10. Southeast Asian haze and socio-environmental–epidemiological feedback

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While the fire and haze season for Indonesia and Malaysia was mild in 2020 despite 'moderate' meteorological outlooks, there were a number of reasons to expect that the socio-economic impacts of COVID-19 would increase the prevalence of agricultural and land clearance fires and the resultant haze pollution. Furthermore, there was mounting evidence revealing that particulate matter in the haze produced by the fires may have increased transmission rates of COVID-19, exacerbated the symptoms of the disease and severity of infection, and increased overall mortality. We explore the reasons why COVID-19-related lockdowns and economic recessions might have led and will continue to lead to the increasing use of fire in Southeast Asia's peatlands in the short and long terms. We then discuss the role that haze pollution (as well as historic population exposure to this pollution) might have played in exacerbating the COVID-19 crisis through interactions between air pollution and the virus. Finally, we speculate that a novel feedback loop may exist that has exacerbated both the severity of the pandemic and the risk of fire-related haze events.

Haze in 2020 and the situation in 2021

The Southeast Asian 'haze season' usually refers to a regional air pollution crisis generally occurring from late August through November, driven by deforestation and agricultural fires, predominantly in Indonesia (Varkkey 2015). Beyond its immediate effects in Indonesia, the haze often travels across borders to affect Singapore, Malaysia, and sometimes further afield. There have also been increasingly regular haze events in northern Southeast Asia caused by agricultural burning in the 'golden

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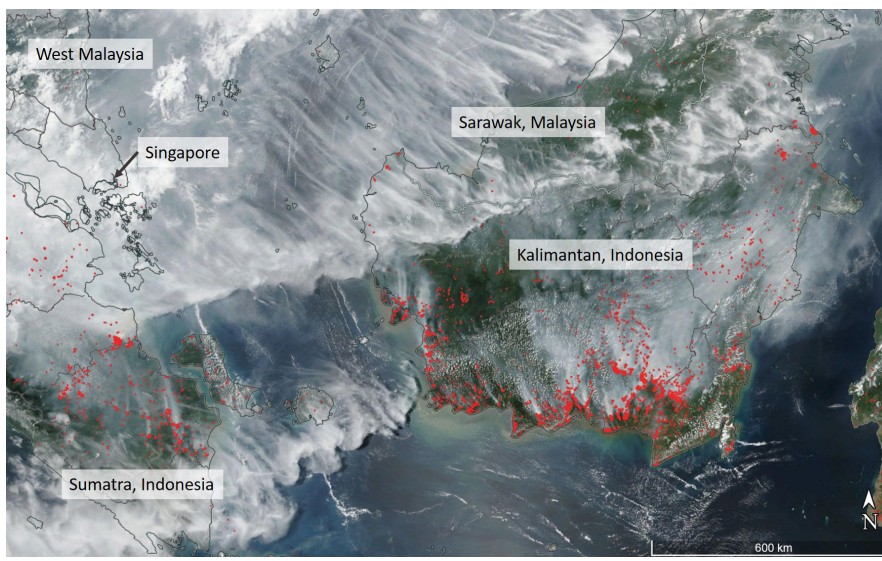
triangle' border region of Thailand, Laos, and Myanmar (Greenpeace Southeast Asia 2020).

Much of the haze originating from Indonesia is produced by fires on carbon-rich tropical peatlands. Under pristine forested and waterlogged conditions, peatlands rarely catch fire. Small-, medium-, and large-scale developers, however, often drain peatlands to prepare them for smallholdings and commercial plantations. This process dries out the surface peat layer such that it becomes highly combustible. Furthermore, fire is sometimes used intentionally as a cheap and efficient way to clear the land (Varkkey 2015). Once ignited, peatland fires are difficult to suppress and may smoulder for weeks or months (Hu et al. 2018).

Predicting the timing, extent, and severity of the haze season is complex given that the fires are a function of the weather and longer-term climate variabilities (e.g. El Niño) as well as land and water management. In March 2021, the NOAA's El Niño–Southern Oscillation forecast suggested that El Niño (associated with hot and dry conditions in Southeast Asia) would be unlikely during 2021 (NOAA 2021), reducing the risk of widespread fires that had plagued previous El Niño-exacerbated dry seasons, such as those in 2015 and 2019 (Figure 10.1).

