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The Co-Benefits of Stakeholder Engagement:

Environmental and Social Safegaurds, Infrastructure Investment, and Deforestation in the Andean Amazon, 2000-2015

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ABSTRACT

Over the last 15 years, the Andean Amazon has undergone an infrastructure boom, as well as a profound shift in the environmental and social governance of infrastructure projects. National governments and international development finance institutions (DFIs) alike have adopted strong new environmental and social safeguards (ESS), including most notably a commitment to prior consultation with project-affected indigenous communities (in some cases requiring the free, prior, informed consent – FPIC – of those communities) and the adoption of formal grievance mechanisms at DFIs. This paper tests the association between the other two reforms – prior consultation and grievance mechanisms – and the environmental impact of infrastructure projects in Colombia, Ecuador, Peru, and Bolivia. It finds that prior consultation regimes have a strong, positive, and significant impact on the relative tree cover change near the site of the project. The other ESS tested here, the establishment of formal grievance mechanisms by DFIs, does not have a significant relationship with tree cover change, though it may be crucial in avoiding other risks. Finally, DFI and country safeguards appear to act as a mutually-reinforcing network, in which each acts as an insurance policy against the other failing or disappearing altogether. .

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1. Introduction

Since the turn of the 21st century, South America's Western Andean nations have adopted some of the world's most ambitious environmental and social protections surrounding infrastructure investment, including most notably the right to prior consultation for affected indigenous communities. These reforms have been matched by the adoption of equally ambitious environmental and social safeguards (ESS) by the international development finance institutions (DFIs) who provide the projects' financing, including not only prior consultation but also the establishment of formal grievance mechanisms for affected communities.

These reforms could hardly have arisen at a more crucial time. Since the end of the recent commodities boom, these Andean nations have undergone an infrastructure boom to take its place. For example, between 2008 and 2015, infrastructure investment rose from 3.6 to 8.4 percent of GDP in Bolivia, from 3.4 to 6.5 percent of GDP in Colombia, and from 3.3 to 6.9 percent of GDP in Peru (INFRALATAM, 2017). Given the extreme biodiversity of the Andean Amazon and the high concentration of indigenous territories there, appropriate regulatory frameworks may help prevent damage to marginalized communities and the forests where they live.

This paper specifically examines the role of these ESS in limiting the environmental impact of infrastructure projects in the Andean Amazonian countries of Colombia, Ecuador, Peru, and Bolivia, since 2000. It finds that prior consultation, though it is often considered a *social* rather than *environmental* safeguard, [1] has a significant role in limiting infrastructure-related deforestation. Formal grievance mechanisms, however, are not found to have a significant deforestation impact, though they may prove crucial in limiting other risks such as social conflict or reputational damage for the development finance institution (DFI) involved.

2. Background

This section reviews the established connection between infrastructure projects and environmental degradation, and the history of DFIs' and nations' reforms to lessen that degradation.

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[1] For example, CAF (2016) lists prior consultation under "Consultation and Community Relations" in its 2016 ESS framework, and the IADB (2006b) lists it as a crucial part of "support for indigenous people's governance."

2.1 Infrastructure and deforestation:

Scholars have long noted the connection between Amazonian deforestation and new infrastructure projects. Most of the resulting literature focuses on two types of infrastructure projects specifically: roads (especially paved roads) and dams.

The use of satellite imagery to trace deforestation around roads is a decades-old practice with an established track record. For example, Malingreau and Tucker (1988) use satellite imagery to trace deforestation in three states of the Brazilian Amazon, and find strong visual evidence linking new roads in this area with nearby deforestation. Pfaff (1997), also using satellite imagery, develops a statistical model and finds that *paved* roads – and the arrival of the first settlers to use those roads to establish new settlements – are both strong predictors of Amazonian deforestation. Furthermore, Pfaff also finds that this impact can be observed not only in the same county were the roads occurred, but in nearby counties as well. Laurance, Goosem, and Laurance (2009) perform a meta-analysis to compile additional mechanisms for the connection between roads and deforestation, and find causes including the "edge effect" of drastic changes in temperature and sunlight from within the forest canopy to the roadside, which impacts animal and plant life near new roads, periodic flooding of nearby forests due to poorly-maintained culverts, and disrupted paths for animal migration and plant pollination.

The environmental impact of dams is somewhat more complex than that of roads. While it is true that the electricity produced by hydroelectric dams can be considered "renewable," it is not necessarily ecologically sound. Beyond initial forest clearing for reservoir instillation, they can also become what Fearnside (2004) calls "virtual methane factories," converting biodegrading organic material on the reservoir floor to methane instead of the much less greenhouse-potent carbon dioxide (which would be the product of such biodegradation on a forest floor). The International Development Finance Club, a global umbrella organization which includes all of the DFIs studied here, considers hydroelectric dams to be "sustainable" only when they can demonstrate a net reduction in carbon emissions (IDFC 2015). The Kyoto Protocol's Clean Development Mechanism considers dams to have net reductions in carbon emissions only when they have a power density ratio (the ratio of the dam's potential output in megawatts divided by the surface area of its reservoir, measured in square kilometers) of no less than four.

While the present analysis focuses solely on deforestation and not carbon emissions, abundant evidence links new dams – especially those with reservoirs – to forest loss. Finer and Jenkins (2012) find that dams contribute to deforestation both directly, at the site of their construction or by the flooding necessary for reservoirs, and indirectly, along the paths of the power transmissions lines and roads that connect the dams to nearby cities and power markets.

2.2 A brief history of International DFIs' and countries' environmental and social safeguards

This paper focuses on projects financed by international DFIs – which includes multilateral development banks (MDBs) as well as national development banks (NDBs) and national export credit agencies (ECAs) operating abroad – because of their unique governance structure. For MDBs as well as NDBs and ECAs operating abroad, project governance and responsibility is shared between national governments and external DFIs. This dual structure may lead to *productive redundancy*: it has meant that affected communities have looked to one institution for recourse when the other does not adequately mitigate their risks.

Major ESS reforms have taken place in DFIs and among Latin American governments since 2000. This section reviews the development of ESS among those DFIs that have seen major reforms since 2000 (the World Bank, the Inter-American Development Bank, the Development Bank of Latin America, and the Export-Import Bank of China) and the nations of Colombia, Ecuador, Peru, and Bolivia.[2]

2.2.1 ESS Reform Among International DFIs: Not from Within but from Without

Of the international DFIs studied here, four institutions have undergone major ESS reform: The World Bank, the Inter-American Development Bank (IADB), the Development Bank of Latin America (CAF, for its original Spanish acronym), and the Export-Import Bank of China

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[2] The World Bank Group (WBG) and the Inter-American Development Bank each have multiple lending arms, which financed different types of projects. The statistical analysis below considers four of these windows separately: the World Bank's International Bank for Reconstruction and Development (which provides sovereign loans to middle-income countries) and International Finance Corporation (which lends to private sector projects), and the Inter-American Development Bank's main IADB (sovereign) lending window as well as its private-sector lending arm, the International Investment Corporation (IIC). Where the phrase "World Bank" occurs, the intention is to indicate the WBG institution rather than a particular lending arm. For the IADB, context should be sufficient to distinguish institution from lender.

(CHEXIM). In each case, ESS reform arose not simply out of enlightened management or even far-sighted risk mitigation on the parts of international DFIs. Rather, ESS arose in large part thanks to external pressure from a variety of sources. Mikesell and Williams (1992) cite three main external avenues for pressure on international DFIs' environmental performance: public opinion in the country where the DFI is located, NGOs in affected countries, and international organizations such as arms of the United Nations. In the cases of Washington, DC-based World Bank Group (WBG) and Inter-American Development Bank (IADB), civil society in both affected and headquarter countries cooperated to improve lending governance. In the case of CAF, reform has come through changing incentives thanks to action on the part of international organizations.

Plater (1998), examining the reform process within the World Bank, points to alliances between organizations of affected people in developing countries and partners in wealthy countries, coalescing around so-called "glocal" conflicts, in which *global* civil society organized around *local* environmental problems caused in turn by *global* capital flows. Anguelovski and Martinez (2014) highlight the importance of organizing that continued after Plater published his work, including the gathering of 200 NGOs in Kyoto in 1997.

This history is especially important here, given the catalytic function that (Brazilian) Amazonian deforestation played in spurring international DFI ESS reform, as Rich (1994) and Blanton (2007) explain. Between 1981 and 1983, the World Bank lent $443.4 million to Brazil for projects related to Polonoroeste, Brazil's Amazonian highway and agricultural expansion program. Showing the importance of this case in catalyzing future reforms, Blanton (2007, 254) refers to it as the "paradigm case of controversial World Bank projects and effective NGO opposition." Unfortunately, although World Bank involvement was conditioned on government commitments to respect established indigenous territories and nature reserves, the ensuing rapid migration of a half-million settlers into the newly-accessible forest outpaced legal protections, leading to widespread deforestation and displacement of traditional communities. In 1984, US Congressional Rep. James Sheuer invited Brazilian ecologist and future Minister of the Environment José Lutzenberger to testify before the House Committee on Science and Technology's Subcommittee on Natural Resources, Agricultural Research and Environment (Eckholm 1984). Sheuer later wrote to the U.S. Treasury Secretary, urging Treasury to pressure the World Bank to tighten its oversight of Polonoroeste loans, while 32 NGOs from 11 countries jointly wrote their own letter to the World Bank itself with similar demands (Rich 1994, 122). In May 1985, the World Bank announced in a meeting with environmental groups that it had halted all Polonoroeste disbursements two months earlier.

Also in 1985, the US abstained when a Polonoroeste-related project came up for a vote in front of the IADB, prompting a moratorium on disbursement until Brazil established a project plan to limit environmental degradation and impacts on indigenous lands. In October of that same year, 120 Amazonian rubber-tappers met with representative of the Environmental Defense Fund, Brazil's Institute for Amazonian Studies, and Oxfam. These organizations lobbied the U.S. Treasury Department, who in turn forwarded a report by them to the World Bank and the IADB. In the face of the public perception of moral authority of international environmental groups – and the dominant political power of the U.S. Treasury Department on these MDB boards – the World Bank and the IADB both began to reformulate their approaches to projects in sensitive social and environmental territories.

Within a few years, these efforts bore fruit in significant reforms to loan governance at the World Bank and the IADB. In 1989, U.S. Congressional Rep. Nancy Pelosi sponsored an amendment (later known simply as the "Pelosi Amendment") to the Oil Pollution Act (which would be passed in 1990 as H.R. 1465), requiring US representative to MDB boards to abstain or oppose MDB project proposals that did not give board members adequate environmental impact assessments (EIAs) at least 120 days before the board vote (Sanford, 1998). That same year, the World Bank formalized its commitment to conducting EIAs with Operational Directive 4.00, Annex A on Environmental Assessment (reprinted in WB 1999). In 1991 it expanded this oversight to including prior consultation with affected indigenous communities, with Operational Directive 4.20 on Indigenous Peoples (WB 1991). In 1990, the IADB followed suit and published its "Strategies and Procedures on Sociocultural Issues as Related to the Environment," enshrining "the principle of community consultation and participation throughout project design and implementation" (IADB 1990, 6). This principle was codified in 1996, with a requirement that all IADB proposals "contain a chapter and/or annex approved by the CESI [Committee on Environment and Social Impact]" (IADB 1996, 9).

While Brazilian civil society was mobilizing around issues of deforestation and community displacement due to the Polonoroeste highway program, NGOs in India were mobilizing over the similarly-problematic Narmada Dam in Gujarat, India, which resulted in the displacement of approximately 120,000 people. The World Bank responded with the establishment of a panel of outside experts (headed by Bradford Morse, United Nations Development Programme officer) to review Bank policy and performance in the Narmada case. The resulting "Morse Commission" report, published in 1992, called for a greater role for civil society in monitoring project outcomes and envisioned the establishment a formal grievance mechanism ("Accountability," 2009). Meanwhile, during the 1994 IDA replenishment, the US pressured the World Bank to create such a mechanism. Within months, the World Bank established their Inspection Panel and the IADB established their Independent Investigation Mechanism, the predecessor to today's ICIM (Independent Consultation and Investigation Mechanism).

As mentioned above, CAF's history of ESS reform came after its financial incentives changed, thanks to trends among international organizations. In 1992, the Global Environment Facility was established in the preparations for the Rio Summit, to support qualifying "green" development projects. In 2009, the Green Climate Fund was established at the United Nations Climate Change Conference in Copenhagen, with a similar mission. In order to quality for accreditation by these two organizations, CAF had to establish its own formal ESS out of the general principles that had guided its lending beforehand (CAF 2010). In 2015, CAF published formal safeguards to govern its joint projects with GEF (CAF 2015), and received GEF accreditation (GEF 2015). In 2016, CAF published overall ESS and received accreditation with the GCF (CAF 2016, GCF 2016).

Unlike the MDBs listed above, the Export-Import Bank of China (CHEXIM) introduced reforms after pressure from its own national government rather than from civil society or international organizations. The China Banking Regulatory Commission (CBRC), together with China's Ministry of Environmental Protection, published a new "Green Credit Policy" in 2007, calling on banks to take responsibility over the environmental impact of their lending projects (Aizawa and Yang 2010). Five years thereafter, the CBRC issued another decree, the "Green Credit Guidelines," encouraging banks to create their own criteria for environmentally-responsible lending (CBRC 2012). In 2016, CHEXIM complied by publishing its "White Paper on Green Finance," which makes specific commitments to "foreground" and mitigate social and environmental risks in its loans.

2.2.2 ESS Reform Among Andean Nations: Not from Above but from Below

For the most part, the nations studied here adopted ESS related to new development projects more recently than did the DFIs discussed above. These ESS arose mostly out of ongoing struggles between indigenous communities and foreign extractive (oil, gas, and mining) investors. These struggles have been well-documented elsewhere (see for example Bebbington and Bury, 2013; Fontaine, 2003; and Ray et al, 2017). Because of the ethnic and economic nature of these conflicts, the primary outcome has been the right of indigenous communities to be consulted in conjunction with development projects that affect them.

