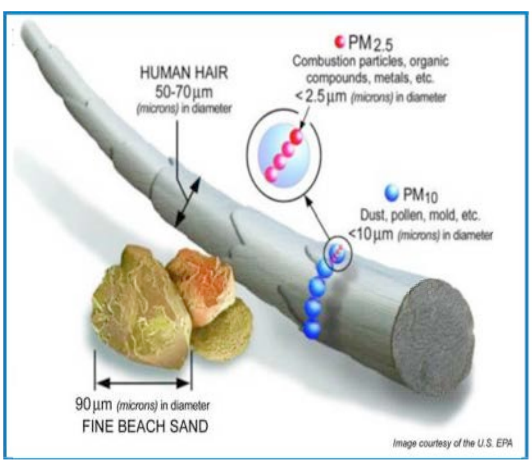
Major air pollutants during haze



Fine particulate matter

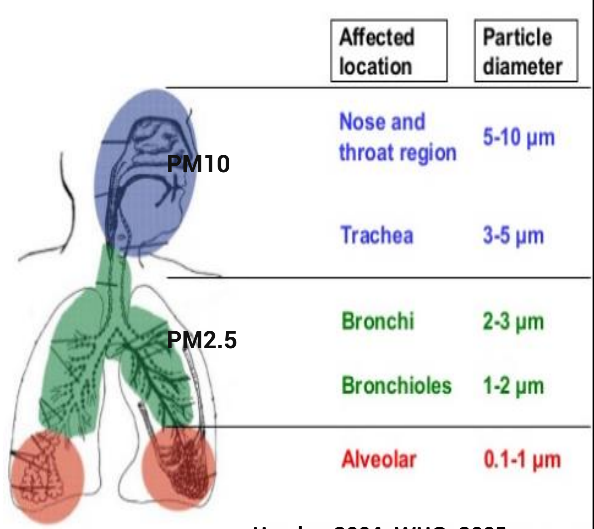
Comparable sizes of coarse to fine scale particulate matter (PM10 to PM2.5, respectively)

- **Fine particles – suspended longer, transported further**



Fine particles – suspended longer, dispersed further

Size-dependent affected location

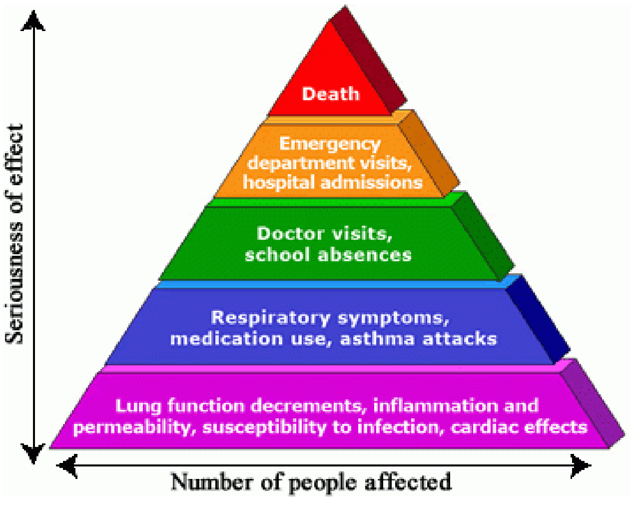


Heyder, 2004; WHO, 2005.

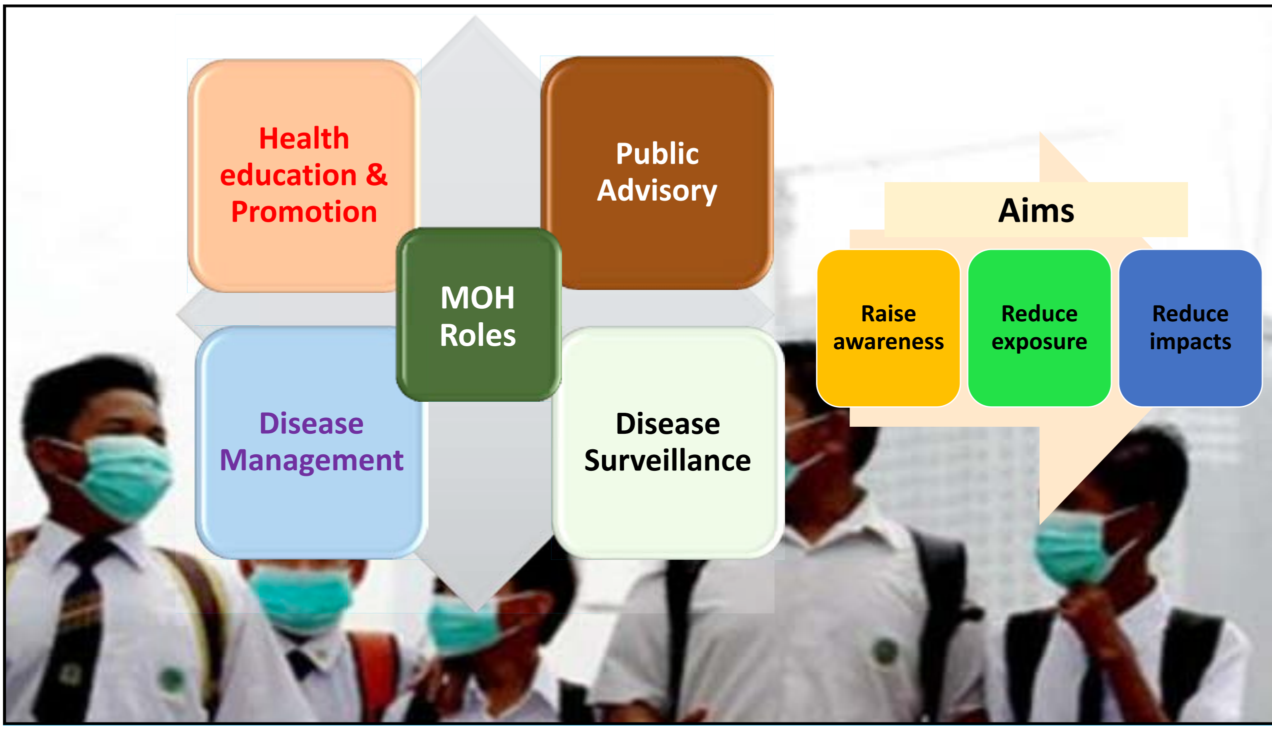
Health impacts

- **Acute effects**
- Irritation – eyes, upper respiratory tract
- Exacerbation of existing chronic health conditions
  - Mainly respiratory diseases (Asthma, COPD)
  - Cardiovascular diseases
- **Long-term effects**
  - There is little studies on the longer-term effects of short-term exposure to haze
  - Existing evidences on long-term effects of particulate matters are derived from studies based on continuous exposure over several years to ambient air quality

Pyramid of Effects

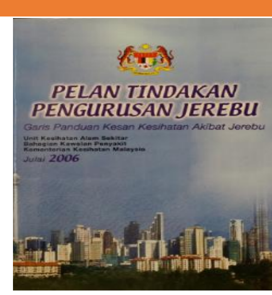


- **Cause: Multifactorial**
- **Cases attributable to haze can only be derived based on scientific epidemiological studies**
- **Surveillance data can only show the pattern / suggest the hypothesis**



Guiding Documents: What do we have?

- <u>Inter-agency Plan</u>
- National Haze Action Plan (Produced by DOE)
  - Spelled out roles of each relevant agency during haze, including MOH



- <u>MOH Plan</u>
- Haze Management Action Plan
  - Spelled out details on technical aspects of:
    - Health advisory
    - Monitoring of diseases
    - Roles of state and district health

Guiding Documents: What do we have?

- **MOH Plan**
- **Disaster and Crisis Management Plan (MOH)**
  - **Spelled out details action to be taken before, during and after any crisis**
    - **Organization / committee for managing crisis**
    - **Command and control**
    - **Resource mobilization**

- **Other documents:**
  - **School children health management guideline**
  - **Health screening of fireman before and after forest fire fighting.**
  - **Methods in improving indoor air quality during haze.**

Progression toward a better response

Revision

NHAP: 1999 → 2002 → 2006 → 2012 → 2013 → 2016/17

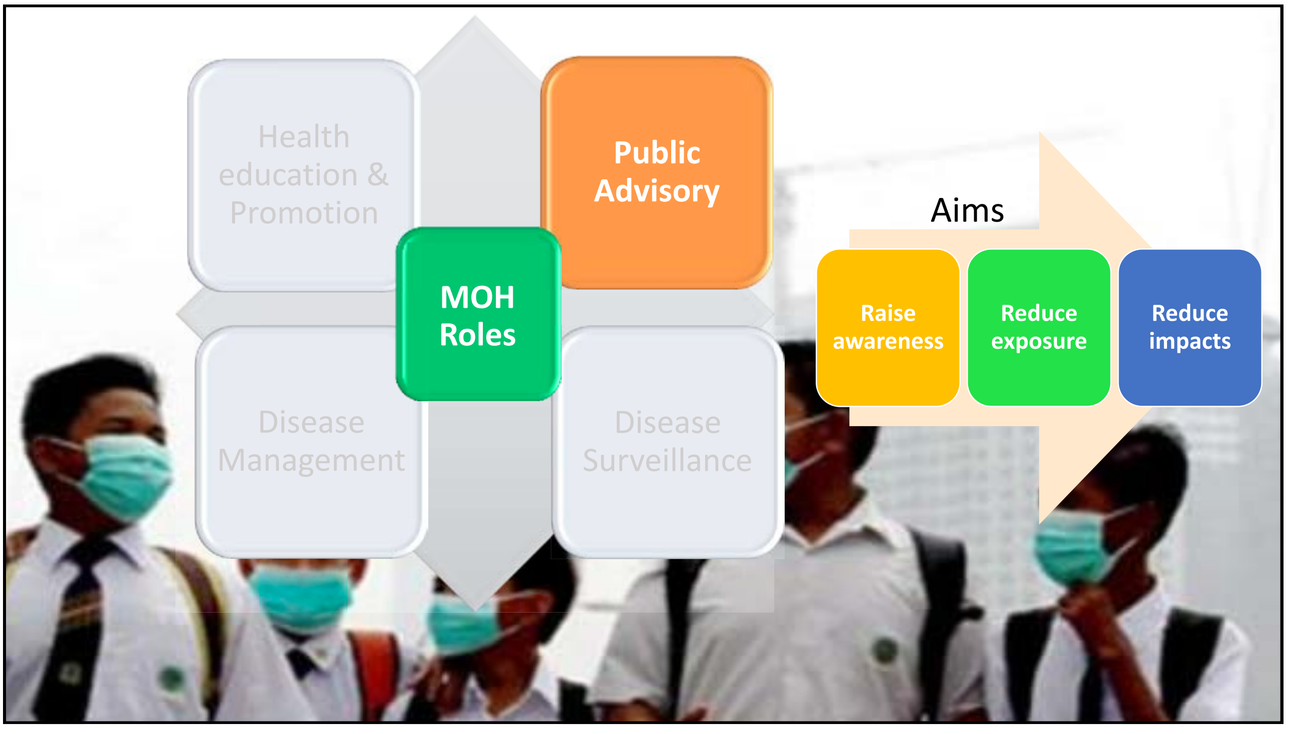
API Level for closing school

API 400

API 300

API 200

Health Action Plan: 2001 → 2006 → 2016/17


Health education & Promotion
Public Advisory
MOH Roles
Disease Management
Disease Surveillance
Aims
Raise awareness
Reduce exposure
Reduce impacts


Most common advisories
Stay indoors
Reduce outdoor physical activity
Wear face mask
More difficult decision
When to close school?
When to cancel public event?
When to stop/cancel sport event?

School Closures

When to close the school, and on what basis?

NHAP Version	API Level for closing school
2006	400
2012	300
2013	200
MOE Instruction (Haze 2015)	150


Haze forces 203 schools to close

BELOW 500 LEVEL: Govt has no plans to declare state of emergency

2014

HRA for closing the school during haze

Information required

- Indoor-outdoor ratio of particulate matter at school environment
- Indoor-outdoor ratio of particulate matter at home environment
- Inhalation rate for children (m3/min)
- Timetable and children activity pattern at school and home
- Scenario of exposure concentration
- Breaking point of PM10 for calculation of API

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PUBLIC HEALTH RESEARCH

Health Risk Assessment of PM_{10} Exposure among School Children and the Proposed API Level for Closing the School during Haze in Malaysia

Norlen Mohamed[1], Lokman Hakim Sulaiman[2], Thahirahtul Asma Zakaria[1], Anis Salwa Kamarudin[1] and Daud Abdul Rahim[1]

Inhaled Dose and Risk Quotient

- **Inhaled Dose**

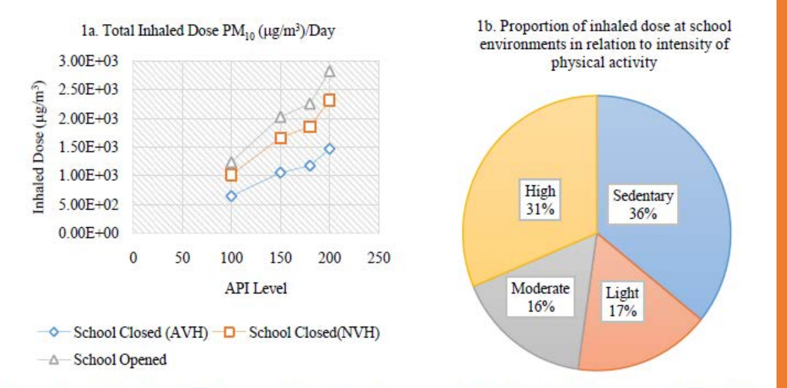
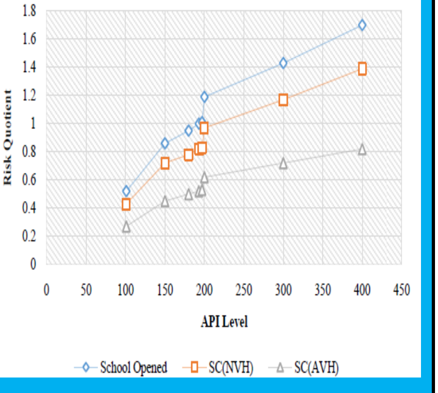


Figure 1 1a. Potential inhaled dose per day by school status (opened or closed), 1b. Proportion of inhaled dose by specific physical activity intensity at school environment

- **Risk**



High intensity Sport Event: e.g Football

Implication if a match is cancelled

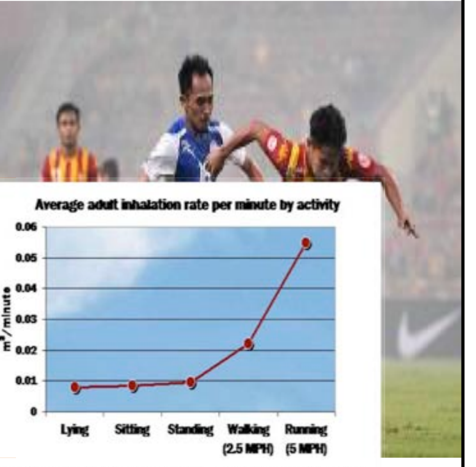
1. **Flight, accommodation for a team has to be cancelled and rearranged**
2. **Very tight schedule**
3. **Ticket sold – Fan outcry**

So, when to cancel a match, & on what basis?

