



Lessons for Jurisdictional Approaches From Municipal-Level Initiatives to Halt Deforestation in the Brazilian Amazon

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Specialty section:

This article was submitted to
People and Forests,
a section of the journal
Frontiers in Forests and Global
Change

Received: 18 September 2019

Accepted: 15 July 2020

Published: 14 August 2020

Citation:

Brandão F, Piketty M-G,
Poccard-Chapuis R, Brito B,
Pacheco P, Garcia E, Duchelle AE,
Drigo I and Peçanha JC (2020)
Lessons for Jurisdictional Approaches
From Municipal-Level Initiatives
to Halt Deforestation in the Brazilian
Amazon.
Front. For. Glob. Change 3:96.
doi: 10.3389/ffgc.2020.00096

Jurisdictional approaches have become popular in international forums as promising strategies to reduce greenhouse gas emissions caused by deforestation and to guarantee sustainable commodity supply. Yet, despite their growing popularity, up to now, there is little consensus on how such approaches should move forward in specific jurisdictions. In this paper we examine two contrasting municipal-level case studies in the eastern Amazonian state of Pará where jurisdiction-wide efforts are underway to reduce deforestation. By developing detailed forest governance intervention timelines since 2005, conducting semi-structured interviews with key informants, analyzing municipal deforestation trends, plus extensive examination of project reports, governmental documents and other secondary sources, this paper performs two main analyses. First, it characterizes the processes in each municipality by linking context and forest governance intervention timelines to deforestation trends. Second it provides a systematic comparison of processes based on (1) the role of the government, (2) multi-stakeholder participation and inclusiveness, (3) adaptive management, (4) horizontal and vertical coordination, and (5) alignment of public and private (supply-chain) initiatives. In so doing, this article answers some of the imperative questions on how to implement and improve jurisdictional approaches aimed at halting deforestation in the tropics.

Keywords: REDD+, supply-chain initiatives, forest governance, multi-stakeholder participation, adaptive management, third-tier jurisdictions

INTRODUCTION

Progress toward more sustainable land use in ways that contribute to economic development and social equity, has long been a priority in tropical landscapes (Jong et al., 2010). Yet, lately, much of the sustainability debate has been dominated by the urgent need to reduce deforestation given the importance of standing forests and other ‘natural climate solutions’ in helping mitigate

catastrophic climate change (Griscom et al., 2017; IPCC, 2019). Policy perspectives to tackle Amazonian deforestation have multiple origins linked to wider conservation and development agendas. While conservationists have argued in favor of expanding protected areas or securing indigenous and local community tenure rights to deter commercial agricultural expansion and to preserve mature forests exposed to encroachment (Nepstad et al., 2006; Soares-Filho et al., 2010), developmentalists have favored incentives for farmers to improve their production practices while complying with land use regulations (Börner et al., 2014; Cunha et al., 2016). In addition, growing demand for agricultural commodities, along with growing competitiveness of agriculture in frontier lands, calls for sustainable interventions by supply chains (Gibbs et al., 2016; Lambin et al., 2018) to complement state regulations and policies for forest conservation.

The Brazilian Amazon is a key landscape where these multiple approaches have been tested, making the country a laboratory of governance innovations. Through many ambitious policies, three levels of Brazilian governments (federal, state, and municipal), the private sector, and civil society organizations were able to engage in reducing Amazonian deforestation in an unprecedented way. Federal policies like the Plan of Action for the Prevention Control of Deforestation in the Amazon in 2004, and state-level initiatives like Pará's Green Municipality Program in 2011 (Whately and Campanili, 2013), to mention only a few examples, were major developments, while private sector arrangements such as the Soy Moratorium in 2006 and the Cattle Agreement in 2009 gave a further impetus to tackle deforestation (Gibbs et al., 2015; Gibbs et al., 2016). Together, these efforts helped reduce Amazonian deforestation by more than 70% since it peaked in 2004 (Godar et al., 2014; Assunção et al., 2015) making Brazil the world's largest contributor to reducing emissions during this period (Seymour and Busch, 2016).

However, these efforts have failed to contain persisting deforestation and have become less effective over time (Schielein and Börner, 2018; Seymour and Harris, 2019). In 2013, deforestation rates slowly started to increase again, and there is a resurgence of concerns that the Amazon is closer to reach a "tipping point", particularly in the eastern and southern portion of the Brazilian Amazon (Lovejoy and Nobre, 2019). For some authors, the steady rise in deforestation is partly linked to the ease with which actors involved in soy, beef and timber production can circumvent government regulations and commodity agreements (Carvalho et al., 2019) and a lack of incentives needed to make forest conservation politically sustainable (Nepstad et al., 2014). In this context, the concept of jurisdictional approaches emerged as a way to tackle deforestation in a more holistic way (Nepstad et al., 2013; TFA, 2017; Boyd et al., 2018). In global debates, jurisdictional approaches emerged from the recognition that international efforts, such as those framed under REDD+ and/or sustainable commodity supply-chain initiatives, were unable to overcome institutional barriers at the landscape level, and thus far failed to achieve the desired changes (Stickler et al., 2018).

Jurisdictional approaches are broadly defined as wall-to-wall frameworks that seek to align governments, businesses, NGOs,

and local stakeholders in specific administrative jurisdictions around common interests in land use governance (Fishman et al., 2017; Boyd et al., 2018). They strongly resemble integrated landscape approaches, but their key distinctive feature is a high level of governmental involvement in a landscape that is defined by policy-relevant boundaries (Ros-Tonen et al., 2018). There are multiple scales where jurisdictional approaches may occur - national, subnational, and local. A major recent focus has been on the subnational level, especially in countries where subnational jurisdictions have broad authority to reduce deforestation (Busch and Amarjargal, 2020). Jurisdictional approaches also have different foci. These include jurisdictional approaches to zero deforestation commitments that are delinked from governments (WWF, 2016), multi-stakeholder jurisdictional programs (Hovani et al., 2018), and jurisdictional approaches to REDD+ and low emissions development (Boyd et al., 2018), among others.

The concept of jurisdictional approach is relatively new, and its analysis is only emerging in the literature. Yet, jurisdiction-wide efforts to reduce deforestation, in its broad sense, irrespective of the extent of government involvement or of how comprehensive the actions are, have been in place for some time. In this paper, we analyze two contrasting initiatives in the Brazilian municipalities of Paragominas and São Félix do Xingu. Municipal-level initiatives have been in place in the Brazilian Amazon at least since the late 2000s, when some municipalities were targeted by federal government strategies to reduce deforestation (Thaler et al., 2019). This was triggered by Brazil's highest deforesters list that defined priority municipalities in order to tackle deforestation more effectively, through command-and-control actions such as credit restrictions and field-based law enforcement (Cisneros et al., 2015). Such strategies included municipal government-led programs and NGO interventions ranging from promoting environmental capacity building of local actors to pilot testing sustainable agricultural practices (Piketty et al., 2015; Gebara et al., 2019).

By analyzing the two cases, our aim is to contribute to ongoing debates, analyses and implementation of jurisdictional approaches to reduce deforestation. Further, we answer the following questions: (1) who should be involved in the design of jurisdictional approaches? (2) how should tradeoffs between inclusiveness and effectiveness be addressed? (3) how can the effectiveness of jurisdictional approaches be measured? (4) how should local jurisdictional approaches align or be nested in higher level approaches? (5) how can such approaches combine public and private actions?

We focus on jurisdictional approaches at local scale as these have received considerably less attention in the literature. We do not assume that our case studies are necessarily perfect illustrations of jurisdictional approaches but rather that are insightful examples of the complexity of interventions involving local governments in reducing deforestation in the real world. The municipalities of Paragominas and São Félix do Xingu were selected because they are emblematic cases of contrasting pathways of forest governance where multiple state and non-state efforts to curb deforestation have been undertaken in the Brazilian Amazon, including governmental programs,

NGO projects, and supply-chain initiatives. On the one hand, Paragominas became known as a “success story” as the first municipality to be taken off the list of highest deforesters through an alliance involving the municipal government, NGOs, ranchers and soy farmers (Sills et al., 2015; Viana et al., 2016). On the other hand, despite many efforts and overall reduction in deforestation rates São Félix do Xingu is still among the top deforestation sites in the Brazilian Amazon (Schneider et al., 2015; Schmink et al., 2017). An analysis of the processes to curb deforestation in these two distinct municipalities provides lessons for both scholars and practitioners in how to support jurisdictional approaches moving forward.

The paper proceeds as follows. In Section “Data Collection and Analysis” we present the methodological approach, including the analytical framework and the data collection methods. In Section “Context” we provide a short background of the Brazilian Amazon policy context and the socio-ecological context. In Section “Input and Output Analysis” we present a summary of the forest governance intervention timelines and the deforestation trends observed. In Section “Characterizing Processes in PGM and SFX” we present a categorization of the processes in the two case study municipalities, and in Section “Comparing Processes to Reduce Deforestation Across Five Indicators” we compare the processes through the lens of five key indicators identified from the literature on jurisdictional approaches. In Section “Lessons for Jurisdictional Approaches” we conclude the paper with a summary of lessons learned for jurisdictional approaches.

