



# The Cost of Fire

An Economic Analysis of Indonesia's 2015 Fire Crisis



A person wearing a green t-shirt with yellow stripes on the sleeve and a grey cap is working in a bamboo forest. They are holding a tool, possibly a machete, and appear to be engaged in a task like clearing or planting. In the background, there is a large fire burning, with bright orange and yellow flames rising from a dark, charred area. The scene is somewhat hazy, suggesting smoke or mist.

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## AN ECONOMIC ANALYSIS OF INDONESIA'S 2015 FIRE CRISIS

### 1. Chronic Man-Made Fires Lead to an Economic and Environmental Disaster

According to the government, 2.6 million hectares of Indonesian land burned between June and October 2015,<sup>1</sup> an area four and half times the size of Bali. Man-made fires – more than 100,000 of them<sup>2</sup>– were used to prepare land for agriculture and to gain access to land cheaply. Absent controlled burning measures or sufficient law enforcement, the fires grew out of control, fed by drought and exacerbated by the effects of El Niño. This vast economic and environmental crisis is repeated year after year, as a few hundred businesses and a few thousand farmers profit from land and plantation speculation practices, while tens of millions of Indonesians suffer health costs and economic disruptions. In 2015, fires cost Indonesia an estimated USD 16.1 billion (IDR 221 trillion). Adding in regional and global costs mean the actual figure is much higher. The government has prioritized a response and the president has called for action. Now is the time for Indonesia to address the underlying drivers of man-made fires, enforce laws and revise policies in order to reduce the risk of these economic disasters from recurring.

By October 2015, eight provinces had burned more than 100,000 hectares each. In line with historical patterns, the islands of Sumatra and Kalimantan – where most of the country's fragile peatlands (*lahan gambut*) are located – were the hardest hit. The provinces of South Sumatra and Central Kalimantan represented 23 percent and 16 percent of the total burned area, respectively. Unlike past years, however, fires in Papua were particularly widespread, resulting in 10 percent of the total area burned nationally. This is a particularly troubling development because Papua's peatlands are some of the last intact in Indonesia.

Draining and conversion of peatland, driven largely by palm oil production, contributes to the intensity of haze from fire. About 33 percent of the total area burned was peatland, leading to noxious haze that blanketed parts of Indonesia and the region, disrupting transport, trade, and tourism, forcing school closures and negatively affecting health. The 2015 fires also contributed

significantly to Indonesia's substantial greenhouse gas (GHG) emissions (Box 2).

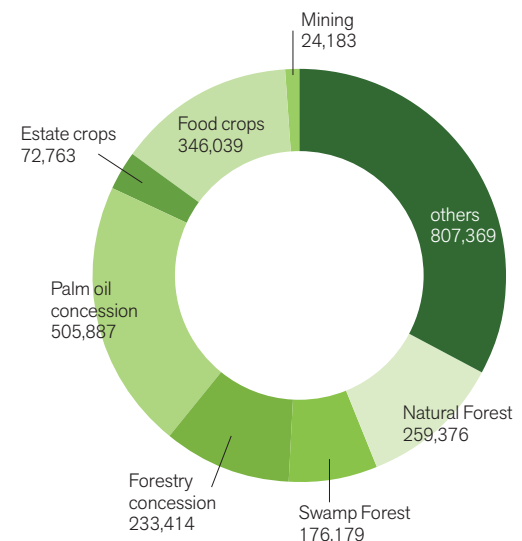
Fire has long been a tool for agriculture in Indonesia. Informally, it also plays an important role in land acquisition. This means that, while many suffer extensive fire and haze-related losses, there are a few who make significant gains. This article looks at this winner-loser dynamic, estimating the economic losses and damages associated with fire and haze in 2015 from eight provinces and relating these to profits gained from one area of agriculture – oil palm.<sup>3</sup>

Hectares burned by province, June – October 2015

Province	Thousand hectares	Percent
S. Sumatra	608	23
C. Kalimantan	429	16
E. Kalimantan	388	15
S. Kalimantan	292	11
Papua	268	10
W. Kalimantan	178	7
Riau	139	5
Jambi	123	5
Other	186	7
<b>Total</b>	<b>2,611</b>	<b>100</b>

Source: Agency for the Assessment and Application of Technology (Badan Pengkajian dan Penerapan Teknologi, BPPT); Ministry of Environment and Forestry; World Bank staff calculations

Hectares burned by land type



<sup>1</sup> Communicated by Indonesia's Ministry of Environment and Forestry at the Meeting of Communication Forum for Disaster Data and Information in Jakarta November 10, 2015.