Number of activities performed and the average duration of each activity during match-play

Activity	Number of activities	Mean duration (s)
Standing (0 km·h^{-1})	122	7.8
Walking (4 km·h^{-1})	329	6.7
Jogging (8 km·h^{-1})	253	3.5
Low speed (12 km·h^{-1})	251	3.5
Backward running (12 km·h^{-1})	26	3.6
Moderate speed (16 km·h^{-1})	120	2.5
High speed (21 km·h^{-1})	57	2.1
Sprint (25 km·h^{-1})	19	2.0
Total	1179	4.5

Greig et al, 2011



Derived from US EPA, *Exposure Factors Handbook (External Review Draft) (2009 Update)*, p. 6-55, *available at:* http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=209866.

Risk Matric for strenuous physical activity

- Outdoor game

Inhalation Rate (m3/min) 95 Percentile

Duration of Sport Activity (Min)	API LEVEL 101	105	110	115	120
90	1.23	1.31	1.39	1.47	1.55
60	1.14	1.21	1.29	1.36	1.43
50	1.10	1.17	1.24	1.31	1.38
40	1.06	1.13	1.20	1.27	1.33
30	1.05	1.11	1.18	1.25	1.32
20	1.02	1.08	1.15	1.21	1.28
15	1.00	1.06	1.13	1.19	1.26
10	0.98	1.05	1.11	1.17	1.24
0	0.95	1.01	1.08	1.14	1.20

- Indoor game
  - Air-conditioning

Duration of Sport Activity (Min)	API LEVEL 101	105	110	115	120	125	130
90	1.01	1.07	1.14	1.20	1.27	1.33	1.40
60	0.90	0.96	1.01	1.07	1.13	1.19	1.25
50	0.86	0.92	0.97	1.03	1.08	1.14	1.20
40	0.83	0.88	0.93	0.99	1.04	1.09	1.15
30	0.79	0.84	0.89	0.94	0.99	1.04	1.09
20	0.75	0.80	0.85	0.90	0.95	1.00	1.04
15	0.74	0.78	0.83	0.88	0.92	0.97	1.02
10	0.72	0.76	0.81	0.86	0.90	0.95	0.99
0	0.68	0.72	0.77	0.81	0.86	0.90	0.94

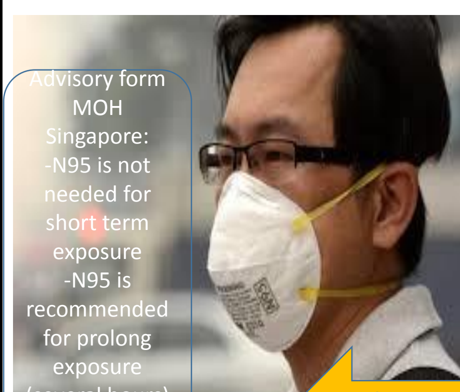
Gaps: for indoor game, lacking of information on pollutant infiltration rate during haze for HRA.
Research is needed in this area

Independent Day 31 August

- **Timing: coincide with Southwest monsoon**
- **Involve various group of people including children**
- **Involve some degree of physical activities**
- **Exposure duration: morning – afternoon**

This vs

This vs This

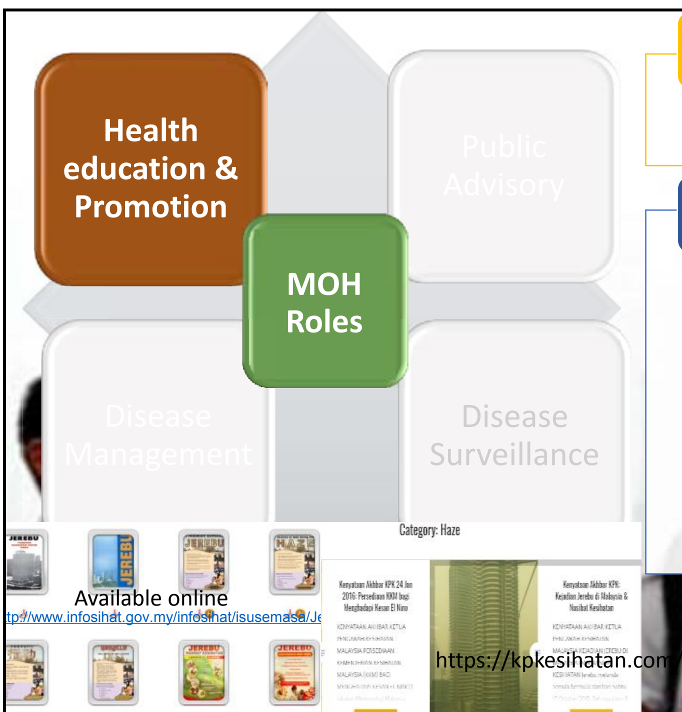


Advisory form MOH Singapore:
-N95 is not needed for short term exposure
-N95 is recommended for prolong exposure (several hours)

In theory, N95 offer better protection from fine particulate matter. Does surgical mask offer some protection? Any evidence from population study?

- **higher price**
- **cause discomfort breathing**
- **Proper fitting to avoid seeping**
- **Less compliance**

- **Lightweight and comfortable**
- **readily available everywhere**
- **very cheap**
- **Most commonly used**
- **It's at least better than not having any mask**

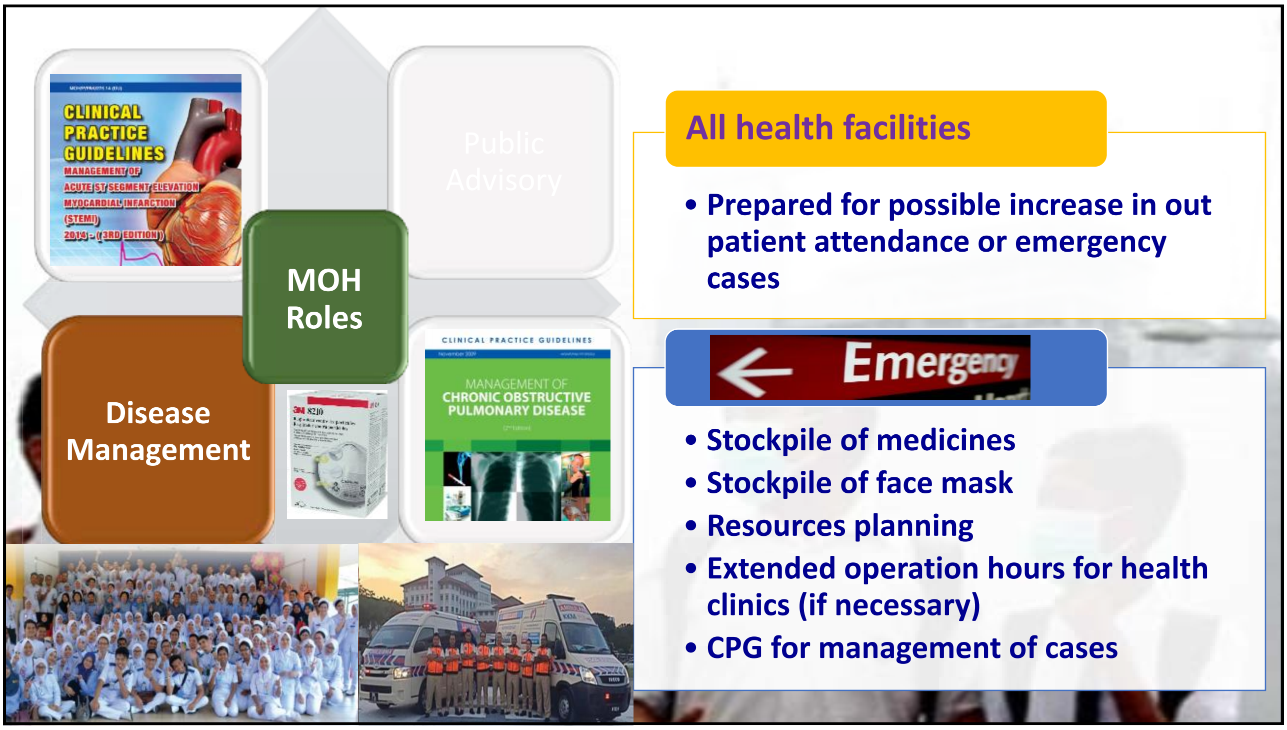


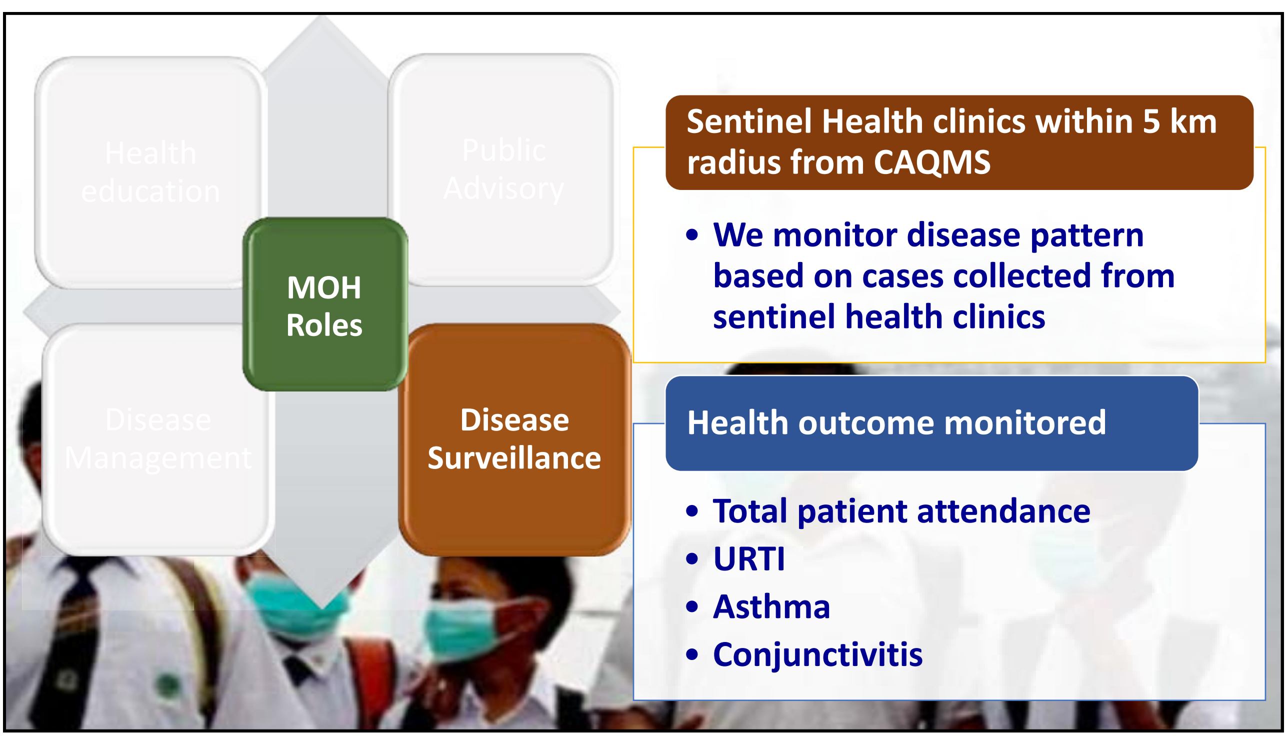
Reaching out the people

- Have to use various means

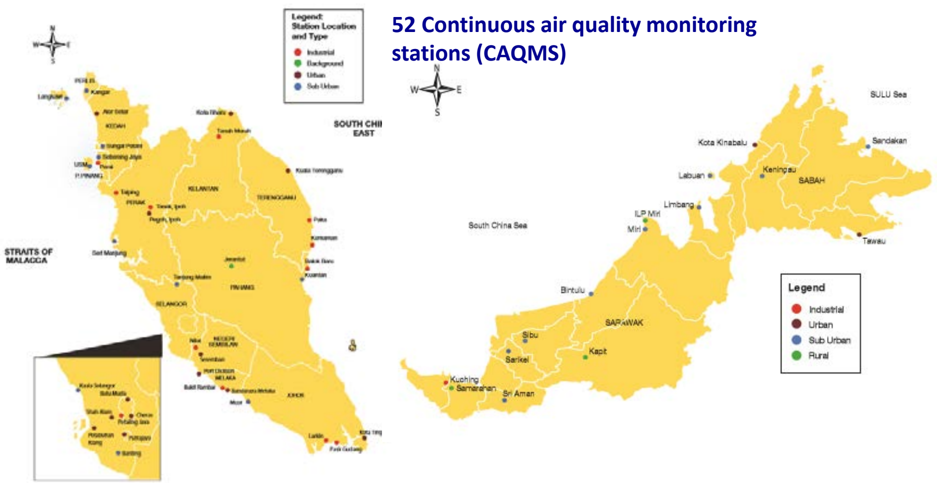
Many ways

- Electronic media
- Media Social
- Website
- Press release
- Health education at clinics/hospital/public event/schools
- Distribution of pamphlets /posters

