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

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Abstract: Land-clearing forest fires in Indonesia cause enormous private and social losses in the form of greenhouse gas emissions, deforestation, habitat destruction, worsened human health, and strained international relations. These fires are almost always deliberately set, often (but not always) 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, explored in part through a large policy experiment focused instead on the use of positive financial incentives. We first summarize our 275-village randomized control (RCT) policy experiment from 4 fire-prone districts in West Kalimantan. These results showed no effects on fire outcomes from a conditional cash payment, even though there were some changes in behavior. The article then draws on survey results and other published documents to explain qualitatively why the results occurred. We argue that climate variation, government policy on decentralization, population density, and accidents appear to explain fire outcomes among villages more than did the opportunity to "win" a conditional payment of USD 10,800. Fundamentally, this sum did not compete with the high net present value of land for growing oil palm. The high net present value appeared to prove irresistible to a small percentage of villagers, despite the illegality of using fire to clear forested margins. More generally, this article provides a broad, cautionary understanding of why policies that only use conditional payments to prevent fires are unlikely to be successful in Indonesia's oil palm regions.

Keywords: randomized control trial; forest fires; fire prevention; deforestation; conditional cash transfers; ecosystem service payments; oil palm; Indonesia; West Kalimantan

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1. Introduction

This article assesses both the potential and limitations of using conditional cash payments to prevent villages from setting land-cleaning fires. Forest fires in Indonesia cause enormous private and social losses in the form of greenhouse gas emissions, deforestation, habitat destruction, worsened human health, and strained international relations. The severe 2015 burning season, for example, resulted in an estimated 2.6 million hectares lost to fires. At the height of the 2015 fires, daily carbon emissions from Indonesian fires exceeded those of the entire U. S. economy [1].

Curbing these fires has been one of the government's highest priorities. Government policy to date has primarily been regulatory in character, mostly involving a series of legal bans. The outcomes of these policies are of great importance locally and internationally. Indonesia, the world's fourth-largest country in terms of population, is by far the dominant supplier in a rapidly growing world market for palm oil. This key oil is used in a wide variety of food and non-food products. Within Indonesia, the growth of oil palm presents a most difficult trade-off for government policymakers. Oil palm has the very desirable effect of reducing poverty in some of the poorest and most remote villages in the country, but currently at the cost of large negative externalities.

In contrast to current government policy, we explore a different policy approach that is focused on cash incentives, with the hope that the results might offer an additional avenue for public policy. This avenue was and is of major interest to Indonesia's Ministry of Finance, yet to date, there has been little analytical basis for policy design.

Our conclusions derive from several sources: a three-year, USD 1 million research project that included a randomized control experiment involving 275 villages in West Kalimantan; village surveys in West Kalimantan; an intensive review of the literature; and multiple decades of prior research by the author team on Indonesian agriculture. We believe that this article makes two primary contributions to the literature. First, the study, to the best of our knowledge, is the first methodologically to combine random control techniques to study fire prevention using villages as the unit of analysis. Second, the study contributes to the commodity analysis literature. Because Indonesia is such a dominant player in world vegetable oil markets, providing an understanding of how and whether the country can control burning has an important bearing also on future vegetable oil demand [2]. The externalities associated with land clearing by fire are causing some importing countries to curtail the import of Indonesian palm oil, with consequent effects on all of the crops (soybeans, rapeseed, sunflower, etc.) that form the world vegetable oil market. For both reasons, therefore, this essay is more than just another case study.

Literature and Institutional Context

Forest fires in Indonesia are almost entirely caused by humans—either intentionally or accidentally [3–5]. Clearing land by fire, runaway trash burning, and fires from discarded cigarettes are but some examples of human actions that lead to fire disasters. Al-though information and instructions through regulatory bans and official speeches may have diminished the number of fires, they have proven far from sufficient to stop people from engaging in inappropriate burning activities. Beyond changing habits, the prevention of fires within communities also typically requires financial resources since fire solutions necessitate funding to pay for manpower and equipment [6–12].

Performance-based payments for ecosystem services (PES) have gained increasing interest as solutions for spurring behavioral change and for compensating communities in material ways [1,13–20]. Policymakers in Indonesia, however, have tended to view PES mainly for expanding conservation regions [21,22] rather than for inducing behavioral change.

Few PES programs have been rigorously evaluated [23–29], and existing assessments of PES programs have tended to suffer from small sample size and selection bias. Small PES programs also tend to be unique, offering only limited generalizations. To provide a more analytic basis for using economic incentives as part of Indonesian fire policy, we undertook a randomized control experiment. Its purpose was to test the impacts of performance-based cash incentives, at the community level, for curtailing land-clearing fires. Before discussing the current experiment, however, it is useful to outline prior attempts in Indonesia to curtail fires.

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 [30]. The most prominent national pay-for-performance incentive for fire prevention is REDD+ (Reducing Emissions from Deforestation and Forest Degradation),

but a number of smaller PES projects have also been implemented [31–35]. The REDD+ initiative, financially underwritten by the Norwegian government, has made slow progress. Nonetheless, after 10 years, it has underwritten an integrated monitoring system and helped the government in 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 regulations and bans rather than rewards. The government has relied, in particular, on bans on the clearing of primary forests and peatlands and on peat-soil restorations [36]. The 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, APRIL (a unit of Asian Agri and the 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 [37]. The APRIL initiative was multi-layered, highly staffed, and well-funded. 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 that adopted no-burn agricultural practices. The prize for winning the incentive was USD 7143—significantly less than in our experiment. A symbolic certificate was given rather than cash, and APRIL funded whatever infrastructure projects the community decided to erect with the winning amount.

The high implementation cost of this program allowed fewer than 10 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 (nearly 3 million smallholders), and what successful villages would have done without the corporate assistance.

