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The Economic Value of the June 2013 Haze Impacts on Peninsular Malaysia

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WorldFish

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EXECUTIVE SUMMARY

Haze has regularly enveloped Malaysia in the last 15 years due to both domestic and international causes. Increased traffic and construction are the usual domestic sources. Internationally, forest fires in Indonesia have been the main contributor. Malaysia faced a haze incident in 1981 and another in 1982, four haze incidents in the 1990s, and nine from 2000 to 2013. The 2013 haze was the worst since 1997.

This study investigated the impacts of the 2013 haze on the people and economy of Peninsular Malaysia with a sample population of 360 respondents in 12 urban and rural districts. To identify how significant the economic costs of the haze impacts were, the estimates calculated were compared with the 2012 GDP of Peninsular Malaysia.

The economic cost of the June 2013 haze was estimated to be MYR 1.49 billion, which was 0.48% of the GDP. The total cost of illnesses (COI) due to haze effects was MYR 78.03 per household or MYR 410.6 million, which was 27.48% of the total cost. The cost of medical treatment and hospitalization was valued at MYR 22.59 per household or MYR 118.9 million for the peninsula. Medical-related leaves taken due to the haze either for oneself or to take care of household members cost MYR 38.54 per household or MYR 202.8 million for the peninsula. Reduced activity days contributed a smaller proportion of MYR 13.17 per household or MYR 69.3 million peninsula-wide. Purchasing air pollution masks as protection against haze exposure was estimated at MYR 3.73 per household or MYR 19.6 million. Loss of income opportunities was MYR 182.05 per household or MYR 958 million peninsula-wide, which was 64.11% of the total economic cost.

An important observation from the June 2013 haze episode was that Malaysians appear to have gotten used to haze and tend to continue with their lives as normal, albeit taking the necessary measures to deal with its impacts. The willingness to participate in the insurance scheme to avoid a decline in quality of life due to haze was supported by only 37.5% of those surveyed. Their average willingness to pay was only MYR 23.90 per household or MYR 125.8 million or 8.42% of the total economic cost of the haze.

1.0 INTRODUCTION

1.1 Haze Incidence in Peninsular Malaysia

Haze has regularly enveloped Malaysia in the past 15 years due to multiple sources, both domestic and international. Increased traffic and construction are the usual domestic sources. Internationally, forest fires in Indonesia have been the main contributor to haze in neighboring Malaysia and Singapore. The fires have been a regular occurrence during the dry season in Sumatra and Borneo, but the situation has deteriorated in the last decade, with timber and plantation firms often blamed for deliberately starting fires to clear land. The worst haze hit in 1997–1998 when the drought caused by the El Niño weather phenomenon led to major fires in Indonesia. The haze spread to Malaysia, Singapore, and south Thailand. This caused more than USD 9 billion in losses in the tourism, transportation, health, and farming sectors. Since then, a number of smaller haze episodes have occurred but they have not been as damaging as the one in 1997. Nevertheless, the Malaysian government took precautionary steps such as closing schools to reduce the health impacts of the haze on school children.

The last intense haze event occurred in October 2010. The effect was felt in Singapore and the southwestern Peninsular Malaysian states. Accordingly, the Economy and Environment Program in Southeast Asia (EEPSEA) commissioned a study to value the health impacts of the haze incident. Three districts in the southernmost state of Johore were the most affected in Peninsular Malaysia. The total costs of illnesses (COI) ranged from MYR113.7 million in the Kota Tinggi district to MYR 24.4 million in the Muar District and MYR 26.7 million in the Batu Pahat district, all in Johore (Mohd Shahwahid 2011). The major components of the COI were economic losses from reduced activity days (RAD) covering 56.96% of the total COI, medical-related work leave (22.98%), and treatment costs at public hospitals (13.97%).

The significance of these COI values can be seen from a comparison to the annual development and administrative budget allocation for each district. The losses relating to the COI were quite substantial, ranging from 1.5 to 1.7 times the districts' annual development budgets and 0.3 to 0.34 times the administrative expenditure of the three districts. Hence, the COI losses suffered by the three districts of Johore were considered significantly high.

An interesting finding was the cause and effect statistical relationship between the visibility index and the air pollution index (API), which was used to measure the haze levels (Mohd Shahwahid 2011). Similarly, rainfall was found to play an important role in moderating haze intensity.

The haze hit again in 2013 beginning in the month of June. Throughout the months of June and July, the haze rose to unhealthy levels for several days, falling back to normal, only to recur for a few days. This pattern continued in the following months until the rainy season in November in Peninsular Malaysia. The API and PSI (Pollutant Standard Index) readings in several states of Peninsular Malaysia and in Singapore reached record highs to very unhealthy and hazardous levels for the first time, exceeding the levels in 1997. Malaysia closed schools in many parts of the country because of the haze. A state of emergency was declared in two southern areas after the pollution indices spiked. The high haze levels eventually led Indonesia to apologize to Malaysia and Singapore for the hazardous air pollution caused by smoke from the forest fires, which were caused by the clearing of land for oil palm plantations.

1.2 Significance of the Study

Haze is an environmental hazard in this part of Southeast Asia; thus, EEPSEA has investigated its disruptive effects and kept the information in a database for interested parties (both government and nongovernmental) for research and/or monitoring purposes. Hence, further studies on the impacts of haze on Peninsular Malaysia are warranted.

It would also be interesting to investigate the progress of actions undertaken by government authorities to monitor and control the haze internally. This has become more significant as the ASEAN Agreement on Transboundary Haze Pollution established in 2002 had not been ratified by Indonesia until January 2015.

1.3 Objectives of the Study

The objectives of this study were as follows:

1. To investigate the frequency and intensity of haze incidents in Peninsular Malaysia,
2. To assess the kinds of impacts the 2013 haze incident had on the local people and economy, and
3. To value the extent of these impacts.

[1] 1 USD = 3.08 Malaysian Ringgit (MYR) in October 2010.

2.0 LITERATURE REVIEW

Malaysia has faced a series of haze incidents since April 1981. The April 1981 haze captured a great deal of public and media coverage as it impaired visibility, which disrupted flight and marine activities. An average concentration of 430 gram per cubic meter (g/m^3) of particulate concentration was reported by Sham (1984) in the Klang Valley. This value was approximately nine times that of the World Health Organization (WHO) threshold.

The second severe haze episode occurred in September 1982; the haze surrounded Petaling Jaya, Selangor. Although the maximum particulate concentration recorded was 244 g/m^3, which was significantly less than that recorded in the 1981 haze, this haze was more persistent (Chow and Lim 1984). These two haze episodes coincided with the occurrence of widespread bushfires and agricultural waste burning in Indonesia (Sham et al. 1991).

Following the above two haze episodes, the 1990s saw four major haze periods occurring in August 1990, June and October 1991, August to October 1994, and September 1997 (Table 1). In the 2000s, the first haze period occurred in August 2005, affecting Port Klang and Kuala Selangor. This was followed in 2006 by another haze which affected eastern Sarawak, East Malaysia, and western and southern Peninsular Malaysia. There were other minor haze incidents in 2009 and October 2010, which affected the southern peninsular states of Johore and Malacca. This was then followed by the severe June 2013 haze.

The haze incidents in June and July 2013 were linked to forest fires in Indonesia. In mid-June, fires raged in several spots on the island of Sumatra, spreading acrid smoke to Singapore and Malaysia.[2]

The haze affecting Malaysia was the worst since 1997, starting with the API hitting an "unhealthy" reading of 172 on 19th June, with Johore and Malacca being the two worst states affected by the haze (Department of Environment 2013a). On 20th June, the haze in Malaysia worsened; Johore and Malacca remained the worst affected states. In Johore, Muar recorded a "hazardous" reading (383), Kota Tinggi was the second worst, hitting a "very unhealthy" reading of 232. In Malacca, an API reading of 137 was recorded in Malacca City exceeding the "unhealthy" API. Likewise, the *New Straits Times* (21 June, 2013) reported that the Johore State Health Department had recorded an increase of at least 21% of citizens with upper respiratory tract ailments.

On 23rd June, *Channel News Asia* reported that the API in Muar spiked to 746, which was way above the maximum hazardous level. This resulted in a declaration of a state of emergency in Muar and Ledang (which was afterwards lifted on 25th June), leaving the towns in virtual shutdown. Meanwhile, *The Star* (25 June, 2013) reported that on 24th June, shifting winds had blown the haze northward, thereby affecting the west coast states of Malacca, Selangor, Negeri Sembilan, Perak, and Penang. The haze also blanketed the east coast of the peninsula, namely, the states of Pahang, Terengganu, and Kelantan. Air quality in central and northern Peninsula Malaysia worsened. Kuala Lumpur recorded an "unhealthy" API of 198, which is on the verge of entering the "very unhealthy" range. Port Dickson was the worst hit by the haze, with the API entering the "hazardous" scale with a reading of 335 (Department of Environment 2013b).

