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Incentivizing compliance: Evaluating the effectiveness of targeted village incentives for reducing burning in Indonesia☆

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ABSTRACT

Periodic peat and forest fires in Sumatra and Kalimantan result in haze that blankets Indonesia and neighboring countries, with effects on human health, the environment and the economy. Although the prevailing approach for preventing and reducing the incidence of fire in Indonesia is regulatory, village-level incentive schemes have been trialed by agribusinesses and pulp and paper companies to prevent burning. In this article, we review one integrated incentive program for villages launched by a pulp and paper company in Riau, Sumatra, in 2015. As part of the study, we surveyed six of the villages that participated in the first year of the program as well as six non-program villages, complemented by spatial analyses of hotspots and burn scars. Our analyses show a declining pattern of burning in the years prior and including 2015, followed by the almost total cessation of burning in the years after. During 2015, a severe El Niño event, the program villages experienced 40% fewer fires, while in non-program villages, there were 23% more fires. The main reason cited by the villages was the increased awareness of the regulations in force prior to the program. The information about these laws and regulations had been disseminated to program villages, as well as some of the adjacent non-program villages, prior to the commencement of the incentive program. The transition to non-burning livelihoods was enabled by ongoing changes in the landscape to permanent agricultural crops such as oil palm and rubber, as well as non-farming livelihoods. Although the benefits of the program were valued at the community level, the incentives appeared to function as a pathway for incentivizing compliance with prevailing regulations rather than inducing voluntary behaviors. We argue that the current trend for strict environmental regulations undermines the potential for using voluntary incentives. Consequently, we suggest that future incentive schemes should focus on providing agricultural support to smallholders to enable them to adapt to the strict requirements of the environmental regulations in force.

1. Introduction

Periodic fires in Sumatra and Kalimantan, often exacerbated by El Niño events, have led to smoke haze covering Indonesia, Malaysia and Singapore as well as Brunei (Gaveau et al., 2014; Kusumaningtyas and Aldrian, 2016; Tacconi, 2016). The human health effects of these fires include respiratory illnesses, eye irritation and skin diseases (Marlier et al., 2012), which can increase the mortality rate among those affected by the haze (Crippa et al., 2016; Koplitz et al., 2016). Fires also cause significant greenhouse gas emissions (Heymann et al., 2017), and affect biodiversity and peatlands (Marlier et al., 2015; Tacconi, 2016). Forest fires can burn the forest canopy as well as disrupt the decomposition system in the forest, leading to the decline of the forest system in the long-term (Kinnaird and O'Brien, 1998). Fires can also burn the litter layer on the surface of the soil, exposing it to erosion and changing the soil composition (Ahlgren and Ahlgren, 1960). These changes affect the regeneration of saplings and also increase the vulnerability of the forest to invasive, exotic species (Kinnaird and O'Brien, 1998). In

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addition, fires can endanger wildlife by disrupting their habitat (Kinnaird and O'Brien, 1998; Nepstad et al., 1999; Wharton, 1966).

The amount of greenhouse gases emitted from forest fires depends on several conditions, particularly the type of soil on which fire occurs. Fires in peatlands produce higher carbon emissions compared to fires in mineral soil due to the high organic carbon content beneath the surface (Agus et al., 2011). It has been estimated that the 1997 fires in Indonesia during the El Niño event released between 0.81 and 2.57 Gt of carbon emissions to the atmosphere (Page et al., 2002), whereas the 2015 fire events during the El Niño season produced an estimated 0.75 Gt (Heymann et al., 2017) to 0.81 Gt (Pribadi and Kurata, 2017) of carbon emissions. The economic consequences of fires in Sumatra and Kalimantan have been significant for both industrial and small-scale farmers and plantations. The damages from recent major fire events in 1997 and 2015 are estimated to have cost Indonesia approximately US $2.8 billion in 1997 (Glover and Jessup, 1999; Tacconi, 2003) and US $16.124 billion in 2015, equivalent to 1.8% of Indonesia's GDP in 2014 (Tacconi, 2016). These figures take into account many negative impacts such as declines in agricultural and forest productivity as well as tourism, disturbance in air and ground transportation, respiratory health issues and school closures. Due to their significant greenhouse gas emissions, the Indonesian Government has identified reducing the incidence of fires as part of the broader strategy for reducing emissions from land uses and forestry in its Nationally Determined Contribution (NDC) (Republic of Indonesia, 2016).

Since the fires of 1997 and 1998, the causes and effects of Indonesian fires have been studied extensively (Carmenta et al., 2017; Cattau et al., 2016a; Dennis et al., 2005; Purnomo et al., 2017; Sloan et al., 2017; Tacconi, 2003, 2016; Vayda, 2006). In normal periods, high humidity and limited dry vegetative matter means that there are very few natural sources of fire, as opposed to Australia, North America or Europe. During El Niño events as well as dry spells in non-drought years (Gaveau et al., 2014), however, the drier conditions enable fires to quickly spread through forests and peat areas. The transnational haze that results from fires, especially with the higher levels of particulate matter from peat fires, has focused attention on how to prevent the outbreak of these fires (Tacconi et al., 2007; Tacconi, 2016). The main causes of large scale escaped fires that have been identified are the use of fire for land clearing by both small-scale farmers and industrial land uses, including forestry operations and timber plantations, and agricultural plantations, including oil palm plantations (Dennis et al., 2005; Purnomo et al., 2017; Sloan et al., 2017; Tacconi, 2003, 2016; Vayda, 2006; Wooster et al., 2012).The focus on these causes has informed the design and implementation of policies and regulations for reducing the incidence of fires in Indonesia. These include regulations banning the use of fire for land clearing (Gokkon, 2015) and more recently, a moratorium on new oil palm and mining concessions (Chan and Soeriaatmadja, 2016). The moratorium is expected to stop the expansion of oil palm and mining concessions and, consequently, would curb the use of fire for land clearing and, subsequently, large escaped fires (Satriastanti, 2016).

Although there are many actors, with differing motivations, responsible for the ignition and spread of fires in Indonesia, in our study we focus specifically on one group of actors, rural communities. Indonesian farmers, historically, have relied on burning as the main method for clearing and managing their lands, and restricting the use of fire without adequate incentives and alternatives could adversely affect poorer households. Consequently, in this paper, we discuss the potential of village-level incentives to be used for preventing and reducing the incidence of fire among rural communities. Historically, the dominant approach to fire prevention in Indonesia has been issuing regulations that prevent the use of fire. Incentives, in this context, represent a departure from previous and ongoing efforts for fire prevention. We review the case study of a program in Riau Province (Sumatra), launched by a pulp and paper company, APRIL, which is called the Fire Free Village Program. The program involves a mixture of incentives, community engagement and support for sustainable agricultural alternatives, and it was launched in the months prior to the major fires of 2015. Following the fires, Presidential Instruction No.11/2015 on the Increased Control of Land and Forest Fires was issued, and it forms the basis for the imposition of a total fire ban, including those used for agricultural purposes (Rogers, 2016). The fire season of 2015, consequently, represents an interesting case study in using voluntary financial incentives for fire prevention during a major El Niño event. The research aims to understand the conditions under which village level incentives are effective for reducing the incidence of fire among rural Indonesian communities. The study addresses the following questions: i) Did the villages included in the FFV Program experience a significant reduction in fire events compared to other villages located in the vicinity of APRIL's plantations and which were not covered by the FFV Program? ii) If there was a significant reduction in fire events in FFV Program villages, what are the factors that contributed to that reduction?

This study provides input for a more nuanced policy towards burning by rural communities in Indonesia and, as a result, it also informs efforts aimed at reducing emissions of greenhouse gases and protecting biodiversity. This research also contributes to the literature on payments and rewards for environmental services in tropical forest regions by analyzing when and where incentives are effective in comparison with regulatory instruments or support for alternative livelihoods.

