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Using Conditional Cash Payments to Prevent Land-Clearing Fires: Cautionary Findings from Indonesia

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March 30, 2021

Abstract

Land-clearing forest fires in Indonesia cause enormous private and social losses from greenhouse gas emissions, deforestation, habitat destruction, worsened human health, and strained international relations. These fires are almost always deliberately set, often by smallholders as they seek to expand farm size. The Government of Indonesia has taken primarily a regulatory approach to preventing these fires, by imposing bans and making them illegal. This paper studies an alternative approach taken in a large policy experiment focused instead on incentives. It draws on a 275-village sample from four fire-prone districts in West Kalimantan. Analytically, it uses a randomized controlled trial, complemented by three rounds of village surveys, to understand the efficacy of conditional cash payments (~US$10,800) to villages that had no fires in 2018, as monitored by satellite technology. Despite the potential for receiving a relatively large conditional payment to villages, private gains from burning by a few households often overrode this important public good for the village. We relate the experimental findings to the underlying causes of the fire outcomes across all villages, finding that climate variation, government policy, population density, and accidents appear to explain fire use more than the conditional payments.

Keywords: randomized controlled trial, forest fires, fire prevention, payments for ecosystem services, Indonesia, West Kalimantan, Dayak people, peat soils

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Introduction

Forest fires in Indonesia are almost entirely caused by humans—either intentionally or by mistake (Austin et al., 2019; Glauber & Gunawan, 2015; Purnomo et al., 2017). Clearing land by fire, runaway trash burning, and fires from discarded cigarettes are but some examples of human actions that lead to fire disasters. Reducing fires thus requires changes in human behaviour. Information and instructions through regulatory bans and official speeches, while important, have proven insufficient to stop people from inappropriate burning activities. Beyond changing habits, the prevention of fires within communities typically requires financial resources, since fire solutions require funding to pay for manpower and equipment (Bolderdijk et al., 2018; Cinner, 2018; Gardner & Stern, 2002; Geller, 2002; Gneezy et al., 2011; Steg & Vlek, 2009; Vlek & Steg, 2007).

Performance-based payments for ecosystem services (PES) have gained increasing interest in recent years as solutions—to spur behavioural change, reduce fires, and to compensate communities in material ways (Blundo-Canto et al., 2018; Börner et al., 2017; Edwards et al., 2020b; Jacka et al., 2008; Redford & Adams, 2009; Seymour & Busch, 2016; Wunder, 2005, 2013; Young, 2016). REDD+ (Reducing Emissions from Deforestation and Forest Degradation) has been the most prominent fire-mitigation PES within Indonesia, but a number of smaller PES projects have also been implemented (Ajayi et al., 2012; Fauzi & Anna, 2003; Pirard & Billé, 2010; van Noordwijk & Leimona, 2010). Policy makers, however, have tended to view PES mainly for the purpose of expanding conservation regions (Jefferson et al., 2020; Salzman et al., 2018) rather than behavioural change. Few of the current PES programs have been rigorously evaluated (Alix-Garcia et al., 2015, 2018; Arriagada et al., 2012; Jayachandran et al., 2017; Pagiola, 2008; Samii et al., 2014; Sommerville et al., 2010; Yin et al., 2013), and existing

assessments of PES programs tend to suffer from small samples and selection bias. Small PES programs also tend to be unique, offering limited generalizability, and the underlying mechanisms by which such schemes might alter behaviour are usually not specified.

To provide a more analytic basis for using economic incentives as part of Indonesian fire policy, we undertook a large randomized controlled experiment. Its purpose was to test the impacts of performance-based cash incentives, at the community level, for curtailing land-clearing fires. A total of 275 villages, spread randomly across four of the most fire-prone districts in West Kalimantan, formed the field sample for our 2018 fire-season experiment (Figure 1).

Figure 1. Location of the Fire-Prevention Trial

Source: Edwards et all, 2021

The results of the experiment, both what happened and why, are described below. In this paper, we focus on three rounds of qualitative and quantitative data, particularly a careful "qualitative autopsy" we undertook after experiment was completed, to provide a broader picture of the political, social, and economic forces that seemed to drive fire outcomes and explain the limited effectiveness of the PES program. A more technical discussion of the experimental design and main result, without drawing on the qualitative data or syntheses, is available in Edwards et al. (2020b).

The next section of the paper describes the methods used in the experiment and our triangulation of multiple qualitative and quantitative data sources here, followed by an overview of prior PES efforts to help place our study within a broader research and policy context. Additional sections discuss the direct and indirect causes of fire, and the reasons why our performance-based incentive scheme seems to have failed in battling fires in West Kalimantan. The essay concludes with several policy lessons from this pay-for-performance experiment.

