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PERSPECTIVE

Changing Amazon deforestation patterns: urgent need to restore command and control policies and market interventions

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Abstract

Market and public policies govern deforestation trends and patterns globally. Here I show that in the Brazilian Amazon, the largest tropical forest in the world, the size of deforestation polygons - the individual portions of cleared forest patches - has significantly increased in response to the current environmental governance. The average size of deforestation polygons in the current government is 61% greater than in the 10 previous years when environmental policies and programs were maintained. As a result, very large polygons (> 100 ha) are now dominating deforestation, suggesting a remarkable change in deforestation patterns and a new wave of destruction of the Amazon forest. To control increasing deforestation trends and changing patterns, command and control policies need to be strengthened along with interventions in the supply chain of Amazon commodities and sustainable development incentives, ensuring a transition to an environmentally sustainable economy.

1. Responding to deforestation in the Amazon

When Amazon deforestation increased over the past decade, Brazil took a number of actions mostly via command and control policies, supply chain interventions (Nepstad et al 2014) and establishment of a large network of protected areas (Trancoso et al 2009). Examples include: (a) the Action Plan for Prevention and Control of Deforestation in the Legal Amazon (PPCDAm—https://redd.mma.gov.br/en/legal-and-public-policy-framework/ppcdam) and its articulation with agencies involved in environmental monitoring and law enforcement; (b) the blacklisting of municipalities with high levels of deforestation and intensification of law enforcement and economic sanctions (Assunção and Rocha 2019); (c) the Amazon Soy Moratorium, an agreement by grain traders not to purchase soy grown on recently deforested land (Heilmayr et al 2020), and a range of other policies including an agreement with major beef processors, as well as fiscal incentives and credit restrictions (Nepstad et al 2014).

In contrast, Brazil’s current governmental response to increasing deforestation heads in the opposite direction, with stimulus for illegal takeover of public lands (Brito et al 2019), illegal mining and agribusinesses within indigenous territories (Ferrante and Fearnside 2019), and degazettement of protected areas (Rochedo et al 2018). In addition, infrastructure projects within the rainforest building new roads (Vilela et al 2020), hydroelectric dams (Atkins 2020) and mining (Sonter et al 2017) are being encouraged. At the same time, sustainable development incentives and programs such as the Amazon Fund (Correa et al 2019) continue to be paralyzed or dismantled. The undermining of environmental agencies, along with a reduction in law enforcement and increased amnesty for deforesters, are clear signals of the current threats to the Amazon rainforest, with land grabbers, illegal loggers and cattle ranchers advancing in the destruction of the rainforest.

The latest deforestation statistics for 2020 show an increase in the annual deforestation rate for the fourth consecutive year. In the last two years clearing has exceeded 10 000 km² yr⁻¹, a rate not seen since 2008. A recent report confirms that 87% of the Amazon deforestation alerts in 2019 were on private properties, 61% of them overlapped areas with legal restrictions for forest suppression and only 0.1% were for licensed forest suppression (MapBiomas 2020). The report concludes that over 99% of Brazilian deforestation is illegal, showing that combatting ongoing deforestation in the Amazon will require a serious
strengthening of environmental governance and the restoration of control. The increased deforestation, however, is the visible feature of a set of processes that demonstrate ineffective control over activities that not only degrade the environment but also create a web of criminality, with impacts of conflicts and violence against local populations, and especially, to those who resist the illegal exploitation of natural resources. As such, controlling deforestation requires a broad mix of enforcement and policy actions.

2. Deforestation patterns and underlying policies

Here I explore how the size of deforestation and their respective share in the overall deforestation statistic has changed in response to the current environmental governance, including the discontinuation of previous policies and programs. The last two years of deforestation in the Amazon (2019–2020) are thus associated with current changes in governance, with the previous ten years being used as a control. I hypothesize that when compared to a long-term average (i.e. the 2009–2018 period) where the governance, policies and programs were consistently maintained, recent changes in environmental governance and policies (2019–2020 period) will lead not only to changes in the rate of deforestation but also in the patterns of deforestation, with alterations in the size of individual deforestation polygons measured in the satellite imagery, referred to as to deforestation patches henceforth.

Analysis of data from the Deforestation Monitoring Program of the Brazilian Amazon Forest by Satellite (PRODES—www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes) reveals that the size of recent deforestation patches (2019 and 2020) have increased substantially and are bigger than in the previous ten years ($p < 0.001$ following the Mann–Whitney–Wilcoxon test; figure 1(A)). The average size of deforestation patches has increased from 10.6 to 24.7 ha in the period 2015–2019 and remained 24.1 ha in 2020. As such, the size of the average deforestation patch experienced a substantial shift in the last two years in response to the current policies, increasing 61% in comparison to the average for the previous ten years (figure 1(B)).