DATA COLLECTION AND ANALYSIS

This paper performs a two-case (“cross-case”) or comparative case analysis (Yin, 2014). Case study analysis is the most suitable method to address “how” and “why” questions and to investigate a contemporary complex social phenomenon in depth and in its real-world context, particularly when the boundaries between the phenomenon and the context are not clearly defined (Yin, 2014). This paper adopts the notion of context-inputs-process-outputs (CIPO) that has been widely used in the literature of educational impact evaluations and extends it to the land use sector (Scheerens, 1990). The context (C) is understood as the socio-economic and biophysical factors that shape outcomes (Börner and Vosti, 2013; Wehkamp et al., 2018). The inputs (I) are the interventions, including policies and initiatives, designed to reduce deforestation and enhance land-use governance (Howlett, 2005). The process (P) is the way local actors implement specific instruments and develop interventions in that particular context (Birkland, 2011). Outputs (O) are deforestation trends in the municipalities over time.

The analysis in this paper is broadly divided in two main parts. In the first part (see Sections “Context” and “Input and Output Analysis”) we briefly present the context (C), the inputs (I) and the outputs (O), while in the second part of the paper (see sections “Characterizing Processes in PGM and SFX” and “Comparing Processes to Reduce Deforestation Across Five Indicators”) we focus on the process (P). For the first CIPO element, the context (C), we summarize the policy and socio-ecological contexts

that affect interventions in the two study municipalities by drawing on peer-reviewed and gray literature. We understand forest governance as a “set of regulatory processes, mechanisms and organizations” through which state and non-state actors at multiple levels shape forest-related actions and outcomes (Lemos and Agrawal, 2006, p. 298).

To capture the inputs (I), we reviewed project reports, governmental documents and other secondary sources for each municipality to build a timeline of interventions since the late 1970s/early 1980s (complete timelines are presented as **Supplementary Information**). Outputs (O) were measured using Brazil’s official forest monitoring data to assess deforestation dynamics in the two municipalities through changes in the extent of municipal deforestation between 2005 and 2018 (INPE, 2019).

To understand the process, we focus on the period since 2005 and perform two different analyses. First, we characterize the processes in each municipality by linking context and the timing of forest governance interventions (inputs) to deforestation trends (outputs). Second, we provide a systematic comparison of processes based on five indicators from the literature on jurisdictional approaches: (1) the role of the government; (2) multi-stakeholder participation and inclusiveness; (3) adaptive management [as defined by Williams (2011)]; (4) horizontal and vertical coordination; and (5) alignment of public and private (supply-chain) initiatives. Along with data gathered during the timeline construction, both analyses drew on data collected in semi-structured interviews with a total of 102 key stakeholders in the two municipalities (Paragominas $n = 70$ in 2013 and 2014; SFX $n = 32$ between 2017 and 2019). Although the interviews did not follow the exact same format in the two municipalities, they document the main public and private initiatives implemented since 2005, including their outcomes and limitations, the role of different actors, and future outlook and expectations. We gave more attention to farmers in the sampling effort given that they are the direct agents of land use change in both municipalities. Both methodological and data triangulation methods were used to be sure we had enough reliable information and avoid biases (Arksey and Knight, 1999).

All data collected were then leveraged to assess the role of each respondent and organization in the process, the relevance of specific initiatives, the role of local governments, the effectiveness of multi-stakeholder processes, political coordination, and overall perceptions of changes observed in each municipality. The main

TABLE 1 | Number of interviews per type of actor.

Actors	Paragominas	São Félix do Xingu
Farmers	39	13
Municipal government	7	8
NGOs	5	4
State or federal organizations	9	3
Private sector and banks	8	3
Others	2	1
Total	70	32

changes that had occurred in both municipalities were also captured through direct participation in local meetings and discussions with municipal staff. **Table 1** above lists the number of interviews with each type of actor.

CONTEXT

Forestry-Related Policy Context in the Brazilian Amazon and Its Multiple Levels

Today, 44.1% of the Amazon is covered by specific legislation for forest protection. Indigenous Territories account for half the area that is formally recognized as protected under federal laws (Santos et al., 2013). Conservation units, protected areas created by the National System for Protected Areas in 2000, make up the other half. In addition to protected areas, another 6.2% of the Amazon is under other special tenure regimes, which includes colonization settlements governed by the Brazilian Agency for Agrarian Reform (INCRA), i.e., federal areas designated for agrarian reform purposes.¹ These settlements may be either federal land ruled by INCRA or state land, in the case of Pará, ruled by the State Land Agency (ITERPA). The remaining territory is privately held (22.7%) or unclaimed/with no clear status (27%) (Santos et al., 2013).

Most forestry-related issues in the Amazon are governed through the 2012 Brazilian Forest Code, which requires private properties to maintain 80% forest cover as legal reserve, with some exceptions. The Forest Code also instituted the Rural Environmental Registry (CAR) system that has been in force in Pará since 2006 and mandates the registration of all rural properties to facilitate social and economic planning and the monitoring of deforestation (Soares-Filho et al., 2014). State governments may reduce the size of legal reserves in private lands outside protected areas from 80 to 50% for the purpose of compliance (but not as a permission to deforest legal reserves above 50%), by designating certain areas as agricultural production zones through Ecological-Economic Zoning plans (Brito, 2019). This is the case of Paragominas and São Félix do Xingu where the 50% rule applies in private areas. For owners who have environmental debts, the Forest Code also tasked state governments with creating an Environmental Regularization Program to regulate the process of complying with the minimum forest area required per property, in the case of illegal deforestation after 2008. Smallholders are excluded from having to restore legal reserves deforested before 2008 (Brito, 2017). Some of the state regulatory competences such as CAR have been decentralized to certain municipalities in recent years, but most of the responsibility remains at state-level.

Socio-Ecological Context of the Case Studies

PGM and SFX are located in the eastern Amazonian state of Pará (**Figure 1**). Although their demographic, temporal and economic

dynamics involve different processes as detailed below, both municipalities were profoundly shaped by frontier expansion dynamics associated with road building and colonization policies during the military regime (1964–1985) (Tritsch and Le Tourneau, 2016; Schmink et al., 2017). This period was marked by intense conflicts over access to land between newcomers and indigenous and traditional riverside dwellers, among the newcomers themselves, and between newcomers and external investors such as mining companies (Schmink and Wood, 2012). As in many other Amazonian frontiers, the predominant economic model was based on environmentally degrading activities such as logging, extensive cattle ranching and slash-and-burn agriculture (Margulis, 2004).

Although frontier expansion started earlier in PGM (1960s) than in SFX (1980s), both municipalities experienced high rates of forest loss in their territories throughout the 1990s and 2000s. By the mid-2000s, when Brazil started to plan ambitious environmental policies which led to impressive progress in forest governance (Hecht, 2012), PGM and SFX were among the top-deforestation municipalities in the Amazon. Consequently, when Brazil's Federal Government intensified actions to reduce deforestation and launched a list of critical municipalities in 2008, both SFX and PGM were on it. The list of highest deforesters identified the municipalities to be subsequently targeted by command-and-control actions, such as credit restrictions and field-based law enforcement (Cisneros et al., 2015).² This instrument ended up triggering the emergence of local processes to curb deforestation in both municipalities (Thaler et al., 2019).

Despite both being highly deforested municipalities in absolute terms by the mid-2000s, SFX and PGM have had their own occupation dynamics and differ significantly in size, tenure, % of deforested area, and agrarian structure (**Table 2**). PGM witnessed a land-use intensification and diversification process involving the rapid expansion of mechanized agriculture and an increase in timber plantations (Tritsch et al., 2016). This intensification was largely because there were few unclaimed areas to expand. At the same time, mining became an important source of municipal revenue, particularly since the late 2000s. In contrast, in SFX, livestock continued to expand, increasing the size of herds and extending pastureland. This was associated with the existence of large portions of unclaimed lands, particularly at APA *Triunfo do Xingu*. According to IBGE agricultural census (IBGE, 2017), nearly 90% of the municipal landholdings are used for livestock activities, not only by large scale ranchers but also by a substantial number of smallholders. In general, smallholders tend to focus on breeding while larger actors tend to specialize in raising and fattening cattle (Garcia et al., 2017). In contrast to PGM, mechanization and grain crop production have remained relatively low. Soybean is not yet produced in SFX, and there are no records of timber plantations. Still, the number of landholdings growing permanent crops is increasing mostly due to the expansion of cocoa, a promising new crop

¹The other two special tenure regimes are quilombola territories, which are collective titles given to communities with proven African ancestry; and military areas.

²The list of highest deforesters was one of the main instruments designed under the Plan for the Protection and Control of Deforestation in the Amazon (PPCDAm), the umbrella program that concentrated federal efforts after 2004.

