Lorenzo Pellegrini

Impacts of community monitoring of socio-environmental liabilities in the Ecuadorian and Peruvian Amazon

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3ie accepted the final version of the report *Community monitoring of socio-environmental liabilities with advanced technologies: evidence from a randomised control trial in the Ecuadorian and Peruvian Amazon* as partial fulfilment of requirements under grant TW8R2.1006, awarded under the Transparency and Accountability in Extractives Evidence Programme. The content has been copy-edited and formatted for publication by 3ie.

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Summary

Ecuador and Peru are two countries that have recently seen an expansion of the hydrocarbon frontier matched by intense negative environmental change, severe health impacts and social conflict. Many of these effects have stemmed from the way in which negative environmental impacts have been (mis-)handled.

The ability of regulators to detect and manage the impacts of hydrocarbon extraction has remained insufficient. Companies have also not consistently pursued effective strategies to minimise environmental risks and to mitigate their impact when they are unavoidable. As a consequence, environmental liabilities generated by oil extraction (e.g. oil spills, disposal of highly contaminated formation waters and drilling muds) continue to create adverse environmental and public health outcomes.

This impact evaluation focuses on an ongoing initiative that seeks to enhance the detection, monitoring and reporting capabilities of local communities as a strategy to strengthen their ability to produce claims concerning environmental degradation that has a direct impact on human welfare.

The area covered by the intervention is in the Ecuadorian and Peruvian Amazon and includes towns, villages and sparsely populated areas. The intervention trains members of local communities and equips them with high-tech but relatively inexpensive tools such as mobile phones, drones and online apps. The objective of the intervention, which combines advanced technology and capacity-building among local youth who work as monitors, is to increase the rate of detection of environmental liabilities.

The intervention is also expected to increase the dissemination of reports of liabilities not only to the appropriate authorities (maximising the possibility that action will be taken), but also to the media. It is expected that improved detection, monitoring and reporting will ultimately lead state and corporate actors to mitigate the socio-environmental impacts of oil extraction.

The impact evaluation leverages the randomised phase-in approach used in the implementation of the monitoring programme to construct treatment and control groups. That is, the order of inclusion in the programme has been randomised for 24 monitoring teams, and during implementation, the treatment and control groups coexisted.

We estimated the impact of the intervention in terms of increased detection of environmental liabilities, reporting to state authorities and uptake by the media. The findings suggest that the intervention did significantly increase detection and reporting to state authorities. Reporting by the media has similarly increased, but from such a low base as to remain not very meaningful.

The results of the impact evaluation indicate that in relatively remote areas, community-based environmental monitoring of extractive industries can be an effective tool to help create the necessary conditions to hold companies to account and contribute to improving practices in the long run. The results might also raise awareness of these impacts beyond the areas where extractive industries are already operating; however, the limited attention of the media to these impacts remains a challenge.

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Abbreviations and acronyms

ACODECOSPAT	Kukama Association for the Conservation and Development of San Pablo de Tipishca (Peru)
FDA	Amazon Defense Front (Ecuador)
FECONACO/FECONACOR	Achuar Federation of Native Communities of the Corrientes River (Peru)
FECONAT	Kichwa Federation of Native Communities of the Tigre River (Peru)
FEDIQUEP	Quechua Indigenous Federation of the Pastaza River (Peru)
OEFA	State Agency for Environmental Enforcement (Peru)
PUINAMUDT	Amazon Indigenous People Together in Defense of Their Territories (Peru)
UDAPT	Union of Peoples Affected by Texaco (Ecuador)

1. Introduction

Extractive industries occupy an important place in the annals of Latin American economic development; the continent's rich mineral resources were central to the colonial dynamics unleashed more than 500 years ago. The relationships established then have arguably left behind institutional structures whose impact still reverberates today (Engerman and Sokoloff 2012; Galeano 1973).

In the contemporary era, extractive industries have not only focused on mineral resources but also on hydrocarbons. Not unlike the legacy of mining, the experience of Latin American countries with oil extraction can be described as a mixed blessing.

Some analysts have argued that the sector has been a source of extensive foreign direct investment and economic dynamism, even if its overall contribution to employment generation and national economic development has been limited (Manzano et al. 2008). Others have asserted that the overall impact of extractive industries at the national level has been negative, amounting to a resource curse (Acosta 2011; Papyrakis and Pellegrini 2019).

When it comes to the effects of the oil sector on the environment, extraction has been associated with several adverse impacts. These include extensive pollution of ecosystems due not only to accidental spills of crude oil during production and transportation through oil pipelines, but also deliberate strategies. For example, the discharge of what are known as 'produced waters' (toxic byproducts of the process through which crude oil is separated from other co-existing compounds) into rivers and streams has resulted in extensive damage to Amazonian ecosystems (Yusta-García et al. 2017).

The negative impacts of oil have, of course, not been limited to flora and fauna, but have also gravely damaged the health and wellbeing of the indigenous and *mestizo* settlers that live in the Amazon (Arellano et al. 2017; Barraza et al. 2018, 2017; Buccina et al. 2013). Nevertheless, factors including rising oil prices during the previous decade, heavy investment from China into the region, and the arrival of progressive governments promising increased public spending have all combined to create an 'extractive imperative'. As a result, there has been a marked increase in hydrocarbon extraction in the last decade (Arsel et al. 2016).

Ecuador and Peru are two notable examples of countries that have recently seen or are planning a massive increase in hydrocarbon extraction – from 7% of the Peruvian Amazon covered by oil and gas concessions in 2003 to 50% in 2010 (Orta-Martínez and Finer 2010). Likewise, it has risen from 32% of the Ecuadorian Amazon covered by concessions to the planned 68% (Lessmann et al. 2016). It has caused intensely negative environmental change, severe health impacts and social conflict (Martínez-Alier 2011).

Many of these effects have emerged from the way in which negative environmental impacts have been handled. In particular, the ability of regulators to detect and manage the impacts of hydrocarbon extraction has remained insufficient. Similarly, companies have not consistently pursued effective strategies to minimise environmental risks and to mitigate their impact when they are unavoidable (Watts 2005).

As a consequence, environmental liabilities generated by oil extraction (e.g. oil spills, disposal of highly contaminated formation waters and drilling muds) continue to create adverse environmental and public health outcomes.

This impact evaluation focuses on an ongoing initiative that seeks to enhance the detection, monitoring and reporting capabilities of local communities as a strategy to strengthen their ability to produce claims concerning environmental degradation that has a direct impact on human welfare.

The intervention trains and equips local communities with high-tech but relatively inexpensive tools, such as mobile phones, drones and online apps. The objective of the intervention, which combines advanced technology and capacity building among local youth who work as monitors, is to increase the rate of detection of environmental liabilities.

The intervention should also increase the dissemination of reports of liabilities, not only to the appropriate authorities (maximising the possibility that action will be taken), but also to the media. It is expected that improved detection, monitoring and reporting will ultimately lead state and corporate actors to mitigate the socio-environmental impacts of oil extraction.

2. Description of the intervention area in Ecuador and Peru

2.1 Oil extraction in the northern Ecuadorian Amazon

In Ecuador, the exploration for petrol deposits started in the northern part of the Amazon in the 1920s. In 1967, the consortium Texaco-Gulf drilled the first productive oil well in Lago Agrio, Sucumbíos (Arsel et al. 2019) (Figure 1).

Figure 1: Well platform, Vía Auca, Orellana Province

Photo: José Cisneros, ISS

The Ecuadorian Amazon is a highly biodiverse lowland of tropical rainforest and home to approximately 740,000 people of different ethnicities; 250,000 people belong to 11 different indigenous groups (López et al. 2013, p.14). Even though oil is certainly a national concern, its role in the Ecuadorian Amazon is greater than in the rest of the country. In what remains a rural area with low population density, oil extraction plays an outsized role economically, socially and environmentally (Arsel et al. 2019).

While there are direct positive economic effects related to employment creation and service opportunities, oil extraction is also associated with negative economic externalities such as the subnational Dutch disease effect (Raveh 2013). Although most of the benefits of oil extraction accrue to the country as a whole, the environmental impacts of oil are decidedly local. These impacts also concern ecosystems that are critical for human health.

