〈特集〉

An Overview on Transboundary Haze Pollution in Malaysia

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Abstract

This paper discusses on chronological of haze events in Malaysia since the past four decades and few preventive measures taken to deal with the issue at national and regional level. The transmission of haze smokes occurs due to the forest fires, land clearing, biomass burning and deforestation for agricultural activities in Indonesia has caused the hazy condition in neighbourhood country particularly Malaysia. The impact of haze have caused the deterioration of air quality, environmental damages and affected to public health, life quality and economic domino sector. Several approaches have been taken by the government to prevent, monitor, assess and mitigate the haze problem since few years back. The National Haze Action Plan was established in 1997, as a proactive counter measure to deal with haze issue. At the regional level, the ASEAN Agreement of Transboundary Haze Pollution was developed in 2002 and force by 2003 by ASEAN members in order to facilitate with prevention and mitigation measures to minimize the impact of haze.

Keyword : air quality, transboundary haze, regulations, mitigation measures
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Introduction

Haze phenomenon is one of the hot topics in Malaysia especially when it hit this country during Southwest monsoon season from August to October, annually. The widespread of thick smoke due series of biomass burning and forest fires for agricultural activities especially in Sumatera and Kalimantan, Indonesia has caused the transboundary hazy pollution particularly in Malaysia, Singapore, Brunei and Southern Thailand (Sastry, 2002 ; Abas, 2004 ; Mahmud, 2008 ; Pentamwa and Oanh, 2008 ; Permadi and Kim Oanh, 2013).

The series of transboundary haze had caused the deterioration of air quality in Malaysia. The effect of frequent haze incident also brought negative impact to environmental damage, public health, economic sector and life quality (Othman, 2014 ; Sahani, 2014). The adverse health effects of haze related to respiratory illness where number of cases reported in asthmatic attacks, bronchitis in children and adults after haze episode in 1997 (Nasir 2000). Tourism industry affected by the reduction number of tourists arrival into this country, at certain period. As a result, the travel operators, street traders and hawkers could not generate income and sustain their business, and making another domino effects in the economy sector. The agricultural and livestock sector faces losses due to the decreasing of yield production from plant-based foods. There was reported that the average two to three million of chickens dies in northern region of Malaysia in a month due to haze (MStar Online, 2015), as one of few incidents reported of haze event. Life quality of the publics also affected where peoples are recommended to stay into the house, unable to go anywhere since the common practices of Air Pollutant Index (API) has gazetted not to do activities outside building to prevent health issues. Hence, the outside routine activities of the peoples also disrupted. The haze has caused people to feel more comfortable to be in homes and buildings. Many other subsequent outdoor activities and events had to be postponed or cancelled due to poor air quality.

Several measures were taken to monitor, prevent

and mitigate the haze incidents. In 1997, Malaysian government has established the National Haze Action Plan in order to facilitate the haze issues at national level. The policy and mechanism of national disaster management is governed and executed under the National Security Council Order 20, and this order applies on haze incident since it has become common issue in the nation. At regional level, the ASEAN Agreement of Transboundary Haze Pollution was established by June 2002. However, the effectiveness of prevention measures developed through this agreement being questionable by the ASEAN communities. Studied made by Forsyth（2014）has revealed that there are evidences of public argument on current policy approaches to haze where the action taken is not capable of handling haze issue.

This paper, therefore, discusses the chronologies of transboundary haze smokes pollution in Malaysia that are mostly causes from the land clearing and forest fires for vegetation in Indonesia. The approaches taken into account including monitoring process, prevention and mitigation during haze period are also addressed.

Haze Chronologies in Malaysia

Haze is one of the air pollution sources which usually occur from the forest burning, bush fires, land clearing and deforestation. The search for information begins with looking at local and international newspaper articles on haze event, news archives from Malaysia and Singapore and journal papers that published since the haze episode in 1972 until recent event in 2016. This event already affected Malaysia for more than 40 years.