Prior Performance-Based Payment Schemes for Fire Prevention in Indonesia

Before discussing our experiment, it is useful to outline prior attempts in Indonesia to use PES approaches for fire curtailment. A recent inventory of PES in Indonesia identified nine projects that were actively making conditional payments for the provision of ecosystem services, four of which were carbon related (Suich et al., 2017).

The most prominent national pay-for-performance incentive for fire prevention is REDD+ (Angelsen et al., 2012). This initiative, financially underwritten by the Norwegian government, offers one billion USD to slow Indonesia's emissions from deforestation. Progress under REDD+ has been relatively slow, but after ten years it has underwritten an integrated

monitoring system, the formation of an implementing agency, and a funding instrument for receiving payments. Although REDD+ provides incentives at the national level, the main strategy deployed by the government of Indonesia has primarily relied on enforcement rather than rewards. The government has relied, in particular, on bans on the clearing of primary forests and peatlands, and on peat-soil restorations (Wijaya et al., 2019). This policy emphasis on peat arises because peat soils have exceptionally high organic content; they burn readily; and, once on fire, they are extremely difficult to extinguish.

A second type of performance-based payment comes from private- sector initiatives to help address fire and haze problems. For example, in 2015 the APRIL Group, (a unit of Asian Agri and Sukanto Tanoto‘s RGE Group) established a Fire Free Village Program to raise the awareness of communities surrounding its oil palm plantations and to provide incentives for these communities to go (or remain) fire free (Alliance, 2017). The April initiative was multi-layered, highly staffed, and well invested. Local members of the community were recruited as facilitators to introduce fire-free concepts through a range of community activities. APRIL then equipped villages with mechanical land clearing tools and supported villages who adopted no-burn agricultural practices. The prize for winning the incentive was US $7,143, significantly less than our program. A symbolic certificate was given rather than cash, and APRIL funded whatever infrastructure projects the community decided to do with the winning amount.

The high implementation cost of this program allowed fewer than ten villages to join the incentive scheme in the first year. By the third year of its implementation, 18 villages participated, with 15 villages winning the incentive prize. While quite successful in showing the positive role of incentives, the April initiative also raises questions about costs, whether it could

be scaled to cover entire districts and provinces, and whether the successful villages would have been just as successful without the assistance.

In a third initiative, the Coordinating Ministry for the Economy announced in 2017 a "Grand Design" on fire prevention (BAPPENAS, 2016)—a plan to cut in half the number of fire hotspots in the country by 2019. The plan also sought to restore over 9,000 square miles of degraded peat areas by Indonesia's peatland restoration agency (BRG), and to boost prevention efforts in 731 historically fire-prone villages in Sumatra and Kalimantan. The action plan involved multiple government agencies that collectively sought US $2.73 billion for plan implementation. Inspired by the Fire Free Village Program, each of the fire-prone villages would be eligible for US $21,000 if it managed to prevent land and forest fires for a year. Thus far, however, the necessary financial commitments have been limited, and the "Grand Design" remains more or less on hold (Jefferson et al., 2020).

We draw three conclusions from prior performance-based initiatives. First, there is widespread interest, within both the public and private sectors, in developing incentive-based schemes to assist with fire prevention. Second, successful efforts, mostly in the private sector, have been limited in scale, involved substantial amounts of external expertise and funding at the village level, and not been rigorously evaluated. Third, there is convincing evidence on how best to design government policies, especially large-scale efforts. Collectively, these conclusions motivated our experiment and underscore the importance of the findings.

The Experiment

Our randomized controlled trial sought to test the impact of a performance-based incentive cash payment at the village level for curtailing fire in Indonesia. Following a year of exploratory study, the actual experiment took place between January 2018 and December 2018 within four districts in West Kalimantan: Kubu Raya, Sanggau, Ketapang, and Sintang. They were purposively selected based on their history of fire, the extent of their forest margin and peat land, and their share of smallholders.[2]

We then removed from these four districts villages without fire in two out of three of the last three fire seasons and all villages in the subdistricts with the least fire. 275 villages remained (Figure 1). Within this purposively selected sample, 75 villages were randomly assigned to a treatment group and the remaining 200 villages to a control group. Under a memorandum of understanding (MOU) with the four heads of districts, villages in the treatment group were eligible for a performance-based incentive scheme that had three components: (a) village facilitation to introduce the experiment to the community and to provide basic knowledge on fire prevention, (b) an IDR 10 million (~US$750) up-front grant to help with fire prevention, and (c) a conditional payment of IDR 150 million (~ US$10,800) at the end of the fire season if the village was successful in eliminating fires during the 2018 dry season. The prize for going fire free successfully was a cash payment that was equivalent, depending on village size, of 10-20% of the village's annual budget. Villages were given the freedom to decide collectively within their community on how they wanted to spend the cash prize if they won. Monitoring of hotspots was conducted with Terra and Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data.