In a third initiative, the Ministry of National Development Planning announced in 2017 a "Grand Design" on fire prevention [38]—a plan to cut in half the number of fire hotspots in the country by 2019. The plan also sought to restore over 9000 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 USD 2.73 billion for plan implementation. Inspired by the Fire-Free Village Program, each of the fire-prone villages would be eligible for a substantial cash reward 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 [21].

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 limiting the use of fire for land clearing. Second, successful efforts, mostly in the private sector, have been limited in scale, have involved substantial amounts of company expertise and funding at the village level, and, for the most part, have not been rigorously evaluated. Third, there is no convincing evidence as yet on how best to design government fire-prevention policies, especially those involving large numbers of smallholder producers.

2. Methods

Our experiment—what happened and how—is briefly summarized below. Our intent is to provide readers with key experimental design and statistical results; however, we do not duplicate the many important experimental details and statistical analyses found in Edwards et al. [39].

Our randomized trial sought specifically to test the impact of a performance-based incentive cash payment at the village level for curtailing land-clearing fires 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 (Figure 1). These districts were purposively selected based on their history of fire, the extent of their forest margins and peat land, and their share of smallholder producers.

Figure 1. Location of the Fire-Prevention Trial.

In designing the experiment, we found little in the existing literature that was directly helpful. One study in Uganda [40] used random control techniques to study forest cover; however, that study was for a region where the opportunity cost of land was low and which contracted with individual farmers, not villages. We also examined carefully the review by Asquith [41] on what had been learned from using large random control trials for examining land conservation issues. Mostly, however, the experimental design in our study evolved after lengthy discussions with the experienced author team, numerous meetings with the Ministries of Finance, Planning, and Villages, and lengthy consultations with SAMPAN (Sahabat Masyarakat Pesisir Pantai), the local NGO with whom we worked.

After having selected the four districts, we completed a listing of all the villages. We then removed those villages without fire in two out of the last three fire seasons and all urban villages, leaving 275 villages. Within this sample, 75 villages were randomly assigned to a treatment group and the remaining 200 villages to a control group. This randomization procedure was crucial in assuring ex-ante equality between treatment and control groups, i.e., ensuring the two groups had statistically comparable means for such variables as size of forest margins, levels of education, and other metrics of social capital.

Under a memorandum of understanding 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 (~USD 750) up-front grant to help with fire prevention, and (c) a conditional payment of IDR 150 million (~USD 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, to 10–20% of the village's annual budget.

Villages were given the freedom to decide collectively within their community 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. Specifically, we measured fire as thermal hotspot detections in the NASA MODIS Active Fire Product (MCD14ML), publicly available, at 1 km. resolution and based on 4 satellite passes per day. The MODIS Active Fire Product includes the fire location, date, and time of detection for each fire detected by the Terra or Aqua MODIS sensors. It is generally regarded as the most accurate and complete method for detecting fires [39].

Two features of the experiment's design deserve special mention. First, there is an important collective feature for winning payments in the experiment. Contracts were made with districts and villages, not with individual villagers. One implication of the design was that a small number of rogue actors, i.e., people who intentionally set fires, could preclude an entire village from winning.

Second, the four sample districts are home to numerous indigenous Dayak people. About 40% of the experiment villages had more than 90% Dayak residents [39]. Land clearing for subsistence paddy production has historically used burning techniques. As discussed in a later section, fire is an integral part of traditional village farming practices. These farming methods posed the important question of which fires were "outside" the practical and analytical concerns of the experiment. Our interest was in major land clearing of new areas by rogue actors. To ensure villages were not penalized for these practices, they were asked to record coordinates of fires that they had used for traditional agriculture purposes. These hotspots were then removed from the village fire counts. We deducted only self-reports. The only other plausible way to distinguish traditional from other fires would have been to inspect the satellite data manually for every detection and close follow-up contact on the ground, both of which would have been very costly. There may have been some measurement error in detecting the traditional fires, but we take consolation in the fact that ex-post analysis showed that payment success was the same whether these fires were included or excluded.

We worked closely with a West Kalimantan-based NGO, SAMPAN, which helped conduct facilitation meetings in the 75 treatment villages, and with follow-up surveys. These village interactions focused on introducing the project, teaching communities the needed steps to win, explaining potential sources of funding for fire prevention, and demonstrating how to use offline GPS devices to record coordinates. Facilitators emphasized that small traditional fires adhering to strict local practices would be permissible.

3. Results and Commentary

A total of 21 of the 75 treatment villages managed to go fire-free and won the incentive payment. A 28% success rate initially appeared promising. However, hotspot detections were similar across treatment and control groups, with 72% and 71% of treatment and control villages, respectively, having fires (Figure 2).

After trying many alternative statistical analyses, we concluded that the incentive had no significant impact on fire outcomes. Villages in all four districts behaved similarly. There was, however, some evidence of behavioral shifts, such as the creation of village fire brigades, in treatment villages. We examine the reasons for the (lack of) impacts and fire outcomes in the sections that follow.

To understand better the behavioral differences across fire and non-fire villages, we drew on our village-level data collection, especially the more in-depth set of discussions in 10 villages—5 of which were selected randomly from villages that had 5 or fewer fires and 5 from villages that had more than 5 fires [42]. These interviews, which were led personally by one of this article's Indonesian authors, delved deeper into the reasons behind the village's 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, villagers, smallholder producers, 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 and our own hypotheses of why villages won or lost the conditional payment.