<sup>2</sup> Global Fire Emissions Database: <http://www.globalfiredata.org/index.html>.

<sup>3</sup> A version of this article was published as part of the World Bank's *Indonesia Economic Quarterly*, December 2015.



### Box 1. Certification Standards Could Encourage Environmentally-Friendly Production Practices

In 2015, the estimated economic cost of fire to Indonesia (USD 16 billion) was larger than the estimated value added from Indonesia's 2014 gross palm oil exports (USD 8 billion)\* and the value added from the country's entire 2014 palm oil production (USD 12 billion). While not all fires are set to clear land for oil palm, oil palm – an important and growing sector of the economy – is a large driver of land conversion. Given government support for its continued expansion,\*\* coupled with the negative externalities of fire use in some oil palm production, a consideration of the relative costs of both is warranted.

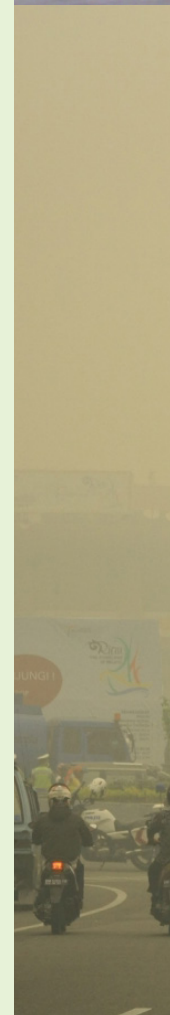
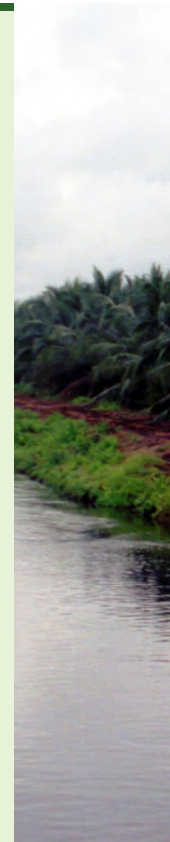
**Efforts to ensure sustainable oil palm exist, but face challenges.** Indonesia has a mandatory certification scheme – the Indonesian Sustainable Palm Oil Initiative (ISPO) – governing oil palm production on plantations greater than 25 hectares that prohibits the use of fire. Most large companies also subscribe to the Roundtable on Sustainable Palm Oil (RSPO) – a voluntary certification scheme globally accepted as the mark of sustainability. In addition, the Indonesian Palm Oil Pledge (IPOP) is a platform where participating companies pledge to produce and trade only deforestation-free oil palm within their supply chains. This means not sourcing palm oil produced on peat or old shrub lands or from areas that were once primary or secondary forest. Traceability is a key element of the IPOP commitment as it mandates that the palm fruit produced or traded is consistent with deforestation-free and sustainable agriculture practices. Given that IPOP members represent 60-65% of Indonesia's (2013) 33 million tons of annual crude palm oil production, commitment to such standards implies a significant part of Indonesian production should be deforestation-free. However, there are technical challenges to ensuring the IPOP pledge is met. Specifically, government has expressed concern that some producers, namely smallholders, may not be able to comply and have pushed for these producers to be exempted. Monitoring is impeded, in part, by the absence of a transparent, agreed-upon map of sensitive areas that are off-limits to development.

**Several steps could make certification schemes more robust, leading to more sustainable production practices.** On the policy side, a government regulation for peatland protection, restoration, and management, including a roadmap for transitioning people and production off of sensitive peatland areas, should be formalized and enforced. Technical follow-up is also needed. Specifically, given that some certification standards, including RSPO, call for the protection of lands with high conservation value and/or high carbon stock, a government-led and publically-consulted inventory – including on peatlands – would provide a single set of data to inform a baseline upon which policy and investment decisions could be made. Additionally, monitoring and implementation of responsible production standards would be strengthened considerably with the finalization of the OneMap Policy, which aims to integrate relevant land-use and boundary data into a single, publically available database for Indonesia. Such a map could help guide investment decisions by demarcating forest from non-forest lands. Data could also be integrated to include additional information on sensitive ecosystems (e.g., peatlands and primary forest), and identify lands that may need further protection.

