Impermanence and failure: the legacy of conservation-based payments in Sumatra, Indonesia

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Abstract
Projects that pay communities or individuals to conserve natural areas rarely continue indefinitely. When payments cease, the behaviors they motivate can change. Previous research on conservation-based payments recognizes the impermanence of conservation success, but it does not consider the legacy of payments that failed to effect change. This research assesses impermanence and failure by investigating the legacy of village-level conservation payments made through one of the largest Integrated Conservation and Development Projects in Indonesia. The Kerinci-Seblat Integrated Conservation and Development Project aimed to conserve forest area and promote local development through voluntary conservation agreements (VCAs) that provided payments for pro-conservation pledges and activities from 2000 through 2003. Project documentation and previous research find that payments failed to incentivize additional forest conservation, producing nonsignificant differences in forest-cover change during the project period. To examine the legacy of these payments in the post-project period, this research uses matched difference-in-differences and triple differences models to analyze forest cover change in villages (n = 263) from 2000 through 2016 as well as matched binary logistic regression models to assess enduring differences in household (n = 1303) livelihood strategies within VCA villages in 2016. The analysis finds that VCA villages contained significantly more forest loss than the most similar non-VCA villages outside the national park, and greater payments predict increased forest loss in the post-project period. In addition, farming high-value tree crops and cultivating private land were the most important attributes for modeling VCA affiliation among randomly selected households. These results demonstrate that, after payments ceased, project failures increased in severity over time. Those who design and implement conservation-based payments bear great responsibility to ensure their projects are informed by local voice, align with community preferences, and provide sufficient benefits, lest they result in a conservation legacy of increased failure.

1. Introduction
The widespread conversion of natural habitat and resulting declines in biodiversity demand effective conservation solutions (Gibson et al 2011, Pereira et al 2012, Laurance et al 2014, Haddad et al 2015, Waldron et al 2017, Jones et al 2018, Coleman et al 2019). There is substantial evidence that protected areas (PAs) shelter more land from conversion than the most similar unprotected land (Andam et al 2010, Sims 2010, Nolte et al 2013, Shah and Baylis 2015, Sills and Jones 2018). Despite their relative successes, de facto land management within PAs remains difficult to regulate (Watson et al 2014, Geldmann et al 2019),
and one-third of PAs that seek to exclude people are under intense human pressure (Jones et al 2018). Further, PAs can limit local decision-making and resource rights, making them inappropriate in some situations (Adams et al 2004). Empowering communities to design, implement, and benefit from local conservation is critical to the success of PAs and agendas for sustainable development (Oldekop et al 2016, Erbaugh et al 2020). Some projects seek to improve the efficacy of PAs and support local people by providing economic incentives for pro-conservation activities within or near protected lands (Jack et al 2008, Lambin et al 2014, Börner et al 2017).

Payments for ecosystem services (PES) represent a widespread approach to environmental governance that offers economic incentives for pro-conservation behavior. Billions of dollars in PES are allocated through more than 550 different programs that remunerate groups or individuals in order to protect ecosystem function (Salzman et al 2018). Despite the rapid growth in PES from the 1990s to the present, evidence on how and when payments result in improved ecosystem services remains inconclusive (Fattanayak et al 2010, Brouwer et al 2011, Agrawal et al 2014). The evaluation of PES programs often suffers from a lack of baseline data and insufficient counterfactual analysis (Agrawal 2014, Ferraro and Hanauer 2014, Ferraro et al 2015). Recent studies address these shortcomings, providing better evidence that PES can generate additional conservation during or soon after payments were made (Jayachandran et al 2017, Havinga et al 2020). Assessing the conservation legacies of PES projects, however, remains uncommon.

The conservation legacy of a project refers to its long-term impact in reference to its stated objectives (Miller 2013). Investigating PES projects to better understand their conservation legacies is particularly important, since such payments are deployed extensively and can produce considerable changes in conservation behaviors (Salzman et al 2018, Wunder et al 2018). Introducing payments for conservation may erode the intrinsic motivation of individuals or groups to continue conserving natural habitat or protect ecosystem services (Agrawal et al 2015). ‘Impermanence’ refers to the tendency for conservation outcomes to shift once extrinsic rewards cease (Engel et al 2008, Wunder et al 2008). Some empirical research examines the impermanence of positive conservation outcomes from PES (Andersson et al 2018), but few if any studies evaluate outcomes after payments fail to incentivize conservation.