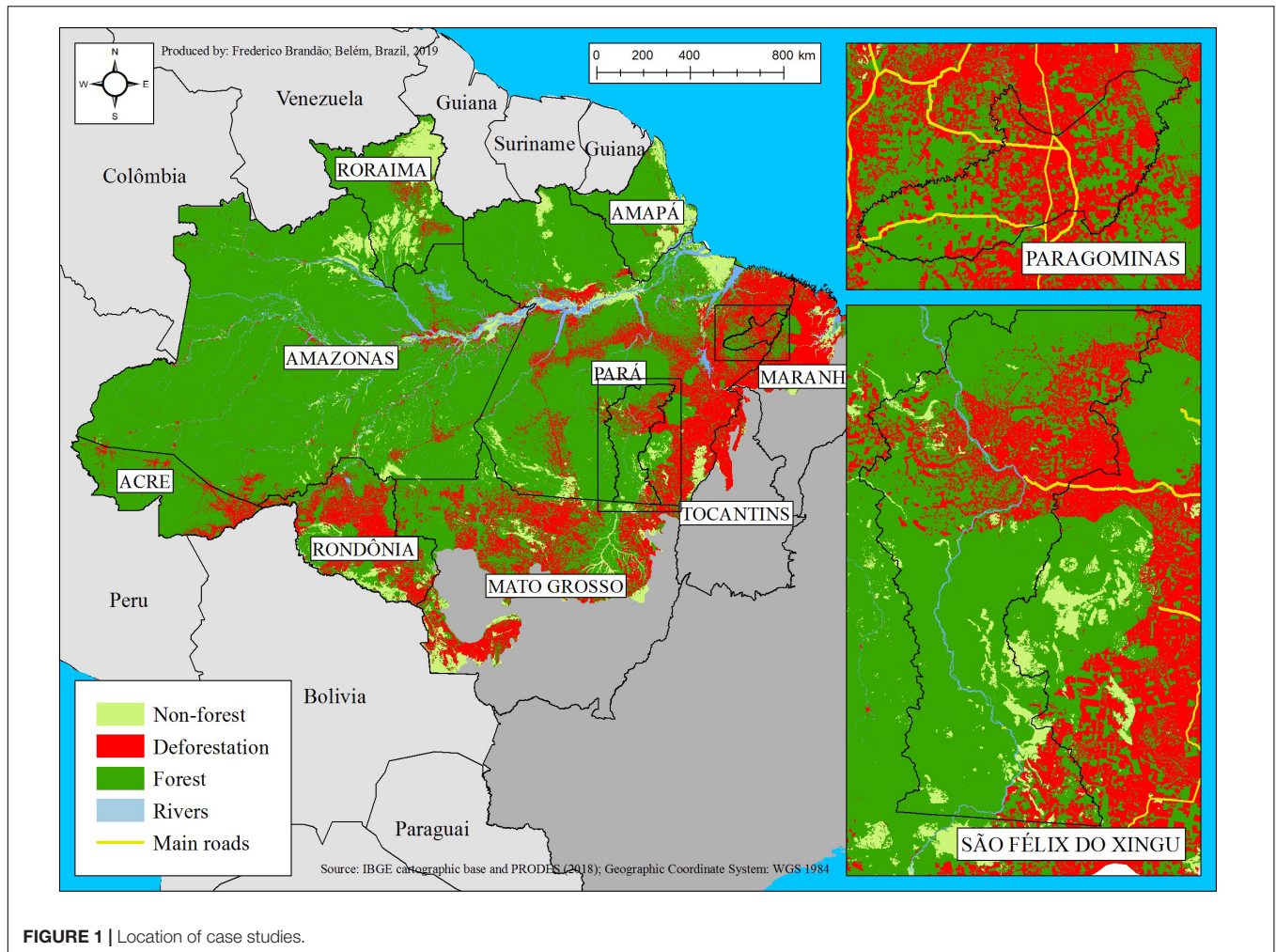


FIGURE 1 | Location of case studies.

TABLE 2 | Comparison of the context in Paragominas and São Félix do Xingu.

Similarities	Differences
<p>History of violence and absence of state.</p> <p>Deforestation frontier triggered by governmental policies between the 1960s and 1980s. High deforestation rates in the 1990s and early 2000s (on the list of municipalities with the highest rate of deforestation in 2008).</p> <p>Timber extraction and cattle ranching were predominant land use activities in the past.</p>	<p>Territorial size: SFX (84,212.85 km²) is four times larger than PGM (19,352.25 km²) (IBGE, 2015).</p> <p>Land tenure: Most of SFX is covered by formally protected areas (Indigenous Territories cover 53%, federal conservation units 6% and state conservation units 13%), while private landholdings account for 22% and INCRA settlements account for 6%. Most PGM territory is mostly covered by private landholdings (90%) while protected areas only include Indigenous Territories (5%). INCRA settlements account for the remaining 5%.</p> <p>Agrarian structure: SFX is smallholder oriented: 88% of the properties and 17% of the area. PGM is medium to large landholder oriented: 39% of the properties and 92% of the territory according to the Agricultural Census (IBGE, 2006).</p>

Source: own data.

among smallholders which, in 2017, involved approximately 1,355 families (IBGE, 2017).

in efforts to reduce deforestation and promote sustainable land use are listed in the following **Table 3**.

INPUT AND OUTPUT ANALYSIS

Inputs: Forest Governance Interventions

Figure 2 provides a brief visual summary of the timelines of forest governance interventions. The main similarities and differences

Outputs: Deforestation Trends

Both SFX and PGM mirror the general deforestation trends in the Brazilian Amazon and witnessed a rapid reduction in deforestation rates starting in 2005. In the case of SFX, an initial period of abrupt reduction starting in 2011 was followed by a period of stabilization at low rates and then by a slight increase

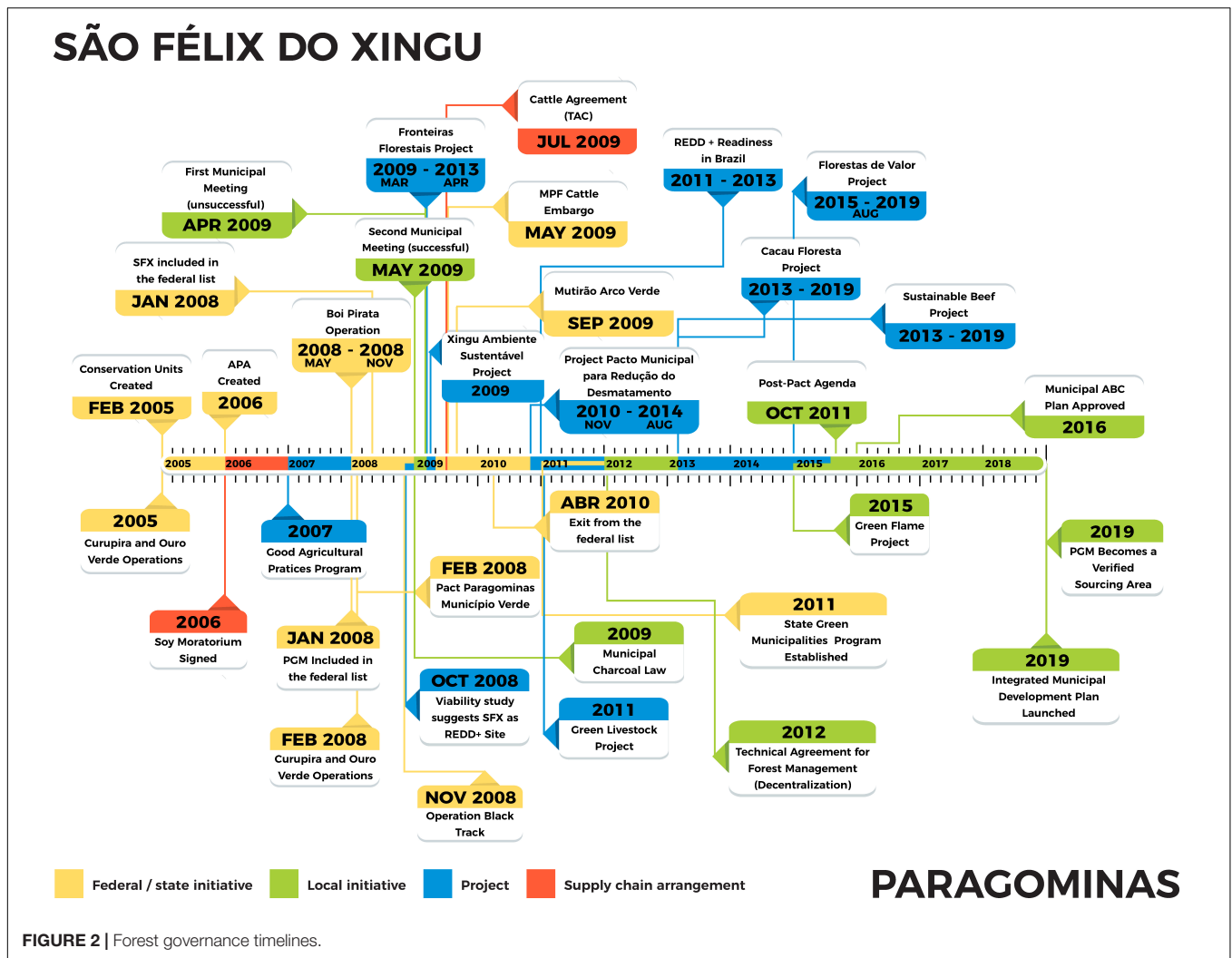


TABLE 3 | Similarities and differences between initiatives in Paragominas and São Félix do Xingu.