According on records at the National Archives and Newspaper Archives of Singapore（Remember Singapore, 2013）, Malaysia was covered with thick haze smoke in 1972 after days of burning of extensive forests and grass lands at surrounding areas of Palembang, Indonesia. Meanwhile, a reddish haze occurred in Johor Bahru Pasir Gudang and Kota Tinggi in 1975 due to the deforestation activity at Kota Tinggi. No further information can be found from this incident. On October 1977, the smokes from the raging forest fires at Sumatera, Indonesia had struck the western and southern parts of Peninsular Malaysia and caused low visibility of eyesight. Later in May 1979, a combination of haze smoke and mist had covered Johor Bahru and the source of this haze was undetermined.

The occurrence of haze on March 1983 over Malaysia and Sarawak atmosphere was due to thousands of hectares of forests being burnt in East Kalimantan, Indonesia. This thick smoke had reduced eye visibility to a very low level approximately 1 km. Other hazy days were recorded in September 1987 as a result of forest fires at Indonesia and it was also worsen by drought weather. The visibility was dropped rapidly to 2–3 km.

The Peninsular Malaysia atmosphere was covered with haze smoke in 1991 due to the forest fire in Sumatera, Indonesia. No further information related to this haze episode was recorded. On September 1994, the haze recurred after a lapse of three years and the hazy condition lasts for over a month. But for this time, it was more severe compared to 1991 event. The incident was found to a serious forest fires in Kalimantan and South Sumatera in Indonesia which causes the worst of hazy condition. It was also exacerbated by dry weather and lower wind condition coupled with emission from local pollution sources such as from industries, motor vehicles and open burning from wastes and landfills. During this haze episode, it has involves adverse social and economic impacts which also included the aggravated medical conditions, reduced outdoor activities, and school and airport closure. It was reported that estimated cost involved for medical sector was up to USD 600 million while the losses suffered by the aviation industry due to flight cancellation amounted up to USD 700 million for Malaysia alone（Nichol 1998）.

Another haze episode occurred during September to November 1997. The haze source came from the same sources as previous years but it was also exacerbated by the El-Nino phenomena, which brought prolonged dry season in that year and almost 37,938 hot spot was observed in Indonesia. The most affected location was in Sarawak region where, worsened air quality of several locations has been recorded in 10 days in a row. Due to this condition, Haze Emergency was declared in Sarawak after the API reading already reached over 500. It was estimated that almost 10 hectares of forest was burned and more than 40,000 peoples experienced with health problems while many deaths reported（Hasli, 2015）.

After 7 years Malaysians enjoyed clean air, in August 2005 another series of smoke haze struck Peninsular Malaysia, which caused by the opening of

agricultural land and forest fires in Sumatera, Indonesia. During this event, two air quality monitoring stations located in Port Klang and Kuala Selangor (central Peninsular Malaysia) recorded the API readings exceeding 500 on 11 August 2005 and a Haze Emergency was declared on that particular day. The Haze Emergency was lifted two days later after API readings for both locations dropped to below hazardous level (<301) and visibility level is improved. But the haze shifted to northern states of Kedah, Penang and Perlis due to air and wind movement to these states recorded unhealthy API readings until 14 August 2005. The air quality returned to normal level after 51 air monitoring stations recorded good and moderate. From mid July to mid August 2006, another episode of slight and moderate level of haze events hit Peninsular Malaysia. Most of the air quality monitoring stations recorded unhealthy API readings. Meanwhile, few areas in Sarawak experienced intense haze episode in late September to mid October with unhealthy status.

A short haze period struck southern of Peninsular Malaysia especially at Muar, Johor on mid October 2010 where the API readings recorded unhealthy to hazardous air quality level, with the highest reading was recorded 432 (hazardous). Due to this circumstance, all 170 schools in Muar district were closed on 21 October 2010. During the dry period from May to September 2011, the overall air quality in Malaysia faced slight deterioration due to transboundary haze pollution as a usual activity of fires at Central Sumatera and Kalimantan, Indonesia. Therefore, several short spell of haze episode was experienced in Malaysia. The same situation was also occurred in 2012 during dry period from June to August. It was also exacerbated by local peat fire in Miri, Sarawak that resulted in high API reading.