Figure 10.1. A true-colour satellite image with fire hotspot detections (red) over parts of Malaysia, Indonesia, Singapore, and Brunei during the height of the 2019 haze season, on 14 September 2019



Source: NASA Worldview (2019).
Note: Visible plumes of smoke shroud much of Kalimantan, while plumes from fires on Sumatra are driven by the wind northwards towards Singapore and the Malay Peninsula.

However, the Singapore Institute of International Affairs (SIIA), which releases annual 'Haze Outlook' reports, warned that the impacts of the COVID-19 pandemic could increase the risk of a severe transboundary haze incident, in spite of the low probability of El Niño (SIIA 2020).

COVID-19 and tropical peatland fires

By the end of March 2021, Indonesia had the highest number of COVID-19 cases and deaths in East and Southeast Asia, with 1,470,000 confirmed cases and 39,865 deaths as of 24 March 2021. With only 2.12% of the population vaccinated by the end of March 2021, the disease seemed likely to remain a public health crisis in the region throughout 2021, including the haze season later in the year. The potential influence of the pandemic on tropical peatland fires can be broken down into three critical COVID-19 impacts:

1. The reallocation of government budgets for environmental protection and fire prevention to the COVID-19 response and the deregulation of environmental laws to encourage economic recovery;
2. Lockdown and physical distancing measures inhibiting the deployment of government, NGO, and private sector personnel responsible for environmental protection, community engagement, and fire prevention; and
3. The economic impacts of the pandemic and associated lockdowns on certain plantation companies who might use fire and illegal encroachment to raise profitability.

First, in April 2020, the Indonesian Ministry of Environment declared a reallocation of 1 trillion rupiah (US$111 million) from its budget to help forest communities and farmers affected by COVID-19 (PPID 2020). The consequences of the reallocation included a 50% budget cut for the ministry's fire-fighting teams that were responsible for finding and fighting fires; this in turn led to a 34% reduction in the area of fire patrolling (Ungku and Christina 2020).

And, while the mandate of the Peatland Restoration Agency, a key agency in the fight against peatland fires, was extended for a further four years, several new laws and policies were passed in 2020 that accelerated environmental deregulation in the name of economic recovery and food security. For example, the Omnibus Law on Job Creation included the scrapping of a provision that required the maintenance of

a minimum 30% watershed and/or island area as forest area and the shortening of a requirement for plantation companies to develop 30% of their concession areas from three to two years. A new 'food estate' programme, in turn, allowed protected forest areas to be cleared in the process of establishing millions of hectares of new farmland. Such deregulations put fire-prone peatlands at risk of accelerated development (Jong 2021).

Second, lockdowns and social distancing rules compounded budget cuts, further inhibiting patrol efforts. It was not just government personnel who were stating that COVID-19 restrictions 'hamper … our access to the flames' (Ungku and Christina 2020), but also stakeholders in the private sector who were finding it difficult to assess the situation on the ground, even on their own plantations (Jong 2020). NGOs, often responsible for encouraging more sustainable peatland livelihoods through outreach, fire-free programmes, and demonstration projects, shifted their focus to online activities at a crucial time of the year, and the effectiveness of online activities was highly dependent on reliable internet access, which was often lacking (Ungku and Christina 2020).

Finally, Indonesia's economy contracted for the first time in 20 years in the second quarter of 2020, shortly after COVID-19 hit, and there were concerns of a prolonged recession (Ing 2021). Key sectors linked to fires and haze came into the COVID-19 pandemic on the heels of an already challenging financial year. In particular, palm oil saw especially low commodity prices in 2019 (Khoo 2019), influenced by issues like the European Union's decision to phase out palm oil-based biofuels by 2030.

There were concerns that the associated unemployment and economic pressures will drive smallholders as well as some plantation companies to shift to cheaper and less sustainable practices. Smallholders surveyed in Indonesia reported an average 5% decline in selling prices of fresh fruit bunches (FFB), which affects turnover cost efficiency and fertiliser input expenses, with probable long-term knock-on effects for attainable FFB yield (Nurkhoiry and Oktarina 2020).