On 25th June, even though the haze had cleared off a bit in the southern parts of the nation, Port Klang recorded "very unhealthy" API values that rose to the "hazardous" range with a reading of 487. The drifting smoke from the south also caused other places in Selangor and Kuala Lumpur to be blanketed by thick smog, very close to entering the "hazardous" level. Seri Manjung in Perak, which is 200 km away from the coast, was also hit hard by the haze.[3] Visibility remained poor in Kuala Lumpur and several other states. Malaysians were able to breathe easier when overnight rain in numerous parts of the west coast helped to clear the skies. There was a significant drop in the API values in most areas, including Port Klang.[4]

[2] *Cable News Network (CNN).* 25 June 2013
[3] *The Malaysian Insider,* 25 June, 2013
[4] *The Straits Times,* 19 June, 2013

Table 1. History of past and recent haze episodes

Year	Highest API	Cause of Haze	Haze Impacts
1981 April (Klang, Selangor)	Hazardous (TSP 430 g/m3), nine times that of WHO standard	Coincided with the occurrence of widespread bushfires and agricultural waste burning in Indonesia (Sham et al. 1991)	Impaired visibility resulting in disruption of flights and marine activities (Sham 1984)
1982 September (Petaling Jaya, Selangor)	TSP 244 g/m^3, five times that of WHO standard	Coincided with the occurrence of widespread bushfires and agricultural waste burning in Indonesia (Sham et al. 1991)	Not widespread
1990 August (Klang Valley, Kuala Lumpur, and Selangor)	four times the mean ambient value	Local open burning (Sham et al. 1991)	Only isolated places and not widespread
1991 June[1] and October[2] (Klang Valley, Kuala Lumpur, and Selangor)		[1] Bushfires and agricultural waste burning in Indonesia [2]Injection of suspended ash particulates from Mt. Pinatubo, Philippines; associated with the advent of prevailing winds that transported suspended particulates (Cheang et al. 1991; Zainal Abidin, Young, and Inouye 1993)	
1994 August–October (Central region of western Peninsular Malaysia)		Large forest fires and open burning in the neighboring countries (i.e., Indonesia), affecting central region of western Peninsular Malaysia (MMS 1995)	
1997 September (Kuala Lumpur, Petaling Jaya, Klang, and Kuching reached unsafe levels; Kuala Lumpur had the worst air quality)	Hazardous (no value stated)	Forest fires in Indonesia due to slash-and-burn activities; intense haze exacerbated by the drought due to El Niño Southern Oscillation (ENSO) event.	A State of Emergency was declared for 20 days in Kuching, Sarawak. Several flights were cancelled. The number of tourists in 1997 fell 13% from 7.1 million in 1996 to 6.2 million in 1997. A total of 1.5 million cases of asthma attacks were reported in four states in Malaysia—Selangor, Malacca, Sabah, and Sarawak—at the height of the haze period (Mohd. Nasir et al. 1998). Malaysia incurred an economic loss of USD 310 million, with 50.65% from industrial production losses and 40.97% from tourism losses. Short-term health damages took up 2.58% of the losses (Mohd Shahwahid and Jamal 1999).

Table 1 continued

Year	Highest API	Cause of Haze	Haze Impacts
2005 August (Port Klang and Kuala Selangor)	531 (Port Klang)		This haze resulted in the closure of 816 schools in Kuala Lumpur and Selangor because the API was beyond 300 and considered hazardous to health (*The News Straits Times*, 12 August, 2005). Visibility dropped to less than 400 m and flights to Subang Airport near Kuala Lumpur were suspended. Schools and one of Malaysia's key ports, Northport, also suspended operations. Shipping in the Malacca Straits was also affected by the haze. Some government hospitals and clinics saw a 150% rise in respiratory complaints.
2006 (Most parts of Malaysia - eastern Sarawak, and western and southern Peninsular Malaysia)	Unhealthy. 198 (Nilai) 171 (Putrajaya)		Bad visibility posed a threat to sea vessels without navigation devices. Anger and hardship among Malaysians Had implications on tourism and economic activities such as hawking, night markets, and outdoor activities.
2009	108 (Kuala Lumpur)		None
2010 October (West coasts of Johore and Malacca)	In Muar, API reached 432 at 11 a.m. on 20 October (*The Star Online*, 21 October, 2010)	Open burning in Indonesia	School closed in Muar for several days. Prior to this, 80,282 students from 204 schools were advised not to attend school.
2013 (Western, central, and southern Peninsular Malaysia)	746 (Muar)		Schools closed in serious areas (those reaching 300 API). Citizens were advised to avoid outdoor activities in areas reaching 150 API. State of Emergency was declared on 23rd June in Muar and Ledang. All schools closed (24th June) in Kuala Lumpur, Selangor and Malacca.

Note: TSP = total suspended particles

Meanwhile, mild haze had begun to affect Singapore on 13th June before the air quality worsened and remained in the "unhealthy" range for a few days.[5] The PSI reading first hit levels unseen since 1997 when a PSI of 155 was recorded on 17 June 2013.[6] On 19th June 2013, the PSI reading of 321 breached the "hazardous" mark for the first time in the nation's history, exceeding its previous record of 226 (very unhealthy) during the 1997 haze. This worsened on 20th and 21st June 2013 when the PSI reading reached 371 and 400, respectively.[7] Shortly after, the new record was broken again at 12 noon, with a PSI reading of 401.[8]

3.0 METHODOLOGY

3.1 Impacts of the Haze on the Local Population and Economy

Data was gathered on the impacts of the haze on Malaysians by conducting structured interviews. Surveys were undertaken by a group of enumerators well-briefed prior to the actual survey and after undergoing a pilot survey involving some 30 samples in Bandar Baru Bangi, Selangor. The actual survey was undertaken in eight states of Peninsular Malaysia that were likely to face serious haze incidents (Table 2). The period of the survey was a two-week period from the last week of August to the first week of September 2013. All the data collected was compiled into one common database.

To investigate the impacts of haze on the local people, structured interviews using questionnaires were conducted. The questionnaire was intended to ascertain household perceptions of the haze, and how these affected household behavior and spending patterns. The respondents selected were members of households with a preference for household heads. The enumerators met them at selected public areas such as malls, public parks, and markets for the interviews. They recorded the information obtained in the questionnaire forms. The questionnaire covered health effects, including illnesses suffered and their intensities, durations, and associated costs. Loss of productivity and quality of life were also assessed. The respondents were further asked as to whether they would be interested to contribute to mitigation measures in order to protect their air quality from deteriorating due to haze. Socioeconomic background information on the sample households was also included.

Table 2. Survey locations and sample sizes

District	State	Sample Size (Households)	%
Muar	Urban, Johore	30	8.3
Johore Bahru	Sub-urban, Johore	30	8.3
Malacca town	Urban, Malacca	30	8.3
Jasin	Sub-urban, Malacca	30	8.3
Seremban	Urban, Negeri Sembilan	30	8.3
Beranang	Sub-urban, Negeri Sembilan	30	8.3
Kajang	Urban, Selangor	30	8.3
Kuala Lumpur	Urban, Kuala Lumpur	30	8.3
Penang island	Urban, Penang	30	8.3
Ipoh	Urban, Perak	30	8.3
Grik	Sub-urban, Eastern Perak	30	8.3
Kuantan	Urban, Pahang	30	8.3
	Total	360	100.0

[5] *Channel News Asia,* 24 June, 2013
[6] *Online Wall Street Journal,* 18 June, 2013
[7] *Channel News Asia,* 20 June, 2013
[8] *Channel News Asia,* 21 June, 2013

The information gathered from the questionnaire was used to value the impacts of the haze using various economic valuation methods (Table 3). The COI approach was undertaken on local households to profile the various forms of health impacts due to the haze, which included the extent of exposure to illnesses such as cough, sore throat, conjunctivitis, and asthma. The respondents were asked if they had undergone medical treatment and if so, whether it had been self-treatment or from formal medical centers. Apart from medical treatment, the respondents were asked whether they had incurred inconvenience relating to travel, health, occupation, and other routine activities, and to assess the value of the losses they had incurred using approaches like foregone earnings. Information on expenditure undertaken on mitigation measures to reduce the health impacts and inconveniences was collected. To protect against facing a decline in air quality, the Contingent Valuation Method (CVM) was used to assess if households would be willing to pay an insurance premium. This was an indirect way of determining the value the respondent households placed on clean air.

Table 3. Economic valuation methods adopted to assess the haze impacts

Forms of Impact	Valuation Methods	Data Used
Medical illnesses	Cost of illnesses, contingent valuation	Haze-related sicknesses and productivity losses Medical treatment Health-related inconveniences
Closure of businesses and offices	Opportunity cost	Loss of business opportunities and sales
Inconvenience related to travel, health, and economic activities	Contingent valuation	Willingness to pay an insurance premium to cover against the inconveniences
Masks	Expenditure method	Number and price of masks purchased

3.2 Data Collection on API and Rainfall Intensities

Inquiries were made to government agencies to obtain relevant statistical data on haze and rainfall intensities across districts in Peninsular Malaysia. The data on the frequency and intensities of haze for the period May to September 2013 were obtained from the Department of Environment (DOE) while the data on rainfall intensities was purchased from the respective meteorological stations in the study areas. The level of haze is typically measured by API. In order to conduct the regression analysis, API data and rainfall readings were collected from matching districts or districts immediately adjacent as shown in Table 4.

Table 4. Data on API and rainfall readings from matching districts

Department of Environment (API Data)	Meteorological Station (Rainfall Data)
Alor Setar	Alor Setar
Muar	Batu Pahat
Ipoh	Ipoh
Banting	KLIA Sepang
Kota Tinggi	Kluang
Bandaraya Malacca	Malacca
Petaling Jaya	Petaling Jaya
Perai	Perai
Larkin Lama	Senai

3.3 Occurrence of Haze and Its Relationship with Rainfall Patterns

The intensity and distribution of haze across the states and their relationship with important factors in Peninsular Malaysia were investigated. To ensure the occurrence of haze during the study period was not commonly occurring throughout the year, statistical tests were undertaken to compare the API levels before, during, and after the haze incidence period. Statistical tests were undertaken to test the following hypotheses:

1. H_0: $u_{bef} = u_{during}$
2. H_0: $u_{during} = u_{after}$
3. H_0: $u_{bef} = u_{during} = u_{after}$

Similarly, to understand the relationship between haze impacts and the occurrences of rain, the following statistical tests were undertaken:

1. The t-test was undertaken to test H_0: $u_{bef} = u_{during}$ and H_0: $u_{during} = u_{after}$
2. The Anova test for (H_0: $u_{bef} = u_{during} = u_{after}$) during the June 2013 haze incident
3. Regression analysis to show the relationship between daily API and the rainfall measurements between 14th and 29th June 2013.