The repeated haze episode was experienced by most parts of Peninsular Malaysia in the month of June 2013. The air quality deteriorated to unhealthy and hazardous level. The state of Johor, Melaka and Negeri Sembilan were the most affected areas with the highest API readings recorded at Muar over 500. The Haze Emergency was declared in June 23, and lifted on June 24 after the API level reduced to below 300 and eye visibility was improved, later.

In 2014, the country was struck with hazy condition by two times. The first haze episode was moderate and it occurred between February and March where unhealthy and hazardous levels of air quality affected areas of Klang Valley, Perak, Melaka, Negeri Sembilan and Johor. The haze was due to peat land and forest fires in several states particularly Kedah, Perak, Selangor, Pahang, Johor, Kelantan and Terengganu. The worse API reading of hazardous level (>301) was recorded at Port Klang and Banting. This situation has caused 230 schools in affected areas to be closed. The second episode of haze struck during southwest monsoon from June to October. West coast of Peninsular Malaysia faced very unhealthy (>200) air quality on July 22 especially in Seri Manjung, Perak with API reading was obtained to 260. Meanwhile, in Sarawak, several areas suffered with unhealthy to very unhealthy air condition with the highest API was recorded 270 in Sibu on July 28. Back to west coast and northern parts of Malaysia, these areas experienced another unhealthy air quality status from 17 September to 12 October, 2014.

From August to the end of October 2015, the nation experienced with southwest monsoon season. During this monsoon, the overall air quality across the country was deteriorated again due to the haze smoke transported from Indonesia. It was stem from massive land, forest fires and deforestation activities at Sumatera and Kalimantan where 34 locations in the country recorded unhealthy status for the first time in Malaysia's history since 1997. All schools in Selangor, Putrajaya, Kuala Lumpur, Negeri Sembilan, Melaka, Johor and Sarawak closed for at least 2 days due to the API readings reached 200 and very unhealthy status (211) was recorded at Banting, Selangor on 10 October 2015.

The hazy condition occurred on 22nd February 2016 at Kuala Baram, Sarawak caused by bush fires of 80 hectares near the Industrial Training Institute (ILP) Miri showed that the API reading was 336, exceeding dangerous level (Letchumy Taboo, 2016). But there was no further announcement due to the haze in that location.

On 4th April 2016, the haze events struck Sabah due to 200 hectares of forest reserves fires had resulted the closure of 77 schools in districts of Beaufort, Papar and Kuala Penyu by Ministry of Education Malaysia after the API reading showed 279, which is very unhealthy condition, as reported by Bernama News (2016) and Astro Awani (Abdullah, 2016a). The next following day, the closed schools increased to 83 as the API reading still indicated unhealthy reading