Similarities	Differences
<p>Most initiatives and jurisdictional actions were triggered by federal command-and-control actions in the context of the highest deforesters list.</p> <p>Similar initial goals to get off the list. Reducing annual deforestation rate to less than 40 km² and have 80% of the private municipal area under CAR. Municipal zero-deforestation pacts signed (2011 in SFX and 2008 in PGM).</p> <p>Secondary goals to getting off the list included environmental regularization and agricultural intensification with support from external actors and projects.</p> <p>Despite their efforts, neither municipality has seen the benefits of conditional climate finance (either carbon sales or certification mechanisms).</p>	<p>External actors involved: in SFX, the federal government through the Ministry of Environment (MMA) and NGOs such as The Nature Conservancy (TNC), International Institute of Education of Brazil (IEB) and Institute of Forestry and Agricultural Management and Certification (IMAFLOA) assumed major relevance. In PGM, the most important external actors since the mid-2000s were The Amazon Institute of People and the Environment (Imazon), TNC, Brazilian Agricultural Research Corporation (EMBRAPA) and, since 2014, the French Agriculture Centre for International Development (CIRAD).</p> <p>The main municipal initiatives evolved in different ways. In SFX, this included a Post-Pact Agenda 2012 and a Municipal Low Carbon Agriculture (ABC) Plan 2016, both of which no longer operate. In PGM, the process evolved from the Green Municipality initiative to an Integrated Municipal Development Plan in 2019, which has just started.</p> <p>Some secondary goals differed. PGM focused more on economic upgrading and forest restoration, while SFX focused on economic alternatives for smallholders and indigenous peoples.</p> <p>Private sector initiatives differed. In SFX, the Cattle Agreement played a key role, while in PGM it was the Soy Moratorium. The SFX case was also linked to a certain extent to REDD+ efforts while in PGM that was not the case.</p>

Source: own data.

in recent years. In the case of PGM, deforestation stabilized at residual levels in 2012. **Figure 3** depicts the trends. However, while reductions were similar, the overall trajectories differ. PGM is an old frontier where deforestation started in the 1960s, mostly linked to the construction of Belém-Brasília road. By 2005, 42% of the municipal area was deforested and a significant proportion of the remaining forests was undergoing degradation (Hasan et al., 2019). By contrast, by 2005, SFX represented a new frontier with only 16% of accumulated deforestation.

CHARACTERIZING PROCESSES IN PGM AND SFX

Based on the context and analyses of inputs and outputs, along with the interview data focused on actor perceptions we identified three distinct moments in time in each jurisdiction.

Categorization of PGM

Command and Control (2005–2008)

PGM was subject to an initial phase of command and control (2005–2008). In 2005, PGM was impacted by several federal field-based law enforcement operations such as *Curupira* and *Ouro Verde*. Since 2006, the municipality has also been monitored by the Soy Moratorium, the main Amazon-level non-state sustainability instrument in the soy sector (Piketty et al., 2015). Yet, being added to the highest deforesters list in 2008 which led to credit restriction and the launching of the Arc of Fire operation, was the decisive moment. PGM faced heavy pressure to reverse a situation which had severe negative social and economic impacts for example due to the closure of illegal sawmills and charcoal ovens, as consensually mentioned by interviewees. This led the municipal government, with support from the main local actors including timber entrepreneurs, soybean growers and ranchers, to start negotiations with the Ministry of Environment to produce a roadmap to get PGM off the list. The first step was the announcement of a local zero-deforestation pact in February 2008. In March, with support from NGOs, PGM started to advance on CAR implementation and deforestation monitoring (Coudel et al., 2013). Later in the same year, the federal operation *Rastro Negro*, targeted illegal charcoal production among smallholders. That was the last and decisive law enforcement operation. Contrary to previous operations, *Rastro Negro* was operationalized in close collaboration with the municipal government, already engaged in the spirit to reduce deforestation as a necessary step to get off the list. These interventions became known as the Green Municipality initiative.

Green Municipality (2009–2014)

This phase corresponded to a period in which the Green Municipality Initiative focused on municipal government's legal and operational capacity. That was particularly visible on issues related to the environment, for example with the Charcoal Law in 2009 (Coudel et al., 2013). In 2010, PGM was the first municipality to be taken off the list and the criteria negotiated with the federal government (annual deforestation rate of less than 40 km² and 80% of private properties under CAR) were

adopted as a federal regulation for other municipalities in the Amazon. Simultaneously, the government of Pará incorporated the Green Municipality guidelines and established a state-level program using the same name, while local politicians took on state-level roles. In parallel, the *Pecuária Verde* project targeting livestock intensification and adoption of best management practices also provided international visibility to local ranchers (Silva and Barreto, 2014). During this period, PGM became a symbol of sustainability in the Amazon. Smallholders and indigenous groups were relatively absent from the political success (Viana et al., 2016). The role of NGOs and external actors was significantly reduced, particularly since the goal to get off the list was achieved. Since 2013, when the new municipal government took over, the term Green Municipality initiative became obsolete and was no longer used. This phase ended in 2014 when the Soy Moratorium was replaced by the Grain Protocol in Pará. The new agreement has similar aims (to forbid the sale of soybean produced in deforested areas) and took over some of the Cattle Agreement conditions (Piketty et al., 2017).

Moving Beyond Zero Deforestation (2015–2019)

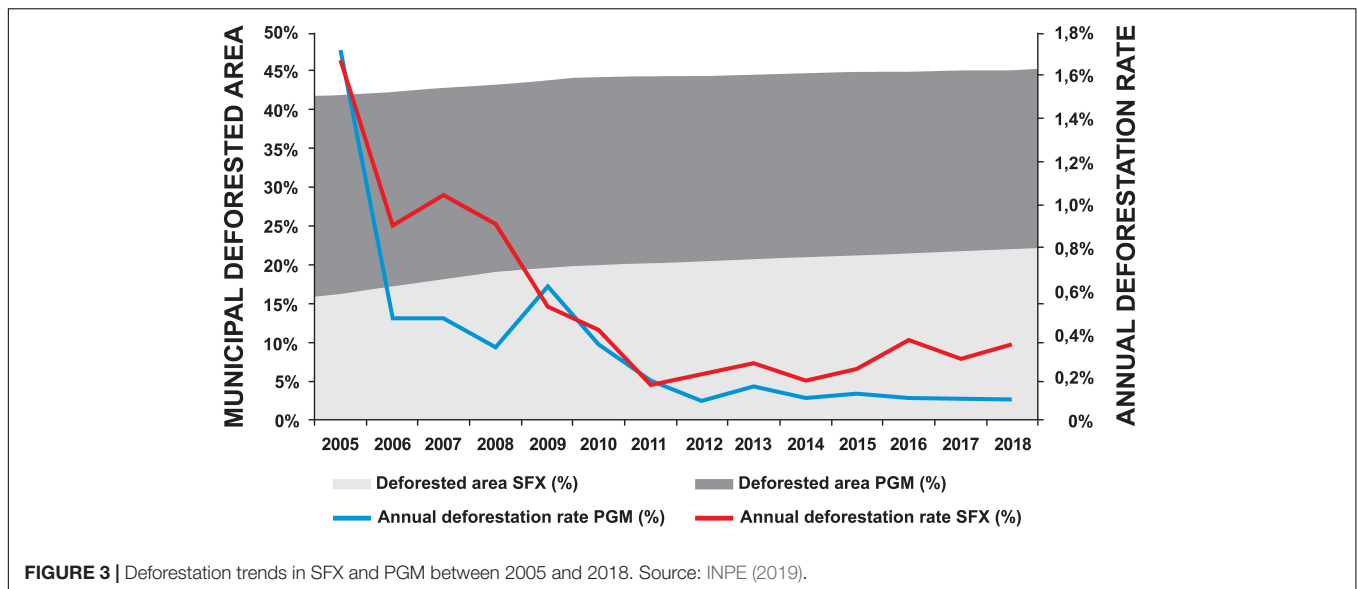
In the third stage, deforestation rates remained very low (below 25 km² per year) and the aim of PGM moved to improve local economy dynamics. Moreover, other ecological challenges emerged, especially fires and forest degradation (Hasan et al., 2019) which led to the need to combine more efficient production systems, incentive mechanisms and forest restoration initiatives (Osis et al., 2019). In 2015, 28 properties with forest reserves deficits were allowed to become regularized through civil law contracts with landowners with forest surpluses in the same municipality (Brito, 2019). This was possible because the municipality introduced a local law in 2014 regulating compensation for deforested legal reserves (Piketty et al., 2015) and became a pioneer in authorizing such a procedure in Pará. Because the struggle to expand intensified cattle ranching mostly concerned a small group of ranchers linked to the political elite and efforts to access premium markets failed (Silva and Barreto, 2014), the focus shifted to landscape-level strategies. In this period, PGM launched an Integrated Municipal Development Plan based on land use suitability and targeting jurisdictional certification as a strategy to obtain funding and market incentives. It also achieved the Verified Sourcing Area status through the Sustainable Trade Initiative.³ Smallholder participation in the local agenda is on the increase through training efforts, institutional consolidation carried out jointly with the smallholder union, and their involvement in the design of the Integrated Municipal Development Plan.

Categorization of SFX

Command and Control (2005–2009)

The first stage, command and control (2005–2009), was characterized by external initiatives that attempted to reduce deforestation. These included the formal creation of federal and

³Verified Source Area is a concept based on a local pact between private and public institutions to achieve some sustainable targets. Responsible investors or buyers are connected with these areas, thereby valorizing local efforts for sustainability.



state conservation units, the inclusion of SFX on the municipal list of highest deforesters in 2008, and two federal command-and-control operations: Operation *Boi Pirata* and the *Cattle Embargo*. These operations caused local tensions and revolt (Sousa et al., 2016). They were nevertheless key moments that triggered change in local perception: deforestation was no longer acceptable and there was a need to look for alternative models delinked from deforestation. Ranchers and slaughterhouses were highly active in this period, particularly since the main target of command and control was livestock production. The municipal government and several smallholder organizations also took an active part in local discussions. During this period, NGOs played a leading role in promoting local negotiations, agreements, capturing political attention, and fundraising. The Federal Public Prosecutor's (MPF) Office also took on a major role (throughout the region) pressuring slaughterhouses and, indirectly, ranchers to stop deforestation. MPF's actions led to the legally binding Terms of Adjustment of Conduct (referred here as Cattle Agreement) in which the main slaughterhouses agreed not to buy cattle from deforested areas.⁴ This stage ended with two local meetings between all stakeholders that set the stage for the beginning of a broad local agreement focused on reducing deforestation in SFX (Neto and Silva, 2014).