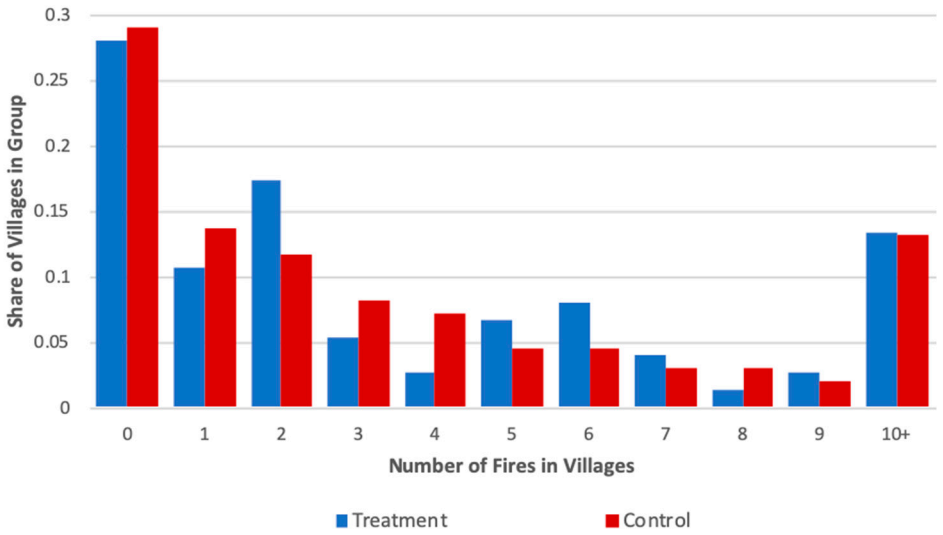

Figure 2. Share of Treatment and Control Villages, by Number of Fires.

We sought explanations at varying geographic scales for the fire data shown in Figure 2. Modern social science methods impose high standards on what can be described as a causal relationship, and we do not attempt to assign causal weights to each factor. Our insights below explore the underlying qualitative explanations of land-clearing fires based on what we observed and what we derived from extensive discussions with villagers.

3.1. 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. Across 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 [43,44]. For example, for every one-degree rise in te SSTA index for the Nino 3.4 ocean region, there is a 50% increase in the number of hotspot detections [39]. Climate variation thus sets the common temporal variation in which fires take place. Determining whether or not 2018 was an exceptional fire year seemed the obvious starting point for assessing what had transpired.

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. This dryness created favorable 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 likely occurred. The frequency and intensity of fires are both linked to rainfall. In El Nino years, small fires more easily become large fires that are more difficult to contain.

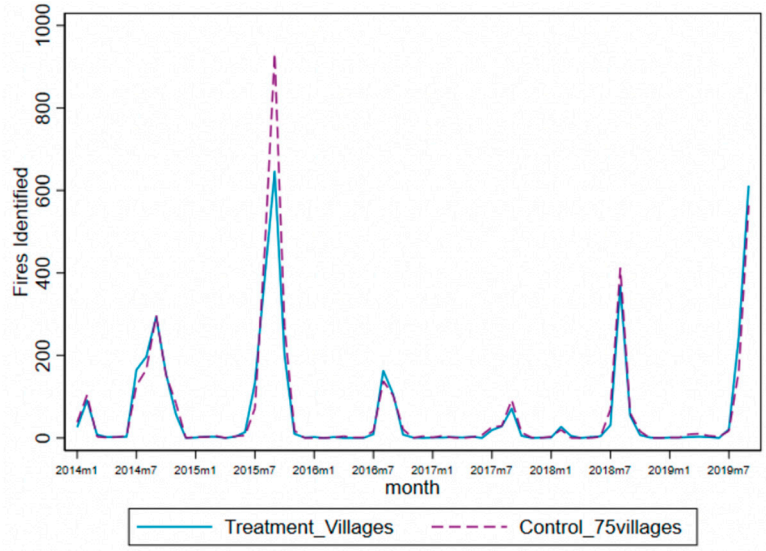

Figure 3. Fires in Experimental and Control Villages, 2014–2019.

3.2. Government Structure and Policy

The changing locus of government activities has had an indirect impact on forest fires [1,45,46]. Forest authority in Indonesia, which was centralized during President Soeharto's era (1968—1998), 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 in issuing licenses and managing existing licensed areas. However, 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. Everybody's problem is nobody's business. Morevover, having legal authority does not guarantee an agency's capability to enforce that authority. Forestry offices frequently have small, undertrained staff and limited budgets.

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 [47–49]. 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, the dividing of larger districts into two separate units, has been shown to increase deforestation and fires [50,51]. (Importantly, none of the four districts in our study sample had been split since the decentralization policies began.) By 2005, local governments had allocated 20 million hectares for oil palm expansion—much more area than was then planted [52,53]. 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 [54–56].

The 2014 Village Law increased budget allocations and authority over local governance [57]. Currently, communities manage under 5% of the total area of forest concessions, while the private sector takes more than 95%. Under the social forestry scheme, the federal government, in 2016, pledged to accord local communities land title and management rights over forests. However, progress has been slow, and near-term outcomes of this transfer remain to be seen [45,58].

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 [43]. 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 was "someone else's" task, especially if the fires were in areas of disputed boundaries, uncertain land rights, or plantation lands within villages.

3.3. Village Size

Villages in Indonesia that are less developed are prone to use burning techniques for agriculture [49]. 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 the 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%) was the same in both fire and non-fire villages in our study sample (i.e., treatment and control villages). This 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—1600 versus 4400 people. Smaller villages were perhaps 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 statistical phenomenon. If bad actors, i.e., those who set fires, are distributed uniformly across the population, hotspots would be proportional to size, with large villages having more fires.

3.4. Village Patrols and Leadership

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. Fires 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 reported having established fire brigades after the widespread fires of 2015. 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. Finally, we looked at the distances, measured in hours, from villages to fire stations. Two hours by jeep would be considered nearby, and ten hours by jeep would not be uncommon. Remoteness has real meaning in a fire context. While treatment villages reported more fire patrols as a consequence of the experiment, little that we saw or heard suggested that these brigades had made a difference in fire outcomes. It appears that individuals were hired for patrols but, for whatever reasons, were either inactive or ineffective.

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. ("Headman" is a misnomer, but not by much. Of the 75 treatment villages, 74 had male leaders.) Women were active in village affairs,

however, and in several villages, the headman's wife played an active role in promoting the experiment.