Studying conservation failures and their legacies promises to better inform the design and implementation of conservation governance. Connecting where, when, and why conservation projects failed to meet their stated objectives can provide useful information on the design and implementation of conservation projects (Catalano et al 2019). Analyzing how the impacts from projects that failed to meet their objectives persist or change over time can provide information useful for when conservation researchers, practitioners, and donors want to weigh the long-term risks and benefits of intervention. This research assesses the legacy of conservation-based payments made through one of Indonesia’s largest integrated conservation and development projects that failed to reduce local forest cover change.

### 1.1. The Kerinci-Seblat integrated conservation and development project

The Kerinci-Seblat National Park (KSNP) anchors the study area for this research. This research examines forest cover and livelihoods in the national park and villages within 3 km of its border. In total, the park and its surrounding villages span four provinces, 15 districts (kabupaten/kota), and cover nearly 26 000 km². The park and villages adjacent to it are approximately equal in area to the nation of Burundi. Though the history of conservation in the Kerinci-Seblat landscape begins nearly a century ago (Aumeeruddy 1994), KSNP was formed primarily during the last three decades.

The Government of Indonesia declared Kerinci-Seblat a national park in 1982 (Minister of Agriculture Decree No. 736/Mentan/X/1982). The newly declared park combined 15 conservation areas, adding approximately 100 000 additional hectares (Bettinger 2015). Despite several disputes concerning the park boundary, the Ministry of Forestry and sub-national governments agreed to an official boundary in 1993 (Wibowo 1999). However, the KSNP boundary was not officially mapped or marked by physical objects until 2000. This undertaking was made possible with funding from the Kerinci-Seblat Integrated Conservation and Development Project (KS-ICDP) (World Bank 2003).

The KS-ICDP began in 1996 and ceased activities in 2003 (World Bank 2003). It allocated $18.8 million for three objectives: (a) mapping and formally establishing park boundaries; (b) improving park management and service delivery; and (c) promoting sustainable development in forest proximate communities (World Bank 1996). This research focuses on the KS-ICDP’s third objective. Specifically, it investigates the legacy of voluntary conservation agreements (VCAs), which sought to promote forest conservation in the Kerinci-Seblat landscape by providing conservation-based payments to nearby villages (figure 1).

VCAs implemented through the KS-ICDP aimed to reduce forest cover loss by providing results-based payments at the village-level. The agreements stipulated that village members would cease all deforestation and forest degradation and implement a number of sustainable livelihood initiatives with village-level funding from the project (World Bank 1996, 2003, Wood et al 2014). Trained local facilitators wrote VCAs in collaboration with village councils.
Figure 1. Kerinci-Seblat National Park with potential and actual VCA villages (IUCN 2016). Potential VCA villages are those with land within 3 km of the national park boundary.

and village heads to select locally appropriate activities. Once drafted, local authorities signed the VCA. According to standards for the project facilitation, all of the adults in a village where authorities signed a VCA were aware of how the agreement was drafted and what it stipulated (Wood et al. 2014). Of the 234 villages available for selection in the KSNP landscape, and the 134 villages in the ‘park buffer zone,’ project managers and the Indonesian Government selected 75 villages (Linkie et al. 2008). The 72 villages that agreed to sign a VCA were promised approximately $25 000 in development grant money ($34 069.10 AFI) for fulfilling the terms of the agreement. Upon signing the VCA, villages were to receive the initial grant disbursement ($12 500), with the second tranche of funding disbursed upon the initiation of pro-conservation livelihood activities. However, payment schedules were delayed by unforeseen bureaucratic challenges. Sixty-four percent of villages advanced to the second stage of payments (World Bank 2003, p 23). Records from the facilitating organization, the World Wildlife Fund (WWF) indicate 43% (n = 31) of villages that signed a VCA received half of the total payment or less, 8% (n = 6) received more than 50% but less than 95% of the total payment, and 49% (n = 35) of villages received over 95% of the total payment (SM table 1.1 available online at stacks.iop.org/ERL/17/054015/mmedia).

Project documentation and peer-reviewed literature conclude that VCAs did not generate additional forest conservation. Infrastructure development and smallholder agriculture were the primary drivers of forest-cover loss in the Kerinci-Seblat landscape during and after the VCA project (Linkie et al. 2003, 2004, Bettinger 2014, 2015). An early example in the conservation literature of counterfactual analysis estimated with statistical matching measured forestcover before and during the VCA implementation (2000–2003). It found no significant differences in forestcover loss between VCA and the most similar non-VCA villages and concludes VCAs failed to conserve additional forest area (Linkie et al. 2008).