4.0 RESULTS

4.1 Trend in API Readings and Test of Statistical Difference

There was a clear indication of the occurrence of haze in several western states of Peninsular Malaysia according to the APIs during the month of June 2013 from the 14th until the end of the month. A comparison was made with the levels before and after this period. Figure 1 shows that there were spurges of rising API readings in all the districts investigated during the two-week period in June. Relatively high readings were recorded in

1. Muar, Johore (API 670);
2. Malacca City, Malacca (API 380);
3. Banting, Selangor (API 260); and
4. Seberang Perai, Penang (API 220).

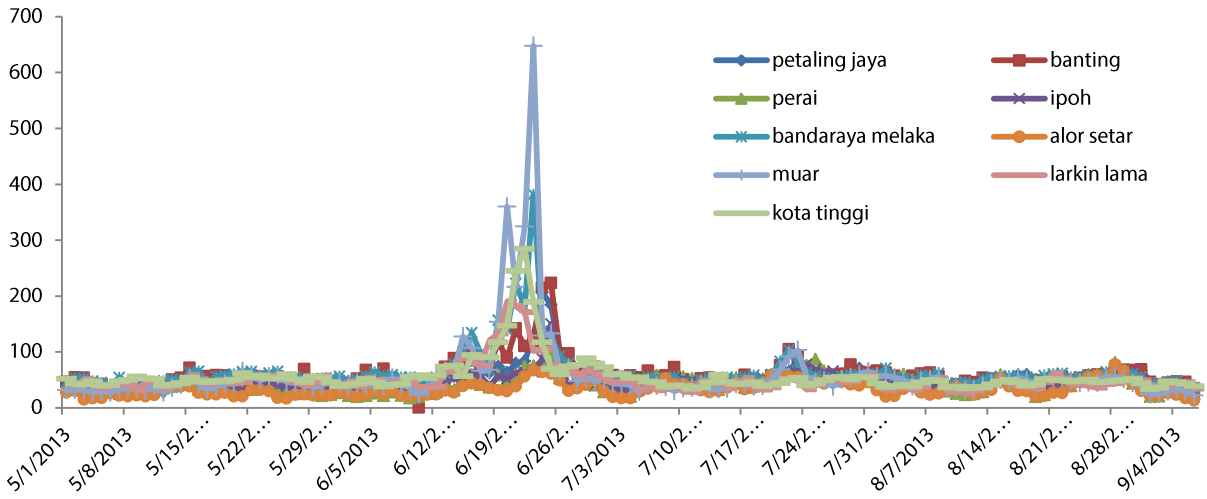

Figure 1. Trend in API readings during the June 2013 haze

4.1.1 Haze intensities at district level

In Johore, there are several districts where the Department of Environment has set up monitoring stations, including Muar, Kota Tinggi, and Larkin. Muar experienced four API surge cycles beginning on the 13th of June with an API reading of 66, which reached a mini peak of 128 on the 15th. Thereafter, it simmered down to 66 on the 17th of June (Figure 2). The main cycle had a reading of 216 on 21st June that eventually peaked on the 23rd at 648, thereafter falling to 66 on the 24th of June. The haze episode eventually had another mini cycle that peaked at 71 and then dropped to a reading of 48 on the 30th of June.

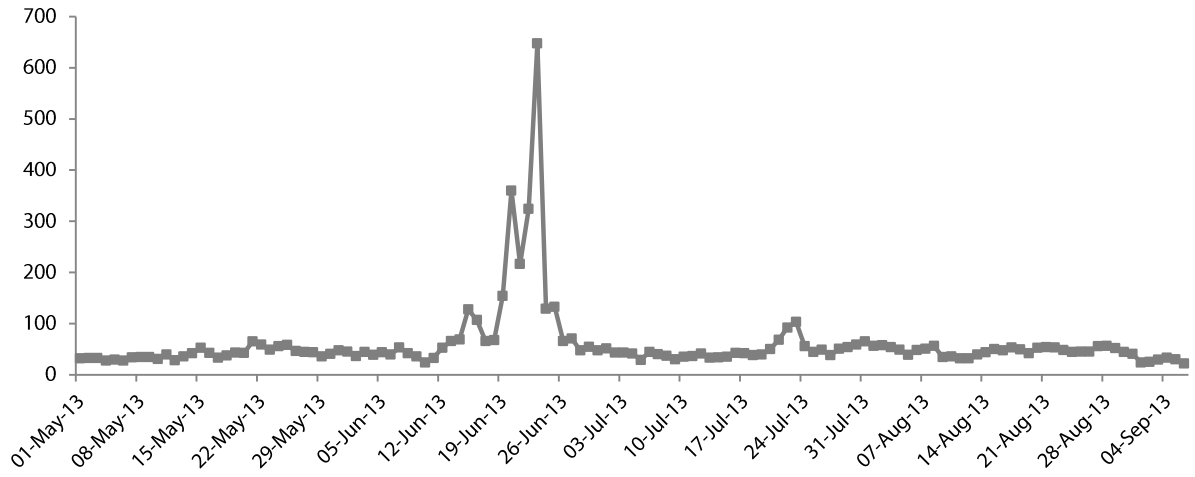

Figure 2. Trend in the API readings for the period May to September 2013, Muar, Johore

Source: Plotted using data collected from the Department of Environment's "apims.doe.gov.my" portal

An API reading of 648 is considered to be a state of emergency (> 500), considered a danger to health, that warrants the expectation of severe aggravated symptoms. The general population is then advised to follow the orders of the National Security Council and other instructions/advice for action given through announcements by the mass media.

Table 5 provides the API categories in terms of the status of air pollution and required health measures to be taken by groups of society. The haze occurrences have caused much inconvenience and hardship among Malaysians and have affected tourism and economic activities, such as hawking, night markets, and outdoor activities. The components found in the haze include carbon monoxide, sulfur dioxide, nitrogen dioxide, ozone, dust, and metals that can have adverse effects on human health, especially in children, the elderly, and those suffering from diseases such as asthma, allergies, pneumonia and lung disease. Smokers and those who work in open areas also face higher risks to their health.

Table 5. API categories by level of pollution and health precautions

API	Status	Level of Pollution	Health Precautions
0–50	Good	Low, no ill effects on health	No restriction of activities for all groups
51–100	Moderate	Moderate pollution, no ill effects on health	No restriction of activities for all groups
101–200	Unhealthy	Mild aggravation of symptoms among high-risk groups, e.g., those with heart or lung disease	Restriction of outdoor activities for high-risk persons General population should reduce vigorous outdoor activity

Table 5 continued

API	Status	Level of Pollution	Health Precautions
201–300	Very unhealthy	Significant aggravation of symptoms and decreased exercise tolerance in persons with heart or lung disease	Elderly and persons with known heart or lung disease should stay indoors and reduce physical activity. General population should avoid vigorous outdoor activity. Those with any health problems need to consult a doctor.
301–500	Hazardous	Severe aggravation of symptoms and a danger to health	Elderly and persons with existing heart or lung disease should stay indoors and reduce physical activity. General population should avoid vigorous outdoor activity.
Above 500	Emergency	Severe aggravation of symptoms and a danger to health	The general population is advised to follow the orders of the National Security Council and to always abide by instructions given through mass media announcements.

Source: Department of Environment (2000)

The following are the API trends for four other districts with different API levels. Perai district in Penang had a haze cycle beginning from 14th June, 2013, with an API reading of 40, peaking on the 25th with a reading of 107 and then declining on the 30th June to 41 (Figure 3). At its peak, the population of Perai faced an unhealthy environment diagnosed to result in mild aggravated symptoms mainly among the high-risk groups, such as those with heart or lung disease. The high-risk persons were advised to restrict their outdoor activities while the general population was advised to reduce vigorous outdoor activity.

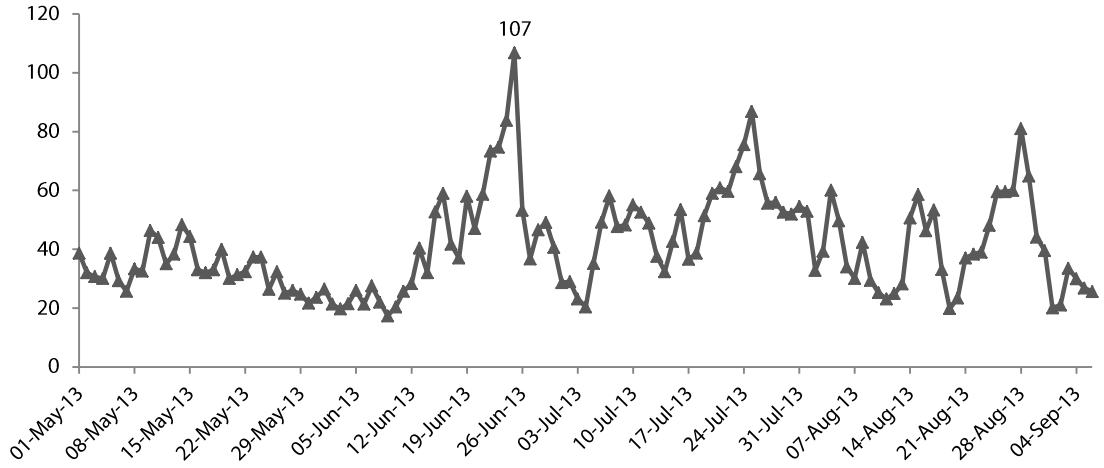

Figure 3. Trend in the API readings from the period May to September 2013, Perai, Penang

Source: Plotted using data collected from the Department of Environment's "apims.doe.gov.my" portal

Two districts in Selangor—Petaling Jaya and Banting—and a district in Johore (Kota Tinggi) saw peak periods in the "very unhealthy" category of API readings ranging 200–300. Petaling Jaya, an urban residential and industrial township, had haze from the 13th of June with an API reading of 52 to the 30th of June with a reading of 43. The peak occurred on the 24th with a "very unhealthy" API reading of 206 (Figure 4).