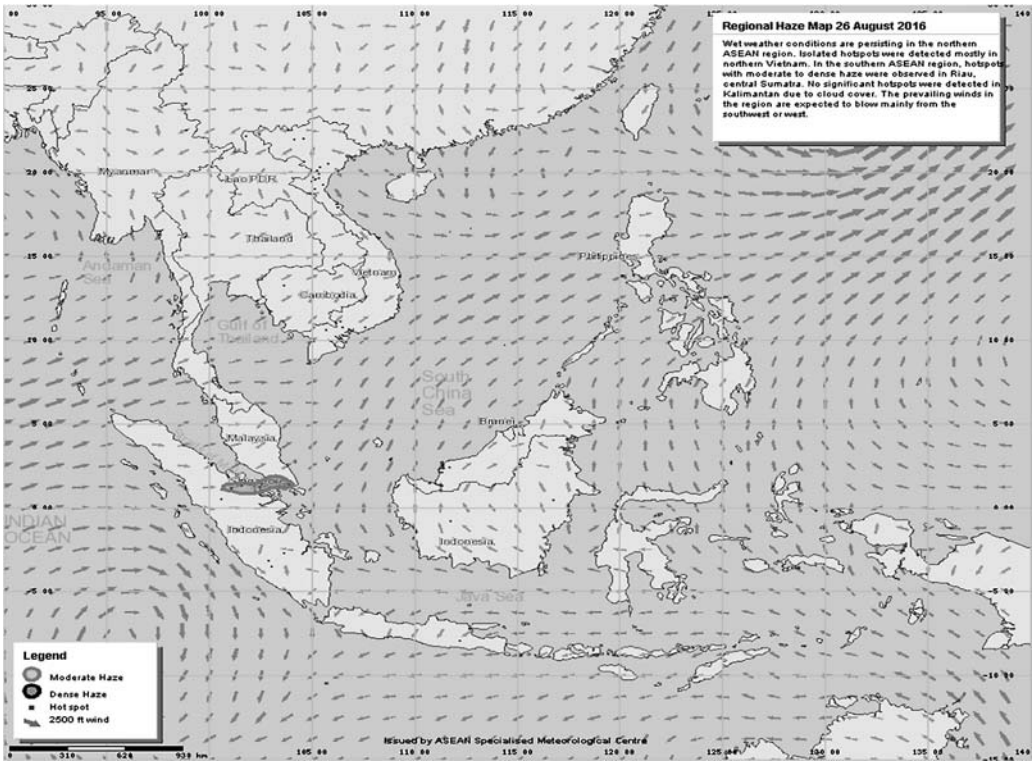

Fig. 1　Satellite image of haze dense in Johor（Data source : ASEAN Haze Action Online, 2016）

with 150（Abdullah, 2016b）.

As there are trend of the occurrence of haze for the past 6 years in a row, it is possibly assure that similar incidents will occur again in dry season around August 2016. This is based on trend and pattern that have been observed during past few years, from 2010 until March 2016. Since the El-Nino phenomena and drought season is currently affecting the country, a few haze issue have been reported in local media until April due to the open burning cases, farm lands, bushes and peat soil forest reserve fires, although the southwest monsoon season has not arrived yet（Then, 2016 ; The Star Online, 2016）. The Minister of Natural Resources and Environment of Malaysia, Dr. Wan Junaidi Tuanku Jaafar mentioned that three fire incidents in Kuala Baram mangrove area in Miri, peat swamp forest reserves in Klias and Keningau, Sabah and Kuala Langat forest reserve in Selangor has caused the haze episodes in early year of 2016 where those areas showed deterioration of air quality status. There were 1,460 cases of open burning was reported in January and 25 April 2016, which was due to forest reserves, mangrove areas, construction sites, landfills as well as industrial and agricultural plots（Nik Anis, 2016）.

On 16-18 August 2016, slight haze was reported in North Malaysia especially at Manjung and Tanjung Malim, Perak stations for few days. The API readings are almost reached 100. Meanwhile, the haze situation hit Southern Malaysia on 26-28 August 2016 where the API reading almost reached 100 at Larkin Lama station and over 100 at Pasir Gudang station. This is due to forest fires in Sumatera, Indonesia and the dense of haze can be found in regional haze hotspot map from ASEAN Haze Action Online website, as illustrated in **Fig. 1**. The summary of haze episodes that struck the nation is shown in **Table 1**.

Haze Pollution Monitoring, Regulation and Mitigation Action

In Malaysia, about 52 locations have been installed with continuous air quality monitoring system（CAQM）. The locations are divided into 4 categories, namely industrial, urban, background and sub-rural. Data collection and management was conducted by Alam Sekitar Malaysia Sdn. Bhd.（ASMA）, a private company appointed by Department of Environmental（DoE）Malaysia from 1995 to 2015. Currently, these locations are equipped with monitoring system with particulate matter 10 microns（PM10）parameter including other standard gaseous parameter such as sulfur oxide（SO_x）, nitrogen oxide（NO_x）, carbon monoxide（CO）and ozone（O_3）. Based on unofficial report, there are only 12 selected locations equipped with PM2.5 parameter system. However, only API