Project documentation echoes the narrative of failure, identifying bureaucratic hurdles and a short project timeframe as primary drivers (World Bank 2003). Four years after project activities ceased, however, a purposive survey of 12 VCA villages reported

1 At the time of project implementation, the survey of ‘villages’ in the KSNP landscape included administrative units that varied by province. These units were desa in Jambi, Bengkulu, and South Sumatra Provinces, and jorong in West Sumatra (as opposed to nagari). See supplemental materials (SM 1) for further information.
that households continued to implement 43% of the pro-conservation livelihood activities stipulated in the agreement (Wood et al 2014). Though the purposeful survey research neither reports population-level outcomes nor considers the relationship between pro-conservation activities and forest cover change, it raises questions about how conservation failures might change over time. The research presented here investigates the impermanence of conservation outcomes, drawing on a suite of quantitative methods to assess differences between VCA and non-VCA villages after VCA activities ceased.

2. Methods

This research employs a ‘portfolio approach’ to assess forest cover change and livelihood strategies in and around KSNP (Young et al 2006). Portfolio approaches combine multiple data and analyses to strengthen support for conclusions. When findings from multiple analyses in a portfolio approach converge, they provide greater confidence in the findings and support for a conclusion; when they diverge, they provide greater insight but decreased support for any one conclusion. The portfolio for this research incorporates two analyses. A forest cover analysis considers the average impact of VCA participation and payment on forest cover loss in the post-project period; a livelihood analysis examines enduring associations between household livelihood strategies and VCA participation.

The forest cover analysis and the livelihood analysis operationalize information gathered from project leaders, reports, and previous literature. Former project staff and the lead author identified villages that signed VCAs and linked them to village-level boundaries from the Village Master File 2000 provided by the Central Bureau of Statistics (Badan Pusat Statistik) (BPS 2015). Additional information on the village identification process is available in the supplemental materials (SM 1). Project materials and previous literature identified the variables that determined selection of VCA villages. These variables include village area dedicated to timber or agricultural concession, accessibility, slope, and population in the year 2000 (World Bank 1996, 2003, Linkie et al 2008). To measure these variables in VCA as well as non-VCA villages, this research generates a dataset from public and proprietary data sources (table 1). Statistical matching balances these variables across VCA and non-VCA villages to account for selection bias that may impact forest cover or livelihood outcomes. Estimates from the forest cover analysis and the livelihood analysis were further adjusted using a set of time-sensitive or confounding variables that did not determine VCA selection, but had the potential to impact the dependent variable.

The forest cover analysis measures differences in post-project forest cover loss between VCA and non-VCA villages. Data for this analysis are the result of processing remotely sensed land cover products to provide annual data on forest cover for the Kerinci-Seblat landscape from 2000 to 2016. This analysis builds on the findings from previous literature, which establishes parallel trends in forest cover change between VCA and non-VCA villages before the year 2000 (Linkie et al 2008). A suite of difference-in-differences (DD) and triple differences (DDD) models estimate the average effect of treatment on treated (ATT) units. In the context of the forest cover analysis, treatment refers to VCA participation and the effect of interest is forest cover loss. Thus, the forest cover analysis investigates if VCA villages continued to demonstrate non-significant differences in forest cover loss after the KS-ICDP project ended using DD models that incorporate key covariates as well as two-way fixed effects (Angrist and Pischke 2009), multiple matching strategies (Ho et al 2007, lacus et al 2008, Stuart 2010, King and Nielsen 2016), and alternative assumptions for treatment timing (Callaway and Sant’Anna 2020, de Chaisemartin and d’Haultfœuille 2020). To better understand heterogeneous impacts from the VCA program, the analysis of forest cover also measures differences in forest cover loss between VCA villages that received full payment and those that did not using DDD models (Cunningham 2021). Further information on the form of these models, the analytical approach, and robustness checks are available in the supplemental materials (SM 2.1).