Municipal Pact and Local Enthusiasm (2010–2013)

After the previous period of apprehension and revolt, optimism and enthusiasm became the dominant trends in the municipality. Several projects were implemented, or their main activities peaked in this period, with efforts to get all the different stakeholders on board. Many organizations opened local offices, hired staff and received countless visitors. The *Pacto Municipal* project became the structural intervention in the municipality (Sousa et al., 2016). A local agreement on reducing deforestation,

⁴It implies not buying from areas on IBAMA's embargo list, not being in an area deforested after 2008, having UC and IT overlapping, nor being on the slave labor list. The first step would be to join the CAR.

a multi-stakeholder forum and a post-pact agenda were the main outputs of the project. This period was characterized by a strong component of CAR implementation. To get off the list of highest deforesters, municipalities were required to have at least 80% of their territory registered with CAR. Moreover, the Cattle Agreement required slaughterhouses to only buy animals from registered landholdings.

Building the capacity of both municipal governments and civil society organizations was also important. Some of these actions were linked to REDD+ efforts as SFX was selected as an NGO-led pilot project. However, the REDD+ orientation did not last long due to changing priorities of local organizations (Gebara et al., 2019) and lack of donor funds. For instance, the Municipal Green Fund created to support the development of sustainable economic activities failed to attract funding. At the end of this period, the limits of this strategy became apparent: too much participation and focus on institutional capacity and too little effort to promote economic alternatives to deforestation started to cause disappointment. Despite positive results of CAR implementation (SFX achieved 80% of CAR coverage in November 2011), deforestation, which had reached its minimum level in 2011, slowly started to increase again, particularly among smallholders in INCRA settlements and at the APA *Triunfo do Xingu*. Nonetheless, deforestation rates in private landholdings outside APA remain low (below 10 km² per year), suggesting a positive effect of the Cattle Agreement, of CAR implementation and of credit restrictions in these territories.

Disappointment and Value Chain Initiatives (2014–2019)

With the end of *Pacto Municipal* project in 2014, local actors, in particular smallholders, were faced with a slump in expectations, according to interviews with their representatives. Several organizations stopped their field activities in the municipality, and, at the same time, multi-stakeholder forums became less relevant. Most of the work on CAR implementation ended and

the focus on capacity building moved toward improving land use practices through value chain related projects. Among large landholders, intensification and developing transparency and traceability became priorities in the cattle sector. An important attempt to solve the traceability problem was the *Rebanho do Xingu Seal*. The seal guarantees zero deforestation throughout the three production stages (breeding, raising, and fattening) through the analysis of CAR and GTA (Portuguese acronym for the health inspection document provided by the state agency ADEPARA). The pilot initiative was able to identify around 500 beef cattle raised on deforestation-free properties, whose meat was sold at Walmart stores. However, this initiative stagnated as it was unable to solve problems, including high implementation costs and lack of market incentives for zero deforestation beef. Among smallholders, the most important land use strategy became restoration of degraded pastures with cocoa-led agroforestry systems and the production of certified cocoa. Despite some dynamism in the cocoa sector, up to now, initiatives in both the beef and cocoa sectors have shown limited capacity to be a game changer. In 2016, a municipal ABC plan was adopted as the main development strategy and inherited a significant part of the post-pact agenda. However, successive changes in the municipal government reduced the ownership of these agendas. In recent years, the focus has switched to themes such as credit, technical assistance and clarifying land tenure, which are considered to be the main structural constraints to broader adoption of improved land use practices.

COMPARING PROCESSES TO REDUCE DEFORESTATION ACROSS FIVE INDICATORS

Table 4 below summarizes the main differences between the processes at the two locations.

Government Role

Interestingly, government engagement in PGM and SFX differed considerably. The PGM case was marked by strong municipal government leadership in all phases, with particular relevance to the first. The mayor of PGM quickly reacted when federal command and control intensified and local actors were apprehensive, and, in many cases, were willing to respond to federal officials with violence. It was a risky decision as the political dividends from opposing local interest groups who profit from continued deforestation were not clear at the time. Yet, given that the mayor's leadership was accepted by the local elite, the municipal government managed to find the local social support required to achieve its primary goals. In contrast to PGM, governmental involvement was more intermittent along the three phases in SFX. Local responses to SFX being on the list of highest deforesters, for example, were mainly led by third parties, such as NGOs outside the municipality with donor support. Based on our analysis of CIPO elements, we classified the process in PGM as bottom up, i.e., led by actors at the municipal level whereas the process in SFX was more top down, i.e., led by external actors.

Multi-Stakeholder Participation and Inclusiveness

The SFX is clearly an example where the presence of external actors and externally funded projects required the engagement of a broad base of local actors through participatory processes. Particularly in the second phase, many efforts were made to strengthen the capacities of more marginalized groups, such as smallholders and indigenous groups, and there was a strong emphasis on building multi-stakeholder platforms.⁵ While the rationale of these initiatives was to promote wide participation as a strategy to strengthen ownership of governance processes and, in this way, to achieve more effective results, too much participation turned out to be counterproductive. According to interviewees, too many multi-stakeholder platforms, countless meetings and speeches that encouraged participation raised high hopes among participants that were eventually not fulfilled, leading to general demobilization and disenchantment. Moreover, important players behind deforestation, such as land speculators, were rarely targeted by participatory processes.

Conversely, the example of PGM was more selective and elitist, as discussed by Viana et al. (2016). Despite the broad-based pact signed virtually by all stakeholders, some groups including smallholders and indigenous groups did not participate or even influence the PGM strategy. Since most deforestation was taking place on medium and large landholdings, and smallholders accounted for only a small part of the territory, it was possible to achieve deforestation targets without involving all stakeholders. Despite their initial tense reaction, the local elites were ready to take steps to achieve agricultural intensification and economic diversification as pathways to curb deforestation. This attitude was facilitated by PGM's old frontier status.

Adaptive Management

As the process advanced in PGM and SFX (second and third phases), the difference in governmental leadership between the two municipalities was also reflected in their ability to manage stakeholder expectations and take new steps. PGM responded faster and quickly mobilized local actors. This pioneer status and political capacity enabled the municipality to define the rules to get off the list of highest deforesters. As such, the local Green Municipality initiative became obsolete, which led to a shift to new targets, such as the new Integrated Municipal Development Plan and Verified Sourcing Area status described earlier. By contrast, SFX took nearly 2 years longer to reach a minimum agreement and had to accept the rules previously defined by PGM. Moreover, as SFX is much larger and more complex, despite tremendous effort and significant reduction in deforestation, it was not able to reduce the annual deforestation rate to 40 km² to get off the list of highest deforesters. This led to pessimism, as the expected benefits and satisfaction from the efforts already attained did not materialize. Some interviewees claim that this target is impossible for SFX given its size and, hence, they argue that the success of PGM was the reason for

⁵Conselho Municipal do Meio Ambiente, Conselho Municipal de Desenvolvimento Rural, Conselho Gestor da APA Triunfo do Xingu, Comitê Gestor do Plano ABC, Comissão da Agenda do Pacto.

TABLE 4 | Summary table comparing cases across the five indicators.

Indicators	Paragominas	São Félix do Xingu
Government role.	Bigger governmental role and bottom up, i.e., led by actors at the municipal level who partnered with external actors.	Reduced governmental role and more top down, i.e., led by external actors to the municipality.
Multi-stakeholder participation and inclusiveness.	In theory, inclusion of all groups, but in practice the process was led by political and economic elites.	Strong emphasis on broad participation, inclusion of vulnerable groups and formal participation through multi-stakeholder platforms.
Adaptive management.	Rapid response and pioneer status led to the governmental capacity to control the process and to adopt new targets.	Slower response and convoluted process. Despite formal approval of new targets and goals, it was impossible to operationalize them.
Horizontal coordination through cross-sectoral policy alignment and vertical coordination across different levels of government.	No initial horizontal coordination and only recent efforts to build a coherent strategy. High vertical alignment with both state and federal governments.	Huge effort to build sectoral policies but no capacity to coordinate them. Exceedingly difficult coordination with state (opposition political groups) and federal governments (lack of contact).
Alignment of public and private initiatives.	Soy Moratorium was effective for a time but there was no alignment with public efforts. No market incentives either for beef or soy.	Cattle Agreement fundamental in triggering local action but no alignment with governmental action (only CAR implementation at the beginning). No market incentives for beef.

the failure of SFX. Notwithstanding, the changes in targets and activities introduced in 2016 by the new Municipal ABC Plan did not differ significantly from the previous arrangement, and in the end were not substantially implemented.

Horizontal and Vertical Coordination

Both case studies revealed some efforts to promote cross-sectoral policy alignment, but the processes mainly focused on specific commodities and actors. Yet, a few differences were apparent. In SFX, there has been since the second phase a huge effort and investment to build sectoral policies, particularly by NGOs. For example, several projects and activities focused on indigenous livelihoods, economic alternatives for smallholders, cattle intensification for medium and large-scale landholders, and capacity building for local institutions. Yet, despite the many efforts to align sectoral demands and transform them into programs, their operationalization remains difficult. In PGM, sectoral strategies targeting medium-large scale production of commodities have long played a central role (for example *Pecuária Verde* project). Recent instruments such as the Verified Sourcing Area status and the Integrated Municipal Development Plan were important steps toward promoting more coherent strategies across the jurisdiction, although it is still too early to judge whether this will be achieved.