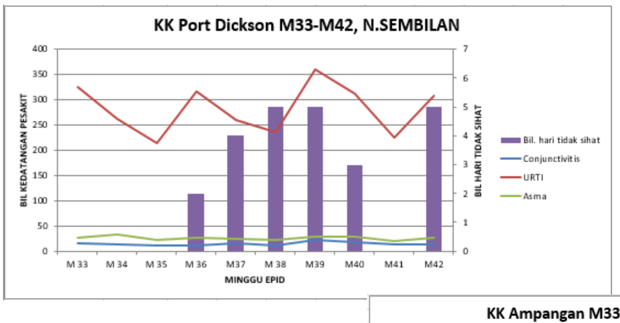

CLINICAL PRACTICE GUIDELINES
MANAGEMENT OF
ACUTE ST SEGMENT ELEVATION MYOCARDIAL INFARCTION (STEMI)
2014 (3RD EDITION)
Public Advisory
MOH Roles
Disease Management
CLINICAL PRACTICE GUIDELINES
MANAGEMENT OF CHRONIC OBSTRUCTIVE PULMONARY DISEASE
All health facilities
• Prepared for possible increase in out patient attendance or emergency cases
Emergency
• Stockpile of medicines
• Stockpile of face mask
• Resources planning
• Extended operation hours for health clinics (if necessary)
• CPG for management of cases

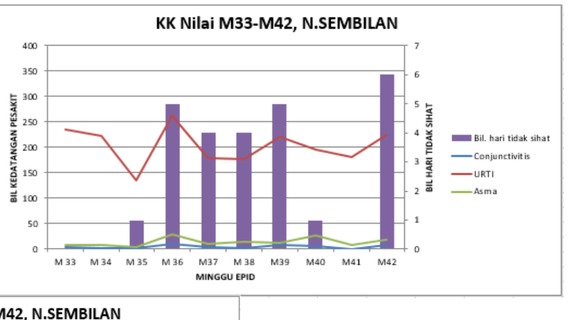

Health education
Public Advisory
MOH Roles
Disease Management
Disease Surveillance
Sentinel Health clinics within 5 km radius from CAQMS
• We monitor disease pattern based on cases collected from sentinel health clinics
Health outcome monitored
• Total patient attendance
• URTI
• Asthma
• Conjunctivitis

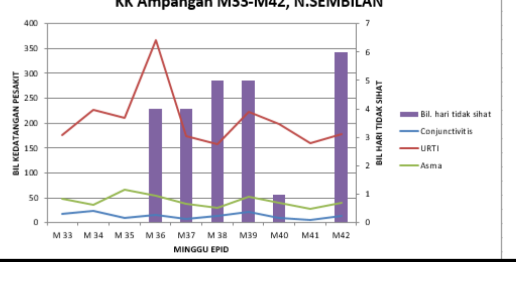
Sentinel health clinics are located within 5 km radius from the CAQMS



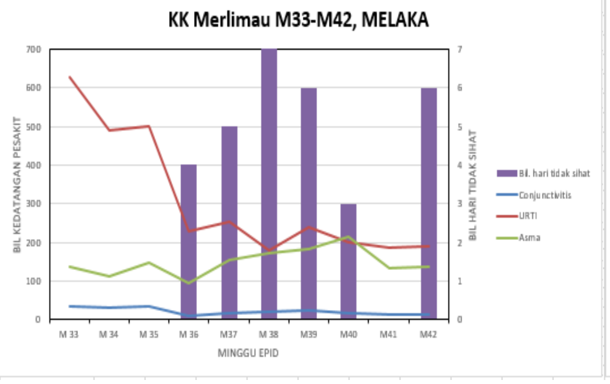
Disease pattern during haze 2015: Negeri Sembilan

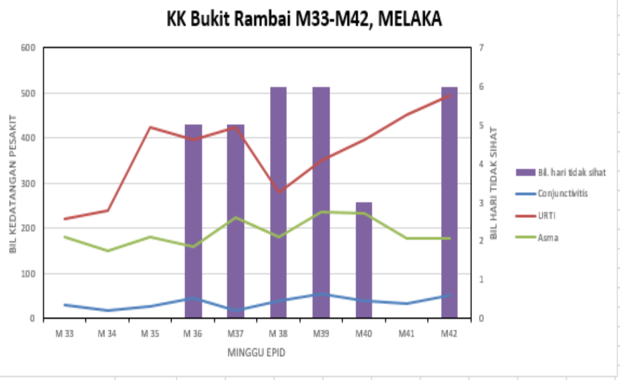




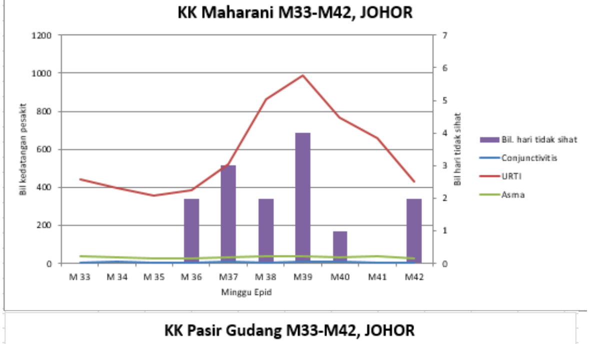


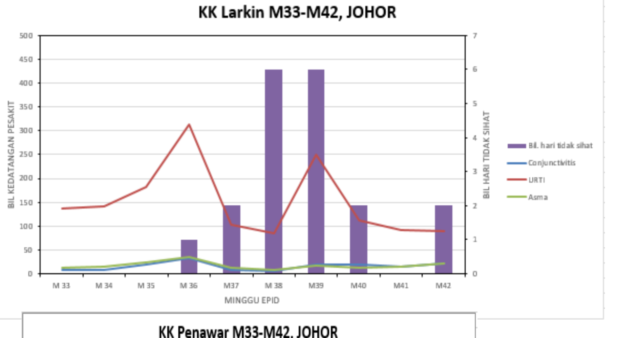
Disease pattern during haze 2015: Melaka

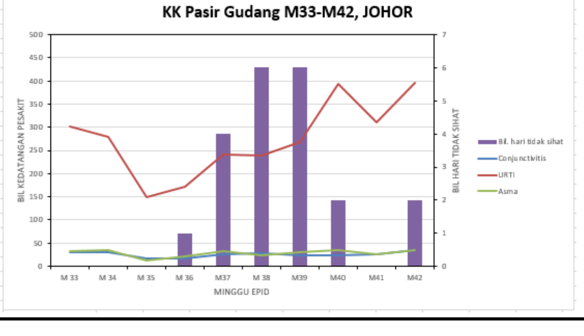


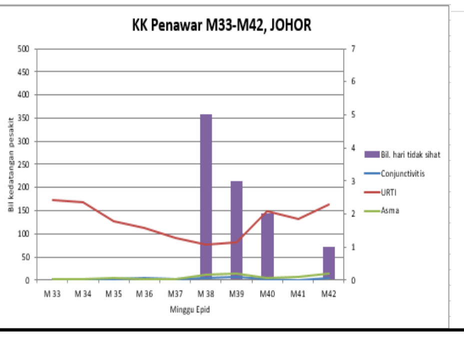


Disease pattern during haze 2015: Johor

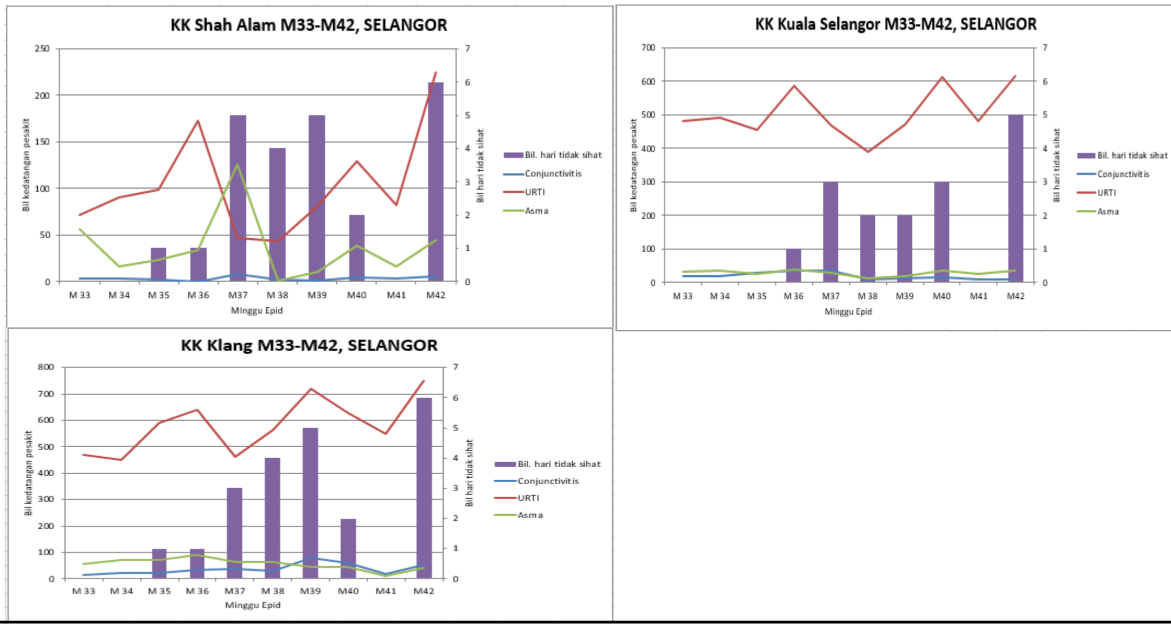


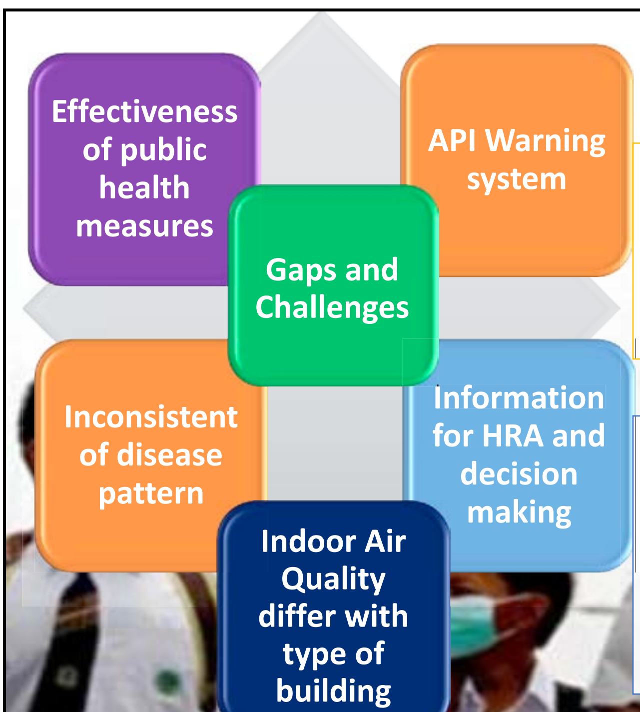






Disease pattern during haze 2015: Selangor





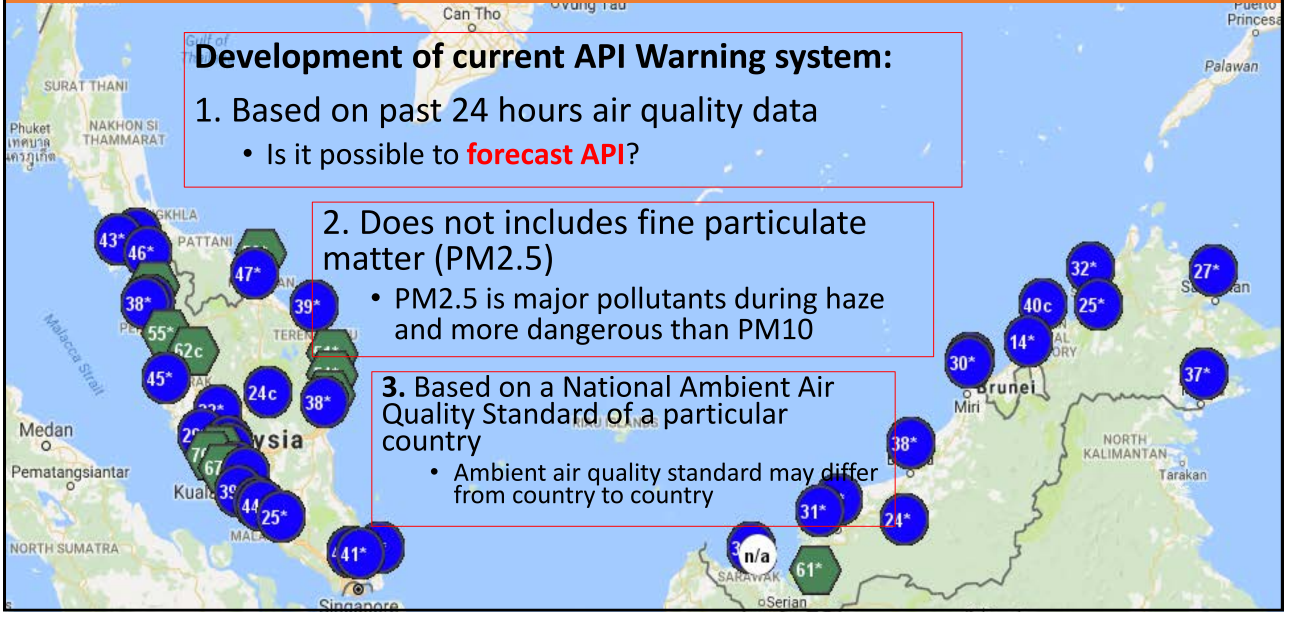
Gaps and challenges to protect public health

- Main issues are related to lack of solid evidence pertaining to each category of gaps

Giving impact on

- Decision making
- Communicating risk

Gaps and Challenges to protect public health



Development of current API Warning system:

1. Based on past 24 hours air quality data
   - Is it possible to **forecast API**?

2. Does not includes fine particulate matter (PM2.5)
   - PM2.5 is major pollutants during haze and more dangerous than PM10

3. Based on a National Ambient Air Quality Standard of a particular country
   - Ambient air quality standard may differ from country to country

GAPS for Effective HRA and Decision Making

- **Main advisory – stay indoor BUT Indoor air quality** for various type of building during haze is not known
- Infiltration rate (indoor-outdoor ratio) of pollutants during haze for
  - natural ventilated building – not known
  - Air conditioning ventilated building – not known

More research is needed in this area

GAPS for Effective HRA and Decision Making: Cancelling of public events

- **<u>Complex nature of exposure</u>**
  - Involve different group of people
  - Different type of activity & and time spent for each activity
  - Involve movement of people from one location to another location

Research is needed for profiling of exposure activity and time spent by public at various public events

GAPS: Disease Surveillance indicates impact on health is not uniform

- **Acute Effects:**
  - Data based on disease surveillance shown **<u>inconsistence pattern by location</u>**. It <u>suggest</u> that the impact on health is <u>not uniform or varies by location</u>.
  - Estimation of impact based on **<u>a localized study is not adequate</u>** to reflect the impact of haze on human health in Malaysia.
  - A **<u>pool estimate</u>** is required.
- **Long-term health effects:**
  - difficult to detect by surveillance system
  - Long term prospective research is required (difficult and costly)

More Research is needed to cover bigger area of affected locations, taking into consideration various source of data

Gaps: measures to improve indoor air quality and protect people during haze

- Intervention to improve indoor air quality (using air filter) by type of building: **lack of evidence**
- Effectiveness of public health measures (for example closing school, cancelling public events etc)
  - This general advise are mainly based on risk assessment and there is **little evidence** from epidemiological studies
- Effectiveness of surgical mask: the use of surgical mask is not without controversy.
  - **Lack of evidence**

Thank You

UNIVERSITY OF MALAYA

5 QS Stars | #=133 QS World University Rankings | #=23 | #151-200 Graduate Employability Ranking | #27 Asian University Rankings

Literature Review On Haze & Health

Prof. Dr Awang Bulgiba Awang Mahmud FASc
Dr Rafdzah Ahmad Zaki DrPH
Dr Nasrin Aghamohammadi PhD
Department of Social & Preventive Medicine, Faculty Of Medicine, University of Malaya.