The livelihood analysis measures enduring differences in livelihood strategies between households within a subset of VCA and non-VCA villages based on cross-sectional survey data. The subset of VCA and non-VCA villages were drawn from three districts (Kerinci, Sungai Penuh, and Merangin) in Jambi Province during 2016, the final post-project year included in the forest cover analysis. The three selected districts contain some of the greatest amounts of forest cover and National Park area in the Kerinci-Seblat landscape. Households in villages within 3 km of the National Park were selected via a random stratified cluster sample. Matched binary regression models evaluate if randomly selected households that report participating in forest intensive livelihood strategies are more or less likely to reside in VCA villages (Wooldridge 2002, lacus et al 2008). Further elaboration of the models, analytical approach, and robustness checks are available in the supplemental materials (SM 2.2). The supplemental materials also include complete information on all elements of the sampling design (SM 3). For the livelihood analysis as well as the forest cover analysis, the lead author cleaned and modeled all data using R software and produced all visualizations with R and ArcGIS.

Together, the two analyses measure the primary objective of the VCA program and the mechanism of change it aimed to influence. The forest
Table 1. Model variables organized by analysis.

| Variable | Treatment information | Data source |
|----------|------------------------|-------------|
| Forest cover analysis (2000–2016) | Forestcover change<sup>a</sup> Identified tree-cover change in KSNP and outside of KSNP within forest (i.e. not plantation) area, converted pixels to hectares | Hansen et al (2013), Margono et al (2014) |
| VCA status<sup>b</sup> | Household identified as within VCA or non-VCA village; total VCA payment made | Project documents, BPS (2014) (see SM 1) |
| Primary forest<sup>c</sup> (2000) | Measured within villages, converted to hectares | Margono et al (2014) |
| Elevation<sup>c</sup> | Meters | Jarvis et al (2008) |
| Non-forest area (2000) | Total ha of non-forest area within 3 km of the national park boundary | Hansen et al (2013), Margono et al (2014) |
| Slope<sup>c</sup> | Calculated total area of village over 10% slope, following Blackman et al (2017) | Processed in ArcGIS 10.6.1 from Jarvis et al (2008) |
| Concession area<sup>c</sup> | Combined oil palm, timber, and selective logging concession area | Global Forest Watch (2014a, 2014b, 2014c) |
| Distance to roads<sup>c,d</sup> | Estimated temporal trends using road data from 2000 and 2016 (interval periods not available) | CIESIN (2013), Badan Informasi Geospasial (2014) |
| Population (1 km estimates)<sup>c,d</sup> | Calculated within villages | CIESIN (2018) |
| Livelihood analysis (2016) VCA status<sup>d</sup> | Household identified as within VCA or non-VCA village | Project documents, BPS (2014) (see SM 1) |
| Primary crop<sup>b</sup> | Combined into: high-value tree crops, rice, tubers, other | Primary survey (see SM 3) |
| Private land<sup>b</sup> | Dichotomous (1 = cultivates private land) | Primary survey |
| Formal land title<sup>b</sup> | Dichotomous (1 = holds formal title) | Primary survey |
| Elevation<sup>c,d</sup> | Meters | Jarvis et al (2008) |
| Distance to KSNP<sup>c,d</sup> | Euclidean distance in meters | Processed from primary survey and IUCN (2016) |
| Distance to concession area<sup>c,d</sup> | Euclidean distance in meters | Processed from primary survey and MEF (2017) |
| Total yearly income<sup>d</sup> | Logged in rupiah | Primary survey |
| Sex of household head (HHH)<sup>d</sup> | Dichotomous (1 = female HHH) | Primary survey |
| Age of HHH<sup>d</sup> | Years | Primary survey |
| Years of education<sup>d</sup> | Years | Primary survey |

<sup>a</sup> Dependent variable.
<sup>b</sup> Independent variable of interest.
<sup>c</sup> Matching variable.
<sup>d</sup> Model covariate.

Cover analysis evaluates the legacy of forest-cover change in VCA villages. The livelihood analysis considers enduring differences in household livelihood strategies between VCA and non-VCA villages. If the analysis of forest cover and the analysis of livelihoods find significant and complementary results concerning the impermanence of project outcomes, they support a conclusion concerning the conservation legacy of VCAs. However, if the analyses are non-significant or in contrast, they either support a narrative of non-significant project legacy or temper any analytical conclusions about the project’s conservation legacy. Table 2 summarizes the complementarity of these analyses.

