



The need for long-term remedies for Indonesia's forest fires

In late 2015, an environmental disaster with global consequences unfolded in Southeast Asia. Unusually extensive and persistent fires in Indonesia razed thousands of square kilometers of tropical forest and peatland, casting a toxic cloud of smoky haze over the region and dumping billions of tons of CO₂ into the atmosphere. Similar fires have occurred annually for decades, but strong El Niño conditions made the 2015 fires the worst since 1997.

The fires occur mostly on Sumatra and the Indonesian portion of Borneo (Kalimantan). The 1997 event burned 45,600 km² (Heil & Goldammer 2001); the 2015 event is likely to have burned somewhat less than this because monsoon rains arrived in November, but exact estimates are not yet available. The fires have multiple causes with the primary driver being land clearing for agriculture, especially for industrial oil-palm and paper-pulp plantations. Forests ignite easily after brief dry periods (Gaveau et al. 2014), especially where some biomass has already been chopped in preparation for the burning season. Many of the fires occur on carbon-rich peatlands, where they can enter the soil, smolder for months underground, and resurface when conditions are favorable.

The environmental costs of the Indonesian fires are enormous. The tropical forests that are burned are among the world's most biodiverse ecosystems, harboring thousands of plant species and endangered mammals, including the orangutan (*Pongo borneo*) and the Sumatran tiger (*Panthera tigris*) (Posa et al. 2011). Burned land does not easily regenerate into forest; instead, it develops into scrubland or grassland that is prone to repeat burning.

A major impact of the fires is the haze that spreads to neighboring Singapore, Malaysia, and even to southern Thailand and the Philippines. During the 2015 event, in Indonesia 40 million people endured 2 months of nearly continuous exposure to hazardous levels of air pollution and tens of thousands suffered from respiratory ailments. In Palangka Raya, the capital of Central Kalimantan, air pollution indices soared to 5 times the hazardous level. In Singapore hundreds of kilometers away from most of the fires, the air quality index also peaked at hazardous levels. The long-term impacts of the haze on health are not well understood. Of particular concern is fine particulate matter (PM_{2.5}). One study estimated that elevated PM_{2.5} in strong El Niño years in Southeast Asia leads to an annual increase of 10,800 adult deaths (approximately 2%) from cardiovascular diseases (Marlier et al. 2012),

although this estimate is uncertain because it relies on international data from air pollution not specifically related to forest fires. The haze affects not only health but tourism, education, and other industries. During the 2015 haze, tourism numbers dropped in Indonesia, Malaysia, Singapore and Thailand, sporadic school closures occurred, and outdoor events were cancelled.

The larger scale longer term impact of the Indonesian fires is on global climate. The 1997 event released an estimated 2.97–9.42 GtCO₂, the majority from peat combustion (Page et al. 2002). This represented 13%–40% of global anthropogenic total CO₂ emissions in 1997. Data on emissions from the 2015 fires will not be available until the northern spring of 2016.

The impacts of the 2015 fires are yet to be translated into economic terms, but they are likely to exceed the estimated impacts of \$4.5 billion from the 1997 fires (Glover & Jessup 2006). The 1997 impacts represented over 1% of the combined gross domestic product of Indonesia, Singapore, and Malaysia at the time. If the impacts of the 2015 fires are similar in proportional terms, the absolute costs will be about \$16 billion. All these numbers are lower bounds because they exclude impacts that are difficult to quantify, in particular lost biodiversity and long-term damage to human health.

What can be done to prevent future burning? The situation in Indonesia largely mirrors that in forested countries around the world: land clearing (in this case by burning) brings large benefits to concessionaries and local people and diffuse benefits to society at large (through, e.g., cheap and plentiful timber and oil palm products), but it imposes diffuse costs over billions of people now and centuries into the future (through air pollution, climate change, and biodiversity loss). The specific problem of peat-soil fires may be more tractable in the near term: peat fires are a side effect of the land-clearing forest fires, exact great costs, and provide few or no benefits.

The Indonesian president has expressed a commitment to solving the burning problem, including a plan to dig new canals and thereby reflood peatlands. But implementation of reforms will be hampered by Indonesia's decentralized government, opaque legal infrastructure, and weak law enforcement. Large-scale burning is already illegal in Indonesia. There have been calls for large landholding concessionaires, particularly multinational companies, to be prosecuted for fires occurring on land under

their management and for these prosecutions to extend to other countries, including Singapore and Malaysia, where some of the companies are held. But the beneficiaries of the burning and land clearing also include smallholders, government officials, law enforcement officers, and investors. Some of these beneficiaries are connected to the large companies; others are not. Essentially, this is a wholesale cash-in on the Indonesian environment, with poor regulation and poor enforcement allowing the free market to run wild. Because of this, actions against large companies alone will not solve the problem. Indeed, most large companies have transitioned to mechanical clearing and many even stand to lose from burning when the fires enter their timber concessions (Abood et al. 2015; Marlier et al. 2015) or oil-palm plantations. One study estimated that small- to medium-sized enterprises are responsible for most of the burning and 60% of overall emissions (Gaveau et al. 2014), but it should be noted that these smaller enterprises usually rely on large multinationals for access to markets. A further complication is that it remains difficult to identify and prosecute arsonists because different agencies' maps show overlapping land claims and because chains of ownership among companies are convoluted. This is perhaps compounded by a lack of will to take legal action against smallholders who were promised for increased access to new agricultural lands prior to the 2014 national election.

At a regional level, the 2002 Association of Southeast Asian Nations' (ASEAN) Agreement on Transboundary Haze Pollution was finally ratified by Indonesia in 2014, but this agreement has to date manifestly failed to stop the fires. Singapore has attempted to mitigate the fires through political, legal, and economic pressure by, for example, imposing fines on culpable companies (Lee et al. 2016) and withdrawing products from supermarket shelves. But the maximum fines (\$1.4 million per company per year) and the size of the Singapore market are tiny next to the value of the oil-palm and paper industries—the former alone generated \$19 billion in export revenue for Indonesia in 2014.

The international community can potentially mitigate the Indonesian fires by incentivizing forest conservation through payments for reducing emissions from deforestation and forest degradation (REDD+). But in most areas carbon payments will not match the value of agriculture (Gaveau et al. 2014). The net present value of oil palm (\$3,000/ha to \$20,000/ha), for example, usually exceeds potential income from REDD+. Carbon payments specifically for peatland soil conservation may be more feasible: the massive soil carbon stocks can potentially be protected from fire without landowners completely forgoing agricultural activity.

Comparing an account of the 1997 fires (Heil & Goldammer 2001) with the events of 2015 gives one an eerie sense of history repeating itself. Will anything be different in the aftermath this time? We believe it is naive

to expect Indonesia to solve the forest-fire problem on its own. The proceeds of environmental destruction line the pockets of wealthy Indonesians and provide a route out of poverty for millions; meanwhile, the costs of environmental destruction are shared regionally and globally. Unless this situation changes, there will remain strong incentives to burn and deforest. The actors on the ground will change their behavior only if they see forest conservation as a viable economic alternative. The necessary payments for forest conservation may be politically unpalatable at a regional level if neighboring countries perceive haze-free air as an inalienable right that should not be paid for. We see the best hope for solutions at the global level, through REDD+ and other mechanisms. Those concerned about Indonesia's forest fire problem will have welcomed the outcome of the 2015 COP21 negotiations in Paris, which placed a renewed emphasis on tropical forest conservation.

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