Community Monitoring and Technology Transfer to Prevent Deforestation: A Field Experiment in the Peruvian Amazon
Pre-Analysis Plan

Jacob Kopas
Earthjustice

Tara Slough
Columbia University
University of California, Berkeley
New York University

Johannes Urpelainen
Johns Hopkins SAIS

June 25, 2019

Revised Pre-Analysis Plan registered prior to viewing of outcome data.

Abstract

Continued and accelerating deforestation of the Amazon rainforest represents a grave threat. While substantial investments have been made in satellite monitoring to detect deforestation events in the region, much of this data remains inaccessible to "first responders," namely indigenous communities in the Amazon and, to a lesser extent, the officials tasked with prosecuting these crimes. To what extent does providing this information to forest communities allow them to respond to such threats and better manage collective forest resources? We develop a Pre-Analysis Plan for a field experiment in the Peruvian Amazon that will provide indigenous communities with training, technology, and eventually weekly updated data detected by satellite monitoring on threats to collectively-held forests. We measure a rich set of outcomes using satellite data, original end line surveys, and administrative data on cases prosecuted to assess the impacts of the community monitoring program.

1 Introduction

This document provides a pre-analysis plan for the field experiment "Community Monitoring and Technology Transfer to Prevent Deforestation: A Field Experiment in the Peruvian Amazon." The goal of the pre-analysis plan is to prevent data mining and ensure that hypotheses are tested based on an analytical framework derived from first principles (Casey, Glennerster, and Miguel, 2012). This project represents one of the six Metaketa-III Natural Resources Governance studies. The results of this study will also be incorporated into a larger meta-analysis of the six projects.

Our intervention is an offer for an indigenous community to participate in a monitoring program of the community's collective forests. The monitoring program itself provides communities with monitoring technology (GPS smartphones), organizational support, and monthly-updated satellite imagery. Communities will then use the program to identify threats to collectively-held forests and take action to prevent or mitigate deforestation through community government or by informing national officials.

The main organization in charge of implementing the intervention with be Rainforest Foundation US in direct coordination with local indigenous federations and in consultation with the Peruvian Ministry of the Environment's National Program for Forest Conservation and Climate Change Mitigation (PNCBMCC) and other local partners. Indigenous federations are political bodies that unite indigenous communities in a geographical region and are run by elected officials from those communities. Federations have delegated authority to coordinate and propose projects or development plans with member communities, but which must be approved by a vote from community delegates. Rainforest US and the researchers will coordinate with the ORPIO federation, which has jurisdiction over the Loreto department, and the ORKIWAN and FECONAMNCUA federations of the Napo basin, and the FECONATIYA and FECOTYBA federations of the Lower Amazon river basin.

The primary outcome indicator for this study will be the relative rate of deforestation in indigenous community territory. We will measure this outcome through Landsat satellite data provided by the University of Maryland Global Land Analysis and Discovery (GLAD) lab, and processed through the *Alertas Tempranas* (early warnings) system managed by Geobosques, a

department within the Peruvian Ministry of the Environment. This study will also measure the impact of the intervention on community government and perceptions of community members through an end-line survey.

This intervention is a continuation of a preexisting program through Rainforest Foundation US, and which RFUS has already been successfully piloted in several communities of the Shipibo Conibo peoples in the Ucayali Department. Our partners conducted the pilot program in 2016 in a combined area of 20,000 hectares of titled indigenous lands that abut the Sierra del Divisor National Park, and which had suffered an increasing number of deforestation events according to the GLAD satellite alert system. RFUS, partnering with indigenous federations in the area, successfully implemented the project in the participating communities, and established monitoring teams which verified deforestation events and collected data. The Peruvian government eventually used this information as evidence to open an investigation into the deforestation on community lands. RFUS's successful implementation of this pilot project provides a firm basis of knowledge and experience that will permit our partner's to continue to implement the project in the selected river basins.

We are confident that the planned intervention will enjoy a relatively high level of compliance among communities in the Napo and Lower Amazon river basins, given the experience of RFUS with pilot communities and the shared features and similar circumstances between the pilot communities and the proposed intervention areas. Pilot communities and the subjects of this study are all threatened by deforestation, either currently possess a collective title for collectively-held lands or are in the process of obtaining one, and have large areas of forested communal lands, on average more than 10,000 HA. The indigenous federations that govern participating communities have also expressed interest in implementing the project within their jurisdiction.

2 Study Setting and Sample

2.1 Intervention Area

The selection of the intervention areas for this study is based on the criteria used by our implementing partner for prioritizing community monitor training. They selected several river basins

within the Peruvian Amazon (roughly corresponding to the departments of Loreto, Ucayali, and Madre de Dios) that conformed to the following criteria:

1. Presence of recognized indigenous communities (i.e. *Comunidades Nativas* under Peruvian legislation) with the majority of their territory still forested and territory averaging 10,000 hectares.

2. Relative density of communities and ease of transportation

3. Lack of previous forest monitoring interventions

4. Principal environmental threat to communities is deforestation (i.e. no petroleum or large mining operations)

5. Community is not involved in the growing of coca.[1]

6. Political stability of indigenous federations (e.g. no foreseen elections or turnover in leadership) during project implementation period.

The river basins that fulfilled these requirements were the Lower Amazon (the portion east of Iquitos until the border with Brazil and Colombia) and the Napo basin (between the Ecuadorian border and Iquitos). Based on the above criteria, these river basins were selected as the two main intervention areas of the study.

2.2 Pre-selection process

We conducted a pre-selection process with federation leaders to determine the final sample of communities from which we will then make the randomized selection into the primary treatment arm. The pre-selection process provides two benefits for the study. First, the process will help identify the complete universe of indigenous communities in each of the selected river basins. This is necessary because although we are currently using the most accurate database of indigenous communities (which combines government and NGO collected data), this information is

---

[1]New varieties of coca have emerged that can be grown at substantially lower altitudes, including in the Amazon. Coca represents an illegal source of revenue for communities. We exclude coca growing communities as they are unlikely to accept participation in a monitoring program for obvious reasons.

likely incomplete and there could be additional communities in each basin that could potentially be included in the study.[2] Secondly, a pre-selection process will allow us to gauge initial interest in the project and thereby limit the prevalence of non-compliance with the randomized selection process by communities that do not accept the offer to participate.

The pre-selection process took place in July and August 2017, and consisted of a trip by our implementing partners. During this trip, our partners identified a complete list of indigenous communities in each basin and meet with community leaders and federation leaders from each eligible community within four federations. The criteria we applied for determining the final subject pool is based on the fifth and sixth criteria for basin selection (lack of coca production and political stability), in addition to the federation leader's subjective perception of the likelihood of a community accepting the invitation to participate in the intervention.

After randomization, there will still be a chance for non-compliance, which we define as failure to accept and complete the monitoring training. Non-compliance will be identified after the first round of socialization meetings with communities selected into the treatment group. During these meetings, which will take place within each community or in a neighboring community (for communities in close proximity), our partners will describe the monitoring project and request that the leaders discuss the possibility within their communities and express their desire to participate through a letter.