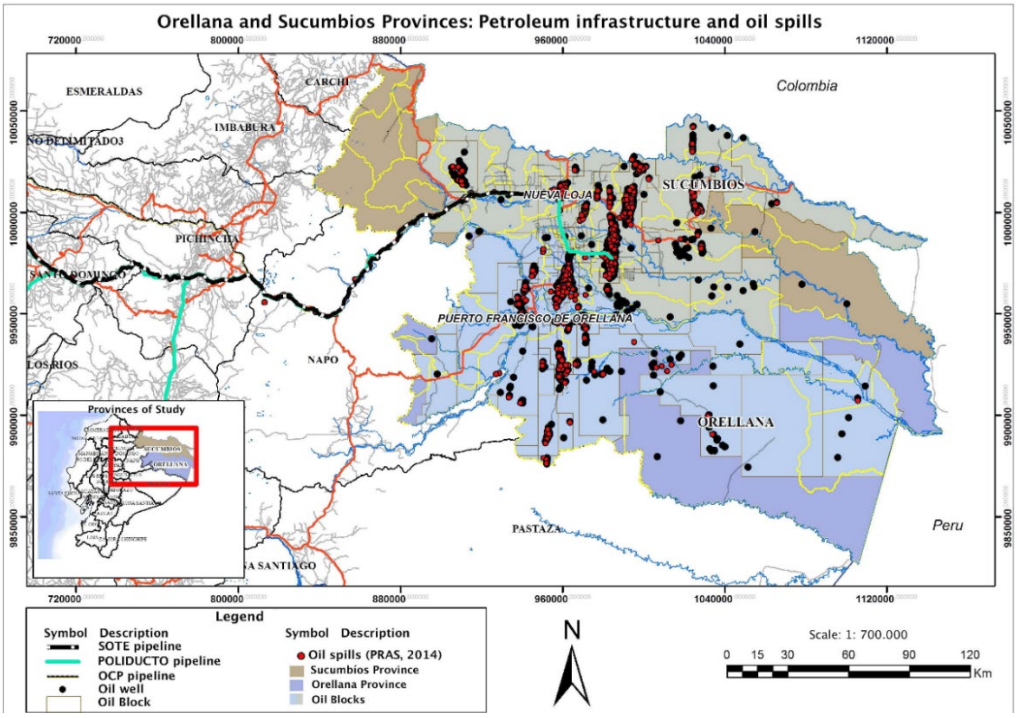
While there are few epidemiological studies on the impacts of oil extraction in tropical environments (O'Callaghan-Gordo et al. 2016), in the study area of the Ecuadorian Amazon the following health problems have been reported for communities exposed to the oil industry: higher risk of spontaneous abortions among women (San Sebastián et al. 2002; San Sebastián and Armstrong 2001); higher risk of overall cancer and cancer mortality among men (San Sebastián 2001); and higher risk of childhood leukaemia (Hurtig and San Sebastián 2005; San Sebastián and Hurtig 2005).

The Ecuadorian Amazon is contractually partitioned into oil concession areas, so called "*bloques*" (blocks), assigned to different national and international companies. In the region, 39 oil blocks are allocated for operation, covering approximately 3.5 million hectares (3,475,734.21 ha, or 59% of the whole Amazon region). Five blocks are not allocated to any operator (851,311.44 ha) and 15 blocks (2,497,222.98 ha) are still up for bidding in the eleventh oil concession round (Secretaría de Hidrocarburos – Petróleo Ecuador n.d.).

According to the Executive Report of Hydrocarbon Statistics for the year 2009, there are 3,299 oil wells, of which 1,008 correspond to state-owned companies and 2,291 to private companies (López et al. 2013, p. 24).

The northern part of the Ecuadorian Amazon, and the provinces of Sucumbíos and Orellana in particular, are delineated by the rivers San Miguel and Putumayo to the north (border with Colombia), by the Peruvian border to the east, by the border with Pastaza province to the south, and by the Andes mountain range to the west.

Figure 2: Orellana and Sucumbíos provinces: petroleum infrastructure and environmental liabilities reported to state authorities up to 2014.

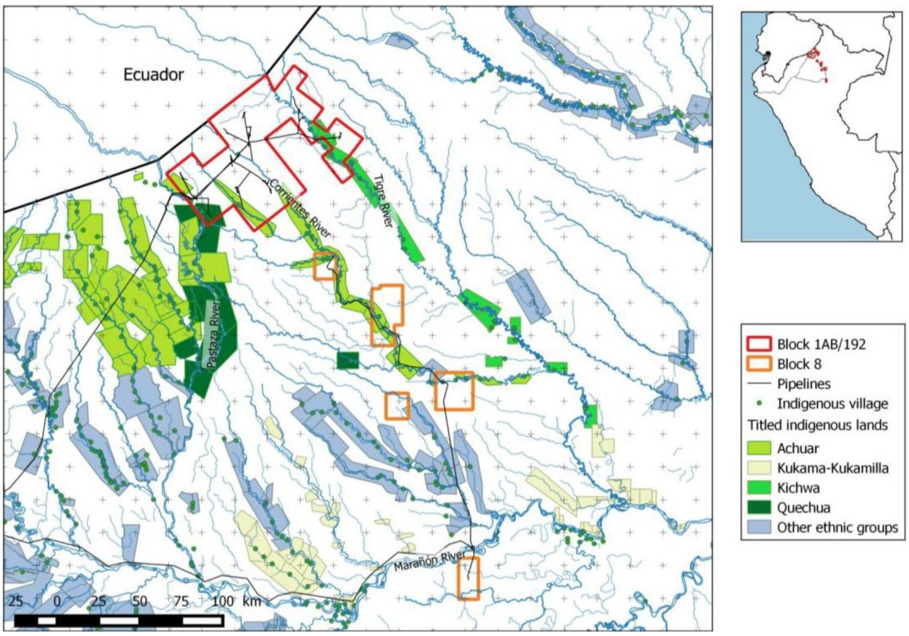


Sources: SENPLADES 2013 and Social and Environmental Remediation Programme 2014.

2.2 Oil extraction in the northern Peruvian Amazon

Oil extraction in Peru is taking place in the country's Amazonian territories. In the northern Peruvian Amazon, oil concessions known as Block 1AB (now 192) and Block 8 were leased in 1969 and 1971 (Figure 3).

Figure 3: Map of 1AB/192 and 8 oil concessions in the northern Peruvian Amazon



Source: Own elaboration with information from Instituto del Bien Común and Environment Ministry of Peru.

These concessions overlap with the Corrientes, Pastaza, Tigre and Marañón river basins. The oil blocks were first held by PetroPeru (the Peruvian national oil company) and Occidental Petroleum Corporation (a US-based company commonly referred to as OXY), then transferred to Pluspetrol del Norte SA (a seemingly transnational company, whose headquarters and the nationality of its main shareholders are hard to trace) in 1996 and 2001 (Orta-Martínez et al. 2018).

In August 2015, the 1AB/192 concession expired and a new contract was signed with Pacific Stratus Energy, a subsidiary of Toronto-based Pacific Rubiales Energy. These oil blocks are the longest-running oil projects in the Peruvian rainforest and the most productive in Peru (Orta-Martínez and Finer 2010), with an accumulated production of 1,032 million barrels and 433 wells drilled (39.2% of total national oil production and 97.6% of total production of the Peruvian Amazon (MEM 2014).

The negative environmental and public health impacts of oil extraction have been identified and extensively documented by various Peruvian state agencies since the early days of the oil field (Orta-Martínez et al. 2007). A report published by the Research Institute of the Peruvian Amazon in 1985 reported pollution from hexavalent chromium and found concentrations of lead in fish samples above acceptable limits for human consumption (Maco et al. 1985).

Both the Ministry of Energy and Mines (MEM 1998) and the Peruvian Regulatory Body for Energy Investment (OSINERG 2004) reported concentrations of hydrocarbons, barium, lead, mercury and chlorides in rivers and river sediments of the area above the maximum permissible limits, and recorded the "presence of visible petroleum spills in different places and extensive areas with scarce or deteriorated vegetation cover" (MEM 1998).

In 2005, the Ministry of Health found that 98.6% of Achuar children between 2 and 17 years of age exceeded the acceptable limits for cadmium in their blood, and 66.2% exceeded that for lead. It was also found that 99.2% and 79.2% of adults, respectively, exceeded these limits (DIGESA 2006). In 2013, analysis conducted by different governmental agencies showed widespread oil pollution in the area, leading the Peruvian government to declare, first, an environmental state of emergency, and later, in 2014, a health emergency in the Pastaza, Corrientes, Tigre and Marañón river basins.