*Expansion of oil palm production is a significant driver of land conversion, including in sensitive peatlands, and fire is often part of this process*

\* Based on a gross export value of USD 17.5 billion in 2014 and total palm oil production value of USD 25.5 billion (IDR 302.5 trillion) multiplied by the palm oil industry value added share 0.556 of total palm oil output taken from the Indonesian 2008 Input-Output table. Data sources: Food and Agriculture Organization, Indonesian Palm Oil Producers Association, and Indonesian Ministry of Agriculture.

\*\* The government aims to increase crude palm oil production to 40 million tons by 2020, from about 31 million tons in 2014 (Krisnamurti, B., 2008, "Government strategic policies in sustainable oil palm development," presentation at the Indonesian Palm Oil Conference and Price Outlook 2009, Bali).



## 2. Palm Oil Production is Worth Billions: Who Benefits?

**Indonesia's fire story is not just one of loss and damage; fires contribute to significant economic upside for a diverse, if concentrated, group of actors.** Fire is an integral part of the process of large-scale conversion of the nation's rich forest assets, particularly peatland, into agricultural lands for private benefit. The growth in the prevalence of fire correlates with the expansion of lucrative agricultural commodities such as palm oil and acacia for wood fiber. Land conversion by fire is prohibited by Law No. 32/2009 and penalties include fines and prison terms. Yet, the alternative of mechanical clearing with heavy equipment can be many times more expensive.<sup>4</sup>

**There are three common uses for fire in Indonesia: (i) land clearing and preparation; (ii) land acquisition; and (iii) as a mechanism to force inhabitants off the land.** As a tool for acquisition, land-holders burn beyond their concession boundaries or those with no formal claim to the land burn land and then claim it. Without effective enforcement there is no control; and, given the profitability of crops such as oil palm, there is a strong incentive to continue the practice.

**Analysis by the Center for International Forestry Research (CIFOR) provides an example of the role of fire in the lucrative palm oil industry.** Looking at 11 sites outside of concessioned plantations across 4 districts in Riau Province, CIFOR concluded that using fire for land acquisition and clearing generates a cashflow of at least USD 3,077 per hectare of oil palm in just three years.<sup>5</sup> While the production process involves illegal means for land clearing, the resulting palm oil is processed at the same facilities as legally-produced palm

fruit before both types are sold for consumption. If every hectare burned in 2015 were converted to oil palm, the value would be about USD 8 billion, highlighting the scope for high profit in a short period of time. Poor land management and governance allow this ecologically-destructive activity to continue. Peatlands are a target as they generally are uninhabited and relatively free of overlapping claims.

**The CIFOR work finds that 85 percent of the cashflow generated goes to local elites – i.e., those in power or able to take financial risk – and to plantation developers.** Smaller profits accrue to the land claimant (1 percent), land broker (2 percent), tree cutters (3 percent), slashers (3 percent) and burners (1 percent), and the oil palm farmer (5 percent). Without alternative commensurate economic opportunities, it is no surprise oil palm plantation expansion (especially on peat) continues. However, rapid expansion incurs negative impacts that carry domestic, as well as regional and global losses, affecting far more people than the relatively few who benefit.

*If every hectare burned in 2015 were converted to oil palm, the value would be about USD 8 billion*

<sup>4</sup> Simorangkir, D., 2007, "Fire use: Is it really the cheaper land preparation method for large-scale plantations?", *Mitig Adapt Strat Glob Change*, 12: 147–164.

<sup>5</sup> Purnomo, H., Shantiko, B., Gunawan, H. 2015, Political economy study of fire and haze, presented at the International Seminar "Toward a sustainable and resilient community: Co-existence of oil palm plantation, biodiversity and peat fire prevention", August 5, 2015, University of Riau, Pekanbaru, Bogor, Indonesia: Center for International Forestry Research.



## Box 2. Fire, Peat and Climate Change

**Calculating the GHG emissions from Indonesia's fires is difficult and hinges primarily on quantifying the amount and depth of peatland burned.** While all fires produce GHG emissions, the CO<sub>2</sub> emissions from fire are usually balanced by regrowth after the fire. However, this is not the case for peat fires because they burn carbon that has been deposited over thousands of years and cannot be replaced. Peatlands have long been a target for land conversion – draining seemingly unproductive swamp land and then clearing it with fire for agriculture. Dry peatland is quick to burn and difficult to extinguish.