Table 1 The summary of haze occurrence in Malaysia

Year	Month	Description
1972	October	• Occurrence of thick haze due to burning of forests and grass lands around Palembang, Indonesia
1975	—	• Jungle clearing works in Johor Bahru and Kota Tinggi
1977	October	• Thick haze due to forest fires in Sumatera covered of western and southern parts of Malaysia
1979	May	• A combination of haze smoke and mist was covered Southern Johor where the source of this haze was undetermined
1983	March	• Burning of thousand hectares of forests at East Kalimantan causing a blanket of smoke over Malaysia especially Sarawak
1987	September	• Days of hazy smoke affected Malaysians as resulted of drought weather and forest fires at Indonesia
1991	October	• Hazy condition caused by raging fires in Indonesia
1994	September	• Forest fires in Sumatera and Kalimantan, Indonesia • Worsen by dry weather and lower wind condition in Malaysia
1997	September-November	• Caused by forest fires in Kalimantan • El-Nino phenomena worsen the hazy condition • Haze Emergency declared in Sarawak (API>500)
2005	August	• Forest fires and opening agricultural land in Sumatera • Haze Emergency declared in Port Klang and Kuala Selangor
2006	July- August	• Slight to moderate haze in Peninsular Malaysia • Intense haze in Sarawak (API>100, unhealthy) in September to October
2010	October	• Unhealthy to hazardous level (API>400) in Muar • 170 school closed
2011	May- Setember	• Slight deterioration (API>100) in Malaysia • Fires from Central Kalimantan and Sumatera
2012	June-August	• Dry period in Malaysia • Peat land fires in Miri, Sarawak • High level of API readings
2013	June	• Air quality deteriorated to unhealthy and hazardous level in Johor, Melaka and Negeri Sembilan • Haze Emergency declared in Muar (API>500)
2014	February-March	• API status : unhealthy to hazardous in Klang Valley, Perak, Melaka, Johor and Negeri Sembilan (API>300) • Due to peatland fires in few states in Peninsular
2014	June-October	• Unhealthy status (API>200) in west coast Peninsular Malaysia (Manjung : API=260) • Unhealthy to very unhealty condition in Sarawak (Sibu : API=270)
2015	August-October	• Massive land and forest fires in Sumatera and Kalimantan • 34 areas recorded unhealthy status. (Banting : API= 211) • Schools closed in Putrajaya, Johor, Melaka, Selangor, Kuala Lumpur, N. Sembilan and Sarawak
2016	February-April	• 80 hectares of bush fires in ILP Miri (API>300) • 200 hectares reserved forest fires in Kuala Penyu, Sabah • 83 schools in Beaufort, Papar and Kuala Penyu closed due to unhealthy level (API>200)
2016	August	• Slight haze in Manjung and Tanjung Malim, Perak in mid August • Moderate haze dense reported in Johor (API>100) • Due to forest fires in Sumatera • El-Nino phenomena worsen the hazy condition

readings of PM10 and O_3 (if O_3 reading exceeding PM 10) are displayed to the general public at the current situation. This situation has brought the concern on API readings accuracy among the peoples especially during haze event by their observation of human eye visibility is limited but the API readings are contradicted to the visibility. Thus, arguments has arises by the peoples who lived in Johor Bahru, which is located near with Singapore and they do keep comparing the API and PSI readings in neighbourhood country. Singapore government has implemented the use of PM 2.5 parameter devices since May 2014. Due to these arguments, the installation of PM2.5 parameter into the devices at all locations can only fulfill by the end of 2017 (Bernama, 2015).

In 1993, the DoE developed the first Malaysian Air Quality Index (MAQI), which this index system acts by informing the current status of ambient air quality to both decision makers and public society, as shown in **Table 2**. Later in 1996, the DoE has improved and enhancing the existing system in accordance with the latest system used by United State Environmental Protection Agency (USEPA). This new system is called Air Pollution Index (API) and it closely follows the Pollutant Standard Index (PSI) of United State to provide better accuracy of API reading.