3. Results

VCA villages demonstrated a significant increase in long-term forest loss outside KSNP and non-significant differences in forestcover loss within KSNP. Average forestcover loss over time illustrates rising forestcover loss throughout the post-project period (figure 2). After adjusting for VCA selection criteria, time-varying covariates, as well as year and village fixed effects, the analysis of forest cover supports the conclusion that non-KSNP forestcover change in VCA villages was greater than the most similar non-VCA villages in the post-project period (figure 3). The ATT for signing a VCA is between...
24.0% ($\beta = 0.214, SE = 0.084$) and 26.4% ($\beta = 0.234, SE = 0.072$) more forestcover loss outside the national park. Measuring this effect by the amount of VCA SE = $0.269, SE = 0.157, SE = 0.068$) to 24.4% ($\beta = 0.19, SE = 0.05) times less likely to be within a VCA village. Though forest intensive livelihood strategies are significantly associated with VCA affiliation, yearly household income was not.

Additional variables that showed some significant association across multiple models include years of HHH education and if a household member claimed a formal property title. One additional year of HHH education increases the odds a household is from a VCA village by 1.01 ($\beta = 0.19, SE = 0.05) and 1.13 ($\beta = 0.12, SE = 0.06) times more likely to be within a VCA village. Though forest intensive livelihood strategies are significantly associated with VCA affiliation, yearly household income was not.

Table 2. The relationship between the forest cover analysis and the livelihood analysis. Significant findings that are complementary provide additional support that analysis findings represent legacy effects from VCA payments. Significant findings that are not complementary provide less support that the findings represent legacy effects from VCA payments.

| Household in VCA villages are: | VCA villages have: |
|--------------------------------|--------------------|
| More likely to report forest intensive livelihood strategies | Complementary results: Increased severity of failure that is more likely related to the VCA mechanism. |
| Less likely to report forest intensive livelihood strategies | Complementary results: Increased severity of failure that is less likely related to the VCA mechanism. |

The DDD and doubly robust staggered treatment estimates of ATT provide additional support to findings from the canonical DD models. The DDD models estimates the ATT for advancing to the second payment stage between 64.4% ($\beta = 0.497, SE = 0.135$) and 79.7% ($\beta = 0.586, SE = 0.170$) more forestcover loss compared to VCA villages that did not advance. Villages that defected from the project after the first round were non-significantly different from the most similar villages that did not receive VCA payments. The staggered treatment DD model also finds similar differences between second and first stage VCA villages. It estimates the overall ATT as 22.9% ($\beta = 0.206, SE = 0.100$) to 30.8% ($\beta = 0.269, SE = 0.111$). Villages that advanced to the second VCA payment stage drive overall estimates, with a group-wise ATT of between 66.9% ($\beta = 0.512, SE = 0.151$) and 72.8% ($\beta = 0.541, SE = 0.177$), as compared to the most similar non-VCA villages. Villages that received only the first payment demonstrate mixed significance, with two of three matching models estimating they demonstrated 17.3% ($\beta = −0.19, SE = 0.068$) to 24.4% ($\beta = −0.28, SE = 0.102$) less forestcover loss in the post-project period, as compared to non-VCA villages.

Significance, magnitude, and direction of the ATT for models of forestcover outside KSNP are broadly robust to different matching techniques. Non-significance, magnitude, and direction of additional KSNP forestcover loss within VCA villages are also broadly robust to different matching techniques and model specifications. None of the models violated the parallel trends assumption, thus confirming previous research that established non-significant differences between VCA and non-VCA forestcover loss during project implementation (Linkie et al 2008). The supplemental materials provide an extended discussion of matching results and model estimates (SM 4).

The livelihood analysis finds that forest intensive livelihood strategies were the most important variables for predicting if a randomly selected household was from a VCA village (table 3). Specifically, farming high-value tree crops or cultivating privately held land were significant predictors a household resided within a VCA village. Households that farmed high-value tree crops (coffee, cinnamon, oil palm, or rubber) are between 2.18 ($\beta = 0.78, SE = 0.32$) and 3.13 ($\beta = 1.14, SE = 0.27$) times more likely to be in a VCA village, with significant results across all matching strategies. The relationship between cultivating private land and VCA village affiliation is also significant across all matching strategies. Households that reported cultivating private land were between 3.32 ($\beta = 1.20, SE = 0.58$) and 5.06 ($\beta = 1.62, SE = 0.80$) times more likely to be within a VCA village. Though forest intensive livelihood strategies are significantly associated with VCA affiliation, yearly household income was not.
Favoring a conservative interpretation of these models, this article does not discuss findings without broad support from two or more matched estimates at the 95% confidence threshold.

All matched models performed similarly in the livelihood analysis, but outcomes from matching pretreatment differ. AUC values are broadly similar across models, ranging from 0.70 to 0.73. The CEM approach demonstrates the best covariate balance (SM 4) and retained the largest number of households in VCA villages (table 3). The supplemental materials (SM 4) include data on covariate balance from coarsened exact, full, Mahalanobis, and genetic matching. All matching methods improve overall covariate balance, but only CEM retained over 90% of households from VCA villages.