**Most peat is found on Sumatra, Kalimantan and Papua but there is no agreed map nor a complete baseline of peatland areas.** Allowing drainage and burning of peatland has significant, even global, consequences for climate change, as well as on health and the economy in Indonesia and the region. In addition to contributing significantly to GHG emissions, peat fires also produce haze, due to their high content of aerosols.

**The Global Fire Emissions Database version 4 (GFED4) provides a best, if uncertain, estimate of the GHG emissions impact of the 2015 fires** by extending estimates of earlier years based on satellite-derived burned area and fuel consumption with satellite detections of active fires.\* GFED estimates that in 2015 Indonesian fires contributed roughly 1,750 million metric tons of carbon dioxide equivalent (mtCO<sub>2</sub>e) to global emissions in 2015. By comparison, based on its 2nd National Communication to the United Nations Framework Convention on Climate Change, Indonesia estimates that its annual economy-wide emissions are 1,800 MtCO<sub>2</sub>e. Indonesia has pledged to reduce emissions by 29 percent (or 41 percent with international financial support) compared with a business as usual scenario by 2030 as part of its contribution to keep global temperatures from exceeding 2 degrees Celsius. Fires like those in 2015 will make reaching this target impossible.

*Fires like those in 2015 are likely to make achievement of Indonesia's emissions reduction targets unattainable*

\* This approach is described in Van der Werf et al. (2010), "Global fire emissions and the contribution of deforestation, savanna, forest, agricultural, and peat fires (1997–2009)" Journal of Atmospheric Chemistry and Physics, and further detailed on the GFED website.

## 3. The 2015 Fires Cost Indonesia an Estimated USD 16.1 Billion: Who Pays?

**The World Bank estimates that the 2015 fires cost Indonesia at least USD 16.1 billion (IDR 221 trillion), equivalent to 1.9 percent of 2015 GDP.** This is more than twice the reconstruction cost following the Aceh tsunami.<sup>6</sup> The analysis estimates impacts on agriculture, forestry, trade, tourism and transportation. The short-term effect of haze exposure on health and school closures are also included. Other costs captured include those of emergency response and fire suppression as well as costs to the environment. However, the estimate does not capture long-term impacts on health of sustained exposure to haze, nor the loss of all ecosystem services. Furthermore, it does not incorporate regional or global losses.

**The estimates presented here cover the period from June 1 to October 31, 2015 and 2.4 million of the estimated 2.6 million hectares – or 94 percent – of the burned area in South Sumatra, Central Kalimantan, South Kalimantan, West and East Kalimantan, Riau, Jambi, and Papua.** The analysis uses a disaster assessment methodology developed by the UN Economic Commission 1 for Latin America and the Caribbean (ECLAC).<sup>7</sup> Costs are based on an analysis of the types of land burned as reported by the Government of Indonesia.<sup>8</sup> Where available, actual costs are used. Calculated damages are an estimate of the amount of financing needed for reconstruction and rehabilitation, while calculated losses represent the reduction in economic activities and income resulting from the disaster.

**According to the estimates, fire and haze resulted in damage and loss values ranging between USD 857 million (IDR 11.8 trillion) in Jambi to USD 3.9 billion (IDR 53.7 trillion) in South Sumatra.** As a share of provincial GDP, Central Kalimantan is estimated to have suffered the largest decrease – 34 percent – half of which came from losses to agriculture, mainly oil palm plantations. Real GDP growth in the affected provinces may be lower by between 0.7 and 4.7 percentage points in 2015, all else equal.

**Agriculture and forestry have sustained estimated losses and damages of USD 8.8 billion (IDR 120 trillion) in 2015.** Damages to agriculture include those to infrastructure and equipment, while losses capture the cost of reclaiming burned lands for planting and the foregone production revenue during this reclaiming period. As a result, the 2015 fires are estimated to cause additional losses of about USD 800 million

<sup>6</sup> As reported by the World Bank: <http://www.worldbank.org/en/news/feature/2012/12/26/indonesia-reconstruction-chapter-ends-eight-years-after-the-tsunami>.

<sup>7</sup> ECLAC (2014), Handbook for Disaster Assessment: <http://caribbean.eclac.org/content/handbook-disaster-assessment>.

