

Smoke-haze: A transboundary air pollution issue in Southeast Asia

Background

The UN Environment Foresight Briefs are published by UN Environment to, among others, highlight a hotspot of environmental change, feature an emerging science topic, or discuss a contemporary environmental issue. The public is thus provided with the opportunity to find out what is happening to their changing environment and the consequences of everyday choices, and to think about future directions for policy.

Introduction

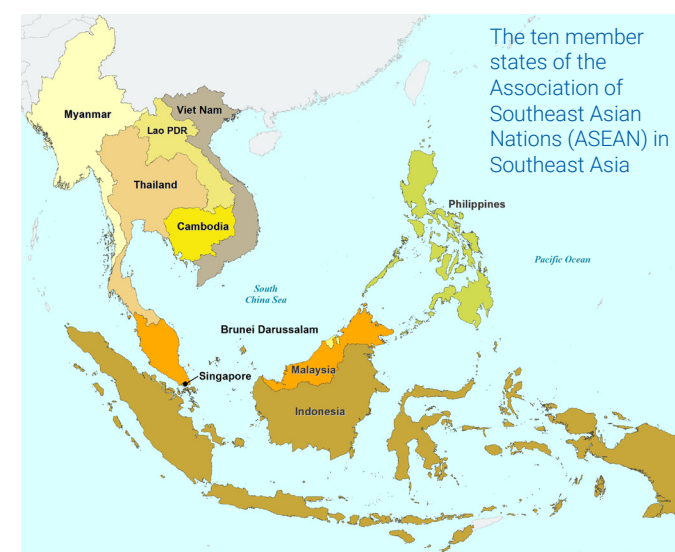
Air pollution results from the emission of harmful substances into the air. Human-driven activities and, to some extent, natural sources contribute to air pollution. Forest fires, dust storms, volcanic eruptions, pollen dispersal, sea spray, evaporation of organic compounds

and natural radioactivity are some of the natural events that may pollute the air. Human activities that contribute to air pollution include industrial processes, transport, cooking and heating using solid fuels, the use of various household and farming chemicals, and certain agricultural practices such as slash-and-burn.

Transboundary haze pollution affects about half of the countries in Southeast Asia (Varkkey 2017) and is defined by the Association of Southeast Asian Nations (ASEAN) as "haze pollution whose physical origin is situated wholly or in part within the area under the national jurisdiction of one Member State and which is transported into the area under the jurisdiction of another Member State" (ASEAN 2002).

The haze is made up of smoke consisting of small airborne particles containing many harmful compounds and over 60 per cent are derived from fires started in peatlands (Gaveau, et al. 2014) (Page, et al. 2002) (Reddington, et al. 2014). Rapid land use change, forest fires and the natural climate phenomenon El Niño–Southern Oscillations (ENSO) which occasionally creates excessively dry conditions, have fuelled a smoke-haze pollution problem in Southeast Asia (Nazeer and Furuoka 2017). Land clearance for agriculture and settlement are the major drivers behind the setting of most fires. The fires then ignite the underlying peat soils once these are drained, emitting air pollutants, along with carbon dioxide (CO₂) which contribute to global warming (Saharjo 2015). The transboundary haze pollution has been an almost annual occurrence in Southeast Asia since the late 1990s (ASEAN 2017). It usually occurs during the southwest monsoon season between June and September and becomes more severe during periods of dry weather. The

affected countries include Indonesia, Malaysia, Singapore and Brunei, and to a lesser extent Thailand, Vietnam and the Philippines (ASEAN 2017).



Why is this issue important?

The importance of this issue lies in the fact that smoke-haze pollution has been occurring for several decades in Southeast Asia and with each passing year the pollution gets worse and lasts longer (Lin et al 2017). While the haze in 2015 was the longest on record (Tan 2015) the pollution standards index (PSI) data from Singapore has exhibited increasingly higher peaks. The longer the issue goes unaddressed, the greater the public and environmental health impacts and economic costs become. Furthermore, it risks straining relations between the countries within the ASEAN region.