[2] Full details of the experiment and its design can be found in Edwards et al. (2020a).

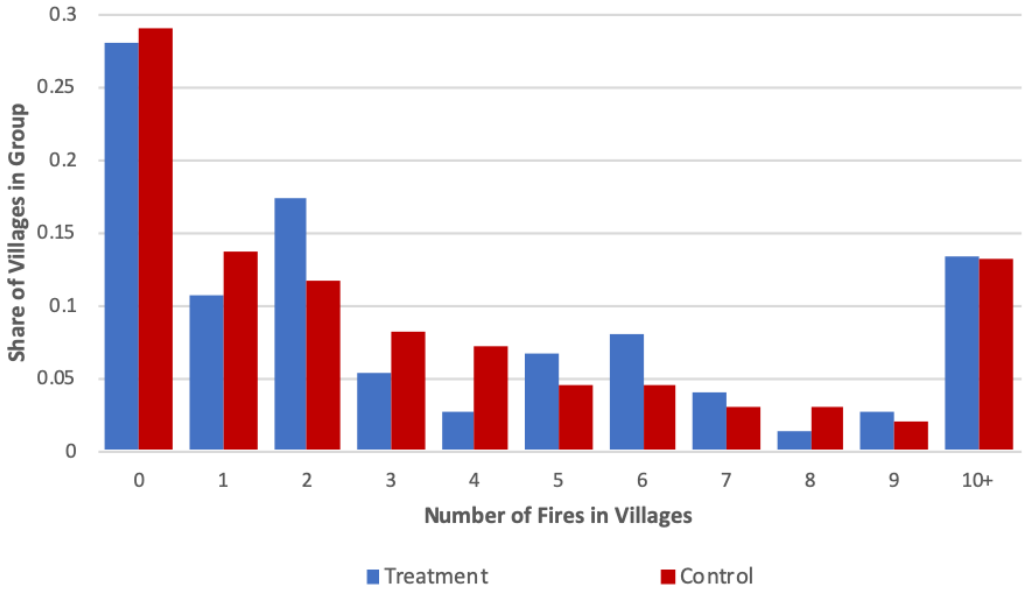
The four sample districts are home to numerous indigenous Dayak people. About 40% of the experiment villages had more than 90% Dayak residents. Land clearing for subsistence paddy production has historically used burning techniques. As discussed in a later section, fire is an integral part of village farming practices. These farming methods posed the important question of which fires were "outside" the practical and analytical concerns of our experiment. To ensure villages were not penalized for these practices, villages were asked to record coordinates of fires that they had used for traditional agriculture purposes—for example, growing upland rice for home consumption—and these hot spots were then removed from the village fire counts.

We worked closely with a West Kalimantan based NGO (*Sahabat Masyarakat Pesisir Pantai*, SAMPAN), which helped conduct facilitation meetings in the 75 treatment villages, and with follow-up surveys. Facilitation focused on introducing the project; teaching communities the needed steps to win; informing villages of basic fire mitigation techniques; explaining potential sources of funding for fire prevention; and demonstrating how to use offline GPS devices to record coordinates. To avoid resistance from the community, facilitators emphasized that small traditional fires adhering to strict local practices would be permissible.[3]

Twenty-one of the 75 treatment villages managed to go fire-free and won the incentive payment. However, hotspot detections were similar across treatment and control groups, with 72 percent and 71 percent of treatment and control villages, respectively, having fire (Figure 2).

[3] We understand that fire is fire, whatever its intended purpose. Our concern, however, was not in changing upland rice systems of the region, but rather to understand the causes of rogue fires set deliberately to clear land, mostly for oil palm. There are shades of grey in distinguishing fires between "traditional" and "rogue". We were consistent in the fire-counting rules that we used to assess performance in program villages, and believe that not making this distinction would weaken he design.

Figure 2. Share of Treatment and Control Villages, by Number of Fires



Source: Experimental results.

We reluctantly concluded that the incentive had no major impacts on fire outcomes, even though there was some evidence of behavioural shifts, such as the creation of fire brigades.

Surveys

To understand better the behavioural differences across villages, we undertook three rounds of data collection. The first, as noted above, focused on capturing the process of facilitation. Facilitators filled out observation forms that provided information on attendance by gender, duration of the facilitation meetings, questions from participants, and difficulties or unusual events that happened during the facilitation. For example, three commonly asked questions were on alternatives for land clearing other than fire; reporting requirements for use of the IDR10 million up front money; and whether fires within corporate plantations, but inside village boundaries, would count as a failure for winning the incentive payment.

A baseline survey was also conducted for the 75 treatment villages, as well as an end-line survey for the 75 treatment villages and for 75 control villages randomly chosen from the full set of 200. Data were collected about village heads, village physical characteristics, village demography, socio-economic conditions, and fire management capacity before and after the experiment, and perceptions about the incentives that had been offered.