Headmen also tended to work more in agriculture (82%) as compared to leaders in villages with fires (41%). 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.

3.5. Farming Practices and Accidents

The main cause of large fires in West Kalimantan is 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 [59]. In our in-depth study of 10 villages, 9 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 on 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 [60]. 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 landscape (Figure 4).

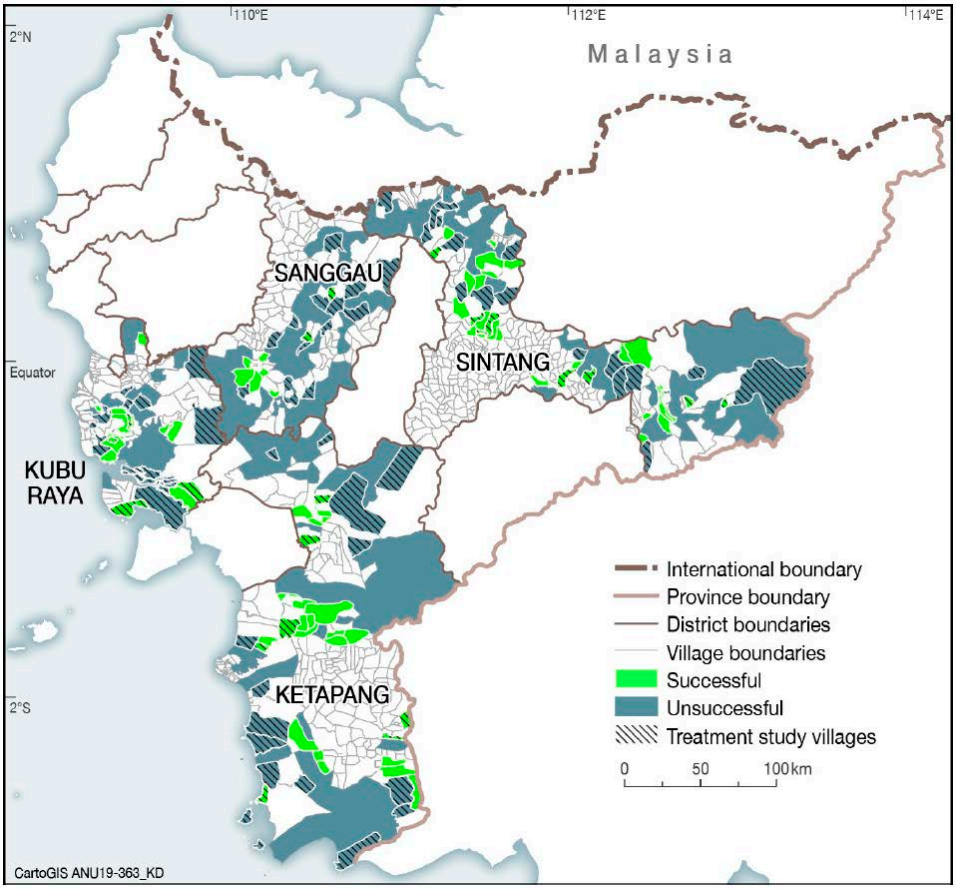

Figure 4. Locations of Successful and Unsuccessful Villages.

The 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 [61]. Today, many Dayaks pursue other sources of income, such as working for oil palm companies. Nevertheless, small, controlled fires are traditional in Dayak farming, a practice that has been sustainable over time and that does not appear to be a major source of out-of-control blazes or regional environmental damage.

Dayak land-clearing practices maintain a strict set of rules to contain fire: communally supervised burning systems, partitions, small size of fields, and adjustments to wind direction and time of 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% Dayak ethnicity), whereas only 4 Dayak villages had fires. 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 use 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 in small boats near swampy wetlands and light cigarettes to help repel mosquitos. Accidental fires are sometimes the result. These traditional methods seem to matter as a source of fires, 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 the 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 and one that we perceive to have handled well. Second, we are uncertain about village commentary on such causes as discarded cigarettes and lightning strikes that came up in conversations with villagers. It may well be the case that villagers knew of individuals who had deliberately set land-clearing fires. We suspect that respondents, not unreasonably, were unwilling to discuss these matters with "outsiders", even during interviews and conversations over several days with local interviewers. There is a ban on burning, and it is illegal. The President of Indonesia has spent considerable time in oil palm-producing provinces discussing the negative impacts of fires. We sometimes felt, 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. Field staff members from the Center on International Forestry Research [62] report that smallholders in the province of Sumatra also indicated discarded cigarettes and lightning as common causes of forest fires. This CIFOR report also expresses considerable doubt about the validity of these replies.

3.6. Conflicts between Private Gains and Public Goods

Although the 275 sample villages were remote, all were in districts with access to palm oil processing mills. Often 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 USD 3000 and USD 20,000 [63]. In contrast, the costs of clearing land using mechanical methods ranged from USD 150 to USD 180 per hectare, while clearing land by burning costs USD 3 to USD 5 per hectare. 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 [40], 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.

We have debated—with no definite conclusion—whether a USD 25,000 (rather than a USD 10,800) conditional payment would have changed the result. It would certainly have raised the potential costs of such an experiment (75 villages × 25,000 = USD 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 thousands of villages in all of Indonesia's oil palm provinces. In a similar vein, a policy approach that focused on millions of individual smallholder producers rather than on villages did not appear to be sensible or feasible in terms of sheer numbers, even if it solved the collective action constraint on desired outcomes.

3.7. Other Survey Evidence

Every effort was made in the 10-village survey to add specificity to the individual and group factors that led to the setting of fires. This topic did not lend itself to standard questionnaires, neat statistical tabulations, or revealing quotations. We were outsiders probing into illegal activities—activities that villagers knew were illegal. By necessity, the interviews were more discussion-like, with hints here and there as to what was really going on. A write-up of what we learned was completed after each village was visited, and readers interested in the village-by-village accounts are referred to [42] and to Appendix A. Despite the small sample (curtailed because of COVID travel restrictions), we formed eight impressions from the discussions across the five "winning" villages.