2.3 Study Sample

We identified 76 eligible communities, of which 36 were assigned to treatment. We created 18 blocks, stratifying on the four federations (which implies stratifying on river basin), community titling status, and then area deforested in 2015 and 2016 (in bins by federation, titling status). From each block, we randomly selected two treatment communities and one alternate community. The random assignment was videotaped and conducted in the presence of the federation

---

[2]Data on indigenous communities come from IBC (2016) which combines data collected from regional governments, NGOs, and direct fieldwork. Interviews and consultations with our partners Rainforest US and other organizations and government officials in Peru have confirmed that this database represents the most accurate and complete collection of data on native communities in the Peruvian Amazon. This information is also used by national indigenous federations, NGOs, and the government in negotiation of land titling in the Amazon region.

leaders in August 2017.[3]

The community monitoring treatment is assigned at the community level. As per two of our outcomes, satellite measurements of 30×30 meter grid cells on a monthly basis and endline surveys, this study employs a cluster randomized design. Thus, all units of analysis are either community level or clustered by community. We randomly assigned 22 communities in the Napo basin to the primary treatment of an offer to join the monitoring program. There are 24 control communities in this basin. We assigned 14 communities to this treatment and 16 communities to the control condition in the Amazon river basin. Thus, the total number of communities receiving the monitoring treatment is 36 and the number of control communities is 40.

The indigenous communities that will participate in this study consists of small villages of a few family clusters belonging to the same ethnic group, and having on average just under 300 members each. Communities in the intervention region will typically have one or two primary village settlements, although some have several, smaller satellite settlements of a few families within the territory. However, each community is organized around a single government structure consisting of an elected council (*Consejo Comunitario*) and a deliberative body (*Asemblea Comunitaria*), which is comprised of all members of the community and is the ultimate authority with state recognition and legal jurisdiction over the community's collective lands. Rainforest Foundation US, has contact with leaders from communities in both river basins, but has not yet begun to implement forest monitoring projects with communities in either area.

Although Peruvian legislation requires the national government to provide legal recognition and titles for all indigenous community lands, in practice titling had effectively halted after land reform efforts ended in the mid 1980s. However, the overwhelming majority of communities in each of the selected river basins have received titled land. In addition, a new wave of titling sponsored by the Inter-American Development Bank through the PTRT-3 (*Proyecto de catastro, titulación y registro de tierras rurales en el Perú*), will title 403 new indigenous communities, and will

---

[3]In the original random assignment in 2017, there were 17 blocks representing 73 communities. In January, 2018, RFUS expressed interest in adding additional communities to the project. This addition was in response to external funding that RFUS had just received and the expressed interest of 3 communities in the Napo River Basin that were not involved in the original randomization. These communities were inadvertently left out in the previous round of randomization due to an error by the community leaders from the Napo River federations. We designated these communities a block and randomly assigned two communities to treatment.

cover untitled communities within the project area. We consider the territory of the community for purposes of this study to equal the community's formally titled and/or demarcated land.

There exists a complication in demarcating community boundaries in untitled communities. While this would be completed during the training visits for treatment communities, we will not be able to measure the territory of untitled communities in control before the intervention. Because this affects only a small number of communities in the Amazon basin, there are three options for addressing this issue, in order of the steps that will be taken.

1. Meet with the DRA (*Dirección Regional de Agricultura*) of the regional government in Iquitos and obtain information info on the area demarcated for these communities

2. During endline data collection, ask community authorities in untitled control communities for their titling claims

3. Estimate the extent of the territory by using he following algorithm:

   - Calculate the average number of hectares for that Cuenca, and use that statistic as the estimated extension of territory;

   - Draw a polygon for which the community point is in the midpoint of one edge, and the rest of the territory extends away from the river to fill out the full etimated extension;

   - Other edges will stop at neighboring communities and rivers, or until they reach the full length of a side of a square with an area equal to the estimated area.

All communities that will participate in the study live in the Peruvian Amazon rainforest, one of the most biodiverse areas in the world, with the second highest number of bird species in the world and in the top 10 in nearly every other IUCN biodiversity category. The study area is a rich carbon sink, storing an average of 150 Mg C per hectare. Forest resources are also very important for sustaining indigenous communities' culture and economy. Peruvian Amazon indigenous communities are culturally and spiritually tied to their forests and traditionally depend on them for food security and medicine.

The communities participating in the study have collectively-held land that is largely forested. However, like many indigenous communities in the Amazon basin, these forest resources are

threatened by unauthorized logging, non-indigenous colonizers using slash-and-burn agriculture, the cultivation of illicit drugs (coca), and illegal gold mining. These threats are highest during the dry season in the Peruvian Amazon, which corresponds roughly to the months of May through October, when timber is easier to cut and forests are easier to clear for agriculture. Although most communities are aware of and concerned about the general threat to their lands, effective protection of community forests are frequently hindered by three problems: (1) community lands cover a large area of forest, and specific information of individual events of deforestation are difficult to identify; (2) limited organizational or community resources often prevents communities from coordinating an effective response to deforestation threats; and (3) sharing information with national-level authorities with the power to enforce existing laws against unauthorized deforestation is difficult for remote communities. The Rainforest Foundation-US monitoring program specifically addresses these concerns.

The parties responsible for illegal clear-cutting and occupation of indigenous lands in the study intervention area are typically colonizers from Peru's costal or highland regions. These colonizers occupy areas of indigenous territory assuming that either the land is wild, state land (under Peruvian legislation, *tierras eriazas*, which can convert to private land after occupation and productive use), or that any occupation will be unnoticed by the indigenous community since indigenous territories tend to be large (frequently over 5,000 hectares) and community population sizes relatively small (100-200 families). In some instances, colonizers will enter into negotiations or rental agreements with select indigenous families for occupation of land or timber extraction. For these cases, the rental agreement is rarely if ever discussed with the community as a whole and can lead to tensions within the village, as the occupied land is considered collective property of the entire community. In both cases, the community often does not discover the occupation until colonizers are settled or logging and mining operations are well under way, at which point it becomes quite difficult for the community to eject the invading parties.

As mentioned above, the primary threat to forest resources is from clear-cutting due to agricultural colonization, illegal clear-cut logging, and gold mining. There is also less-invasive selective logging of highly valuable wood in community lands. We will not measure the impact

of monitoring on this type of activity for two primary reasons. First, according to our partners, Rainforest US, most of the highly valuable timber in the intervention area has already been extracted, and this activity is not a major driver of deforestation. Second, the satellite data and the GLAD early alert system we rely on for both the monitoring treatment and for outcome measures are not sensitive enough to measure forest degradation from selective logging. Therefore we would not expect the monitoring treatment to have an impact on this type of activity, nor would we be able to measure the impact.

3 Treatment and Randomization

This study's intervention is an offer for a community to participate in a monitoring program of the community's collective forests. The monitoring program itself provides communities with monitoring technology (GPS smartphones), organizational support, and training to use weekly updated satellite imagery to identify potential deforestation events. Communities will then by able to use information provided through monitoring to possibly take action to prevent or mitigate deforestation.

Our partners will implement the monitoring treatment over a period of three months from October to December 2017. The training will consist of three visits to each treatment community, although trainings in nearby communities will be combined to reduce time and travel costs. During the first visit, our partners will present information about forest monitoring program and develop a community monitoring plan. Each plan will identify key resources and threats according to the interests and existing knowledge of each community. The community will also identify a list of volunteers for participating in monitoring teams. Rainforest US will recommend that a monitoring team should consist of three monitors, and will provide enough equipment and payment for only three individuals.[4] These volunteers will then be trained in the use of GPS technology (smartphones) over the next two training dates. Teams will also be provided a monthly salary for the duration of the project (through December 2018), and also be given supplies and resources to patrol lands by boat and foot. During the final training period, the

---

[4]However, the final number of monitors will be dependent upon the availability of volunteers and the autonomous decision of the community. Therefore, individual monitor teams may be composed of more or less members, who will share the equipment and payments accordingly.

monitoring teams will conduct test patrols with trainers using recent satellite data. By February 2018, monitoring teams will be fully trained and begin able to conduct regular patrols.