We undertook a series of simple regressions on the end-line data to determine which factors were associated with fire incidence. Among the more interesting associations were: size of village population—large villages had higher numbers of fires; share of peat-soil area—soil type was unrelated to fire incidence; extent of forest margin—the larger the margin the greater likelihood of greater numbers of fires; size of village budget—the existence of a task force lowered number of fires. Limited sample size prevented more disaggregated breakdowns, however these correlates helped use carefully target our third set of village interviews.

The final round of data collection was conducted after the experiment had been completed and was comprised of multi-day interviews in 10 villages—five of which had no fires, and five of which had multiple fires. These final interviews delved deeper into the reasons behind village success and failure in winning the incentive payment. Interviews were conducted both individually and in groups, and almost always included the village head, village secretary, village religious leader, village fire team, “regular” villagers, and members of oil palm companies if a company had land in the sample village. We conducted both focus group discussions and in-depth individual interviews, with questions that were based on diagnostics from prior survey data, our exploratory statistical analyses, and our own hypotheses of why villages won or lost in the experiment.

Specifically, our field work focused on open-ended discussions of the following issues: (a) Knowledge of the study—whether the incentive being offered was well understood by members of the community; (b) Efforts to win—what follow up and how much effort was made after the initial facilitation meeting, and whether certain activities were more popular or more effective in both spreading information and reducing fire; (c)Village leadership—what role did village leaders play in spreading information and motivating villages to win the incentive; (d) Characteristics of village and culture—whether the size of peatland and forest margins were related to the difficulties in managing fire, and whether Dayak villages behaved differently; (d) Source of fire—how much control local villagers have over fire, where most fires came from, how far they were located from the densely populated areas, and how easy they were to suppress; (e) Existing fire management capacity—whether villages internally had budget, equipment, and manpower support to prevent and fight fire, or whether they relied on external government and company resources to assist with fire; and, and (f) Alternative sources of income—whether agriculture, specifically crops that require land clearing, was the only source of income available in the village. Detailed field notes of the discussions were kept, and interview data were combined into a final report that told the story of these ten villages.[4]

Global, National, and Local Explanations for the Extent of Fires

Providing the "why" explanations for the fires shown in Figure 2 was an integral part of the research.[5] We emphasize that our sample is limited regionally to four districts in one province, and that there is great heterogeneity in biophysical and human circumstances across

[4] See Hadiwidjaja (2019). To ensure confidentiality, specific village names, as well as personal names, were redacted in this report.
[5] Edwards et al., (2020a) discusses these econometric findings in more detail.

Indonesia. We also emphasize that while modern social science imposes high standards on what can described as a causal relationship, we do not attempt to assign causal weights to each factor described. Our insights below rather explore the underlying qualitative explanations of land-clearing fires on the basis of what we observed, triangulation of existing evidence, and what we derived from extensive discussions with villagers.