Key indicators of the ASEAN countries, Southeast Asia

- Countries: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam
- Total land area: 4.5 million km²
- Total population: 634,484,900
- GDP (nominal): \$2.557 trillion (exchange rate)
- GDP per capita: \$4,034 (current prices)
- GDP per capita (PPP): \$15,164 (current prices)
- Population density (pple/km²): 141
- Proportion of forest land: 45 per cent (2015 estimate)

Source: (ASEAN 2018), (ASEAN 2017b)

What are the findings?

There are human and natural causes

Economic development, land encroachment and natural climate phenomena are major driving forces behind the fires and haze in the ASEAN region. The increasing demand for land for agriculture and settlement to meet the needs of the growing human population leads to the clearance of forests. The most common method of clearing forests is the slash-and-burn method. It involves felling of trees and vegetation followed by setting fire to the area. It is popular because it is an efficient and inexpensive method of preparing land for agriculture. In addition, the natural climate phenomenon El Niño Southern Oscillations (ENSO) and the positive Indian Ocean Dipole at times creates excessively dry conditions ideal for fires. Indeed, the combination of the two resulted in particularly severe haze events in 1997, 2006 and 2015 (Koplitz, Mickley, et al. 2016) (Nazeer and Furuoka 2017).



Thick smoke from peat fires outside Palangka Raya, Central Kalimantan.
Source (16 October 2015) <https://www.flickr.com/photos/cifor/35054025464/>

Agribusiness (especially oil palm and timber) are important crops with oil palm output from Indonesia and Malaysia amounting to almost 90 per cent of total worldwide output (Varqa 2017). The literature indicates linkages between commercial plantations and haze pollution, but more research is required as there are indications that even small holder plantations may be contributory factors as well. For instance, it remains unclear whether fires shown in satellite imagery from 2013 originate from large plantation farms or the small holder farms that surround these commercial ventures (Tan 2015).



Smallholder farming in the haze, Palangka Raya, Central Kalimantan
Source: (13 October 2015) <https://www.flickr.com/photos/cifor/sets/72157660141979565>

Economic impacts

Economic impacts arise from the haze-related effects on sectors such as agriculture, forestry, trade, tourism and transportation. Education is also impacted as children are requested to stay home to minimize their exposure to the harmful haze. Low visibility disrupts transport and tourism leading to losses in revenue (Lin, Wijedasa and Chish 2017).

For instance, in 2015, forest fires in some of the Sumatran and Kalimantan provinces of Indonesia

generated thick clouds of haze across the Malacca Strait paralyzing air travel in Pekanbaru, Batam, Kualanamu (Medan), Aceh and Jambi. The 2015 haze cost Indonesia \$ 16 billion (Varkkey 2017) (World Bank 2016). Recent data estimates that the cost of controlling Indonesian forest fires is about \$1.2 billion (Nazeer and Furuoka 2017).



A primary school pupil wearing a mask while in school. Palangka Raya, Central Kalimantan
Source: (12 October 2015) <https://www.flickr.com/photos/cifor/sets/72157660141979565>

Impacts on health

The health impacts of smoke-haze include premature deaths, respiratory ailments and exacerbation of existing heart and lung conditions (WHO 2016). The impacts on health are associated with a huge cost to the society. The Southeast Asia region is one of the worst affected worldwide and over the years, the number of premature deaths attributed to air pollution has been increasing. In 2012, ambient air pollution from particulate matter was responsible for over 5 million DALYs in the ASEAN region (WHO 2016). The DALY (disability adjusted life years) is the number of years lost due to ill-health, disability or early death (WHO 2016). The haze episode in 2015 is estimated to have resulted in around 100 000 deaths in Indonesia, Malaysia and Singapore, twice as much as the episode in 2006 (Koplitz, Mickley, et al. 2016).