All four countries studied here signed on to the International Labour Organisation's Convention 169 on Indigenous and Tribal Peoples within a decade of its introduction (ILO 1989). Furthermore, all four have enshrined ILO 169 in their national legal standards, as Table 1 shows. As Baluarte (2004) and Larsen (2016) note, the ratification of ILO 169 brought a seismic shift in how governments and communities approached resource disputes.[3]

TABLE 1: Adoption of ILO 169 and Incorporation into National Law, by Country

Country	ILO 169 Ratification Year	National Legislation	
		Year	Mechanism
Bolivia	1991	2009	Nueva Constitución Política del Estado
Colombia	1991	1997	Supreme Court Decision SU039/1997
Ecuador	1998	2010	Ley Orgánica de Participación Ciudadana
Peru	1994	2011	Ley de Consulta Previa

Sources: Asamblea Constituyente de Bolivia (2009), Asamblea Nacional del Ecuador (2010), Congreso de la República (2011), ILO (1989), Ocampo and Agudelo (2014).

The mechanism by which ILO 169 is reflected in national legal protections varies widely across these four countries, discussed below. Colombia was the first country in which national

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[3] ILO 169 is a revision and replacement of the 1957 ILO Convention 107, which protected indigenous peoples from labor exploitation in European overseas colonies. In 1986, an ILO Committee of Experts concluded that ILO 107 was written for the benefit of indigenous peoples but without sufficient allowances for self-determination for the indigenous communities themselves. ILO 169 explicitly addresses the rights of indigenous communities to decide if, when, and how they are to integrate with surrounding cultures.

legal protections were established. These emerged out of conflict, similar to the World Bank and IADB ESS discussed above. Colombia's 1991 constitution dictates that indigenous territories are to be governed by indigenous councils, including in matters of resource use and distribution and the preservation of natural resources ("Constitución Política de Colombia", 1991, Art. 330). Nonetheless, in 1992, Occidental Petroleum signed a contract with the Colombian oil company Ecopetrol for seismic exploration of the Samoré Block in the territory of the U'wa indigenous community. The U'wa sued Occidental in 1995 and won in court, only to have the Supreme Court overturn the decision. However, in 1997, the national ombudsman's office (*Defensoría del Pueblo*) challenged this ruling to the Constitutional Court on behalf of the U'Wa people, and won. This ruling, SU039/1997, set the stage for future rulings, as Haller, et al (2007) note. For example, Decree 1320 of 1998 was established to provide a framework for indigenous consultation, but was struck down itself for having been enacted without the indigenous consultation required by SU039/1997 (Ocampo and Agudelo, 2014).

The other countries shown here (Bolivia, Ecuador, and Peru) enacted legal protection to codify ILO 169 in a less combative context. In each of these three countries, leftist (in the cases of Bolivia and Ecuador) and center-left (in the case of Peru) governments were elected in the early-to-mid 2000s thanks to coalitions built among indigenous, labor, and environmentalist organizations. Intrinsic to these victories were promises to enact major legal reforms to enshrine the causes dear to these groups.

Both Bolivia (2009) and Ecuador (2008) established new constitutions as part of this process. Bolivia's constitution was the stronger in this regard, guaranteeing that rural indigenous communities should have the right to prior and informed consultation over any use of natural resources found in their territories (Asamblea Constituyente de Bolivia 2009, Article 403). Ecuador's new constitution did not explicitly enshrine the right to indigenous consultation, but did give Mother Nature (*Pachamama*) her own legal rights, specifying that anyone would be legally allowed to sue public authorities to force them to defend these rights. In practice, this meant that communities need not prove that their private property is damaged in order to use the courts to stop and mitigate the damage (Asamblea Nacional del Ecuador 2008, Art. 71), a move especially favorable to NGOs, indigenous communities with uncertain land tenure, and the poor. Tanasescu (2013) notes that in its first enforcement, a municipal was made to pay for restoration of a river whose path it had modified to make room for a new road, thanks to a lawsuit on behalf of nature by local citizens.

Both Ecuador and Peru have enacted laws to directly address the right to prior consultation for indigenous communities. Ecuador's 2010 Citizen Participation Law states that the national government must consult with indigenous, Afro-Ecuadorean, and coastal Montubio communities regarding all decisions that might affect their environment (Asamblea Nacional del Ecuador 2010, Art. 83). Peru's 2011 "Law of Prior Consultation" codifies these rights in much more detail, recognizing the rights of communities' elected officials to negotiate on their behalf and laying out a seven-step process for the consultations (Congreso de la República 2011). For more on these electoral changes and the resulting legal protections in Bolivia, Ecuador, and Peru, see Ray and Chimienti (2017), Sanborn and Chonn (2017), and Saravia López and Rua Quiroga (2017).

3. Model of Analysis in the Present Paper

This paper aims to further the literature on infrastructure, development banks, and the environment, by testing the association between major ESS reforms and the environmental performance of infrastructure projects financed thereafter. This section explains the choices of environmental impact studied (deforestation), method (tree cover change as measured by satellite imagery) and location (the nations of Colombia, Ecuador, Peru, and Bolivia).

3.1 Choice of Impact Studied: Deforestation

The analysis below examines only one of many possible environmental impacts: deforestation. Many other important social and environmental aspects of infrastructure expansion exist, of course, including water quality, air quality, access to ancestral lands, and the cultural politics surrounding the popular conceptualizations of natural resources as spiritual, community, or economic entities are all important aspects of the social and environmental impacts of the expansion of infrastructure projects in Latin America (see for example Carruthers 2008, Wickstrom 2008).

Nonetheless, as the history section above mentions, NGO mobilization regarding DFI-backed projects in these countries centered on the preservation of forests for the sake of communities therein. Thus, this paper chooses deforestation as its primary impact variable in order to measure whether civil society participation requirements improved an outcome demonstrated to be highly important to civil society. Furthermore, deforestation is an attractive choice of environmental impact to study, as the preservation of the Amazon rainforest unites the concerns of international DFIs concerned with their climate impacts and the local concerns embodied in what Martinez-Alier (2014) calls "the environmentalism of the poor."

3.2 Choice of Method: Satellite Imagery

As mentioned above, the use of satellite data to measure tree cover change is well-established. This paper uses the "Global Forest Change" database managed by the Unversity of Maryland in conjunction with Hansen et al (2013). At the time of this writing, the Hansen et al data included data for tree cover change between 2000 and 2015. It is compiled based on USGS LANDSAT imagery with 30m resolution. As Chen et al (2015) note, this resolution is fine enough to show deforestation, though it is too course to show forest degradation. However, it cannot distinguish between forest cover and plantation-based tree cover. For that reason, this analysis mostly uses the term "tree cover loss" instead of "deforestation," unless it clear from the satellite images that no plantations are involved.

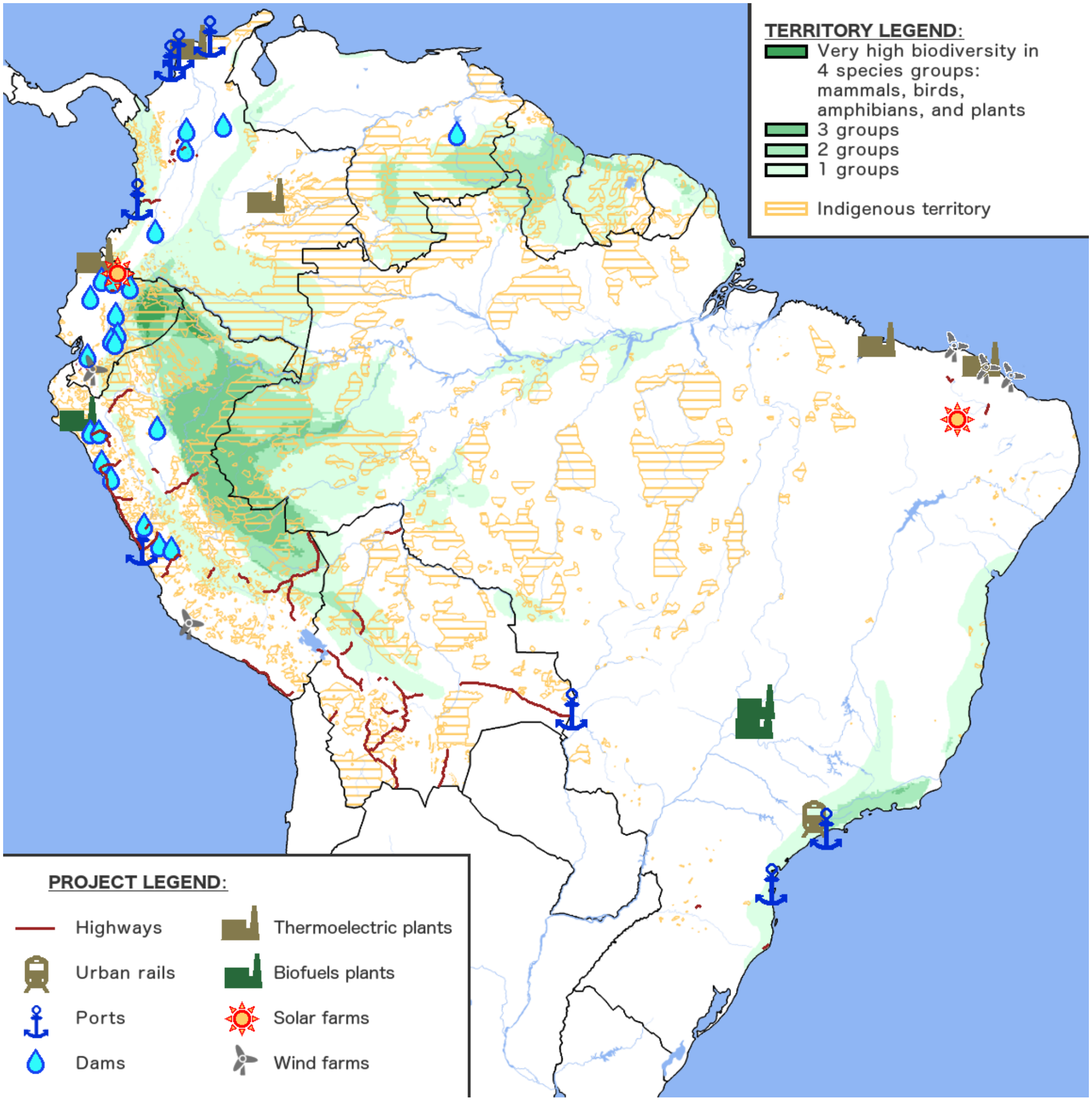
Methodologically, this paper expands on the work of Buchanan et al (2013) at William and Mary's AidData Research Lab. These authors use the Hansen database to investigate the relative tree cover change rates within 10km of World Bank projects globally. Instead of seeking differences among lenders, the present analysis investigates the impacts of ESS reforms, regardless of DFI or national government involved. It also relaxes the traditional use of 10km radii around projects, and instead uses site-specific radii established using a common set of rules across projects, discussed in more detail below.

3.3 Choice of Location: Colombia, Ecuador, Peru, and Bolivia

This paper takes as its geographic focus the western Amazon, home to some of the most sensitive territory, both socially and environmentally, in the Western Hemisphere. Figure 1 shows all of the international DFI-financed infrastructure projects in Amazonian countries from 2000 to 2015, together with indigenous territory and varying levels of biodiversity. The richest biodiversity in South America is found along the western periphery of the Amazon basin, especially in eastern Ecuador and northern Peru. Among the indigenous territories shown here, arguably the most sensitive are those in the "Uncontacted Frontier" of the border region between Peru, Brazil, and northwestern Bolivia: home to the highest concentration of uncontacted and voluntarily isolated indigenous communities in the world (Survival international, n.d.).

Of the 100 projects shown in Figure 1, 84 are in the western Andean countries of Colombia, Ecuador, Peru, and Bolivia. Nearly all of the projects shown to be in areas that are both highly-biodiverse and home to indigenous communities are in a few sections of these four countries: The Pacific coast of Colombia, central Ecuador, inland Peru, and western Bolivia. Venezuela is home to just three projects, Suriname has one, and Brazil has 17 – but none in areas that are both highly biodiverse and indigenous territory. Because of this geographic distribution of international DFI-financed infrastructure projects, this paper specifically focuses on the history and performance of projects in the four countries of Colombia, Ecuador, Peru, and Bolivia.

FIGURE 1: Completed International DFI-Financed Infrastructure Projects in Amazon-Basin Countries, 2000-2015



Note: Individual projects considered here are listed in Appendix B. Source: DFI annual reports, Bass et al. (2010), LandMark (n.d.), Red Amazónica de Información Socioambiental Georreferencial (n.d.).

3.4 Choice of Projects

For the purposes of this analysis, infrastructure projects are defined as all "hard" infrastructure projects (energy and transportation) that contribute to an increase in a country's fixed capital stock. Thus, while roads form a crucial element of this dataset, not all roads are included. Specifically, roads are included when they entail paving previously-unpaved roads or rehabilitating paved roads, but they are *excluded* in the following cases:

- Repairing roads after natural disasters,
- Re-grading of unpaved roads, which must occur repeatedly in order to maintain usability,
- Periodic maintenance of paved roads
- All work regarding neighborhood (as opposed to inter-municipal) roads

However, major rehabilitations of paved roads, which make the difference between a road being passable by truck year-round or otherwise, are included.

4. Data description

As mentioned, this paper examines the tree cover change surrounding 84 infrastructure projects financed by international DFIs from 2000 to 2015. The following sections describe the characteristics of these projects, tree cover change around them, and the ESS that applied to them, either from DFI or national authorities.