The discharge of produced waters is an especially important factor in these and other serious impacts. Consequently, the manner in which these produced waters are disposed of has been one of the main drivers of indigenous social mobilisation (Orta-Martínez et al. 2018).

More than 10,000 indigenous people, mostly Achuar, Kichwa, Quechua, and Kukama-Kukamilla, live in these river basins (Instituto del Bien Común 2016). Since the 1990s, they have been represented by four federations: the Achuar Federation of Native Communities of the Corrientes River (FECONACO, now FECONACOR), the Kichwa Federation of Native Communities of the Tigre River (FECONAT), the Quechua Indigenous Federation of the Pastaza River (FEDIQUEP), and the Kukama Association for the Conservation and Development of San Pablo de Tipishca (ACODECOSPAT).

Since 2011, these organisations joined a platform called PUINAMUDT (Amazon Indigenous People Together in Defense of Their Territories), which coordinates activities associated with common concerns (Orta-Martínez et al. 2018). Each of the four organisations has developed a community-based programme that monitors the operation and impacts of the oil industry.

3. Intervention, theory of change and research hypotheses

3.1 Intervention

The intervention being evaluated is an enhanced monitoring package used by community monitors to detect and report socio-environmental impacts of oil activities in the Ecuadorian and Peruvian Amazon. Monitoring activities by local communities are already taking place through basic participatory systems that have been implemented jointly by the implementing agency and the research team (Orta-Martínez and Finer 2010).

Implementing agencies try to ensure a fair and logistically feasible geographical representation of monitors, who are relatively young because of the physical requirements of the monitoring work. Monitors are paired by location and commit to oversee a specific geographical area; details are provided in Tables A1 and A2 in the appendix. All monitors are literate and are trained to use information and communication technology as part of the intervention.

The most common occupation for monitors is work on their own, on the family farm, or as a day labourer. The monitors, apart from training events that take a few days per year, dedicate one day each month to routine monitoring and make specific visits to sites when they are alerted about a new environmental liability. In Ecuador and Peru there are two and three monitoring coordinators, respectively, who are in charge of overseeing the activities and collect and manage the information provided by individual monitors.

In principle, the coordinators receive a basic payment and monitors are reimbursed for expenses; when possible, they also receive a payment equivalent to that of a day labourer. Given the precarious financial situation of the implementing agencies, actual payments tend to fluctuate over time and delays in disbursement are not uncommon.

The monitoring activities are ultimately aimed at improving oil extraction practices and implementing effective remediation activities to ameliorate impacts. In turn, these improvements are expected to lead to the betterment of the welfare of local communities that suffer the negative consequences of extraction, with health impacts being of particular concern.

In both Peru and Ecuador, formal procedures to report oil spills rely mostly on the oil companies themselves. Thus, in Peru, all oil spills bigger than one barrel (159l) need to be reported to the Peruvian enforcement agency (Organismo Estatal de Fiscalización Ambiental (OEFA)) by the oil companies through a preliminary report of accidents, or "*informe preliminar de siniestros*". The Directorate of Supervision of the OEFA will then conduct a field mission to the site, issuing a field report. The Directorate of Supervision of the OEFA will also supervise the environmental remediation of the site and, if appropriate, will issue an accusative technical report (usually a year after the occurrence of the oil spill). Based on both reports, the Directorate of Supervision, Sanction and

Application of Incentives may initiate an administrative sanction procedure. A similar procedure is in place in Ecuador.

The media regularly covers social mobilisation associated with oil extraction. This coverage concerns both socio-environmental impacts (especially contamination and its effect on human health) and the redistribution of rents generated by extraction (for example, employment of the local labour force and the construction of physical infrastructure) (Pellegrini et al. 2018). In both Ecuador and Peru, oil spills are the main environmental liability reported by the media.

The intervention is an enhanced monitoring package allowing communities to leverage technologies that are now common, inexpensive and developed for and together with the users. These include (open source) apps, smartphones, drones and user-friendly interfaces of routines and protocols for the collection, storage, organisation and transfer of information in standard formats.

The potential impact of the deployment of the technology is very large. For example, one of the main impacts of oil extraction are the all-too-common oil spills and a well-functioning package would enable early detection (drones); documentation (smartphones and apps linking pictures, GPS information and narrative description); storage (apps for local and cloud-based synchronising and back-up); transmission to the headquarters of indigenous organisations (apps for the collection of synchronised and backed-up information); and eventually the transmission of this information to state agencies, oil companies and mass media (interfaces and reporting protocols).

There are 24 monitoring teams belonging to three implementing agencies: UDAPT (Union of Peoples Affected by Texaco, the group that represented the plaintiffs in the Texaco/Chevron lawsuit) and FDA (Amazon Defense Front, an NGO with social and environmental objectives) in Ecuador; and PUINAMUDT (Amazon Indigenous Peoples United in Defense of their Territory, a federation of four Peruvian indigenous organisations).

In Ecuador, these implementing agencies are two social organisations that represent indigenous and *mestizo* people and communities, while in Peru, the implementing agency is a federation representing indigenous people. In principle, the monitoring teams cover a specific portion of territory[1] and operate with some degree of independence in terms of day-to-day organisation.

The development process was kick-started at the Hack the Rainforest hackathon in February 2015. A hackathon is a work marathon of digital activists ('hackers') developing software that is tailor-made for users. At the hackathon, indigenous activists, technologists and civil society partners convened in the town of Tarapoto in the Peruvian Amazon to address challenges faced by community-based monitors of oil activities in the Amazon.[2]

[1] The boundaries of communities and organisations are often contentious in the Amazon (Reyes-García et al. 2012). As a consequence, all territorial subdivisions used in the intervention, and embedded in this impact evaluation, have to be considered in context, are indicative and should not be considered as a basis for exclusive rights.
[2] See http://www.hacktherainforest.org/ Accessed: 01 July 2018.

The backbone of the package is composed of training events, software (smartphone apps that are connected to software for the collection, transmission and management of information) and hardware (smartphones and drones).

The apps contain simple forms used by the monitors, who visit contaminated sites to record time, geographical position, classification and description of the environmental liability, as well as pictures and audio recordings of witnesses who can provide additional information. If appropriate, a drone can be used to take aerial photographs and videos.

The development and refinement of the package proved to be more challenging than initially expected and some ambitions had to be scaled back: for example, the use of open-source mapping technologies has been temporarily abandoned by the team in Ecuador, who have reverted to using commercial software that provides quicker and more functional solutions underpinning the website.

As another example, it was found that the do-it-yourself approach to drone building was an ill fit for field conditions, and rather than assembling fixed-wing drones, the team adopted ready-to-fly drones that have become extremely popular during the implementation of the intervention. The increase in popularity is underpinned by plummeting prices and ever-improving specifications. However, some of the ambitions in terms of tailoring, technological control and long-range surveillance through drones have been frustrated since the fixed-wing models have been abandoned.

3.2 Theory of change

The intervention ultimately aims to increase environmental quality (therefore reducing the oil-related health risks of local populations) in target areas by first improving remediation of environmental liabilities (increasing both incidence of remediation and speed at which they are initiated and completed), and second, by reducing the incidence of environmental liabilities (e.g. oil spills from pipelines).

Both outcomes are expected to result from the same outputs – increased rate of detection and reporting – but realised over different timescales and through different mechanisms. In particular, considering the time necessary to update remediation procedures and physical infrastructure, the ultimate objectives of the intervention fall outside the time horizon of this impact evaluation. For these reasons, the evaluation focuses on intermediate steps and aims to estimate to what extent the intervention increases the rate of detection and reporting of environmental liabilities.

It is assumed that the number of environmental liabilities is significantly larger than those formally known without intervention. In other words, the intensification of monitoring activities that complement existing (albeit limited) efforts undertaken by state and corporate actors should lead to improved detection rates.

It is also assumed that detection alone is not sufficient to achieve meaningful outcomes without effective reporting. This assumption is, of course, supported by extensive ethnographic evidence that local communities often 'know' or perceive negative socio-environmental impacts, but their knowledge might not be transmitted in a timely and accurate manner to relevant authorities. It is also assumed that, even when communities report their knowledge, either this knowledge is not compatible with established protocols or it is not taken seriously by authorities due to various biases.