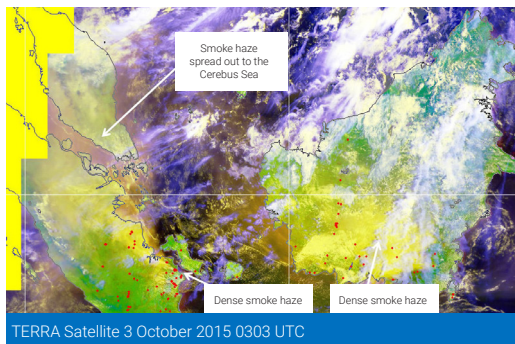
Environmental and social impacts

Ecosystem damage is one of the impacts of the fires which lead to habitat destruction, loss of peat resources and natural rainforest areas. Peatlands are an important element of the hydrological cycle moderating the micro-climate, regulating floods during the rains and providing water during the dry seasons. The increasing demand for land has led to encroachment onto peatlands, which are protected under Indonesian law (Varkkey 2017).

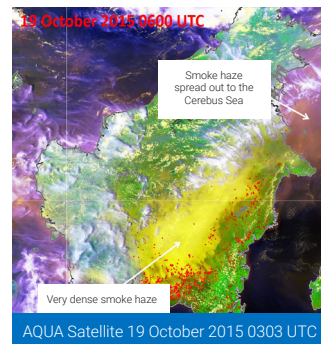
Peat fires lead also to loss of soil biological properties including the incineration of seedlings and the soil seed bank (ASEAN Undated). The ash formed during the fires is thought to increase topsoil erosion, which is eventually washed into the surrounding coastal waters leading to eutrophication in water and loss of soil fertility on land (Palani, et al. 2010).

Some animals subjected to prolonged smoke exposure, may die or migrate into other areas or even human settlements. Rare species such as the Sumatran tiger and Orang utan are affected. The fires sometimes extend into protected areas such as the biodiversity-rich Kuti National Park in Kalimantan (Chisholm, Wijedasa and Swinfield 2016) (Posa, Wijedasa and Corlett 2011).

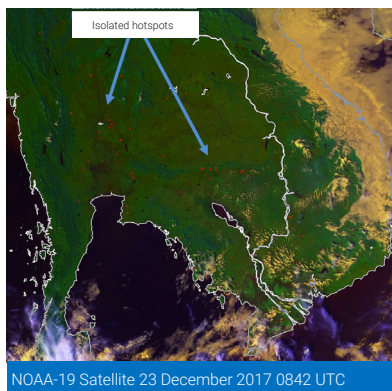
The relationship between carbon dioxide and global climate change is one that is well documented. There has been an increasing trend in carbon dioxide emissions from the ASEAN region. Data from 2013 highlighted a



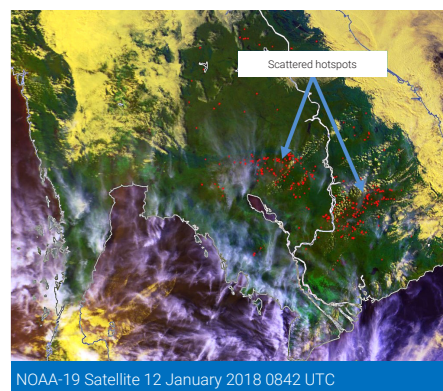
TERRA satellite image shows smoke haze from Sumatra affecting Peninsular Malaysia and Singapore. Dense haze was observed mainly over South Sumatra and Central Kalimantan.
Source: <http://asmc.asean.org/wp-content/uploads/2015/11/fig2.jpg>



AQUA satellite picture shows a large area of Kalimantan shrouded in very dense smoke haze.
Source: <http://asmc.asean.org/wp-content/uploads/2015/11/fig3.jpg>



NOAA-19 satellite image shows dry weather conditions over Myanmar.
Source: <http://asmc.asean.org/wp-content/uploads/2018/01/figure8.jpg>



NOAA-19 satellite image shows dry condition and scattered hotspots detected over Sub-Mekong region.
Source: <http://asmc.asean.org/wp-content/uploads/2018/02/figure6.jpg>

30 per cent average increase in carbon dioxide emissions from the 2005 levels (ASEAN 2017).