We begin with a brief survey of the causes of fires in Indonesia and the potential of financial incentives for fire prevention, followed by a discussion of the case study of the Fire Free Village Program in Riau Province, Indonesia.

2. The causes and consequences of burning in Indonesia

The causes of fire in Indonesia range from commercial land clearing, clearing and other burning by small-scale farmers and unintentional escaped fires (Carmenta et al., 2017; Dennis et al., 2005; Tacconi, 2003, 2016). Although the exact contribution of small-scale and commercial producers is uncertain (Gaveau et al., 2017; Sloan et al., 2017; Tacconi, 2016), fire has an ongoing and historical role in small-scale farming in Indonesia. Swidden farming systems, still common in many parts of Indonesia, used fire as both an efficient tool for clearing forests and scrub while returning nutrients to the soil (Verma and Jayakumar, 2012). Fire is also used in grassland to promote the regrowth of grass for cattle grazing, as practiced widely in the Eastern Indonesian islands of Sumba and Flores islands and to improve visibility for hunting (Chokkalingam and Suyanto, 2004; Tacconi and Ruchiat, 2006). The use of fire, therefore, helps sustain the livelihoods of people. The burning practices that have been adopted indicate that local people have a significant level of knowledge about the use of fire. It is still unknown, however, whether local people have full knowledge of the long-term positive and negative impacts of burning. Without the use of fire, certain farming and grazing systems may no longer be financially viable for local communities (Tacconi and Ruchiat, 2006).

The decline of swidden agriculture and the shift to more intensive land uses (Cramb et al., 2009; Mertz et al., 2009) has not eliminated the use of fire in Indonesia. Rather, fire has retained its instrumentality as an efficient means for clearing land as well as a simple method for evading Indonesia's complex and restrictive policies for land use and forest management. This is reflected in the use of fire for the expansion of industrial land uses. The first, and most controversial, use of fire in this scenario is for the establishment of timber and oil palm plantations as fire is a cheap and quick tool to clear land (Gouyon et al., 2002; Simorangkir, 2007). Analyses of the causes of large fire events in the late 1990s and early 2000s indicated that this was a major cause of fire (Tacconi et al., 2007). A more recent study of fires in Kalimantan, however, found that most fires (68–71%) originated in non-forest areas rather than concessions and that fires started within concessions tend

be contained (Cattau et al., 2016a). This may reflect, however, better land management practices by concessionaires in the period since the 1997 fires, including the introduction of certification standards, such as from the Roundtable on Sustainable Palm Oil (RSPO) (Carlson et al., 2017; Cattau et al., 2016b). Similarly, in 2015, the land ownership of where most of the fires occurred was unclear, with 55% of the burnt area not belonging to defined stakeholders (Tacconi, 2016). More recently, a study has described a process where burning is the first step of making land claims in areas where there is unclear tenure, following which, the lands are then traded for the purposes of cultivation, including oil palm (Purnomo et al., 2017). Smallholders, in contrast, may continue to burn as they have few alternatives for clearing land or access to subsidized fertilizers and pesticides to replace the functions of burning at an affordable price (Brandi et al., 2015; INOBU, 2016).

3. Fire prevention in Indonesia and the potential for community incentives

The Government of Indonesia has attempted to reduce the incidence of fires by issuing a number of regulations since the 1980s. In 1995, the Minister of Forestry, through Decree No. 188/Kepts-II/1995, established the National Centre for Forest Fire Control to control fires inside forest areas. In 1996, the Minister of Environment formed the National Coordinating Team for Land Fire that focused on fire outside of forest areas. Additionally, the Minister of Environment issued Decree No. Kep.-40/MenLH/09/97 to form a National Coordinating Team for Forest and Land Fire Control to address fires that occurred inside and outside of forest areas (Herawati and Santoso, 2011). This was strengthened by Act No. 41/1999 that bans corporations from clearing land for oil-palm plantations by using fire. In addition to national policy, the ASEAN Agreement on Transboundary Haze Pollution provides a platform for international cooperation in monitoring and preventing fire incidents, while Singapore's Transboundary Haze Pollution Act considers the businesses responsible for haze pollution that reaches Singapore as criminals, and both instruments were already in place prior to the 2015 fires (Cattau et al., 2016a). The continued occurrence of significant fire events demonstrates that these laws have had limited effectiveness. Following the 2015 fires, the Indonesian President issued Presidential Instruction No. 11/2015, increasing the control of land and forest fires and forming the basis for the imposition of a total ban on fires, coupled with stronger law enforcement efforts.

The regulatory approach has both advantages and disadvantages. The regulatory approach does not address one of the causes of major fire events during 2015, which were escaped fires from unmanaged, idle lands that have no clear ownership (Cattau et al., 2016a). For the Ministry of Environment and Forestry, sanctions are easier to apply to registered companies with clearly defined concession boundaries than investigating the causes and actors responsible for fires in unmanaged lands. This may reflect the methods used for detecting fires, which rely heavily on satellite imagery and concession maps, and field investigations are often met with resistance by local communities (Liljas, 2016). These methods, however, have limited effectiveness too, as there are often mismatches between *de jure* and de facto land occupancy both inside and outside of concession boundaries (Gaveau et al., 2017). Despite the successes in prosecuting many companies for fires in 2015, none of the companies prosecuted had actually paid a fine by early 2017 (Jong, 2017). Small-scale farmers are also targeted as part of fire bans, however, usually by local patrols such as the Forest and Land Fire Task Force, or *Satuan Kebakaran Hutan dan Lahan* (SATKARHUTLA), which is a collaboration among the police, military and other agencies for fire prevention (Rohadi, 2017). Enforcing fire bans also raises issues of equity. Commercial operations have more resources to use mechanical clearing methods and adhere to environmental standards, including certification schemes such as the RSPO certification scheme, than small-scale farmers (Brandi et al., 2015; Lee et al., 2012). The alternative proposed methods for clearing are often not appropriate or accessible for small-scale farmers, especially swidden farmers, which has led to farmers either abandoning their land or continuing to burn in secret (Rohadi, 2017).

Incentives, targeted at smallholders and communities, could have the potential to support fire prevention while mitigating the adverse effects on poor farming households. Payments for Environmental Services (PES) have been proposed and used for voluntarily solving environmental problems, including watershed protection, forest and ecosystem restoration and reducing greenhouse gas emissions (Sloan et al., 2018; Tacconi, 2012; Wunder, 2015). Empirical studies that have evaluated the effectiveness of financial incentives in conservation report mixed results (Wunder et al., 2018). It is therefore important to investigate if incentives for fire prevention could motivate and enable smallholders to shift from using burning to alternative practices that do not require using burning, as well as considering the limitations of incentive programs.

The Fire Free Village (FFV) Program in Pangkalan Kerinci district in Riau Province (Sumatra Island, Indonesia) launched by the APRIL Group is a community engagement scheme for fire prevention. The APRIL Group is a major manufacturer of pulp and paper and owns natural and planted timber plantations throughout Indonesia. In response to frequent fires affecting their plantation forests, the APRIL Group implemented a new scheme for reducing the use of fire in communities surrounding their plantations. One of the five programs includes No Burn Village Rewards, where a full reward of IDR 100,000,000 is given to the village community, through the village government, under the condition that fires do not occur within the village boundaries during the dry period, usually from July to October. A half reward, amounting to IDR 50,000,000, will be given to the village community if the burnt areas are maintained below 2 ha, and no reward will be given if the burnt areas are larger than 2 ha. The community decides the allocation of the funds to a high priority community initiative through village meetings, which are led by the village government and attended by various representatives of village communities. The use of the reward funds is not restricted to fire prevention or suppression activities or equipment. Rather, the receiving villages are given the freedom to use the rewards in a way that is deemed beneficial for the village communities. Other components of the FFV Program include: appointing a local fire crew leader in each village, awareness raising programs, air quality measurements, and providing alternative technologies for land clearing (Table 1). Selected villages are eligible for the No Burn Village Rewards for 2 years and will enter the Fire

Table 1
Fire free village program in Riau, Indonesia.