While larger, more publicly visible transnationals (e.g. Sime Darby, Wilmar, or Golden Agri Resources) made commitments to compliance with sustainable certification schemes such as the Roundtable for Sustainable Palm Oil (RSPO) to maintain sustainability practices at all times, this was not the case for less prominent small- and medium-sized companies that had not yet made such commitments. In the face of COVID-19-related economic pressures, such companies might have

been more inclined to infringe upon environmental regulations to offset immediate losses and increase short-term profitability, including the use of fire and illegal encroachment into tropical peat swamp forests (Suwiknyo 2020).

These economic pressures, combined with government cutbacks and movement restrictions, might have decreased the likelihood of effective policing, prosecutions, and convictions, raising the possibility of a more severe transboundary haze event should there be a strong El Niño dry season. The likelihood of a longer-term economic downturn suggested that the impacts of COVID-19 would reach far beyond 2020 and 2021.

How might haze exacerbate the pandemic?

While COVID-19 might have increased the risk of a significant haze incident, there was growing evidence suggesting that air pollution both decreased base-level immunity to the disease and increased mortality rate from it.

A growing body of literature has found statistically robust correlations between air pollution and COVID-19 cases, hospital admissions, and deaths (Cole, Ozgen, and Strobl 2020). In a US study, an increase in concentrations of fine particulate matter ($PM_{2.5}$) of just 1 μgm^{-3} was associated with a 15% increase in COVID-19 deaths (Wu et al. 2020), while a similar study from England found that an increase in the long-term average $PM_{2.5}$ concentrations of 1 μgm^{-3} could explain a 12% increase in COVID-19 cases (Travaglio et al. 2021). These results were especially concerning for the Southeast Asian haze season because concentrations of $PM_{2.5}$ can reach hundreds to thousands of μgm^{-3} during haze events, many times higher than the concentrations investigated in the aforementioned studies.

Understanding the precise pathological mechanism for the correlation has remained a work in progress, although Acute Respiratory Distress Syndrome (ARDS), which has long been linked to polluted air, has been a major cause of COVID-19 related deaths. One notable finding from both the US and UK studies (Travaglio et al. 2021; Wu et al. 2020) was that high rates of COVID-19-related deaths correlated not only to contemporaneous air pollution conditions but also to prolonged exposure to polluted air over time. For example, those living in US counties that had experienced worsening air pollution over the previous 15 to 20 years had a substantially higher mortality rate. $PM_{2.5}$ particles, the particles in air pollution that are small enough to be inhaled into the lungs

and even enter the bloodstream, have the long-term effect of weakening human respiratory, cardiovascular, and immune systems. In the context of COVID-19, someone with already weakened lungs and respiratory tracts has a higher risk of not only becoming infected but also suffering worse symptoms (Wu et al. 2020). Both acute and chronic exposure to haze, therefore, decrease the base-level immunity of the population to COVID-19 and increase the risk of death.