(a) Winning villages did not win by luck, but no single explanation is sufficient for explaining no-fire outcomes.
(b) Active village governance was a necessary, but not a sufficient, condition for villages to win. Good governance ensured a good flow of information where the study was known not only by the village head but also by many others throughout the community
(c) Winning villages had a so-called "mover" who proactively made efforts to win. In most cases, the mover was either one of or both the village head and village secretary. In one village, however, the mover was a non-village official who used his own resources to create his own fire team, knowing that he could get a share of the incentive if his village won.
(d) The most common method used by villages to win the incentive was more coordination during land clearing. The fire team was usually assigned to help during land clearing. Villages did not stop the practice of burning for land clearing due to the study; however, they tried to be more careful. (Some villagers interpreted this as trying to avoid getting caught by satellites.)
(e) Informal socialization, mostly during prayer meetings, was perceived to be the most effective way of creating awareness among winning villages.
(f) Submitting hotspot coordinates was the strongest proof that the village had made efforts to win the incentive. Recording hotspot locations was not an easy task for villages to accomplish in this study. The offline GPS application that villages had to use to record coordinates demanded additional efforts to learn, and many villages claimed to not do it because they did not know how to use the app. As a result, very few villages, including the winning ones, submitted the coordinates.
(g) In terms of culture, there was a spectrum of rigidity on whether villages planted paddy strictly according to Dayak traditions, e.g., not planting on peat soils. Non-Dayak and less rigid Dayak farmers who grew rubber, oil palm, and other crops did plant on peat soils.

(h) The existence of companies, based on community testimonies, generally brought positive impacts to villages in terms of fire management. Companies seemed willing to provide staff and equipment to protect their own plantations as well as community land.

4. Discussion

Conducting social science research at the village level in Indonesia is complicated. There are five levels of governance—national, provincial, kabupaten (district), kacematan (county), and village—that sometimes require permissions for what can and cannot be done. Our sponsorship by the Office of the Vice President was enormously helpful in enabling our research activities to proceed in some of Indonesia's most remote villages.

The research reported in this article covered a total of three years. The project was ambitious and stretched the author team logistically, culturally, and intellectually. Looking back, we are mostly happy with what transpired. We are quite certain that our results have relevance for Indonesia and for other regions where the opportunity cost of land is high. Our conjecture, though we do not have data to prove it, is that conditional payments to prevent land clearing by fire would be far more effective in regions where there were not highly productive agricultural opportunities for using the land being burned

There is little in the existing literature that was directly helpful in research design. We believe that we are the first to combine the clearing land by fire with RCT techniques and with villages as the unit of analysis. The use of villages, rather than individual producers, was an intentional part of the design since villages are the public finance unit that the government would use for such payments. On the other hand, villages per se do not set fires; only individuals do. This important distinction was omnipresent as we sought answers to why the fires occurred.

The experiment was laid out with the hypothesis that villages would respond to the conditional payments. After initial analyses showed that they did not, the project made a mid-course correction to find out why. Probing the reasons for fire setting, an illegal activity, necessitated indirect methods and discussions rather than lengthy formal questionnaires. Conversations within Indonesian society generally tend to be indirect in character. Progress in getting what we believe to be credible answers turned out to be a very delicate task and took more time than we had originally budgeted.

Dayak fire traditions in agriculture presented their own challenges. We resorted to less-than-perfect reporting of traditional fires, but not all treatment villages were able to master the hand-held hardware that was used for recording and reporting traditional fire activity. Yet, we know of no other method that could have been used that was not prohibitively expensive. In retrospect, however, we should have invested more in the training of village recorders.

Some analysts have suggested that Dayak villages should have been removed from the sample. We strongly disagree. We were attempting to simulate an actual policy as it would most likely be implemented by the government. Indonesia's national motto, "unity in diversity", is also a strongly held operating principle for the government. Excluding an ethnic group would be summarily rejected if a conditional payment policy were to be enacted.

The research team also worried about information flows about the project within villages. We decided against repeated village visits to push the experiment, in large part because that would not happen if the policy we were simulating actually occurred. While 100% information flow would have been ideal, we were very encouraged by the fact that 92% of the treatment villages held additional facilitation meetings, and 72 % of the treatment villages actively used religious and other gatherings to spread information about the experiment [39].

The experiment was demanding in terms of what it took to win the conditional payment, i.e., zero land-clearing fires. The average treatment village had a population of around 2400, or 400 households—though counting households in multigenerational longhouse settings is not straightforward. The median number of hotspots per treatment village

was about four. During our experiment, therefore, only about 1% 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, we were unable to establish the specific traits of 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? Were they extremely poor? What we do know, however, is that their numbers were small and that the 100% compliance demanded by our experiment may have set too difficult a standard. Fortunately, the groundwork has been laid for answering the foregoing questions. We have the GPS coordinates of the fires, and it should be possible in a few years to revisit these villages to determine who is working the land cleared by the fires of 2018.

5. Conclusions

Our field experiment, which used conditional cash payments (~USD 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% 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 a 100% fire-free village (i.e., no deliberately lit fires) to win the conditional payment. The number of households who did not comply—less than 1% 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 the 1% of 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?

Fundamentally, however, we believe that basic economics drove the fires, and, conversely, the fires drove the economics. The net present value of land is high in these villages as a consequence of the well-established oil palm industry. That high profitability, and the financial incentives it provides for illegal behavior, occurs in large part because of the potential for using low-cost fire techniques for clearing land. Once the decision has been made to clear, relative costs, and often the physical unavailability of machinery, inevitably drive poor farmers 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 province, simultaneously creates large negative externalities in the form of deforestation, habitat destruction, damaged human health, and strained international relations.