Year commenced	28 July 2015
Location	Pangkalan Kerinci, Riau, Indonesia
Incentive program features	• No Burn Village Rewards calculated on annual basis: • Full Reward (IDR 100,000,000) if no land burned • Half Reward (IDR 50,000,000) if < 2 ha of land burned • No Reward if > 2 ha of land burned • Use of rewards decided through community meetings
Other features	Village crew leader, Sustainable agricultural assistance, Community fire awareness, Air quality monitoring
Performance indicators	• Contribution to the reduction in burnt areas • Contribution to short term positive engagement with local communities • Contribution to long term community cultural shift, education & mindset change • Contribution to long term economic sustainability of local communities to earn not burn • Contribution to APRIL return on Investment
Implementing agencies	APRIL; 2 local non-government organizations - Rumah Pohon and Blue Green; Masyarakat Peduli Api (MPA); Local government; Police; Military, The Provincial Disaster Mitigation Agency (BPBD)
Target groups	9 villages surrounding APRIL's concession in Riau

Source: (APRIL, 2016).

Table 2
Burnt areas and 2015 reward status in FFV program villages.

Villages	Burnt area (Ha – APRIL)					Total	FFV program reward
	2013	2014	**2015**	2016	2017		
Sering	50	30	**11**			91	No reward
Kuala Tolam	100	30	**0.15**	0.8		131	Half reward
Kuala Panduk	122	87				209	Full reward
Teluk Binjai	70	30	**0.7**			101	Half reward
Teluk Meranti	200	83	**21.2**			304	No reward
Segamai	300	250		10.5		561	Full reward

Bold indicate the year of focus for the study
Source: APRIL Group.

Resilient Community (FRC) phase in the third year, where they will no longer be eligible for the rewards but will continue to receive support from APRIL for the other components of the program.

An initial review of the program has pointed to promising success in some aspects of the program, while encountering limited success in others (APRIL, 2016). Overall the review found that the program appears to have led to a reduction in the incidence of fire in the villages surrounding the plantations that had been included in the FFV Program. The program was planned prior to the extensive fires of 2015, and implementation started just after the beginning of the fire season in July 2015. The new administration of President Joko Widodo responded to the fires and subsequent haze by issuing a Presidential Instruction No. 11/2015 that banned burning, including by smallholders. The regulation was implemented strictly in Riau, with harsh penalties for farmers caught burning.

4. Methods

4.1. Village selection

The Program villages were sampled based on whether they received a full, half or no reward for reductions in burning during the first year of the program, which coincided with the El Niño event (Table 2). Non-program villages were sampled according to their similarity with the program villages selected, including size and relative risk according to APRIL's risk assessment map. Geographically, the villages are all located in the same region and most villages were directly adjacent or proximate with one another (Table 3). In 2016, Asian Agri, a palm oil company that belongs to the same Royal Golden Eagle International Group as APRIL, also launched a Fire Free Village Program, which included two of the non-program villages, Segati and Lalang Kabung Village (Asian Agri, 2017). As the program started in 2016, it would not have affected the behavior of communities during the 2015 period.

Fire is heavily influenced by the presence and extent of particular land use/covers, such as degraded forests and peatlands, at least where these are proximate to agricultural activities (Cattau et al., 2016a; Sloan et al., 2017). To assess the comparability of our FFV Program villages and non-program villages in this respect, we quantified the areas of various land use/cover classes in each village. Classes were predominantly according to visual interpretations of Landsat and SPOT satellite imagery of ca. 2015 for peatlands (Miettinen et al., 2016a). This interpretation defined ten land use/cover classes (Table 4) (Miettinen et al., 2016a). Around 40% of the total area of the five Non-program Villages (mostly within Segati and Kerumutan villages) were not visually interpreted because they were not situated on peatlands mapped by Miettinen et al. (2016a) – all other village areas were on peatlands thus defined and so visually interpreted accordingly. For areas not on peatlands, we quantified land use/covers using the Moderate Resolution Imaging Spectroradiometer (MODIS) land-cover classification of Miettinen et al. (2016b). The land use/cover classes of the MODIS classification were equated to those of the Landsat/SPOT visual interpretation according to Table A.1.

In general, sets of FFV Program and Non-program villages are comparable overall with respect to their relative frequencies of different land covers (Table 4). Similarly, as expected among adjacent villages, the relative frequencies of different livelihoods (e.g., farming, fishing, small business) and agricultural land uses (e.g., oil palm, rubber) were highly comparable among the two village sets overall (Tables 11 and 12; discussed later). Considering these points as well as the fact that both village sets are predominantly peatland, it is plausible that both sets of villages also experience similar types mixes of fire 'types', namely small agricultural fires on peatlands. Such overall comparability should not be interpreted to mean that inter-set differences in fire patterns have been totally 'controlled' per se. Variations among villages, including among villages of a given set, remains considerable (Tables 4 and 12) and the small number of villages as well as the open-ended nature of the surveys in this study preclude statistical controls of village-level attributes effecting burning (Gaveau et al., 2013). In this light, the survey presented below provide an exploratory and qualitative analysis of the effectiveness of the incentive scheme in reducing the incidence of fire.

4.2. Village survey protocols

The study provides exploratory report of the motives and dynamics by which villages reduced burning activities during the first year of the FFV Program. For a set of ten village in Pangkalan Kerinci district, split evenly between Program villages during the first year of the FFV

Table 3
Data for FFV program and non-program villages.

Village/administrative village	Administration type		Population (households/Individuals)	Area (ha)	Road access		Nearest palm oil mill (km)
	Village	Administrative village			Easy	Difficult	
FFV program villages							
Sering	x		506/1822	9113	x		0–20
Kuala Tolam	x		321/1138	32,981	x		41–80
Kuala Panduk	x		520/1567	23,994	x		0–20
Teluk Binjai	x		400/1500	48,531	x		21–40
Teluk Meranti		x	1100/3000	160,231	x		81 +
Segamai	x		288/1040	4563		x	41–80
Non-program villages							
Benteng Hilir	x		600/2400	3844	x		0–20
Lalang Kabung	x		637/2639	7119	x		0–20
Kerumutan		x	1431/5376	43,538	x		0–20
Mak Teduh	x		503/1985	31,444	x		0–20
Pangkalan Terap	x		200/800	26,238		x	0–20
Segati	x		2700/6000	75,281	x		0–20

Table 4
Area of land use/cover classes in the fire-free program and non-program villages.