Methods

Systematic Review

Reid CE, Brauer M, Johnston FH, Jerrett M, Balmes JR, Elliott CT. 2016. Critical review of health impacts of wildfire smoke exposure. Environ Health Perspect 124:1334–1343; http://dx.doi.org/10.1289/ehp.1409277

Search strategy

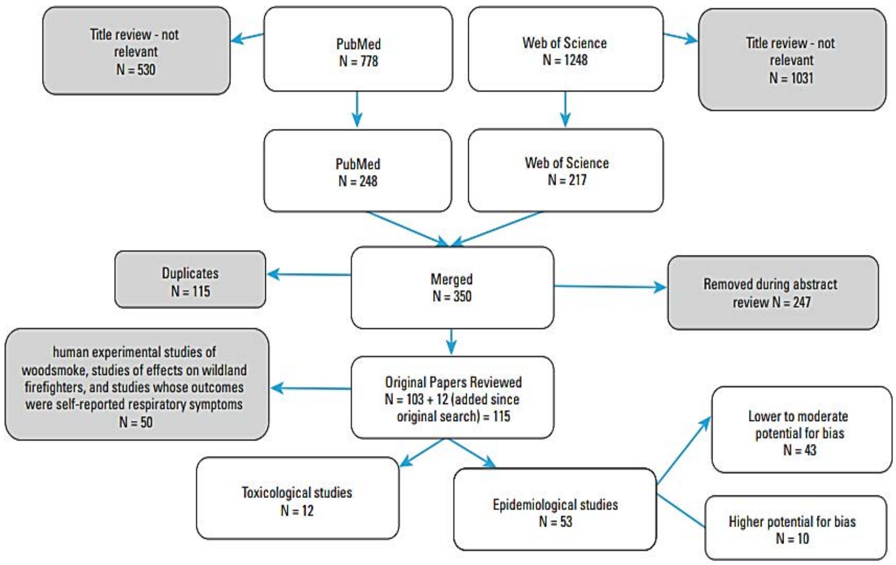
- Database: PubMed, Web of Science, and PsychInfo
- Search term/keywords:

forest fire, wildfire, wildland fire, peat fire, agricultural fire, prescribed fire, agricultural burning, bushfire, landscape fire, or biomass burning

AND

public health, human health, population health, community health, epidemiol*, toxicol*, firefighter or fire fighter, respiratory, lung function, asthma, cardiovascular, ocular, birth outcomes, birth weight, pre-term birth, psychological, mental health, PTSD (post-traumatic stress disorder), physiological, biomarker, cancer, mortality, or chamber

Studies selection flow chart



*PsychInfo did not yield any new peer-reviewed journal articles

Summary of Findings

Mortality

- Growing evidence from the more recent, adequately statistically powered studies demonstrates associations between wildfire smoke exposure and all-cause mortality, but more studies are needed to determine whether specific causes of mortality are most affected.
- A study of the 1997 southeast Asian wildfire found an increase in mortality in Malaysia associated with a measure of visibility and measured PM_{10} (PM ≤ 10 µm in aerodynamic diameter) both linearly and with various discrete levels of PM_{10}(Sastry 2002).
- A cross-sectional analysis of cardiovascular mortality among people older than 65 years in the Brazilian Amazon, where the predominant source of air pollution is from wildfires, found a significant association between the percentage of hours of $PM_{2.5}$ over 25 µg/m^3 and cardiovascular mortality (Nunes et al. 2013).

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Mortality

- A study of 13.5 years of data including 48 days affected by wildfire smoke in Sydney, Australia, demonstrated a significant increase in mortality associated with smoke-affected days (Johnston et al. 2011). An earlier study of mortality in Sydney, using 8 years of data, found a suggestive increase in mortality associated with wildfire-related PM_{10} (Morgan et al. 2010).
- A meta-analysis of data from 2003 to 2010 in 10 cities in southern Europe found increases in cardiovascular mortality associated with PM_{10} that were stronger on smoke-affected days than on non-affected days, but smoke was not significantly associated with respiratory mortality (Faustini et al. 2015).
- In Madrid, mortality, but not specifically respiratory or cardiovascular mortality, was associated with PM_{10} on days with advection events associated with biomass burning (Linares et al. 2015).

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All cause mortality

Article	Exposure assessment type	Direction of association
Sastry 2002	Monitored PM_{10}	↑↑ [table 4: 245µg/m³ (pm10 threshold) – Adj RR: 2.039]
Morgan et al. 2010	Monitored PM_{10}	↑↑ Mortality Bushfire PM_{10} was associated with a small increase in all-cause mortality at lag 0 days (0.80% [CI = -0.24% to 1.86%]), but was not associated with cardiovascular mortality or respiratory mortality. Background PM_{10} was associated with small increases in all-cause mortality and cardiovascular mortality but not with respiratory mortality]
Johnston et al. 2011	Smoky versus non-smoky days	↑↑ [Smoke events were associated with a 5% increase in non-accidental mortality at a lag of 1 day OR (95% confidence interval (CI)) 1.05 (95%CI: 1.00–1.10).]
Faustini et al. 2015 (meta-analysis)	Smoky versus non-smoky days	↑↑ [Smoky days were associated with increased cardiovascular mortality (lag 0–5, 6.29%, 95% CIs 1.00 to 11.85). PM_{10}-related mortality was higher on smoky days (natural mortality up to 1.10% and respiratory mortality up to 3.90%) *results were expressed as the percentage increase in risk (%IR)]
Linares et al. 2015	Monitored PM_{10}	↑↑ [PM_{10} had a greater impact on organic mortality with advection (RR all ages=1.035 [1.011–1.060]; RR≥75 years=1.066 [1.031–1.103]) than did $PM_{2.5}$ without advection (RRall ages=1.017 [1.009–1.025]; RR≥75 years=1.012 [1.003–1.022]).]
Shaposhnikov et al. 2014	Monitored PM_{10}	↑↑

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Respiratory causes of mortality

Article	Exposure assessment type	Direction of association
Johnston et al. 2011	Smoky versus non-smoky days	↔ [OR: 1.09 (0.88 , 1.36)]
Morgan et al. 2010	Monitored PM_{10}	↔ RR per 10 µg/m³ PM_{10}: 1.00 (0.97 , 1.04)
Faustini et al. 2015 (meta-analysis)	Smoky versus non-smoky days	↔ 0.97 (0.90, 1.03)

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Cardiovascular causes of mortality

Article	Exposure assessment type	Direction of association
Nunes et al. 2013	Modelled $PM_{2.5}$ and satellite data	↑↑ [The correlation between annual percentage of hours of $PM_{2.5}$ exposure and cardiovascular disease and acute myocardial infarction mortality rates (33% and 39%, respectively) are statistically significant ($r = 0.33$; $p < 0.001$ and $r = 0.39$; $p < 0.001$).]
Faustini et al. 2015 (meta-analysis)	Smoky versus non-smoky days	↑↑ [PM_{10}-related mortality was higher on smoky days with a suggestion of effect modification for cardiovascular mortality (3.42%, p-value for effect modification 0.055), controlling for Saharan dust advections.]
Johnston et al. 2011	Smoky versus non-smoky days	↑ [cardiovascular mortality OR (95%CI) 1.10 (95%CI: 1.00–1.20).]
Morgan et al. 2010	Monitored PM_{10}	↔
Linares et al. 2015	Monitored PM_{10}	↔

Respiratory Morbidity

- Epidemiological studies have demonstrated significant associations between wildfire smoke exposure and declines in lung function among non-asthmatic children and increases in physician visits for respiratory problems, respiratory emergency department (ED) visits and respiratory hospitalizations.

Respiratory Morbidity

ASTHMA

Lung function among people with asthma	Jacobson et al. 2012	Monitored $PM_{2.5}$	↔
	Jalaludin et al. 2000	Monitored PM_{10}	↔
	Vora et al. 2011	Temporal comparison	↔
	Wiwatanadate and Liwsrisakun 2011	Monitored $PM_{2.5}$ & PM_{10}	↔
Medications	Elliott et al. 2013	$PM_{2.5}$ monitoring, statistical modelling, and satellite information	↑↑ [During the fire season a 10 ug/m3 increase in $PM_{2.5}$ associated with a 6% increase in salbutamol dispensations (RR = 1.06, 95% CI 1.04-1.07) in fire-affected populations]

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Respiratory Morbidity (cont)

ASTHMA

Medications	Yao et al. 2016	Modelled $PM_{2.5}$	↑↑ [A 10 μg/m3 increase in modeled $PM_{2.5}$ associated with increased salbutamol dispensations (RR = 1.04, 95% CI 1.03–1.06), and physician visits for asthma (1.06, 1.04–1.08)]
	Tse et al. 2015	Temporal and spatial comparisons	↑↑
	Vora et al. 2011	Temporal comparison	↑↑ [increase in number of doses from baseline (Average # doses: 0.94 ± 1.3 doses per day) to both during fires (2.6 ± 2.0 doses per day; p = 0.03), and remained elevated post fires (1.6 ± 1.3 doses per day), figure 1]
	Johnston et al. 2006	Monitored $PM_{2.5}$ & PM_{10}	↑↑
	Arbex et al. 2000	Monitored Total Suspended Particles	↑ [Only 4th quartile of sediment (above 17 mg) presented significant association with inhalation therapy, exhibiting a relative risk of 1.20 (1.03–1.39).]

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Visits

ASTHMA	Article	Exposure assessment type	Direction of association
Physician visits	Henderson et al. 2011	Monitored PM_{10}	↑↑ [Odds ratios (ORs) for a 30-µg/m3 increase in TEOM-based PM_{10} were 1.05 [95% confidence interval (CI), 1.03–1.06] for all respiratory physician visits, 1.16 (95% CI, 1.09–1.23) for asthma-specific visits, and 1.15 (95% CI, 1.00–1.29) for respiratory hospital admissions.]
		Modelled PM_{10}	↑↑
		Binary satellite indicator	↑
	Yao et al. 2014 2016	Monitored $PM_{2.5}$	↑↑ [significant effect of measured $PM_{2.5}$ on upper respiratory infections on all fire season days (RR = 1.03; 95% CI = 1.02–1.05), with no similar effect observed with the modelled estimates.]
		Modelled $PM_{2.5}$	↑↑ [Effects of modelled $PM_{2.5}$ were small but marginally significant on the most extreme fire days (RR = 1.01; 95% CI = 1.00–1.02) for all 89 LHAs.]

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ASTHMA	Article	Exposure assessment type	Direction of association
ED visits	Johnston et al. 2002	Monitored PM_{10}	↑↑ [Strongest effect seen on days when PM_{10} >40 g/m3 (adjusted rate ratio, 2.39; 95% CI, 1.46–3.90), compared with days when PM_{10} levels <10 g/m]
	Rappold et al. 2011	Temporal and spatial comparisons	↑↑ [In exposed counties, significant increases in cumulative RR for asthma [1.65 (95% confidence interval, 1.25–2.1)], COPD [1.73 (1.06–2.83)], and pneumonia and acute bronchitis [1.59 (1.07–2.34)] were observed. ED visits associated with cardiopulmonary symptoms [1.23 (1.06–1.43)] and heart failure [1.37 (1.01–1.85)] also significantly increased.]
	Duclos et al. 1990	Temporal comparison	↑↑
	Johnston et al. 2014	Smoky versus non-smoky days	↑↑
	Smith et al. 1996	Temporal comparison	↑ [0.0067 (95% CI : -0.0007, 0.0141]
	Tse et al. 2015	Temporal and spatial comparisons	↔

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ASTHMA	Article	Exposure assessment type	Direction of association
Hospitalizations	Morgan et al. 2010	Monitored PM_{10}	↑↑ [A 10 g/m3 increase in bushfire PM_{10} associated with a 1.24% (95% confidence interval 0.22% to 2.27%) increase in all respiratory disease admissions (at lag 0), a 3.80% (1.40% to 6.26%) increase in chronic obstructive pulmonary disease admissions (at lag 2), and a 5.02% (1.77% to 8.37%) increase in adult asthma admissions (at lag 0).]
	Delfino et al. 2009	$PM_{2.5}$ monitoring, statistical modelling, and satellite information	↑↑
	Arbex et al. 2007	Total Suspended Particles monitoring	↑↑ [A 10 mg/m3 increase in the 5-day moving average (lag 1–5) of TSP concentrations was associated with an increase of 11.6% (95% CI 5.4 to 17.7) in asthma hospital admissions.]

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ASTHMA	Article	Exposure assessment type	Direction of association
Hospitalizations	Martin et al. 2013	Smoky versus non-smoky days	↑↑ [In Sydney, events associated with a 6% (OR=1.06, 95%CI=1.02-1.09) same day increase in respiratory hospital admissions. Same day chronic obstructive pulmonary disease admissions increased 13% (OR=1.13, 95%CI=1.05-1.22) and asthma admissions by 12% (OR=1.12, 95%CI=1.05-1.19).]
	Johnston et al. 2007	Monitored PM_{10}	↑ [Positive relationship between PM10 & admissions for all respiratory conditions (OR 1.08, 95%CI 0.98–1.18) with a larger magnitude in the Indigenous subpopulation (OR1.17, 95% CI 0.98–1.40).]
	Tse et al. 2015	Temporal and spatial comparisons	↔ [No observed increase in emergency department and/or hospitalization rates, oral corticosteroid dispensing frequency, or new asthma diagnoses after either wildfire.]

