Land System Change: Deforestation in The Amazon Rainforest: A Need for Governmental Regulation and Cooperation

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University of Warwick
2021

Figure 1. Deforestation rates in Amazon rainforest highest in a decade [7].

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Executive Summary

Land-system change for agricultural growth has led to increasing deforestation of the Amazon rainforest. Forest environments have essential roles in the hydrological cycle, regulating the Earth's climate through evapotranspiration and mitigating global warming. Forest environments are also crucial for ecosystems and biodiversity, all of which contribute to human livelihoods, providing food, sources of medicine, recreation and maintenance of the preferred conditions for human existence. As the largest rainforest in the world, the Amazon is a crucial area for protection. The Amazon rainforest also absorbs the most greenhouse gases compared to any other tropical rainforest and therefore, its protection can be essential to avoiding the transgression of several of the planetary boundaries, including stratospheric ozone depletion, biodiversity loss, climate change, ocean acidification and land system change. Current governance is ineffective due to a persistent failure to enforce policies that were previously effective in decreasing deforestation, which has consequently led to a recent increase. In order to prevent degrading the Amazon rainforest, the Bolsonaro administration should, 1) enforce the current strategies properly, 2) improve its administrative services, 3) inform consumers of the harmful effects of deforestation and 4) cooperate with other governments that possess parts of the Amazon rainforest.

Foundational Science

Tropical rainforests are deforested and converted to cropland and pasture [13] to accommodate for commercial agriculture expansion [15,21], in order satisfy human demands and seize economic opportunities [9]. With 62% of global forest cover currently deforested, the planetary boundary of 'land-system change' faces increasing risk of transgressing the

75% boundary set by Steffen et al [23 p.6]. Due to the important services of forest environments to ecosystems, human well-being, and climate regulation, transgressing this boundary could be severely dangerous [23], as further land system change can "threaten biodiversity and undermine the regulatory capacities of earth" [21 p.18]. Tropical forests are vital components of the hydrologic cycle, cooling the climate through evapotranspiration, eventually causing clouds to form and precipitation to occur [4]. This process is seen to reduce surface temperatures and can therefore mitigate global warming [4]. A change in temperature and rainfall can disrupt the ecological niches that forest species have adapted to, lowering biodiversity. Higher temperatures and reduced rainfall can also reduce moisture, which has been seen to cause drought and subsequent forest fires [5]. Forest fires have also been found to release greenhouse gases [26], worsening the effects of global warming. The burning of rainforests can also be detrimental to human health, through the release of "particulate matter (PM), poisonous polycyclic aromatic hydrocarbons (PAHs), and ozone precursors" [26 p. 3, 8, 24], which can lead to cardiopulmonary diseases [26].

Home to 250,000 species of large trees, 30,000 plant species and 30 million species of animals [22, 11 p.1721], the Amazon rainforest is the largest tropical rainforest in the world [22] and can have a significant role in mitigating global warming and a more specific effect on cooling the midlatitudes, which are beginning to warm due to deforestation of Amazonia [4]. The Amazon rainforest reportedly accounts for "a quarter of global emissions from land use change" [5 p.1] and absorbs more greenhouse gases than any other tropical rainforest [26]. With much of the Amazon already deforested [20], further loss can have harmful positive feedback through the release of carbon dioxide and reduced evaporative cooling [4, 26]. Further to this, deforestation may accelerate the spread of human health issues in the Amazon region, such increases in malaria [26] and can even result in temperature induced mortality [12]. Finally, the potential loss of rainfall in the Amazon can hinder crop production over the next 30 years, which can be economically destructive [14]. Although the effect of

deforestation in the Amazon on rainfall requires further research [15], it is generally agreed that removal of forest cover increases temperatures and reduces rainfall [5, 15, 26].

Deforestation in the Amazon rainforest is counterproductive to eight of the Sustainable Development Goals, at least [26] but most closely links to Goals 12: *Responsible Consumption and Production* and 15: *Life on Land.* In order to adhere to the Sustainable Development Goals, protect biodiversity, limit the effect of global warming and avoid disruption of rainfall patterns, effective management is vital.

Assessment of Current Governance

Brazil had previously been globally revered as an example for effective implementation of policies that reduce carbon dioxide emissions [16]. Current governance strategies primarily include monitoring, licensing, inspections, and fines [22]. Such strategies are part of the 'Action Plan for Prevention and Control of Legal Amazon Deforestation (PPCDAm)' [20]. Launched in 2004, the plan was undoubtedly effective in reducing deforestation in the Amazon rainforest [22], which subsequently resulted in decreasing carbon emissions between 2004 and 2013 [5 p.9]. Despite this decrease, Amazonian deforestation continued to significantly contribute to carbon dioxide emissions in the atmosphere between 1995 and 2017 [5 p.2].