Village	Ocean/ water	Seasonal water	Pristine PSF	Degraded PSF	Tall shrub/ secondary PSF	Fern/low shrub)	Smallholder agriculture	Plantation	Cleared/ burned	Total area (ha)
Non-program										
Lalang Kabung	–	–	–	663	325	–	1719	3863	550	7119
Pangkalan Terap	350	338	10,869	4325	75	150	3394	6119	619	26,238
Mak Teduh	–	169	11,106	6894	1694	13	869	10,644	56	31,444
Kerumutan	–	856	9588	11,344	1819	513	4044	13,756	1619	43,538
Segati	–	–	13	21,600	–	–	25,825	8956	18,888	75,281
Benteng Hilir	31	–	–	869	–	–	663	2206	75	3844
Total non-program	381	1363	31,575	45,694	3913	675	36,513	45,544	21,806	187,463
Total non-program (% total area)	0%	1%	17%	24%	2%	0%	19%	24%	12%	100%
FFV program villages										
Kuala Tolam	450	–	2756	6581	438	938	2475	18,631	713	32,981
Segamai	6	–	–	–	69	–	3150	1338	–	4563
Sering	556	–	550	1206	138	–	3756	2100	806	9113
Teluk Meranti	8181	1844	24,394	70,994	2219	4769	6150	39,206	2475	160,231
Kuala Panduk	331	206	11,719	4513	–	225	2625	4338	38	23,994
Teluk Binjai	2056	19	25,694	10,844	544	–	3350	6013	13	48,531
Total FFVP	11,581	2069	65,113	94,138	3406	5931	21,506	71,625	4044	279,413
Total FFVP (% total area)	4%	1%	23%	34%	1%	2%	8%	26%	1%	100%

Note: 'PSF' refers to Peat Swamp Forest. 'Ocean/Water' refers to inlet rivers extending from the ocean through the study villages. See Table B.1 for aerial measures of each land-use/cover class by village.

Program and adjacent villages that were not part of the scheme, the study employed a range of open-ended survey methods to solicit opinions on the dynamics underlying reductions in burning within Program villages following the implementation of the Program.

In each village, focus group discussions and five individual interviews were conducted with respondents that broadly reflected the livelihood diversity of the village. The focus group discussions involved village leaders and representatives of the main livelihood and occupational cohorts, including those with a direct link to landscape burning (e.g., farmers). The focus groups discussed topics including livelihoods and land uses, including uses of fire as well as participants' perceptions regarding the incentive program. Interviews with individual respondents were similarly structured, although without questions regarding the general profile of the village. The respondents were selected based on their representativeness of different livelihoods and occupations, including farmers, fishermen and entrepreneurs, within the village. The results of the focus group discussions and individual interviews from both non-program and program villages were used to compare individual and collective perceptions, especially regarding the causes of fire, the reasons for stopping and the benefits of the program.

Based on our literature review and preliminary fieldwork, we identified four potentially confounding factors that could affect the results from any study of the effectiveness of the incentive program. These four factors were:

- Environmental conditions such as El Niño events and droughts that increase fire risk (Gaveau et al., 2014; Tacconi, 2016);
- Strictly enforced regulations for prohibiting burning (Rohadi, 2017);
- Actual and alternative livelihood systems (Cramb et al., 2009; Tacconi et al., 2007); and
- Unrestricted community financing initiatives such as the Village Fund (Antlöv et al., 2016), which could dilute the effects of the incentive scheme.

To try to mitigate these confounding factors, we selected the year 2015 as the study period. That year was the first year of the program, as well as coinciding with the major El Niño event, but also the year before the Presidential Instruction that banned burning was enforced nationwide. According to national regulations issued prior to the Presidential Instruction, smallholders were allowed to burn as part of their livelihood activities. To identify the conditions that enabled farmers to switch to non-burning livelihoods, we analyzed their transitions in livelihoods as well as any outside support that may have been provided, including corporate social responsibility (CSR) programs. The study period also coincided with the launch of the Village Fund, a national program designed to provide unrestricted funds to villages largely for infrastructure development. Administrative villages were excluded from the scheme. We also specifically asked respondents in villages to describe the benefits of the village fund and, specifically in the program villages, compare with them the FFV Program incentives to identify the additionality of the incentives.

4.3. Fire activities at the village level, 2013–2017

Respondents' accounts on the means and efficacy of burning suppression were complemented with remote sensing data on the annual burned extent within the village boundaries over the period of 2013–2017 annually. The extent of burn scars across the villages was calculated using the latest Collection 6 version of the MODIS Terra and Aqua-combined global burned area product (MCD64AI) data (Giglio et al., 2009). The data describes the area burned according to the Terra and Aqua sensor from 500 m MODIS surface reflectance and 1 km MODIS active fire observations (Giglio et al., 2009). The burned pixels were identified by applying a threshold based on the vegetation index (VI) from shortwave infrared (SWIR) band of MODIS satellite image and temporal texture measurement (Giglio et al., 2009, 2015). The burned pixel represents the burned area within a given year of observation (2013–2017), excluding missing data and water bodies at 500 m resolution.

These burn scar data were also compared against separate active-fire 'hotspot' data, derived from 1 km MODIS data, for the same period (Giglio et al., 2016). Kernel density involves clustering the points based on the distance from each point based on a mathematical function (Anderson, 2009). Kernel density was used to visually represent annual hotspot density regardless of the village administrative boundaries.

5. Results

The analysis of hotspots and burn scars indicates a trend of declining incidence of fire over the years 2013–2017, with at least 90%

Table 5
Hotspots in study villages from 2013 to 2017.

Villages	Fire incidents (MODIS 1 km resolution)					
	2013	2014	2015	2016	2017	Total
FFV program villages						
Sering	8	0	0	0	0	8
Kuala Tolam	0	5	0	0	0	5
Kuala Panduk	6	8	0	0	0	14
Teluk Binjai	1	1	0	0	0	2
Teluk Meranti	46	42	15	0	0	103
Segamai	1	0	3	3	4	11
Non-program villages						
Benteng Hilir	0	35	0	0	0	35
Kerumutan	9	1	9	0	0	19
Lalang Kabung	0	1	0	0	0	1
Mak Teduh	2	0	0	0	0	2
Pangkalan Terap	4	11	1	0	0	16
Segati	67	6	20	0	0	93

reduction of hotspot and burnt area in 2016 (Tables 5 and 6, and Fig. 1). These trends apply both to the program and non-program villages. During 2015, the program villages experienced 40% less fires, while in non-program villages, there were 23% more fires. These figures suggest that the program had some positive effect during its first year. The data have some limitations as the actual village territory or the area controlled by the community may not match the boundaries provided by the Central Statistics Agency. The fire incidents recorded by the different sources do not exactly align, reflecting the limitations of using hotspot data to measure fire occurrence as well as the discrepancies between the different methods. Despite these differences, most of the data indicate a steady decline in fires until and including 2015, the first year of the FFV Program.

The results from the interviews confirm the trend of declining burning with the main determinant of stopping burning was the awareness of the legal consequences of burning. The results from the village-level focus group discussions (Table 7) and individual interviews (Table 8) reveal that respondents saw that legal awareness, either before or after the Presidential Instruction, as the main reason for ceasing burning. This is evident through another 50% of program villages citing fear of prosecution as a reason (Table 7, Column e). Although 50% of villages cited the Presidential Instruction No. 11/2015 (Table 7, Column a) as the main reason for stopping burning, another 58% cited fire bans in place prior to 2016 (Table 7, Column b) as a reason for stopping burning. The pre-2016 fire ban (Table 7, Column b) refers to the initiative of the local police that issued a local instruction detailing the illegality of burning in 2014 (Maklumat Kapolda Riau Nomor MAK/1/III/2014). This instruction was then disseminated by APRIL as part of the FFV Program (Table 7, Column d), with the support of the police, in both the program and non-program villages, which highlighted the illegality of burning as stated in the Law No. 32/2009 on Environmental Protection and Management. Some of these information dissemination activities took place in May 2015 (Klikriau.com 2015). All of the villages stated that the effective dissemination of information regarding burning was a reason for stopping burning.