4.1 Tree Cover Change Near international DFI-Financed Infrastructure Projects

Between 2000 and 2015, the 84 projects studied here were associated with the loss of 5,663 km^2 in tree cover within 10km of the projects, or 14.2 percent of the total nearby tree cover. As Table 2 shows, this rate of tree cover loss is much higher than the overall rate of deforestation in those four countries over this time period, which was just 3.9 percent. This level of tree cover loss is equivalent to 25.4 kilotons of new CO^2 emissions, or about seven percent of the total loss in carbon sequestration from deforestation in these countries over this time period.

TABLE 2: Tree Cover Loss Within 10km of international DFI-Financed Infrastructure Projects, 2000-2015

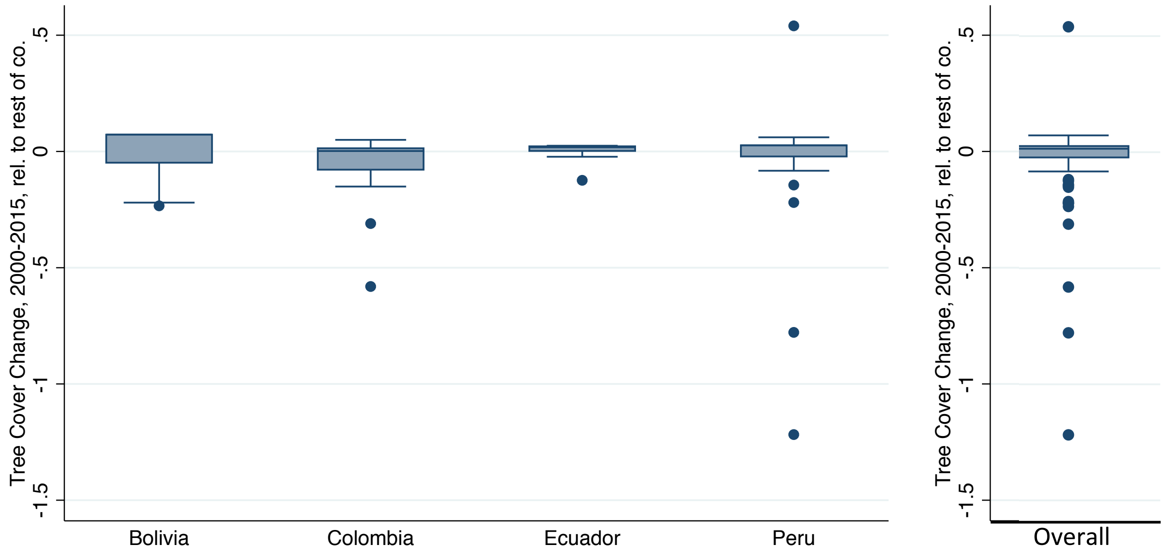
	Country				Total
	Bolivia	Colombia	Ecuador	Peru	
Within 10km of projects:					
Total tree cover change (km^2)	-2,937.9	-156.7	-45.0	-2,523.5	-5,663.1
Total initial tree cover (km^2)	14,730.8	4,219.2	2,570.7	18,400.0	39,920.7
Tree cover change (%)	-19.9%	-3.7%	-1.7%	-13.7%	-14.2%
Emissions equiv. (MMT CO_2)	97.0	7.9	2.5	146.2	253.5
Remaining territory:					
Total tree cover change (km^2)	-35,138.1	-21,917.2	-3,631.6	-18,487.8	-79,174.6
Total initial tree cover (km^2)	503,812.0	675,512.3	147,430.1	711,338.2	2,038,092.6
Tree cover change (%)	-7.0%	-3.2%	-2.5%	-2.6%	-3.9%
Emissions equiv. (MMT CO_2)	1,159.6	1,109.0	198.4	1,071.1	3,538.0

Note: Emissions are calculated using the average carbon intensity per km^2 of forest in each country, using median estimates in Saatchi et al (2011): 9.0 kT/km^2 in Bolivia, 13.8 in Colombia, 14.9 in Ecuador, and 15.8 in Peru.

However, as Table 2 also shows, the rate of tree cover loss associated with DFI projects varied widely among the four countries studied here. The highest rate was seen in Bolivia, where nearly 20 percent of tree cover within 10km of DFI projects was lost between 2000 and 2015. On the other extreme, the projects in Ecuador were associated with a loss of just 1.7 percent of tree cover within 10km, a *lower* rate than in the rest of the country.

Figure 2 explores this variation across individual projects, by country. “Relative tree cover change” is defined here as the log difference between tree cover change within 10km of the project and tree cover change in parts of the country *not* within 10km of an international DFI-financed infrastructure project, in order to take into account different national contexts. As the figure clearly shows, great variation exists, with some projects exhibiting much less tree cover loss than the rest of the countries where they occurred (shown as *positive* relative tree cover change), and others exhibiting much more, especially among projects in Peru.

FIGURE 2: Relative Tree Cover Change within 10km of international DFI-Financed Infrastructure Projects, 2000-2015



N	18	20	14	29	81
Mean	+0.4%	-5.8%	+0.2%	-5.4%	-3.3%
Median	+7.2%	-0.2%	+1.8%	+2.6%	+1.5%
St. Dev.	11.2pp	15.1pp	3.9pp	29.2pp	19.8pp

Note: The total number of projects is only 81 instead of 84, because this model results in three observations' elimination from the dataset. This problem is resolved in the following section. Relative tree cover change is measured as the log difference between local and national treed cover change percent rates: ln(1+Δ local TC) – ln(1+Δ nation TC excluding areas near projects).

The areas within 10km of international DFI-financed infrastructure projects had a median tree cover loss that was 1.5 percent better than the remainder of the nations where they were built. They had a mean level of 3.3 percent *worse* tree cover loss, but that was driven primarily by a few extreme outliers, so that level is not statistically significantly different from zero, as Figure 2 shows.

4.2 Safeguards:

The high variance shown in Figure 2 raises the question of what DFIs and governments can do, in the face of such divergent outcomes, to limit the possibility of their projects experiencing the tree cover loss of the highly-negative outliers. This paper attempts to answer this question by seeking relationships between DFIs' ESS processes and the tree cover change in the areas surrounding their infrastructure projects. Table 2 shows the most common ESS among the DFIs most active in financing infrastructure projects in the Western Andean countries studied here.

CAF's approach to safeguards has been unique and bears explanation. CAF established formal ESS in 2016, after the time period studied here. Before that point, its lending was governed by its 2010 "Environmental Strategy," which states that CAF "makes sure operations have complied with the participation process demanded by the country's legal system and, where it sees a need, calls for additional step of public consultation" (CAF 2010, 18). This principle is certainly laudable in its intent, but its ambiguity makes it impossible to label as having across-the-board requirements beyond respect for national laws. Thus, for the sake of accuracy, Table 3 shows CAF requiring prior consultation (as it currently does), but the case-by-case analysis below recognizes that it did not have a formal consultation requirement from 2000-2015.

All eight of the DFIs shown in Table 3 require the completion of EIAs and compliance with host-country environmental standards. Six require consultation with affected communities, while only four MDBs – the World Bank, and IADB, and their private-sector lending arms – have (or require the establishment of) formal grievance mechanisms to address problems that arise. Due to DFIs' unanimity regarding EIAs and host-country standards, this paper examines the association between the other commonly-accepted safeguards – prior consultation and formal grievance mechanisms – and tree cover loss near project sites. The recent enactment of stronger versions of these policies – free, prior, informed *consent* of affected communities (known as FPIC) and *project-level* grievance mechanisms – are crucial developments, but unfortunately too few projects in this dataset have those protections for this paper to analyze the impacts of these reforms. Finally, it is important to note that Table 3 shows only prior consultation provisions that have incorporated formal processes of engagement, using the approach of Kvam (2017). While many more DFIs have statements broadly supporting the principle of public information or consultation, only the World Bank and IADB had standardized processes with space for affected communities to impact project design.

TABLE 3: Required Safeguard Processes for Infrastructure Project Planning

	MDBs					NDBs Operating Abroad		
	IBRD	IFC	IADB	IIC	CAF	CDB	CHEXIM	BNDES
Environmental impact assessments (EIAs)	X	X	X	X	X	X	X	X
Compliance with host-country env. standards	X	X	X	X	X	X	X	X
Assistance with host-country standards					X			
Consultation with affected indigenous communities	X	X	X	X	X		X	
Consent of affected communities		X	X					
Formal grievance mechanisms	X	X	X	X				
Project-level grievance mechanisms	X	X						

Note: CAF and CHEXIM established their community consultation safeguards in 2016, after the time period studied here. Thus, while those slots are marked here, the analysis below takes into account the absence of those protections before 2016. The IADB requires consent of affected communities only in cases of involuntary resettlement.

Sources: Baker (2013), CAF (2016), CHEXIM (2016), Goodland (2004), HImberg (2015), IADB (1990, 2006a, 2006b), IFC (1998, 2006a, 2006b), IIC (2013), ILO (1989), IR (2007), Kennedy (1999), Ocampo and Agudelo (2014), Rivasplata et al (2014), WB (no date), Yuan and Gallagher (2017).

The distribution of which institutions guarantee prior consultation and grievance mechanisms is more complicated than Table 3 suggests, because international DFIs have gradually adopted these ESS over the last few years. Prior to the adoption of formal prior consultation processes, many DFIs had principles or guidelines related to consultation, but most have adopted standardized prior consultation more recently. Thus, for example, not every CAF project examined here required prior consultation, and not every IFC project had a formal grievance process.

Countries also have their own history of the adopting safeguards that apply to the projects studied here, as mentioned in the previous section. All four countries examined here are signatories to the International Labour Organisation's Convention 169 (ILO 1989) and have enacted their own legislation recognizing the right to prior consultation for indigenous communities affected by new development projects.

Combining the evolution of DFI prior consultation safeguards and national legislation yields the matrix of DFI and country consultation standards shown in Table 4. Projects in a given country, financed by a given DFI, have prior consultation guarantees if they were approved after the prior consultation enactment date shown in the table.

TABLE 4: Prior Consultation Adoption for Infrastructure Projects, by Country and DFI

	Bolivia	Colombia	Ecuador	Peru
MDBs				
IBRD	1992	1992	1992	1992
IFC	2006	1998	2006	2006
IADB	1996	1996	1996	1996
IIC	1990	1990	1990	1990
CAF	2009	1998	2010	2011
NDBs Operating Abroad				
BNDES	2009	1998	2010	2011
CDB	2009	1998	2010	2011
CHEXIM	2008	1998	2008	2008

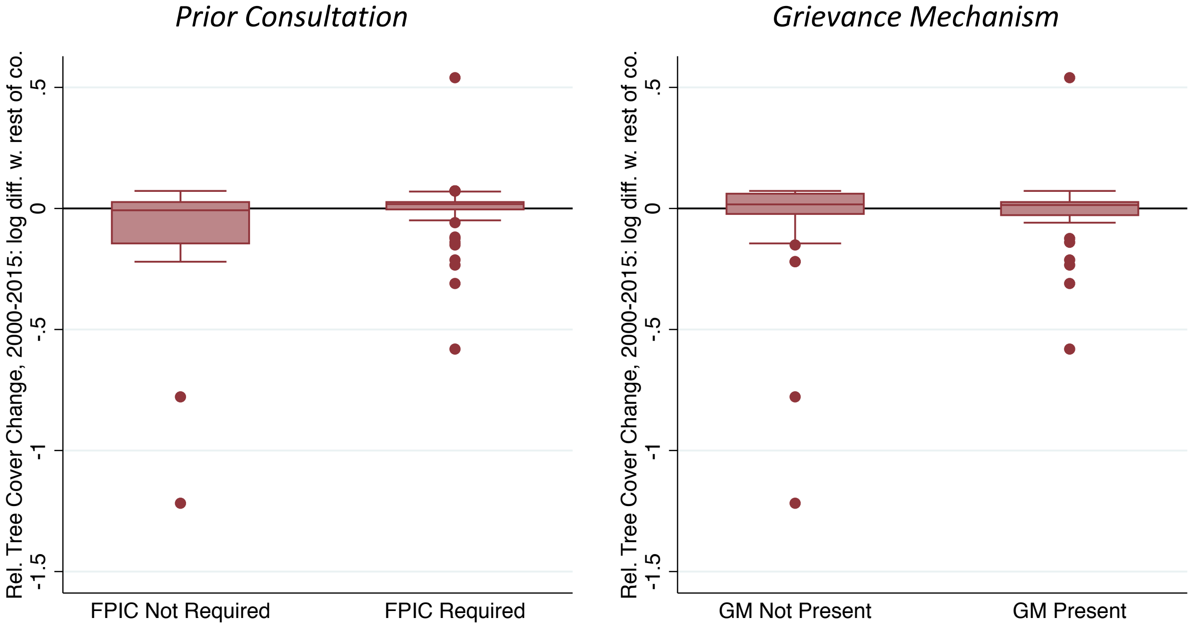
Sources: Asamblea Constituyente de Bolivia (2009), Asamblea Nacional del Ecuador (2010), Baker (2013), CAF (2016), CHEXIM (2016), Congreso de la República (2011), Deruyttere (2004), Goodland (2004), HImberg (2015), IADB (1990, 2006a, 2006b), IFC (1998, 2006a, 2006b), IIC (2013), ILO (1989), IR (2007), MacKay (2005), Ocampo and Agudelo (2014), WB (no date), WB (1992), WB (2003).

The adoption of formal grievance mechanisms by WBG and IADB lending offices evolved over time in a similar way to prior consultation safeguards, with the IBRD and IADB adopting them in 1994 (with the IADB further reforming theirs in 2010), followed by the IIC in 2002 and the IFC in 2006 (Bradlow, 2005; Brown et al, 2013; Cordonier Segger and Weramantry, 2017; Himberg 2015; IADB, 2009; IFC, 2009; IIC, 2009). There is no equivalent evolution in grievance mechanisms in national legislation, because such complaints are handled through national judicial systems.