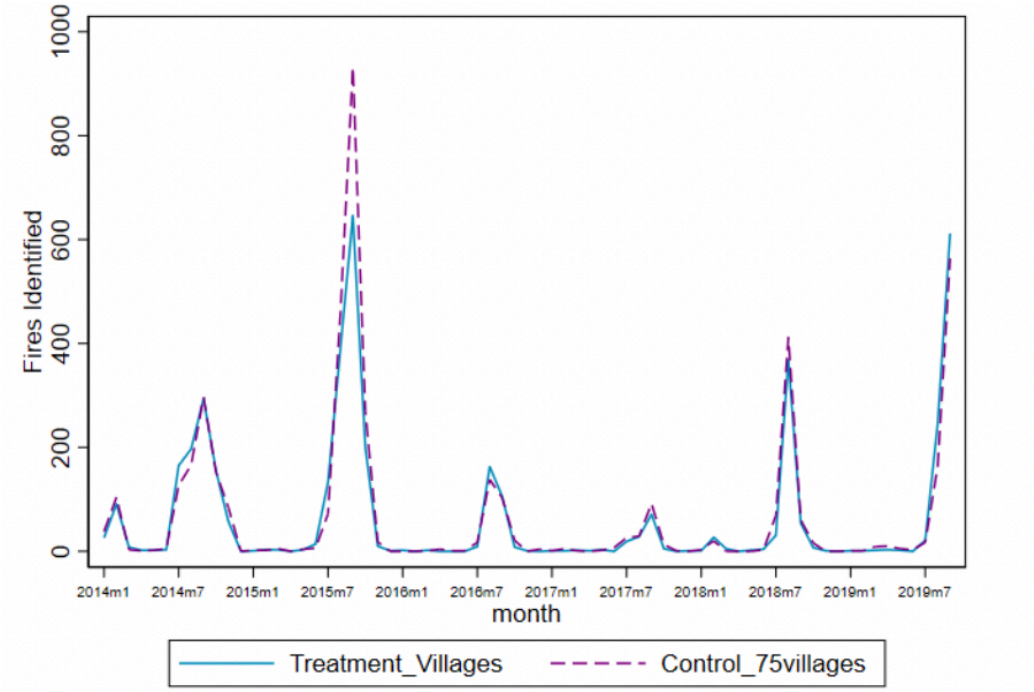
Climate Variation

Fires in the oil palm regions of Indonesia vary by month and by year. Within years, the fire season typically lasts between July and December. Among years, the number and magnitude of land-clearing fires are related to rainfall. Low precipitation is typically linked to moderate and severe El Nino events—defined broadly as years when the sea surface temperature anomaly (SSTA) in the central Pacific Ocean is greater than +0.5 degrees Celsius. For example, for every one degree rise in the SSTA index for the Nino 3.4 ocean region, there is a 50 percent increase in the number of hot-spot detections (Edwards et al., 2020a). Climate variation thus sets the global conditions, the common temporal variation, in which fires take place.

As Figure 3 suggests, 2018 (the year our experiment took place) was a year of moderately severe dryness: the average Nino3.4 SSTA between July to December 2018 was +0.62 degrees C.[6] This dryness created favourable conditions for both accidental and intentional burning. Had our experiment taken place instead in 2016—when the July-December Nino3.4 averaged -0.55 degrees C—half as many hot spots would have occurred. The frequency and intensity of fires is also linked to rainfall. In El Nino years, small fires more easily become large fires that are more difficult to contain.

[6] See Naylor et al. (2007) and Falcon et al. (2004) for fuller explanations of the links among SSTAs, monsoon onset, and rainfall in Indonesia.

Figure 3. Historical fires, 2014—19, in experiment villages



Source: Authors' calculations from MODIS hot-spot data.

Government Structure and Policy

The changing locus of government activities has also had an indirect impact on forest fires (Edwards et al., 2020b; Naylor et al., 2019; Ricketts et al., 2010). Forest authority in Indonesia, which was centralized during the Soeharto era (1968—98), has become increasingly decentralized. Since 2004, provincial governments have been given the authority to administer state forest areas. District governments also now have more power: issuing licenses, and managing existing licensed areas. But it also remains true that the central, provincial, district, and village governments all maintain some jurisdiction and control over forests and land use. This overlap often creates confusion with respect to responsibilities for fire mitigation and control.

Decentralization was intended to move action and responsibility to local jurisdictions. Despite limited capacity in many cases, fire management at the village level does offer some advantages. Village communities are most able to detect and address fire within their village. Village communities can often deal directly with land-rights, agriculture practices, and early fire detection within their areas (Boyd et al., 2018; Fishbein & Lee, 2015; Irawan et al., 2019). Communities with strong advocacy power, for example, can limit oil palm companies from entering their village. On the other hand, some village leaders have found it in their personal economic interests to "give" more land to outside concessions than appropriate, work little with companies on fire issues, and do nothing about excessive land encroachment by fire.

More generally, decentralization and in particular district-splitting has been shown to increase deforestation and fires (Burgess et al., 2012; Edwards et al., 2019).[7] By 2005, local governments had allocated 20 million hectares for oil palm expansion—much more area than was then planted (Colchester et al., 2006; Siahaan, 2007). This process often created tenure conflicts between companies and communities, which in turn led to fires. Local members of the communities, who felt frustrated for not being treated fairly by companies or government policies, frequently decided to pursue more extreme measures, including burning land, as a way to make their political voices heard (Awang, 2006; Suyanto, 2007; Suyanto et al., 2004).

The 2014 Village Law increased budget allocations and authority over local governance (Antlöv et al., 2016). Currently, communities manage under five percent of the total area of forest concessions, while the private sector takes more than 95 percent. Under the social forestry scheme, the national government in 2016 pledged to accord local communities land title and

[7] Importantly, none of the four districts is our study sample had been split.

management rights over forests. However, progress has been slow and near-term outcomes of this transfer remain to be seen (Evans, 2019; Naylor et al., 2019).

There remain many ambiguities on the ground about which government entities can issue laws and regulations, which are supposed to enforce these regulations, which can issue forest concessions, and which have management responsibility for state-owned forest land (Naylor et al., 2019). These continuing ambiguities in responsibility and authority continue to cause problems. A frequent collective-action comment heard among villages was that preventing and extinguishing fires were "someone else's" task, especially if the fires were in areas of disputed boundaries, uncertain land rights, or plantation lands within villages.