### 4. Discussion

VCA project outcomes in the Kerinci-Seblat landscape were impermanent, and project failures increased in severity during the post-project period. The VCAs made through the KS-ICDP aimed to promote forest conservation within and outside the national park and catalyze local development by disbursing funds for pro-conservation activities. However, VCA villages demonstrated significantly higher levels of long-term forest loss outside KSNP and nonsignificant levels of forest cover change within the national park. In addition, a randomly selected household was more likely to be from a VCA village if it reported farming high-value agricultural commodities on privately cultivated land. These complementary findings point to a conservation legacy in stark contrast to the primary objective of the conservation agreements. This discussion considers why failure occurred during implementation, why it increased in severity following project activities, and the long-term impacts of greater project compliance to provide insights for research on conservation governance.

Focusing on project implementation, in addition to design, is of critical importance for understanding conservation failures. Several ICDPs implemented in different country contexts, but with a similar focus on community participation and local development (Alpert 1996, McShane and Wells 2004), failed to promote conservation within PAs or enhance livelihoods (Garnett et al 2007, Weber et al 2011). ICDPs that achieved conservation successes were defined by timely implementation aided by the ability to work within local institutions and with local governments (Brown 2002).

Bureaucratic delays, problems with disbursing funds, and rigid project timelines inhibited the success of VCAs and their associated payments. Thirty-six percent of villages did not advance to the second payment stage. Unforeseen challenges working with local government to disburse funding delayed payment schedules, and the majority of villages received...
Figure 3. Model estimates of average additional forestcover loss inside (KSNP) and outside (non-KSNP) the national park in the post-treatment period (2003–2016) for VCA villages. Panels visualize the average effect of project participation on forestcover loss (A), the average effect of an additional $10,000 of payment on forestcover loss (B), and the average effect of advancing to the second stage of project payment (C). Values have been calculated from IHS transformed coefficient estimates (SM 3), and all error bars represent 95% confidence intervals.

their first payment in the final year of the project (World Bank 2003; supplemental materials: SM 1). PES provided through the public sector more often run into bureaucratic difficulties, similar to those experienced in the KS-ICDP (Wunder et al. 2008). To successfully integrate conservation and development, projects must work through the multilevel interactions and relationships between local actors, resources, and government organizations (Moore et al. 2018, Hayes et al. 2019, Verde Selva et al. 2020). As this research demonstrates, short-term projects challenged by implementation barriers risk more than failing to ‘do good’ by incentivizing significant improvements in conservation outcomes. They also risk promoting long-term outcomes in opposition to their stated objectives.

VCAs made through the KS-ICDP demonstrate a legacy of increased failure. Previous studies of VCA impacts found no significant differences in national park forestcover within VCA and non-VCA villages (Linkie et al. 2008). After investigating the legacy of VCAs in the post-project period, the research supported previous findings that differences in forestcover loss between VCA and non-VCA villages within the national park were nonsignificant. However, assessing the legacy of VCAs outside of the national park tells a different story. Non-KSNP forestcover loss was between approximately 24.0% and 26.4% higher in VCA villages as compared to the most similar non-VCA villages. The concept of leakage provides some insight for explaining why VCA villages contained higher levels of forestcover loss outside the national park as compared to similar non-VCA villages.

Leakage in conservation refers to when activities trigger resource use or land conversion outside the primary area of focus, thus reducing the overall benefit of the payment (Meyfroidt and Lambin 2008, Ostwald and Henders 2014, Henders et al. 2015, Meyfroidt et al. 2018). Specifically, analyzing PES for leakage determines if payments displaced resource exploitation to a different location. For example, increasing the strictness of forest protection in one location or nation can displace forest cover loss to other locations or nations (Meyfroidt and Lambin 2009, Meyfroidt et al. 2010). Though the results from this research resemble project failure due to leakage, they differ from standard accounts in one important way. The stated objective for implementing VCAs was to conserve all forestcover within VCA villages. In signing the VCAs, village governments pledged to cease all forest clearing. Leakage from implementing VCAs and making payments would see the displacement of forest-cover loss to non-VCA villages. Instead, our findings support the conclusion that non-KSNP forestcover loss increased due to VCA participation. This indicates that behaviors changed within VCA villages to promote forest intensive livelihoods on the periphery of the National Park. It does not indicate that behaviors changed in non-VCA villages.