Among the program villages, 50% specifically cited the FFV Program as being a reason for stopping burning, which referred to both the incentive component and dissemination of information about the legal consequences of burning (Table 7, Column c). Around 33% of villages stated that prior understanding of the impacts of fires, particularly negative health impacts, was one of the main drivers of the shift of behavior from burning to non-burning (Table 7, Column f). Other reasons (Table 7, Column g), such as shortages of available land and fear of fire spreading to adjacent land, were cited as reasons of stopping burning by 33% of the program and non-program villages. Although none of the villages admitted that burning is still practiced (Table 7, Column h), one of the possible reasons is the fear of prosecution, as Table 5 shows that fires occurred in both FFV Program and non-program villages in 2016 and 2017. The reasons for the persistence of burning in some places should be studied further.

The same rationale for not burning was even more strongly expressed in the individual interviews. About 63% of the overall number

Table 6
Burnt area in study villages from 2013 to 2017.

Villages		Burnt Area (MODIS 500 m resolution)					
		2013	2014	2015	2016	2017	Total
FFV program villages							
Sering	Ha	641	0	0	0	0	641
	% of village area	7.19%	0.00%	0.00%	0.00%	0.00%	
Kuala Tolam	Ha	411	45	0	48	24	528
	% of village area	1.27%	0.14%	0.00%	0.15%	0.07%	
Kuala Panduk	Ha	402	37	233	0	0	672
	% of village area	1.70%	0.16%	0.98%	0.00%	0.00%	
Teluk Binjai	Ha	68	167	0	0	0	235
	% of village area	0.14%	0.35%	0.00%	0.00%	0.00%	
Teluk Meranti	Ha	4100	573	579	24	24	5300
	% of village area	2.58%	0.36%	0.36%	0.02%	0.02%	
Segamai	Ha	235	684	98	0	0	1017
	% of village area	5.21%	15.17%	2.17%	0.00%	0.00%	
Non-program villages							
Benteng Hilir	Ha	0	0	0	0	0	0
	% of village area	0.00%	0.00%	0.00%	0.00%	0.00%	
Kerumutan	Ha	957	214	967	0	24	2162
	% of village area	2.19%	0.49%	2.21%	0.00%	0.05%	
Lalang Kabung	Ha	113	0	0	0	0	113
	% of village area	1.57%	0.00%	0.00%	0.00%	0.00%	
Mak Teduh	Ha	524	0	19	48	0	590
	% of village area	1.66%	0.00%	0.06%	0.15%	0.00%	
Pangkalan Terap	Ha	1522	119	0	24	0	1665
	% of village area	5.78%	0.45%	0.00%	0.09%	0.00%	
Segati	Ha	4548	429	902	129	0	6009
	% of village area	6.03%	0.57%	1.20%	0.17%	0.00%	

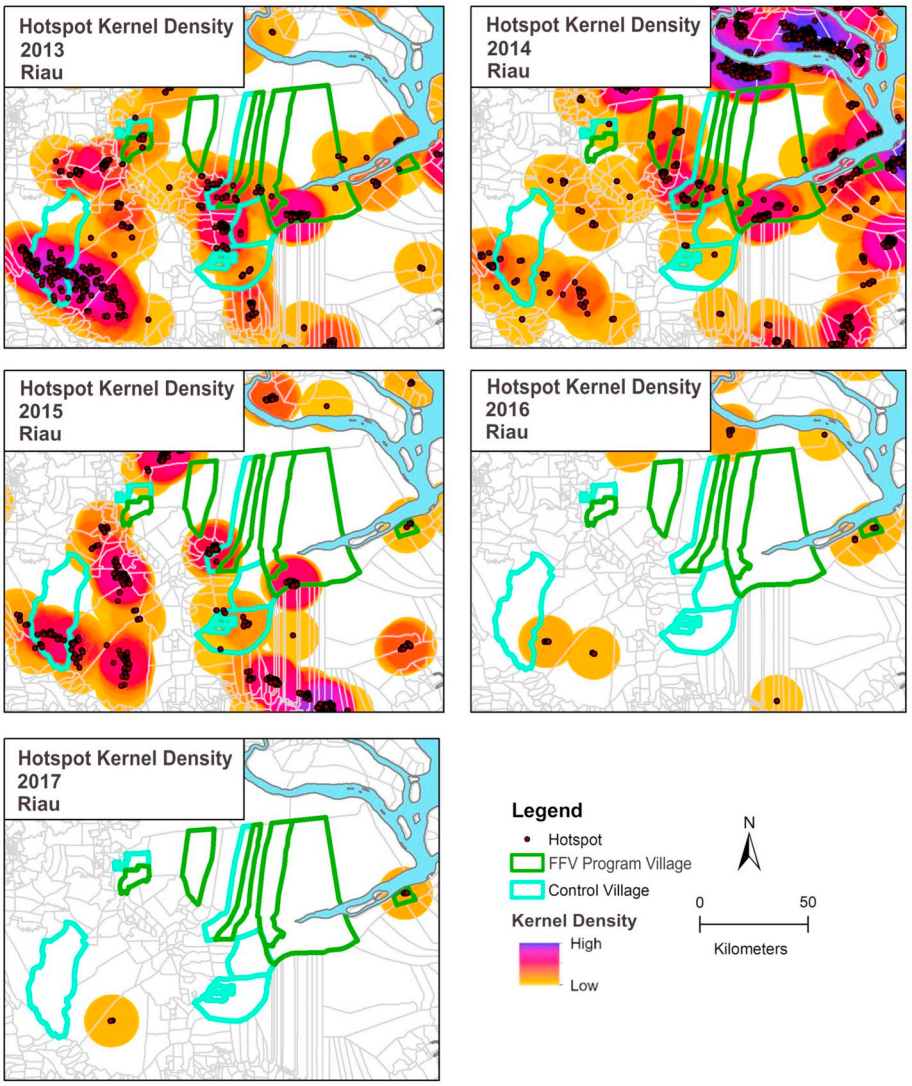

Fig. 1. Hotspot (MODIS) density in program and non-program villages in 2013–2017.

Table 7
Reasons for no longer burning discussed in village focus groups.

Village	Reasons							
	Fire ban (2016)	Fire ban (before 2016)	FFV program (APRIL or ASIAN AGRI)	Effective socialization	Fear of prosecution	Understanding of negative impacts of fires	Other	Still burning
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
FFV program villages								
Sering	x	x	x	x	x			
Kuala Tolam	x		x	x		x		
Kuala Panduk		x	x	x		x	x	
Teluk Binjai		x		x	x		x	
Teluk Meranti		x		x		x		
Segamai	x			x	x			
Total count	3 (50%)	4 (67%)	3 (50%)	6 (100%)	3 (50%)	3 (50%)	2 (33%)	0
Non-program villages								
Benteng Hilir		x		x			x	
Lalang Kabung		x		x	x			
Kerumutan		x		x				
Mak Teduh	x			x		x		
Pangkalan Terap	x			x			x	
Segati	x			x				
Total count	3 (50%)	3 (50%)	0	6 (100%)	1 (17%)	1 (17%)	2 (33%)	0
Overall count	6 (50%)	7(58%)	3 (25%)	12 (100%)	4 (33%)	4 (33%)	4 (33%)	0

Table 8
Reasons for stopping burning (respondents in individual interviews).