5. Results

Figure 3 shows the distribution of relative tree cover change among projects that do and do not have formal prior consultation processes and grievance mechanisms. The presence of prior consultation mechanisms appears to be associated with a sizeable reduction in tree cover loss. Having a prior consultation process appears to raise the average relative tree cover change from a median level of -0.8 percent +1.8 percent and from a mean of -12.3 percent to -0.5 percent, compared to the remainder of the territory in the nations where the projects occurred. However, these differences are not conclusive, as the extremely high standard deviations mean that the means are not statistically significantly different from zero. However, the results seem more ambiguous for formal grievance mechanisms. Projects with these mechanisms in place had a higher *mean* relative tree cover change, but a lower *median* than the surrounding territory.

FIGURE 3: Relative Tree Cover Change Near international DFI-Financed Infrastructure with and without ESS



N	19	62	***N***	38	43
Mean	-12.3%	-0.5%	***Mean***	-5.3%	-1.4%
Median	-0.8%	+1.8%	***Median***	+1.7%	+1.4%
St. Dev.	32.9pp	12.6pp	***St. Dev.***	24.4pp	14.6pp

Note: Relative tree cover change is measured as the log difference between local and national treed cover change percent rates: ln(1+Δ local TC) – ln(1+Δ nation TC excluding areas near projects).

5.1 Regression Analysis of ESS on Tree Cover Change

To more closely examine the impacts of the two safeguards requires a formal difference-in-difference model, using the form

$$Rel\Delta TC_i = \alpha + \delta_1 PC_i + \delta_2 GM_i + \beta_1 \Delta Pop_i + \beta_2 Year_i + \delta_3 ITC0_i$$

where:

$Rel\Delta TC_i$ is the relative tree cover change with 10km of a project, measured as the log difference of the local tree cover change and the tree cover change in all parts of the country *not* within 10km of such a project.

PI_i is a binary variable expressing the presence or absence of a prior consultation mechanism.

GM_i is a binary variable expressing the presence or absence of a formal grievance mechanism.

ΔPop_i is the annual rate of population growth in the state (or department) of the project, in the five years prior to the project.

$Year_i$ is the year in which the project was approved.

$ITC0_i$ is a binary variable indicating countries with zero initial tree cover within 10km in 2000.

Relative tree cover change is expressed as

$$Rel\Delta TC_i = ln\left(\frac{TC_{P,2015}}{TC_{P,2000}}\right) - ln\left(\frac{TC_{\sim P,2015}}{TC_{\sim P,2000}}\right) = ln\left(\frac{TC_{P,2015}/TC_{P,2000}}{TC_{\sim P,2015}/TC_{\sim P,2000}}\right)$$

$$= ln\left(\frac{TC_{P,2015}}{TC_{\sim P,2015}}\right) - ln\left(\frac{TC_{P,2000}}{TC_{\sim P,2000}}\right)$$

where P indicates areas within 10km of an international DFI-financed infrastructure project and ~P indicates all national territory *not* within 10km of such a project. Using log differences rather than simple ratios allows for a more straightforward interpretation of results, as coefficients are expressed in positive or negative percent for tree cover change that is more positive or negative than what was experienced in the surrounding area. The second line of the expression above shows that defining $Rel\Delta TC$ as the log difference of tree cover change rates is arithmetically identical to defining it as a more classic difference-in-difference model form: the change in the ratio of tree cover levels between areas near projects and other areas.

Local population growth prior to project approval is included in order to differentiate whether tree cover loss is due to an area growing in population *regardless* of the project, from the change related to the project itself. It is measured as the annual rate of population increase at the state (or department) level during the five years prior to the project's approval. Project approval year is included because this model relies on end-point estimates of tree cover, in 2000 and 2015, so it is important to distinguish projects approved in 2000 (which show 15 years of tree cover change in this sample) from those approved in 2014 (which show only 1 year), for example. The model also differentiates projects with zero tree cover nearby in 2000, because these projects cannot possibly experience tree cover loss, only gain.

Table 5 shows the results of this model for each safeguard considered separately and for both together. While prior consultation regimes are significantly associated with 11.6 percent less tree cover loss, there is no significant result for the presence of formal grievance mechanisms.[4] Furthermore, an F-test for over-specification shows that including grievance mechanisms does not explain observed variation any better than considering prior consultation mechanisms alone. Thus, for analytic purposes, Model 1 should be considered the primary model.

The significant correlation between prior consultation provisions and more positive (less negative) relative tree cover change is not unexpected, given the history of scholars in other contexts finding the importance of knowledge as a common-pool asset (see for example Ostrom and Hess 2007), and the significant impact that information disclosure ("right to know") requirements have had on firm behavior (see for example Bennear and Olmstead 2007; Foulon, Lanoie, and Laplant 2002; Konar and Cohen 1995; and Wolf 1996). It is worth noting that the *lack* of significant results for grievance mechanisms may be misleading, because of possible survivor bias. If a filed grievance results in the cancellation of funding for a project, that project will no longer be included in the present dataset. For example, in 2011 the Bolivian environmental NGO *Foro Boliviano Sobre el Medio Ambiente y Desarrollo* (FOBOMADE) filed a complaint with the IADB's Independent Consultation and Investigation Mechanisms (MICI), the bank's formal grievance office, alleging inadequate EIA and prior consultation processes in the construction of a bridge over the Bení river, connecting the towns of San Buenaventura and Rurrenabaque (IADB 2014, Molina Carpio 2014). Before the complaint could be adjudicated, the government of Bolivia shifted the IADB funds from that loan to another project. Thus, that project no longer appears in the present data. Furthermore, Buntaine (2016) finds that MDBs are less likely to approve projects in countries where grievances have been filed in the prior five years. Thus, formal grievance mechanisms may impact outcomes through the *exclusion* of problematic projects from the present dataset in one of two ways: projects may be cancelled and future projects may be denied in countries where complaints have been filed.

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[4] These findings reinforce those of Buntaine (2016, 133-136), who finds that having a World Bank Inspection Panel case lowers the environmental risk of a country's future World Bank loan portfolio only for countries that predominantly borrow from the Bank's IDA concessional window – which applies to none of the countries studied here.

TABLE 5: Regression Results (N=81)

	Prior Consultation (Model 1)		Grievance Mech. (Model 2)		Both (Model 3)	
	Coefficient	**St. Error**	**Coefficient**	**St. Error**	**Coefficient**	**St. Error**
Safeguards:						
Prior consultation	**0.135****	0.051			**0.157***	0.065
Grievance mech.			0.057	0.049	-0.033	0.060
Controls:						
Prior local Δ pop.	-1.026	2.477	-0.402	2.569	-0.896	2.500
Year	-0.002	0.007	0.003	0.007	-0.005	0.008
Zero initial TC	**0.107***	0.052	0.101	0.054	**0.108***	0.052
Intercept	4.732	13.699	9.023	15.879	9.023	15.879
R^2	0.1262		0.0627		0.1296	
F-Statistics:						
This model	F (4,76) = **2.74***		F (4,76) = 1.27		F (5,75) = 2.23	
Compared to Model 1					F (1,75) = 0.29	

Note: * indicates P≤0.05 Standard errors are shown in italics. Model 1 is shaded because it explains the observed variation best, based on the F-tests shown here.

The results discussed follow the pattern of Buchanan et al (2013) of measuring tree cover change within 10km of infrastructure projects. However, that method is not without its drawbacks. Most importantly, the choice of 10km is an arbitrary one, which in some cases may include impacts from extraneous sources while in other cases it may not encompass all of the source-related tree cover change. Thus, the resulting tree cover change rates include substantial variation in tree cover change that cannot be explained by any of the variables considered here, leading to extremely low R^2 values and mostly statistically insignificant model F-statistics shown in Table 5.

This section explores a possible improvement over the traditional use of 10km radii, by measuring tree cover change at site-specific radii, based on each project's surroundings. Site-specific radii apply the same rules for radius selection to each project, to allow flexibility for variations in individual projects' surroundings, without sacrificing comparability among projects. These radii are defined as the point where the local source-based tree cover change fades into the background rate of the change of surrounding area. It takes into account as much as possible of the source-based tree cover change, while including as little as possible of the tree cover change from other, unrelated, nearby sources.

Mathematically, a site-specific radius is defined using a third-degree polynomial trend line for tree cover change as a function of an expanding radius, as measured at 1km, 2km and so on.

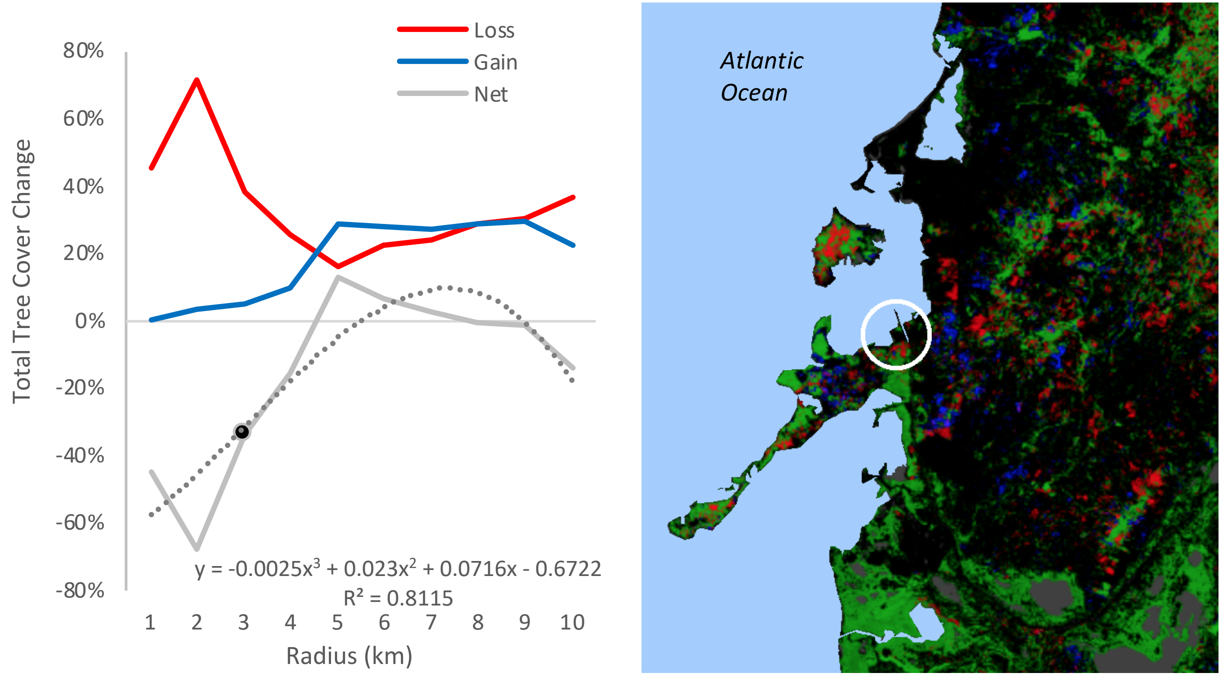
The second derivative of this trend line yields an inflection point, after which the tree cover change ceases to be dominated by source-related tree cover change and begins to be dominated by the background rate of change. For most projects, the tree cover change trend line reaches an inflection point at or before 10 km; in those cases, there is no need to measure tree cover change beyond 10km. However, in cases where no inflection point is forthcoming within 10km, further measurements are taken until an inflection point emerges.

A few exceptions exist to this process. First, for projects with zero tree cover change in the area immediately surrounding a project (which is only the case for very small projects), then the site-specific radius is the largest radius with zero tree cover change, before unrelated tree cover changes can be taken into account. Similarly, where there is an obvious introduction of a new source of unrelated tree cover change, the site-specific radius must be small enough to avoid taking it into account.

Figure 4 illustrates the process of choosing site-specific radii using two examples: Puerto Bahía near Cartagena, Colombia, and Route 3 of the *Corredor Vial Interoceánico Sur* in southern Peru. As the included tree cover change maps show, the choice of site-specific radii allows for the exclusion of extraneous tree cover change in smaller projects, while still encompassing applicable tree cover change for larger projects. It is useful in situations with extremely volatile tree cover changes within 10km (like Puerto Bahía) as well as projects where the tree cover change simply slowly fades out as the radius increases (as in Route 3).

FIGURE 4: Examples of site-specific radii and their definitions (red=loss, blue=gain)

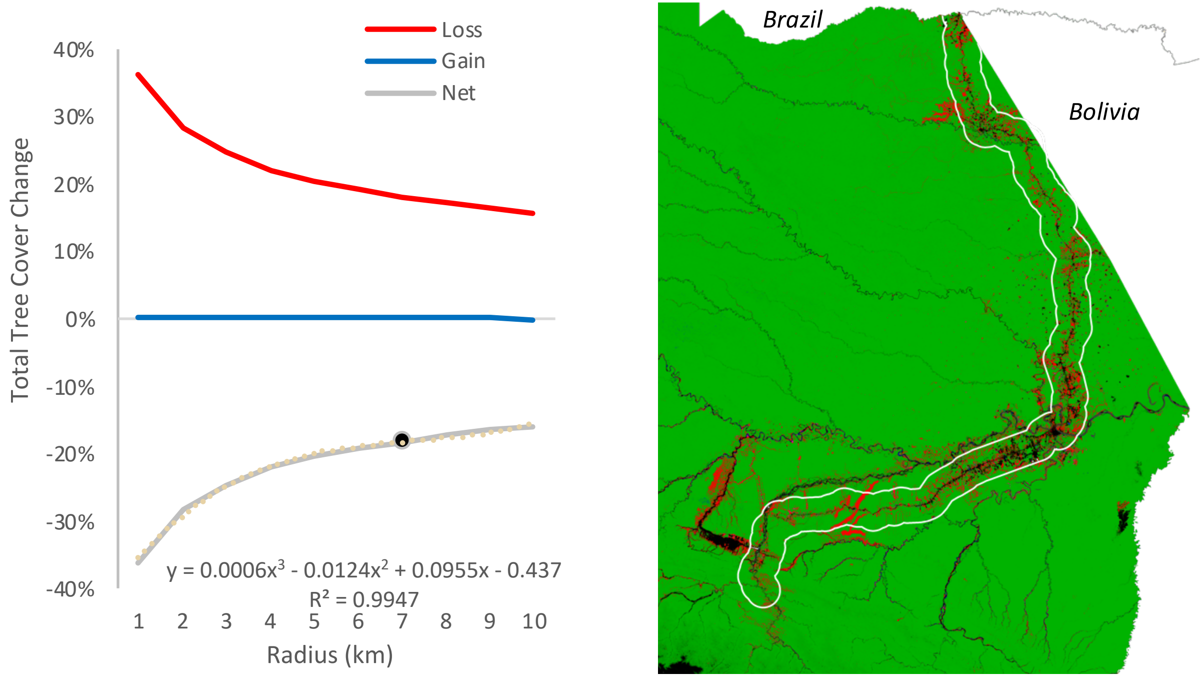
4A: Puerto Bahía, Colombia



Tree Cover Change, Trendline, and Infl. Point.