We had hoped that conditional payments to villages might offer one policy avenue for dealing with this difficult trade-off, but 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 public agencies and village smallholders on land-clearing machinery. Implementing such programs for all villages in the key oil palm provinces is likely to be a long and daunting task.

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Appendix A. Quantitative Descriptors of a Subset of Treatment Villages

The survey of 10 villages suggested several insights on the fire circumstances of villages that had few versus many fires. Column 1 of Table A1 presents averaged data for 5 villages drawn randomly from the treatment set that had 5 or fewer fires. Column 2 shows averaged data for 5 random villages that had 6 or more fires.

We are well aware of the small sample size in this table. In normal circumstances, we would have returned to the field and expanded the sample size to at least 50. However, COVID-related travel restrictions by the Governments of Indonesia and the United States, as well as by Stanford University, precluded additional fieldwork. We attempt no statistical assessment of between-column differences but believe that the tabulated data may still help readers visualize the landscape of treatment villages.

Table A1. Comparative Data from a 10-Village Survey in West Kalimantan, 2018.

	Averaged Data, 5 Villages With 5 or Fewer Fires	**Averaged Data, 5 Villages With 6 or More Fires**
Number of fires (hotspots)	2	36
Population of village	1255	1183
Size of village	9780 ha	7419 ha.
Agriculture is main job of village headman	4 of 5 villages	4 0f 5
Village head born in village	3 of 5	4 of 5
Percent forest area	21	18
Percent peat soils	24	26
Percent oil palm area	42	67
Dayak as main ethnicity	4 of 5	3 of 5
Oil Palm main economic village activity	2 of 5	3 of 5
Military attended meetings	4 of 5	5 of 5
Number of villagers in sire task forces	20	24
Distance from fire station	2 h by jeep	5 h by jeep
Hung project posters	4 of 5	2 of 5
Distributed project flyers	2 of 5	2 of 5
Discussed project at religious services	5 of 5	3 of 5

References

1. Edwards, R.B.; Naylor, R.L.; Higgins, M.M.; Falcon, W.P. Causes of Indonesia's forest fires. *World Dev.* **2020**, *127*, 104717. [CrossRef]
2. Byerlee, D.; Falcon, W.P.; Naylor, R.L. *The Tropical Oil Crop Revolution: Food, Feed, Fuel and Forests*; Oxford University Press: Oxford, UK, 2017; 288p.
3. Austin, K.G.; Schwantes, A.; Gu, Y.; Kasibhatla, P.S. What causes deforestation in Indonesia? *Environ. Res. Lett.* **2019**, *14*, 024007. [CrossRef]
4. Glauber, A.J.; Gunawan, I. *The Cost of Fire: An Economic Analysis of Indonesia's 2015 Fire Crisis*; World Bank: Washington, DC, USA, 2015.
5. Purnomo, H.; Shantiko, B.; Sitorus, S.; Gunawan, H.; Achdiawan, R.; Kartodihardjo, H.; Dewayani, A.A. Fire economy and actor network of forest and land fires in Indonesia. *For. Policy Econ.* **2017**, *78*, 21–31. [CrossRef]
6. Bolderdijk, J.W.; Lehman, P.K.; Geller, E.S. Encouraging Pro-Environmental Behaviour with Rewards and Penalties. In *Environmental Psychology: An Introduction*; Steg, L., Van den Berg, A.E., De Groot, J.I.M., Eds.; Wiley & Sons: New York, NY, USA, 2012; pp. 273–282.
7. Cinner, J. How behavioral science can help conservation. *Science* **2018**, *362*, 889–890. [CrossRef]
8. Gardner, G.T.; Stern, P.C. *Environmental Problems and Human Behaviour*, 2nd ed.; Pearson Custom Publishing: Boston, MA, USA, 2002; ISBN 0-536-68633-5.
9. Geller, E.S. The Challenge of Increasing Pro-environment Behavior. In *Handbook of Environmental Psychology*; Bechtel, R.B., Churchman, A., Eds.; Wiley: New York, NY, USA, 2002; pp. 525–540.
10. Gneezy, U.; Meier, S.; Rey-Biel, P. When and why incentives (don't) work to modify behavior. *J. Econ. Perspect.* **2011**, *25*, 191–210. [CrossRef]
11. Steg, L.; Vlek, C. Encouraging pro-environmental behaviour: An integrative review and research agenda. *J. Environ. Psychol.* **2009**, *29*, 309–317. [CrossRef]
12. Vlek, C.A.J.; Steg, L. Human behavior and environmental sustainability: Problems, driving forces, and research topics. *J. Soc. Issues* **2007**, *63*, 1–19. [CrossRef]
13. Blundo-Canto, G.; Bax, V.; Quintero, M.; Cruz-Garcia, G.S.; Groeneveld, R.A.; Perez-Marulanda, L. The Different Dimensions of Livelihood Impacts of Payments for Environmental Services (PES) Schemes: A Systematic Review. *Ecol. Econ.* **2018**, *149*, 160–183. [CrossRef]
14. Börner, J.; Baylis, K.; Corbera, E.; Ezzine-de-Blas, D.; Honey-Rosés, J.; Persson, U.M.; Wunder, S. The Effectiveness of Payments for Environmental Services. *World Dev.* **2017**, *96*, 359–374. [CrossRef]