Village Poverty and Size

Villages that are less developed are prone to use burning techniques for agriculture (Edwards, 2019). Remote villages with dense forest margins are also more likely to practice land clearing with fire that is associated with *swidden* agriculture, both because of the availability of forested land, and because of the limited financial capacity to afford land-clearing machinery.

In our experiment, most villages were frontier-like—remote and poor, but not in abject poverty. Some villages were accessible only by boat, some by dirt roads, some by motorcycle paths, and some only on foot. Villagers indicated that availability of land was the most important determinant of land clearing by fire. A number also said privately that land clearing would only stop when there was no longer land available, irrespective of other sources of income. Interestingly, the average portion of village land still in forest (28 percent) was the same in both fire and non-fire villages in our study sample (i.e., treatment and control villages). This

counterintuitive result arises, we believe, because the four districts were purposively chosen in part because of their forest extents.

Village size also seemed important in shaping fire outcomes. Non-fire villages were on average only one-third as large, in terms of population, as villages with fires—1,600 versus 4,400 people. We suspect that smaller villages were more cohesive and better informed, with a better flow of information from our facilitations to most community members. This finding may also be partly a mechanical phenomenon. If bad actors, i.e., those who set fires, are distributed uniformly across the landscape, hot spots would be proportional to size, with large villages having more. Note that a similar mechanical concern presents itself for village area—with more land to ignite—but we did find any evidence of this.

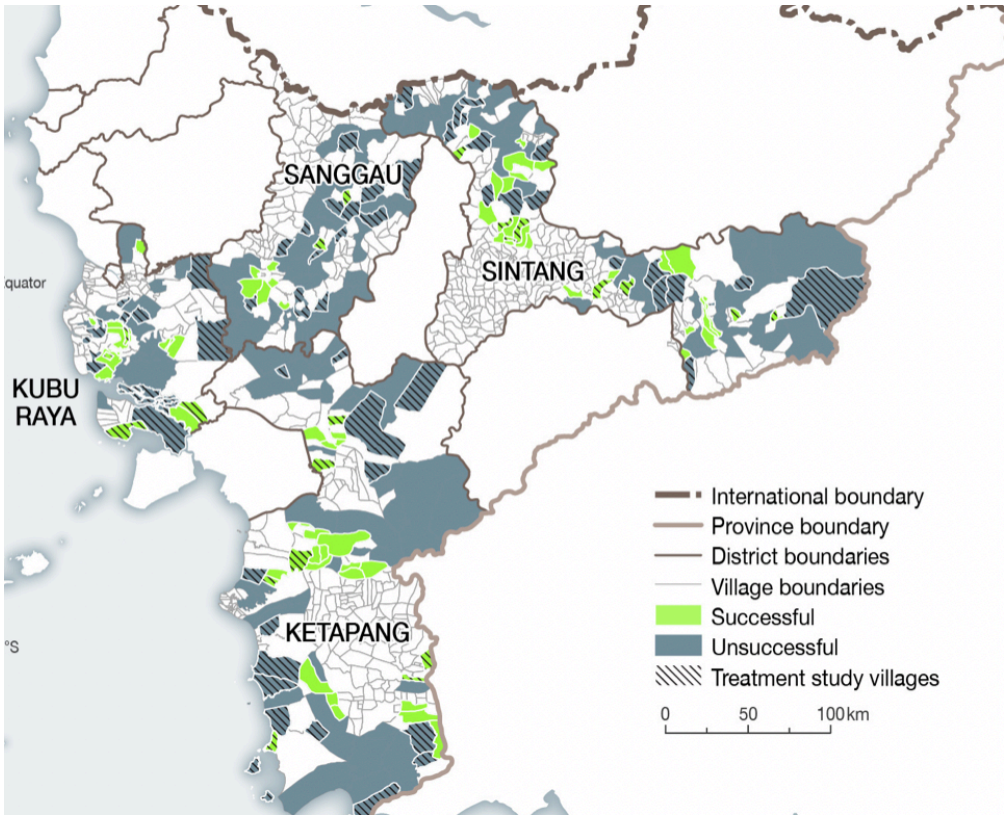
Farming Practices and Accidents

The main cause of large fires in West Kalimantan is for land clearing, which tends to be especially severe during the drought years associated with El Nino events. Fire is the most practical and cheapest method of land clearing, and both smallholders and companies often use this method to convert forest into cultivated land for oil palm, rubber, and other crops (Simorangkir, 2007). In our in-depth study of 10 villages, nine indicated that fire was the only way in which land was cleared. The remaining village, which was almost entirely Javanese in ethnicity, claimed to clear by using a combination of chemicals and human labor.

Fire is used at times over peat land that has been intentionally drained to grow crops. Burning is thought by many in the region to reduce acidity and to generate nutrients before planting—generally correct points for mineral, but not peat soils (Cattau et al., 2016). Regionally, however, there was no clear relationship between the use of fire on peat versus non-

peat soils, and the distribution of non-fire treatment villages was spread quite evenly across the four districts (Figure 4).