Resulting radius: 3km

4B: Corredor Vial Interoceánico Sur, Route 3, Peru



Tree Cover Change, Trendline, and Infl. Point.

Resulting radius: 7km

Note: Maps are not to scale relative to each other, to preserve visibility given Puerto Bahía's much smaller size.

Using site-specific radii has another important advantage compared to using 10km radii, beyond measuring project-related tree cover change more accurately. It also allows the inclusion of three projects for which tree cover change cannot be measured at 10km. These observations all had zero tree cover near the projects sites in 2000, and extremely low tree cover (less than 0.01 percent each) within 10km of the project sites. Nevertheless, in each case, the few trees in the area disappeared by 2015, yielding -100 percent tree cover changes, making it impossible to measure tree cover change in the form ln(1+Δ local TC) – ln(1+Δ nation TC excluding areas near projects). These three observations are as follows.

- Bolivia's Tiquina-Copacabana road, on the desert shores of Lake Titicaca, had zero tree cover within 3km of the road. However, the entire area within 10km of it had a tree cover rate of 0.002 percent in 2000, which fell to zero by 2015, yielding a tree cover change of -100 percent.
- Bolivia's Rio Seco-Huarina road had zero tree cover within 4km of the road in 2000. However, the entire 10km area had 0.002 percent tree cover in 2000, which fell to zero by 2015. Thus, using the 10km measure yields a tree cover change rate of -100 percent.
- Peru's Cerro Mulato micro-dam is surrounded by farmland (outside of the town of Chongoyape), and so had zero tree cover within several kilometers in 2000. Nonetheless, the entire area within 10km of the dam had 0.009 percent tree cover in 2000, which fell to zero by 2015, yielding a tree cover change of -100 percent.

In each of these cases, small unrelated changes in tree cover within 10km of the project sites yield extreme tree cover change *percentages*. Nonetheless, this factor alone does not warrant excluding them entirely from the analysis, as they are otherwise unremarkable projects. Using site-specific radii addresses the outlier problem without removing them from the analysis.

Table 6 shows the tree cover change associated with projects when measured with site-specific radii. As explained above and demonstrated statistically below, this method is more accurate as it includes only tree cover change that is demonstrably associated with the project sites. When measured with this higher standard, the tree cover change rate associated with international DFI-financed projects is actually greater than when it is measured conventionally within a 10km radius: 15.9 percent, four times the 3.9 percent rate in the remaining territories.

Taken together, these projects are associated with the loss of 4,450.5 km^2 of tree cover, which is equivalent to 212.7 million metric tons of CO_2 emissions. A conservative estimate of the social cost of these emissions (taking into account the climate change-related costs but not the loss in local forest-based livelihoods) range between $2.1 billion USD and $10.5 billion USD, using estimates from the Interagency Working Group on Social Cost of Carbon for 2010.[5]

TABLE 6: Tree Cover Loss Associated with international DFI-Financed Infrastructure Projects, 2000-2015

	Country				Total
	Bolivia	Colombia	Ecuador	Peru	
Associated with projects:					
Total tree cover change (km^2)	-1,788.5	-63.5	-11.1	-2,587.4	-4,450.5
Total initial tree cover (km^2)	8,387.1	2,116.3	670.7	16,898.5	28,072.6
Tree cover change (%)	-21.3%	-3.0%	-1.7%	-15.3%	-15.9%
Emissions equiv. (MMT CO_2)	59.0	3.2	0.6	149.9	212.7
Remaining territory:					
Total tree cover change (km^2)	511,702.2	676,909.7	149,459.5	713,360.7	2,051,432.1
Total initial tree cover (km^2)	-36,331.4	-21,985.5	-3,666.0	-18,409.2	-80,392.1
Tree cover change (%)	-7.1%	-3.2%	-2.5%	-2.6%	-3.9%
Emissions equiv. (MMT CO_2)	1,198.9	1,112.5	200.3	1,066.5	3,578.2

Note: Emissions are calculated using the average carbon intensity per km^2 of forest in each country, using median estimates in Saatchi et al (2011): 9.0 kT/km^2 in Bolivia, 13.8 in Colombia, 14.9 in Ecuador, and 15.8 in Peru.

Figure 5 shows the distribution of relative tree cover change, when measured at site-specific radii, by country. The outliers that dominate Figure 2 have been curtailed, with the range of observations here stretching only from -60 percent to +10 percent, rather than the -150 percent to +50 percent shown above. However, the standard deviations are still strong enough to prevent the means from being statistically significantly different from zero.

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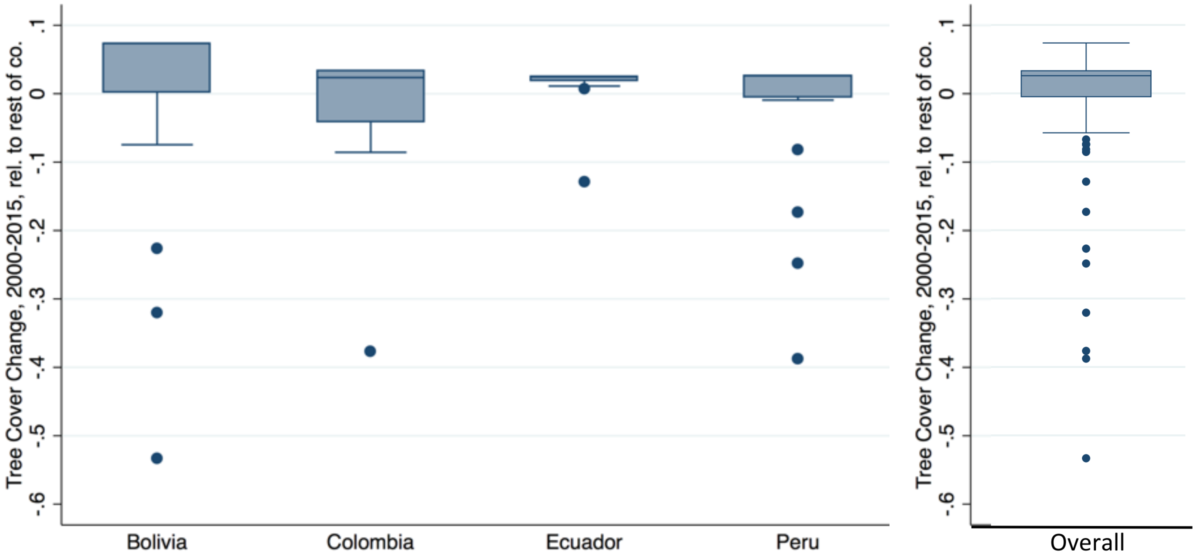
[5] These estimates use the most recent US Interagency Working Group on the Social Cost of Carbon estimates for the cost of emissions in 2010, the only estimate within the 2000-2015 period: between $10 and $50 per metric ton of CO2 (US Government, 2013). As Grieg-Gran (2008) points out, the cost of limiting emissions through forest conservation are well below this level: less than $5 USD per metric ton of CO2. Furthermore, Ickowitz, Sills, and De Sassi (2017) explain that the social costs of Amazonian deforestation are likely to fall on poorer households, while the opportunity costs of limiting deforestation are disproportionately represented among those already well-off.

FIGURE 5: Relative Tree Cover Change Measured within Site-Specific Radii of international DFI-Financed Infrastructure Projects, 2000-2015

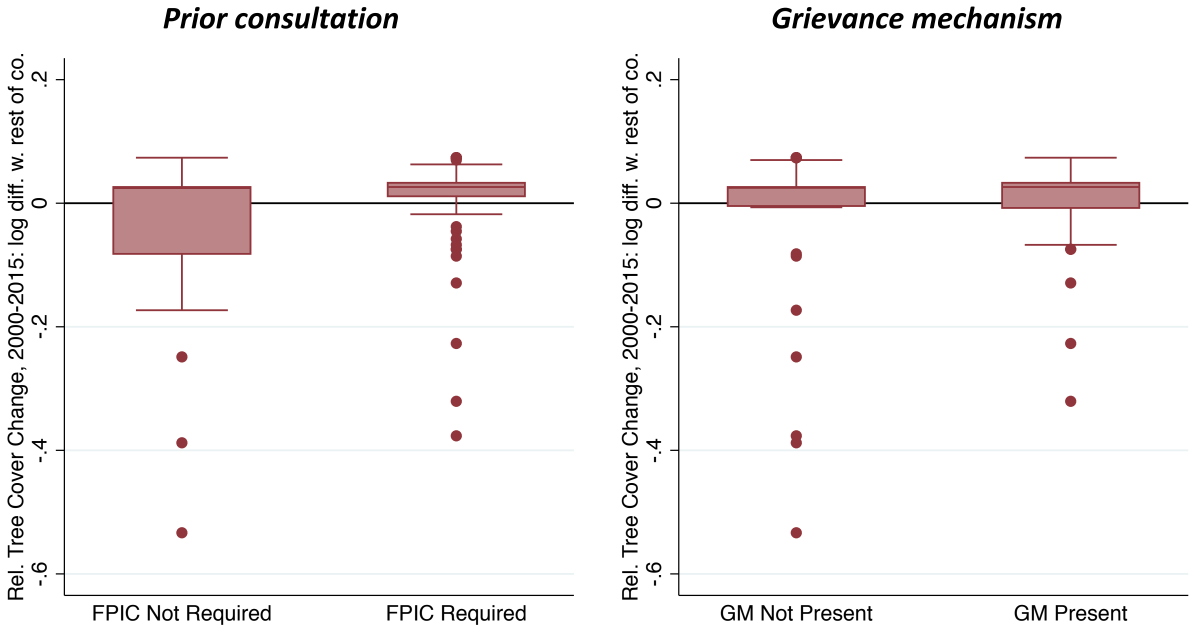


N	20	20	14	30	84
Mean	-0.6%	-1.7%	+1.1%	-1.3%	-0.8%
Median	+7.4%	+2.4%	+2.5%	+2.6%	+2.6%
St. Dev.	16.6pp	9.4pp	4.1pp	9.4pp	10.9pp

Note: Relative tree cover change is measured as the log difference between local and national treed cover change percent rates, as explained in the following section.

Figure 6 shows the distribution of relative tree cover change rates over the two safeguards examined here, when measured at site-specific radii (as Figure 3 does for tree cover change measured within 10km). As in Figure 3, above, prior consultation mechanisms appear to be associated with less tree cover loss: having a formal prior consultation mechanism raises the average relative tree cover change from -5.2 percent to +0.4 percent. However, these means are dominated by outliers; the standard deviations (while much smaller than those in Figure 3) are still quite large, and the means are not significantly different from zero. Also as above, grievance mechanisms show an ambiguous – at best – relationship with tree cover change.

FIGURE 6: Distribution of Relative Tree Cover Change (Measured within Site-Specific Radii), by ESS, 2000-2015



	FPIC Not Required	FPIC Required		GM Not Present	GM Present
N	19	65	***N***	38	46
Mean	-5.2%	+0.4%	***Mean***	-2.2%	+0.3%
Median	+2.4%	+2.6%	***Median***	+2.5%	+2.6%
St. Dev.	16.8pp	8.2pp	***St. Dev.***	14.0pp	7.4pp

Table 7 shows the results of repeating regression Models 1 through 3 with tree cover change measured at site-specific radii. Considered jointly, these models nearly double the R^2 values of Table 5 without losing degrees of freedom (or observations, as noted above). Furthermore, they have highly-significant model F-statistics. Thus, these models explain the variation in relative tree cover change among projects much better than those shown above.

As above, prior consultation mechanisms are significantly related to tree cover loss: projects with a prior consultation requirement have 5.6 percent less tree cover loss than other projects, relative to the surrounding territory. Also as above, formal grievance mechanisms are not significantly related to tree cover change, and including this variable fails an F-test for over-specification, so it should be omitted. Thus, Model 4 is preferable to Model 6. Finally, whether a project has zero initial tree cover is the *most* significant factor in relative tree cover change, which is to be expected given the impossibility of tree cover loss at these sites.