The total deforested area resulting from large patches (i.e. greater than 100 ha) has also surged in the last five years and peaked in 2020, contributing to 35.8% of the overall deforestation. The contribution of large patches to the total area deforested has thus been consistently rising over the last decade, and in 2020 their share to total deforestation exceeded patches smaller than 20 ha and patches between 20 and 100 ha for the first time in the recent monitoring (figure 1(C)). These results suggest that the area of deforestation patches and the contribution of large patches to total deforestation has changed in response to the current environmental policies for the Amazon and the discontinuity of previous efforts to combat deforestation. The dominance of large forest loss patches in the total deforestation denotes a pivotal change in deforestation patterns, suggesting that landholders, land grabbers and illegal loggers no longer fear the once well-regarded government efforts of monitoring and enforcement, introducing a new wave of destruction of the Amazon forest.

High deforestation rates associated with large patches have previously been seen in the Brazilian Amazon: in 2004, when the annual deforestation peaked at nearly 28 000 km², large patches also dominated the deforestation process. This scenario was the catalyst for the creation of the PPCDAm, a collaborative effort headed by the presidency and involving multiple federal ministries, with the goal of reducing deforestation rates and greenhouse gas (GHG) emissions. As a base for command and control policies, the PPCDAm, together with market interventions in supply chains, succeeded in reducing deforestation rates by 83% from 2004 to 2012 (Nepstad et al 2014; Assunção and Rocha 2019). A near real-time remotely sensed deforestation detection system (DETER—www.obt.inpe.br/OBT/assuntos/programas/amazonia/deter) was used to support law enforcement operations on the ground, and in some cases the information on location and attributes of deforestation patches allowed enforcement to confront offenders still in the field clearing the forest.

By the end of 2012, when annual deforestation was the lowest on record, deforestation patterns changed and became dominated by numerous and diffuse small patches (Rosa et al 2012, Kalamandeen et al 2018, Schielein and Börner 2018). Patch size continued to decrease until 2015 (figure 1(B)), at which point they reached the smallest size recorded. This has been partially attributed to landholders strategically adapting their practices to elude DETER and other satellite monitoring programs that detected deforestation in nearly real time with coarse resolution imagery. To respond to this changing pattern, the DETER-B system was created, with the ability to detect small deforestation patches using higher spatial resolution imagery (Diniz et al 2015). However, since 2015, the size of deforestation patches has increased substantially in response to the gradual weakening of environmental governance. First, environmental licensing requirements were lowered, the ratification of indigenous lands were suspended, and protected areas were downsized (Rochedo et al 2018). Subsequently, the legal norms as to land tenure changed to benefit deforesters and land grabbers (Brito et al 2019). More recently, the amnesty to deforesters was expanded, along with the undermining of environmental agencies and a reduction in law enforcement actions (Brito et al 2019, Ferrante and Fearnside 2019). These policy changes and reduced enforcement have been encouraging large
Figure 1. Changing deforestation pattern in the Brazilian Amazon from 2008 to 2020 and federal governance (data source: www.obt.inpe.br/OBT/assuntos/programas/amazonia/prodes). (A) Probability density curves and box-whiskers plots of deforestation patch size for recent (2019–2020) and previous (2009–2018) deforestation. Recent and previous distributions of deforestation patch area are significantly different ($p < 0.001$) following the Mann–Whitney–Wilcoxon test. (B) Averaged area of deforestation patch from 2008 to 2020 and annual deforestation. The dashed black line shows a ten year average for previous deforestation (2009–2018) and the dashed red line shows a two year average of recent deforestation (2019–2020). The dotted black arrow indicates a 61% increase in the recent deforestation patch area. Recent averaged patch area and annual deforestation are highlighted in red. (C) Changes in the contribution of deforestation patch area classes to annual deforestation from 2008 to 2020. Large patches (>100 ha) are increasing in their overall contribution to the annual deforestation and are now dominating total deforestation. The timeline under x-axis in panels (B) and (C) shows the presidents of Brazil and changes in political leadership over time.
deforestation patches, which are now dominating the overall deforestation pattern (figure 1(C)), indicating it is time to foster monitoring and enforcement again.

3. Restraining deforestation using command and control policies as well as market interventions

The policies and programs employed to control Amazon deforestation in the past were quite effective. For instance, it is estimated that conservation policies avoided 56% of the forest clearing that would have happened between 2004 and 2008 in a scenario without these policies (Assunção et al 2015). In particular, the command and control policies implemented between 2007 and 2011 are estimated to have reduced 75% of the deforestation that would have happened had they not been implemented (Assunção et al 2013). Likewise, other specific policies and programs also contributed to a slowdown in deforestation. Blacklisting municipalities with high deforestation rates reduced deforestation in targeted regions with no measurable effect on agricultural production (Assunção and Rocha 2019), while the environmental land cadastre of private properties is estimated to have decreased deforestation by 10% between 2005 and 2014 (Alix-Garcia et al 2018). The Soy Moratorium is thought to have prevented up to 27 000 km$^2$ of deforestation in soy-suitable locations between 2006 and 2016 (Heilmayr et al 2020).