The use of smartphones loaded with custom-designed apps enables monitors to record the damage associated with environmental liabilities using high-quality imagery, to record a precise GPS reading of the site, and to input (in text or audio) additional pertinent information. The apps developed specifically for this purpose store and organise this information and transmit all or part of it to the implementing agencies. Put crudely, the use of smartphones and custom-made apps will transform community monitoring of spills from hearsay to accurate, reliable and easily transmittable information.

It is theorised that the introduction of advanced technology into the process of monitoring will, in the medium term, increase the number of administrative processes and disciplinary actions issued by state agencies regarding environmental liabilities, resulting in increased remediation in the medium to long term. In the long term, this will improve the operational practices of the industry and reduce liabilities altogether.

The first effect will happen not only because of the already mentioned accuracy/reliability effect. The information collected in this manner will be shared with the company and state regulators in offices dealing with environmental quality or the extractive industry; however, the reports are also expected to enter the national environmental emergency response systems and automatically start an administrative sanction procedure, thereby establishing the link between transparency and accountability.[3]

The information is also shared via the internet to inform the media and other parties concerned with preserving the Amazon rainforest and the wel-being of its inhabitants (e.g. the ombudsman in Peru, journalists in Latin America and beyond). In other words, the intervention is expected to increase transparency in terms of public knowledge of oil impacts.

It is assumed that both national states and corporations will have an individual as well as a shared interest in limiting negative publicity and would take the necessary steps for environmental remediation and improved operations.

The responsiveness of state institutions and companies rests on strong assumptions regarding the effectiveness of transparency to induce accountability. If state institutions and companies are, to some extent, indifferent to political mobilisation and public opinion, then the ultimate objectives of the intervention will be out of range, especially in the short time horizon. Nevertheless, in the longer term, the intervention might still provide an input into much broader processes of societal transformation, leading to different state-society relations and improved accountability for companies.

It is worth highlighting that the theory of change underpins the intervention, while the impact evaluation tests some quantifiable hypotheses therein. These hypotheses are then interpreted in the context of the qualitative information that has been collected. Thus, the theory of change is broader (and in part non-testable) than the impact evaluation can cover.

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[3] See, for example the procedure to inform via email the Peruvian environmental agency, http://www.oefa.gob.pe/reporte-de-situacion-de-emergencia, accessed on 01/07/2018.

3.3 Research hypotheses

There is substantial evidence that community-based monitoring increases control over territories and can lead to improved social outcomes (Cepek 2008; Israel et al. 1998). Community-based activities are much less costly than professional monitoring, but often more effective (Danielsen et al. 2005) and tend to focus on resource management issues that have the potential to influence human welfare (Conrad and Hilchey 2011). They also hold the promise of empowering and enhancing capacity among local stakeholders while leveraging their knowledge and capabilities.

However, such monitoring suffers from three major shortcomings. First, there is limited experience of systematic monitoring of extractive industry impacts through community-based schemes; hence there is little systematic evidence of their strengths and weaknesses. Second, monitoring of large and difficult-to-access areas (such as the Amazon rainforest) is extremely laborious and time-consuming, at times nearly prohibitively so. Third, detection of environmental liabilities alone is a necessary but not sufficient condition for effectively communicating collected information. Clear, detailed and timely reporting to the appropriate state agencies, companies and mass media is also needed in order to prompt changes in the industrial actors' socio-environmental performance.

High-tech tools (e.g. drones, mobile phones and custom-made apps) provide a tantalising possibility of reducing the aforementioned shortcomings by increasing the rate of detection, augmenting monitoring and achieving improved dissemination. The research questions that emerge are:

1. Can detection of environmental impacts be improved? The variable of interest will be the number of environmental impacts detected, i.e. oil-polluted sites including oil spills, production water and drilling mud dumping sites.
2. Can reporting be improved? The variable of interest will be the number of complaints filed to state agencies.
3. Can improved monitoring lead to an increase in information available through the media? The variable of interest will be the number of events reported by the media.[4]

[4] In its original conception, the theory of change included questions regarding administrative procedures and sanctions, compensation of local communities and environmental remediation. In practice, these questions turned out to be difficult to address in the context of this impact evaluation. In terms of sanctions, in Peru the sanctioning procedure is transparent and information is available through OEFA; however the process takes several years and is incompatible with the time frame of the impact evaluation. In Ecuador, the team managed to obtain limited access to information on sanctioning procedures and these appear to be relatively uncommon.

Compensation of local communities turned out to be a very contentious topic for state authorities and companies as well as for local communities, and the little information we could gather is contradictory. Finally, very little usable information regarding remediation could be collected because of the challenges associated with defining 'proper remediation'. While the implementing agencies have received training regarding the basics of environmental remediation, also as a consequence of the training, it appeared that defining a binary variable would involve arbitrary decisions when information on the actual remediation practice is limited and when there are doubts about the appropriateness and comprehensiveness of the remediation techniques employed.

4. Timeline

The intervention was planned in four steps/rounds and the monitoring teams were assigned randomly to each round so that they would be treated incrementally. By the end of the intervention (and the quantitative impact evaluation) all groups would be treated.

As it happens, the synchronisation of the intervention across the two countries proved to be rather challenging. The organisation of the rounds in a predetermined six-months-apart schedule proved equally difficult. In terms of synchronising across the two countries, it soon became evident that because of festivities, political events (such as elections) and activities concerning one or the other implementing agencies, it would be very difficult to have exactly the same schedule in both countries.

In terms of keeping to the six-month gap between each round of training, the same reasons and also conflicting schedules of trainers, practical/technical issues (related, for example, to the availability of equipment in good working order) resulted in a less orderly schedule. In any case, the data used in the analysis are monthly, and variability in the gaps between training sessions should not affect the results.

Apart from collecting data during the intervention, a baseline was constructed. While the original plan was to collect data for the three months preceding the beginning of the intervention, it soon appeared that there was much variability in the monthly data. Furthermore, the data management practices of the implementing agencies were less than ideal and much of the information needed to be collected from various sources.

While the collection of data for the baseline became quite a challenge, with little additional effort we could expand the time frame of the baseline. Thus, the team decided to collect data on the six months prior to the beginning of the intervention and extend the baseline.

Table 1: Schedule of monitoring training workshops in Ecuador

WORKSHOP	DATE	TRAINING
1st Workshop	July 2016	3 groups of monitors: FDA1, UDAPT 1, UDAPT 2
2nd Workshop	January 2017	3 groups of monitors: FDA 2, FDA 4, UDAPT 6
3rd Workshop	July 2017	4 groups of monitors: FDA 6, FDA 7, UDAPT 4, UDAPT 5
4th Workshop	April 2018	2 groups of monitors: FDA 5, FDA 3

Source: Project documentation

Table 2: Schedule of monitoring training workshops in Peru

WORKSHOP	DATE	TRAINING
1st Workshop	March 2016	3 groups of monitors: FEDIQUEP
2nd Workshop	November 2016	4 groups of monitors: FECONACOR
3rd Workshop	May 2017	3 groups of monitors: OPIKAFPE
4th Workshop	November 2017	2 groups of monitors: FECONACOR

Source: Project documentation

5. Evaluation: design, methods and implementation

The unit of observation of the study is the team of monitors. The intervention was randomised, phased-in over approximately 24 months – stepped-wedge approach – with different teams of monitors being trained and equipped at approximately six-month intervals from one another (see the previous section for details of the intervention schedule).

A total of 24 teams participated with 12 in each country (balanced) and the study covers approximately 24 months. The first six months are the baseline, then the intervention was rolled out and the first six teams participated in the training programmes and received the technological package. At that point, this created six treatment and 18 control groups.

The remaining 18 control teams were trained incrementally. Eventually, by the end of the intervention all the groups had been treated. The randomised schedule was prepared at the beginning of the intervention and communicated to the implementing agencies.

The administration of the treatment in such a phased-in manner was delivered according to a randomised schedule to avoid selection bias between early- and late-treated groups and hence between treatment and control groups at each point in time. The unit of the random phase-in is the organisation to which the monitoring groups belong in a geographically specified area. Specifically, in Ecuador the groups from FDA and UDAPT were trained together, as they cover contiguous areas that offer relatively easy transportation to the training centre located in Lago Agrio (Nueva Loja, the capital of the Sucumbíos province).