The level of vertical coordination in the two cases differs remarkably. On the one hand, PGM achieved high levels of coordination with the federal government and even more intense coordination with the state government in the first and second phases. The operation *Rastro Negro* is one example of municipal and federal collaboration. The adoption of Green Municipalities as a state-level program and the spread of the PGM model throughout the state is an example of effective collaboration between the municipality and the state. Additionally, political stability was stronger in PGM, linked to the central role that local elites played in maintaining the political configuration. Conversely, in SFX, there was a serious lack of vertical coordination. Interviewees pointed to difficult articulation with

both the state government (opposition party) and the federal governments (lack of contact). In SFX, distinct political groups have been in power along the three phases, and nearly every local election resulted in significant strategic changes in municipal politics. The political setting is also very problematic in SFX since two of the last four elected mayors were charged with corruption, and one environmental secretary was murdered in the same period. In most cases, articulation across governance levels was led by NGOs that tend to have more permanent structures. As many of the structural problems were related to lack of operational capacity of state and federal agencies (for example, related to APA *Triunfo do Xingu* and tenure regularization in general) these problems remain largely unresolved which has limited the capacity of SFX to progress.

Alignment of Public and Private Initiatives

Both the Soy Moratorium and the Cattle Agreement, as initiatives involving private commitments to remove commodity-driven deforestation from their supply chains, played an important initial role in both municipalities, as confirmed by interviews with private sector representatives and farmers. PGM was particularly targeted by the Soy Moratorium in the first phase, while in SFX, the Cattle Embargo and later the Cattle Agreement played a determining role in engaging local ranchers in the first and second phases. In many cases, efforts to implement CAR were directly financed by meatpackers and slaughterhouses. However, the cases we analyzed point to a clear mismatch between public and private efforts. On the one hand, corporate actors focus on reassuring investors and buyers that their products are deforestation-free, but are doing the minimum with respect to environmental and social commitments, even some legal requirements, as discussed elsewhere (Tonneau et al., 2017). On the other hand, municipal actors target economic benefits and long-term development. Since the private sector failed to compensate farmers and local government for improved sustainability through premiums or other market incentives,

these actors have yet to see the benefits of aligning with corporation aims. This was particularly sensitive in the third stage for example in the attempt to promote traceability and certified beef through the *Rebanho do Xingu* Seal, which failed to create a viable system to compensate ranchers. In part due to the lack of incentives associated to the beef chain, in SFX the Cattle Agreement lost effectiveness over time.

LESSONS FOR JURISDICTIONAL APPROACHES

Jurisdictional approaches appear in current global agendas as promising strategies to address deforestation, yet critical analysis of existing experiences is lacking. The two contrasted municipal-level efforts to reduce deforestation in the Brazilian Amazon highlighted in this study provide a broader understanding of if, where and how local jurisdictional approaches can help reduce deforestation. The case studies also help identify common principles that could strengthen processes across diverging geographic, social, economic and political contexts. In the following sub-sections, we answer the five questions we posed in the introduction.

Who Should Be Involved in the Design of Jurisdictional Approaches?

By definition, governments are meant to be at the core of jurisdictional approaches as their competence is required to address the structural constraints driving deforestation. As seen in PGM, strong government leadership was essential for progress. Yet, in many forest frontiers, poor domestic policy and legal frameworks, along with weak state monitoring and enforcement capacity predominate. This leads us to question to what extent jurisdictional approaches to reduce deforestation are possible where state capacity and local authority to tackle deforestation is weak. In such situations, the role of non-state actors should not be underestimated, given their longer-term commitment to supporting key interventions in certain municipalities even in periods when local governments play a less active role.

How Should Tradeoffs Between Inclusiveness and Effectiveness Be Addressed?

Promoting equitable participation and mitigating risks of unequal benefit sharing are important aspects of any strategy to reduce deforestation. In that sense, multi-stakeholder platforms and local participation more broadly have been highlighted as key to preventing global agendas from capturing local processes (Hovani et al., 2018) and promoting greater equity and legitimacy in policy design and implementation (Loft et al., 2017). However, multi-stakeholder platforms and participation in general should be carefully addressed and fine-tuned to local realities as they are difficult to implement in practice and to maintain in the medium/long run. Our findings confirm that not all problems can be solved through the participation of diverse stakeholders (Larson et al., 2019). Overvaluing participation as a box-ticking requirement

may also have counterproductive effects in the long run, such as demotivation, if those responsible are incapable of bringing about the necessary changes. In that sense, understanding participation as a medium/long-term target and accepting a certain level of tradeoff between inclusiveness and effectiveness would be a more pragmatic approach. This is particularly relevant in cases where deforestation drivers are associated with specific local groups or where unequal power relations between actors with conflicting priorities may jeopardize processes (Rodríguez-Ward et al., 2018; Sarmiento-Barletti et al., 2020).

How Can the Effectiveness of Local Jurisdictional Approaches Be Measured?

Based on the experience gained in PGM and SFX trying to get off the list, it is clear that it is not possible to impose the same targets or expect the same rate and level of deforestation reduction in all cases. Each jurisdiction is unique in terms of features (e.g., spatial configuration, agrarian structure, land use activities, or deforestation drivers), and is shaped by exogenous factors (e.g., market trends, value chain configurations, and different interventions that interact in distinct ways in each jurisdiction). As a result, jurisdictions may be more or less ready to halt deforestation, and reach net, gross, legal or illegal zero-deforestation targets. While the final objective remains important, it is at least as important to recognize the progress made. This avoids a sense of failure that may wrongly delegitimize the efforts invested and may call the leadership of the initiatives taken into question. If such progress is not recognized, local efforts might not be sufficiently valued by external observers, donors or higher-level governments, which might lead to contradictory actions and/or demotivate local stakeholders.

The problem of unrealistic expectations about achievements or limited time frames to promote structural change has also been mentioned elsewhere (Boyd et al., 2018). In that sense, developing a transparent and participatory monitoring system to highlight progress and identify gaps is a viable option. It is not only a question of having a system that would allow comparison between jurisdictions using general indicators. Such monitoring should focus on what is progressing, what is not and how local actors perceive those progresses and shortcomings. This reinforces other claims that metrics need to be developed to establish values, track progress and enable adaptive management in ways that inform stakeholders understanding of the impacts of their actions and what else needs to be done (Sayer et al., 2015; Reed et al., 2016).

How Should Local Jurisdictional Approaches Be Aligned With or Nested in Higher-Level Approaches?

Coordination between levels of government is the key to matching the scale associated with different challenges including environmental regularization and land tenure (Reydon et al., 2019). The authorities of subnational governments to address deforestation vary from country to country; Brazil is one of the countries where second-tier subnational governments (i.e., states) have the greatest authority to reduce deforestation

(Busch and Amarjargal, 2020). Interestingly, the emergence of the local initiatives in PGM and SFX was in direct response to the absence of state-level action in reply to federal command-and-control actions. While, in theory local governments can better understand and target local drivers, they require institutional support at higher levels to solve critical issues. In some cases, decentralizing state capacities may suffice to address those structural constraints. But in cases where decentralization is not possible or feasible, finding the right mix of local action to promote ownership of processes and subnational action is the key to solving critical problems. This prevents one-size-fits-all models or universal recipes that may work in one place but not in others.

How Can Such Approaches Combine Public and Private Actions?

Despite supporting efforts to strengthen synergies with jurisdictional initiatives (Lambin et al., 2018), in general, supply chain initiatives and private efforts have hardly dialogued with governmental efforts at local level and even at subnational level. Although they can provide an initial impetus in cases where value chain actors are not sufficiently engaged, meaningful market incentives have yet made their way in the Amazon and corporations mostly do the minimum required to avoid criticism, as has been the case at least in the soybean and beef chains. Private action is still very modest and far below what would be needed to promote and sustain change at local level, particularly as market incentives are the key to maintaining local engagement and guaranteeing progress. Since pay for performance incentives have been “too low and too slow” to reach the ground (Seymour and Busch, 2016), there are few remaining options than governmental incentives and *ad hoc* non-governmental support to encourage actors to pursue positive agendas and to continue pursuing them in areas where progress is being made, at least until significant external investments are available. In that sense, a transparent and participatory monitoring system would also help local actors to communicate externally and to attract private investment that is truly engaged in promoting sustainability.

While our case studies suggest that there is still a long way to go to build robust and sustainable long-term strategies at local level, new opportunities are emerging. Major corporations recognize that they will miss their 2020 zero-deforestation global targets and are looking for new models and strategies to

rapidly implement their commitments. At the same time, the global community is calling for enhanced ambition to achieve the Paris Agreement goals, and new donor- and market-based opportunities are developing with promises of increasing funding for governments responsible for tropical forests. The extent to which local jurisdictions will be able to design attractive strategies for such investment, and finance will be able to reach the ground, is uncertain, but surely both are required for success. In that sense, it will be wise to start closing that gap as rapidly as possible.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

AUTHOR CONTRIBUTIONS

FB and M-GP conceived the ideas, planned the manuscript, performed the data analysis, and led the writing. FB collected the data for SX. RP-C, M-GP, and JP collected the data for PGM. PP, BB, AD, RP-C, EG, and ID contributed to the drafts. All authors approved the final manuscript.

FUNDING

This research was part of the Priority 18 of the CGIAR (Consultative Group on International Agricultural Research) Research Program on Forests, Trees and Agroforestry (FTA, <http://foreststreesagroforestry.org>) and of CIFOR's Global Comparative Study on REDD+. The funding partners that have supported this research include the Norwegian Agency for Development Cooperation (NORAD) and the CGIAR Trust Fund (www.cgiar.org/funders).

SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/ffgc.2020.00096/full#supplementary-material>

REFERENCES

- Arksey, H., and Knight, P. (1999). *Interviewing for Social Scientists: An Introductory Resource with Examples*. London: Sage. doi: 10.4135/9781849209335
- Assunção, J., Gandour, C., and Rocha, R. (2015). Deforestation slowdown in the Brazilian amazon: prices or policies? *Environ. Dev. Econ.* 20, 697–722. doi: 10.1017/S1355770X15000078
- Birkland, T. (2011). *An Introduction to the Policy Process*. New York, NY: Routledge.
- Börner, J., and Vosti, S. A. (2013). “Managing tropical forest ecosystem services: an overview of options,” in *Governing the Provision of Ecosystem Services*, eds R. Muradian and L. Rival (Dordrecht: Springer Netherlands).
- Börner, J., Wunder, S., Wertz-Kanounnikoff, S., Hyman, G., and Nascimento, N. (2014). Forest law enforcement in the Brazilian amazon: costs and income effects. *Glob. Environ. Chang.* 29, 294–305. doi: 10.1016/j.gloenvcha.2014.04.021
- Boyd, W., Stickler, C., Duchelle, A. E., Seymour, F., Nepstad, D., Bahar, N. H. A., et al. (2018). *Jurisdictional Approaches to REDD+ and Low Emissions Development: Progress and Prospects*. Washington, DC: World Resources Institute.
- Brito, B. (2017). Potential trajectories of the upcoming forest trading mechanism in Pará state, Brazilian amazon. *PLoS One* 12:e0174154. doi: 10.1371/journal.pone.0174154
- Brito, B. (2019). The pioneer market for forest law compliance in Paragominas, Eastern Brazilian amazon. *Land Use Policy* 94:104310. doi: 10.1016/j.landusepol.2019.104310
- Busch, J., and Amarjargal, O. (2020). Authority of second-tier governments to reduce deforestation in 30 tropical countries. *Front. Forests Glob. Change* 3:1. doi: 10.3389/ffgc.2020.00001

- Carvalho, W. D., Mustin, K., Hilário, R. R., Vasconcelos, I. M., Eilers, V., and Fearnside, P. M. (2019). Deforestation control in the Brazilian amazon: a conservation struggle being lost as agreements and regulations are subverted and bypassed. *Perspect. Ecol. Conserv.* 17, 122–130. doi: 10.1016/j.pecon.2019.06.002
- Cisneros, E., Zhou, S. L., and Börner, J. (2015). Naming and shaming for conservation: evidence from the Brazilian amazon. *PLoS One* 10:e0136402. doi: 10.1371/journal.pone.0136402
- Coudel, E., Viana, C., Piketty, M. G., and Pocard-Chapuis, R. (2013). *Conditions and Impacts of the Green Municipality Process in Paragominas (and Para State). Research Report of the CRP6 Project Emerging Countries in Transition to a Green Economy*. Montpellier: CIRAD.
- Cunha, F. A. F., Börner, J., Wunder, S., Cosenza, C. A. N., and Lucena, A. F. P. (2016). The implementation costs of forest conservation policies in Brazil. *Ecol. Econ.* 130, 209–220. doi: 10.1016/j.ecolecon.2016.07.007
- Fishman, A., Oliveira, E., and Gamble, L. (2017). *Tackling Deforestation Through a Jurisdictional Approach: Lessons From The Field*. Gland: WWF.
- Garcia, E., Ramos Filho, F., Mallmann, G., and Fonseca, F. (2017). Costs, benefits and challenges of sustainable livestock intensification in a major deforestation frontier in the Brazilian amazon. *Sustainability* 9:158. doi: 10.3390/su9010158
- Gebara, M. F., Sills, E., May, P., and Forsyth, T. (2019). Deconstructing the policyscape for reducing deforestation in the Eastern amazon: practical insights for a landscape approach. *Environ. Policy Govern.* 29, 185–197. doi: 10.1002/eet.1846
- Gibbs, H. K., Munger, J., L'roe, J., Barreto, P., Pereira, R., Christie, M., et al. (2016). Did ranchers and slaughterhouses respond to zero-deforestation agreements in the Brazilian amazon? *Conserv. Lett.* 9, 32–42. doi: 10.1111/conl.12175
- Gibbs, H. K., Rausch, L., Munger, J., Schelly, I., Morton, D. C., Noojipady, P., et al. (2015). Brazil's soy moratorium. *Science* 347, 377–378. doi: 10.1126/science.aaa0181
- Godar, J., Gardner, T. A., Tizado, E. J., and Pacheco, P. (2014). Actor-specific contributions to the deforestation slowdown in the Brazilian amazon. *Proc. Natl. Acad. Sci. U.S.A.* 111, 15591–15596. doi: 10.1073/pnas.1322825111
- Griscom, B. W., Adams, J., Ellis, P. W., Houghton, R. A., Lomax, G., Miteva, D. A., et al. (2017). Natural climate solutions. *Proc. Natl. Acad. Sci. U.S.A.* 114, 11645–11650. doi: 10.1073/pnas.1710465114
- Hasan, A. F., Laurent, F., Messner, F., Bourgoin, C., and Blanc, L. (2019). Cumulative disturbances to assess forest degradation using spectral unmixing in the northeastern Amazon. *Appl. Veget. Sci.* 22, 394–408. doi: 10.1111/avsc.12441
- Hecht, S. B. (2012). From eco-catastrophe to zero deforestation? Interdisciplinary, politics, environmentalisms and reduced clearing in Amazonia. *Environ. Conserv.* 39, 4–19. doi: 10.1017/S0376892911000452
- Hovani, L., Cortez, R., Hartanto, H., Thompson, I., Fishbein, G., Adams, J., et al. (2018). *The Role of JURISDICTIONAL Programs in Catalyzing Sustainability Transitions in Tropical Forest Landscapes*. Arlington, VA: The Nature Conservancy.
- Howlett, M. (2005). “What is a policy instrument? Tools, mixes, and implementation styles,” in *Designing Government From Instruments to Governance*, eds M. Hills, M. Howlett, and P. Eliadis (Montreal: McGill-Queen's University Press).
- IBGE (2006). *Agriculture and Livestock Census Brazilian Institute of Geography and Statistics*. Available online at: <https://sidra.ibge.gov.br/pesquisa/censo-agropecuario/censo-agropecuario-2006/segunda-apuracao> (accessed August 15, 2019).
- IBGE (2015). *Instituto Brasileiro de Geografia e Estatística. Malhas Territoriais*. Available online at: <https://geoftp.ibge.gov.br> (accessed June 15, 2018).
- IBGE (2017). *Agriculture and Livestock Census Brazilian Institute of Geography and Statistics*. Available online at: <https://censos.ibge.gov.br/agro/2017/> (accessed August 15, 2019).
- INPE (2019). *Projeto PRODES: Monitoramento da Floresta Amazônica Brasileira por Satélite (Instituto Nacional De Pesquisas Espaciais)*. Available online at: <http://www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes> (accessed June 20, 2019).
- IPCC (2019). *Climate Change and Land: an IPCC Special Report on Climate Change, Desertification, Land Degradation, Sustainable Land Management, Food Security, and Greenhouse Gas Fluxes in Terrestrial Ecosystems*. Geneva: IPCC.
- Jong, W. D., Börner, J., Pacheco, P., Pokorny, B., Sabogal, C., Benneker, C., et al. (2010). “Amazon forests at the crossroads: pressures, responses and challenges,” in *Forests and Society – Responding to Global Drivers of Change*, eds G. Mery, P. Katila, G. Galloway, R. I. Alfaro, M. Kanninen, M. Lobovikov, et al. (Vienna: IUFRO).
- Lambin, E. F., Gibbs, H. K., Heilmayr, R., Carlson, K. M., Fleck, L. C., Garrett, R. D., et al. (2018). The role of supply-chain initiatives in reducing deforestation. *Nat. Clim. Chang.* 8, 109–116. doi: 10.1038/s41558-017-0061-1
- Larson, A. M., Sarmiento-Barletti, J. P., Ravikumar, A., and Korhonen-Kurki, K. (2019). “Multi-level governance: some coordination problems cannot be solved through coordination,” in *Transforming REDD+: Lessons and New Directions*, eds A. Angelsen, C. Martius, V. De Sy, A. E. Duchelle, A. M. Larson, and T. T. Pham (Bogor: CIFOR).
- Lemos, M. C., and Agrawal, A. (2006). Environmental governance. *Annu. Rev. Environ. Resour.* 31, 297–325. doi: 10.1146/annurev.energy.31.042605.135621
- Loft, L., Pham, T. T., Wong, G. Y., Brockhaus, M., Le, D. N., Tjajadi, J. S., et al. (2017). Risks to REDD+: potential pitfalls for policy design and implementation. *Environ. Conserv.* 44, 44–55. doi: 10.1017/S0376892916000412
- Lovejoy, T. E., and Nobre, C. (2019). Amazon tipping point: last chance for action. *Sci. Adv.* 5:eaba2949. doi: 10.1126/sciadv.aba2949
- Margulis, S. (2004). *Causes of Deforestation of the Brazilian Amazon. World Bank Working Paper*. Washington, DC: World Bank.
- Nepstad, D., Irawan, S., Bezerra, T., Boyd, W., Stickler, C., Shimada, J., et al. (2013). More food, more forests, fewer emissions, better livelihoods: linking REDD+, sustainable supply chains and domestic policy in Brazil, Indonesia and Colombia. *Carbon Manage.* 4, 639–658. doi: 10.4155/cmt.13.65
- Nepstad, D., McGrath, D., Stickler, C., Alencar, A., Azevedo, A., Swette, B., et al. (2014). Slowing Amazon deforestation through public policy and interventions in beef and soy supply chains. *Science* 344:1118. doi: 10.1126/science.1248525
- Nepstad, D., Schwartzman, S., Bamberger, B., Santilli, M., Ray, D., Schlesinger, P., et al. (2006). Inhibition of amazon deforestation and fire by parks and indigenous lands. *Conserv. Biol.* 20, 65–73. doi: 10.1111/j.1523-1739.2006.00351.x
- Neto, P., and Silva, R. (2014). *Processo de Construção da Sustentabilidade em São Félix do Xingu-PA. Projeto Xingu Ambiente Sustentável*. Belém: Instituto Internacional de Educação do Brasil [IEB].
- Osis, R., Laurent, F., and Pocard-Chapuis, R. (2019). Spatial determinants and future land use scenarios of Paragominas municipality, an old agricultural frontier in Amazonia. *J. Land Use Sci.* 14, 258–279. doi: 10.1080/1747423X.2019.1643422
- Piketty, M. G., Piraux, M., Blanc, L., Laurent, F., Cialdella, N., Ferreira, J., et al. (2017). “Municípios verdes”: from zero-deforestation to the sustainable management of natural resources in the Brazilian Amazon,” in *Living Territories to Transform the World*, eds P. Caron, E. Valette, T. Wassenaar, D. E. G. Coppens, and V. Papazian (Versailles: Ed. Quae).
- Piketty, M.-G., Pocard-Chapuis, R., Drigo, I., Coudel, E., Plassin, S., Laurent, F., et al. (2015). Multi-level governance of land use changes in the Brazilian amazon: lessons from Paragominas, State of Pará. *Forests* 6, 1516–1536. doi: 10.3390/f6051516
- Reed, J., Van Vianen, J., Deakin, E. L., Barlow, J., and Sunderland, T. (2016). Integrated landscape approaches to managing social and environmental issues in the tropics: learning from the past to guide the future. *Glob. Change Biol.* 22, 2540–2554. doi: 10.1111/gcb.13284
- Reydon, B. P., Fernandes, V. B., and Telles, T. S. (2019). Land governance as a precondition for decreasing deforestation in the Brazilian Amazon. *Land Use Policy* 94, 104313. doi: 10.1016/j.landusepol.2019.104313
- Rodriguez-Ward, D., Larson, A. M., and Ruesta, H. G. (2018). Top-down, bottom-up and sideways: the multilayered complexities of multi-level actors shaping forest governance and REDD+ arrangements in Madre de Dios, Peru. *Environ. Manag.* 62, 98–116. doi: 10.1007/s00267-017-0982-5
- Ros-Tonen, M., Reed, J., and Sunderland, T. (2018). From synergy to complexity: the trend toward integrated value chain and landscape governance. *Environ. Manag.* 62, 1–14. doi: 10.1007/s00267-018-1055-0
- Santos, D., Pereira, D., and Veríssimo, A. (2013). *Uso da Terra. O Estado da Amazônia*. Belém: Imazon.
- Sarmiento-Barletti, J. P., Larson, A. M., Hewlett, C., and Delgado, D. (2020). Designing for engagement: a realist synthesis review of how context affects the