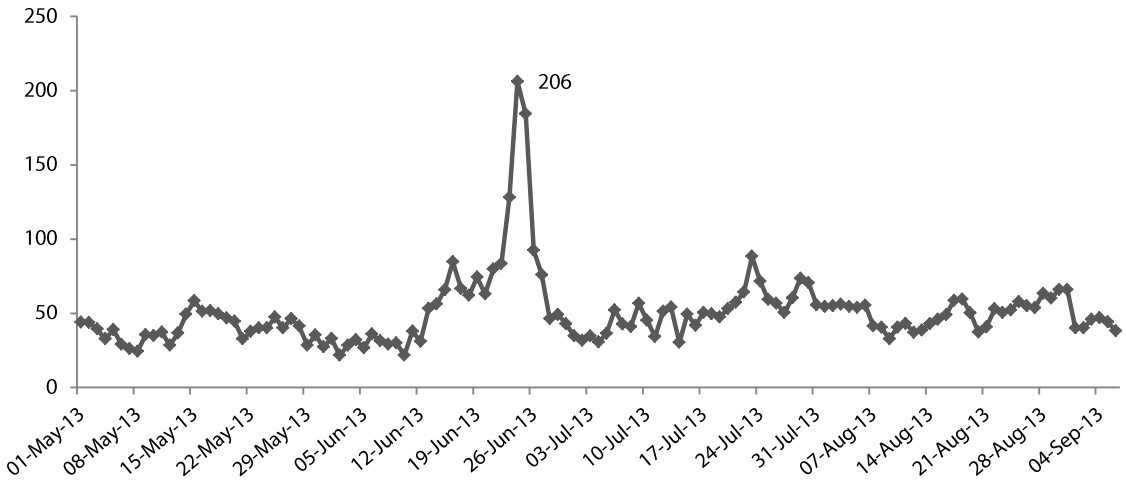

Figure 4. Trend in API readings from the period May to September 2013, Petaling Jaya, Selangor

Source: Plotted using data collected from the Department of Environment's "apims.doe.gov.my" portal

On the other hand, Banting, a rural township located within the peat swamp forest belt, had its intense haze period beginning from the 13th of June but at a higher API reading of 73, ending on a similar level on the 30th of June (Figure 5). The peak period on the 24th and 25thof June had API readings of 214 and 223, with both days in a "very unhealthy" state of environment. Kota Tinggi district had its intense haze period also beginning from the 13th of June with an API reading of 73 but ending slightly later on the 3rd of July with a reading of 60 (Figure 6). The peak period on the 21st and 22nd June had API readings of 245 and 284, considered as "very unhealthy." Under a "very unhealthy" state of environment, persons with heart or lung disease are expected to show significant aggravated symptoms and decreased exercise tolerance. Elderly persons and those with known heart or lung disease should stay indoors and should reduce physical activity. The general population should avoid vigorous outdoor activity. Those with health problems need to consult their doctor.

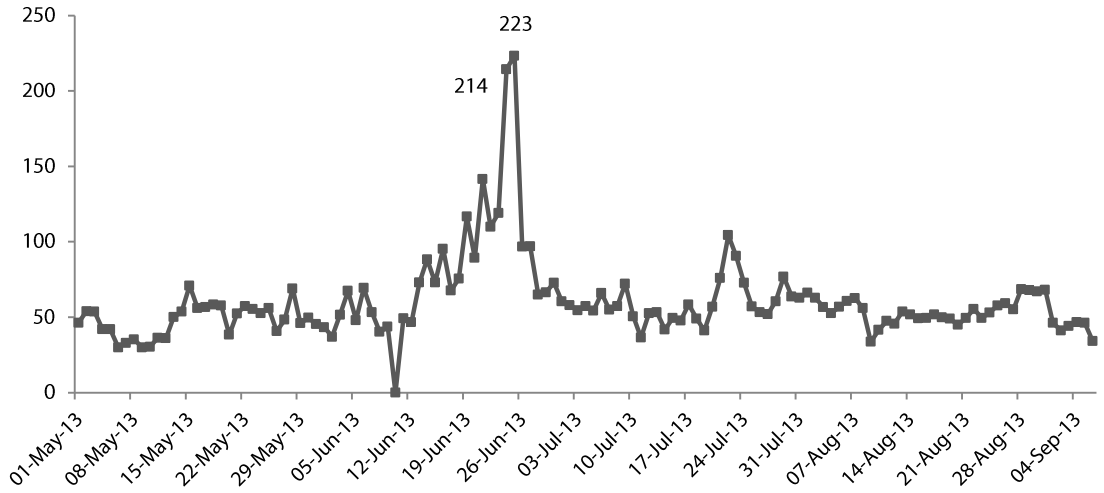

Figure 5. Trend in API readings from the period May to September 2013, Banting, Selangor

Source: Plotted using data collected from the Department of Environment's "apims.doe.gov.my" portal

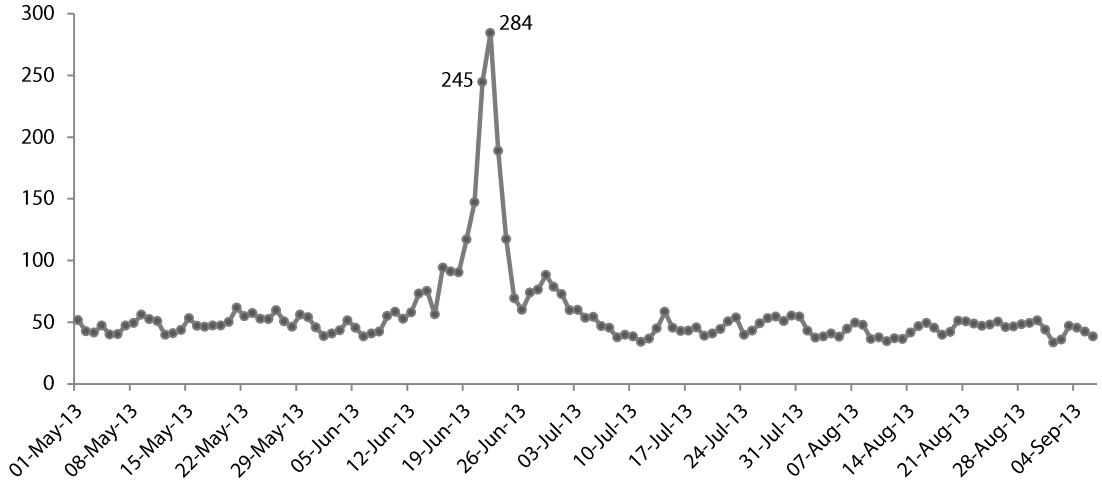

Figure 6. Trend in API readings from the period May to September 2013, Kota Tinggi, Johore

Source: Plotted using data collected from the Department of Environment's "apims.doe.gov.my" portal

For Malacca City, an urban residential and business township, the haze lasted from the 13th of June with an API reading of 62 to the 30th of June with a reading of 60 with two peaks occurring on the 21st with an API reading of 223 (very unhealthy) and on the 24th with a reading of 385 (hazardous). The hazardous state of environment poses a danger to the elderly and persons with existing heart or lung disease; severe aggravated symptoms are expected. Vulnerable groups should stay indoors and reduce physical activity. The general population should also avoid vigorous outdoor activity.

4.1.2 Statistical difference of means

The above graphical analyses show the changes in the API trends during the intense haze period in the third and fourth weeks of June 2013 along with the periods before and after the haze period. There was a need to verify if there were differences in means between the intense haze period with that before or/and after this period, using tests of statistical significance. The statistical tests used were the t-test and analysis of variance (ANOVA). For the nine districts, it was found that the means of the API readings during the June intense haze period were significantly different from the means of API readings before and after the period (Table 6).

Table 6. Tests of difference of means of API readings before, during, and after the 2013 haze episodes in several districts

Districts	Hypotheses Tested						
	H_0: $U_{before} = U_{during}$			H_0: $U_{during} = U_{after}$			H_0: $U_{before}=U_{during}=U_{after}$
	U_{during}	U_{before}	t-stat	U_{during}	U_{after}	t-stat	ANOVA (F-stat)
Petaling Jaya	86.55	36.69	4.78*	86.55	41.74	2.22*	16.05*
Banting	106.63	47.29	4.90*	106.63	55.29	3.93*	19.04*
Perai	55.91	30.48	7.00*	55.91	41.33	2.43*	22.92*
Ipoh	61.99	38.16	4.83*	61.99	42.66	1.88*	14.36*
Malacca City	128.08	53.27	3.45*	128.08	52.79	3.31*	11.27*
AlorSetar	42.07	24.66	7.41*	42.07	33.90	1.81*	20.91*
Muar	159.14	40.56	2.93*	159.14	39.11	2.66*	7.79*
Larkin Lama	100.58	45.19	3.17*	100.58	41.65	3.64*	11.40
Kota Tinggi	114.57	48.63	3.16*	114.57	49.93	3.63*	11.52*

Note: *Statistically significant at the 5% level

4.2 Awareness of the June 2013 Haze in Peninsular Malaysia

Of the 360 respondents, 97.2% were aware of the June 2013 haze incident in Peninsular Malaysia. In fact, 9 out of the 12 districts covered by the survey had 100% awareness among the respondents (Figure 7). The exceptions with 93.3% level of awareness occurred in the districts of Grik and Jasin, both rural districts. Hence, even respondents living in rural areas had been aware of the haze. It is possible that with the use of information technology, information spread out rapidly even to remote areas.