<sup>8</sup> For 33 percent of the land these details are unknown. In these cases the lowest land value is applied.

per year for the next three in the case of estate crops (e.g., palm oil, rubber, and coconut) and five years for forests. Damages to estate crops affected companies and small-holder farmers. Costs to food crops (USD 1.7 billion) translate into lower incomes for farmers and possible impacts on food security. Forestry losses, at USD 3.9 billion, account for the lost value of timber and the cost of reforestation.

*In 2015, fire and haze cost Indonesia USD 16.1 billion - twice the cost of reconstruction following the 2004 tsunami*

**Haze has also contributed to the death of 19 people and more than 500,000 cases of acute respiratory infections.**<sup>10</sup>

Immediate health costs<sup>11</sup> totaled USD 151 million.<sup>12</sup> The long-term costs cannot yet be quantified. Existing research suggests long-term exposure to air pollutants correlates with increased cardiovascular and chronic

**Costs to the environment were substantial—26 percent of the total—and include losses to biodiversity (applying the government's biodiversity value per hectare) as well as losses to ecosystem services.**

Because the impact on ecosystem services is especially difficult to quantify, the assessment focuses on a single foregone service – carbon storage<sup>9</sup> Lost capacity for carbon storage represents the single biggest cost of the fires, underscoring their global impact.

**High levels of haze through most of September and October cost the transportation sector USD 372 million.** Most of the losses were borne by seaports as cargo shipping was interrupted by poor visibility. Transport costs contributed to slower growth in trade services, which suffered USD 1.3 billion in losses. Tourism lost USD 399 million in revenues due to the fires and haze. The costs to manufacturing and mining totaled USD 610 million.

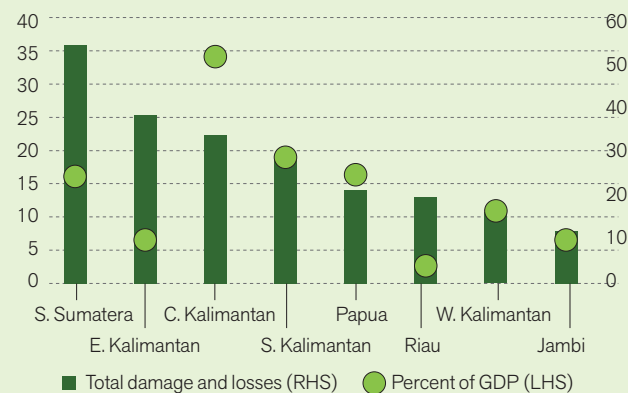
respiratory illness. A study on the effects of the 1998 Indonesian haze crisis on fetal, infant and under-three child mortality showed that air pollution led to 15,600 fewer surviving children.<sup>13</sup>

**Haze also forced school closures for up to 34 days, resulting in USD 34 million in costs.**<sup>14</sup>

In some instances, schools closed for weeks at a time, obliging teachers to accommodate take-home assignments. Conditions were worst in October, impacting 24,773 schools and 4,692,537 students. Child-care costs and foregone wages increase when parents must care for children normally in school; these costs are not included in the World Bank assessment. Long-term, sustained school closures could contribute to weaker graduation rates if reclaiming lost school days becomes burdensome.

### Many provinces suffered damage and losses due to fire and haze...

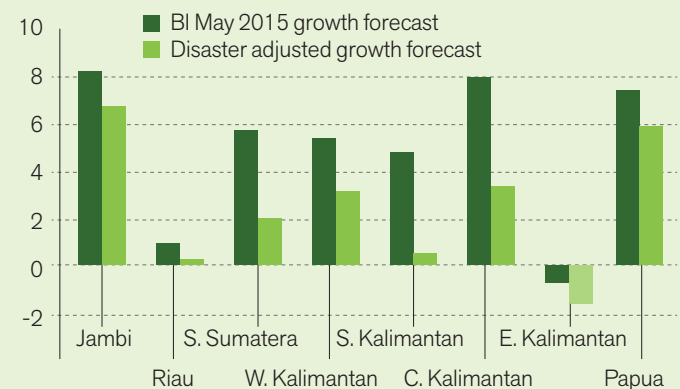
(percent, LHS; IDR trillions, RHS)



Source: BPS; World Bank staff calculations

### ...which reduced 2015 GDP growth

(percent)



Note: The provincial growth forecasts are from Bank Indonesia (BI) Archipelago Report (Laporan Nusantara), August 2015.

Source: BI; BPS; World Bank staff calculations

<sup>9</sup> This number is not meant to be an exact accounting of GHG emissions; rather, it serves to give a sense of the potential magnitude of lost ecosystem services. A value of USD5 per ton is applied to an approximation of the average carbon content of the lands impacted by fire.