Brazil, therefore, has considerable experience and an established framework for controlling deforestation, particularly when clearing occurs in large patches. Large patches are easier to map and inspect with satellite imagery, and detection has a higher accuracy and is thus more suitable for field enforcement campaigns. However, despite Brazil’s capabilities, there has been a lack of political willingness to control deforestation. In two years of the current government there has been a widespread dismantling of the environmental policies and programs developed over the last three decades, sending a clear message of impunity, if not a ‘green light’, to those involved in illegal deforestation. Through links between politicians and ranchers, predatory agribusiness policies have been favored, in detriment to the Amazon forest (Pereira et al 2020).

The lack of immediate actions for controlling deforestation poses a risk to global efforts to curb GHG emissions and biodiversity losses, and threatens essential climate-stabilization services provided by the Amazon forest, such as moisture recycling and water vapor transportation (Weng et al 2018). These are essential features to maintain rainfall patterns associated with critical economic activities within and beyond the Amazon borders, such as agriculture (Costa et al 2019) and hydroelectric generation (Weng et al 2018). Failing to protect the forest may lead to a feedback loop where the forest is no longer resilient enough to maintain itself, eventually tipping towards a more savanna-like ecosystem (Lovejoy and Nobre 2018). This is likely to be exacerbated under a changing climate, with more droughts and forest fires projected for future (Staal et al 2018). Ensuring the productivity of rainfed agriculture through long-term climatic aptitude by reduced deforestation through environmental compliance should be, therefore, a concern of both government and agribusiness in Brazil (Costa et al 2019).

The environmental crisis unfolding in Brazil has been neglected amidst the medical, economic and political chaos currently ravaging the Amazon, triggered by the COVID-19 pandemic. Controlling Amazon deforestation patterns requires immediate strengthening of command and control policies, along with the fostering of Brazilian science and technology agencies that are essential to maintain intellectual and operational capabilities. Monitoring and environmental law enforcement agencies must act together again to succeed in the deforestation detection and enforcement in real time. Along with the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) and the Federal Police, state environmental agencies also need to be supported and work together in their role in controlling the deforestation and to re-establish environmental governance in the remote Amazon. Fines, embargos, and credit restrictions are among the key (de jure) enforcement measures to be restored with a (de facto) market impact through a public catalogue of non-compliant properties that can be consulted by buyers such as beef processors and supermarkets, allowing them to avoid commodity suppliers linked to illegal deforestation.

The prioritization of command and control policies in Brazil will be challenging under the current political circumstances, and the Amazon rainforest may need an international support if it is to continue providing globally critical climate-stabilization services. In this regard, international pressure on markets that trade commodities linked to deforestation may be the most effective mechanism to convince Brazil to step back from its present policies and recognize the rainforest as an asset. Re-establishing command and control policies targeting large patches of deforestation is an urgent response to show deforesters that the state is committed to restoring governance in the agriculture frontiers, with monitoring and enforcement as an important first step. However, as markets are the fundamental drivers of changes in landscape and natural resource use, interventions in supply chains, credit restrictions, along with sustainable development programs and incentives (Nepstad et al 2014, Stabile et al 2020) are essential to ensure a transition to an environmentally sustainable economy. Eliminating land grabbing, implementing payments for ecosystem services, targeting investments to increase productivity and assistance to small farmers are key strategies to
slow down deforestation while increasing production and social well-being (Stabile et al 2020). Encouraging more sustainable farming models such as agroforestry systems are essential to conciliate production and conservation at the farm scale (Porro et al 2012). Tracking and exposing international companies importing commodities from areas with illegal deforestation has been quite effective in ensuring that buyers implement controls and maintain transparent supply chains (Gardner et al 2019) or cope with the risk of having their businesses exposed and linked to illegal deforestation. World leaders can help as well by establishing certification requirements for imports and ensuring that countries are trading in clean commodities, produced on farms and ranches free of illegal deforestation. For instance, as nearly 20% of Brazil’s beef and soy exports to the EU have been linked to illegal deforestation (Rajão et al 2020), the Mercosur-EU trade agreement under negotiation could be conditioned to enforcement of existing environmental laws in Brazil, among other possible measures (Kehoe et al 2019). Higher standards of governance and transparency in the supply chains of commodities from the Amazon (Gardner et al 2019) could therefore be an important contribution towards curbing EU telecoupled GHG emissions. At the same time, consumers can also make intelligent choices that can help in pressuring companies and governments in regard to their policies for Amazonian commodities and deforestation. Above all, however, one thing is clear: we all have a role to play in rescuing the world’s largest rainforest from destruction and maintaining the environmental stability of the planet we depend on.

Data availability statement

The data that support the findings of this study are openly available at the following URL/DOI: https://terrabrasilis.dpi.impe.br/app/map/deforestation?hl=pt-br.

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Author contributions

R T conceived the original idea for the study, developed the methodology, performed the analysis and wrote the manuscript.

Conflict of interest

No competing interest.

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