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a. Asthma and COPD combined. **Respiratory Morbidity**

COPD	Article	Exposure assessment type	Direction of association
Physician visits	Yao et al. 2016	Monitored $PM_{2.5}$	↑↑
		Modelled $PM_{2.5}$	↑↑ [A 10µg/m^3 increase in modelled $PM_{2.5}$ associated with increased COPD (1.02, 1.00–1.03),]
ED visits	Rappold et al. 2011	Temporal and spatial comparisons	↑↑ [In exposed counties, significant increases in cumulative RR for COPD [1.73 (1.06–2.83)],]
	Duclos et al. 1990	Temporal comparison	↑↑
	Johnston et al. 2014	Smoky versus non-smoky days	↑↑ [The 46 validated fire smoke event days during the study period associated with same day increases in COPD (OR 1.12; 95% CI 1.02, 1.24).]

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a. Asthma and COPD combined. **Respiratory Morbidity**

COPD	Article	Exposure assessment type	Direction of association
Hospitalizations	Morgan et al. 2010	Monitored PM_{10}	↑↑ [A 10 g/m3 increase in bushfire PM_{10} associated with ↑ in COPD admissions (at lag 2),]
	Johnston et al. 2007	Monitored PM_{10}	↑↑ [Greatest for COPD (OR1.21, 95%CI 1.0 – 1.47), asthma (OR1.14, 95%CI 0.90 – 1.44) and asthma and COPD combined (OR 1.19, 95%CI 1.03 – 1.38). Effect sizes greater in Indigenous people, esp for COPD admission - odds of admission doubled with each rise of 10 µg/m3 in ambient PM_{10} (OR 1.98 95%CI 1.10–3.59).]
	Delfino et al. 2009	$PM_{2.5}$ monitoring, statistical modelling, and satellite information	↑↑
	Martin et al. 2013	Smoky versus non-smoky days	↑↑ [Same day COPD admissions increased 13% (OR=1.13, 95%CI=1.05-1.22)]
	Mott et al. 2005	Temporal comparison	↑↑

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b. Upper respiratory infections.
c. Lower respiratory infections.
d. Upper respiratory infections and acute bronchitis combined.

RESPIRATORY INFECTIONS	Article	Exposure assessment type	Direction of association
Physician visits	Yao et al. 2016	Monitored $PM_{2.5}$ b	↑↑ [(RR = 1.03; 95% CI = 1.02–1.05)] with no similar effect observed with the modelled estimates.
		Modelled $PM_{2.5}$ b	↔
		Monitored $PM_{2.5}$ c	↑↑
		Modelled $PM_{2.5}$ c	↑↑
	Henderson et al. 2011	Monitored PM_{10} d	↔
ED visits	Duclos et al. 1990	Temporal comparison	↑↑
	Rappold et al. 2011	Temporal and spatial comparisons	↑ [ED visits for all the respiratory diagnoses elevated in exposed counties [cRR = 1.66; 95% confidence interval (CI), 1.38–1.99] but not in the referent counties [1.06 (0.89–1.25)].]
Hospitalizations	Johnston et al. 2007	Monitored PM_{10}	↔

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PNEUMONIA AND BRONCHITIS	Article	Exposure assessment type	Direction of association
ED visits	Rappold et al. 2011	Temporal and spatial comparisons	↑↑ [ED visits for pneumonia and acute bronchitis [1.59 (1.07–2.34)] increased significantly.]
	Johnston et al. 2014	Smoky versus non-smoky days	↔
Hospitalizations	Delfino et al. 2009	$PM_{2.5}$ monitoring, statistical modelling, and satellite information	↑↑ [Per 10 μg/m3 wildfire-related $PM_{2.5}$, acute bronchitis admissions across all ages increased by 9.6% (95% CI 1.8% to 17.9%), pneumonia admissions for ages 5–18 years by 6.4% (95% CI 21.0% to 14.2%).
	Morgan et al. 2010	Monitored PM_{10}	↑↑ [Bushfire PM_{10} associated with moderate increase in elderly pneumonia & acute bronchitis admissions at lag 1 day (2.81 0.19 to 5.50, but the pattern of lag effects was erratic and the association not reflected in bushfire back scatter particles.]
	Martin et al. 2013	Smoky versus non-smoky days	↑ [In smaller cities, trend towards a lagged association with pneumonia and bronchitis, which was statistically significant in Newcastle (Figure 2).]

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Cardiovascular Morbidity

- Results from studies of associations between cardiovascular outcomes and wildfire smoke exposure are inconsistent. Many studies of wildfire smoke exposure have found no associations with grouped cardiovascular disease outcomes, although a few have documented evidence for specific end points.
- Too few studies and too many inconsistencies in findings exist to determine whether wildfire smoke exposure is associated with specific cardiovascular outcomes, despite evidence that exposure to ambient PM is associated with increased risk of cardiovascular morbidity

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Cardiovascular Morbidity

OVERALL CARDIOVASCULAR MORBIDITY	Article	Exposure assessment type	Direction of association
Physician visits	Henderson et al. 2011	Monitored PM_{10}	↔
		Modelled PM_{10}	↔
		Binary satellite indicator	↔
	Moore et al. 2006	Temporal comparison	↔
	Lee et al. 2009	Monitored PM_{10}	↔
	Yao et al. 2016	Monitored $PM_{2.5}$	↓↓
		Modelled $PM_{2.5}$	↔
ED visits	Rappold et al. 2011	Temporal and spatial comparisons	↔
	Johnston et al. 2014	Smoky versus non-smoky days	↔

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OVERALL CARDIOVASCULAR MORBIDITY	Article	Exposure assessment type	Direction of association
Hospitalizations	Morgan et al. 2010	Monitored PM_{10}	↔
	Hanigan et al. 2008	PM_{10} estimated from visibility data	↔
	Henderson et al. 2011	Monitored PM_{10}	↔
		Modelled PM_{10}	↔
		Binary satellite indicator	↔
	Johnston et al. 2007	Monitored PM_{10}	↔
	Martin et al. 2013	Smoky versus non-smoky days	↔

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CARDIAC ARREST	Article	Exposure assessment type	Direction of association
Out-of-hospital cardiac arrest	Dennekamp et al. 2015	$PM_{2.5}$ monitoring	↑↑ [Among men during fire season, greater increases in OHCA observed with IQR increases in the 48-hr lagged PM with diameter ≤ 2.5 µm ($PM_{2.5}$) (8.05%; 95% CI: 2.30, 14.13%; IQR = 6.1 µg/m3)]
	Haikerwal et al. 2015	Modelled $PM_{2.5}$	↑↑ [Adjusting for temperature and relative humidity, increase in IQR of 9.04 lg/m3 in $PM_{2.5}$ over 2 days moving average (lag 0-1) was associated with a 6.98% (95% CI 1.03% to 13.29%) increase in risk of OHCA, with strong association shown by men (9.05%,95%CI 1.63% to 17.02%) and by older adults (aged ≥65 years) (7.25%, 95% CI 0.24% to 14.75%).]
ED visits	Johnston et al. 2014	Smoky versus non-smoky days	↔
ACUTE MI			
ED visits	Haikerwal et al. 2015	Modelled $PM_{2.5}$	↔
Hospitalizations	Haikerwal et al. 2015	Modelled $PM_{2.5}$	↑↑ [Lag 2, Percentage Change % (95% CI = 2.34 (0.06 to 4.67)]

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HYPERTENSION	Article	Exposure assessment type	Direction of association
Physician visits	Henderson et al. 2011	Monitored PM_{10}	↔
Hospitalizations	Arbex et al. 2010	Monitored Total Suspended Particles	↑↑ [A 10 mg/m3 increase in the TSP 3 day moving average lagged in 1 day led to an increase in hypertension-related hospital admissions during the harvest period (12.5%, 95% CI 5.6% to 19.9%) that was almost 30% higher than during non-harvest periods (9.0%, 95% CI 4.0% to 14.3%).]
CARDIAC ARRHYTHMIAS			
ED visits	Johnston et al. 2014	Smoky versus non-smoky days	↔
Hospitalizations	Delfino et al. 2009	$PM_{2.5}$ monitoring, statistical modelling, and satellite information	↔
	Martin et al. 2013	Smoky versus non-smoky days	↔

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CEREBROVASCULAR DISEASE	Article	Exposure assessment type	Direction of association
ED visits	Johnston et al. 2014	Smoky versus non-smoky days	↔
Hospitalizations	Delfino et al. 2009	$PM_{2.5}$ monitoring, statistical modelling, and satellite information	↑
	Morgan et al. 2010	Monitored PM_{10}	↔
ANGINA			
Dispensations of fast-acting nitroglycerin	Yao et al. 2016	Monitored $PM_{2.5}$	↑↑ [A 10 μg/m3 increase was associated with a 3% increase (RR = 1.03; 95% CI = 1.01–1.05) in the meta-regression estimate for nitroglycerin dispensations across all 89 LHAs (Figure 2).]
ED visits	Haikerwal et al. 2015	Modelled $PM_{2.5}$	↑ [Lag 2 = 1.71 (-0.74 to 4.23) @ table 3]
Hospitalizations	Haikerwal et al. 2015	Modelled $PM_{2.5}$	↔

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Other Morbidity

BIRTH OUTCOME	Article	Exposure assessment type	Direction of association
Birth weight	Holstius et al. 2012	Temporal comparison	↓↓ [mean birth weight estimated to be 7.0 g lower [95% confidence interval (CI): –11.8, –2.2] when wildfire occurred during 3rd trimester, 9.7 g lower when it occurred during 2nd trimester (95% CI: –14.5, –4.8), and 3.3 g lower when it occurred during 1st trimester (95% CI: –7.2, 0.6).]
Proportion of cohort surviving	Jayachandran 2009	Satellite data	↓↓
Low birth weight	Cândido da Silva et al. 2014	Monitored $PM_{2.5}$	↑↑ [Association between exposure to air pollutants and risk of LBW significant for 4th quartile of $PM_{2.5}$ concentrations in 2nd trimester (OR = 1.51, 95% CI = 1.04 to 2.17)]
MENTAL HEALTH			
Physician visits	Moore et al. 2006	Temporal comparison	↔
Hospitalizations	Duclos et al. 1990	Temporal comparison	↔

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- Consistent evidence of associations between wildfire smoke exposure and respiratory morbidity in general, and specifically for exacerbations of asthma and COPD.
- Growing evidence suggests associations with respiratory infections and all-cause mortality.
- More research is needed to determine whether wildfire smoke exposure is consistently associated with cardiovascular effects, specific causes of mortality, birth outcomes, and mental health outcomes.
- Research into which populations are most susceptible to health effects from wildfire smoke exposure is also needed to inform public health planning for future wildfires.

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Vulnerable Populations

Vulnerable Populations

- Few epidemiological studies have investigated whether specific populations are more susceptible to wildfire smoke exposure than the general population.
- Susceptibility factors investigated include those related to life stage, pre-existing disease, socioeconomic status (SES), and ethnicity. However, most of subgroup differences are based on observed changes in the magnitudes of point estimates, not on significance tests.

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Vulnerable Populations: age group

- The findings for differential effects by age are inconclusive.
- A study of PM_{10} exposure in Malaysia from the 1997 Southeast Asian wildfires found higher rates of mortality among people 65–74 years old compared to others; a smaller suggestive effect was found among those ≥ 75 years old (Sastry 2002).
- People ≥ 65 years old had higher rates of respiratory hospitalizations compared to younger adults exposed to biomass burning in the Brazilian Amazon (Ignotti et al. 2010) and wildfire smoke in Australia (Morgan et al. 2010).
- Such older adults were also found to have higher rates of hospitalization for asthma than their younger counterparts during California wildfires (Delfino et al. 2009), and higher rates of out-of-hospital cardiac arrests and hospitalizations for IHD in Victoria, Australia (Haikerwal et al. 2015).

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Vulnerable Populations: age groups

- Other studies, however, have found higher effects for younger adults than for older adults.
- Wildfire PM-related respiratory admissions during Indonesian wildfires exceeded predictions for 40- to 64-year-olds but not for those ≥ 65 years (Mott et al. 2005).
- Similarly, ED visits for COPD, and pneumonia and acute bronchitis were more strongly associated with peat fire smoke among people < 65 years old compared to people ≥ 65 in North Carolina (Rappold et al. 2011).
- Although respiratory physician visits were associated with PM_{10} among people 60–70 years old and among those ≥ 80 in a British Columbia wildfire, younger adults exhibited stronger associations (Henderson et al. 2011).

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Vulnerable Populations: age groups

- Children with asthma did not experience increased respiratory symptoms or medication use during Australian wildfires, whereas adults did (Johnston et al. 2006).
- Similarly, highest PM-related increase in physician visits for asthma during a wildfire in British Columbia was found for adults (Henderson et al. 2011), as was true for ED visits for asthma on smoke-affected days in Australia (Johnston et al. 2014).
- Asthma hospitalizations among children ages 0–5 years more strongly associated with wildfire $PM_{2.5}$ exposure than asthma hospitalizations for both older children and adults < 65 years old during a California wildfire; but greatest association was found for people ≥ 65 years (Delfino et al. 2009).

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Vulnerable Populations: SES

- Few studies have investigated how socio-economic status (SES) influences responses to wildfire smoke exposure.
- Henderson et al. (2011) noted findings of no effect modification by neighborhood SES on associations between wildfire smoke exposure and physician visits in British Columbia, Canada, but detailed results were not presented.
- In contrast, during a North Carolina peat fire, North Carolina counties with lower SES had higher rates of ED visits for asthma and CHF compared to counties with higher SES (Rappold et al. 2012).
- Similarly, in Indonesia, districts with lower food consumption demonstrated larger adverse associations between smoke exposure and survival of birth cohorts than those with higher household food consumption (Jayachandran 2009).

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Vulnerable Populations: others

- A recent study found that body mass index modified the association of wildfire smoke exposure on exacerbations of asthma, as measured by prevalence of physician-dispensed short-acting beta-agonists for children with asthma in southern California (Tse et al. 2015).
- Only one ethnic subgroup has been studied in relation to differential health outcomes associated with wildfire smoke exposure. Indigenous people in Australia experienced higher rates of hospitalization for respiratory infections (Hanigan et al. 2008), and IHD (Johnston et al. 2007) associated with exposure to bushfire smoke than non-indigenous people. This effect may be explained by underlying health status, access to medical services, or other social characteristics in this group (Martin et al. 2013).