The project will also provide a monetary compensation for monitoring teams of the equivalent of $80USD per monitor/month. According to consultations with our partner, Rainforest US, this payment is a necessary economic compensation for the individual labor monitors invest in the program, and the project would not be possible without this compensation. We will not include a separate monitoring arm without compensation.

Monitoring patrols will consist of two main activities. First, monitoring teams will use GIS data from satellite alerts to identify possible deforestation events on their territory. They will then visit these sites and identify and potentially document (taking GIS data, photos, etc.) the location and source of the threat. Information will be recorded using an intuitive and user-friendly app (Locus Pro Map) designed especially for GIS data collection. Second, monitoring teams will also be able to conduct regular patrols of territory and respond to potential threats identified by other sources (word of mouth, sightings by community members, etc.). Manuals for monitoring trainings developed by RFUS are on file with the EGAP project and available from researchers upon request.

In addition, our partners will conduct monthly visits to each treated community during the project implementation period. During these follow-up visits, our partners will provide updated satellite data from the Geobosques/GLAD early warning system through SD cards that can easily be downloaded into smartphones. This early-warning system is based on weekly updates of Landsat satellite imagery (30m resolution) analyzed through the University of Maryland and provided freely on the internet. Rainforest US will provide monitoring teams with a monthly summary of early warnings, which teams can then use to compare potential threats to community resources identified through the early-warning system with deforestation activity discovered first-hand through community monitoring. Communities will also provide our partners with update on the monitoring activities of communities and any responses to forest threats planned by the community.

Rainforest US will also use monthly trips to collect information on the frequency of patrols

River	Federation	Block 1	Block 2	Block 3	Block 4	Block 5	Block 6	Total
Napo	ORKIWAN	T, $n=5$	T, $n=4$	T, $n=4$	T, $n=4$	T, $n=4$	T, $n=4$	$n=25$
Napo	FECONAMNCUA	NT, $n=5$	T, $n=4$	T, $n=5$	T, $n=4$			$n=18$
Napo	FECONAMAI*	NT, $n=3$						$n=3$
Amazon	FECONATIYA	NT, $n=4$	M, $n=4$	T, $n=5$				$n=13$
Amazon	FECOTYBA	NT, $n=3$	NT, $n=4$	T, $n=5$	T, $n=5$			$n=17$

Table 1: Blocks. Among titled and untitled blocks, blocks were created based on past deforestation levels. The abbreviations T, NT, and M indicate titling status, titled, not titled, and mixed, respectively. The additional communities in FECONAMAI were added to the sample in January 2018.

River Basin	Total Communities	Control	Treatment (Monitoring)
Napo	46	24	22
Amazon	30	16	14

Table 2: Allocation of communities to each treatment arm.

and any community meetings or decisions resulting from the monitoring intervention. Information from satellite data and monitoring teams will them be shared within the community. Colonizers could also potentially gain access to satellite information, but the data is also available freely on the internet to any colonizer with an internet connection.

3.1   Random Assignment

In collaboration with indigenous federation leaders, we created seventeen blocks of three to five units. We blocked completely on federation (and thus river basin), titling status (with one mixed block), and then on deforestation in the past two years. The composition and size of the blocks are listed in Table 1. As is evident from the table, we will block by river basin. We also will seek additional efficiency gains by blocking within each river basin on geographic characteristics and past deforestation patterns (2012-2017).

Table 2 summarizes the treatment assignment. Within each block, we will assign one unit to the "monitoring only" treatment and one unit to the "monitoring + state engagement" treatment. Given the heterogeneity in the size of these blocks, all empirical specifications will use IPW.

The randomization was conducted in August 2017 upon conclusion of the community selection process. Prior to community selection, RFF will create a list of pre-selected communities

together with indigenous federation leaders. We assume that this will minimize the threat of non-compliance. If, however, a treatment community refuses to participate/complete training activities, there is a randomly assigned "backup" community from each basin that will be assign treatment in the case of non-compliance by one of the assigned communities. Both communities (original and replacement) will be coded as "assigned to treatment" for the purposes of analysis if they are assigned to treatment.

4 Implementation Plan

The study will be implemented as follows:

1. **July-August 2017**. Pre-selection of communities; approval by community-level and regional indigenous authorities; recruitment of local staff; primary treatment arm assignment.

2. **September 2017-April 2018**. Implementation of community monitoring trainings for the primary treatment arm. Community monitoring teams will be equipped and fully trained by the end of this period.

3. **May 2018-April 2019**. Community monitoring teams patrol community forests in treated communities. The research team will measure deforestation with satellite data from this period.

4. **April-May 2019**. End line survey in treatment and control communities.

5 Argument and Hypotheses

5.1 Argument in Brief

The community forests under examination in this study are Common Pool Resources (CPR), or resources that are sufficiently large to make it impossible to fully exclude others from use, but which can theoretically be managed so that use of the resource does not undermine the longterm stock (Ostrom, 1990). The extensive literature on Common Pool Resources governance has highlighted the importance of resource monitoring in contributing to the emergence and maintenance of local institutions that can solve collective actions problems and promote the sustainable use of the resource (Ostrom, 1990; Dietz, Ostrom, and Stern, 2003).

In contrast to typical expositions of CPR problems around overuse of resources, the fundamental threat of deforestation in the communities that we study is external to the community itself. The principal threats consist of: (1) an influx of coca growing; (2) harvesting of wood (timber); and (3) invasions of settlers for the purposes of agriculture. The first two threats come from criminal networks or gangs. There are, however, instances of collusion between community members and external actors that facilitate extraction.

The primary mechanism through which monitoring can contribute to sustainable resource governance is through the provision of information to the users of the resource. By decreasing costs on information, users can rationally adjust their behavior and coordinate to sanction non-compliance by other users.

However, information may not be the only mechanism through which the intervention can affect forest management. The intervention itself provides training and leaves an organization structure that can also help promote collective action within the community, and in particular around problems related to management of community forests. This increased organizational capacity, which includes increasing human capital within the community, can also increase the community's ability to mobilize politically and demand better enforcement by the state or to enforce community decisions against external actors. Increasing organizational capacity and human capital have also been signaled as key to the development of the indigenous people's movement more broadly in Latin America (Yashar, 2005).

Finally, the exact effectiveness of local institutions in controlling and managing common pool resources is likely dependent on variation in local conditions, including the specific characteristics of the resource and users in question (Agrawal, 2007). For the communities within our sample, the primary users (community members) have limited involvement with direct drivers of deforestation. Rather, the primary threats to forests resources are external actors that are not involved with community institutions that regulate resource use. Community government can police cooperation of members by limiting unauthorized contracts or deals with external actors, and by mobilizing community participation to enforce sanctions against non-community members. However, given this context, external enforcement by state actors may be necessary for

controlling deforestation and excluding external actors from community lands.

5.2 Community-level Mechanisms

The first mechanism through which the present treatment works is by providing communities with recent information about deforestation. While satellites and Geobosques' *Alertas Tempranas* system has been identifying deforestation weekly since since at least 2012, this information is not readily accessible to indigenous communities in remote parts of the Amazon forest. Therefore, the intervention's use of smartphone technology and monthly visits can provide treatment communities with remote-sensing satellite and direct observational data that would not otherwise be available. Since affected communities serve as the first line of defense against illegal deforestation for wood or agriculture, information transmission should reduce "search costs" (i.e. costs related to obtaining and processing information) for relevant information on resource use and status.