TABLE 7: Regression Results Using Site-Specific Radii

	Prior Consultation (Model 4)		**Grievance Mech. (Model 5)**		**Both (Model 6)**	
	Coefficient	**St. Error**	**Coefficient**	**St. Error**	**Coefficient**	**St. Error**
Safeguards:						
Prior Consultation	**0.056***	0.026			0.060	0.034
Grievance Mech.			0.028	0.025	-0.007	0.032
Controls:						
Prior local Δ pop.	0.529	1.361	0.758	1.396	0.570	1.381
Year	0.001	0.003	0.003	0.004	-0.000	0.004
Zero initial TC	**0.092*****	0.024	**0.092*****	0.025	**0.093*****	0.024
Intercept	-1.359	6.833	-6.251	7.358	-0.455	7.952
R^2	0.2100		0.1783		0.2105	
F-Statistics:						
This model	F (4,79) = **5.25*****		F (4,79) = **4.29****		F (5,78) = **4.16****	
Compared to Model 4					F (1,78) = 0.05	

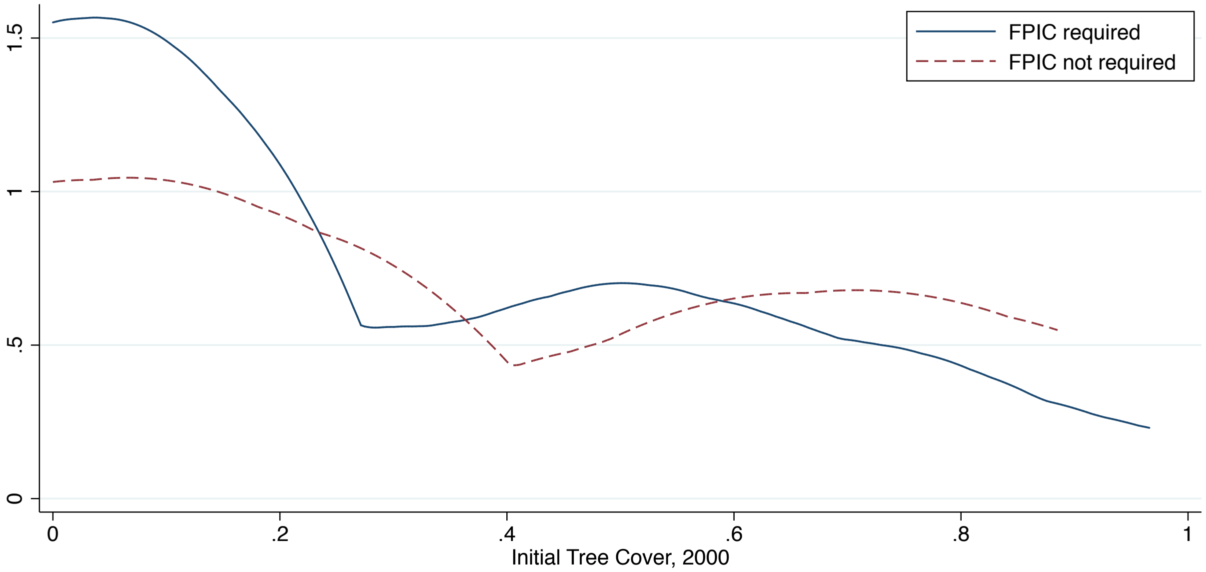
Note: N=84. * indicates P≤0.05; *** indicates P≤0.001. Model 4 is highlighted because it offers the most explanatory power of these three, based on the F-test shown.

5.1.1 The Role of Site Selection

In all of the models shown thus far, the one variable with consistently significant results has been whether a project site had zero local tree cover in 2000. Thus, it is important to distinguish whether projects with prior consultation required perform better relative to tree cover change because of their *initial* conditions. In other words, this raises the question of whether prior consultation simply adds a bureaucratic hurdle that encourages countries to avoid using international DFIs with prior consultation requirements for projects in heavily forested areas. Such a finding would be consistent with the work of Buntaine (2016, 82), who interviewed 54 individual staff members at four Washington, DC-based MDBs and found that it was common for World Bank staff to report avoiding certain projects because of the added "hassle factor" of pursuing safeguards in environmentally or socially risky loans. Furthermore, the World Bank's own Independent Evaluations Group reported in 2010 that most Latin American and Caribbean team leaders "had encountered clients who wanted to avoid all or part of a project because of safeguard policies" (46). If the results seen in Table 7 are simply a restatement of these observed tendencies, then they do not speak to the usefulness of prior consultation in preventing deforestation so much as its impact on sending risky projects to DFIs with looser safeguards – surely not the intention of safeguard designers.

Figure 7 shows the distribution of initial tree cover levels among projects with and without prior consultation requirements. Projects with prior consultation requirements do appear to be more heavily concentrated in areas with zero or very low tree cover. (The bi-modal distribution shown here is not unexpected, as the region is characterized by dense tropical forest and open desert).

FIGURE 7: Distribution of Initial Tree Cover Levels among Projects with and without Prior Consultation Requirements (Kernel Density)



	N	Mean ITC	Median ITC	St. Dev., ITC	% with zero ITC
With P.C.	65	25.8%	8.7%	31.1pp	40.0%
Without P.C.	19	31.6%	8.8%	36.1pp	42.1%
Total	84	27.1%	8.7%	32.2pp	40.5%

Based on Figure 7, it does appear to be the case that DFIs with stricter safeguards are likely to choose less risky projects. However, this tendency alone does not explain all of the difference seen in Table 7. A Blinder-Oaxaca decomposition, shown in Table 8, can more explicitly differentiate the importance of prior consultation in Model 4. The results show that almost all of the observed difference in performance between projects with and without prior consultation requirements is due to the coefficients, rather than the endowments. In other words, the difference is related to how well projects with prior consultation provisions performed *given the initial characteristics* of the project, and not those characteristics themselves.

TABLE 8: Blinder-Oaxaca decomposition of the observed differences in Model 4 (Table X)

	Absolute Difference	Share of total
Endowments	-0.002	4.0%
Coefficients	-0.059	105.8%
Interaction	0.005	-9.8%
Total difference in observed means	0.056	100.0%

5.2 Country and Type:

Table 9 shows the result of including country and project type variables, both individually and together. Even without including an explicit country control, the model implicitly includes differences in national tree cover changes (in that the dependent variable's calculation includes national tree cover in 2000 near projects and elsewhere, nationally). However, it is worth exploring whether the differences in the national institutions that oversee project implementation have their own impact. This is especially true given that, in the cases of Ecuador, Peru, and Bolivia, prior consultation regimes were enacted by regimes that had come to power with the support of indigenous and environmentalist groups, as mentioned above, and might be expected to have important institution-specific mechanisms for improved performance under these regulatory regimes.

It is also worthwhile to seek out any differences among project type, given the extensive literature linking certain types of infrastructure projects (especially paved roads and dams with reservoirs) to deforestation in the Amazon basin, as mentioned above. When differentiating by type, this model divides projects into seven categories: biofuel, dams (divided into those with and without reservoirs), fossil fuel power plants, ports, roads, and unconventional renewable energy (including solar and wind farms).

Table 9 shows the results of including country and project type controls into the basic model. Every variation fails an F-test for over-specification when compared to Model 4 in Table 7. Thus, even though Model 7 shows a significant result for Ecuador, this result should be disregarded, as an extraneous artifact of over-specification. The lack of significant differences among project type is a particularly striking given the existing literature linking certain types of infrastructure projects (especially paved roads and larger dams) with deforestation.

Table 9: Regression Results with Country and Type Variables, Using Site-Specific Radii

	Country (Model 7)		Type (Model 8)		Both (Model 9)	
	Coefficient	**St. Error**	**Coefficient**	**St. Error**	**Coefficient**	**St. Error**
Prior Consultation	0.039	0.029	0.050	0.029	0.044	0.033
Controls:						
Prior local Δ pop.	0.135	1.358	0.440	1.422	-0.033	1.469
Year	-0.001	0.004	-0.002	0.004	-0.002	0.004
Zero Initial TC	**0.118*****	0.027	**0.105*****	0.025	**0.125*****	0.029
Country:						
Colombia	0.029	0.035			0.042	0.039
Ecuador	**0.085***	0.040			0.078	0.057
Peru	0.003	0.030			0.011	0.034
Type:						
Dam: R.o.R.			0.088	0.105	0.058	0.110
Dam: w/ res.			0.007	0.106	0.002	0.107
Fossil fuel power			0.034	0.116	0.005	0.121
Port			0.004	0.108	-0.003	0.112
Road			0.026	0.102	0.036	0.105
Unconv. R.E.			0.073	0.117	0.046	0.121
Intercept	2.730	7.126	3.261	7.644	4.590	8.082
R^2	0.2616		0.2612		0.2840	
F-statistics:						
This model	F (7,76) = **3.85****		F (10,73) = **2.58****		F (13,70) = **2.14***	
Compared to Model 4	F (3, 76) = 1.77		F (6, 73) = 0.84		F (9, 70) = 0.80	
Compared to Model 7					F (6, 70) = 0.36	
Compared to Model 8					F (3,70) = 0.74	

Note: N = 84. * indicates P≤0.05; ** indicates P≤0.01; *** indicates P≤0.001. R.o.R. indicates "run of the river" dams, without reservoirs.

Finally, even if *institutional* differences between countries are not significant, differences in the institutional *will and capacity* across countries – and DFIs – may be relevant. Table 10 shows the results of including considerations for the environmental performance of the institutions related to each project, measured as the Environmental Performance Index for each project's international DFI and nation.[6] As Table 10 shows, however, EPI scores do not help explain variations in tree cover. Not only are their impacts insignificant, but F-tests show that these models have less explanatory power than Model 4, which excludes EPI scores.

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[6] The methodology for calculating country and international DFI EPI scores for each project is discussed in Appendix B.

TABLE 10: Regression Results with EPI Scores for Countries and international DFIs at Site-Specific Radii

	Country (Model 10)		Type (Model 11)		Both (Model 12)	
	Coefficient	**St. Error**	**Coefficient**	**St. Error**	**Coefficient**	**St. Error**
Prior Consultation	0.046	0.030	0.053	0.027	0.041	0.031
Controls:						
Prior local Δ pop.	0.581	1.369	0.366	1.404	0.374	1.407
Year	-0.002	0.006	0.001	0.004	-0.002	0.006
Zero Initial TC	**0.094*****	0.024	**0.094*****	0.024	**0.097*****	0.025
EPI:						
Borrower	0.002	0.003			0.002	0.003
DFI			-0.102	0.197	-0.137	0.202
Intercept	4.472	11.264	-2.114	7.018	4.837	11.316
R^2	0.2143		0.2127		0.2190	
F-statistics:						
This model	**4.26****		**4.22****		**3.60****	
Compared to Model 4	0.41		0.25		0.43	
Compared to Model 10					0.46	
Compared to Model 11					0.62	

Note: N = 84. * indicates P≤0.05; ** indicates P≤0.01; *** indicates P≤0.001. The methodology for calculating environmental performance index (EPI) scores is discussed in Appendix C.

5.3 The role of International DFIs

Beyond the enactment of prior consultation provisions, the *implementation* of these requirements is a crucial element in project impacts. This is an intrinsically institutional topic. This section explores the role of international DFIs by examining the comparative performance of the different DFIs and the importance of international DFIs' prior consultation requirements compared to *national* prior consultation standards

Table 11 shows the results of comparing DFIs to each other within Model 4. The DFIs shown in Table 11 are not mutually exclusive. Since projects are often co-financed (and some road segments are financed under multiple different loans from different DFIs operating separately), this is a test of the *participation* of particular DFIs in particular projects.

TABLE 11: Regression Results, Disaggregated by DFI

	Simple (Model 13)		With Countries (Model 14)	
	Coefficient	St. Error	Coefficient	St. Error
Prior Consultation	0.051	0.035	0.032	0.045
DFI:				
IBRD	-0.024	0.043	-0.012	0.051
IFC	-0.064	0.039	-0.068	0.042
IADB	-0.056	0.041	-0.048	0.044
IIC	0.050	0.053	0.039	0.055
CAF	-0.055	0.039	-0.053	0.039
BNDES	0.041	0.080	0.003	0.089
CDB	0.013	0.073	-0.012	0.079
CHEXIM	0.005	0.084	-0.017	0.090
Controls:				
Prior Local Population Growth	0.630	1.485	0.329	1.516
Approval Year	0.001	0.005	0.001	0.005
Zero initial Tree Cover	**0.110*** **	0.026	**0.126*** **	0.029
Country:				
Colombia			0.036	0.040
Ecuador			0.060	0.050
Peru			0.005	0.034
Intercept	-2.135	9.449	-1.565	10.780
Model:				
R^2	0.3036		0.3211	
F-statistics:				
This model	F (12, 71) = **2.58****		F (15, 68) = **2.14***	
Compared to Model 4	F (8, 71) = 0.53		F (11,68) = 0.54	
Compared to Model 13			F (3, 68) = 0.58	

Note: N = 84. * indicates P≤0.05; ** indicates P≤0.01; *** indicates P≤0.001.

None of the DFIs significantly out-perform any other, and including them yields an F-statistic that indicates over-specification when compared to Model 4. This is a useful result because it indicates that the difference shown above is due to policy, rather than other institutional aspects of the DFIs that have adopted them (mostly northern-based MDBs).

Another relevant question is the importance of whether the DFI or the national government provides the prior consultation protection. After all, as established above, in many cases the DFIs here established their ESS only after civil society groups in affected countries complained of not being taken into account by the relevant authorities in their national governments. With this in mind, it is worthwhile to disaggregate Model 4 by the type of institution that requires prior consultation: the DFI, the host country, or both.

Table 12 shows the results of this analysis. It also includes country controls, because of the institutional nature of the question asked in this section: *Given an active or passive DFI,* do any countries perform better than others? While prior consultation continues to show significant results, neither DFI leadership nor any particular country makes a significant difference.