The revision of Malaysia Ambient Air Quality (MAAQ) Guideline that was introduced on 1999 has been improved with the introduction of new standard of ambient air quality for Malaysia to coop with the

Table 2　The Malaysia Air Pollution Index（API）with level of pollution and health measures

API	Status	Level of Pollution	Health Measures
0–50	Good	Pollution low and has no ill effects on health	• No restriction of activities for all groups of people • To practice health lifestyle, e. g. not to smoke, exercise regularly and to observe proper nutrition
51–100	Moderate	Moderate pollution and has no ill effects on health	• No restriction of activities for all groups of people • To practice health lifestyle, e. g. not to smoke, exercise regularly and to observe proper nutrition
101–200	Unhealthy	Mild aggravation of symptoms among high risk persons, i. e. those with heart or lung disease	• Restriction of outdoor activities for high risk persons • General population should reduce vigorous outdoor activity
201–300	Very Unhealthy	Significant aggravation of symptoms and decreased exercise tolerance in person with heart or lung disease	• Elderly and persons with known heart or lung disease should stay indoor and reduce physical activity • General population should avoid vigorous outdoor activity • Those with any health problems to consult doctor
301–500	Hazardous	Severe aggravation of symptoms and endangers health	• Elderly and persons with existing heart or lung disease should stay indoors and reduce physical activity • General population should avoid vigorous outdoor activity
＞500	Emergency	Severe aggravation of symptoms and endangers health	• General population advised to follow the orders of the National Security Council and always to follow the announcements through the mass media

Source : Ministry of Health Malaysia ; Department of Environment（2000）

National Haze Action Plan in haze monitoring. This new standard adopted six air pollutant parameters, which from the previous guideline takes into account five parameters（PM10, SO_x, NO_x, CO and O_3）and added one additional parameter, which is PM2.5. The DoE will also tighten the concentration limit of air pollutants in stages until 2020 with 3 interim stages at year 2015, 2018 and finally this standard will be fully implemented on 2020, as tabulated in **Table 3**.

The DoE had provided some preventive measures during haze season for public use. The first preventive measure taken was to impose "Total Ban on Open Burning". However, this instruction did not include burning for religion purpose, cremations, barbeques and grills and gas flaring. Besides, all 52 air-monitoring stations nationwide should operate continuously to detect changes in air quality status without any failure.

Table 3　New standard of ambient air quality in Malaysia（Department of Environmental, 2015）

Pollutant	Time average	Ambient Air Quality Standard		
		IT-1 (2015)	IT-2 (2018)	Standard (2020)
		μg/m^3	μg/m^3	μg/m^3
Suspended particulate size 10 μm or less（PM 10）	1 year	50	45	40
	24 hour	150	120	100
Suspended particulate size 2.5 μm or less（PM 2.5）	1 year	35	25	15
	24 hour	75	50	35
Sulfur dioxide（SO_2）	1 hour	350	300	250
	24 hour	105	90	80
Nitrogen dioxide（NO_2）	1 hour	320	300	280
	24 hour	75	75	70
Ozone（O_3）	1 hour	200	200	180
	8 hour	120	120	100
Cabon monoxide（CO）(mg/m^3)	1 hour	35	35	30
	8 hour	10	10	10

DoE has activated the Standard Operating Procedure（SOP）to prevent open burning and peat land fires, and tighten the enforcement action on emission from industries and smoky motor vehicles in cooperation with Road Transport Department（RTD）. Decisive legal action and strict warning also applies to those who carry out open burning at plantation and industrial areas, construction sites, whereas for small cases of open burning will be penalized. Other measures to prevent open burning are to order the local authorities and municipal councils to monitor garbage-dumping landfills and sites in their jurisdiction. This includes the monitoring on areas that often burned through the air by using drones or helicopter. In conjunction with this event, the DoE should do daily checks and close monitoring on preventive measures to tackle peat fires. They also should enhance their communication system at DoE operation rooms to ensure that information can be delivered with more effective. Besides, they need to conduct air and ground surveillance frequently in order to detect and monitor any fire outbreaks. The related agencies also have an authority to catch the environmental criminals without warrants.