The results from this research point to forest conversion from smallholder agriculture as a likely driver...
| VCA selection variables                  | Model 1: No matching | Model 2: CEM | Model 3: Mahal. matching | Model 4: full matching | Model 5: genetic matching |
|-----------------------------------------|----------------------|-------------|--------------------------|------------------------|-------------------------|
| Elevation                               | −0.18                | −0.08       | 0.07                     | 0.14                   | 0.05                    |
| Distance to KSNP                        | −0.60                | −0.09       | 0.06                     | −0.10                  | 0.19                    |
| Distance to concession area             | −0.10                | −0.08       | −0.05                    | −0.09                  | −0.04                   |
| Agricultural household                  | 0.47                 | 0.16        | 0.00                     | −0.04                  | 0.06                    |
| Household demographics                  |                      |             |                          |                        |                         |
| Total income (logged)                   | −0.10                | 0.16        | −0.14                    | −0.30                  | −0.07                   |
| Female (HHH)                            | −0.10                | −0.19       | 0.32                     | 0.52                   | 0.11                    |
| Age (HHH)                               | −0.01                | 0.01        | 0.01                     | 0.02                   | 0.01                    |
| Years of education (HHH)                | 0.03                 | 0.12        | 0.07                     | 0.12                   | 0.01                    |
| Number of adults                        | −0.15                | −0.15       | −0.33                    | −0.23                  | −0.58                   |
| Forest intensive livelihood strategies   |                      |             |                          |                        |                         |
| Farms high value tree crop             | 1.06                 | 0.78        | 1.09                     | 1.14                   | 1.07                    |
| Cultivates private land                | 1.01                 | 1.39        | 1.20                     | 1.62                   | 1.35                    |
| Formal land title                      | −0.85                | −1.06       | −0.85                    | −1.19                  | −1.05                   |
| Model and sample information           |                      |             |                          |                        |                         |
| Intercept                               | 2.76                 | −5.0        | −0.91                    | −0.85                  | 0.79                    |
| Matching method                        | None                 | Coarsened exact | Mahalanobis | Full | Genetic |
| Sample size (Treated: control)          | 1220 (172: 1048)     | 786 (156: 630) | 452 (121: 331) | 1085 (131: 954) | 308 (154: 154) |
| HHs from VCA villages retained         | 100%                 | 90.7%       | 70.3%                    | 76.2%                  | 89.5%                   |

*p < 0.1; **p < 0.05; ***p < 0.01.
of increased forestcover loss in VCA villages. After adjusting for VCA selection criteria and demographic variation, forest intensive livelihood strategies are the most significant predictors of VCA village residence. Specifically, cultivating private acreage and farming high-value tree-crops were the most predictive and significant variables when modeling the likelihood a randomly selected household was from a VCA village. Other studies point to a similar relationship between smallholder agriculture and forest conversion in central and southern Sumatra. Oil palm plantations and smallholder agriculture are a prominent driver of forest conversion in Sumatra and across Indonesia (Jepson et al. 2001, Linkie et al. 2003, Clough et al. 2016, Widianaingsih et al. 2016). However, in areas of higher elevation, coffee cultivation more often drives forest conversion (Gaveau et al. 2009, Levang et al. 2012). In the Kerinci highlands, coffee and cinnamon (Cassievera sumatera) production are often associated with forestcover loss (Wibowo 1999). There are unverified reports from 2007 of increased clearing for coffee production in the Kerinci-Seblat landscape in response to rising coffee prices (Agionby and Wiggins 2007). The results in this research account for increases in population, distance to roads, and many other confounders that often determine where coffee and other agricultural commodities are produced. After adjusting for these other possible explanations of forest loss or commodity agriculture production, the results support the conclusion that a behavioral dynamic determined by village participation in the VCA project complicated greater forest clearing, and that households within VCA villages were more likely to farm coffee and cinnamon than the most similar households in non-VCA villages. Further, the most well-paid VCA villages contained the greatest forestcover loss in the post-project period. The relationship between VCAs, forestcover loss, and forest-intensive livelihood strategies indicate that project participation and payments resulted in the future conversion of forests.