<sup>10</sup> "Indonesia Forest Fires: Widodo to Visit Stricken Regions as Death Toll Mount," The Guardian, October 28, 2015.

<sup>11</sup> Direct health costs include increased incidence of inpatient and outpatient care, medical equipment and health worker overtime pay due to haze-induced illness. Data on utilization and facility visits are from The Center for Health Crisis Management at the Ministry of Health. Unit costs are based on local regulation

on Community Health Centre (Puskesmas) user fees, and case base group payment for inpatient cases (INA CBG).

<sup>12</sup> In addition, lost wages as a result of missed work due to illness totaled IDR 54 trillion.

<sup>13</sup> Jayachandran, S., 2008, "Air Quality and Early-life Mortality: Evidence from Indonesia's Wildfires," NBER Working Paper No. 14011.

<sup>14</sup> The World Bank estimates an average daily loss of productivity in the seven provinces covered in this section (excluding East Kalimantan) multiplied by the number of school closures as a result of haze.



Estimated losses and damages from forest fires and haze, June-October 2015 (USD millions)<sup>15</sup>

	Jambi	Riau	S. Sumatera	W. Kalimantan	S. Kalimantan	C. Kalimantan	E. Kalimantan	Papua	Total
Agriculture	210	181	1,033	349	523	1,242	1,128	173	4,839
Estate crops	134	134	260	238	169	1,075	1,006	95	3,112
Food crops	77	47	773	111	355	166	122	77	1,727
Environment	226	229	1,205	376	387	776	530	523	4,253
Biodiversity loss	17	24	72	23	27	33	33	58	287
Carbon emission	209	204	1,133	353	360	743	498	465	3,966
Forestry	136	304	972	168	698	92	815	746	3,931
Manufacturing & mining	29	183	133	61	122	14	69	0	610
Trade	184	292	290	120	139	131	108	68	1,333
Transportation	20	31	81	17	66	111	32	13	372
Tourism	10	116	118	54	38	42	16	4	399
Health	36	22	28	12	24	17	12	1	151
Education	4	4	9	4	6	5	4	3	39
Firefighting costs	10	11	49	14	24	35	31	22	197
<b>Total in USD million</b>	<b>866</b>	<b>1,373</b>	<b>3,919</b>	<b>1,176</b>	<b>2,028</b>	<b>2,464</b>	<b>2,746</b>	<b>1,552</b>	<b>16,124</b>

<sup>15</sup> The World Bank estimates an average daily loss of productivity in the seven provinces covered in this section (excluding East Kalimantan) multiplied by the number of school closures as a result of haze.



### Box 3. Other Costs – The Unknown Cumulative Impact of Fire and Haze on Flora and Fauna

**The full impact of Indonesia's systemic fire and haze on flora and fauna is unknown.** Fire destroys natural genetic variability, which helps species adapt resistance to parasites and infectious diseases. Burning biomass produces the precursors of ground-level (tropospheric) ozone (O<sub>3</sub>), which impacts plant growth and photosynthesis and leads to long-term effects on ecosystem structure and function. O<sub>3</sub> has been shown to reduce yields of major food crops and to affect the nutritional quality of wheat, rice and soybean. It can also reduce the capacity of land to act as a carbon sink. The particulate matter in haze has also been shown to reduce local rainfall, which could, in turn, impact recently planted crops.

**Sustained exposure to haze could also lead to the “volcano effect”, i.e., a decrease in plant productivity in the short term due to limited sun exposure and a deleterious effect on plant physiology and photosynthesis.** In the longer term, it could lead to an overall weakening in the ability of plant species to recover from shocks as a result of cumulative exposure to stress. In extreme cases, haze exposure could affect a species' ability to survive. Fire and haze also negatively affect pollinators, in turn affecting agricultural production. Chronic exposure to haze creates a sustained environment of stress, the impacts of which on productivity and evolution are unknown.

**The recurring nature of Indonesia's fire crisis is of particular concern.** While species can adapt, adaptations may not always be beneficial or possible. Fire wipes out living soil organisms, requiring years before pioneer species can recolonize. More concerning, however, is that long-term environmental stress will eventually lead to a tipping point, after which ecosystems will be altered irreversibly. How or when ecosystems will change is not known but the impact of this process could extend beyond Indonesia.