Village	Reasons							
	Fire ban (2016)	Fire ban (before 2016)	FFV program (APRIL or ASIAN AGRI)	Effective socialization	Fear of prosecution	Understanding of negative impacts of fires	Other	Still burning
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
FFV program villages (n = 30)								
Sering	0	3	2	1	0	2	1	0
Kuala Tolam	3	2	1	3	0	1	0	0
Kuala Panduk	1	4	2	1	2	1	0	0
Teluk Binjai	1	4	1	0	1	0	0	0
Teluk Meranti	0	5	0	0	4	0	0	0
Segamai	0	5	0	1	2	0	0	0
Total count	5 (17%)	23 (77%)	6 (20%)	6 (20%)	9 (37%)	4 (13%)	1 (0.3%)	0
Non-program villages (n = 30)								
Benteng Hilir	0	3	0	2	0	0	2	0
Lalang Kabung	0	2	1	4	2	0	1	0
Kerumutan	2	3	0	3	2	0	0	0
Mak Teduh	3	1	2	0	0	1	2	0
Pangkalan Terap	2	3	1	2	0	0	0	0
Segati	1	3	0	0	2	0	0	1
Total count	8 (27%)	15 (50%)	4 (13%)	11 (37%)	6 (20%)	1 (0.3%)	5 (17%)	1 (0.3%)
Overall count	13 (22%)	38 (63%)	10 (17%)	17 (28%)	15 (25%)	5 (8%)	6 (10%)	1 (0.15%)

of respondents indicated that the fire ban prior to 2016 was the main reason for stopping burning (Table 8, Column b). In program villages, this figure was even higher at 77% and in non-program villages, 50% of respondents cited it as a reason. Fewer respondents cited the ban enforced in 2016 as a reason for stopping burning, with only 17% of respondents in the program villages and 27% of respondents in the non-program villages (Table 8, Column a). This reflects the trend described in the focus group discussions where people described stopping burning either prior or during 2015 as a result of the fire ban. This is related to the issuance of the local instruction banning burning that was disseminated by APRIL as part of the FFV Program, with the support of the police, in both the target and non-program villages. In contrast to the focus group discussions, only 20% of respondents in the program villages cited the FFV Program as the specific reason for stopping burning, although this referred to both the incentive and legal compliance components (Table 8, Column c).

During the focus group discussions and individual interviews, respondents described several pathways for adjusting to the restrictions imposed on the use of fire for agricultural purposes. The most typical response of farmers was to shift to plantation crops such as oil palm and rubber (Tables 9 and 10). In the focus group discussions, 75% of the villages described a trend where they moved to plantation crops prior to 2016, while another 33% of villages shifted to other crops in 2016 or after (Table 9, Column b and c). Another 42% described adapting to the fire ban by shifting to non-farming livelihoods, including fishing, trade and labor (Table 9, Column d). Finally, 83% stated that they continued to farm the same crops, including plantation crops, without burning (Table 9, Column a). None of the respondents stated that there was no effect from stopping burning. In all of the program and study villages at the time of the interviews, people farmed either oil palm (50%) or rubber (23%) or both (Table 12). Alternative livelihoods included fishing (12%), labor (< 17%), business (5%) or the civil service (8%) (Table 11). The cultivation of staple crops, such as rice and corn, which were formerly farmed in swidden systems, only represented < 1% of

Table 9
Effects of stopping burning (focus groups).

Village	Effects				
	Farming the same crops, but no longer burning	Shifted to plantation/agroforestry crops	Shifted to plantation/agroforestry crops (Pre-2016)	Shifted to other livelihoods	No effects
	(a)	(b)	(c)	(d)	
FFV program villages					
Sering	X		X		
Kuala Tolam	X		X		
Kuala Panduk	X		X	X	
Teluk Binjai		X	X	X	
Teluk Meranti			X		
Segamai	X	X		X	
Total count	4 (67%)	2 (33%)	5 (83%)	3 (50%)	0
Non-program villages					
Benteng Hilir	X		X		
Lalang Kabung	X		X		
Kerumutan	X		X	X	
Mak Teduh	X		X		
Pangkalan Terap	X	X		X	
Segati	X	X			
Total count	6 (100%)	2 (33%)	4 (67%)	2 (33%)	0
Overall count	10 (83%)	4 (33%)	9 (75%)	5 (42%)	0

Table 10
Effects of stopping burning (individual interviews).

Village	Effects				
	Farming the same crops, but no longer burning	Shifted to plantation/agroforestry crops	Shifted to plantation/agroforestry crops (Pre-2016)	Shifted to other livelihoods	No effects
	(a)	(b)	(c)	(d)	
FFV program villages					
Sering	1	1	2	0	1
Kuala Tolam	0	0	5	0	1
Kuala Panduk	2	1	2	1	0
Teluk Binjai	0	1	3	0	0
Teluk Meranti	0	0	3	1	0
Segamai	0	0	3	0	0
Total count	3 (10%)	3 (10%)	18 (60%)	2 (7%)	2 (7%)
Non-program villages					
Benteng Hilir	3	2	1	3	0
Lalang Kabung	5	0	0	0	0
Kerumutan	1	2	3	0	1
Mak Teduh	2	1	3	0	1
Pangkalan Terap	0	3	1	2	0
Segati	0	0	1	0	2
Total count	11 (37%)	8 (27%)	9 (30%)	5 (17%)	4 (13%)
Overall count	14 (23%)	11 (18%)	27 (45%)	7 (12%)	6 (10%)

the livelihoods in the villages at the time of the focus group discussions.

Land-use transitions away from swidden agriculture supported reductions in burning generally and were relatively marked (rapid) in FFV program villages. Among four of the six program villages, the transition from swidden farming generally occurred between 2014 until 2016 (Table 13, Column a and f), mainly due to information dissemination on the illegality of burning. Rice and maize fields in these villages were generally replaced with oil palm and rubber (Table 13, Column d and i). In two of the program villages, farmers continue to cultivate either rice or maize but not as extensively as before. In the village of Segamai, the reason for stopping burning was the prosecution of a farmer for burning in the village as a result of the stricter prohibitions on burning after 2015 (Table 13, Column h). Among the non-program villages, around 50% of the respondents described a transition of swidden rice farming to oil palm, starting around the year 1993 in one village and the year 2000 in two others (Table 13, Column a, f, d and i). Rice farming only continued in one of the villages, Mak Teduh, although burning ceased in 2016 as a result of the ban. Maize farming has been more persistent, although in smaller percentages and, according to the respondents, without burning.

In general, the reasons for ceasing burning were largely motivated by legal awareness and fear of prosecution, supported by a broader transition to oil palm and rubber across the landscape. Despite the lack of attribution of the FFV Program as a reason for ceasing burning, most respondents in the focus group discussions described the incentives as having benefits for the village. The majority saw the benefits of the program as being through improved public infrastructure and amenities, such as roads, public markets and mosques (67%) (Table 14, Column b), while others cited improved governance (33%) and improved village government infrastructure, such as village administration offices (17%) (Table 14, Column a and c). Only one of the villages described the shift to mechanical land clearing methods as a benefit of the program (Table 14, Column e). From the individual interviews, 47% of people saw no direct benefits to themselves (Table 15, Column e), while 30% highlighted improved public infrastructure as a benefit (Table 15, Column b), with few other benefits cited. No respondents mentioned that “no fires” was considered as a benefit. This may reflect their interpretation of the question as referring only to how the

Table 11
Current livelihoods of communities (as estimated during focus group discussions).

Village	Livelihoods					
	Farming	Fishing	Livestock	Trade/Labor	Entrepreneur	Civil service
FFV program villages						
Sering	25%	30%	5%	20%	0%	20%
Kuala Tolam	80%	10%	0%	10%	0%	0%
Kuala Panduk	85%	10%	0%	0%	5%	0%
Teluk Binjai	50%	10%	0%	40%	0%	0%
Teluk Meranti	70%	30%	0%	0%	10%	0%
Segamai	70%	10%	0%	0%	0%	20%
Total percentage	63%	17%	0.8%	12%	3%	7%
Non-program villages						
Benteng Hilir	55%	1%	0%	15%	0%	30%
Lalang Kabung	25%	< 1%	< 1%	95%	0%	< 1%
Kerumutan	80%	0%	0%	7%	7%	7%
Mak Teduh	90%	70%	0%	5%	0%	0%
Pangkalan Terap	78%	15%	0%	0%	25%	8%
Segati	90%	0%	0%	< 1%	5%	5%
Total percentage	68%	7%	< 0.2%	< 21%	6%	9%
Overall percentage	66%	12%	0.5%	< 17%	5%	8%

Table 12
Crops currently planted by farmers (as estimated during focus group discussions).