The training schedule ensured that there would be an approximate balance in the treatment of groups belonging to FDA and UDAPT. The 12 groups of monitors that were treated in Peru were matched in groups of three belonging to the same umbrella organisation. This clustering was necessary to overcome the logistical challenges of providing capacity-building activities and introducing the monitoring package on the ground simultaneously to groups that were geographically spread over large and remote areas.

Our identification strategy is based on the randomised phased-in introduction of the intervention that allows us to construct a counterfactual by examining the not-yet-treated teams as control groups. In the econometric analysis, we exploit before-and-after differences together with time trends of non-treated groups. The preferred estimation technique is a panel-fixed effects model with covariates based on high-frequency monthly data.

The treatment of all groups by the end of the programme was necessary on ethical and political grounds as it ensured that all participants would eventually benefit, making it more acceptable for groups to join the project and its evaluation. The distribution of groups was balanced across the two countries.

Monthly monitoring data were collected over approximately 24 months by treatment and non-treatment groups; the first 6 months for the baseline and then 18 months of actual phased-in intervention. The data include both output and outcome variables. In terms of outputs, the variables of interest include the training of monitors and the availability of the monitoring package (i.e. information on the actual intervention).

Data on outputs are a necessary (but not sufficient) condition to observe and measure outcomes and impacts. In terms of outcomes, we have a set of variables related to actual use of the tools in the detection and reporting of socio-environmental liabilities (that is, oil impacts that are directly related to human welfare (outcomes)).

These variables include: the number of liabilities identified and documented (as stored in the ICT devices of the monitors and those in the offices of the social organisations), the number of reports made to authorities (state agencies and oil companies) and the number of events that have been echoed in the media.

The detections and reports to state authorities have been recorded on the basis of information shared by the implementing agencies. The events that were reported by the mass media have been registered by asking the monitoring teams (for example, for reports that appeared on local radio), whose answers have been combined with a systematic web-based search of repositories of local and national mass media.

The quantitative analysis does not include time-invariant covariates for each monitoring team, since the estimation technique uses fixed effects. Descriptive data regarding the profile of the various monitoring areas are presented below (Section 7.1).

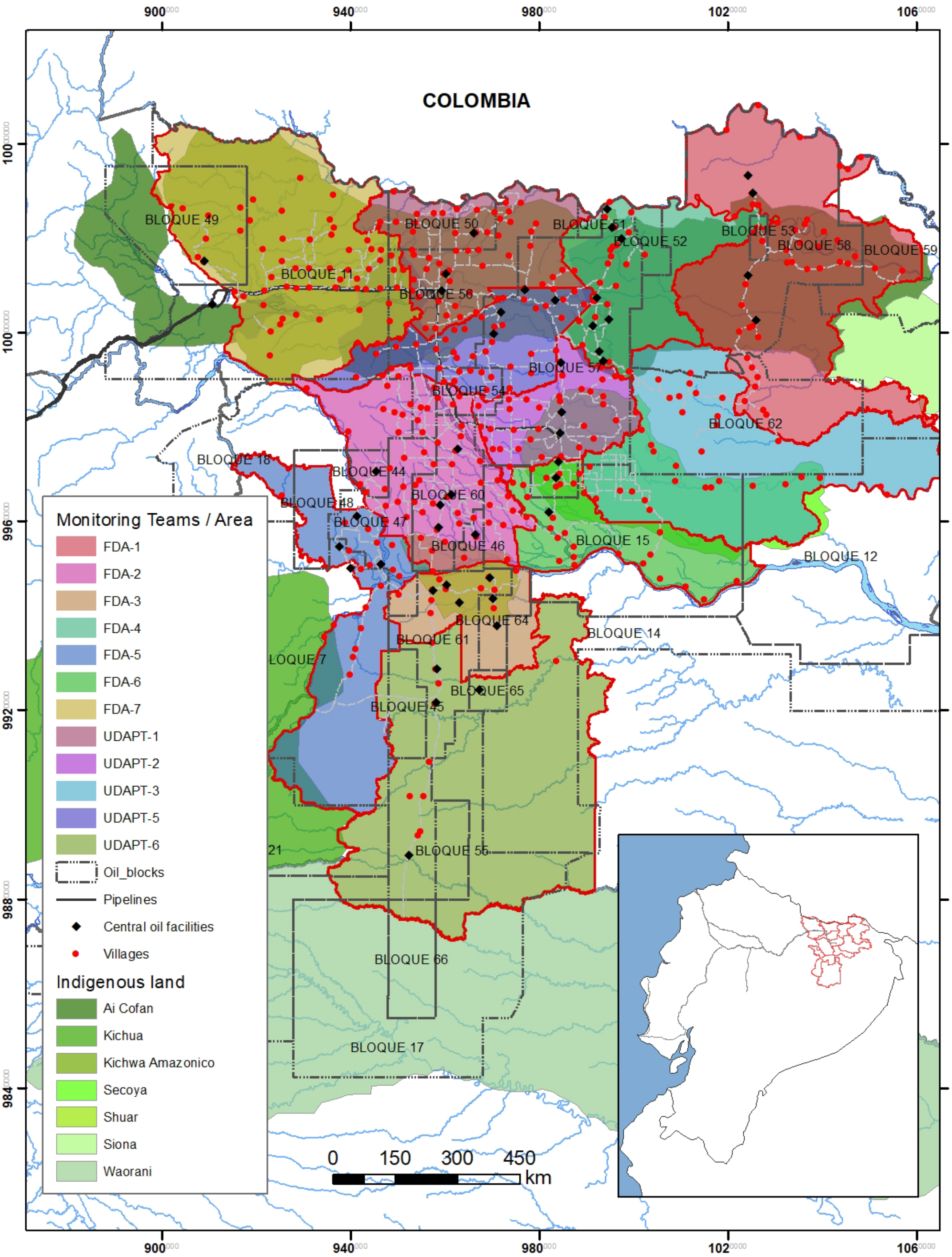
The time frame of the impact evaluation is rather short. While this frame does not allow for the analysis of many impact variables that will play out in the longer term, it has the advantage that in the meantime, no other project promoting community-based monitoring has been implemented in the area. This avoids contamination of our control groups and attribution problems.

The sampling for this study is based on two main eligibility criteria: first, we only sample geographic areas located in the Amazonian rainforest that are crossed by oil infrastructure and/or have ongoing oil extraction activities. These areas are somewhat remote and not easy to access. Second, these areas become eligible if they have social organisations (indigenous or *mestizo*) with environmental monitors working there independently from oil companies (that is, neither directly paid nor organised by companies).

For both Ecuador and Peru, this resulted in a collaboration with three large (indigenous and social) organisations with a total of 24 teams of monitors, with the purview of several million hectares of rainforest in the concerned Amazonian areas. The monitors work in geographical clusters with every cluster being at least 10,000 hectares in size and having an area of approximately 90,000 hectares on average. The total area being monitored is 2.2 million hectares (Table A1 and Table A2; Figure 4 and Figure 5).