15. Jacka, B.K.; Kouskya, C.; Simsa, K.R.E. Designing payments for ecosystem services: Lessons from previous experience with incentive-based mechanisms. *Proc. Natl. Acad. Sci. USA* **2008**, *105*, 9465–9470. [CrossRef]
16. Redford, K.H.; Adams, W.M. Payment for ecosystem services and the challenge of saving nature: Editorial. *Conserv. Biol.* **2009**, *23*, 785–787. [PubMed]
17. Seymour, F.; Busch, J. *Why Forests? Why Now?: The Science, Economics, and Politics of Tropical Forests and Climate Change*; Center for Global Development: Washington, DC, USA, 2015; pp. 1–250. ISBN 978-1-9332-8685-3.
18. Wunder, S. *Payments for Environmental Services: Some Nuts and Bolts*; Center for International Forestry Research: Jakarta, Indonesia, 2005.
19. Wunder, S. When payments for environmental services will work for conservation. *Conserv. Lett.* **2013**, *6*, 230–237. [CrossRef]
20. Young, M. Transformational Change: In search of excellence. In *Transformational Change in Environmental and Natural Resource Management: Guidelines for Policy Excellence*, 1st ed.; Young, M., Esau, C., Eds.; Taylor & Francis: London, UK, 2016; ISBN 978-1-3157-1591-9.
21. Jefferson, U.; Carmenta, R.; Daeli, W.; Phelps, J. Characterizing policy responses to complex socio-ecological problems: 60 fire management interventions in Indonesian peatlands. *Glob. Environ. Chang.* **2020**, *60*, 102027. [CrossRef]
22. Salzman, J.; Bennett, G.; Carroll, N.; Goldstein, A.; Jenkins, M. The global status and trends of Payments for Ecosystem Services. *Nat. Sustain.* **2018**, *1*, 136–144. [CrossRef]
23. Alix-Garcia, J.M.; Sims, K.R.E.; Yañez-Pagans, P. Only one tree from each seed? Environmental effectiveness and poverty alleviation in Mexico's Payments for Ecosystem Services Program. *Am. Econ. J. Econ. Policy* **2015**, *7*, 1–40. [CrossRef]
24. Alix-Garcia, J.M.; Sims, K.R.E.; Orozco-Olvera, V.H.; Costica, L.E.; Fernández Medina, J.D.; Monroy, S.R. Payments for environmental services supported social capital while increasing land management. *Proc. Natl. Acad. Sci. USA* **2018**, *115*, 7016–7021. [CrossRef]
25. Arriagada, R.A.; Ferraro, P.J.; Sills, E.O.; Pattanayak, S.K.; Cordero-Sancho, S. Do payments for environmental services affect forest cover? A farm-level evaluation from Costa Rica. *Land Econ.* **2012**, *88*, 382–399. [CrossRef]
26. Pagiola, S. Payments for environmental services in Costa Rica. *Ecol. Econ.* **2008**, *65*, 712–724. [CrossRef]
27. Samii, C.; Lisiecki, M.; Kulkarni, P.; Paler, L.; Chavis, L.; Snilstveit, B.; Vojtkova, M.; Gallagher, E. Effects of Payment for Environmental Services (PES) on Deforestation and Poverty in Low and Middle Income Countries: A Systematic Review. *Campbell Syst. Rev.* **2014**, *10*, 1–95. [CrossRef]
28. Sommerville, M.; Milner-Gulland, E.J.; Rahajaharison, M.; Jones, J.P.G. Impact of a community-based payment for environmental services intervention on forest use in Menabe, Madagascar. *Conserv. Biol.* **2010**, *24*, 1488–1498. [CrossRef]
29. Yin, R.; Liu, T.; Yao, S.; Zhao, M. Designing and implementing payments for ecosystem services programs: Lessons learned from China's cropland restoration experience. *For. Policy Econ.* **2013**, *35*, 66–72. [CrossRef]
30. Suich, H.; Lugina, M.; Muttaqin, M.Z.; Alviya, I.; Sari, G.K. Payments for ecosystem services in Indonesia. *Oryx* **2017**, *51*, 489–497. [CrossRef]
31. Ajayi, O.C.; Jack, B.K.; Leimona, B. Auction Design for the Private Provision of Public Goods in Developing Countries: Lessons from Payments for Environmental Services in Malawi and Indonesia. *World Dev.* **2012**, *40*, 1213–1223. [CrossRef]
32. Angelsen, A.; Brockhaus, M.; Sunderlin, W.D.; Verchot, L. (Eds.) *Analysing REDD+: Challenges and Choices*; Center for International Forestry Research: Bogor, Indonesia, 2012; pp. 1–426.
33. Fauzi, A.; Anna, S. Assessment of sustainability of integrated coastal management project: A CBA-DEA Approach. *Indones. J. Coast. Mar.* **2003**, *1*, 34–48.
34. Pirard, R.; Billé, R. *Payments for Environmental Services (PES): A Reality Check (Stories from Indonesia)*; Institute for Sustainable Development and International Relations: Paris, France, 2010.
35. van Noordwijk, M.; Leimona, B. Principles for fairness and efficiency in enhancing environmental services in asia: Payments, compensation, or co-investment? *Ecol. Soc.* **2010**, *15*, 17. [CrossRef]
36. Wijaya, A.; Samadhi, T.N.; Juliane, R. Indonesia Is Reducing Deforestation, But Problem Areas Remain. Available online: https://www.wri.org/blog/2019/07/indonesia-reducing-deforestation-problem-areas-remain (accessed on 10 May 2022).
37. Fire Free Alliance. Fire-Free Village Program: Members Review 2017. Available online: https://www.aprildialog.com/wp-content/uploads/2019/01/190109-FFA-Members-Review-2017.pdf (accessed on 10 May 2022).
38. BAPPENAS. Grand Design Pencegahan Kebakaran, Hutan, Kebun dan Lahan. Available online: https://www.cifor.org/knowledge/publication/6669/ (accessed on 10 May 2022).
39. Edwards, R.; Falcon, W.P.; Hadiwidjaja, G.; Higgins, M.M.; Naylor, R.L.; Sumarto, S. Fight Fire with Finance: A Randomized Field Experiment to Curtail Land-Clearing Fire in Indonesia. Available online: https://www.socialscienceregistry.org/trials/3222 (accessed on 10 May 2022).
40. Jayachandran, S.; De Laat, J.; Lambin, E.F.; Stanton, C.Y.; Audy, R.; Thomas, N.E. Cash for carbon: A randomized trial of payments for ecosystem services to reduce deforestation. *Science* **2017**, *357*, 267–273. [CrossRef]
41. Asquith, N. Large-scale randomized control trials of incentive-based conservation: What have we learned? *World Dev.* **2019**, *127*, 104785. [CrossRef]
42. Hadiwidjaja, G. *Field Report Why Villages Succeed or Fail in Preventing Fires in West Kalimantan: Lessons from 10 Villages*; Stanford University Center on Food Security and the Environment: Stanford, CA, USA, 2019.