Recent data indicates that emissions from the fires in 2015 were the largest in southeast Asia, increasing by 110 per cent compared to the 2006 emissions during the same months (Koplitz, Mickley, et al. 2016) (Huijnen, et al. 2016).

What is/has been done?

Transboundary air pollution is a growing environmental threat that calls for sustained regional cooperation if it is to be addressed. The impacts of the fires on the health of people, ecosystems and wildlife and on climate change are recognized; and it is important that the root causes are attended to and not just reacting after the events. As early as 1998, the United Nations Environment Programme (UNEP) called for global action to address this problem. Since then, there have been programmes addressing various aspects of the problem.

The World Health Organization (WHO) in May 2015, passed a resolution, "Health and the environment: addressing the health impact of air pollution", at its World Health Assembly (WHA 2015). The resolution calls on member states to use research to inform programme implementation, policy development and raise awareness on the dangers of air pollution.

ASEAN Regional Haze Action Plan

The regional haze action plan was adopted by Ministers of Environment in the region in December 1997 and encouraged formulation of policies for prohibiting open burning and enforcing strict control of slash-and-burn practices during the dry period. This led to the adoption of a policy on zero burning in April 1999. Guidelines have since been developed to implement this policy and various public awareness activities have been carried out to enhance implementation. Some of the benefits envisaged included reduction in haze pollution, reduction in greenhouse gas emissions and better soil management through techniques such as recycling of plant biomass and other techniques which reduce the requirement for the application of inorganic fertilizers.

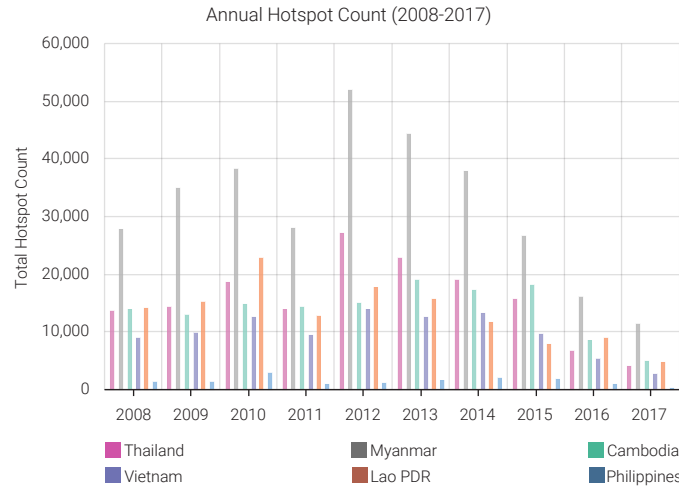
The policy on zero burning prohibits open burning especially amongst plantation and timber companies in the region but allows a certain element of controlled burning as a complete ban may not be feasible amongst the smallholder farmers.

ASEAN Agreement on Transboundary Haze Pollution

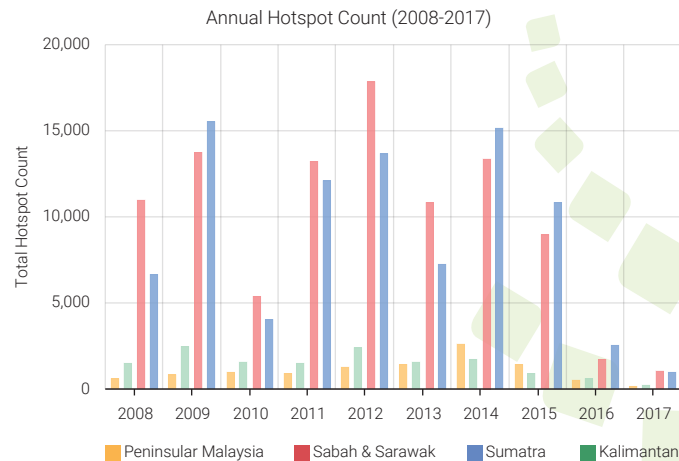
Signed in June 2002 by all ASEAN member states, the ASEAN Agreement on Transboundary Haze Pollution was the first regional cooperation agreement worldwide to aim to mitigate and prevent haze pollution arising from land and forest fires. The treaty came into force in 2003 (Nazeer and Furuoka 2017).