Figure 4. Locations of Successful and Unsuccessful Treatment Villages



Source: Adapted from Edwards et al. (2020a)

Use of fire is a long-accepted agricultural practice by Dayak communities. In the past, Dayak people who lived inside and around forests depended on agriculture as their sole source of income. Today, many Dayaks have pursued other sources of income, such as working for oil palm companies. Nevertheless, burning remains an integral part of their farming practices and their connection to nature.

Dayak land-clearing practices, however, maintain a strict set of rules to contain fire: communally supervised burning system, partitions, small size of fields, and adjustments to wind direction and timing of the day. Traditional Dayak communities grow upland paddy for home food consumption, and rarely plant on peat land, as paddy does not grow well on this type of soil. Interestingly, of the 21 treatment villages that had no fires, 11 were predominantly Dayak (i.e., greater than 90 percent Dayak ethnicity), whereas only four Dayak villages had fires.[8] This result helps lay to rest one commonly held assumption: that Dayaks are the primary instigators of fires in the region.

Aside from agriculture, communities used fire for fishing and hunting. Deer hunting is widespread in the region. As deer graze on young grass, villagers also intentionally burn land cover to develop grassy areas to attract deer. Fish is another of the region's main staples. Although men typically do the hunting, women are usually responsible for putting food on the table and catching fish. They fish by staying on water in small boats near swampy wetlands, and light cigarettes to repel mosquitos. Accidental fires are sometimes the result. These traditional methods seem to matter, although they also provide a convenient excuse. In any event, when discussing the sources of fire, communities repeatedly blamed negligently discarded cigarettes as one of the most common causes.

Two summary points follow from this discussion of the village context. First, fire is an integral part of the production practices of many of our sample villages. Sorting out traditional farming practices from deliberate attempts to set large land-clearing fires—the latter being our major concern—proved to be a key feature of our study. Second, we note village commentary on such causes as discarded cigarettes and mosquito control. Our conjecture, however, is that

[8] This numerical finding was after traditional fires had been subtracted from the village hotspot count.

villagers knew of individuals who had deliberately set land-clearing fires. We believe that respondents were unwilling to discuss these matters with "outsiders", even in the course of interviews and conversations over several days. There is a ban on burning and it is illegal. The President of Indonesia has spent considerable time in oil palm producing provinces talking about the negative impacts of fires, and has enlisted the army and police in efforts to stop burning. We suspect, but cannot prove, that villagers knew more about who started fires and why than they were willing to share, and that "accidents" provided an easy reply. Sorting out this issue more precisely would likely require spending months in each village, not days.

Leadership, Equipment, and Information

Village leadership appeared key to local fire outcomes in our experiment. We were able to infer this point from discussions at the village level. Age is a sensitive topic, and finding adequate statistical metrics proved difficult. In terms of age, the headman in villages without fires, appeared to be younger. They also tended to work more in agriculture (82 percent) as compared leaders in villages with fires (41 percent). Good leaders also found ways to keep the importance of curtailing fires in village conversations. As winning was a collective effort, widespread knowledge about the conditional payment was key. For example, predominantly Christian Dayak villagers frequently mentioned that traditional evening prayer services served as an important forum for information transfer about the experiment.

Among the 10 villages studied in depth, we found considerable variation in knowledge about our experiment. Since the facilitation process was virtually identical in all treatment villages, the information-transfer thus appeared inadequate in some communities, and this

influenced the collective response to our incentive program. Our sense is that the experiment worked more successfully in ethnically homogenous villages.

We note that the experiment was demanding in terms of fire incidence, even after allowing for traditional burnings. The average treatment village had a population of around 2,400, or 400 households—though counting households in multigenerational settings is not straightforward. The median number of hot spots per treatment village was about 4. During our experiment, therefore, only about 1 percent of the treatment households were engaged with rogue fires—perhaps even less when accidents are accounted for. Because the experiment used villages as the unit of observation, not households, we were unable to establish the specific traits for this small minority of fire-creating households. For example, did they not know about the experiment? Did they know and not care? Were they clearing new land for newly married sons or daughters? Were they newcomers to the village? And were they extremely poor? What we do know, however, that their numbers were small, and that the 100 percent compliance (i.e., no deliberately lit fires) demanded by our experiment proved to be perhaps too high a standard. Fortunately, we have laid the groundwork for answering the foregoing questions. We have the GPS coordinates of the fires and it should be possible in few years to revisit these villages to determine who is working the land cleared by fire in 2018.