In fact, more recently, Brazil has seen diminishing efforts to enforce these strategies, which has been counterproductive to the conservation of the Amazon rainforest and has allowed for deforestation rates to begin to increase again [17], as shown in Figure 2. Consequently, Pereira and Viola describe the policies in place to protect the Amazon rainforest as "inadequate" [19 p.477]. Carvalho et al support this, arguing that 45% of Amazon deforestation is not detected quickly enough and that only 24% of cases that are detected result with issuing of fines [6 p.127]. Further, due to poor quality administration, only 0.2 to 5% of fines issued are paid [6 p.127]. It is argued that such underwhelming regulation and

enforcement of anti-deforestation policies could be a result of recent economically driven leadership in Brazil [19]. For example, Michael Temer, president of Brazil from 2016 to 2019, reportedly halved the budget of the Ministry of Environment, hindering their ability to administer deforestation policies [19]. The current government seems to possess the same indisposition to restricting deforestation, undermining environmental protection by championing laws such as legalising mining in the Amazon area and executing weaker controls and less frequent inspections [22], which could put pressure on ecosystems and biodiversity [2].

Due to a lack of research on the effectiveness of governance in the Amazon region [19], it is difficult to conclude exactly how successful current governance is on limiting deforestation in the Amazon. However, as the PPCDAm seemingly led to annual rates of deforestation decreasing by 75% from 2004 to 2017 [20 p.2], it is reasonable to assume that if this were properly implemented today, deforestation rates would fall again. However, due to the profitability of agriculture in the Amazon [15], there is much disagreement over how to effectively satisfy human demands, promote economic growth and ensure environmental protection simultaneously [9], complicating the ability to efficiently protect the Amazon rainforest. This policy brief will therefore aim to provide effective recommendations to address these concerns.
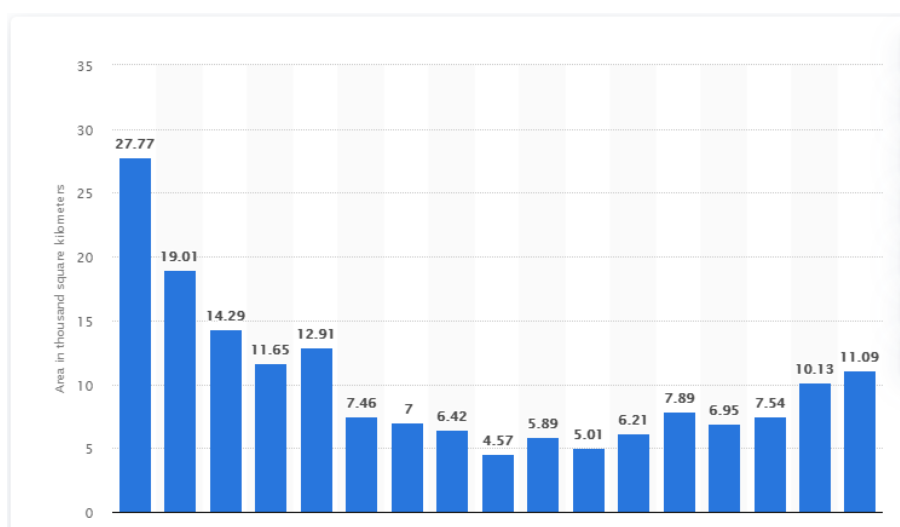

Figure 2. Brazil: Deforested Area in The Amazon [18].

Government Recommendations

In order to combat complete degradation of the Amazon rainforest and protect biodiversity and essential ecosystem services, it is vital that appropriate action is taken.

As the PPCDAm seems to be effective in combating deforestation, it is crucial that the Bolsonaro administration ensures its proper implementation. In a study by Zhao et al on the influence of traffic enforcement on speeding behaviours, it was concluded that increasing fines was an effective method in reducing the chance of speeding [27]. Although further research is needed to see how effective this would be in the context of deforestation, increased issuing of fines is a strategy that should be encouraged, along with increased monitoring through cameras, as the PPCDAm requires. This needs to be implemented in conjunction with improvements to the quality of administration services to ensure fines are successfully issued and paid. This could be done through policy demanding the creation of a new department, outside of the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) [3], specifically responsible for the management of fines.