Second, the training and monitoring program aims to strengthen communities' response to threats to their communal territory. The information provided via the monitoring system and the work of the community monitors should allow communities to coordinate around specific threats to forest resources. From an organizational perspective, the hiring of a monitor also promotes a more centralized process in terms of responding to deforestation activities. Collective responses to threats to communal lands should, in principle, provide a stronger line of defense against illegal logging. As such, changes in collective action capacity and community organization with specific reference to deforestation should also reduce the extent of deforestation activity within their territories.

Upon receiving information on the threat of deforestation on community lands, the community can take one of two (or both) courses of action: (1) inform state officials; or (2) take autonomous action as a community. In either course of action, the community will act through its two principal governing bodies, the village council (*Consejo Comunitario*) and the village assembly (*Asamblea Comunitaria*). The village council is an executive board of elected officials (all community members) that initiate actions in name of the community. However, the village assembly, which consists of all members of the community, is the highest authority in the community and

14

must approve all community decisions. The village council will propose a given course of action, and the assembly will then vote to approve.

5.3 State Enforcement

The Peruvian state ultimately has responsibility for enforcing its laws with regard to deforestation. Such enforcement is quite costly in the river basins that we study, particularly in the absence of information about deforestation activity in the form of complaints (*denuncias*). Second, the indigenous communities in which the intervention will be conducted typically have limited contact with the state. There are many explanations for this limited contact ranging from racism, cultural/language barriers, and limited state presence. By empowering communities to bring their grievances to state agents, the probability of state enforcement against offenders should increase. The threat of such enforcement should deter continued deforestation.

However, there exist several barriers to enforcement by state officials. To the extent that communities share results of monitoring with environmental prosecutors etc., it may facilitate state enforcement by addressing informational problems. On the other hand, of the lack of state enforcement is driven by (a) high costs of enforcement; (b) higher-level directives not to enforce; or (c) agency problems in enforcement, it is less clear how the monitoring intervention should change levels of enforcement. We will consider these possibilities in our interpretation of evidence.

5.4 Main Hypotheses

In light of the argument, we posit a set of hypotheses linking the community monitoring intervention to lower levels and rates of deforestation in treatment communities. We specify a larger set of outcomes in order to test the mechanisms underlying the predicted relationship with deforestation.

Hypothesis 1. *Manipulation check: Relative to control communities, members of monitoring communities are more likely to conduct monitoring of forests.*

Hypothesis 2. *Awareness of Deforestation: Relative to members of control group communities, members of monitoring communities manifest greater awareness of the incidence of deforestation in the Peruvian*

15

Amazon.

Hypothesis 3. *Community Governance: Relative to members of control group communities, members of monitoring communities report more frequent and/or recent community meetings.*

Hypothesis 4. *Collective action: Relative to members of control group communities, members of monitoring communities manifest higher levels of willingness to participate in collective action.*

Hypothesis 5. *Deforestation: Relative to the control group, community monitoring (both treatment arms) reduces deforestation events and area.*

Hypothesis 6. *Trust in the State: Relative to members of control group communities, members of monitoring communities report higher or lower trust in the Peruvian state to address deforestation. [Two-sided]*

5.5 Secondary Hypotheses

Hypothesis 7. *Exposure to program: For the social outcomes, effects are larger among monitors (or would-be monitors) with a higher difference exposure to the monitoring program than for citizens at large.*

Hypothesis 8. *Population: The effects of community monitoring are magnified in communities with smaller population sizes, as they will better be able to resolve collective action problems.*

Hypothesis 9. *Displacement of Deforestation: Relative to the control group, community monitoring increases deforestation events and area within a buffer zone outside the monitored communities.*

5.6 Meta-Analysis Hypotheses

This project is one of six coordinated projects funded by Evidence in Governance and Politics' Metaketa-III grant. Below, we reproduce the hypotheses tested in the broader project. The hypothesis labels correspond to the meta-analysis pre-analysis plan.

Hypothesis 10. *H1: Community monitoring improves use of the natural resource.*

Hypothesis 11. *H2: Community monitoring increases users' satisfaction with resource use in the community.*

Hypothesis 12. *H3: Community monitoring improves users' sense of stewardship over resource use.*

Hypothesis 13. *M1: The impact of community monitoring is greater where the pre-existing severity of the resource problem is greater.*

Hypothesis 14. *M2: The impact of community monitoring is smaller where the pre-existing likelihood that management bodies authoritatively exercise enforcement for resource misuse is greater.*

Hypothesis 15. *M3: The impact of community monitoring is greater where the pre-existing likelihood of community coordination around resource use (proxied by smaller population) is greater.*

Hypothesis 16. *M4: The impact of community monitoring is greater in sites with higher rates of compliance with treatment assignment.*

Hypothesis 17. *I1: Enhanced community monitoring increases the perception on the part of the management body that its performance is under scrutiny.*

Hypothesis 18. *I2: Enhanced community monitoring increases the perception on the part of the management body that users in the community are interested in and attend to resource issues.*

Hypothesis 19. *I3: Enhanced community monitoring increases the perception on the part of users that they may experience punishment by sanctioning bodies for violating regulations or standards.*

Hypothesis 20. *I4: Assignment to the community monitoring increases the rate of monitoring within communities.*

6 Data Collection and Operationalization

Our outcome data comes from three distinct sources. We outline the characteristics of each data source in this section.

6.1 Behavioral Monitoring Data

The monitoring application allows us to generate fine-grained measures on how monitors conducted their monitoring including where they walked and evidence (photographic) that they gathered. In addition the monitors filled out monthly reports on their monitoring activities and

observations. We use this data to understand the basis for which communities gained new information and had the opportunity to respond to threats to their lands.

While these records are only available for the treatment group, they provide descriptive evidence that speaks to the question of whether we were able to induce monitors to monitor. Is it possible to "impose" monitoring as an institution? If this condition does not obtain, we do not expect further success of the program.

6.2 Remote-sensed Deforestation Data

One outcome measure for this project will be deforestation rates and area deforested on community lands. To measure deforestation, we will use monthly measures of Landsat satellite data provided by the University of Maryland Global Land Analysis and Discovery (GLAD) lab. Satellite imagery for the entire Peruvian Amazon is available publicly through the GLAD lab's website and is taken at a resolution of $30 \times$ 30m grid cells. At this level of resolution, we will be able to detect the clearing of a forested grid-cell, although smaller levels of degradation (for example the selective logging of valuable timber such as mahogany) will not be detectable. The advantage of using this data to measure is that it is available freely and on a weekly-updated basis, there are satellite images available from several years prior to the start of the project, and data can be drawn for several years following the project, allowing us to measure the longer term impact of the monitoring project. The data typically identifies deforestation *events*, providing coordinates for each event. As such, our outcome measures are coded such that higher values correspond to more deforestation.

Once all communities are mapped in GIS, we will overlay the grid of $30 \times 30m$ cells from Landsat. All cells containing any community territory will be included in the experimental sample. (Avelino, Baylis, and Honey-Rosés, 2016) provides some commentary on the spatial aggregation of satellite imagery data. We plan to analyze at the most disaggregated level (30×30m grid cells). In contrast to much existing work, we know the level of treatment assignment, the community, so all standard errors will be clustered at this level.[5] The authors demonstrate that

---

[5]The efficiency results in Avelino, Baylis, and Honey-Rosés (2016) are driven mostly by the lack of information about the process of assignment to treatment. Such concerns are less relevant when this process is known.