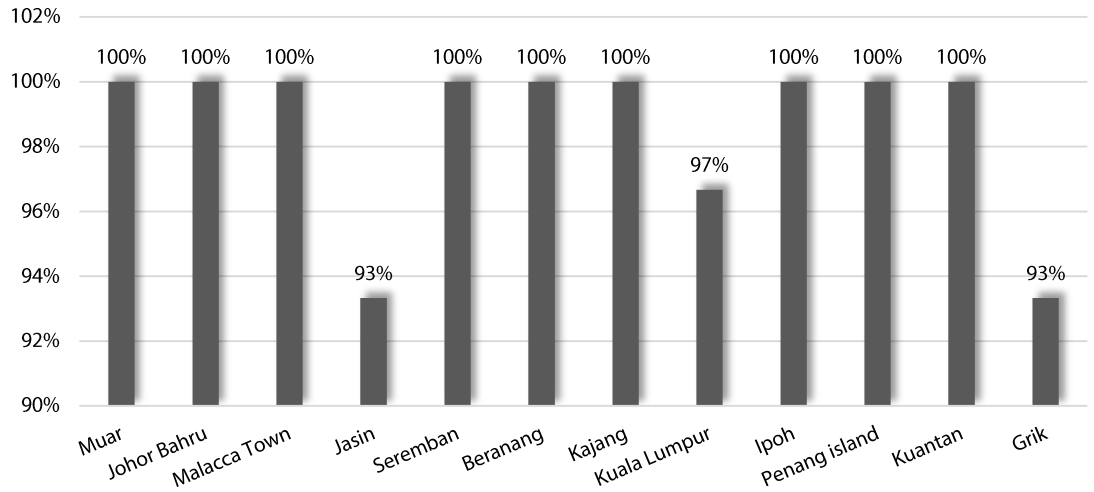

Figure 7. Haze awareness among districts in Peninsular Malaysia

The main sources of information were from the respondents' own personal observation (46%) and from reading the newspapers (42%) (Figure 8). Hearsay and word-of-mouth delivery from neighbors and colleagues was also influential, taking up 10%. With the exception of respondents from Grik, Kuantan, Ipoh, and Penang, a high majority of respondents from all the other districts experienced the haze personally, without having to rely on media reports (Table 7). In the four districts mentioned, 86.7% of the respondents relied on media reports on the haze.

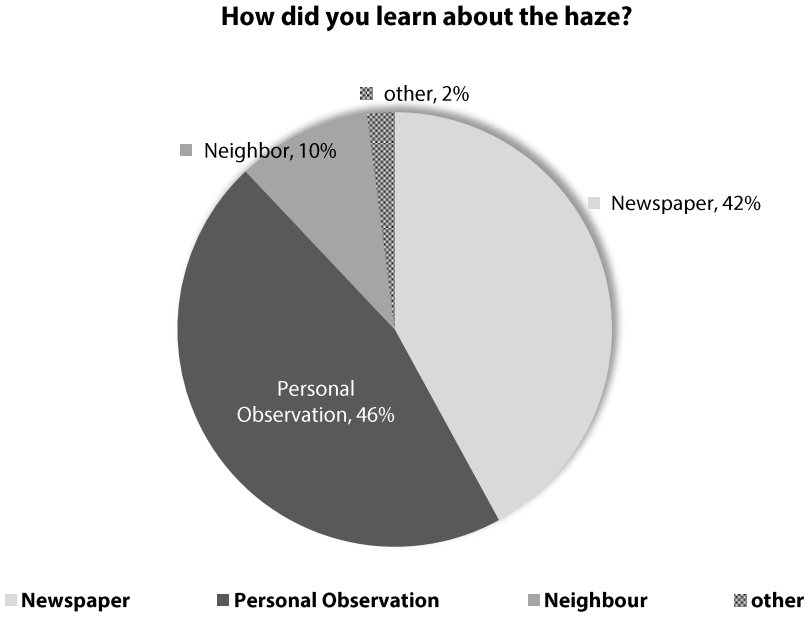

Figure 8. Sources of information on the haze for the respondents

Table 7. Sources of information on the haze by district*

District	Newspaper	Personal Observation	Neighbor	Others
Muar	26.7	96.7	0.0	0.0
Jasin	73.3	76.7	3.3	3.3
Malacca Town	16.7	100.0	6.7	0.0
Kuala Lumpur	16.7	100.0	6.7	3.3
Johore Bahru	86.7	76.7	16.7	10.0
Grik	86.7	43.3	33.3	6.7
Kuantan	86.7	43.3	33.3	6.7
Ipoh	86.7	43.3	33.3	0.0
Penang	86.7	43.3	33.3	0.0
Kajang	70.0	70.0	3.3	3.3
Seremban	70.0	63.3	6.7	0.0
Beranang	50.0	70.0	3.3	3.3

Note: * There were multiple sources of information that contributed to the awareness of the respondents. Hence, the total percentage of responses for each district exceeded 100%.

Although haze is not a new phenomenon in Malaysia, the level of awareness of previous incidents varied. Awareness of haze events in Malaysia was higher for the more recent incidents. Only 7.22% were aware that Malaysia had experienced haze in 1994, 27.22% were aware about the large 1997 incident, 44.72% of the 2006 haze, and 33.33% of the 2010 occurrence (Table 8). A larger proportion was aware of the 2006 incident than the 2010 incident. An important reason for this was that the 2010 incident was localized in the southwestern part of the peninsula covering the states of Johore and Malacca. The low awareness of the earlier haze incidents was probably due to the ages of the respondents who may have been children then or not yet born.

Table 8. Recollection of previous haze incidents

Year of Incident	Number	Percentage
1994	26	7.22
1997	98	27.22
2006	161	44.72
2010	120	33.33

4.3 Haze Impacts

Some 293 respondents or 81.4% were affected by the 2013 haze, implying that a small proportion (18.6% or 67 respondents) was not affected by the haze at all (Table 9). All of the respondents from Muar were affected by the haze. Other districts with high levels of respondents affected by the haze were in the districts of Johore Bahru, Malacca Town, and Penang Island. All three areas recorded 96.67% of affected respondents. Seremban, Kuala Lumpur, Kuantan, and Grik had 93.33% affected respondents. Despite being located in the hills of the Main Range with vast forest areas and despite being on the east coast, Grik and Kuantan respondents reported exposure to the haze indicating that haze had spread over the peninsula. The respondents in cities and townships located inland also reported being affected by the haze. These included Kajang (90%), Beranang (73.33%), and Ipoh (70%).

The major impacts were health- and lifestyle-related, involving 73.89% and 52.22% of the total number of respondents, respectively (Table 10). These high occurrences influenced the efforts undertaken by the respondents to moderate or overcome these effects. Medical treatment and illness prevention costs would have eaten into the respondents' expenditure budget. Similarly, lifestyle activities like outdoor dining, leisure, and recreational activities would have had to be postponed or reduced. Travel for social or holiday purposes would have had to be postponed and cancelled. Travel-related activities and occupational-related losses, however, affected only 11.67% and 1.11% of the respondents, respectively. Note that only a small number felt that the haze had affected their ability to fulfill their occupation obligations.

Table 9. Distribution of respondents affected by the 2013 haze

Location	Percentage
Muar	100.00
Johore Bahru	96.67
Malacca Town	96.67
Jasin	67.67
Seremban	93.33
Beranang	73.33
Kajang	90.00
Kuala Lumpur	93.33
Ipoh	70.00
Penang Island	96.67
Kuantan	93.33
Grik	93.33
Total	81.40

Table 10. Nature of the 2013 haze impacts

Nature of Impact	Number of Responses[1]	Percentage[2]
Health-related	266	73.89
Lifestyle-related	188	52.22
Travel-related	42	11.67
Occupation-related	4	1.11

Notes: (1) Multiple selection of responses by respondents because more than one impact could occur. (2) Percentage of the number of respondents experiencing the respective impacts over the total number of respondents (360).

Health-related impacts were consistently high among the respondents in all the districts investigated (Table 11). With the exceptions of Malacca Town (6.7%) and Muar (10.0%), high proportions of respondents from all the other locations were affected by lifestyle-related impacts as well. It is possible that the households in Malacca Town and Muar had gotten used to the haze as they had experienced it more frequently. Major locations where lifestyle changes were high were Kuala Lumpur and Kajang, both with 83.3% of respondents affected. As for travel-related impacts, certain districts like Jasin (43.3%), Johore Bahru (20.0%) and Kuantan (16.7%) showed higher frequencies. Occupation-related impacts occurred only rarely (6.7%) and in Penang Island and Kuantan.

Table 11. Nature of the 2013 haze impacts by location

Location	Health-Related (%)	Lifestyle-Related (%)	Travel-Related (%)	Occupation-Related (%)
Muar	76.7	10.0	0.0	0.0
Johore Bahru	70.0	50.0	20.0	0.0
Malacca Town	90.0	6.7	0.0	0.0
Jasin	83.3	66.7	43.3	0.0
Seremban	86.7	60.0	6.7	0.0
Beranang	60.0	66.7	10.0	0.0
Kajang	76.7	83.3	10.0	0.0
Kuala Lumpur	90.0	83.3	6.7	0.0
Ipoh	73.3	53.3	10.0	0.0
Penang Island	43.3	36.7	13.3	6.7
Kuantan	80.0	83.3	16.7	6.7
Grik	56.7	26.7	3.3	0.0
Overall	73.9	52.2	11.7	1.1

4.3.1 Health-related impacts

The forms of health-related impacts were classified into several categories as follows:

1. Throat-related illnesses from mild and transient itchy throat to intense coughing; before coughing becomes intense, typically the individual gets a mildly itchy throat first before it develops into a cough
2. Mild breathing problems to intense asthma
3. Mild eye irritation to intense conjunctivitis
4. Blurred vision due to thick PM_{10} particles in the air
5. Headaches
6. Skin irritation

The survey was undertaken in the last week of August and first week of September 2013, after the haze had simmered down and when air pollution levels had returned to normal. As mentioned earlier, health-related haze impacts affected 73.89% of the samples. These were dominated by eye irritations involving 36.11% of the respondents, coughing occurring among 37.50%, blurred vision in 23.61%, and itchy throat affecting 21.94% (Table 12). The fact that high proportions had both mild and intense effects also suggested that the medical treatments adopted may not have been equally effective for all the respondents. Other forms of health impacts that occurred were headaches (13.61%), skin irritation (11.94%), breathing difficulties (16.11%) and asthma (4.72%). As a proportion of the total health-related impact responses (596), it was reiterated that coughing, eye irritation, blurred vision, and itchy throat were the major concerns affecting 22.65%, 21.81%, 14.26% and 13.26%, respectively. Other health-related impacts affected a smaller proportion of the total responses.