By January 2015 the Agreement had been ratified by all ASEAN Member States, giving a new impetus for implementation (Heilmann 2015). To further enhance ASEAN’s capabilities on addressing the transboundary haze pollution, a *Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation* was adopted in August 2016 with a vision of a haze-free region by 2020. The Roadmap will require all countries to localize the ASEAN transboundary haze pollution agreement by developing and implementing national and local level policies, strategies and actions (ASEAN 2016).

Already, some countries have enacted their own laws to speed up implementation of actions to curb and address land and forest fires. An example is the Transboundary Haze Pollution Act of 2014 enacted to address the issue in Singapore and in the region. The success of this Act will depend on high levels of enforcement and compliance. Strong implementation of national laws could also have positive impacts across borders. For instance, the Transboundary Haze Pollution Act in Singapore enables the government to prosecute its plantation owners who may set fires outside the country and be fined up to \$ 2 million and will thus act as a deterrent. Although it takes time to realise the dividends of environmental regulation, there are some indications of an overall positive impact. An analysis of the number of hotspots (locations with possible active fires) between 2008 and 2017 shows a general declining trend within the region and at country level. For instance, hotspots in Myanmar declined from 52,033 in 2012 to 11,345 in 2017 hotspots, while in Sumatra they declined from a high of 17,841 in 2012 to 1,074 in 2017 (ASMC 2018).



North ASEAN fire hotspots counts derived from NOAA-18 satellite (2006-2015) and NOAA-19 satellite (2016-2017). (ASMC 2018)



South ASEAN fire hotspots counts derived from NOAA-18 satellite (2006-2015) and NOAA-19 satellite (2016-2017). (ASMC 2018)

There are also some positive impacts on some health indicators. For instance between 2005 and 2016, the number of deaths attributed to lower respiratory infections has been on the decline ranging from a decline of just over 50 per cent in Myanmar to 5.9 per cent in Vietnam (IHME 2018). However, more research is needed to confirm these trends.

Percent change in causes of death 2005-2016 (all ages)

Country	% change 2005-2016			
	LRI	COPD	IHD	Lung cancer
Brunei Darussalam	65.2	50.8	60.0	89.0
Cambodia	-31.2	37.4	29.7	51.2
Indonesia	-34.7	17.9	14.2	
Lao PDR	-32.2	11.5	13.1	
Malaysia	28.4	31.8	39.6	44.5
Myanmar	-53.7	8.8	9.2	
Philippines	19.3	49.7	43.8	
Singapore	30.9	-7.8	2.9	21.7
Thailand	64.3	5.3	9.0	31.2
Vietnam	-5.9	15.9	23.5	35.1

LRI = Lower respiratory disease; COPD = Chronic obstructive pulmonary disease; IHD = Ischaemic heart disease. (IHME 2018)

Peatland Restoration

Peatland in Southeast Asia covers an area of 25 million ha. They are important for economic growth, livelihood support and ecosystem health. They also play a major role in the hydrological system and thus are important for agriculture. However rampant drainage and overall unsustainable management practices have made them vulnerable to fire with negative impacts on food security and on human and ecosystem health. Many initiatives at regional level are underway to restore the peatlands. These aims to promote wise use and to prevent fires and thus hasten the restoration of these precious ecosystems. Some of these include the ASEAN Peatland Management Initiative, ASEAN Peatland Management Strategy 2006-2020, and the ASEAN Programme on Sustainable Management of Peatland Ecosystems 2014-2020.

In January 2016, the government of Indonesia established the National Peatland Restoration Agency under Presidential Regulation No. 1 Year 2016, to focus specifically on improving the management of peatlands across the country (Fardah, 2016). The Agency will focus on the priority provinces of Riau, South Sumatra, Jambi,

Central Kalimantan, South Kalimantan, West Kalimantan and Papua. The target is to restore the approximately two million hectares of degraded peatland within five years. In addition, the Indonesian Ministry of Environment and Forestry has declared a temporary ban on new forest concessions and on all land-clearing operations by palm oil companies starting in the Leuser Forest Ecosystem area in Aceh and North Sumatra province. This is likely to reduce pressure on peatlands.