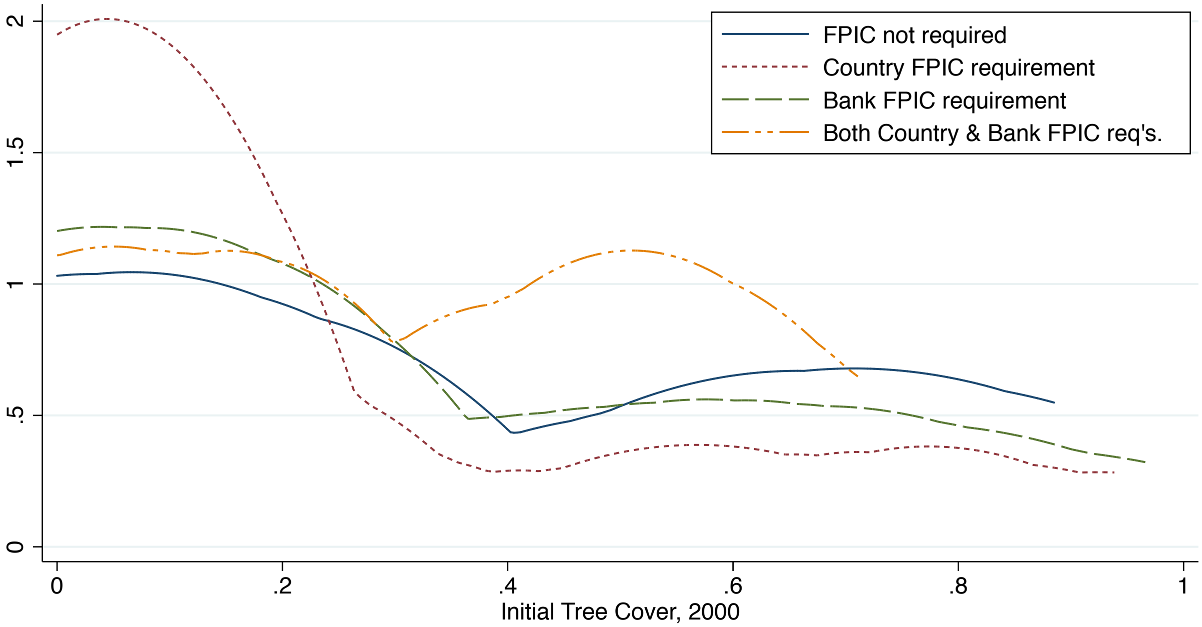
TABLE 12: Regression Results, Disaggregated by Source of Prior Consultation Requirement: Country, DFI, or Both

	Simple (Model 15)		With Countries (Model 16)	
	Coefficient	**St. Error**	**Coefficient**	**St. Error**
Safeguards:				
Country-only P.C. Requirement	**0.085***	0.036	**0.097***	0.048
DFI-only P.C. Requirement	0.028	0.032	0.019	0.031
Both	**0.076***	0.034	**0.150***	0.060
Controls:				
Prior local population growth	0.065	1.415	-0.960	1.443
Approval year	-0.004	0.004	-0.009	0.005
Zero initial tree cover	**0.097*****	0.024	**0.102*****	0.028
Country:				
Colombia			-0.056	0.054
Ecuador			0.070	0.040
Peru			0.022	0.033
Intercept	7.611	8.946	17.346	10.701
Model:				
R^2	0.2355		0.3040	
F-statistics:				
This model	F (6,77) = **3.95****		F (9,74) = **3.59*****	
Compared to Model 15			F (3, 74) = 2.46	

Note: N = 84. * indicates P≤0.05; ** indicates P≤0.01; *** indicates P≤0.001.

However, as above, before drawing conclusions from Table 12, it is important to disaggregate the role of site selection from the role of policy. As Figure 8 shows, projects with national prior consultation protections but without DFI requirements for them are much likelier than other projects to be located in areas with low initial tree cover. The mean initial tree cover level for these projects is 21.1 percent, compared to other groups with means between 27.0 percent and 31.6 percent.

FIGURE 8: Tree Cover in 2000 at Infrastructure Project Sites, by Prior Consultation Protection Type



	N	Mean ITC	Median ITC	St. Dev., ITC	% with zero ITC
No P.C.	19	31.6%	8.8%	36.1pp	42.1%
Country-only P.C.	20	21.1%	4.4%	31.6pp	35.0%
DFI-only P.C.	25	27.0%	0.0%	34.4pp	52.0%
Co. & DFI P.C.	20	29.1%	33.9%	26.9pp	30.0%
Total	84	27.1%	8.7%	27.1pp	40.5%

Since the *type* of prior consultation enforcement is a categorical variable, to test the importance of ITC as an interaction variable, a Blinder-Oaxaca decomposition is not useful in this case. Thus, to eliminate the interference of differences in site selection, Table 13 limits Models 12 and 13 to those observations with non-zero initial tree cover, yielding Models 17 and 18. Of the resulting two models, only Model 18 (including country controls) has a significant F-statistic (and also shows that adding country controls significantly helps explain the variation in tree cover change). Model 18 shows that the lack of significant impact of DFI prior consultation requirements seen in Table 12 is a mere artifact caused by the "zero initial tree cover" variable. It also shows that projects in countries with national prior consultation requirements are expected to have 30.4 percent better tree cover change around infrastructure projects, relative to the rest of the country, than projects with no prior consultation requirements. In cases with no national prior consultation policy, a project's related relative tree cover change can still improve by 10.6 percent from the associated DFI's prior consultation policy. This rate rises to 32.4 percent if country and the DFI both have prior consultation policies.

TABLE 13: Regression Results, Disaggregated by Source of FPIC, Where Initial Tree Cover >0

	Simple (Model 17)		With Countries (Model 18)	
	Coefficient	**St. Error**	**Coefficient**	**St. Error**
Safeguards:				
Country P.C. requirement	**0.122***	0.060	**0.304****	0.096
DFI P.C. requirement	0.063	0.053	**0.106***	0.051
Both	**0.129***	0.056	**0.424*****	0.116
Controls:				
Prior local population growth	-0.430	2.018	-2.890	1.978
Approval year	-0.004	0.007	**-0.021***	0.008
Country:				
Colombia			-0.144	0.092
Ecuador			0.080	0.061
Peru			**0.169***	0.064
Intercept	7.178	14.657	**41.749***	16.623
Model:				
R^2	0.2484		0.3593	
F-statistics:				
This model	F (5,43) = 1.390		F (8, 40) = **2.87***	
Compared to Model 17			F (3, 40) = **7.29*****	

Note: N = 49. * indicates P≤0.05; ** indicates P≤0.01; *** indicates P≤0.001.

Table 14 tests the difference in strength of the associations shown in Table 13. The only non-significant difference is between country-only prior consultation requirements and double-source prior consultation requirements. In other words, while the introduction of a consultation requirement into a context that previously did not have one is significant, regardless of the source of this new safeguard, an *additional* DFI requirement – in a context where the host government already requires prior consultation – is useful mostly in that it prevents future projects from losing all prior consultation protections if the host country drops its protection. In this way, DFI and country systems act in a form of *productive redundancy*. They serve as insurance policies that even if partner institutions back out of their commitments, the vulnerable populations affected by infrastructure projects will still have a place at the planning table.

TABLE 14: F-tests for Significance of Differences in Coefficients Shown in Table 10.

	Source of Prior Consultation Requirements		
	Country only	Bank only	Country and Bank
No P.C. Requirement	**9.96****	**4.21***	**13.41*****
Country-only P.C. Req.		**5.42***	3.11
Bank-only P.C. Req.			**8.98****

Note: All F-tests here are F (1,41).

Based on the results of Model 18, DFI safeguards appear to act as a form of productive redundancy, or insurance against the possibility of countries rolling back their protections. As row 1 shows, country and bank safeguards are associated with significant improvements in outcomes compared to no safeguards at all. As row 2 shows, bank safeguards are not associated with significant improvements *in addition to* country safeguards but serve as an insurance policy against countries rescinding their protections. Finally, as row 3 shows, country safeguards *are* associated with significant improvements *in addition to* bank safeguards. These results suggest that in countries outside of this region, which may not have similar legal protections, bank safeguards may fill the void left by national governments in the protection of their most vulnerable communities.

6. Discussion

This paper shows that within a limited scope of analysis, prior consultation protections can have significant impact on deforestation related to infrastructure projects. The sections below extrapolate these findings to relevant policy discussions and lays out a research agenda for continuing this work.

6.1 Policy Implications

Prior consultation is a relatively new protection in the countries studied here, but unfortunately it is already under attack. Ballón and Molina (2017) document a significant rollback in national prior consultation protections since the end of the commodities super-cycle in Colombia, Peru, and Bolivia, as governments have prioritized expanding extractive production quickly given falling prices.

Moreover, even before the end of the super-cycle, indigenous communities in these countries have not always been ensured adequate inclusion in prior consultation processes.

Sanborn, Hurtado, and Ramírez (2016) and Pozo (2012) explain that FPIC has been unevenly applied in Perú, because the military government of the 1970s relabeled many indigenous communities as "peasant" communities as a rhetorical push to unite disadvantaged groups around their shared economic challenges. These "peasant" groups – many of whom speak Quechua and self-identify as such – have not always been included in prior consultation processes. Ray and Chimienti (2017) show that, while that Ecuador's 2010 Citizen Participation Law requires the government to meet higher environmental and employment standards for projects that do not receive community approval during the prior consultation process, ministry official overseeing these processes have not always kept a record of community support or opposition, in order to determine which set of standards applies.

Maintaining political will for the importance of prior consultation at the national level, then, is a crucial area for policy implications of this work. As Humphrey (2015) states, without the buy-in of governments seeking financing for particular projects, they may avoid the "hassle factor" associated with international DFI ESS and simply take their proposals to banks with fewer requirements. Humphrey and Machaelowa (2013) show that MDB lending patterns in Latin America suggest that borrower demand is an important factor in which projects receive financing from which banks, so a situation with bank ESS but without country commitment to the process could simply result in countries taking their proposals to less-strict banks.

Another possibility is for countries to self-finance projects that have failed international DFI ESS processes. For example, in the example cited above in which Bolivia shifted funding away from a project that had been challenged through the IADB's MICI grievance mechanism, the Bolivian government has continued to pursue that project with its own financing. In 2014, the Bolivia Highway Administration (*Administradora Boliviana de Carreteras,* or ABC) announced that it would self-finance the bridge, having signed a contract with Chinese contractor Sinopec (Escóbar 2014).

Given the ability of governments to "shop around" for the most favorable terms for an infrastructure loan, or even self-finance these projects, it is crucial for international DFIs to maintain their commitments to prior consultation processes. After all, most bank safeguards were enacted absent national standards. Furthermore, banks that have not yet adopted prior consultation protections, such as BNDES and the CDB when they operate outside of their home countries, would be well-served to consider incorporating them. Though these requirements are often conceptualized as *social* safeguards, this paper shows that they have significant *environmental* impacts.

6.2 Areas for Future Research

This paper hopes to serve as an initial inquiry into the environmental impacts of ESS reform. Nevertheless, it is important to interpret the results discussed above with a healthy level of caution, as the total number of projects carried out in the region and time period studied here is modest. Thus, ample space remains for this work to be continued with added breadth and/or depth.

This line of research would be well served to be continued with greater breadth of types of infrastructure projects and types of impacts. Other forms of hard infrastructure undoubtedly contribute to countries' fixed capital stock, including telecommunications, water, sewer, and power distribution networks as well as oil and gas pipelines. Unfortunately, however, it is not possible to trace the precise locations of every kilometer of new power or phone lines, or water and sewer pipes, with the same level of detail as for roads, dams, and power plants. However, they might reasonably be expected to have a significant relationship with tree cover change, by opening up rural areas for new housing developments and encourage in-migration from other areas, in addition to their stated purposes of increasing local living standards and competitiveness. Furthermore, as Finer and Jenkins (2012) find, some of the deforestation associated with dams happens not at the site of dams, but along the associated power transmission lines. If precise information about the locations of these networks and pipelines becomes publicly available in the future, it would be worthwhile to repeat the present analysis with these inclusions.

As crucial as deforestation may be as a social and environmental impact, it is hardly the only one worth considering. For example, the line of research cited here would be well served to incorporate environmentally-motivated social conflict. This is especially true given the lack of significant relationship between international DFIs' formal grievance mechanisms and deforestation shown here. It may be that the impact of those mechanisms is better observed in preventing and mediating conflict rather than preventing deforestation. CLACSO (2000-2012) list every social conflict and protest in Latin America from 2000-2012. It would be highly useful for future research to pair individual protests listed in the CLACSO database with development projects to measure projects' tendency to inspire conflict, and the ability of national governments and development banks to resolve these conflicts.

This essay examined projects before and after the enactment of free, prior, informed consultation protections for indigenous communities. A further wave of reform enshrined free, prior, informed *consent* of those communities for projects overseen by the World Bank and IFC. As of year-end 2015, only two infrastructure projects in the Andean region have incorporated this protection: the Callao Muelle Norte port in Lima, Peru, and the Puerto Bahía port outside Cartagena, Colombia. Thus, FPI-consent could not be incorporated into the present analysis. Nonetheless, if consultation mechanisms are associated with better environmental outcomes, as the results of this essay suggest, further benefits may be visible once sufficient projects have been approved with FPI consent have been completed. It would be helpful to revisit the present analysis after this practice has garnered a larger presence in the global infrastructure finance portfolio, to test the potential environmental impact of this ambitious social protection.

There is also a significant need for future research of a deeper nature than this paper can provide. This analysis is limited to the *de jure* presence or absence of social and environmental protections. It does not take into account the institutional factors behind how – or how well – these are *implemented*. For example, it would be worthwhile to examine whether banks without their own prior consultation requirements have better environmental performance when they co-finance projects with banks that *do* have such requirements. Unfortunately, this dataset is not large enough to explore these questions, as it contains just 10 projects that were co-financed by banks that do and do not require prior consultation processes, and just 16 projects with co-financing of any type.