"the estimate of the treatment effect is unbiased when the true level is perfectly divisible by the unit of analysis" (15). The communities contain a very large ($\geq 10^4$) number of units so any bias resulting from the disaggregate unit of analysis is minimal.[6]

The satellite data also allows us to exploit temporal variation in deforestation activity. While there is in principle weekly satellite data, when there is cloud cover during image taking, however, there is additional noise in the data. As such, we aggregate at the monthly level to minimize the probability of obtaining no clear image within a time period, t. The temporal aggregation is uncorrelated with treatment assignment and provides a comprehensible unit of analysis. The "robustness" of results to this temporal unit can be assessed by moving the temporal window forward or backward as necessary. If there is no clear image of a given subset of grid cells in a given month, we impute a "0." Given the empirical strategy defined here, our main estimand is the ATE on monthly rates of deforestation. The estimator will average across months. Given that deforestation (in the short run) is a monotonic process, deforestation in months with cloudy images will be picked up on subsequent images, and the average across months is still estimable. This does add some noise to efforts to detect seasonal trends.

6.3 Survey Outcomes

The survey consists of an endline surveys of 10 residents and 2 community leaders per community. The community leader interviews consist of the survey plus a qualitative endline. We were unable to survey in one block due to threats to the safety of enumerators. As such, we drop that block and include the remainder of the communities. We will provide details as to any further missingness of communities in the discussion of results. Note that there are substantial risks to operating in the Amazon and our data collection decisions were made to protect monitors and respondents. The English version of the survey instrument is appended to this document.

In thes survey, we will also collect data on the change in government capacity of indigenous village councils and assemblies, the primary government bodies for indigenous communities in the Peruvian Amazon. Specifically, we gather data on community records of indigenous

---

[6]The Monte Carlo results in Avelino, Baylis, and Honey-Rosés (2016)suggest that under the specified DGPs, any bias would attenuate effects.

government in Peru; a source of information that has not yet been studied, but which has the potential to provide high-quality, time-series data on community governance.

Nearly all recognized indigenous communities in the Peruvian Amazon region follow a similar government structure established by national legislation and promoted by indigenous federations to improve governance and access to national and international development aid. This structure consists of an elected executive body, the *Consejo Comunitario* (village council), and a deliberative body, the *Asamblea Comunitaria* (village assembly), comprised of all adult members of the community. Communities will typically keep a record of all important meetings of the council and the assembly through a series of short meeting minutes commonly referred to as *Actas Communitarias* (community registry). We refer to these documents in interviews with community leaders to measure organizational capacity.

6.4 Community-level Covariates and Mediating Outcomes

We will also collect data on population size to test for conditional treatment effects for community size. This information will be collected during the initial socialization meetings with treatment communities and during the endline survey with control communities. Although this will involve using some post-treatment data, population data, which tends to be relatively stable in sample communities for short time periods such as the length of this study (1 year), is highly unlikely to be affected by the treatment. In addition, the study will collect data on mediating outcomes to provide evidence on SUTVA assumptions and that the treatment is producing an effect through the theorized mechanisms. Specifically we will collect information about the number of monitoring trips conducted during the study period and the number of deforestation events verified by monitoring teams in each community. We will define other community-level covariates to use for verifying randomization assumptions and improve accuracy of effect estimates at a later date. These may include population size, area of collective lands, ethnicity, and distance from Iquitos.

7 Operationalization of Outcome Variables

7.1 Operationalization of Main Hypotheses

Our site-specific hypotheses are tested using a mix of behavioral, survey, and remote-sensed outcome data as enumerated in the following table. We will ultimately construct a z-score index for each hypothesis, as follows, consisting of the measures within each outcome. For outcome families in which outcomes are measured at different units of analysis (e.g. leaders and citizens), we collapse outcomes to the community level to construct the index.

1. Orient all k outcomes in the same direction.

2. For each outcome, Y_{ij}^k, calculate a normalized $\tilde{Y}_{ij}^k$ as follows:

$$\tilde{Y}_{ij}^k = \frac{Y_{ij}^k - \bar{Y}_{ij}^k | Z_j = 0}{\sigma_{Y_{ij}^k} | Z_j = 0} \tag{1}$$

   where $\bar{Y}_{ij}^k | Z_j = 0$ indicates the control group mean and $\sigma_{Y_{ij}^k} | Z_j = 0$ indicates hte control group standard deviation.

3. Calculate $\sum_k \tilde{Y}_{ij}^k$ and re-standardize by Equation 1 such that the control group mean on the index is 0 and the control group standard deviation is 1.

However, we also plan to report the individual outcomes such that the any variation across outcomes in a hypothesis family is known.

7.2 Meta-Analysis Operationalization

The following tables contain the operationalization of outcomes that we use for the meta-analysis. In this sense, this pre-analysis plan represents this project's anticipated contribution (ITT estimates) to the meta-analysis. In the meta analysis, the components of each index outcome will be indexed using a z-score index, as specified in the meta-analysis pre-analysis plan.

8 Estimation

We describe two estimators of the ITT, as follows. First, an estimator of the ITT of the monitoring treatment without covariate adjustment can be written:

Hypothesis		Source	Outcome
Manipulation check	1	Behavioral	Reports submitted (monitor-community-month level)
	2	Behavioral	Distance of monitoring trips conducted (monitor-community-month level)
	3	Survey	"Don't know" or "Did not answer" response on Q34 and Q35 (on the support of monitoring committees) [This is a secondary measure.]
Awareness of Deforestation	1	Survey	"Deforestation" (or related open-ended response) mentioned among top three issues in Q14-Q14B: "What are the main problems facing the community today?"
	2	Survey	Q15: "Do you know well the situation of the forest in your territory?" (Likert scale 1-3) with "do not know" coded as "no"
	3	Survey	Q16: "According to your personal knowledge, what is the situation of the forest in the collective territory of your community? Would you say that the forests are in ..." outcome is an indicator for identifies a status.
	4	Survey	Q17: "According to your personal knowledge, what are some threats to the forest of the collective territory of your community?" Measure 1 is governance (union of #2, #11, or #12); Measure 2 is physical threats (union of #4, #5, and #7); Measure 3 is the union of Measures 1 and 2.
	5	Survey	Q18: "If you would like to find out what condition the community mount is in, would you have any way of finding out?" Indicator for "yes"
	6	Survey	Q19: "In the last month, have you discussed the conditions of your community's mount with other members of your household or community?" Indicator for "yes"
Community Governance	1	Survey	Q1*:"How many times did the Junta Directiva meets?" (Community leaders only)
	2	Survey	Q2*: "When the Junta Directiva meets, how often do you discuss the problems related to cutting down trees on the traditional lands of your community?" (Community leaders only)
	3	Survey	Q3*: "When the Community Assembly meets, do most members of the community participate?"
	4	Survey	Q20: "In the last month, have you attended any meeting of the community assembly or community council?" (citizens and monitors only)
	5	Survey	Q21: "At the last meeting of the community assembly or community council that you attended, was the topic of the nature or natural resources of your community discussed or mentioned?" (citizens and monitors only)
	6	Survey	Q24: "How do you feel about the work of the Board of Directors of your community?"
Collective action	1	Survey	Q20: "In the last month, have you attended any meeting of the community assembly or community council?" (citizens and monitors only)
	2	Survey	Q34: "Would you voluntarily participate in a committee organized by the community to investigate the problem if it required half a day of travel outside the community?" (elicited willingness to pay)
	3	Survey	Q35: "Would you contribute voluntarily with some rice to feed the members of a committee organized by the community to investigate the problem?" (elicited willingness to pay)
	4	Survey	Q33: "If the community discovered that some THIRD PARTIES were occupying communal lands or felling community trees, how likely would you be to participate in a community meeting to decide what should be done?"
	5	Survey	Q36: "If a family in your community makes a business to sell trees from the community's territory to third parties without consulting others, how often does the community punish them?" [This is a secondary measure since community is the "actor."]
	6	Survey	Q37: "If a family in your community makes a business to rent land from the community's territory without consulting others, how often does the community punish them?" [This is a secondary measure since community is the "actor."]