The UN Environment is currently working with Indonesia (and other countries with significant peatlands) through the Global Peatland Initiative programme, to build the knowledge base and develop options for sustainable peatland management. The UN-REDD Programme is exploring ways to reduce the impact of the palm oil industry on forests and peatland using fiscal incentives. Some of the activities include mapping of carbon stocks and involving industry stakeholders in REDD+ planning and decision-making.



Harvesting palm oil
Source: <http://www.kwiknews.my/sites/default/files/PalmOil.jpg>

What are the implications for policy?

Strengthen the implementation and enforcement of existing international and sub-regional cooperative frameworks

There are a multitude of frameworks for cooperation on the environment at the international, sub-regional and national levels that have provisions for transboundary environmental pollution. It is important to promote cooperation and synergies between their enforcement to reduce overlap and gaps in implementation. Furthermore, collaboration could lead to exchange of best practice and collective problem solving by the governments involved. Such an approach would allow for identification of areas of strength and synergy enabling each to leverage their comparative advantage and leading to better use of financial and human resources and strengthened regional cooperation.

Strengthen political leadership and partnerships

Political will to address the air pollution issue is generally strongest following a major haze event and dissipates once the emergency is over until the cycle begins again with the return of the next haze. A global compact on pollution would ensure sustained engagement at the highest level and make prevention a priority for all. It would also encourage policymakers and other key partners, including the private sector, to integrate prevention measures into planning. The non-binding New York Declaration on Forests in 2014 set a target to cut natural forest loss in half by 2020 and strive to end it by 2030 (UN 2014). It is supported by governments, civil society and the private sector. One of the pledges by the private sector was to eliminate deforestation in the production of agricultural commodities by 2020. Within the ASEAN region, the palm oil companies Golden-Agri Resources and Asian Agri; and paper producers Asia Pulp and Paper (APP) and Asia Pacific Resources International Ltd (APRIL) were among those that have joined the growing industry movement to tackle deforestation, with policies that commit to zero deforestation (UN 2014).

Examples of sub-regional air pollution initiatives in Asia and the Pacific

- Acid Deposition Monitoring Network in East Asia (EANET)
- The Malé Declaration on Control and Prevention of Air Pollution and its Likely Transboundary Effects for South Asia
- The Framework Convention on Protection of the Environment for Sustainable Development in Central Asia
- Secretariat of the Pacific Regional Environment Programme (SPREP)
- Asia Pacific Clean Air Partnership (APCAP) Joint Forum (formerly called Joint Forum on Atmospheric Environment in Asia and the Pacific)

Use of data to feed policy and implementation processes

It will take a combination of enforceable legislation and political will for ASEAN to eliminate the haze scourge. The ASEAN Specialised Meteorological Centre (ASMC) provides meteorological data and daily haze updates for the region. It is mandated to monitor land and forest fires and the occurrence of transboundary smoke haze. The Centre provides climate predictions, fire danger ratings and hotspot information, satellite images, and air quality information. ASMC and Singapore Meteorological Service have also supported training of staff in ASEAN region on haze monitoring and modelling. In addition, the Asian Co-benefits Partnership is useful for strengthening regional cooperation, sharing information and knowledge management and linkages between greenhouse gases and air pollution. The success of this system will depend on the willingness of governments to use available data to accurately support decision making and action. Furthermore, studies on the effects of haze on biodiversity and ecosystems are required to support science-based policy implementation at national and regional level.



CIFOR researchers install a device to examine peat dynamics in the Tumbang Nusa research forest outside Palangka Raya, Central Kalimantan.