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UNIVERSITI KEBANGSAAN MALAYSIA
The National University of Malaysia

Impact of Haze on Health in Malaysia

Dr Mazrura Sahani
Faculty of Health Sciences, UKM
15th April 2017

Forum on the Impact of Haze on Human Health in Malaysia

MySEE MALAYSIAN SOCIETY FOR ENVIRONMENTAL EPIDEMIOLOGY

UNIVERSITI KEBANGSAAN MALAYSIA National University of Malaysia

Introduction

- Air pollution is a major environmental risk to health affecting both developed and developing countries alike.
- By reducing air pollution levels, countries can reduce the burden of disease from stroke, heart disease, lung cancer, and both chronic and acute respiratory diseases, including asthma (WHO, 2016).
- Substantial studies on the health effects of ambient air pollution were published internationally. These studies ranged from mortality, morbidity effects to molecular epidemiology.
- Both animal and human studies provide evidence for respiratory and cardiovascular effects associated with exposure to Ultrafine particulates (UFPs). Observed effects in selected studies include lung function changes, airway inflammation, enhanced allergic responses, vascular thrombogenic effects, altered endothelial function, altered heart rate and heart rate variability, accelerated atherosclerosis, and increased markers of brain inflammation (HEI, 2013) .
- Chronic long-term effects of haze exposures are not well studied or established locally, more need to be done (Sastry 2000; Afroz *et al*. 2003).
- This paper provides an overview of studies on impact of haze on health in Malaysia.

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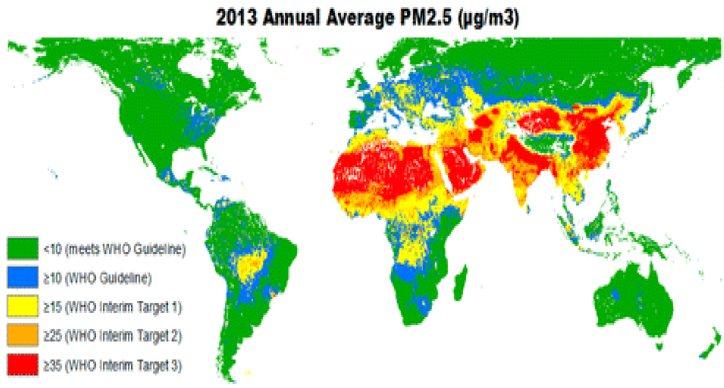
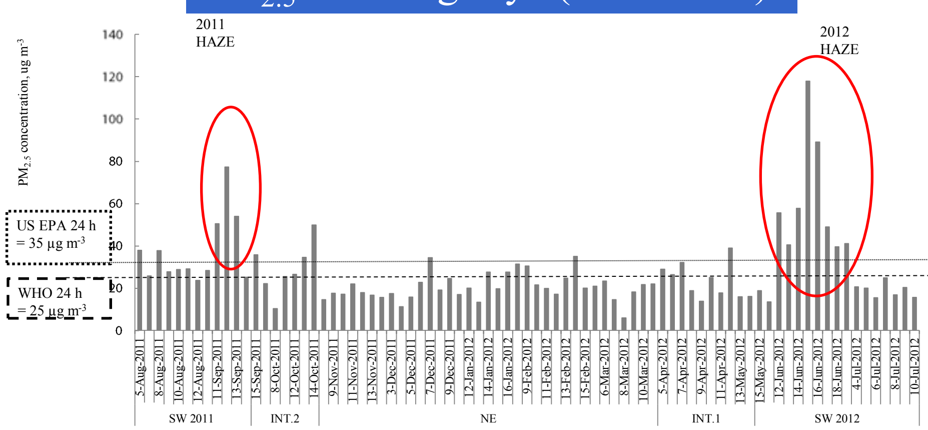


- In 2013, globally **88%** of the world's population lived in areas **exceeding** the WHO annual Air Quality Guideline of 10 µg/m^3 $PM_{2.5}$.
- Between 1990- 2013, **20.4%** increased in global population-weighted $PM_{2.5}$ driven by trends in South Asia, Southeast Asia, and China

(Brauer et al 2016.)

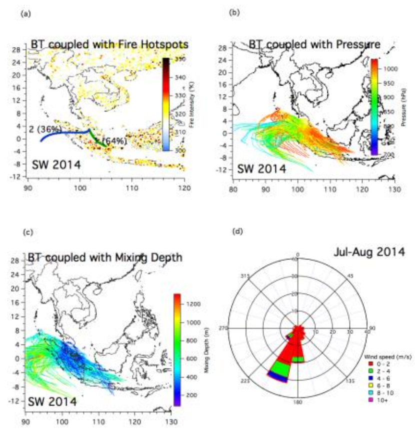
Haze in Malaysia

$PM_{2.5}$: Petaling Jaya (2011-2012)



Amil et al. Seasonal variability of $PM_{2.5}$ composition and sources in the Klang Valley urban-industrial environment. *Atmospheric Chemistry and Physics* 16, 5357-5381, 2016.

Circulation of Wind and Transport of Air Mass: South-west monsoon



Khan, M. F., et al. (2016), Comprehensive assessment of PM2.5 physicochemical properties during the Southeast Asia dry season (southwest monsoon), *Journal of Geophysical Research: Atmospheres*, *121*(24), 2016 JD025894,doi:10.1002/2016JD025894.

Receptor modeling: Source Apportionment

1. **Positive Matrix Factorization Model for environmental data analyses**
https://www.epa.gov/air-research/positive-matrix-factorization-model-environmental-data-analyses

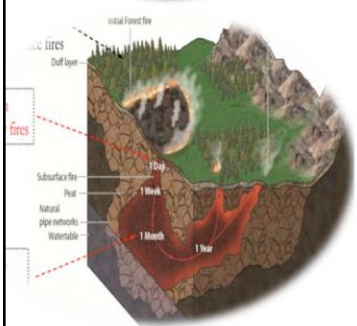
2. **Chemical Mass Balance (CMB) Model**
https://www3.epa.gov/scram001/receptor_cmb.htm

3. **Unmix 6.0 Model for environmental data analyses**
https://www.epa.gov/air-research/unmix-60-model-environmental-data-analyses

4. **Principal Component Analysis/Absolute Principal Component Analysis (PCA/APCS)**
http://www.sciencedirect.com/science/article/pii/0004698185901325

Sources

Sources of Haze



- Land-use changes
- Slash & burn
- Oil palm plantation
- Peat combustion
- Anthropogenic activities

Latif MT et al, 2016

Hazardous Air Pollutants

Case Studies from Asia

Edited by
Dong-Chun Shin

2016

CRC Press
Taylor & Francis Group

5 Air Pollution and Health in Malaysia

Mazrura Sahani, Md Firoz Khan, Wan Rozita Wan Mahiyuddin, Mohd Talib Latif, Chris Fook Sheng Ng, Mohd Famey Yussoff, Amir Afiq Abdullah, Er Ah Choy, Norhayati Mohd Tahir

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5.1 BACKGROUND

Air Quality & Haze Episodes in Malaysia

ASM TRANSBOUNDARY HAZE STUDY

Stakeholder Consultation Workshop
12 May 2016

Health effects of haze pollution studies in Malaysia

- The more common health symptoms following high exposure to air pollutants during the haze include throat irritation, coughing, difficulty in breathing, nasal congestion, sore eyes, cold attacks and chest pain (Mohd Shahwahid & Othman 1999).
- During the 1997 haze, Hospital Kuala Lumpur recorded a substantial increase in cases of upper respiratory tract infections, conjunctivitis, and asthma, with a 2-day delayed effect for asthma incidences, for example in June there were only 912 cases of asthma recorded in Selangor while in September, more than 5000 cases were recorded (Awang *et al.* 2000).
- Brauer and Hisham-Hashim (1998) investigated haze-related illnesses during the 1997 haze period (August – September) and reported significant increased in asthma and acute respiratory infections in Kuala Lumpur hospital.
- In Kuching, Sarawak, outpatient visits increased between 2 to 3 times during the peak 1997 haze period while respiratory disease outpatient visits to Kuala Lumpur General Hospital increased from 250 to 800 a day (WHO 1998).

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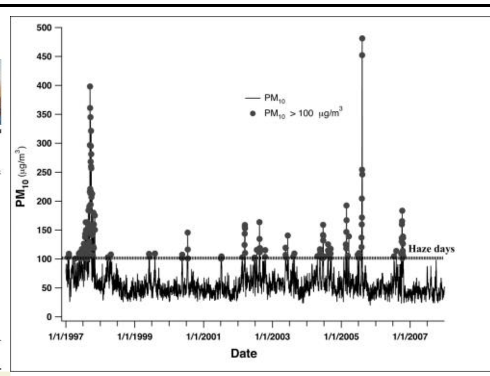
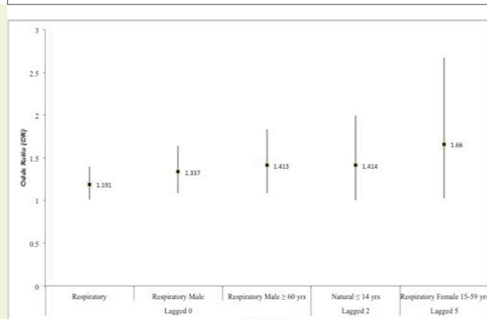
A case-crossover analysis of forest fire haze events and mortality in Malaysia

Mazrura Sahani, Nurul Ashikin Zainon, Wan Rozita Wan Mahiyuddin, Mohd Talib Latif, Rozita Hod, Md Firoz Khan, Norhayati Mohd Tahir, Chang-Chuan Chan

HIGHLIGHTS

For natural mortality, haze events at lagged 2 showed significant association with children less than 14 years old (OR)=1.41; 95% (CI)=1.01-1.99). Respiratory mortality was significantly associated with haze events for all ages at lagged 0 (OR=1.19; 95% CI=1.02-1.40).
Age-and-gender-specific analysis showed an incremental risk of respiratory mortality among all males and elderly males above 60 years old at lagged 0 (OR=1.34; 95% CI=1.09-1.64 and OR=1.41; 95% CI=1.09-1.84 respectively).
Adult females aged 15 to 59 years old were found to be at highest risk of respiratory mortality at lagged 5 (OR=1.66; 95% CI=1.03-1.99).





Atmos. Chem. Phys., 16, 597–617, 2016
www.atmos-chem-phys.net/16/597/2016/
doi:10.5194/acp-16-597-2016

Atmospheric Chemistry and Physics
Open Access
EGU

Fine particulate matter in the tropical environment: monsoonal effects, source apportionment, and health risk assessment

M. F. Khan[1,2], M. T. Latif[1,3], W. H. Saw[1], N. Amil[1,4], M. S. M. Nadzir[1,2], M. Sahani[5], N. M. Tahir[6,7], and J. X. Chung[1]

The mass closure model identified four sources of $PM_{2.5}$: a) mineral matter (MIN) (35%), b) secondary inorganic aerosol (SIA) (11%), c) sea salt (SS) (7%), d) trace elements (TE) (2%) and e) undefined (UD) (45%).
PMF 5.0 identified five potential sources and **motor vehicle emissions and biomass burning** were dominant followed by marine and sulfate aerosol, coal burning, nitrate aerosol, and mineral and road dust.

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The systemic risk (HI) posed by the exposure of $PM_{2.5}$ was at a considerably safer level compared to the SEA region.
The lifetime CR indicated follows the order of As > Ni > Pb > Cd for mineral/road dust, coal burning and overall $PM_{2.5}$ concentration and; As > Pb > Ni > Cd for motor vehicle/biomass burning.
Among the trace metals studied, As predominantly showed the largest lifetime cancer risk in $PM_{2.5}$

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Concentration and source identification of polycyclic aromatic hydrocarbons (PAHs) in PM_{10} of urban, industrial and semi-urban areas in Malaysia

Anas Ahmad Jamhari[a,d], Mazrura Sahani[a,*], Mohd Talib Latif[b,e], Kok Meng Chan[a], Hock Seng Tan[c], Md Firoz Khan[b,e], Norhayati Mohd Tahir[c,f]
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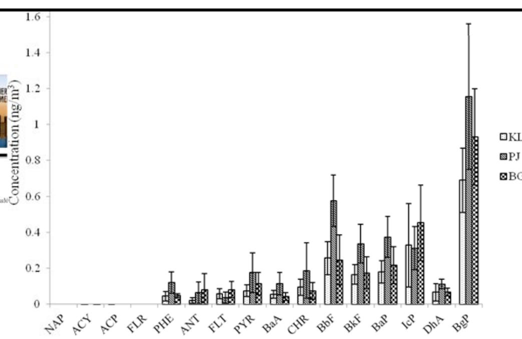
HIGHLIGHTS

This study found that **> 80% of total PAHs** consisted of 5-ring and 6-ring PAHs such as benzo[a]pyrene (BaP), indeno[1,2,3-cd]pyrene (IcP), benzo[b]fluoranthene (BbF), benzo[k]fluoranthene (BkF) and benzo[g,h,i]perylene (BgP).

The presence of benzo[g,h,i]perylene (BgP) with high conc at all locations suggested a source indicator for traffic emission.



- Fig Molecular distribution of PAHs in KL, PJ and BG ambient atmospheric particles in unit ng/m³.

- As comparison, haze particles were characterized by relatively low levels of benzo[a]pyrene (BaP_{eq}) and high levels of benzofluoranthenes (BFs).
- The BaP equivalency results showed that the potential health risk associated with haze smoke particles was **four times higher** than that of street level particles whereas the lowest health risk was associated with ambient atmospheric particles.
- BaP, is one of the most toxic polycyclic aromatic hydrocarbons (PAH) and is usually used as an indicator for cancer risk assessment (Jung *et al.* 2010).

Atmospheric Environment 65 (2013) 69–79

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ATMOSPHERIC ENVIRONMENT

Short-term effects of daily air pollution on mortality

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H I G H L I G H T S

- ► We model the association of air pollution and mortality using Poisson regression.
- ► RR for each pollutant was obtained for every IQR increase at different lag times.
- ► O_3, CO and PM_{10} were the important pollutants associated with natural mortality.
- ► All pollutants except SO_2 were associated with respiratory mortality.
- ► Those who have respiratory diseases are at higher risk of mortality.