Village	Livelihoods						
	Oil Palm	Rubber	Coconut	Vegetables (e.g. Chilies)	Corn	Rice	Fruit (e.g. Pineapple)
FFV program villages							
Sering	20%	0%	0%	0%	0%	3%	2%
Kuala Tolam	64%	16%	0%	0%	0%	0%	0%
Kuala Panduk	60%	85%	0%	0%	0%	0%	0%
Teluk Binjai	50%	0%	0%	0%	0%	0%	0%
Teluk Meranti	56%	14%	0%	0%	0%	0%	0%
Segamai	42%	7%	21%	0%	< 1%	0%	0%
Total percentage	49%	20%	4%	0%	< 0.2%	0.5%	0.3%
Non-program villages							
Benteng Hilir	50%	0%	0%	0%	< 1%	0%	5%
Lalang Kabung	25%	0%	0%	0%	< 1%	0%	0%
Kerumutan	64%	16%	0%	0%	< 1%	0%	0%
Mak Teduh	90%	40%	0%	0%	2%	5%	0%
Pangkalan Terap	8%	70%	0%	0%	0%	0%	0%
Segati	63%	27%	0%	0%	0%	0%	0%
Total percentage	50%	26%	0%	0%	< 0.8%	0.8%	0.8%
Overall percentage	50%	23%	2%	0%	< 0.5%	0.7%	0.6%

incentives provided by the scheme were used rather than the benefits to the community in general.

6. Discussion

The results of the study indicate that the incentive component of the Fire Free Village Program had an effect other than just inducing a voluntary behavior, in this case restricting the use of fire. Rather, the incentives were introduced as part of a comprehensive, private sector program that also included disseminating information about the laws governing burning and the legal consequences of non-compliance. Or, more simply, part of a program that included rewards and described potential sanctions for non-compliance. The dissemination of information on the sanctions for non-compliance also involved cooperation with the local government as well as representatives from law enforcement agencies. As this information dissemination process occurred in both the program and some of the non-program villages during 2015, it reduced some of the expected differences between the program and non-program villages. In general, however, during 2015, the program villages experienced 40% fewer fires, while in non-program villages, there were 23% more fires.

Compliance with these laws, however, did not occur in isolation. Respondents described a transition from swidden subsistence crops to plantation crops, in particular oil palm and rubber as well as non-farming livelihoods. In general, farmers in the villages were either cultivating alternative crops on separate plots or were in villages that already were cultivating these crops, simplifying the transition to permanent crops when the fire bans were implemented. Many of these changes occurred prior to the Presidential Instruction issued late in 2015 and reflect broader regional changes (Clough et al. 2016; Rogers 2016). The issuance of this regulation cemented the trajectory that had begun several years before.

The study consequently does not either present a simple case study for the effectiveness of voluntary incentives nor the effectiveness of strict compliance regimes. The inception of the program either coincided or was preceded by information dissemination of the illegality of burning. The intention of the program was to restrict burning during a nominated burning season (July – September). In some situations, however, the information was disseminated in the presence of the police, who presented the program as a strict ban and highlighted the severity of the consequences of non-compliance (Klikriau.com 2015). Although the local interpretation of the relevant laws was fairly strict, and supported by a local police department decree, the underlying national laws at the time allowed some burning by smallholders. Consequently, despite there being the potential for the program to incentivize voluntary changes in practices and behaviors prior to 2016, many respondents understood it as a strict fire ban. These results confirm the conclusions of other studies that have demonstrated that the influence of state actors, in particular bureaucracies, in the implementation of voluntary and market-based schemes cannot be ignored (Giessen et al. 2016; Giessen and Sahide 2017; Krott et al. 2014). Consequently, although private sector actors may prefer voluntary or market-based instruments to achieve positive environmental outcomes, collaboration with state actors and bureaucrats may produce unintended results.

The fire ban is, for the most part, accelerating the existing smallholder transition from swidden farming and other livelihoods to oil palm and rubber (Cacho et al. 2014; Clough et al. 2016; Potter and Badcock 2004). With the issuance of the local government instruction banning fire in 2014, followed by the Presidential Instruction in late 2015, bans on the use of fire became strictly enforced at the local level, leading to changes in livelihoods and land uses. Awareness programs, followed by actual prosecutions were the motivating factors in most villages. These transitions could be summarized as follows. Where farmers had access to alternative land uses or livelihoods, they intensified these activities, such as replacing maize and rice with oil palm. Where farmers had no viable alternative, they continued farming without burning or burning covertly and not reporting it. The patterns found in the study sites reflect the trends reported in other recent research in Sumatra, indicating a more systematic trend across the island (Rohadi 2017). Although most of the farmers interviewed seemed able to adapt to the fire bans, the consequence of these adaptation strategies was replacing staple food crops with cash crops. Whether this affects food security in the present or future was not addressed as part of this study, although in one village, respondents reported now having to rely on subsidized rice or purchasing rice from the market as a result of the changes in farming.

Consequently, replicating the program or similar incentive instruments across Indonesia should be considered carefully. Although Indonesia has not experienced an El Niño event since that of 2015, the strictly interpreted Presidential Instruction remains in force. Similarly, the particular land use dynamics and drivers of deforestation found in Riau province are not consistently found throughout Indonesia (Abood et al. 2015; Bong et al. 2016; Praputra et al. 2016). Transitions to independent, smallholder oil palm production systems are contingent on a range of factors, most importantly, is access to a mill (Byerlee et al. 2016; Corley and Tinker 2016). Rubber farmers are constrained by their access to processing facilities although rubber can travel further

Table 13
Transitions from swidden agriculture.

Village	Rice (Swidden)					Maize (Swidden)				
	Year stopped farming	Villagers affected	Reason	Alternative crops	Continuing farming without burning	Year stopped farming	Villagers affected	Reason	Alternative crops	Continuing farming without burning
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)
FFV program villages										
Sering	2013	3%	–	Irrigated rice farming (*sawah*)	Yes	2016	2%	2016 fire ban	Fruits	No
Kuala Tolam	2016	10%	2016 fire ban	Oil palm	No	2016	10%	2016 fire ban	Oil Palm	No
Kuala Panduk	2015	90%	Low quality seedlings	Rubber & oil palm	No	2015	90%	< 2016 fire ban	Rubber & oil palm	No
Teluk Binjai	2014	50%	< 2016 fire ban	Oil palm & other livelihoods	No	2014	25%	< 2016 fire ban	Oil palm & other livelihoods	No
Teluk Meranti	2015	50%	< 2016 fire ban	Oil palm	No	2015	20%	< 2016 fire ban	Oil Palm	No
Segamai	Not farming	–	–	–	–	Still farming	95%	Prosecution case	94%: rubber, oil palm, coconut < 1%: maize (using mech. tools)	Yes
Control villages										
Benteng Hilir	2000	2%	More profitable crops	Rubber & oil palm	No	Still farming	1%	< 2016 fire ban	< 1%: rubber & oil palm, < 1%: maize (using mech. tools)	Yes
Lalang Kabung	1993	100%	More profitable crops	Oil palm	No	Still farming	100%	More profitable crops	> 99%: oil Palm, < 1%: maize	Yes
Kerumutan	2015	1%	Pests	Oil palm	No	Still farming	< 1%	–	< 1%: maize (using mech. tools)	Yes
Mak Teduh	Still farming	70%	2016 fire ban	65%: rubber, oil palm, 5% rice (*sawah*)	Yes	Still farming	2%	–	2%: maize (using mech. tools)	Yes
Pangkalan Terap	2016	100%	2016 fire ban	Rubber, oil palm, other livelihoods	No	Not farming	–	–	–	–
Segati	2000	100%	More profitable crops	Oil palm	No	2000	10%	More profitable crops	Oil Palm	No

Table 14
Benefits of FFV Program for communities (focus groups).