Source: <https://www.flickr.com/photos/cifor/35724121802/in/album-72157660141979565/>

Strengthen public awareness and education

The reduction of transboundary air pollution will require greater action from all. An advocacy programme that informs and mobilizes the citizenry to action to reduce their own pollution is also recommended. Citizens can also act as advocates obliging commercial businesses in the public and private sectors to implement commitments towards pollution control. ASEAN countries should also explore cooperation with global initiatives such as the Climate and Clean Air Coalition, or the BreatheLife Campaign led by the World Health Organization, United Nations Environment and the Climate and Clean Air Coalition to encourage action at local government level to reduce air pollution.

Upcoming Brief

Faith and Environment

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Bibliography

- ASEAN. 2002. *ASEAN Agreement on Transboundary Haze Pollution*. Kuala Lumpur: Association of Southeast Asian Nations (ASEAN). <http://asean.org/storage/2012/05/AATHP.pdf>.
- ASEAN. 2016. 12th Meeting of the Conference of the Parties to the ASEAN Agreement on Transboundary Haze Pollution adopt the Roadmap on ASEAN Cooperation towards Transboundary Haze Pollution Control with Means of Implementation. <http://environment.asean.org/media-release-12th-meeting-of-the-conference-of-the-parties-to-the-asean-agreement-on-transboundary-haze-pollution/>
- ASEAN. 2017. *ASEAN Community Progress Monitoring System 2017*. Community Relations Division (CRD), Jakarta: The ASEAN Secretariat, 346. http://www.aseanstats.org/wp-content/uploads/2017/09/ACPMS_2017.pdf.
- ASEAN. 2017b. *ASEAN Statistical Report on Millennium Development Goals 2017*. Jakarta: Association of Southeast Asian Nations (ASEAN). http://www.aseanstats.org/wp-content/uploads/2017/08/ASEAN_MDG_2017.pdf.
- 2018. *ASEANstats Database*. Accessed March 18, 2018. <https://data.aseanstats.org>.
- ASEAN. Undated. *Overview of Controlled Burning Practices*. Jakarta: ASEAN. http://haze.asean.org/?wpfb_dl=17.
- ASMC. 2018. *ASEAN Specialised Meteorological Centre - Hotspot Information*. Accessed April 11, 2018. <http://asmc.asean.org/asmc-haze-hotspot-annual#>.
- Chisholm, R A, L S Wijedasa, and T Swinfield. 2016. The need for long-term remedies for Indonesia's forest fires. *Conserv. Biol.* 30: 5-6.
- Fordah. 2016. Peatland Restoration Agency established to prevent forest fires. <https://en.antaranews.com/news/102502/peatland-restoration-agency-established-to-prevent-forest-fires> (14th January 2016). Presidential Regulation No. 1 Year 2016 available from the Ministry of Environment and Forestry Republic of Indonesia at http://www.forda-mof.org/files/SK.05_BRG.pdf
- Gaveau, David L A, Mohammad A Salim, Kristell Hergoualc'h, Bruno Locatelli, Sean Sloan, Martin Wooster, Miriam E Marlier, 2014. Major atmospheric emissions from peat fires in Southeast Asia during non-drought years: evidence from the 2013 Sumatran fires. *Sci. Rep.* 4 (6112). doi:doi:10.1038/srep06112.
- Heilmann D. 2015. The ASEAN Agreement on Transboundary Haze Pollution and Its Effectiveness As a Regional Environmental Governance Tool. *Journal of Current Southeast Asian Affairs*, 34, 3, 95–121
- Huijnen, V, M J Wooster, J W Kaiser, D L A Gaveau, J Flemming, M Parrington, A Inness, D Murdiyasar, B Main, and M van Weele. 2016. Fire carbon emissions over maritime southeast Asia in 2015 largest since 1997. *Sci. Rep.* 6 (26886). doi:doi: 10.1038/srep26886.
- IHME. 2018. *Global Burden of Disease: Country Profiles*. Accessed April 11, 2018. <http://www.healthdata.org/results/country-profiles>.