However, the transboundary haze is not considering with above prevention measure due to the haze smoke usually come from the neighbor country. Therefore, there are other approaches have been taken to tackle this issue especially in South East Asia region. In 1997, the Regional Haze Action Plan（RHAP）was adopted in Malaysia, Singapore and Brunei Darussalam with objectives to prevent land and forest fires through better management, policies and enforcement ; to es-

tablished operational mechanisms to monitor land and forest fires ; and to strengthen regional land and forest fire-fighting capability and other mitigation measures. To enhance the capability of RHAP to address the transboundary haze issue, any other agreement has been made. Thus, the ASEAN Agreement on Transboundary Haze Pollution (AATHP) was introduced in 2002 with the aim to prevent, monitor and mitigate land and forest fires in order to control transboundary haze pollution (Haze Action Online, 2015). The content of this agreement are monitoring and assessment, prevention, preparedness, national and joint emergency response, procedures for deployment of people, materials and equipment across borders and technical cooperation and scientific research.

The ASEAN Coordinating Centre for Transboundary Haze Pollution Control (ACC) was established under this agreement with purposes to facilitate cooperation and coordination among ASEAN members in managing impact from deforestation and land clearing in particular haze pollution arising location. In order to facilitate the overall process, a Standard Operating Procedure for Monitoring, Assessment and Joint Emergency Response was developed to assure the regular communication of data between the ACC and National Monitoring Centre (NMC) or National Focal Point (NFP) among ASEAN members and to coordinate the requests and offers of assistance and includes the reporting of joint mobilization of resources. Based on experience from previous events, it can be seen the involvement of agencies from other ASEAN members offering their manpower and equipment to help Indonesia government that struggled to extinguished fires in Sumatera and Kalimantan.

In 1993, ASEAN Specialised Meteorological Centre (ASMC) was established and based in Singapore as a regional collaboration program in monitoring weather condition among ASEAN countries. After the force of AATHP in 2003, the ASMC roles has extended to cover the whole ASEAN region in monitoring, preventing and assessing the land and forest fires and the occurrence of transboundary haze smoke that might affects this region.

Although the AATHP had been finally ratified by Indonesia on September 2014, the weak enforcement from Indonesian government has caused this phenomena persisted in subsequent years as a result of deforestation and land clearing activities for vegetation carried out by the oil palm companies until now. There are many issues need to be consider in haze monitoring and prevention. The main concerns on slash and burn for agricultural practice, which there should have a strict guideline in order to reduce the impact on environmental damage and pollution. The analysis of wind patterns and speed should be done where this condition will reflects to severity of fires and the movement of smoke pollution. The climate change and global warming issue also will influence the haze event, which can cause of flash fires from natural occurrence or human error.

Conclusion

The transboundary haze incidents already persists for more than 40 years caused by land clearing, deforestation and forest fires at large scale in Indonesia had brought a lot of harm towards life quality, public health and economic sector in affected country particularly Malaysia. To ensure the accurate API readings in Malaysia, the related agencies should upgrade the current system by adding PM2.5 parameter into the monitoring devices. Although there are approaches taken to mitigate this issue, the effectiveness of haze prevention and enforcement is still become an argument among the peoples in affected countries since the transboundary haze occurred every year until now. Therefore, revision of current measures on haze prevention, monitoring and assessment is needed to reduce the haze impact and to improve the mitigation action in future.

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マレーシアにおける越境ヘイズ汚染の状況

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本稿では，マレーシアにおける過去 40 年のヘイズ事象の歴史と，国または地域レベルの予防的対策について議論した。煙がもたらすヘイズは，森林火災，開墾，バイオマスの燃焼に起因し，インドネシアにおける農業活動がもたらす森林破壊が，近隣諸国とりわけマレーシアにヘイズをもたらしてきた。ヘイズの影響で大気質や環境は悪化し，公衆衛生や生活の質，経済も影響を受けている。近年，政府によりヘイズの問題を予防し，観測し，評価し，緩和するするためのいくつかの対策が実施されてきた。1997 年には，ヘイズ問題に対処するものとして，国家ヘイズ行動計画が策定された。地域（ASEAN）レベルでは，ヘイズの影響を最小化する予防対策および緩和対策を促進するため，2002 年に ASEAN 越境ヘイズ汚染条約が締結され，2003 年に発効した。

キーワード：大気質，越境ヘイズ，規制，緩和措置