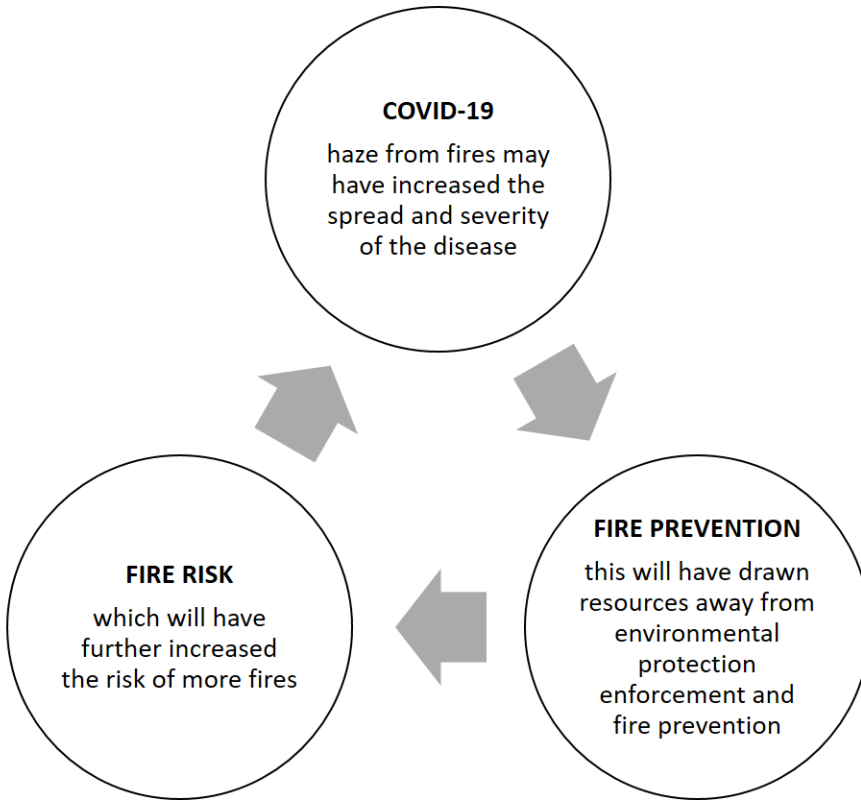
Perhaps most worryingly, there was also evidence to suggest that particulate matter may have also acted as a vector for the relatively tiny virus (Barakat, Muylkens, and Su 2020; Setti et al. 2020), offering a surface to which the virus could cling. Frontera et al. (2020) have suggested that viruses travelling on the surfaces of air pollution particles were able to survive longer and travel further (> 2 m) through the air, potentially increasing the basic reproduction number (R), i.e. the spread, of the disease. The minute nature of the haze pollution particles as a host for the virus (as opposed to larger droplets of saliva) was also linked to deeper penetration into the human respiratory system, causing a more severe infection (Frontera et al. 2020). While COVID-19 lockdowns led to a notable decrease in aerosol optic depth (AOD, representing density of particulate matter) over Southeast Asia, it was found that, in areas with extensive forest fires and agricultural burning, AODs remained at very high levels, even during lockdown periods (Kanniah et al. 2020).

A novel socio-environmental–epidemiological feedback mechanism?

The impact of air pollution on the virus's spread and severity is likely to have been scaled with the concentration of particulate matter in the air and the density of people exposed to both the disease and air pollution (Cole, Ozgen, and Strobl 2020; Frontera et al. 2020). Major haze incidents in Southeast Asia are conducive to this effect, with hazardous levels of particle concentrations coinciding with densely populated urban centres.

From this, we may deduce that there is the potential for a novel socio-environmental–epidemiological reinforcing feedback loop (Figure 10.2), whereby environmental air pollution from fires might have led to an increase in the spread and severity of disease, which might in turn have drawn resources away from environmental protection enforcement and fire prevention, which might have further increased the risk of more fires. This vicious cycle might not have been unique to

Figure 10.2. The socio-environmental–epidemiological feedback loop



Southeast Asia and haze, possibly also playing a role in exacerbating COVID-19 and air pollution crises in other deforestation fire-affected regions, such as Russia and Brazil.

Beyond the COVID-19 pandemic, tropical peat swamp forests in Southeast Asia also present suitable conditions for the potential emergence of novel zoonotic infectious diseases in the future (Harrison et al. 2020; Morand and Lajaunie 2021). This is due to their high biodiversity, the presence of many potential vertebrate and invertebrate vectors, and high levels of habitat disruption and wildlife harvesting. Morand and Lajaunie (2021) found that increases in outbreaks of zoonotic and vector-borne diseases similar in nature to COVID-19 from 1990 to 2016 were heavily linked to deforestation in tropical countries. In particular, and of important relevance to haze crises, deforestation for oil palm plantations was singled out as a driver of outbreaks of vector-borne diseases (Morand and Lajaunie 2021). Combined with the high likelihood of fires in these areas (and the potential for these

fires to exacerbate a pandemic's health effects, as discussed above), any future outbreaks will likely have dire impacts on the public health and livelihoods of remote local communities around peatland areas, most of whom have limited medical facilities and high dependence on external trade (Harrison et al. 2020).

Hence, both in terms of the mitigation of the COVID-19 pandemic and reducing the potential for the emergence of future pandemics, it remains extremely important for governments to continue to prioritise environmental protection and fire prevention, especially in tropical peatlands, throughout and beyond this time of crisis.

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