Conflicts between Private Gains and Public Goods

There is an Indonesian expression that translates: “if a fire burns for an hour, the embers will live for a day; if it burns for a day, embers will live for a month.” The truth in that saying underscores the importance of organized means for fire surveillance. It also helps to explain why fires occurred mainly in more remote parts of the village. They also occurred more often in

villages with little or no fire-fighting capability. All fire-free villages had fire brigades and some fire-fighting equipment. Moreover, several villages also reported having established fire brigades after the widespread fires of 2015, as well as following our facilitations in the treatment villages. However, since brigades were "not needed' in the "wet" year of 2016, some of the brigades were reportedly discontinued. Fires were often found in areas where land rights were contested, and—though we have only anecdotal evidence—were ignited to lay claim to "ownership" of the land.

Although our sample villages were remote, they were in districts with palm oil processing mills. Often mill-access was difficult, but it was nonetheless available most months of the year. As a consequence, the net present value (NPV) of a hectare of cleared land is considerable. The exact NPV of land is dependent on the type of soil, clearing costs, expected prices for fruit bunches, and discount rates. That is why various estimates put the range of NPVs per hectare anywhere between US$ 3,000 and US$ 20,000 (Chisholm et al., 2016). In contrast, the costs of clearing land using mechanical methods ranged from US $150 to $180 per hectare, while clearing land by burning cost US $3—5 per hectare.[9] Moreover, unless a village had access to land clearing machinery from a plantation or public agency, fire remained about the only feasible land-clearing method. Unlike the often-cited Uganda study (Jayachandran et al., 2017), where the opportunity cost of land was low, both the economic circumstances and the fire outcomes were very different in West Kalimantan. Relatively small payments were sufficient in Uganda to cause individual smallholders to cease cutting trees. A crucial difference may also have been the choice of "contracting "parties": in Uganda, agreements were with individual smallholders and there were few if any collective action issues. In Indonesia, with villages as the statistical unit, private and collective motivations frequently collided.

[9] End results from the two methods, however, are typically not the same. Mechanical removal permits the removal of stumps, the creation of drains, etc., whereas burning does not.

We have debated—with no definite conclusion—whether a US$25,000 (rather than a US$10,800) conditional payment would have changed the result. It would certainly have raised the *potential* costs of such an experiment (75 villages x 25,000 = US $1.9 million)—well beyond our capacity to fund from research grants. Moreover, from a policy perspective, a payment that large—relative to other items in village budgets—would raise doubts about the cost effectiveness of this approach for fire-fighting if it were to be made available to the tens of thousands villages in all of Indonesia's oil palm provinces.

Conclusions

Our field experiment, which used conditional cash payments (~US$10,800) to prevent land-clearing fires in villages, proved to be difficult logistically and revealing substantively. It showed the critical importance of having a rigorous control group for interpreting results. The 28 percent of the treatment villages that did not burn, while initially impressive, proved insignificant when the control group showed a comparable percentage. Our study, therefore, provides an important cautionary tale about the importance of research design, specifically the importance of having a credible counterfactual when evaluating environmental programs.

After allowing for traditional fires, our study required 100 percent village (i.e., no deliberately lit fires) to win the conditional payment. The number of households who did not comply—less than one percent on average—was a small group whose desire for private gains clearly exceeded their concerns about the welfare of the village as a whole. In other words, their expected private gain exceeded the social cost that they deemed likely from the collective. On the other hand, the fact that this percentage was so low offers some consolation on the degree of collective cohesiveness that exists in the village. The common perception that most villagers are

casually setting fire appears to be a misperception. This small-numbers phenomenon also raises the broader question of carrots versus sticks in policy design. Can broad-based conditional incentive schemes be effective at the village level for dealing with 1% of the households who set fires, or will social pressure by fellow villagers and penalties or incentives targeted at specific wrongdoers be necessary for effective fire curtailment?

We also determined that vigorous village leadership was one key in villages going fire free; that smaller villages were more successful than larger communities in controlling fires; that predominantly Dayak villages had better fire outcomes than other groups; and that active fire brigades were likely important in preventing fires.

Fundamentally, however, we believe that basic economics drove the fires. The net present value of land is high in these villages as the consequence of a well-established oil palm industry. Given the costs, and often the complete physical unavailability of land-clearing machinery, relatively poor farmers were/are inevitably driven toward the use of land-clearing fires. The net result is a terrible dilemma for everyone. Oil palm, the means for higher incomes for many people in this relatively poor region, is simultaneously creating huge negative externalities in the form of deforestation, habitat destruction, human health, and international relations. We had hoped that conditional payments to villages might offer one policy avenue for dealing with this difficult trade-off, but alas, our experiment casts doubt about this approach for Indonesia. More village peer pressure, fire-fighting expertise, and equipment would be helpful, as would greater cooperation between plantations and village smallholders on land-clearing machinery. But implementing such programs for all villages in the key oil palm provinces would likely be an extremely daunting task.

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