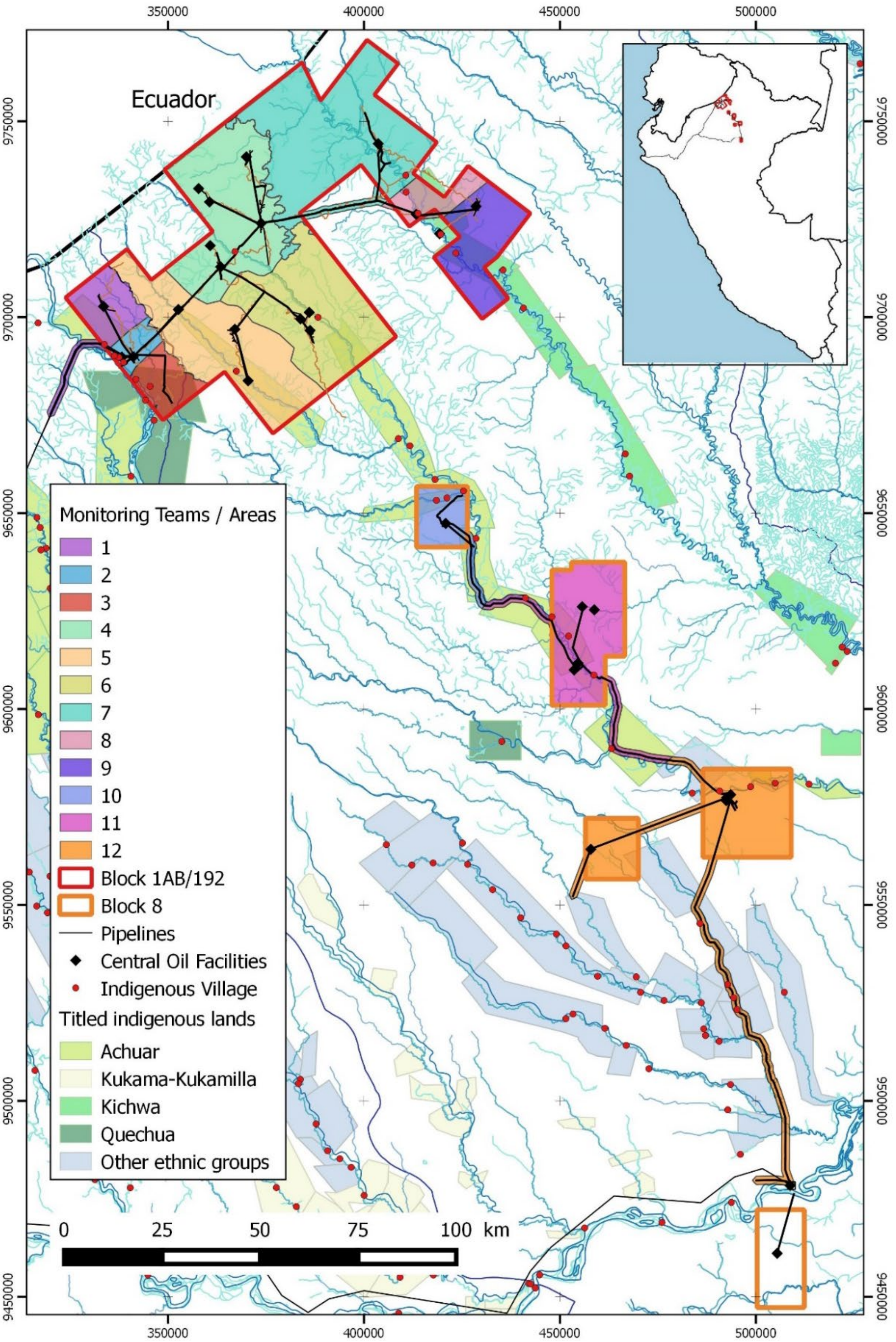
From each monitoring team, the evaluation team collected reports regarding the environmental liabilities (oil spills, disposal of formation waters, etc.). For each detected liability, information was also collected on whether it had been reported to state authorities and whether the event was echoed by the media. Since we included all eligible units in our sample (that is, the entire eligible population), we do not have to impose probability sampling.

Figure 4: Monitoring areas, Ecuador



Map of the monitoring areas in the northern Ecuadorian Amazon. Own elaboration with GIS data from the Social and Environmental Remediation Programme (oil concessions and oil infrastructure), the Secretariat of Peoples, Social Movements and Citizen Participation (titled indigenous lands) and the Geographic Military Institute (villages, towns and roads).

Figure 5: Monitoring areas, Peru



Monitoring areas in oil blocks 1AB/192 and eight from the northern Peruvian Amazon. Own elaboration with GIS data from Perupetro (oil concessions, oil infrastructure and hydrology) and Instituto del Bien Común (titled indigenous lands and indigenous villages).

6. Programme: design, methods and implementation

The design and implementation of the intervention was carried out with close collaboration between the team of researchers and the implementing agencies. On the one hand, the project and the evaluations have leveraged, from their inception, long-standing partnerships and collaborations between researchers and community organisations involved in the project. On the other hand, the collaboration was essential to ensure that the principles of impact evaluation would be respected.

In particular, the randomised phase-in approach was found to satisfy two criteria. First, it generates randomised control groups meeting the objectives of scientific rigour. Second, and more importantly, it guarantees the equitable implementation of the project across implementing agencies and the various monitoring areas. This ensures that all groups are treated in the end, and only the order of treatment is random.

It should be noted that the implementation of the project and impact evaluation, over the period of approximately two years, did not result in purposefully delayed implementation of the intervention. At the same time, the short timeframe of the impact evaluation does not allow for the collection of evidence on long-term impacts, such as improved operational practices and investment in infrastructure by oil companies; closer and more stringent supervision by state authorities once environmental liabilities are identified; and increased public awareness of the socio-environmental impacts of oil extraction on local communities.

7. Impact analysis and results of the key evaluation questions

7.1 Descriptive statistics

This impact evaluation collected monthly data from the 24 monitoring groups/areas. The baseline covers the six months preceding the intervention that was rolled out until April 2018 in Ecuador and November 2017 in Peru. Thus, we have data for 28 months for the 12 teams in Ecuador and for 27 months for the 12 teams in Peru.

The monitoring project covers 2,228,634 hectares: 1,523,739 hectares in Ecuador and 704,895 in Peru, with the average surface of each monitoring area comprising 92,860 hectares. While the monitored surface is much larger in Ecuador, in terms of location and infrastructure the areas in Peru tend to be more remote, have limited road access and rely on river transportation.

Similarly, mobile connection is relatively common in Ecuador and 9 areas out of 12 are (partially) served by mobile signal. In Peru, 3 areas out of 12 are covered by mobile signal. In terms of oil infrastructure, some areas have pumping and production stations, while others have only pipelines. Detailed information on the geographical characteristics and oil infrastructure in the monitoring areas is available in Table A1 and Table A2.

In terms of detection, a total of 367 environmental liabilities have been detected: 212 and 155 in Ecuador and Peru, respectively. On average, each team detects 0.6 liabilities per month, which is slightly more than one event every other month. Detection is more common in Ecuador than in Peru, and among treatment teams if compared to control teams (Table 3).

Out of all liabilities, 119 have been reported to state authorities: 44 and 75 in Ecuador and Peru, respectively. On average, in each area, one event every five months is reported, or 0.19 reports per month; one is reported every six months and every four months in Ecuador and Peru, respectively (Table 3).

The echo received by the liabilities in the media is limited and 24 events have been reported: 15 and 9 in Ecuador and Peru, respectively. On average, in each area, liabilities are mentioned by the media only once every 2.75 years (Table 3).

Table 3: Descriptive statistics

	Detection per month	Report to state authorities per month	Report by media per month
Ecuador	0.65	0.14	0.03
Peru	0.49	0.24	0.01
Control	0.45	0.16	0.01
Treatment	0.72	0.22	0.04
Complete sample	0.57	0.19	0.02

Source: Project database.

7.2 Key evaluation questions

The key evaluation questions are whether the treatment has increased: detection of environmental liabilities; their reporting to state authorities; and pick-up by the media. The underpinning hypotheses, outcome descriptions and units of measurement are presented in Table 4.

Table 4: Key evaluation questions

Hypothesis	*Outcome description*	*Measurement*
Treated monitoring teams detect more environmental liabilities	The monitoring teams detect liabilities and report them through the technological package	The monthly average of liabilities detected per team
Environmental liabilities detected by the treated monitoring teams are more likely to be reported to state authorities	The monitoring teams detect liabilities and report them to state authorities	The monthly average of liabilities reported to state authorities per team
Environmental liabilities detected by the treated monitoring teams are more likely to be reported by the media	The monitoring teams detect liabilities. They are communicated, directly or through the implementing agencies, to the media that report them	The monthly average of liabilities reported by the media per team

7.3 Impact evaluation

We ran a linear regression with a model containing the treated dummy (*T*, equal to 1 if the team is already treated since all teams are treated by the end of the programme), the time dummies (*t*) and dummies for each monitoring team (Λ). The model is:

$$Y_{ict} = \alpha + \beta_1 T_{ict} + \gamma \Lambda_{ic} + \delta t + \epsilon_{ict}$$

where the subscripts *i*, *c*, and *t* represent monitoring team, country, and time, respectively.