Table 12. Health-related impacts

Health Impacts	Frequency[1]	Percentage of Sample[2]	Percentage of Health Impacts[3]
Eye irritation	130	36.11	21.81
Coughing	135	37.50	22.65
Headaches	49	13.61	8.22
Skin irritation	43	11.94	7.21
Itchy throat	79	21.94	13.26
Breathing difficulties	58	16.11	9.73
Blurred vision	85	23.61	14.26
Asthma	17	4.72	2.85
Total	596		100.00

Notes: (1) Multiple responses because more than one impact could occur. (2) Percentage of respondents experiencing the respective impacts over the total number of respondents (360). (3) Percentage of respondents experiencing the respective impacts over the total number of positive responses (596) for all types of health impacts.

In terms of health impacts by district, the incidence of coughing was highest in the districts of Kuantan, Jasin, Malacca Town, and Ipoh with responses greater and equal to 50%; itchy throat incidence was greater in Kuala Lumpur, Ipoh and Kuantan with the rest of the districts having low levels of such complaints (Table 13). Eye irritation exceeded 50% in Malacca Town (73.33%), Muar (63.33%), and Kuala Lumpur (56.67%), with Kuantan and Jasin respondents having medium levels of eye irritation. Blurred vision affected the respondents in Kuala Lumpur, Ipoh, and Kuantan. Asthma, headache, and skin irritation mildly affected all the districts with a few not affected at all.

Table 13. Distribution of health-related impacts across districts (%)

District	Eye Irritation	Cough	Headache	Skin Irritation	Sore Throat	Breathing Problem	Blurred Vision	Asthma
Muar	63.33	13.33	13.33	20.00	6.67	20.00	10.00	3.33
Johore Bahru	23.33	43.33	–	13.33	10.00	10.00	23.33	3.33
Malacca Town	73.33	50.00	20.00	3.33	16.67	–	–	–
Jasin	46.67	56.67	13.33	33.33	40.00	36.67	20.00	23.33
Seremban	26.67	46.67	6.67	–	13.33	36.67	33.33	3.33
Beranang	26.67	16.67	6.67	13.33	10.00	16.67	6.67	–
Kajang	33.33	30.00	13.33	23.33	16.67	23.33	23.33	3.33
Kuala Lumpur	56.67	33.33	13.33	10.00	56.67	10.00	50.00	–
Ipoh	16.67	53.33	20.00	3.33	50.00	26.67	43.33	10.00
Penang island	10.00	26.67	23.33	–	20.00	6.67	13.33	–
Kuantan	43.33	66.67	20.00	10.00	20.00	6.67	40.00	–
Grik	13.33	13.33	13.33	13.33	3.33	–	20.00	10.00
Average	36.11	37.50	13.61	11.94	21.94	16.11	23.61	4.72

The health-related impacts were also being felt by family members. Some 58.06% of the respondents surveyed were directly affected by the above range of illnesses while 29.44% members of their households (i.e., their spouses, children, and other members of the family) had also been affected (Table 14). About a third (36.94%) of the respondents reported that the haze had not affected them or their family members. Meanwhile, the proportions of the respondents and their household members facing the various health impacts varied. Although 36.94% of the respondents and family members were not affected by haze-related health impacts, the proportions varied when broken down by specific health impacts (Table 15). High proportions of the respondents and family members, i.e., 93.06%, 92.78% and 86.11%, respectively, were not affected by breathing difficulties, asthma, and nasal allergies. Only 52.22% and 44.72% of the respondents and family members were affected by eye irritation and severe coughing, respectively. Severe coughing affected 42.57% of the respondents and 20.28% of their family members, while eye irritation and conjunctivitis involved 36.82% of the respondents and 17.22% of the family members. The other three health impacts were sparingly affecting the populations.

Table 14. Proportion of respondents and family members experiencing health-related impacts

Incidence of Health Impacts	Number	Percentage
Respondents only	209	58.06
Family members only	106	29.44
Respondents and family members affected	227	63.06
Respondents and family members not affected at all	133	36.94

Note: 63.06% of the respondents and their family members experienced health impacts of the haze. About 18.06% were their spouses, 21.67% were their children, and 6.94% were other members of the family (e.g,. grandparents or other close relatives).

Table 15. Proportion of household members affected by health-related impacts

Illness	No Impacts		Own Experience		Other Household Members	
Eye irritation /conjunctivitis	188	52.22%	109	36.82%	63	17.22%
Severe coughing	161	44.72%	126	42.57%	73	20.28%
Nasal allergies	310	86.11%	31	10.47%	19	5.28%
Breathing difficulties	335	93.06%	15	5.07%	10	2.78%
Asthma	334	92.78%	15	5.07%	11	3.06%

4.3.2 Lifestyle impacts

The form of lifestyle-related impacts was mainly a reduction in outdoor recreational activities involving 41.11% of the respondents, followed by reduced dining at outdoor eateries occurring among 26.94% of the respondents (Table 16 and Figure 9). Reduced shopping activities affected only 15.83% of the respondents due to a greater percentage of the population having indoor shopping alternatives like supermarkets. Although some respondents reported that they had experienced impacts upon their travel and occupations, they did not provide details on these impacts.

Table 16. Frequency of form of lifestyle impacts

Lifestyle forms	Frequency[1]	Percentage of Samples[2]	Percentage of Lifestyle Impacts[3]
Reduced outdoor recreation	148	41.11	49.01
Reduced shopping activities	57	15.83	18.87
Reduced dining at outdoor eateries	97	26.94	32.12
Total	302		100.00

Notes: (1) Multiple selection of responses by respondents because more than one impact could occur. (2) Percentage of respondents experiencing the respective impacts over the total number of respondents (360). (3) Percentage of respondents experiencing the respective impacts over the total number of positive responses (302) for all lifestyle-type impacts.

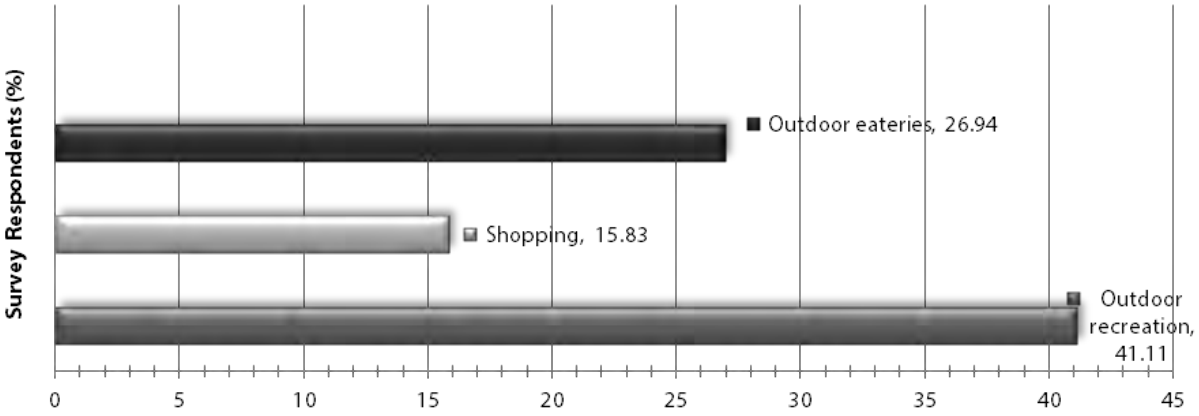

Figure 9. Percentage of form of lifestyle impacts

4.4 Valuing Haze Impacts

The respondents took mitigation and abatement measures in order to contain the health impacts of the haze. Among these measures were wearing air pollution masks to filter the air breathed in. This was a popular effort undertaken by 50.83% of the respondents (Table 17). The health-related impacts caused 22.50% of the respondents to go to the clinic for treatment. Common medicines prescribed for the patients were for cough syrup, eye drops, and skin irritation cream. Although some respondents visited the clinic, many sought self-treatment by purchasing their own medicines. The respondents (32.78%) bought and used eye drops to treat eye irritation. The more popular action was procuring of cough drops and over-the-counter cough syrups; this was done by 38.61% of the respondents. A small minority (2.78%) of the respondents purchased skin irritation creams. Another popular action was just to rest at home, which was done by 49.72% of the respondents. The sum total of the responses to health-related impacts exceeded 100% indicating that some respondents took multiple steps to tackle the situation. Depending on their exposure to the haze, respondents would for example, wear masks and purchase medicines for cough, eye irritation, and skin irritation, either as treatments or precautions.

Table 17. Measures undertaken to tackle the health impacts of the haze

Measures	Number	Percentage
Use air pollution masks	183	50.83
Seek medical treatment	81	22.50
Self-treatment with eye drops	118	32.78
Self-treatment with cough syrup	139	38.61
Self-treatment with skin irritation ointments/creams	10	2.78
Rest at home	179	49.72

Note: Figures reported in this table are from multiple responses.

4.4.1 Cost of masks

Wearing air pollution masks was the simplest action taken by residents exposed to haze when outdoors. The price of masks ranged from MYR 0.80 to MYR 5.00 per piece with an average of MYR 1.15. Respondents who purchased masks also did so for their family members averaging about 3.26 units per family with an average expenditure of MYR 3.75.

4.4.2 Cost of medical treatment

Of the 360 respondents surveyed, more than half (56.94%) sought some type of treatment for ailments caused by the haze, from either public or private clinics or by self-medication (Table 18). Of the respondents seeking help, 21.11% (or 76 respondents) opted not to see a doctor and instead relied on self-medication by purchasing medicines from pharmacies. Some 20% of the respondents sought outpatient medical consultation. Only 1.11% of the respondents required advanced treatment and hospitalization.