Village	Benefits						
	Improved governance	Improved public infrastructure and amenities	Improved government infrastructure	Better access to education	Supported shift to mechanical land clearing methods	No benefits	Do not know
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Sering	X		X				
Kuala Tolam		X					
Kuala Panduk	X	X		X			
Teluk Binjai						X	
Teluk Meranti		X			X		
Segamai		X					
Total count	2 (33%)	4 (67%)	1 (17%)	1 (17%)	1 (17%)	1 (17%)	0

distances when dried (Belcher et al. 2004). In the absence of the possibility of cultivating palm oil or similar perennial crops, smallholders in other parts of Indonesia would not be able to imitate these land-use adaptations to the burning ban. In the context of this strict regulatory environment, the most effective financial instruments for fire prevention among smallholders and local communities should be measures for assisting farmers to find alternatives to burning. Such assistance bundles could include both alternative crops and cropping methods as well as mechanical alternatives to clearing land. These should be supported through local regulations to simplify the use of mechanical clearing methods in smallholder plots. Other important elements for fire prevention include disseminating information about the negative effects of inappropriate burning, especially in relation to human health, which could be supported by a person in the village who has the responsibility for fire prevention and management, such as the Village Crew Leader.

For Indonesia to achieve its NDC, greenhouse gas emissions from peatland and forest fires must be reduced. As part of its current strategy, the Government of Indonesia records emissions from fire as part of the 59.2% of emissions from land use change (Republic of Indonesia 2017; Wijedasa et al. 2018). The Indonesian government states that these emissions should be mitigated through a landscape approach, including regulatory instruments such as moratoriums on forest clearing and peatland cultivation (Republic of Indonesia 2017). The ban on using burning for land clearing can reduce emissions from deforestation and the degradation of peatland and forests. The unintended consequence, however, may be that diverse forest gardens (Belcher et al. 2005), which form part of swidden systems, are replaced with monocultures of oil palm and rubber, which may potentially increase greenhouse gas emissions while affecting biological diversity (Pfund et al. 2011). The effects of the fire ban on land use and land cover change as well as biological diversity, especially on small-scale farms, should be studied more systematically before assuming that it is an effective instrument for reducing greenhouse gas emissions.

7. Conclusion

Despite the potential for using incentives for inducing positive environmental behaviors in Indonesia, the strict regulatory environment preventing burning means that there is little room for inducing voluntary behavior. From the results of the study, incentives were used as a means for collectively building awareness as well as better understanding regulatory requirements and collective action through providing collective benefits. Program villages performed better than the non-program villages, especially during 2015, the first year of the program and the El Niño year, indicating that the incentive program induced a reduction in burning prior to the implementation of the fire ban. The combination of incentives with a strict regulatory environment, however, accelerated an ongoing transition from swidden agriculture to more profitable crops such as oil palm and rubber.

As the preferred method of the Indonesian government for solving environmental problems increasingly focuses on strict regulatory measures, including bans on peatland use among others, the potential for voluntary incentives is decreasing. Although the ban, supported by incentives, may be effective in reducing the incidence of fire in villages where there are easily accessible alternatives, in places where farmers lack any viable alternatives they may be forced to illegally burn or face hardship. The current regulatory environment also inadvertently accelerates a transition to monocultural landscapes, with effects on biological diversity and food security. As an alternative approach, we propose that incentives could be used to enable farmers to comply with the regulations while reducing the harm caused by changing their existing livelihoods.

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Table 15
Benefits of FFV Program for individuals (individual interviews).

Village	Benefits						
	Improved government infrastructure	Improved public infrastructure and amenities	Built or improved infrastructure or amenities for certain groups	Improved livelihoods	No benefits	Disadvantaging Individuals	Do not know
	(a)	(b)	(c)	(d)	(e)	(f)	(g)
Sering	20%	0%	0%	0%	60%	20%	0%
Kuala Tolam	0%	60%	0%	20%	40%	0%	20%
Kuala Panduk	0%	20%	0%	0%	40%	0%	20%
Teluk Binjai	0%	0%	0%	0%	60%	0%	40%
Teluk Meranti	0%	0%	0%	0%	80%	0%	20%
Segamai	0%	100%	0%	0%	0%	0%	0%
Total percentage	3%	30%	0%	3%	47%	3%	17%

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Appendix A. Land use/cover classes

Table A.1
Equivalency of Land Use/Cover Classes As Observed by the Visual Interpretation of Landsat/SPOT Imagery by Miettinen et al. (2016a) and the Automated MODIS Land-Cover Classification of Miettinen et al. (2016b).

Automated MODIS classification[a]	Visual Landat/SPOT classification
Ocean/water	–
Water	Water
Mangrove	Mangrove
Peatswamp forest	Pristine PSF
Lowland evergreen forest	
Regrowth/plantation	Degraded PSF
Lowland mosaic	Smallholder agriculture
Lowland open	Cleared/burned
Montane open	
Large scale palm plantations	Plantation

[a] The urban and various montane land-cover classes of the automated MODIS classification are omitted here because they were not present in the study villages. For the non-peatland proportion of the study area covered only by the Automated MODIS classification, the classes present in the left-hand column adopted the labels in the right-hand column, for consistency with the remainder of the study area. The full set of classes for the visual Landsat/SPOT classification is listed in Table 4.

Appendix B. Land cover area in target and non-program villages

Table B.1
Area (ha) of land cover in 2015 in target and non-program villages, Riau Province.

Village	Ocean/water	Water	Seasonal water	Pristine peat swamp forest	Degraded peat swamp forest	Tall shrub/secondary peat swamp forest	Fern/low shrub	Smallholder agriculture	Plantation	Cleared/burned	Total area
FFV program villages											
Kuala Tolam	–	450	–	2756.25	6581.25	437.5	937.5	2475	18,631.25	712.5	32,981.25
Segamai	6.25	–	–	–	–	68.75	–	3150	1337.5	–	4562.5
Sering	–	556.25	–	550	1206.25	137.5	–	3756.25	2100	806.25	9112.5
Teluk Meranti	6931.25	1250	1843.75	24,393.75	70,993.75	2218.75	4768.75	6150	39,206.25	2475	160,231.25
Kuala Penduk	–	331.25	206.25	11,718.75	4512.5	–	225	2625	4337.5	37.5	23,993.75
Teluk Binjai	1981.25	75	18.75	25,693.75	10,843.75	543.75	–	3350	6012.5	12.5	48,531.25
Non-program villages											
Lalang Kabung		–	–	–	662.5	325	–	1718.75	3862.5	550	7118.75
Pangkalan Terap		350	337.5	10,868.75	4325	75	150	3393.75	6118.75	618.75	26,237.5
Mak Teduh		–	168.75	11,106.25	6893.75	1693.75	12.5	868.75	10,643.75	56.25	31,443.75
Kerumutan		–	856.25	9587.5	11,343.75	1818.75	512.5	4043.75	13,756.25	1618.75	43,537.5
Segati		–	–	12.5	21,600	–	–	25,825	8956.25	18,887.5	75,281.25
Benteng Hilir		31.25	–	–	868.8	–	–	662.5	2206.25	75	3843.75

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