A R T I C L E I N F O

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CO
PM_{10}
Klang Valley
Malaysia

A B S T R A C T

The daily variations of air pollutants in the Klang Valley, Malaysia, which includes Kuala Lumpur were investigated for its association with mortality counts using time series analysis. This study located in the tropic with much less seasonal variation than typically seen in more temperate climates. Data on daily mortality for the Klang Valley (2000–2006), daily mean concentrations of air pollutants of PM_{10}, SO_2, CO, NO_2, O_3, daily maximum O_3 and meteorological conditions were obtained from Malaysian Department of Environment. We examined the association between pollutants and daily mortality using Poisson regression while controlling for time trends and meteorological factors. Effects of the pollutants (Relative Risk, RR) on current-day (lag 0) mortality to seven previous days (lag 7) and the effects of the pollutants from the first two days (lag 01) to the first eight days (lag 07) were determined. We found significant associations in the single-pollutant model for PM_{10} and the daily mean O_3 with natural mortality. For the daily mean O_3, the highest association was at lag 05 (RR = 1.0215, 95% CI = 1.0013–1.0202). CO was found not significantly associated with natural mortality, however the RR's of CO were found to be consistently higher than PM_{10}. In spite of significant results of PM_{10}, the magnitude of RR's of PM_{10} was not important for natural mortality in comparison with either daily mean O_3 or CO. There is an association between daily mean O_3 and natural mortality in a two-pollutants model after adjusting for PM_{10}. Most pollutants except SO_2 were significantly associated with respiratory mortality in a single pollutant model. Daily mean O_3 is also important for respiratory mortality, with over 10% of mortality associated with every IQR increased. These findings are noteworthy because seasonal

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ELSEVIER

ATMOSPHERIC ENVIRONMENT

Seasonal effect and source apportionment of polycyclic aromatic hydrocarbons in $PM_{2.5}$

CrossMark

Md Firoz Khan [a,*], Mohd Talib Latif [a,b], Chee Hou Lim [b], Norhaniza Amil [b,c], Shoffian Amin Jaafar [b], Doreena Dominick [a,b], Mohd Shahrul Mohd Nadzir [a,b], Mazrura Sahani [d], Norhayati Mohd Tahir [e]

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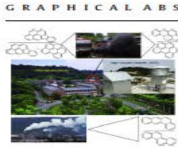
H I G H L I G H T S

- Sixteen USEPA priority PAHs determined in $PM_{2.5}$ at a tropical semi-urban site.
- High molecular weight PAHs are significantly higher in $PM_{2.5}$.
- The combustion of gasoline, diesel and heavy oil are dominant sources of PAHs.
- No potential carcinogenic risk of the airborne BaP_{eq} was found at current site.
- Monsoon effect influences the PAHs distributions as well as health risk.

G R A P H I C A L A B S T R A C T



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Monsoon effect
PAH diagnostic ratio
Positive matrix factorization
Health risk

A B S T R A C T

This study aims to investigate distribution and sources of 16 polycyclic aromatic hydrocarbons (PAHs) bound to fine particulate matter ($PM_{2.5}$) captured in a semi-urban area in Malaysia during different seasons, and to assess their health risks. $PM_{2.5}$ samples were collected using a high volume air sampler on quartz filter paper at a flow rate of 1 m^3 min^{-1} for 24 h. PAHs on the filter paper were extracted with dichloromethane (DCM) using an ultrasonic centrifuge solid-phase extraction method and measured by gas chromatography–mass spectroscopy. The results showed that the range of PAHs concentrations in the study period was between 0.21 and 12.08 ng m^{-3}. The concentrations of PAHs were higher during the south-west monsoon (0.21–12.08 ng m^{-3}) compared to the north-east monsoon (0.68–3.80 ng m^{-3}). The high molecular weight (HMW) PAHs (≥5 ring) are significantly prominent (>70%) compared to the low molecular weight (LMW) PAHs (≤4 ring) in $PM_{2.5}$. The Spearman correlation indicates that the LMW and HMW PAHs correlate strongly among themselves. The diagnostic ratios (DRs) of I[c]P/I[c]P + BgP and B[a]P/B[g]P suggest that the HMW PAHs originated from fuel combustion sources. The source apportionment analysis of PAHs was resolved using DRs-positive matrix factorization (PMF)-multiple linear regression (MLR). The main sources identified were (a) gasoline combustion (65%), (b) diesel and heavy

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ELSEVIER

Transboundary smoke haze pollution in Malaysia: Inpatient health impacts and economic valuation

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Smoke haze impact on inpatient cases
Economic valuation of smoke haze

ABSTRACT

This study assessed the economic value of health impacts of transboundary smoke haze pollution in Kuala Lumpur and adjacent areas in the state of Selangor, Malaysia. Daily inpatient data from 2005, 2006, 2008, and 2009 for 14 haze-related illnesses were collected from four hospitals. On average, there were 19 hazy days each year during which the air pollution levels were within the Lower Moderate to Hazardous categories. No seasonal variation in inpatient cases was observed. A smoke haze occurrence was associated with an increase in inpatient cases by 2.4 per 10,000 populations each year, representing an increase of 31 percent from normal days. The average annual economic loss due to the inpatient health impact of haze was valued at MYR273,000 ($91,000 USD).

Our on-going studies

- Trans-boundary haze air pollution and its associated burden of disease and toxicity in Malaysia.
- Risks of cardiovascular and respiratory hospitalisations from ambient air pollution in Klang Valley region, Malaysia
- (Wan Rozita WM*, Mazrura S **, Ahmad Faudzi Y*, Nor Aini A*, Zamtira S*, Nurul I*, Sohaya K***, Md Khadzir SA***, Khan Md FMohd TL)
- Estimation of Risk on Respiratory and Cardiovascular Emergency Room Visit and Hospital Admission from Exposure to Urban Air Pollution in Cheras, Kuala Lumpur
- Source apportionment and toxicity assessment of fine particulate matter in urban area
- Cytotoxicity and DNA damage from the extract of fine particulates (PM2.5).

MySEE Malaysian Society for Environmental Epidemiology

Universiti Kebangsaan Malaysia National University of Malaysia


THANK YOU
DANK U
MALAYSIA

Psychological effects of the haze and pollution

Prof Dr. Hussain Habil, Ms Sharon L How,
Prof Dr. Umeed Khan,
Prof Dr. Dato'Khairul Abdullah
& Dr Rusdi Rashid
MAHSA University, Kuala Lumpur

What is air pollution?

- Air pollution collectively describes the presence of a diverse and complex mixture of chemicals, particulate matter (PM), or of biological material in the ambient air which can cause harm or discomfort to humans or other living organisms.
- Sources of air pollution can be natural (e.g. volcanic eruptions) or manmade (e.g. industrial activities).

What is air pollution?

- Millions of people worldwide are chronically exposed to airborne pollutants in concentrations that are well above legal safety.
- Air pollution is a serious health problem especially in rapidly growing countries.

What is air pollution?

- Exposure to ambient air pollution is a common public health concern & is associated with a growing morbidity and mortality worldwide.
- During the last decades, the adverse effects of air pollution on the pulmonary and cardiovascular systems have been well established in a series of major epidemiological and observational studies

What is air pollution?

- Widespread forest fires have been a regular event in Sumatra and Kalimantan in recent years with the first serious episode occurring in 1997
- Farmers adopting the ‘slash- and-burn’ technique of clearing land for agricultural usage [6].

The Haze

- Seasonal haze that afflicts several parts of South East Asia has drawn much attention.
- Health, socioeconomic & political impacts on the and political impacts on the Association of Southeast Asian Nations (ASEAN) countries (ASEAN secretariat [5].
- Countries usually affected include Singapore, Malaysia, Brunei, Southern Thailand and Indonesia.

The Haze

- Specifically the widespread forest fires in Indonesia in June 2013 led to widespread haze to neighbouring countries.
- An early study in the medical literature reported acute physical and psychological symptoms of the general population during a haze crisis.[8]

Hazards

- The burning of carbon-rich peat land sends off acrid smoke, dust and dry particles (2.5 micrometers or smaller) into the atmosphere thereby forming haze.[7]

Sensitivity to haze & air pollution

- Children the elderly & people with chronic lung and heart disease are more sensitive to the health effects of haze & air pollution.
- Adoption of the preventive measures from the MOH is advisable when air quality is poor.
- Individuals who develop breathing difficulties are advised to consult their doctor if they develop breathing difficulties.
- Expectant mothers may also be at risk

The haze & psychological health

- Air pollution can drain an individual's psychological health
- It may affect self-control & has the potential to cause a range of conditions such as insomnia, feelings of anxiety & in some cases depression.
- Less is known about the psychological effects that the haze has on behaviour and performance in the workplace.

Overview of the literature

- Recently air pollution has been associated with diseases of the central nervous system (CNS), including stroke, Alzheimer's disease, Parkinson's disease, and neurodevelopmental disorders. [1].

Overview of the literature

- Besides physical symptoms, we assessed the psychological stress of a haze crisis, a temporary perturbation on the ecosystem and a period of uncertainty with hour-to-hour fluctuations of the PSI values [2]
-

Overview of the literature

- Findings show that the perceived dangerous PSI value, not the actual PSI value and number of physical symptoms have been associated with a negative psychological impact during the haze crisis.
- In addition the higher number of physical symptoms was associated with greater psychological stress.[3][4]

Overview of the literature

- Research shows that the perceived dangerous PSI value, not the actual PSI value & number of physical symptoms have been associated with negative psychological impact during the haze.
- A higher number of physical symptoms have been found to be associated with greater psychological stress.[3][4]

Overview of the literature

- According to KC Yam (2015) , The impact of air pollution can make individuals less engaged at work.
- In ego depletion theory it is apparent that both the direct physiological impact of air pollution and the individual's own perception of its severity act to deplete resources affecting self-control.

Overview of the literature

- Workers may experience experience little or no health effects from pollution while another in the same office may suffer badly.
- Ones individual perception & understanding of the meaning of severe pollution may vary from person to person.[9]
- Implications for coping & quality of life

Overview of the literature

- Lundberg, A. (1996) stated Psychological and toxic effects of air pollution can lead to psychiatric symptoms, including anxiety and changes in mood, cognition, and behaviour.
- Increased levels of some air pollutants are accompanied by an increase in psychiatric admissions and emergency calls and, in some studies, by changes in behaviour and a reduction in psychological well-being.

Overview of the literature

- Manifestations are often insidious or delayed, but they can provide a more sensitive indicator of toxic effects than cancer rates or mortality data.
- The sick building syndrome and multiple chemical sensitivity are conditions with toxicology and psychiatric aspects.

Conclusion

- Psychosocial stress can cause symptoms similar to those of organic mental disorders.
- Reactions to stress depend on cultural, individual, and situational variables.
- Imperative to understand the factors in order to be able help prevent trauma.

References

1.Calderón-Garcidueñas, L., Calderón-Garcidueñas, A., Torres-Jardón, R., Avila-Ramírez, J., Kulesza, R. J., & Angiulli, A. D. (2015). Air pollution and your brain: what do you need to know right now. *Primary health care research & development*, *16*(04), 329-345.

2.Ostermann K, Brauer M. In: Forest fires and regional haze in southeast Asia. Eaton P, editor. New York: Nova Publishers; 2001. Air quality during haze episodes and its impact on health.

3. Ho, R. C., Zhang, M. W., Ho, C. S., Pan, F., Lu, Y., & Sharma, V. K. (2014) [3] [4]. Impact of 2013 south Asian haze crisis: study of physical and psychological symptoms and perceived dangerousness of pollution level. *BMC Psychiatry*, *14*, 81. http://doi.org/10.1186/1471-244X-14-81

4. Secretariat ASEAN: Media release: 6th meeting of the conference of the parties to the ASEAN agreement on transboundary. 2010, Jakarta: Association of Southeast Asian

5. Choudhury HK, Saikia J: Factors influencing farmers' adoption of slash and burn agriculture in North East India. For Policy Econ. 2012, 15: 146-151.

6. MB, Jaafar AB, Abdullah AM, Ismail MB, Hassan MN, Abdullah R, Johan S, Noor H: Air quality in Malaysia: impacts, management issues and future challenges. Respirology. 2000, 5: 183-196. 10.1046/j.1440-1843.2000.00248.

7. Schiffman SS. Introduction: health and ecological linkages. Environ Int. 2003;29:351. doi: 10.1016/S0160-4120(02)00168-X.

8. Gadit AAM. Ecology and mental health: time to understand Eco psychiatry. J Pakistan Med Assoc. 2009;59:56–57.

9. Polluted Work: A Self-Control Perspective on Air PollutionR Fehr, KC Yam, W He, JTJ Chiang, W Wei Academy of Management Proceedings 2015 (1), 11610

10. Lundberg, A. (1996). Psychiatric aspects of air pollution. *Otolaryngology--Head and Neck Surgery*, *114*(2), 227-231.

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Economic Impact of Haze on Health

Forum on the Impact of Haze on Human Health in Malaysia, Academy Science Malaysia

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University Malaya

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Contents

- Impact of Haze and its financial implications
- Economic evaluation of healthcare
  - Understanding economic impacts of haze to health
- Economic studies on health impact of haze
- Summary and conclusion

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Impact of Haze

- Haze
  - Financial
    - Health Related
    - Non-health Related
  - Social
    - Stress
    - Limited activity
  - Health
    - Local
    - CVS
    - Respiratory

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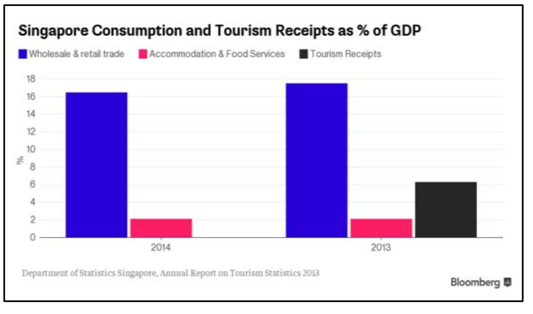
Financial Implications of Haze

Non-health related

* Transportation
* Tourism industry
* Environment
* Agricultural loss
* Manufacturing and trading



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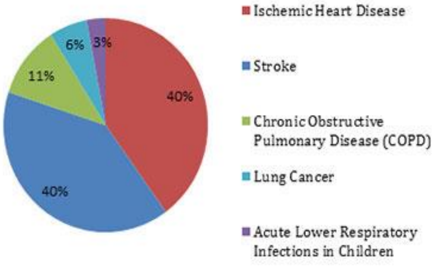
Financial Implications of Haze

Health related

* Affects Health tourism
* Use of self protection devises
* Increase cost to healthcare providers and patients
  - direct Medical costs
  - indirect and intangible cost
* Loss of productivity
  - absence from work
  - absence from school

Increased disease burden lead increased cost



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Social Impact of Haze

- Due to the limitation and restriction of daily lifestyle-activities such as camping, outdoor events or meetings, recreational activities, casual shopping and dining would need to be reduced or postponed.