A breakdown of the medical treatment sought by district is provided in Table 19. On average, the number of respondents who sought self-treatment in Kuantan, Ipoh, Grik, Kuala Lumpur, and Johore Bahru was higher than that of the average in the whole Peninsular Malaysia. Public clinic outpatient numbers were higher in Muar, Malacca Town, and Kuantan than the average for the whole Peninsular Malaysia. Private clinic outpatients outnumbered the peninsula average in Kajang, Kuala Lumpur, Jasin, Ipoh, and Seremban. Medical treatment for family members was higher than the peninsula average in Kuala Lumpur, Kajang, Penang Island, Johore Bahru, Kuantan and Jasin. Slightly higher proportions were hospitalized in Kajang, Kuala Lumpur, Penang Island, and Kuantan.

Table 18. Sources of treatment for ailments caused by haze

Forms of Medical Treatment Taken	Frequency	Percentage
Self-treatment	76	21.11
Public clinics	72	20.00
Private clinics	53	14.72
Hospitalization	4	1.11

Table 19. Sources of medical treatment by district (MYR/household)

District	Public Clinic		Private Clinic		Self-Treatment		Family Treatment		Hospitalization	
	No.	MYR	No.	MYR	No.	MYR	No.	MYR	No.	MYR
Muar	22	23	2	65	3	20	0	0	0	0
Johore Bahru	4	5	4	230	7	250	5	232	0	0
Malacca Town	21	22	3	100	3	20	0	0	0	0
Jasin	5	6	7	415	3	65	4	155	0	0
Seremban	1	1	6	175	6	210	0	0	0	0
Beranang	1	1	3	81	3	28	0	0	0	0
Kajang	1	40	9	335	3	200	4	705	1	100
Kuala Lumpur	1	5	8	1,030	9	160	5	1,050	1	80
Ipoh	1	13	6	320	11	227	1	100	0	0
Penang island	3	61	0	0	3	46	4	235	1	100
Kuantan	9	9	3	280	16	385	2	200	1	200
Grik	3	1	2	95	9	53	0	0	0	0
Total	72	187	53	3,126	76	1,663	25	2,677	4	480
Average		2.59		58.98		21.88		107.08		120
Average per sample		0.52		8.68		4.62		7.44		1.33

The average expenditure associated with the different forms of medical treatment for all respondents is given in Table 20. The expenditure per respondent for self-treatment was estimated at MYR 21.88. The average expenditure for outpatient treatment from a public clinic was estimated at MYR 2.59; it was MYR 58.98 for private clinic consultation and medicine. The average expenditure incurred for medical treatment for family members was MYR 107.08. The average hospitalization cost per household was estimated to be MYR 120. Meanwhile, the costs associated with a visit to a public clinic/hospital were severely underestimated as the government subsidizes these visits. It is, therefore, a cost to the government and thus to society, although not recorded for the individual. Adjusted costs had to be used to reflect opportunity costs. In this case, private clinic consultation and medical costs would be more realistic. For the purpose of estimating the economic costs associated with government clinic/hospital visits, the payment rates for private clinic visits were used.

Table 20. Average expenditure per respondent including family members (MYR/household)

District	Self- Treatment	Public Clinic and Hospital	Private Clinic	Family Treatment	Hospitalization Cost per Treatment
Muar	6.60	1.05	32.50	0.00	–
Johore Bahru	35.71	1.25	57.50	46.4	–
Malacca Town	6.60	1.05	33.33	0.00	–
Jasin	21.67	1.20	59.29	38.75	–
Seremban	35.00	1.00	29.17	0.00	–
Beranang	9.33	1.00	27.00	0.00	–
Kajang	66.67	40.00	37.22	176.25	100.00
Kuala Lumpur	17.78	5.00	128.75	210.00	80.00
Ipoh	20.64	13.00	53.33	100.00	–
Penang island	15.33	20.33	–	58.75	100.00
Kuantan	24.06	1.00	93.33	100.00	200.00
Grik	5.83	0.33	47.50	0.00	–
Average	21.88	2.59	58.98	107.08	120.00
Average per sample	4.62	0.52	8.68	7.44	1.33

The above average medical treatment costs were computed based on the number of respondents and their household members who had incurred treatment. For the purpose of extrapolating the data for the whole population, the figures had to be averaged out for the whole sample (360). The average self-treatment cost per overall sample was MYR 4.62; the average cost for public clinic and hospital outpatient treatment was MYR 0.52; that of private clinic outpatient treatment was MYR 8.68; the average cost for family medical treatment was MYR 7.44; and the average hospitalization cost was MYR 1.33. Adding up the total costs of all the forms of medical treatment and dividing this by the sample size of 360 produced an overall average of MYR 22.59. This was also the average medical treatment cost per household.

4.4.3 Opportunity costs of medical-related leave

Sick days from work taken by the respondents due to the haze (to seek medical treatment, to recuperate, and to look after medically affected relatives and children), and sick days taken by family members to take care of the respondents and children was recorded for all surveyed respondents. A total of 37 respondents took sick leave days, representing 28.3% of respondents (Table 21). The average duration of leave taken was 1.82 days for those who took leave from a total of 67.5 days. Among the respondents, some 25 respondents or 6.9% took days off to help family members, averaging 1.52 days from a total of 38 days. Family members also took medical leave days; eight respondents or 2.25% of the respondents' family members took an average of 2.25 days.

Table 21. Medical-related leave taken due to the 2013 haze

District	Number of Respondents Who Took Leave	Days	Average Leaves Taken	Number of Respondents Who Took Leave for Family Members	Days	Average Leaves Taken	Family Members Taking Leave	Days	Average Leaves Taken
Muar	–	–		–	–		–	–	
Johore Bahru	1.00	3.00	3.00	1.00	1.00	1.00	–	–	
Malacca Town	–	–		–	–		–	–	
Jasin	12.00	18.50	1.54	5.00	9.00	1.80	4.00	6.00	1.50
Serem-ban	1.00	1.00	1.00	1.00	2.00	2.00	–	–	
Bera-nang	5.00	5.00	1.00	1.00	1.00	1.00	–	–	
Kajang	6.00	24.00	4.00	3.00	9.00	3.00	1.00	8.00	8.00
Kuala Lum-pur	2.00	2.00	1.00	1.00	1.00	1.00	–	–	
Ipoh	2.00	2.00	1.00	–	–		–	–	
Penang Island	2.00	3.00	1.50	4.00	4.00	1.00	–	–	
Kuan-tan	6.00	9.00	1.50	8.00	8.00	1.00	3.00	4.00	1.33
Grik	–	–		1.00	3.00	3.00	–	–	
Total	37.00	67.50	1.82	25.00	38.00	1.52	8.00	18.00	2.25

Note: The average duration of leave taken per overall sample was 0.19 days; the average leave taken to take care of family members was 0.11 days; and the average leave taken by family members was 0.05 days

The average number of medical leave days taken was computed based on the number of respondents who had taken such leave. For the purpose of extrapolation of the whole population, the figures were averaged for the whole sample (360). The average duration of personal leave days taken per overall sample was 0.19 days; the average duration of leave days taken to take care of family members was 0.11 days; and the average leave days taken by family members was 0.05.

Medical leave is an opportunity cost to society. The opportunity cost due to leave days taken related to medical problems was calculated as the average daily wage multiplied by the average number of leave days taken. The daily rate was calculated from the midpoint of the annual salary brackets for each respondent (e.g., an annual salary recorded in the MYR 25,000–49,000 bracket was given a midpoint value of MYR 38,000 while annual salaries of MYR >100,000 were estimated at MYR 150,000). An overall average salary for all respondents was calculated at MYR 29,205 per year; the daily rate was based on a five-day work week or 260 working days per year. Accordingly, the average daily wage for the respondents was calculated at MYR 112.33.

Using the average daily wage rate and the average leave for the whole sample, it was estimated that the opportunity cost of the average days of leave taken was MYR 21.06. The opportunity costs were MYR 11.86 for leave taken to take care of family members, and MYR 5.62 for leave taken by family members. The opportunity cost of medical leave days taken due to the haze per household was obtained by adding up the costs for the three categories of medical leave and dividing the total by 360. This gave an average economic value of MYR 38.54 per household.

4.4.4 Reduced activity days (RAD)

The haze caused RAD or work output in three forms. For the respondents directly, for the respondents in order to take care of family members, and for family members directly. The loss of productivity incurred directly by respondents involved 70 respondents or less than one-fifth (19.4%) of those surveyed. The average RAD incurred was 1.11 days (Table 22). There were 27 respondents or 7.5% who also incurred RAD of 0.56 days just to take care of family members. Fifteen or 4.17% of the respondents having family members directly faced an average RAD of 0.87 days.

The average RADs were computed based on the affected respondents only. For the purpose of extrapolation of the whole population, the figures had to be averaged out for the whole sample (360). The average RAD directly imposed on the whole sample was 0.22 days; the average RAD incurred to take care of family members was 0.04 days; and average RAD directly affecting family members was 0.04 days. Adding up the three categories of RAD incurred resulted in an overall average of 0.30 days.

The opportunity cost due to RAD was calculated as the average daily wage multiplied by the average RAD and by the productivity reduction factor of 0.4, a factor for which production was lost. The latter addresses the situation where a person's work productivity is affected by the haze. The opportunity cost due to RAD was MYR 13.17 per overall sample. Since the estimate incorporated RAD for the respondents' family members, this estimate could also be an estimate of the opportunity cost of RAD per household due to the haze.