Table 3: Outcome measures. Behavioral as a source of data corresponds to measures from the monitors' records and electronic records of monitors' actions.

Hypothesis		Source	Outcome
Deforestation	1	Satellite data	Area deforested (grid-cell month)
	2	Satellite data	Deforestation event (binary) (grid-cell month)
Assessment of the State	1	Survey data	Q27: "How do you feel about the management of the forest of the collective territory of your community?"
	2	Survey	Q29: "How do you feel about the work of the Peruvian state in the management of the forest of the collective territory of your community?"
	3	Survey	Q23: "How do you feel about the work of the regional government?"
	4	Survey	Q25: "Do you know who is responsible for controlling the forest of the community?" (indicator for entity outside community, e.g. Peruvian state)

Table 4: Outcome measures continued.

$$Y_{ijb} = \beta_0 + \beta_1 Z_j + \epsilon_{ijb} \tag{2}$$

where i indexes units at which the outcome is measured; j indexes communities; and b indexes blocks. Y_{ijb} is an outcome of interest measured at the individual or grid-cell level.[7] Z_j is an indicator of treatment assignment at the community level. β_1 represents the estimator of the ITT. Note that Equation 2 will be estimated using inverse probability weights, $\frac{1}{p_b}$, where p_b is the probability of assignment to treatment in block b. This accounts for unequal probabilities of assignment to treatment. All standard errors will be clustered at the community (j) level, because the community is the unit of assignment to treatment. We anticipate that the the unadjusted estimates will have relatively less precision (power) than the covariate-adjusted estimates below.

Second, our preferred estimator of the ITT of the monitoring treament with covariate adjustment is written:

$$Y_{ijb} = \beta_0 + \beta_1 Z_j + \lambda_b + \gamma \mathbf{X}_i + \epsilon_{ijb} \tag{3}$$

Here, λ_b represents block fixed effects and $\mathbf{X}_i$ represents a matrix of unit-level covariates. For the purposes of the satellite data, this includes past deforestation data. For survey or interview responses, this includes a vector of demographic controls consisting of: gender, age, education, and ethnicity, and enumerator fixed effects.

---

[7]For any community-level outcomes, Y_{ijb} should be written Y_{jb} and ϵ_{ijb} should be written ϵ_{jb}.

Table 5: Meta-Analysis Outcomes, Site-Specific Operationalization

	Family	Measure	Meta-Analysis Operationalization		Site-Specific Operationalization	
			Operationalization	Notes	Operationalization	Notes
H1	Resource use	Total use/quality	Site-specific: Resource use should be measures based on satellite data or ground measurement.		Area deforested	
H1	Resource use	Events	Site-specific		Occurrence of an early alert in grid cell in time t	
H2	Satisfaction	Satisfaction with resource	How satisfied are you with the status of the resource? [Likert scale]	Site specific: Status is defined relative to the resource/resource problem.	Q22: "How do you feel about the situation of the mount of the collective territory of your community?"	
H2	Satisfaction	Satisfaction with management	How satisfied are you with the management of the resource? [Likert scale]	Site specific: Management defined relative to the management body.	Q27: "How do you feel about the management of the forest of the collective territory of your community?" Q28: "How do you feel about the work of the community council in the management of the forest of the collective territory of your community?" Q29: "How do you feel about the work of the Peruvian state in the management of the forest of the collective territory of your community?"	Construct index with and without this variable; main specification should exclude this question.
H2	Satisfaction	Satisfaction with use by others	How satisfied are you with how other households are using the resource? [Likert scale]	Site specific: Use defined relative to the resource/resource problem.	Q30: "How do you feel with the participation of other families from your community to help in the management of the forest of the collective territory of the community?"	
H3	Knowledge	Certainty	Do you know the status of the resource? [Don't know, not sure, think I know, I know]	The exact question should depend on the site. It should focus on information that was accessible to the monitors, and where an objective measure exists for both the treatment and control groups.	Q15: "Do you know well the situation of the forest in your territory?"	
H3	Knowledge	Knowledge	What is the status of the resource?	Status is defined relative to the resource/resource problem	Q16: "According to your personal knowledge, what is the situation of the forest in the collective territory of your community? Would you say that the forests are in ..."	Responses are: Bad state; more or less; good state. Will compare to baseline deforestation data.

Family	Measure	Meta-Analysis Operationalization		Site-Specific Operationalization	
		Operationalization	Notes	Operationalization	Notes
H3	Knowledge	Knowledge	What are the causes of overuse, deforestation, or degradation?	Site-specific description of resource problem.	Q17: "According to your personal knowledge, what are some threats to the forest of the collective territory of your community?"	Activity with cards.
H3	Knowledge	Access to Knowledge	If you had to find out what is the status of resource would you have a way to find out? [Yes/No]	Site-specific description of the resource/resource problem.	Q18: "If you would like to find out what condition the community mount is in, would you have any way of finding out?"	In conjunction with Q18A (requires an affirmative response to Q18A).
H3	Knowledge	Salience	What are the first, second, and third most important problems facing the community today? [Open ended]	Categorization should be pre-specified by teams.	Q14: "What are the main problems facing the community today?"	Binary coding if deforestation in the top three mentioned problems (open ended question)
H3	Stewardship	Norms	Breaking social norms [replace with site-specific norms] is common. Do you believe it is legitimate to break [norm]?		Q31: "Do you think it is right to SELL trees from the territory of your community to third parties?" Q32: "Do you believe that it is correct to RENT lands from the collective territory of the community to third parties?"	
H3	Stewardship	Willingness to contribute to the common pool resource	Are you willing to contribute to the common pool resource? The funds will pay monitors to continue [or begin, in the control group] monitoring the resource?	Note whtether hypothetical or conducted with actual stakes (if possible)	Q34: "Would you voluntarily participate in a committee organized by the community to investigate the problem if it required half a day of travel outside the community?" Q35: "Would you contribute voluntarily with some rice to feed the members of a committee organized by the community to investigate the problem?"	(Elicitation of willingness to pay) (Elicitation of willingness to pay)
H3	Stewardship	Social norms enforcement	A lottery will be conducted in the community. If an individual did not contribute to the common pool resource wins, should she receive the prize? (The prize will not be awarded to anyone else instead.)	Note if a lottery of respondents is conducted.	–	Not feasible.

Family	Measure	Meta-Analysis Operationalization		Site-Specific Operationalization	
		Operationalization	Notes	Operationalization	Notes
I1	Scrutiny of management body	Knowledge	Do you know who is in charge of managing the resource? [Yes/No]		Q25: "Do you know who is responsible for controlling the forest of the community?"	
I1	Scrutiny of management body	Knowledge	Among those who said "yes" above, who manages the resource?		Q25A: "What position does the person you mention occupy?" (open ended)	Binary coding, 1 if respondent cites community government or national police.
I1	Management body perception of scrutiny	Site-specific (possibly qualitative) measures			Leader interview #4: "When someone in your community notices a threat to nature and nature's resources, for example, from a third-party invasion or a registrar, what does your community do to respond to these threats?"	
I2	Citizens' Interest	Discussion	How many conversations did you have about the resource over the past week/month?		Q19: "In the last month, have you discussed the conditions of your community's mount with other members of your household or community?"	
I2	Citizens' Interest	Attendance	Did you attend any meetings about the resource over the past X months?	X is site-specific.	Q20: "In the last month, have you attended any meeting of the community assembly or community council?" Q21: "At the last meeting of the community assembly or community council that you attended, was the topic of the nature or natural resources of your community discussed or mentioned?"	
I3	Social Sanctioning	Punishment likelihood	If a household in the community does not follow [site-specific] norms, how likely is it that they will be punished? [Likert scale]		Q36: "If a family in your community makes a business to sell trees from the community's territory to third parties without consulting others, how often does the community punish them?" Q37: "If a family in your community makes a business to rent land from the community's territory without consulting others, how often does the community punish them?"	