Providing, failing to provide, or ceasing payments for conservation can change the incentives local communities have for altering land cover. Though payments may aim to promote conservation through financial incentives, there are many reasons why they may not realize their intended impact (Muradian et al. 2013). Monetizing conservation changes behavior in often unforeseen ways, and payments can crowd out inherent motivation for protecting natural landscapes (Agrawal et al. 2015, Rode et al. 2015, Cetas and Yasué 2017). When considering whether or not to provide conservation payments, project implementors must also consider also how payments can affect the real or perceived value of a resource once payments cease (Bryan 2013). A study in Hungary that examined farmers’ behaviors after conservation payments stopped found that the intensity of cropping increased (Kovács et al. 2021). In the context of the KS-ICDP, not only did the termination of payments result in greater forestcover loss within VCA villages, but the villages that received the greatest payments contained significantly higher levels of forestcover loss. With each additional $10,000, VCA villages experienced an average 15.6%–16.2% increase in forestcover loss from 2003 to 2016. In addition, VCA villages that received full payment through the VCA project demonstrated 64.7%–79.7% more forestcover loss than villages that defected from the second stage of implementation. Previous studies found that prior compliance with institutional regulation is a useful indicator when predicting PES success (Martin Persson and Alpízar 2013). The results from this research suggest that compliance for payment can also predict where future forest conversion may occur if payments cease. Once conservation payments cease, competing land-uses continue to provide financial benefits so long as local governments and people comply with the right combination of formal and informal institutions (Kovács et al. 2021). Attending to the long-term viability of conservation-based payments is therefore critical to effect enduring conservation outcomes. The final KS-ICDP project document identifies the importance of long-enduring conservation activities. It reads:

The original project was conceived as a first six-year time-slice of a much longer program. It was always clear that the project was highly ambitious and would need a much longer timeframe to achieve real support for the park within the regional context. Nevertheless, there was never any commitment... to a multi-phased project (e.g., as might have been achieved via an Adaptable Program Loan) nor was any real strategy developed to ensure that provincial/kabupaten governments could sustain integrated activities beyond the project’s lifetime (World Bank 2003).

As this research demonstrates, failing to effectively provide and sustain conservation-based payments risks more than nonsignificant impacts.

5. Conclusion

This research provides empirical evidence that conservation outcomes are impermanent, and project failures can increase in severity over time. It investigates the conservation legacy of conservation-based payments made through one of the largest ICDPs in Indonesia. Villages that signed a conservation agreement and received payments for pro-conservation livelihood activities contained significantly more forest-cover loss after the project ended, compared to the most similar villages. Further, from a ran-
dom sub-sample within the study-region, households that reported cultivating private land and farming high-value tree crops were significantly more likely to reside within a village that signed a conservation agreement. These findings contribute to research on incentive-based conservation governance by highlighting the risk conservation-based payment programs run once payments stop, and they demonstrate the importance of evaluating conservation legacies.

The limitations of this study highlight opportunities for improving future research on conservation impacts. For example, the results concerning household livelihood strategies and VCA affiliation should not be interpreted as a direct result of the VCAs, but instead as complementary findings that support the conclusion that the VCA project generated a legacy of increased forest cover loss (table 2). Future investigations that examine the impermanence of conservation outcomes would do well to collect longitudinal data on environmental, social, and economic outcomes, and draw on the suite of quantitative methods presented here. The potential drivers of conservation outcomes and their impermanence that this study does not address include economic inequality and elite capture (Wilfahrt 2018). Despite its limitations, this research demonstrates the usefulness of econometric methods to analyze a project’s conservation legacy. The findings show that payment-based programs do not merely run the risk of nonsignificant conservation impacts. They can generate legacies of negative conservation outcomes. Learning from such failures represents an opportunity to advance conservation governance.

Evaluating the relationship between PES projects and their conservation legacies will remain critical when assessing the effectiveness of conservation-based payments. Other studies establish and affirm the importance of paying enough to offset opportunity costs of land-cover change (Wunder et al. 2018). Thus, conservation projects that leverage an economic incentive must consider how ‘pay enough’ (Gneezy and Rustichini 2000), for long enough, with the right form of compensation, and at the right times (Frey and Jegen 2001). Failure to do so risks a legacy that promotes behavior in direct opposition to conservation objectives. Future research on the legacies of conservation-based contracts and payments can provide additional insights for developing incentives more attuned to context, values, implementation, and adaptive planning.

Data availability statement

The data that support the findings of this study are available upon reasonable request from the authors.

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Ethical statement

This study received an IRB exemption from the University of Michigan (HUM00119291). Survey respondents confirmed their willingness to participate in the survey research, and all research was conducted in accordance with recognized standards.

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