The same regression was run separately, keeping only the treatment dummy (T), including a linear time trend (t), including separate month effects (t_t), including separate month effects (t_t) and team effects (Λ) simultaneously, including team effects (Λ) and country-specific month effects (t_t). The set of regressions was run again for each country individually, estimating country-specific treatment effects and allowing differential covariate effects and time trends by country. The results are presented in Tables 5–7.[5]

Table 5: Impact evaluation: detection

Detection					
Ecuador and Peru	(1)	(2)	(3)	(4)	(5)
Treatment	0.28**	0.37**	0.40**	0.38**	0.32*
	(0.11)	(0.17)	(0.17)	(0.17)	(0.17)
Ecuador					
Treatment	0.34**	0.45**	0.46**	0.32	
	(0.14)	(0.17)	(0.17)	(0.23)	
Peru					
Treatment	0.21	0.39	0.34	0.31	
	(0.17)	(0.26)	(0.27)	(0.28)	
Linear time trend		X			
Month effects			x	x	
Team effects				x	x
Months-country effects					x

Dependent variable: detections (per month per monitoring team)
Source: Project database

Table 6: Impact evaluation: reporting to state authorities

Reporting to state authorities					
Ecuador and Peru	(1)	(2)	(3)	(4)	(5)
Treatment	0.06	0.10**	0.10**	0.04	0.05
	(0.05)	(0.05)	(0.05)	(0.06)	(0.07)
Ecuador					
Treatment	0.13**	0.15**	0.15**	0.11	
	(0.05)	(0.06)	(0.06)	(0.09)	
Peru					
Treatment	-0.01	0.02	0.03	-0.01	
	(0.08)	(0.06)	(0.07)	(0.11)	
Linear time trend		X			
Month effects			x	x	
Team effects				x	x
Months-country effects					x

Dependent variable: Reports to state authorities (per month per monitoring team)
Source: Project database

[5] As a robustness check, we also run a panel Poisson model that takes into account the count panel nature of the data. The Poisson estimate of the baseline model of Table 5, column 1 is 0.48 (p-value 0.01), which is comparable in terms of economic and statistical significance. For ease of interpretation, we use the OLS model in the text.

Table 7: Impact evaluation: reporting by the media

Reporting by the media					
Ecuador and Peru	(1)	(2)	(3)	(4)	(5)
Treatment	0.04***	0.03**	0.03**	0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Ecuador					
Treatment	0.06***	0.07***	0.07***	0.06**	
	(0.02)	(0.02)	(0.02)	(0.02)	
Peru					
Treatment	0.00	-0.00	-0.01	-0.04	
	(0.01)	(0.01)	(0.02)	(0.02)	
Linear time trend		X			
Month effects			x	x	
Team effects				x	x
Months-country effects					x

Dependent variable: reports by the media (per month per monitoring team)
Source: Project database

Overall, the results suggest that the treatment led to an increase in the detection of environmental liabilities, reporting to state authorities and reporting by the media. The results also indicate that the findings are stable across specifications and are mostly driven by the Ecuadorian teams.

In terms of significance, most specifications are statistically significant on the whole sample, and the size of the coefficient for detection and reporting to state authorities is rather large. Specifically, while for the whole sample approximately 0.6 liabilities are detected per month for each team, the coefficient of the treatment variable is approximately 0.3 (ranging between 0.28 and 0.40).

In the whole sample, approximately 0.2 liabilities are reported to state authorities per month for each team, and the coefficient for the treatment variable is approximately 0.07 (ranging between 0.04 and 0.10). Finally, in the whole sample, 0.02 liabilities are echoed by the media per month for each team, and the coefficient for the treatment variable is approximately 0.02 (ranging between 0.01 and 0.04).

Thus, the treatment increases the number of detections (by approximately one detection every three months by each team) and the number of liabilities reported to the state (by approximately one report per year per team).

In the case of reporting by the media, while the coefficient is large in relation to the average number of reports, this is mostly due to the fact that reporting by the media is uncommon. Also, the variable reported by the media is the one that is likely to contain the most noise and also violate the separability of treatment and control areas. Local media (e.g. radio, print journals) are difficult to trace since they do not have a stable and reliable online presence and, even more importantly, some of the liabilities that are presented by the mass media cannot be easily attributed to one specific event.[6]

[6] See for example, https://www.theguardian.com/world/2017/dec/14/after-years-of-toxic-oil-spills-indigenous-peruvians-use-tech-to-fight-back, accessed on 01/07/2018.

8. Discussion

8.1 Limits of the impact evaluation

This study potentially suffers from common biases affecting impact evaluations. In particular, the Hawthorne effect (or observer effect) could bias to some degree the performance of the monitoring system; that is, knowing that the environmental monitoring activity was subject to an impact evaluation might have led the monitors to perform their tasks more actively than they would have otherwise.

On the one hand, some extent of the Hawthorne effect cannot be excluded since the impact evaluation was an integral part of the intervention from its inception. On the other hand, the whole intervention is precisely motivated by the objective of increasing transparency and promoting the work carried out by the individual monitoring teams and the implementing agencies as a whole.

As such, having a system to collect and manage the information regarding the identified liabilities and the work of the monitoring teams would seem good practice, and any observer effect picked up by this impact evaluation would not bias the results but rather reflect this characteristic of the intervention.

The intervention took place in a relatively short time and it is likely that there was also a learning curve for trainers; some spillover from the early intervention groups cannot be excluded. In fact, the treated groups were invited to the training events to refresh their knowledge and share their experiences. As a consequence, the second and third groups to be rolled out may not be perfectly comparable to the first.

It is worth noting that the actual extent of environmental liabilities generated by the oil industry in the study area is unknown (and unknowable). This creates a challenge as we cannot compare detection trends with those concerning the actual occurrence of the events. Our assumption is that time trends, if they exist, are similar in the treatment and control areas and that detection trends would follow the same path without intervention.

Another issue associated with the liabilities is that they are discrete events that happen over time. A limitation of counting the detection of environmental liabilities is that one large event has the same weight as a minor one and as one of a different sort. In practice, a spill from a main pipeline that continues for several hours is likely to have a larger impact than a smaller spill. It will also be difficult to compare with other liabilities (for example, continuous air pollution created by gas flares).

8.2 Generalisability

At the global level, approximately 30 per cent of rainforest coincides with proven and probable conventional deposits of hydrocarbons, and in the case of the Amazon and Latin America, the overlap is even more pronounced.

Apart from their intrinsic value as repositories of biodiversity and providers of ecological services of global relevance, by definition these areas are sparsely inhabited by rural populations and indigenous peoples facing insurmountable challenges when it comes to exercising their rights.

These factors generate socio-environmental impacts related to pollution, economic distress, social problems and health issues. These impacts are enhanced by the use of sub-standard extraction practices, which are inconsistent with state-of-the-art practices and regulations (Eskeland and Harrison 2003).

One of the main problems related to the impacts of hydrocarbon extraction is that these areas are relatively isolated, making collection and transmission of information (important steps to increase transparency) challenging. While the impact of the specific tools (i.e. the technological package that is the focus of this impact evaluation) is contingent on the sites, implementation agencies and point in time, the evaluation indicates that community-based monitoring with advanced but inexpensive and simple technologies can serve to increase transparency around extractive industry operations.

Globally, the tropics include territories that are on the frontiers of many commodities, such as agricultural and ranching products, agrofuels, timber, rubber, oil, gas, coal, iron ore, gold, bauxite and other minerals (Finer et al. 2008). While the socio-political context and the nature of socio-environmental liabilities and conflicts are diverse, the results of the present evaluation could be relevant beyond the study areas and beyond hydrocarbon activities.

9. Specific findings for policy and practice

The results of the impact evaluation have specific implications for a variety of audiences. Some of these emerge from the overall impact evaluation and others from the experience recorded in particular sites in Ecuador or Peru.

In terms of relevance to policymakers at the national level, the findings demonstrate that community-based monitoring processes do increase detection rates of environmental liabilities. This is significant not only for political purposes, that is, giving ammunition to local communities that could be used in their struggle to hold extractive industries accountable. It also creates a valuable environmental record whose significance might reveal itself in the long term.

For instance, the timing and source of oil-related liabilities that formed the heart of the famous ChevronTexaco case (which resulted in a US$9.5 billion decision) were central to the legal proceedings, with ChevronTexaco arguing vehemently that the pollution at the heart of communities' complaints did not emerge from ChevronTexaco operations (Martinez-Alier 2011).

Improved detection that comes with sound and verifiable data would eliminate such disputes in the future, making it significantly easier for state agencies and the judiciary to arbitrate between conflicting societal actors and businesses. The implication for national policy makers would be that they not only recognise the work carried out by communities, but also create the necessary political and legal structures to ensure the safety and effectiveness of the monitors themselves.