Finally, prior consultation with affected indigenous communities is just one aspect of stakeholder engagement. For example, the universe size examined here does not allow for the consideration of free, prior, informed *consent* (FPIC), only *consultation*. A broader array of projects may expand the dataset sufficiently to probe the impacts of full FPIC rather than "FPIClight" shown here. Furthermore, institutions vary in their ability and willingness to ensure that communities have truly been incorporated into FPIC processes. Laurance et al (2015) note that the level of compliance with ESS can vary greatly. They urge, *inter alia*, a deeper commitment to prior consultation, one that goes beyond what they call "superficial box-ticking" (R260) to true stakeholder engagement. Unfortunately, while the differences in outcomes according to the thoroughness of safeguard application continues to be an important area for future exploration, it is well beyond the capabilities of the present work.

7. Conclusion

Though prior consultation is often conceptualized as a *social* safeguard, this paper shows that it can have significant *environmental* impact. Furthermore, its impact is consistently positive, regardless of whether it is imposed by the national governments that propose the projects or by the transnational development banks that finance them. In this sense, governments and banks form a system of *productive redundancy*, in which each serves as an insurance policy for affected communities, so that if one institution rolls back its protections, prior consultation will be preserved. The same impact was not observed for the other major new ESS reform, the establishment of formal avenues for communities to pursue grievances against projects in case of damages. However, as these are traditionally considered social safeguards, it is likely that this protection's impact is felt in other avenues, such as the prevention of social conflict or reputational damage.

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Appendix A

Acronyms used in this essay

BNDES:	Banco Nacional de Desenvolvimento Econômico e Social (Brazil's national development bank)
CAF:	Development Bank of Latin America
CDB:	China Development Bank
CHEXIM:	Export-Import Bank of China
EIA:	Environmental impact assessment
EPI:	Environmental performance index
ESRM:	Environmental and social risk management
ESS:	Environmental and social safeguards
FPIC:	Free, prior informed consultation
FPI-consent:	Free, prior, informed consent
GM:	Grievance mechanism
IADB:	Inter-American Development Bank
IBRD:	International Bank for Reconstruction and Development (the World Bank's sovereign lending office)
IFC:	International Finance Corporation (the World Bank's private-sector lending office)
IIC:	International Investment Corporation (the Inter-American Development Bank's private-sector lending office)
MDB:	Multilateral development bank
MMT:	Millions of metric tons
NDB:	National development bank
ROR:	Run of the river (indicates dams without reservoirs)
TC:	Tree cover
TDB:	Transnational development bank
USEXIM:	US Export-Import Bank
WBG:	World Bank Group

Appendix B

DFI-Financed Infrastructure Projects Included in This Analysis, and the Corresponding Site-Specific Radii used in Models 4-18

The following tables give a timeline of project approvals by country, bank, and type of project. These tables show the choice of each project's site-specific radius, used in Models 4 through 18. Where applicable, those choices entail tree cover change as a function of the radius chosen for measurement, and the resulting site-specific radius, defined as the x-intercept of the second derivative of these functions. In other cases, an explanation is provided for an alternate choice in site-specific radius.

Table B1: Projects in Bolivia

Approval Year	Type	Bank(s)	Project Name	Tree Cover Change as a Function of Radius	Radius (km)
2002	Road	CAF/IADB	Santa Cruz - Puerto Suárez	$y=0.0006x^3-0.0131x^2+0.0891x-0.4544$	7
		IBRD	La Paz – Oruro [1]	N/A (zero tree cover within 10km)	10
			Rio Seco – Huarina [1]	N/A (zero tree cover within 4km)	4
			Tiquina-Copacabana [1]	N/A (zero tree cover within 3km)	3
			Yacuiba-Boyuibe [1]	$y=0.0003x^3-0.006x^2+0.0484x-0.2821$	7
			Yamparáez-Sucre [1]	N/A (zero tree cover within 6km)	6
2004	Port	IFC	Puerto Aguirre	N/A (zero tree cover change nearby)	1
	Road	IADB	La Paz – Caranavi	$y=-0.00004x^3+0.0007x^2-0.0031x-0.0082$	6
2006	Road	CAF	Huachacalla–Pisiga	N/A (zero tree cover within 10km)	10
			Integración Sur, Phase 2	N/A (zero tree cover within 10km)	10
			Riberalta–Guayamerín	$y=-0.00006x^3+0.0002x^2+0.017x-0.3844$	1
			Uyuni-Potosi	N/A (zero tree cover within 10km)	10
		IADB	Quiquibe-Yucumo [2]	$y=0.0002x^3-0.0046x^2+0.0273x-0.1707$	8
			Yucumo-Rurrenbaque [2]	$y=0.0006x^3-0.0126x^2+0.1076x-0.6697$	7
2011	Road	CAF	La "Y" de Integración	N/A (zero tree cover within 10km)	10
			Uyuni-Cruce Condo K	N/A (zero tree cover within 10km)	10
2012	Road	CAF	Chacapuco-Ravelo	N/A (zero tree cover within 10km)	10
			Quillacollo-Suticollo	N/A (zero tree cover change within 10km)	10
			Uyuni-Tupiza	N/A (zero tree cover within 10km)	10

Notes:

[1] These roads were jointly financed through the "Road Rehabilitation and Maintenance" program.

[2] These roads were jointly financed through the "Santa Bárbara-Rurrenabaque Northern Corridor Highway Improvement" program.

Table B2: Projects in Colombia

App. Year	Type	Bank(s)	Project Name	Tree Cover Change as a Function of Radius	Radius (km)
2005	Dam, w/ res.	IADB	Porce III	N/A (unrelated TC loss at 7km)	6
2006	Road	IADB	Andes-Jardin [3]	$y=-0.00006x^3+0.0005x^2+0.004x-0.0658$	3
			Angelopolis-Caldas [3]	$y=0.0002x^3-0.0054x^2+0.052x-0.2259$	9
			Bolombolo-Venecia [3]	N/A (zero tree cover change within 1km)	1
			Entrerrios-San Pedro [3]	$y=-0.0001x^3+0.0013x^2+0.0023x-0.0971$	4
			La Fabiana-Valparaiso [3]	$y=0.0001x^3-0.0029x^2+0.0204x-0.0583$	10
			Marinilla-Guatape [3]	$y=-0.0001x^3+0.0006x^2+0.0157x-0.1205$	2
			Montenegro-La Fabiana-El Libano-Tamesis [3]	N/A (unrelated TC gain at 6km)	5
			Puerto Triunfo-Autopista [3]	N/A (unrelated TC loss at 7km)	6
			Titiribi-Albania [3]	N/A (unrelated TC loss at 4km)	3
2007	Port	IFC	Terminal Maritimo Muelles el Bosque S.A.	N/A (zero tree cover change within 2km)	2
	Road	CAF	Buga-Buenaventura	$y=-0.0001x^3+0.0031x^2-0.0201x+0.0097$	10
2009	Dam, w/ res.	CAF	Sogamoso	N/A (unrelated TC loss at 5km)	4
	Fossil fuel power	CAF/IFC	Termoflores	N/A (zero tree cover within 2km)	2
		CAF/IFC/IIC	Termo Rubiales	N/A (zero tree cover within 2km)	2
2010	Port	CAF/IFC	Puerto Santa Marta	N/A (zero tree cover within 2km)	2
		IFC/IIC	Puerto Buenaventura	N/A (zero tree cover change within 1km)	1
2011	Dam, RoR	IIC	Patico-La Cabrera	N/A (zero tree cover change within 2km)	2
	Port	CAF/IFC	Puerto Bahía	$y=-0.0025x^3+0.023x^2+0.0716x-0.6722$	3
2014	Dam, RoR	IIC	Los Molinos	N/A (zero tree cover change within 2km)	2

Notes:

[3] These roads were jointly financed through the “Roads for Integration and Social Equality” program.

Table B3: Projects in Ecuador

App. Year	Type	Bank(s)	Project Name	Tree Cover Change as a Function of Radius	Radius (km)
2000	Dam, RoR	BNDES	San Francisco	$y=0.00005x^3-0.0009x^2+0.0055x-0.0105$	6
2004	Dam, RoR	IBRD	Abanico [4]	N/A (zero tree cover change within 2km)	2
			Sabanilla [4]	N/A (zero tree cover change within 2km)	2
2007	Dam, w/ res.	IADB	Baba	$y=-0.0016x^3+0.0308x^2-0.1851x+0.1812$	6
2010	Dam, RoR	CHEXIM	Coca-Codo Sinclair	$y=0.0001x^3-0.0024x^2+0.0129x-0.0242$	8
			Sopladora	N/A (zero tree cover within 6km)	6
2011	Fossil fuel power	CDB	Termoesmeraldas	N/A (zero tree cover change within 2km)	2
	Unconv. renewables	CDB	Villonaco Norte (wind)	N/A (zero tree cover change within 1km)	1
2012	Dam, RoR	BNDES	Manduriacu	$y=0.0037x^3-0.0721x^2+0.4322x-0.7892$	6
		CAF	San José de Minas	N/A (zero tree cover change within 1km)	1
		CAF/IFC	San Bartolo	N/A (zero tree cover change within 1km)	1
	Road	CAF	Ruta Viva	$y = 0.0002x^3 - 0.0019x^2 + 0.0025x - 0.0176$	3
2013	Dam, RoR	CDB	Minas San Francisco	N/A (zero tree cover change within 1km)	3
2014	Unconv. renewables	CAF	Gran Solar	$y=0.005x^3-0.1128x^2+0.8056x-1.8256$	8

Notes:

[4] These dams were jointly financed through the “SIBIMBE” program, with the Netherlands Clean Development Facility.

Table B4: Projects in Peru

Year	Type	Bank(s)	Project Name	Tree Cover Change as a Function of Radius	Radius (km)
2003	Road	IADB/IFC	Red Vial 5 Toll Road Ancón-Pativilca	N/A (zero tree cover change within 10km)	10
2004	Dam, w/res.	IBRD	Cerro Mulato [5]	N/A (zero tree cover change within 3km)	3
			El Sauce [5]	N/A (unrelated tree cover loss at 2km)	1
			Moche I & II [5]	N/A (zero tree cover within 10km)	10
			Tanguche I & II [5]	N/A (zero tree cover within 10km)	10
			Tunnel Graton [5]	N/A (zero tree cover within 10km)	10
2005	Road	CAF	Corredor Vial Interoceánico Sur, Rte. 2 [6]	$y=0.0001x^3-0.0022x^2+0.0123x-0.0318$	7
			Corredor Vial Interoceánico Sur, Rte. 3 [6]	$y=0.0006x^3-0.0124x^2+0.0955x-0.437$	7
			Corredor Vial Interoceánico Sur, Rte. 4 [6]	$y=0.00003x^3-0.0009x^2+0.0091x-0.0684$	10
2006	Road	IADB	Canta – Huayllay	N/A (zero tree cover within 10km)	10
			Sullana-El Alamor	$y=0.0004x^3-0.0054x^2+0.0348x+0.0978$	5
2009	Biofuel	IADB	Maple, Inc. sugar ethanol project	N/A (zero tree cover within 7km)	7
	Road	CAF	Red Vial4: Pativilca-Casma-Chimbote-Trujillo	N/A (zero tree cover within 10km)	10
2010	Dam, w/ res.	IFC	Hydro Cheves	N/A (zero tree cover within 8km)	8
	Road	CAF	Camaná-Dv. Quilca –Matarani-Ilo-Tacna [7]	N/A (zero tree cover within 10km)	10
			Casma-Yaután-Huaraz [7]	N/A (zero tree cover within 2km)	2
			Churín – Oyón [7]	N/A (zero tree cover within 10km)	10
			Lunahuaná - DV. Yauyos- Chupaca [7]	N/A (zero tree cover within 1km)	1
			Reposo-Saramiriza [7]	$y=0.00003x^3-0.0012x^2+0.015x-0.1027$	13
			Tingo María-Aguaytía [7]	y=-0.00004x3+0.0004x2+0.001x-0.1077	3
			Aguaytía-Pucallpa [7]	y=-0.0003x3+0.0087x2-0.0796x-0.356	10
			Tocache-DV. Tocache [7]	$y=-0.0002x^3+0.0045x^2-0.0212x-0.2788$	8
			Trujillo-Sirán-Huamachuco [7]	$y=-0.0003x^3+0.0053x^2-0.0396x+0.0699$	6
		CAF/IBRD	Chongoyape-Cochabamba-Cajamarca [8]	$y=-0.0004x^3+0.008x^2-0.0494x+0.0583$	7
			Ollantaytambo-Quillabamba [8]	$y=-0.00001x^3+0.0001x^2-0.0004x-0.0006$	3
			Lima - Canta [8]	N/A (zero tree cover within 10km)	10
2011	Dam, RoR	CAF	Las Pizarras	N/A (zero tree cover within 11km)	1
2012	Dam, RoR	CAF	Canchayllo	N/A (zero tree cover within 10km)	10
2013	Port	IFC	Callao Muelle Norte	N/A (zero tree cover within 10km)	10
2014	Unconv. renewables	CAF/IADB	Marcona/Tres Hermanas (wind)	N/A (zero tree cover within 10km)	10

Notes: [5] These dams were jointly financed through the “Poechos” program.

[6] These dams were jointly financed.

[7] These roads were jointly financed through the “Infraestructura Vial de Perú” program.

[8] These roads were jointly financed through the IBRD’s “Peru Safe and Sustainable Transport” program *and* CAF’s “Infraestructura Vial de Perú” program.

Appendix C

Methodology: Environmental Performance Index

EPI scores used here are derived from the Environmental Performance Index project managed by Yale University and the Columbia University Earth Institute, with a few adjustments as noted below:

1. As EPI methodology changes over time, in order to calculated scores that are comparable across years, scores are normalized across countries for each year. Two versions of these scores are available: one series from 2000 to 2010 (Yale and CIESIN, 2012), and another from 2007 to 2015 (Hsu, 2016). For the years 2007 through 2010, averages are taken for each country across the two indices, and those results are then normalized.
2. For multilateral development banks, weighted averages are calculated using countries' representation on bank boards for each year.

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