43. Naylor, R.L.; Battisti, D.S.; Vimont, D.J.; Falcon, W.P.; Burke, M.B. Assessing risks of climate variability and climate change for Indonesian rice agriculture. *Proc. Natl. Acad. Sci. USA* **2007**, *104*, 7752–7757. [CrossRef]
44. Falcon, W.P.; Naylor, R.L.; Smith, W.L.; Burke, M.B.; McCullough, E.B. Using climate models to improve Indonesian food security. *Bull. Indones. Econ. Stud.* **2004**, *40*, 355–377. [CrossRef]
45. Naylor, R.L.; Higgins, M.M.; Edwards, R.B.; Falcon, W.P. Decentralization and the environment: Assessing smallholder oil palm development in Indonesia. *Ambio* **2019**, *48*, 1195–1208. [CrossRef]
46. Ricketts, T.H.; Soares-Filho, B.; da Fonseca, G.A.B.; Nepstad, D.; Pfaf, A.; Petsonk, A.; Anderson, A.; Boucher, D.; Cattaneo, A.; Conte, M.; et al. Indigenous lands, protected areas, and slowing climate change. *PLoS Biol.* **2010**, *8*, e1000331. [CrossRef] [PubMed]
47. Boyd, W.; Stickler, C.; Duchelle, A.E.; Seymour, F.; Nepstad, D.; Bahar, N.H.; Rodriguez-Ward, D. *Jurisdictional Approaches to REDD+ and Low Emissions Development: Progress and Prospects*; World Resources Institute: Washington, DC, USA, 2018.
48. Fishbein, G.; Lee, D. *Early Lessons from Jurisdictional REDD+ and Low Emissions Development Programs*; Nature Conservancy and World Bank Group: Washington, DC, USA, 2015.
49. Irawan, S.; Widiastomo, T.; Tacconi, L.; Watts, J.D.; Steni, B. Exploring the design of jurisdictional REDD+: The case of Central Kalimantan, Indonesia. *For. Policy Econ.* **2019**, *108*, 101853. [CrossRef]
50. Burgess, R.; Hansen, M.; Olken, B.A.; Potapov, P.; Sieber, S. The political economy of deforestation in the tropics. *Q. J. Econ.* **2012**, *127*, 1707–1754. [CrossRef]
51. Edwards, R.B. *Export Agriculture and Rural Poverty: Evidence from Indonesian Palm Oil*; Darthmouth College: Hanover, NH, USA, 2019; manuscript in preparation.
52. Colchester, M.; Jiwan, N.; Sirait, M.; Firdaus, A.Y.; Surambo, A.; Pane, H. *Promised Land: Palm Oil and Land Acquisition in Indonesia—Implications for Local Communities and Indigenous Peoples*; Forest Peoples Programme, Perkumpulan Sawit Watch, HuMA, World Agroforestry Centre: Bogor, Indonesia, 2006; pp. 1–197.
53. Siahaan, N.H.T. *Hutan, Lingkungan, dan Paradigma Pembangunan*; Pancuran Alam: Shah Alam, Indonesia, 2007; pp. 1–370.
54. Awang, S.A. *Sosiologi Pengetahuan Deforestasi: Konstruksi Sosial dan Perlawanan*; Debut Press: Bogor, Indonesia, 2006; pp. 1–372.
55. Suyanto, S. Underlying cause of fire: Different form of land tenure conflicts in Sumatra. *Mitig. Adapt. Strat. Glob. Chang.* **2017**, *12*, 67–74. [CrossRef]
56. Suyanto, S.; Applegate, G.; Permana, R.P.; Khususiyah, N.; Kurniawan, I. The role of fire in changing land use and livelihoods in Riau-Sumatra. *Ecol. Soc.* **2004**, *9*, 15. [CrossRef]
57. Antlöv, H.; Wetterberg, A.; Dharmawan, L. Village Governance, Community Life, and the 2014 Village Law in Indonesia. *Bull. Indones. Econ. Stud.* **2016**, *52*, 161–183. [CrossRef]
58. Evans, M. The Future of Social Forestry in Indonesia. Available online: https://forestsnews.cifor.org/60457/the-future-of-social-forestry-in-indonesia?fnl=en (accessed on 10 May 2022).
59. Simorangkir, D. Fire use: Is it really the cheaper land preparation method for large-scale plantations? *Mitig. Adapt. Strateg. Glob. Chang.* **2007**, *12*, 147–164. [CrossRef]
60. Cattau, M.E.; Harrison, M.E.; Shinyo, I.; Tungau, S.; Uriarte, M.; DeFries, R. Sources of anthropogenic fire ignitions on the peat-swamp landscape in Kalimantan, Indonesia. *Glob. Environ. Chang.* **2016**, *39*, 205–219. [CrossRef]
61. Cramb, R.A. *Land and Longhouse: Agrarian Transformation in the Uplands of Sarawak*; Nordic Institute of Asian Studies Press: Copenhagen, Denmark, 2007; pp. 1–422.
62. Center for International Forestry Research. Anthropogenic Fires in Indonesia: A View from Sumatra. Available online: https://www.cifor.org/knowledge/946 (accessed on 10 May 2022).
63. Chisholm, R.A.; Wijedasa, L.S.; Swinfield, T. The need for long-term remedies for Indonesia's forest fires. *Conserv. Biol.* **2016**, *30*, 5–6. [CrossRef]