It is also important to note that the cost of real-time community monitoring is much less than the cost of retroactively reconstructing the environmental history of a particular region.

The findings also demonstrate the importance of the organisational structure behind the community aspect of environmental monitoring. Communities do not naturally exist in a state where such monitoring activities can be carried out successfully. Thus, successful community monitoring requires the presence of strong community organisational structures. This, in turn, necessitates support – financial and otherwise – as well as sufficient time and accumulation of experience.

As the differing results from Ecuador and Peru demonstrate, not all community-based efforts perform at the same level. Differing outcomes would depend not only on external conditions but also the nature of the organisations themselves. The implication for civil society actors – national as well as international – who aspire to assist local communities (indigenous or otherwise) would be that beyond specific interventions, overall support for community structures is a key ingredient for long-term success.

In other words, while measuring the strength and effectiveness of community organisations and structures is difficult to achieve or document, there remains a need for long-term engagement and support between civil society actors and the communities they aim to support.

While this impact evaluation did not study the factors influencing uptake by media organisations, it is possible to speculate that not all reporters and editors would be equally interested in picking up news items from the information provided by community activists. The lesson for news outlets emerging from this evaluation is that community-based environmental monitoring does produce a substantial amount of newsworthy information.

While not every report of an oil spill would make front-page news, there would of course be exceptional (that is, very severe) cases of contamination, and having a direct relationship with community monitors would help the media to capture these occasions in a timely and accurate manner. Moreover, the long-term accumulation of environmental liabilities is itself worthy of media attention.

The growing subfield of environmental journalism – as evidenced in the articles mentioned in this impact evaluation – demonstrates that the combination of growing public awareness of the significance of environmental change, and worsening conditions in many key ecological sites such as the Amazon, will only increase the importance of documenting environmental change around the world. To that end, it would be important for the media to recognise the reporting service provided by community monitors, who provide accurate and free information.

Regarding implications in terms of programme and implementation, a key issue concerns technology. The package of tools used in this project brought together a variety of different hardware and software, whose selection was a function of a complex set of factors. For instance, open-source software is not only less expensive than proprietary software, it also fits well with the overall ethos of many of the implementing agencies (who might be suspicious of multinational corporations) and offers the potential of customisation.

Nevertheless, the experience of the project demonstrates that well-tested and easily available commercial packages do, at times, bring with them the benefit of reliability and predictability. Thus, the goal of using low-cost tools might at times clash with the goals of timeliness and effectiveness. It is difficult to state this in terms of a specific implication for other similar projects apart from that there exists no obvious combination of hardware and software that will achieve the expected results in the field. Extensive testing, flexibility and adaptability would therefore be key to assembling the right tools.

In terms of costs associated with the intervention, for both countries and the whole set of monitors included in this evaluation, the costs would add up to approximately US$140,000 for the first year of implementation if all groups had been treated at the same time. In subsequent years, costs would decrease slightly, but equipment upgrades and the replacement of broken or missing devices as well as refresher workshops would have to be booked regularly.

While this is a modest sum for monitoring oil impacts over relatively isolated areas of the Amazon covering approximately two million hectares, the estimate is based on synergies with academic institutions and a frugal approach that might be difficult to replicate elsewhere and sustain over time. In particular, we would expect that a system of salaries for the monitors would be necessary to ensure the long-term viability of the intervention.

Appendix A: Tables

Table A1: Description of monitoring areas in Ecuador

Organisation	Name	Area (ha)	Pipeline (kms)	Roads (kms)	Province	Years of experience	Population	Pump Station	Production Station	Oil wells	Mobile reception
FDA-1	Cuyabeno	213,724	187	117	SUCUMBIOS	7	7411	1	3	72	0
FDA-2	Sacha	117,547	482	400	ORELLANA	7	39713	0	6	248	X
FDA-3	Taracoa	54,709	186	56	ORELLANA	7	4255	0	6	53	X
FDA-4	Pacayacu	87,896	324	124	SUCUMBIOS	7	8626	1	7	139	X
FDA-5	Coca	119,245	238	115	ORELLANA	7	53104	1	2	29	X
FDA-6	Limoncocha	70,013	79	113	SUCUMBIOS	7	8021	0	3	42	0
FDA-7	Bermejo	193,228	152	209	SUCUMBIOS	7	20711	1	0	45	X
UDAPT-1	Lago Agrio	89,874	289	247	SUCUMBIOS	2	64183	0	3	68	X
UDAPT-2	Shushufindi	57,579	407	224	SUCUMBIOS	2	29812	0	3	125	X
UDAPT-4	Tarapoa	178,940	27	162	SUCUMBIOS	2	8414	0	0	1	X
UDAPT-5	Dureno	69,970	176	192	SUCUMBIOS	2	9392	0	4	54	0
UDAPT-6	Auca	271,013	269	85	ORELLANA	2	9336	0	4	134	X

Sources: see Table A3

Table A2: Description of monitoring areas in Peru

Organisation	Name	Area (ha)	Pipelines (kms)	Roads (kms)	Province	Years of experience	Population	Pump Station	Production Station	Oil wells	Mobile reception
FECONACOR	Lote 1-AB	88,440	32	49	LORETO	13	311	1	2	24	0
OPIKAFPE	Lote 1-AB	126,087	62	89	LORETO	8	344	0	1	29	X
FECONACOR	Lote 8	24,033	47	0	LORETO	13	403	0	1	11	0
FEDIQUEP	Lote 1-AB	28,856	39	27	ALTO AMAZONAS	11	170	0	1	13	0
FEDIQUEP	Lote 1-AB	19,186	17	25	ALTO AMAZONAS	11	450	0	0	6	0
FEDIQUEP	Lote 1-AB	10,281	34	40	ALTO AMAZONAS	11	633	1	1	32	X
FECONACOR	Lote 1-AB	87,276	34	65	LORETO	13	40	1	2	26	0
FECONACOR	Lote 1-AB	90,605	78	115	LORETO	13	67	2	4	73	0
OPIKAFPE	Lote 1-AB	42,104	7	20	LORETO	8	171	0	1	17	0
OPIKAFPE	Lote 1-AB	17,234	17	15	LORETO	8	132	1	0	0	0
FECONACOR	Lote 8	71,383	94	0	LORETO	13	519	1	3	63	0
FECONACOR	Lote 8	99,411	199	0	LORETO	13	635	2	3	84	X

Sources: see Table A3

Table A3: Variables and sources

Variable	*Description*	*Data source Ecuador*	*Year*	*Data source Peru*	*Year*
Organisation	Name of the organisation	Own data	2016-2018	Own data	2016-2018
Name	Name of the area	Own data	2016-2018	Own data	2016-2018
Area	Area in hectares	Own data	2016-2018	Own data	2016-2018
Pipelines	Kilometers of pipeline	Petroecuador and data from various sources	2009	PetroPeru and own data	2013-2015
Km_road	Kilometers of road	Instituto geográfico militar	2012	PetroPeru and own data	2013-2015
Province	Province	Instituto nacional de estadisticas y censos	2010	PetroPeru	2008
Years of experience	Years of community-based monitoring experience	Own data	2016-2018	Own data	2016-2018
Population	Total population	Instituto nacional de estadisticas y censos	2010	Instituto del Bien Común	1999-2013
Pump station	Pumping station – camp	Programa de remediación ambiental y social	2012	PetroPeru	2008
Production station	Production station	Programa de remediación ambiental y social	2012	PetroPeru	2008
Oil wells	Number of wells	Programa de remediación ambiental y social	2012	PetroPeru	2015
Mobile reception	Mobile reception in the area	Own data	2016-2018	Own data	2016-2018

Online appendixes

Online appendix A: Field Notes from workshops on community-based environmental monitoring

https://www.3ieimpact.org/sites/default/files/2019-06/tw8.1006-Online-appendix-A-Field-Notes-from-workshops.pdf

Online appendix B: Pre Analysis Plan

https://www.3ieimpact.org/sites/default/files/2019-06/tw8.1006-Online-appendix-B-Pre-Analysis-Plan.pdf

Online appendix C: Descriptive statistics

https://www.3ieimpact.org/sites/default/files/2019-06/tw8.1006-Online-appendix-C-Descriptive-statistics_0.pdf

Online appendix D: Cost data of the programme

https://www.3ieimpact.org/sites/default/files/2019-06/tw8.1006-Online-appendix-D-Cost-data-of-the-programme.pdf

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