		Meta-Analysis Operationalization		Site-Specific Operationalization	
Family	Measure	Operationalization	Notes	Operationalization	Notes
I4	Monitoring rate	Monitors		This measure should focus on first stage of the experiment. Can include quantitative or qualitative measures (based on conversation with the community leadership). Measures can include information collected or diffused.		Behavioral data on monitoring trips per monht. Unit is the community.
I4	Monitoring rate	Managers		A qualitative or quantitative measure evaluating whether the community managers received new information due to the intervention	–	
–	Coordination		How many community meetings on the resource took place in the past month?		Q1*: "How many times did the Junta Directiva meets?" Q2*: "When the Junta Directiva meets, how often do you discuss the problems related to cutting down trees on the traditional lands of your community?"

These estimators are identical to those used in the estimation of the ITTs for the meta-analysis. For the spillover analysis, we will use the same estimators on satellite data from *outside* the communities.

8.1 Multiple Comparisons

We intend to test multiple relationships and hypotheses as manifest in our hypotheses. As such, we aim to address the threat of multiple comparisons through indexing. The first approach follows Kling, Liebman, and Katz (2007) by dividing our outcomes into families (as in Tables 7.2) and assessing the effects on a standardized index measure from each family, as enumerated above. Additionally, we will follow Benjamini and Hochberg (1995) and implements a false discovery rate (FDR) correction across families.

9 Power Analysis

Given the multiple sources of outcome data with differing units of analysis, we present the results of power simulations on two conservative estimators we employ. These simulations assume full compliance with treatment assignment and no attrition. Earlier in the project, we characterized and analyzed our design in `DeclareDesign` and will share these analyses upon request. The analysis below is a reduced version of those simulation.

9.1 Survey Outcomes

In the context of survey outcome data, we assume 10 respondents per community. We vary the ICC as well as the ITT (here ATE) size. We estimate a regression without covariate adjustment following Equation 5, focusing on the estimator β_1, the effect of monitoring. We report the power of both one- and two-tailed tests at the $\alpha = .05$ level in Table 6.

	Simulated Standardized ATE				
ICC	0.1	0.2	0.3	0.4	0.5
0.00	0.236; 0.324	0.624; 0.728	0.912; 0.94	0.99; 0.996	1; 1
0.20	0.112; 0.202	0.27; 0.396	0.522; 0.622	0.766; 0.854	0.916; 0.958
0.40	0.082; 0.122	0.206; 0.276	0.382; 0.47	0.568; 0.688	0.724; 0.82
0.60	0.098; 0.136	0.154; 0.242	0.266; 0.368	0.396; 0.53	0.556; 0.704

Table 6: Power for one-tailed tests (left and right, respectively) using simulated survey data without covariate adjustment. Each cell represents the estimate over 500 simulated data sets.

Table 6 suggests that for moderate ICC values ($\approx .2$), we can detect a sizable standardized effect of 0.4. Covariate adjustment should increase the precision of the estimates and may lead to modest power gains.

9.2 Deforestation Data

We do a power calculation that mimics our approach to the satellite data with several simplifying features. First, we assume the community (not the grid cell) is the unit of analysis, which should be conservative. In this context, we assume the dependent variable to be continuous representing, for example, the share of area deforested in a given month. We further assume a seasonal pattern, derived from existing deforestation data from the Amazon but standardize by month, such that the simulated treatment effect is a standardized effect on the share of area deforested in a given month. Variance in potential outcomes can be decomposed into the unit, community, month, and observation (e.g. community-month) terms. To show the gains from inclusion of the pretreatment covariate, we estimate two versions of the main regression specification, as follows:

$$Y_{i,m,2018} = \beta_0 + \beta_1 M_{i,2018} \qquad\qquad \text{No covariate adjustment}$$

$$Y_{i,m,2018} = \beta_0 + \beta_1 M_{i,2018} + \gamma \bar{Y}_{i,m,2012-2017} \qquad \text{Adjustment for 6-year average by month}$$

We varying the effect size for the main monitoring treatment (common arm) and the state engagement arm, we show power estimates for both one-tailed tests for the estimator β_1 in the preceding equations in figure Table 7. We cluster standard errors at the community level. This simulation invokes strong assumptions as to the year-to-year seasonal variation. Our assumptions about seasonality and patterns of deforestation underpinning this simulation are drawn roughly from existing data. The gains from covariate adjustment will rely heavily on the correlation between the lagged dependent variable and realized outcomes. In the simulations, the correlation between potential outcomes (unit-month level) in two given years is $\approx .5$. Increasing this correlation leads to substantial gains in power while reducing it leads to losses in power with the covariate-adjusted estimators. Considering our analyses of pre-treatment data, we anticipate

that we can detect a standardized 0.18 effect with a power of 0.8 with the covariate-adjusted estimator, as suggested by Table 7.

Estimator	Simulated Standardized ATE of Monitoring			
	0	0.1	0.2	0.3
No Adjustment	0.048	0.114	0.276	0.46
Adjustment	0.052	0.400	0.840	0.984

Table 7: Power for one-tailed tests (left and right, respectively) using simulated survey data without covariate adjustment. Each cell represents the estimate over 500 simulated data sets.

10   Attrition and Missing Data

Satellite outcome data is based on publicly available satellite data, there is no risk of attrition *per se*. While satellite observations are sometimes compromised by cloud cover or other physical phenomena, such features are uncorrelated with treatment assignment and have been discussed bin detail in the exposition of this data.

The greatest threat of attrition with the survey data comes from a community refusing to participate in the endline survey. RFUS will endeavor to mitigate such problems by identifying uninterested communities in the community selection process and defining the experimental sample accordingly. We know that one block was not surveyed due to poltical risks. We will assess:

- Community-level missingness

- Individual-level missingness (refusal to participate in the survey)

- Item-level missingness

separately. We will assess whether missingness is correlated with treatment by regressing missingness on treatment assignment following Equations 2 and 3. If there is no evidence of an association between treatment assignment and missingness we will estimate the ATE dropping missing observations.

If there is evidence of differential attrition, we will:

1. Estimate the ITT among blocks in which all communities were surveyed.

2. Estimate extreme value bounds on the estimated ITT.

11   Contribution to the Meta-analysis

The meta-analysis associated with this Metaketa is preregistered with EGAP. To the extent that the tests and estimators depart from those pre-specified for the meta-analysis, our contribution to the meta-analysis will adhere to the specifications in that pre-analysis plan.[8]

12   Risk Management Plan

12.1   Weather setbacks (extremely dry or wet)

The Amazon region of Peru still maintains vast expanses of forested land with little presence of state institutions and infrastructure. While this makes an ideal context for the monitoring intervention, it also complicates travel and project logistics. All intervention communities are located along major rivers which are a principal means of ingress and egress. Therefore, weather conditions, including extreme dry conditions during the summer and heavy rains and flooding during the winter months, can cause delay in travel between city centers (e.g. Iquitos) and intervention communities. Heavy rains during winter months can limit the ability to travel by road and by foot due to poor roads or trail conditions. These conditions will not adversely affect the project as the primary mode of travel to communities is river. However, during the summer, long dry periods can reduce river levels cause travel times by boat to increase by 1-2 days.