- outcomes of multi-stakeholder forums on land use and/or land-use change. *World Dev.* 127:104753. doi: 10.1016/j.worlddev.2019.104753
- Sayer, J., Margules, C., Boedihartono, A. K., Dale, A., Sunderland, T., Supriatna, J., et al. (2015). Landscape approaches; what are the pre-conditions for success? *Sustain. Sci.* 10, 345–355. doi: 10.1007/s11625-014-0281-5
- Scheerens, J. (1990). School effectiveness research and the development of process indicators of school functioning. *Sch. Eff. Sch. Improv.* 1, 61–80. doi: 10.1080/0924345900010106
- Schielein, J., and Börner, J. (2018). Recent transformations of land-use and land-cover dynamics across different deforestation frontiers in the Brazilian Amazon. *Land Use Policy* 76, 81–94. doi: 10.1016/j.landusepol.2018.04.052
- Schmink, M., Hoelle, J., Gomes, C. V. A., and Thaler, G. M. (2017). From contested to 'green' frontiers in the Amazon? A long-term analysis of São Félix do Xingu, Brazil. *J. Peasant Stud.* 46, 377–399. doi: 10.1080/03066150.2017.1381841
- Schmink, M., and Wood, C. H. (2012). *Conflitos Sociais e a Formação da Amazônia*. Belém: Ed.UFPA.
- Schneider, C., Coudel, E., Cammelli, F., and Sablayrolles, P. (2015). Small-scale Farmers' needs to end deforestation: insights for REDD+ in São Felix do Xingu (Pará, Brazil). *Int. Forestry Rev.* 17, 124–142. doi: 10.1505/146554815814668963
- Seymour, F., and Busch, J. (2016). *Why Forests? Why Now? The Science, Economics, and Politics of Tropical Forests and Climate Change*. Washington, DC: Center for Global Development.
- Seymour, F., and Harris, N. L. (2019). Reducing tropical deforestation. *Science* 365, 756–757. doi: 10.1126/science.aax8546
- Sills, E. O., Herrera, D., Kirkpatrick, A. J., Brandão, A. Jr., Dickson, R., Hall, S., et al. (2015). Estimating the impacts of local policy innovation: the synthetic control method applied to tropical deforestation. *PLoS One* 10:e0132590. doi: 10.1371/journal.pone.0132590
- Silva, D., and Barreto, P. (2014). *O aumento da Produtividade e Lucratividade da Pecuária Bovina na Amazônia: o Caso do Projeto Pecuária Verde em Paragominas*. Belém: IMAZON.
- Soares-Filho, B., Moutinho, P., Nepstad, D., Anderson, A., Rodrigues, H., Garcia, R., et al. (2010). Role of Brazilian Amazon protected areas in climate change mitigation. *Proc. Natl. Acad. Sci. U.S.A.* 107, 10821–10826. doi: 10.1073/pnas.0913048107
- Soares-Filho, B., Rajão, R., Macedo, M., Carneiro, A., Costa, W., Coe, M., et al. (2014). Cracking Brazil's forest code. *Science* 344:363.
- Sousa, R., Silva, R., Miranda, K., and Neto, M. (2016). *Governança Socioambiental na Amazônia: Agricultura Familiar e os Desafios para a Sustentabilidade em São Félix do Xingu – Pará*. Belém: Instituto Internacional de Educação do Brasil - IEB.
- Stickler, C., Duchelle, A., Nepstad, D., and Ardila, J. (2018). "Policy innovation and partnerships for change," in *Transforming REDD+: Lessons and New Directions*, eds A. Angelsen, C. Martius, V. De Sy, A. Duchelle, A. Larson, and T. Pham (Bogor: CIFOR).
- TFA (2017). *Tropical Forest Alliance 2020 Annual Report 2016-2017*. Cologny: WEF.
- Thaler, G. M., Viana, C., and Toni, F. (2019). From frontier governance to governance frontier: the political geography of Brazil's Amazon transition. *World Dev.* 114, 59–72. doi: 10.1016/j.worlddev.2018.09.022
- Tonneau, J. P., Gueneau, S., Piketty, M. G., Drigo, I. G., and Pocard-Chapuis, R. (2017). "Agroindustrial strategies and voluntary mechanisms for the sustainability of tropical value-chains: the place of territories," in *Sustainable Development and Tropical Agri-chains*, eds E. Bienabe, A. Rival, and D. Loeillet (Dordrecht: Springer).
- Tritsch, I., and Le Tourneau, F. (2016). Population densities and deforestation in the Brazilian Amazon: new insights on the current human settlement patterns. *Appl. Geogr.* 76, 163–172. doi: 10.1016/j.apgeog.2016.09.022
- Tritsch, I., Sist, P., Narvaes, I., Mazzei, L., Blanc, L., Bourgoin, C., et al. (2016). Multiple patterns of forest disturbance and logging shape forest landscapes in Paragominas, Brazil. *Forests* 7:315. doi: 10.3390/f7120315
- Viana, C., Coudel, E., Barlow, J., Ferreira, J., Gardner, T., and Parry, L. (2016). How does hybrid governance emerge? Role of the elite in building a green municipality in the Eastern Brazilian Amazon. *Environ. Policy Govern.* 26, 337–350. doi: 10.1002/eet.1720
- Wehkamp, J., Koch, N., Lübbers, S., and Fuss, S. (2018). Governance and deforestation — a meta-analysis in economics. *Ecol. Econ.* 144, 214–227. doi: 10.1016/j.ecolecon.2017.07.030
- Whately, M., and Campanili, M. (2013). *Programa Municípios Verdes: Lições Aprendidas e Desafios Para 2013/2014*. Belém, PA: Governo do Estado do Pará.
- Williams, B. K. (2011). Adaptive management of natural resources—framework and issues. *J. Environ. Manag.* 92, 1346–1353. doi: 10.1016/j.jenvman.2010.10.041
- WWF (2016). *Jurisdictional Approaches to Zero Deforestation Commodities*. Gland: WWF.
- Yin, R. K. (2014). *Case Study Research: Design and Methods*. Thousand Oaks, CA: Sage.

Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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