*Peatlands account for about one-third of the area burned but are responsible for the vast majority of the haze and CO<sub>2</sub> emissions from the fires*



#### 4. The Case for a Peatland Development Moratorium and Restoration

On October 23, 2015, President Joko Widodo called for a moratorium on new peatland concessions and a cancellation of existing concessions that have not been developed, thereby halting the legal conversion of peatland and peat swamp forests into agricultural land. He also called for peatland restoration, including re-wetting priority areas. This should be accompanied by efforts to conserve remaining peat swamp forests and to stop drainage in areas of deep peat or high biodiversity. Fewer fires on peat will reduce haze, which in turn will reduce the economic and environmental costs.

*The Government has shown commitment to address the underlying drivers of fires and haze, including through measures to restore and sustainably manage peatlands*

The following back-of-the-envelope calculations for the two provinces that will be most impacted – Riau and Central Kalimantan (which together have 151,471 hectares of peatland) – could help better understand the cost of a moratorium. A moratorium includes two primary costs: (i) lost tax and fee revenue to local and national government, and (ii) a reduction in land value for concession holders. The estimated loss in annual revenue to local governments (but not the central government) in Riau and Central Kalimantan would amount to about USD 154 million (IDR 2.1 trillion) and USD 92 million (IDR 1.2 trillion), respectively. To accommodate the lost land value, the moratorium could be accompanied by a concession buy-back, land substitution offer, or a combination of both. At USD 10,000 (IDR 135 million) per hectare – a reasonable estimate for well-managed certified oil palm plantations – a one-time land buy-back would cost USD 9.75 billion (IDR 131.6 trillion) in Riau and USD 5.39 billion (IDR 72.8 trillion) in Central Kalimantan.

**The Government has called for two million hectares of degraded peatlands to be restored by 2020.** In January 2016 President Widodo established the Peatland Restoration

Estimated lost public revenue as a result of one year of a peatland moratorium

Province	Hectares impacted	One-time licensing fees	Land tax revenue (annual)	Personnel tax revenue (annual)	Royalties (annual)	Total annual revenue
(USD millions)						
Riau	975,000	28	95	21	40	184
Central Kalimantan	539,071	16	46	9	29	100



Agency (BRG) to oversee this effort. BRG will focus on restoration in Sumatra, Kalimantan and Papua, where peatlands are greatest. To be effective, restoration must be planned carefully and include a long-term management plan. Poorly implemented, restoration could have unintended effects and costs, especially in areas where local populations depend on these lands for their livelihood. A quick estimate of initial restoration costs for basic canal blocking in two million hectares is USD 1.9 billion (IDR 27 trillion). This does not include recurrent costs of long-term management. It also excludes costs to businesses that must adapt to low-drainage practices or transition to activities that are compatible with wet peatlands. Effective restoration will prioritize areas where investment offers the greatest return, such as those where only a small portion of the peat dome has been impacted. Moreover, international experience demonstrates that conservation of intact wetland habitats is less expensive than restoration.

**The moratorium and restoration plan are welcome first responses and are much cheaper than the costs that accrue from repeated incidence of fire and haze disasters.** However, these steps alone will not

solve Indonesia's fire crisis as both only target peatlands, which represented only one-third of the fires in 2015. A long-term commitment to sustainable landscapes management is needed. This means taking action to improve governance and management of land and natural resources, including: transparently defining land boundaries and allowable uses that recognize and balance trade-offs among land uses and users; improving tenure and use rights with a focus on local communities and customary practice (adat); completing and enforcing spatial planning, taking into consideration ecosystem services and strengthening land licensing procedures accordingly; and aligning institutions, policies and incentives across sectors and levels of government to promote sustainable landscape management. Completion and dissemination of the Government's OneMap Policy is an important step.

*Peatland restoration can be an important part of solving Indonesia's fire and haze problem, but should be complemented with strong conservation measures*

#### Estimated construction cost of peatland restoration

Peatland to be restored	460,000 hectares identified as priority (Musi Banyu Asin + Ogan Komering Ilir + Pulang Pisau)
Cost per hectare	Land reconstruction and/or water management USD 983 per hectare
Cost to restore 460,000 hectares	USD 452 million
Cost to restore 2 million hectares	USD 1.9 million

Note: Restoration cost per hectare is assumed to be \$1,000, which includes the cost for heavy equipment for canal blocking, etc.

Source: World Bank staff calculations





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