- Cause disruptions of peaceful mind
- Limited social networking

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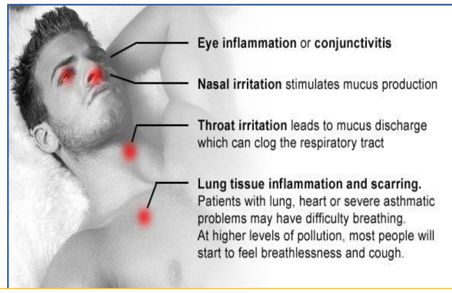
Health Impact of Haze

- Haze causes illness or increase in disease occurrence

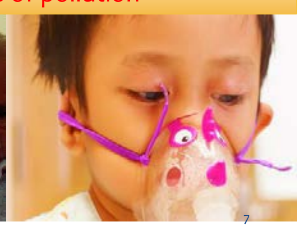
i) Local
- due to irritant and allergic reactions triggered by the pollutants

ii) CVS
- related to thrombus and atherosclerotic plaque
- exacerbation of heart failure and ischemic heart disease

iii) Respiratory
- exaggerate inflammatory response i.e. AEBA, AECOPD, URTI



Young children and elderly suffer most effects of pollution

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Haze Level and Healthcare Utilization

- Haze effects on health cause significant increase in healthcare utilization.
- increased in PM level was associated with increased in hospital admissions and outpatient visits.

- Four SR/MA concluded that for every increase in PM10-2.5, there is 0.3% to 3.7% increase in hospital admission and outpatient visit rate due to haze-related illnesses. The effects are more prominent in short-term, high level of PM exposure, as what we can see with the trend of haze season in Malaysia and Southeast Asia region.

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Haze Level and Healthcare Utilization

- Various systematic reviews and meta analysis reported that during haze, for every 10µg/m^3 increase in PM_{10} ;

Outcome Measure	Results	
Respiratory Hospital Admission	between 0.5% to 3.7% increase in respiratory hospital admission	1. Adar et al (2014)[1] 2. Kochi et al (2009)[2] 3. Atkinson et al (2016)[3] 4. Lu et al (2015)[4]
Cardiovascular Admission	Between 0.3% to 1.7% increase in cardiovascular admission	1. Kochi et al (2009)[2] 2. Lu et al (2015)[4]
Asthma	2.4%-3.7% increase in Emergency Department visit	Kochi et al (2009)[2]
Outpatient	About 0.72% (95% CI: 0.021-1.41) increase in respiratory outpatient visit	Lu et al (2015)[4]

Economic evaluation of Healthcare

Relevance of Health Economics

Economic Evaluation - definition

Economic evaluation (EE) is a technique that was developed by economists to assist decision making when choices have to be made between several resources

Resources are scarce thus have to make choices

EE include measuring the outcome of intervention or implication of a problem, the cost incurred by the intervention/problem and the relevant analysis according to the needs

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Economic Evaluation - Intro

- ✓ EE of health is the assessment of costs and consequences of healthcare program and services
- ✓ Emphasize on alternatives to existing (can be nothing)
- ✓ Costs in economic evaluation are viewed as opportunity costs which are forgone opportunities or sacrifices made in making decision
- ✓ Resources for health are limited but demands for healthcare are greater than supplies

- ➢ Haze impacts on disease burden cause significant implications on the allocation and distribution of resources of healthcare
- ➢ It is important to measure the cost implications of haze on health
- ➢ Similarly, to implement health intervention(s) to overcome the impact of haze to health, cost-effectiveness analysis are needed to optimally use the limited recourses available.

Types of Economic Evaluation for healthcare program

AFFORDABILITY	• Costing study	the cost of mrt is rm300 per IDU who received MRT
SUSTAINABIILITY	• Budget Impact Analysis	MRT costs rm2 million a year but will save the public sector rm500,000 per year
IMPACT ON DISEASE	• Epidemiological Study	MRT will prevent 3000 IDU from HIV infection after 2020
VALUE FOR MONEY	• Cost-Effectiveness Analysis	MRT costs rm1000 per averted HIV among IDUs
PRICE NEGOTIATION	• Threshold Price Analysis	the break even price of MRT is RM200 per IDU on MRT

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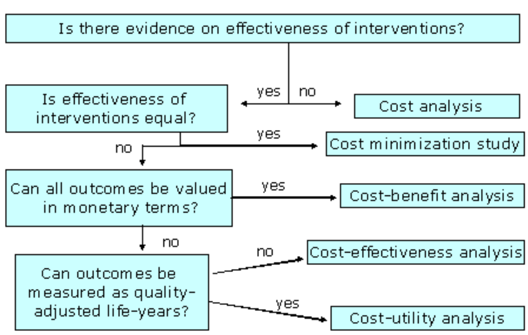
Common tools for Cost-effectiveness Analysis



Source: Gray A. Economic Evaluation. In: Dawes, et al.Eds. *Evidence Based Practice: A Primer for Health Care Professionals*. 2001.

Economic Evaluation Studies on Health Impact of Haze

Understanding economic impacts of haze to health

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Economic impacts of Haze to Health

- Countries affected by haze would incur productivity losses as a result of haze related illnesses suffered by population at risk.
- The productivity losses occurred in terms of foregone production opportunities during the idled workdays of hospital admission and sick leaves obtained by a fraction of the population at risk (and reduced activity days)

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Economic impacts of Haze to Health

- Valuing the damage caused by haze will help policy makers appreciate the scale of the problem as the values can be readily compared with other losses or the merits of alternative resource use.

- The assessment of impact facilitates the establishment of common cross-country environmental policy framework, which will benefit the affected region as a whole.

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Assessment on the economic impacts of haze to health starts with measuring the increment of the related diseases

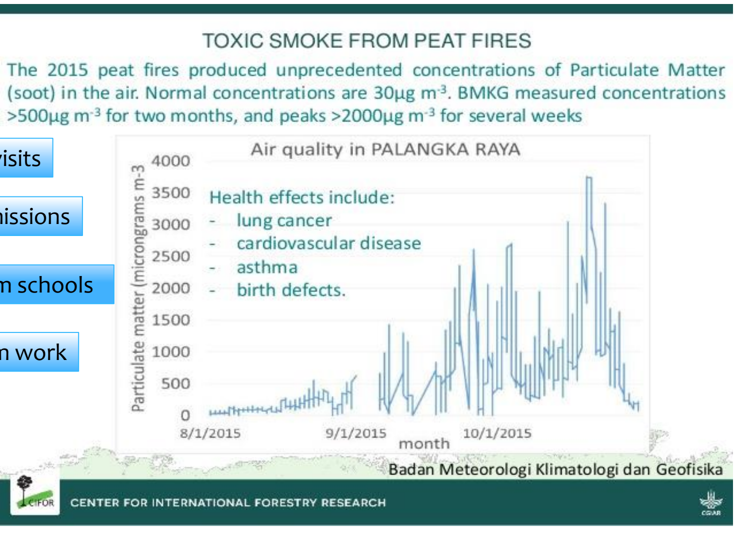
↑ Outpatient visits

Hospital admissions

Absence from schools

Absence from work

↓ productivity



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Economic Impact of the 1998 Haze

Anaman and Ibrahim, Brunei (1998)[5]

- Study: Urban Householder's Assessment of the Causes, Responses and Economic impact
- Questionnaire using Contingent Valuation method to determine WTP for:
  - Public information on haze-related air pollution
  - Haze prevention fund
- COI = costs of self medication (non drug items such as filters + masks) + (lost workdays + treatment cost from other study (from article by same authors)
- WTP
  - US$ 30.6/month (access to public haze advisory information)
  - US$ 254.7/month (Haze fund)
  - Aggregate WTP (population of 100,000) = US$ 25.4M
- COI = costs of self medication (US$ 1M) + lost workdays/treatment costs (US$ 3M) = US$ 4M
- WTP > COI: Attributed to cost of suffering, pain, discomfort avoided (3.3 times COI)

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Cost of Trans-boundary Haze Externalities

Jamal and Shahwahid, Malaysia (1999)[6]

- Conducted a study on the incremental health impacts of haze compared to previous year (1996)
- Included cost of outpatient, inpatient, self-treatment and value of productivity loss due to haze
- Used dose-response functions (DRF) to estimate total increment in haze related health cases and economic value of haze impact on health.
- The incremental cost for outpatient and self-treatment was RM 5, 017,638 while inpatient was RM 236,750
- Incremental LOP (loss of productivity) up to RM 4, 308, 078
- The total incremental COI was estimated at RM 9,562,466
- WTP (Willingness to Pay) to avoid the illness was RM 19, 124,932

  (WTP was based on WHO ratio for Asthma: 2.3 times of COI)

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Catastrophic healthcare cost caused by Haze

Schweithelm et. al., 2006[7]

- Compared the economic impact of haze on haze related illness in Malaysia, Indonesia, Singapore by adjusting the findings from several cost studies.
- Incremental COI Malaysia= US$ 6 M (2.6% from total damage cost or 0.21% of GDP)
- Total economic impact Indonesia = US$ 924 M (COI; US$ 295 M + productivity loss; US$ 167 M + lost consumer surplus/ WTP; US$ 462 M)
- Incremental COI Singapore = US$ 26.47 M (treatment cost; US$ 3.2 M + workdays lost; US$ 10 M)

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The economic value of the June 2013 Haze Impacts on Peninsular Malaysia

Mohd. Shahwahid, Malaysia (2013)[8]

- Applied different approach - using questionnaire and interviewed respondents about June 2013 haze impacts (on health, lifestyle, travel, occupational related issues)
- COI related to haze related illnesses (medical treatment + productivity losses + inconveniences)
- COI = RM 19.6M (masks) + RM 118.9M (treatment and hospitalization) + RM 202.8M (MC) + RM 69.3M (reduce activity days) = RM 410.6M
- WTP for insurance scheme was supported by only 37.5% (average WTP = RM 23.90 per household or RM 125.8M in total)
- Total economic losses = COI (RM 410M) + WTP (RM 125M) + Foregone Income Opportunities (RM 958) = RM 1.5B (0.48% of 2013 GDP)

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Trans-boundary smoke haze pollution: Inpatient health impacts and economic valuation

Jamal et. al., Malaysia (2014)[9]

- To study economic effect of the impact of haze on associated inpatient case at KL and Selangor (from 2005 to 2009)
- Estimated COI based on incremental cost of treatment and lost of productivity due to illnesses attributed to haze (4 years)
- Used DRF to estimate number of incremental health cases (show relationship between PM10/API and haze-related illnesses)
- Average of 19 hazy days/year with 31% total increase of inpatient rate during the haze episode
- Average annual cost of inpatient due to haze valued at RM273,000 (US91,000)
- Estimated economic loss at RM 14, 368 per hazy day
- Projected cost stream in 20 years = RM3.3m to RM5.1m (assuming 2% annual population growth, no changes in DRF, inflation rate of 2% and social discount between 5-10%)

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Health impacts and economic losses assessment of the 2013 severe haze event in Beijing area

Gao et. al. China (2015)[10]

- Used simulated PM2.5 concentrations which was verified with meteorology and air quality measurements
- DRF was from epidemiology study and gridded population data to determine health impact of haze
- Economic assessments were on WTP for a reduction of death and COI (treatment costs + loss of labour productivity)
- Total economic loss = mortality (USD 188.7M) + hospitalization (USD 31.9M) + clinic visits (USD 7.6M) + acute bronchitis (USD 18.5M) + asthma (USD 7.1M) = USD 253.8 M (0.08% of total annual GDP of Beijing)

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Conclusion

- Haze causes illnesses and lead to increased utilization of healthcare services.
- These pose significant economic impacts to the government and population.
- Despite these, Malaysians appear to have become used to haze, and they tend to continue with their lives as normal when haze occurs (as reflected by the low WTP to pay for insurance to mitigate the impact of the haze).
- Health education on limiting the outdoor activities and use of personal protective devices during haze should be given.
- Most importantly is to prevent/reduce haze from occurring.

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Research Gaps

- It is important for us to scientifically document the trend of haze and healthcare utilization in Malaysia so that steps can be taken to combat haze as well as to allocate appropriate resources to meet the healthcare demand associated with haze.

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References

1. Adar SD, Filigrana P a, Clements N, Peel JL. Ambient Coarse Particulate Matter and Human Health: A Systematic Review and Meta-Analysis. Curr Environ Heal reports. 2014;1:258–74.
2. Kochi I, Loomis J, Champ P, Donovan G. Health and economic Impact of wildfires : literature review and impact assessment. In: González-Cabán A, editor. 3rd International Symposium on Fire Economics, Planning, and Policy: Common Problems and Approaches. Colarado, United States of America; 2009. p. 1–14.
3. Atkinson RW, Kang S, Anderson HR, Mills IC, Walton H a. Epidemiological time series studies of PM2.5 and daily mortality and hospital admissions: a systematic review and meta-analysis. Thorax. 2014;69(7):660–5.
4. Lu F, Xu D, Cheng Y, Dong S, Guo C, Jiang X, et al. Systematic review and meta-analysis of the adverse health effects of ambient PM2.5 and PM10 pollution in the Chinese population. Environ Res. Elsevier; 2015;136:196–204.
5. Anaman KA. Urban Householders7 Assessment of the Causes , Responses , and Economic Impact of the Air Pollution Episode in Brunei Darussalam. 2017;18(2):193–205.
6. Othman J, H.O MS. Cost of Trans-boundary Haze Externalities. J Ekon Malaysia. 1999;33(33):3–19.
7. Mohd Shahwahid H.O. The Economic Value of the June 2013 Haze Impacts on Peninsular Malaysia. Laguna, Philippines; 2016.
8. Schweithelm J, Glover D, Jessup T. Indonesia's Fires and Haze : The Cost of Catastrophe. Indonesia's Fire and Haze: the Cost of Catastrophe. 2006. 1-13 p.
9. Othman J, Sahani M, Mahmud M, Sheikh Ahmad MK. Transboundary smoke haze pollution in Malaysia: Inpatient health impacts and economic valuation. Environ Pollut. Elsevier Ltd; 2014;189:194–201.
10. Gao M, Guttikunda SK, Carmichael GR, Wang Y, Liu Z, Stanier CO, et al. Health impacts and economic losses assessment of the 2013 severe haze event in Beijing area. Sci Total Environ. Elsevier B.V.; 2015;511(January 2013):553–61.

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