Ultimately, there is little we can do to prevent or predict delays caused by weather. However, our project timeline takes into account seasonal weather conditions and our design mitigates the risk of extreme weather undoing the randomization process (for example, through differentiated treatment to communities due to travel distance). First, the principal risk due to weather is from extremely dry conditions limiting travel to communities during the summer months. This could cause delays in the implementation of the treatment (monitor training) and in the follow up travel to treatment communities. We mitigate the first of these problems by holding trainings during the beginning of the wet season, when travel conditions to communities are better. The second problem (follow up trips), is likely a lower risk. These trips are done once a month per river

---

[8]See the Meta-Analysis Pre-Analysis Plan at http://egap.org/registration/2815.

basin, and all communities will be visited during the same trip. To avoid differentiated followup for treatment communities, we will begin the trip with the furthest to reach community, and work backward toward the urban center and the easier to reach communities. Therefore, the followup trips will only be conducted if the most difficult to reach community is accesible. If travel to the most distant community is impossible during a given week, then all communities within the basin will have a delayed followup trip.

12.2 Political risks with indigenous populations

There are certain political risks inherent to working with indigenous communities in the Peruvian Amazon because of the potential for difficulties when coordinating with indigenous federations. Each community belongs to a different regional federation, which organizes villages into larger political units based on geographic and sometime ethnic divisions. These federations then serve as de facto regional and national governments uniting diverse communities. Although there is no legal obligation to coordinate with these federations, practically and ethically speaking, having sound relations with these federations is essential for a successful project.

However, coordination with federation leaders also brings additional risks to the project. First, leadership can often change due to periodic elections (which are not always held on a regular basis) or due to corruption scandals. In addition, a corrupt leader could extort the project by threatening to impede access to communities unless project money is distributed directly through leaders. Finally, a federation leader could try to interfere with the randomization process to funnel project funds through preferred communities that support the leader.

The principal means through which we will attempt to mitigate these risks is through the knowledge and experience of our implementing partner RFUS. Rainforest has two local staff in charge of project implementation that have many years of experience coordinating and working within indigenous federations in Peru. They have been assessing the political climate of the different regional federations that have jurisdiction over potential project sites, and are using these criteria for making the final selection of river basins. RFUS has suggested that the greatest chance of success for the project will be to work with the ORPIO federation, which has jurisdiction over two potential project sites, the Amazon and the Marañón River Basins. ORPIO?s current leader-

ship has a stable base of support, has demonstrated good management practices with funding from other projects, and has a good relationship with RFUS staff. RFUS has also suggested delaying implementation of the project until after June federation elections, a decision that we have already incorporated into the project timeline.

12.3 Community level - people dropping out of study or cause conflict

There are also risks at the community level that may affect the project and cause non-compliance. We have identified two potential areas of difficulty. First, a community may ultimately not be interested in participating in the monitoring intervention or may be plagued with internal conflict that would inhibit participation. Second, communities that desire to participate and are selected for the control condition may be resentful, and demand to be compensated with additional project funds or create a monitoring project of their own. The first problem would create a situation of one-sided non-compliance (never-takers), while the second would imply two-sided non-compliance (always-wakers).

To mitigate the first problem, we conducted a pre-selection process in which we require all the communities to manifest an initial willingness to participate in the intervention. RFUS will first hold informational sessions in which representatives of all communities in a given river basin will participate. Each community that desires to participate will then discuss the possibility internally within their community and send RFUS a singed statement indicating their interest in participating. The randomization will then be conducted on the basis of this final list of pre-selected communities.

For the second non-compliance problem, RFUS has advised that the best way of dealing with resentful communities is through an open and transparent selection process. RFUS will emphasize with communities that the selection will be through a lottery and completely fair. RFUS will also have a continued presence in each of the project areas, and has already expressed that it will continue to implement the project in these basins if it proves successful. Therefore, RFUS will also be able to offer the intervention to control communities at a future time, which will reduce the risk of resentment by control communities. In addition, given the training and access to technology involved in the monitoring project, it will be difficult for control communities to

implement an intervention without the help of an outside NGO or foundation.

12.4 Illegal occupation of land for coca and gold extraction

There is a constant risk in the Peruvian Amazon that indigenous land is occupied for means of illegal activities such as coca cultivation, gold mining, or illegal logging. These risks are endemic to the region and affect communities regardless or participation in the intervention. In addition, greater information provided by monitoring teams will potentially allow communities to better limit exposure to these risks and alert national authorities. However, involvement in the monitoring project could expose monitoring teams themselves to a greater danger due to the presence of illegal activity on indigenous land. We will attempt to mitigate this risk for all participants in two ways: (1) by ensuring that all participants are fully aware and adequately trained in risk prevention; and (2) through the continuing involvement and support of our implementing partner, RFUS.

The first method of risk prevention will be incorporated into the training of community monitoring teams. These teams, given their relatively consistent presence in the community?s forest, have the greatest potential to be exposed to elevated levels of risk and therefore will be the focus of our risk prevention efforts. A large segment of the training program for monitors will involve a participatory workshop that will help community members identify and reduce potential risks. The training itself will emphasize conflict prevention and methods for avoiding confrontation with non-community members engaged in illegal activity. However, it is important to note that the community members themselves are in possession of the greatest knowledge of the risks in their lands and how to mitigate these. Therefore, the training will primarily utilize participatory methodology that will help community members apply their knowledge of the area to identify risks and plan how to limit these accordingly.

The second method for mitigating these risks will be through the continued involvement of RFUS, which already has a program in place for assisting communities threatened by illegal loggers or squatters. This program involves funding required medical, legal, or logistical assistance to attend to any individual injured by illegal activity on community lands and to advocate for appropriate state intervention seeking criminal liability for those responsible and adequate

compensation for the community. RFUS also has an extensive network of organizations and advocates both regionally in Ucayali and Loreto, and nationally in Peru, that can help provide assistance to all communities participating in the project.

References

Agrawal, Arun. 2007. "Forests, Governance, and Sustainability: Common Property Theory and its Contributions." *International Journal of the Commons* 1 (1): 111–136.

Avelino, Andre Fernandes Tomon, Kathy Baylis, and Jordi Honey-Rosés. 2016. "Goldilocks and the Raster Grid: Selecting Scale when Evaluating Conservation Programs." *PLOS ONE* 11 (12): 1–24.

Benjamini, Yoav, and Yosef Hochberg. 1995. "Controlling the False Discovery Rate: A Practical and Powerful Approach to Mulitple Testing." *Journal of the Royal Statistical Society. Series B.* 57 (1): 289–300.

Casey, Katherine, Rachel Glennerster, and Edward Miguel. 2012. "Reshaping Institutions: Evidence on Aid Impacts Using a Preanalysis Plan." *Quarterly Journal of Economics* 127 (4): 1755–1812.

Dietz, Thomas, Elinor Ostrom, and Paul C Stern. 2003. "The Struggle to Govern the Commons." *Science* 302 (5652): 1907–1912.

IBC. 2016. Directorio 2016 Comunidades Nativas del Peru. Technical report Instituto del Bien Comun.

Kling, Jeffrey R, Jeffrey B Liebman, and Lawrence F Katz. 2007. "Experimental Analysis of Neighborhood Effects." *Econometrica* 75 (1): 83–119.

Ostrom, Elinor. 1990. *Governing the Commons*. Cambridge university press.

Yashar, Deborah J. 2005. *Contesting Citizenship in Latin America: The Rise of Indigenous Movements and the Postliberal Challenge*. Cambridge University Press.