- Koplitz, Shannon N, Loretta J Mickley, Miriam E Marlier, Jonathan J Buonocore, Patrick S Kim, Tianjia Liu, Melissa P Sulprizio, 2016. Public health impacts of the severe haze in Equatorial Asia in September-October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure. *Environ. Res. Lett.* 11 (094023). doi:doi:10.1088/1748-9326/11/9/094023.
- Koplitz, Shannon N, Loretta J Mickley, Miriam E Marlier, Jonathan J Buonocore, Patrick S Kim, Tianjia Liu, Melissa P Sulprizio, Ruth S DeFries, Daniel J Jacob, and Joel Schwartz. 2016. Public health impacts of the severe haze in Equatorial Asia in September–October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure.* *Environmental Research Letters* 11 (9).
- Lin, Yuan, Lahiru S Wijedasa, and Ryan A Chish. 2017. Singapore's willingness to pay for mitigation of transboundary forest-fire haze from Indonesia. *Environmental Research Letters* (IOP Publishing) 12 (2). doi:https://doi.org/10.1088/1748-9326/aa5c6f.
- Nazeer, N, and F Furuoka. 2017. Overview of ASEAN Environment Transboundary Haze Pollution Agreement and Public Health. *International Journal of Asia Pacific Studies* 13 (1): 73–94. doi:http://dx.doi.org/10.21315/ijaps2017.13.1.4.
- Page, S E, F Siegert, J O Rieley, H D V Boehm, A Jaya, and S Limin. 2002. The amount of carbon released from peat and forest fires in Indonesia during 1997. *Nature* 420: 61-65.
- Palani, Sundarambal, Rajasekhar Balasubramanian, Pavel Tkalich, and He Jun. 2010. Impact of Biomass Burning on Ocean Water Quality in Southeast Asia through Atmospheric Deposition: Field Observations. Supplementary Material. *Atmos. Chem. Phys.* <https://www.atmos-chem-phys.net/10/11323/2010/acp-10-11323-2010-supplement.pdf>.
- Posa, M R c, L S Wijedasa, and R T Corlett. 2011. Biodiversity and conservation of tropical peat swamp forests BioScience. *BioScience* 61: 49-57.
- Reddington, C L, M Yoshioka, R Balasubramanian, D Ridley, Y Y Toh, S R Arnold, and D V Spracklen. 2014. Contribution of vegetation and peat fires to particulate air pollution in Southeast Asia. *Environmental Research Letters* (IOP Publishing Ltd) 9 (9).
- Saharjo, B H. 2015. *Community-based peatland management for greenhouse gas reduction based on fire-free land preparation*. Edited by A K Braimah and H Q Huang. Hoboken, NJ: Wiley.
- Tan, Alan Khee-Jin. 2015. *The 'Haze' Crisis in Southeast Asia: Assessing Singapore's Transboundary Haze Pollution Act 2014*. Faculty of Law, National University of Singapore (NUS). https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2547379.
- UN. 2014. *New York Declaration on Forests: Action Statements and Action Plans*. Climate Summit 2014, New York: United Nations. <https://www.un.org/climatechange/summit/wp-content/uploads/sites/2/2014/07/New-York-Declaration-on-Forest-%E2%80%93-Action-Statement-and-Action-Plan.pdf>.
- Varkkey, Helena. 2017. *The politics of fires and haze in Southeast Asia*. Oxford Research Encyclopedia of Politics, Oxford University Press. doi:DOI: 10.1093/acrefore/9780190228637.013.262.
- Varqa, Sathia. 2017. *Essential Palm Oil Statistics 2017*. Singapore: Palm Oil Analytics.
- WHA. 2015. *Health and the environment: addressing the health impact of air pollution: draft resolution proposed by the delegations of Albania, Chile, Colombia, France, Germany, Monaco, Norway, Panama, Sweden, Switzerland, Ukraine*. Geneva: World Health Assembly, World Health Organisation (WHO). <http://www.who.int/iris/handle/10665/253206>.
- WHO. 2016. *Ambient Air Pollution: A global assessment of exposure and burden of disease*. Geneva: World Health Organisation (WHO). <http://apps.who.int/iris/bitstream/10665/250141/1/9789241511353-eng.pdf>.
- World Bank. 2016. *The Cost of Fire: An economic analysis of Indonesia's 2015*. Washington D.C: The World Bank.