Table 22. Reduced activity days incurred by the respondents due to the 2013 haze

District	One-Self	Days	Average	One-Self for Family Members	Days	Average	Family Members	Days	Average
Muar	9.00	9.00	1.00	–	–		–	–	
Johore Bahru	1.00	5.00	5.00	7.00	6.00	0.86	1.00	2.00	2.00
Malacca Town	8.00	8.00	1.00	–	–		–	–	
Jasin	17.00	5.50	0.32	2.00	–	–	–	–	
Serem-ban	3.00	5.00	1.67	1.00	3.00	3.00	–	–	
Beranang	1.00	–	–	–	–		–	–	
Kajang	5.00	14.00	2.80	2.00	4.00	2.00	3.00	4.00	1.33
Kuala Lumpur	17.00	7.00	0.41	11.00	1.00	0.09	10.00	–	–
Ipoh	2.00	5.00	2.50	–	–		–	–	
Penang island	1.00	1.00	1.00	–	–		–	–	
Kuantan	6.00	18.00	3.00	4.00	1.00	0.25	1.00	7.00	7.00
Grik	–	–		–	–		–	–	
Total	70.00	77.50	1.11	27.00	15.00	0.56	15.00	13.00	0.87

4.4.5 Cost of illness to Peninsular Malaysia

The 2010 national census estimated a population of 21,883,432 people and 5,262,461 households in Peninsular Malaysia (Department of Statistics 2010). If the figures used in this survey are representative of Peninsular Malaysia as a whole, then a simple extrapolation of the total costs to cover the whole population will provide a general overall cost to the peninsula of the effect of the June 2013 haze event.

The average household economic cost of purchasing masks as protection against haze exposure was estimated at MYR 3.73. The total cost to the peninsula was estimated as MYR 19.6 million taking up 4.78% of the COI due to haze effects (Table 23). Medical treatment and hospitalization was valued at MYR 22.59 per household or MYR 118.9 million for the whole population taking up 28.96% of total COI. Medical-related leave days taken due to the haze either for oneself or to take care of household members cost MYR 38.54 per household or MYR 202.8 million taking up a large proportion of 49.39% of the total. RAD contributed a smaller proportion of MYR 13.17 per household or MYR 69.3 million taking up only 16.88% of COI.

Table 23. Costs of illness from the 2013 haze in Peninsular Malaysia

Treatment	Average Household (MYR/hh)	Total Peninsular Malaysia (MYR)	Percentage (%)
Using masks	3.73	19,613,517	4.78
Medical treatment and hospitalization	22.59	118,889,227	28.96
Medical-related leave taken due to the haze	38.54	202,791,200	49.39
Reduced activity days	13.17	69,293,835	16.88
Total	78.02	410,587,779	100.00

4.4.6 Foregone income opportunities

The haze caused some households to suffer a loss or decline in income opportunities such as a reduction in the number of customers patronizing their shops or offices on account of the haze. The loss of income opportunities affected 32.5% of the respondent households. The highest foregone incomes were experienced in the districts of Muar, Malacca, Kajang, Jasin, and Kuantan (Table 24). Almost all the respondent households surveyed in Muar and Malacca were affected. In Muar, the main income sources foregone were fishing and tourism-related services while in Malacca, it was mainly outdoor tourism-related services.

The average income loss was MYR 560.15 per affected respondent household. This average income loss was computed based on affected respondent families only. For the purpose of extrapolation, the figures were averaged for the whole sample. The average income loss for the overall sample was MYR 182.05 per respondent household. Taking the total number of households in the peninsula, the total income foregone was estimated to be MYR 958 million.

Table 24. Estimated income foregone due to the haze incident by districts

District	No.	Income Foregone (MYR/Household)
Muar	29	22,796
Johore Bahru	6	3,270
Malacca Town	29	23,296
Jasin	11	4,500
Seremban	2	600
Beranang	0	0
Kajang	9	6,420
Kuala Lumpur	8	1,100

Table 24 continued

District	No.	Income Foregone (MYR/Household)
Ipoh	5	770
Penang Island	4	600
Kuantan	14	2,185
Grik	0	0
Total	117	65,537
Average per affected sample		MYR 560.15
Average per overall sample		MYR 182.05
Peninsular Malaysia households		MYR 958,016,407

4.4.7 Willingness to pay to avoid welfare loss from the haze

CVM was used in the analysis to obtain the respondents' perceived value of household welfare loss due to the haze incident. The hypothetical market created was in the form of an insurance premium payment to cover the family against any inconvenience or decline in quality of life due to a future haze incident. The respondents were told that there was a move by an insurance company to insure the people in their district and the rest of the country against future incidences of intense haze like the one in June 2013, so that they will not have to experience a similar decline in quality of life and any economic losses.

The willingness to participate in the insurance scheme was supported by only 37.5% of those surveyed. The average premium the respondents were willing to pay (WTP) was MYR 63.73 per affected respondent (Table 25). This WTP was computed based on the affected respondents only. By extrapolating the data, the average WTP for the whole sample was found to be MYR 23.90 per respondent household. Taking the total number of households in the peninsula, the total WTP was estimated to be MYR 125.8 million.

Table 25. WTP to avoid welfare loss from future haze incidents

District	No. WTP to Protect against Future Haze	WTP (MYR/Household)
Muar	5	870
JohoreBahru	3	150
Malacca Town	6	1,470
Jasin	16	467
Seremban	14	940
Beranang	10	730
Kajang	16	735
Kuala Lumpur	22	892
Ipoh	13	540
Penang island	16	790
Kuantan	11	910
Grik	3	110
Total	135	8,604
Average per affected sample		MYR 63.73
Average per overall sample		MYR 23.90
Peninsular Malaysia households		MYR 125,772,818

4.4.8 Aggregate value of the haze impacts

The summary of the total economic costs of the haze impacts is given in Table 26. The total economic costs were estimated to be MYR 1,494.4 million with foregone income opportunities taking up 64.11%. The cost of illnesses took up 27.48% amounting to MYR 410.6 million. Despite the high economic cost incurred, the WTP to avoid a decline in quality of life due to haze was quite low amounting to MYR 125.8 million or 8.42% of the total cost. The impacts upon the transportation sector were minimal. For instance, during the haze in June 2013, there was no reported cancellation of flights.

Table 26. Total economic value of the June 2013 haze to Peninsular Malaysia

Form of Loss	MYR per household	MYR for all households	Percentage
Cost of Illness	78.02	410,587,779.00	27.48
Foregone Income Opportunities	182.05	958,016,407.00	64.11
WTP to avoid a decline in quality of life	23.90	125,772,818.00	8.42
Total		1,494,377,004.00	100.00

4.5 Implications

To identify how significant the economic costs of the haze impacts were, the estimates calculated were compared to the annual GDP of Peninsular Malaysia. Peninsular Malaysia had an estimated GDP of MYR 311.6 billion in 2012. The economic cost of the June 2013 haze was estimated to be MYR 1.49 billion. As a proportion of GDP, the haze impact costs took up only 0.48% (Table 27). In terms of proportion, this estimate is quite similar to the haze incident of 1997. The aggregate value of the haze damage to Malaysia for the latter had been MYR 802 million, which was 0.3% of the nation's GDP (Mohd Shahwahid and Jamal 1999). Another important observation from the June 2013 haze episode is that Malaysians have gotten familiar with haze owing to its regularity. Malaysians seem to take haze as "normal" and continue with their lives, albeit taking precaution measures such as purchasing masks when the haze gets severe.

Table 27. Significance of the economic value of the June 2013 haze impacts to the economy of Peninsular Malaysia

Indicator	MYR per Household	MYR for All Households
GDP per household 2012*	59,214.46	311,613,794,482.00
Aggregate economic cost of the 2013 haze	283.97	1,494,377,004.00
Proportion of haze impacts to GDP (%)	0.48	0.48

Source: Department of Statistics 2014

5.0 CONCLUSIONS

The haze in June 2013 reminded Malaysians of the previous episodes of 1997 and 2010. This study was undertaken to investigate the frequency and intensity of haze incidents in the country, assess the kinds of impacts on the local people and economy, and value the extent of these impacts.

Malaysia faced a series of haze incidents beginning with the April 1981 episode. The April 1981 haze captured a great deal of public and media coverage as it impaired visibility, which disrupted flights and marine activities. The second severe haze episode occurred in September 1982, surrounding surrounded Petaling Jaya, Selangor. Following the above two haze episodes, the 1990s observed four major haze periods in August 1990, followed by June and October 1991, August to October 1994, and September 1997.
In the 2000s, the first haze period occurred in 2005 August, affecting Port Klang and Kuala Selangor. This was followed in 2006, affecting most parts of Malaysia such as eastern Sarawak, and western and southern Peninsular Malaysia. There were other minor incidents like in 2009 followed by the October 2010 haze, which impacted the southern peninsular states of Johore and Malacca. This was followed by the June 2013 haze.

The API readings prior to and after June 2013 were shown to be statistically lower than those during the haze period in that month. This indicates that the haze levels were much higher than normal in June. During the month, it was also shown that there were statistically significant relationships between the API readings and the rainfall levels in several districts. The API readings tended to be lower during and after rain.

The total economic costs of the haze impacts on Peninsular Malaysia were estimated to be MYR 1,494.4 million with foregone income opportunities taking up 64.11%. COI took up 27.48% amounting to MYR 410.6 million. Despite the high economic cost incurred, people's WTP to avoid a decline in quality of life due to haze was quite low amounting to only MYR 125.8 million or 8.42% of the total cost. A breakdown of the COI showed that purchasing masks as protection against haze exposure involved MYR 19.6 million taking up 4.78% of the total COI. Medical treatment and hospitalization was valued at MYR 118.9 million taking up 29.0% of the total COI. Medical-related leave taken due to the haze either for oneself or to take care of household members cost MYR 202.8 million taking up another large proportion of 49.39% of the total COI. Reduced activity days comprised a smaller proportion of the total cost, i.e., MYR 69.3 million taking up only 16.88%.

To determine how significant the economic costs of the haze impacts were, the estimates were compared to the annual GDP of Peninsular Malaysia. As a proportion of GDP, the haze impact costs took up only 0.48%, which was quite similar to the haze incident of 1997. Another important observation from the June 2013 haze episode is that Malaysians seem to have accepted haze as a normal occurrence in their lives, going about business-as-usual while taking precautionary measures such as purchasing masks when the haze becomes bad.

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