Second, much of the literature agrees that a significant motivator of deforestation is the economic benefit it presents, fuelled by global and domestic demand for products that come from deforestation practices [9, 13, 21, 22]. Hence, the next strategy for combating rising deforestation should come in the form of demand-side intervention [21]. Research by Maeda et al, funded by Sao Paulo Research agrees that increased awareness can be effective in altering consumer preferences [15], which would be most successfully achieved through information provision on the harmful effects of deforestation, through packaging policies. For example, products from deforestation could be legally required to feature a graphic image of the degraded Amazon rainforest on the packaging, similar to the warning labels on cigarette packaging in Canada, which has been seen to reduce the chance of smoking and increase the chance of quitting [1]. This should be supplemented with a tax on products produced

from deforestation practices. This was seen to be successful in the aim to decrease plastic bag use, another environmental issue, and may therefore prove effective for deforested products. In fact, Thomas et al report that charging for plastic bags led to an 80% reduction of single use plastic bags across the UK [25 p.2]. Such implementations would require the consumer to want to buy goods that evoke the greatest social and environmental benefits [22]. Fortunately, a 2019 study on 1000 Brazilians aged 16 or over suggested that a majority of Brazilians see the preservation of the Amazon rainforest as important [17], which may allow for the success of these regulations, however, perhaps more research is needed with a larger sample and to identify if attitudes have changed since 2019.
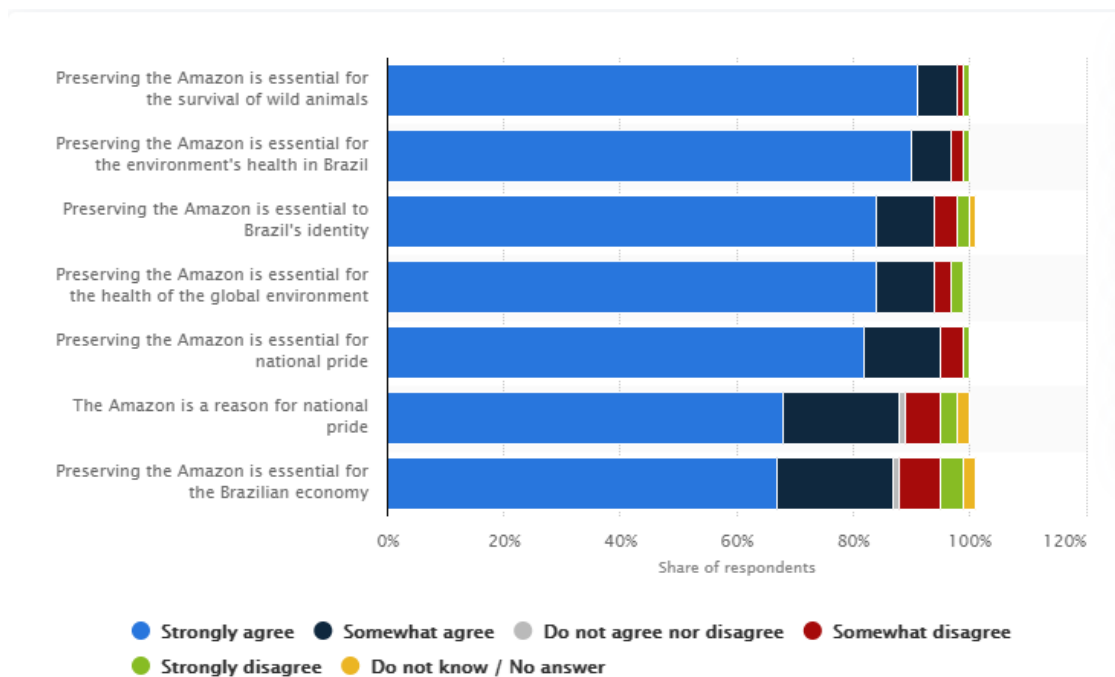

Figure 3. Public Opinion on The Importance of The Protection of the Amazon Rainforest in Brazil in 2019 [17].

Thirdly, Henrich et al argue that "tropical secondary forests sequester carbon up to 20 times faster than old growth forests" [10 p.1]. This is consistent with Wan Mahiri et al who claim that "planting 1000hm2 [of forest] can lead to a sequestration of more than a million tons of CO2" [26 p.2]. Hence, the next proposed strategy is the creation of annual afforestation

targets, set by IBAMA, in line with scientific intelligence to preserve the Amazon rainforest and combat climate change and global warming. This should be supplemented by policies to protect old-growth forests in the Amazon, such as bans on their removal [10].

Finally, cooperation between governments of countries who possess portions of the Amazon rainforest is essential for its protection, but the Brazilian government needs to assume authority and act as an example for the other countries, seeing as it holds the majority of the Amazon rainforest [18] and can seemingly affect deforestation rates when environmental policies are appropriately enacted [20]. The Brazilian government could impose economic penalties on the other governments for poor environmental stewardship for example, but more research is needed to assess how viable this option is.

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