

# **Disappearing Forests: Climate Change and Deforestation in the Democratic Republic of the Congo and Brazil**

Willem Ells

## ***Abstract***

*This article looks at climate change and deforestation in the Democratic Republic of the Congo (DRC) and Brazil. Brazil and the DRC are currently the top two countries in terms of destroying the largest area of primary forest annually. Slash-and-burn agriculture—a destructive method of farming that destroys large plots of land—is a major contributor to the deforestation problem in both Brazil and the DRC. Deforestation worsens climate change because large forests are effective at absorbing carbon dioxide from the atmosphere and because it directly releases carbon. While deforestation has destructive effects on the atmosphere, it is a complicated issue because crops harvested on land clearcut for agriculture are the primary source of income for many impoverished people in both these countries. This article will consider the economic effects of deforestation, its relation to climate change more broadly, and the ethical issues necessary to consider when deciding what future policy courses may be appropriate.*

## **I. Introduction**

Climate change, and its various effects, reach the front page of many newspapers today after being ignored for years. Journalists often highlight it when a major natural disaster or other tragedy occurs. While climate change also has many less visible effects, one of the most notable trends of the past ten years is the increase in the burning of forests. Greenberg (2022) reports on the significant burning of the Amazon rainforest in Brazil, perhaps the most well-known rainforest in the world. Images of the fires burning throughout the rainforest help to visualize and emphasize the damage that widespread deforestation does to the environment.

This article focuses on climate change and deforestation in Brazil and the Democratic Republic of the Congo (DRC), the currently two largest contributors to deforestation worldwide.<sup>1</sup> Specifically, it will focus on the driving factors behind deforestation, how governments have responded, and the ethical implications of proposals to stop the practice. It will consider changing trends, the

---

<sup>1</sup> Weisse and Goldman (2022) and UNICEF-DRC (2021).

importance of agriculture to the economies of these countries that use deforestation, and ethical structures that can be used to approach solving the problem.

Excluding the introduction and conclusion, this article is structured into four major sections. First, it will provide an outline of existing literature on the dangers of deforestation and various aspects of the practice in Brazil and the DRC. Next, some basic socio-economic background information will be explored. Third, the article will analyze facts and statistics specifically regarding the practice in these two countries, with an additional subsection overviewing how the Brazilian and Congolese governments have responded. Finally, the article will consider ethical structures regarding this issue and examine how these can be applied to the cases of Brazil and the DRC.

## **II. Literature Review**

There is extensive research on the driving forces and effects of deforestation in Brazil, the DRC, and the world. Aguiar, Ometto and Martinelli (2011) review existing scholarship on deforestation in Brazil. Fearnside (2008) examines the actors responsible for deforestation in the Amazon rainforest. Moonen et al. (2016) conduct a localized analysis of deforestation in the DRC. Lawson (2014) argues that illegal logging in the DRC is widespread and critical for the government to combat. Turubanova, Potapov, Tyukavina and Hansen (2018) create a model to map primary forest loss and compare Brazil and the DRC against each other. Finally, Lawrence and Vandecar (2014) examine the broad effects of significant deforestation on the global climate.

- Aguiar, Ometto and Martinelli (2011) overview and synthesize existing scholarship on deforestation in Brazil. They describe how cattle ranchers, subsistence farmers, and commercialized farming primarily drive deforestation in the Amazon rainforest. In particular, they emphasize how agricultural businesses, which grew rapidly in the early 2000s, threaten the relatively untouched western and central areas of the rainforest. The authors point out that the rate of deforestation stabilized and began to fall in the early 21<sup>st</sup> century, largely due to attempts by the Brazilian government to mitigate damage. However, they stress that biodiversity remains threatened and that significant amounts of carbon continue to be released into the atmosphere. Finally, they point out that there are many competing interests and needs to consider when creating policies to combat deforestation.
- Fearnside (2008) focuses on the importance of considering various actors and their roles in Amazonian deforestation. For instance, he argues that landless migrants—farmers who constantly seek new land to cultivate—play a large role both by clearing land and pushing nearby landowners to do the same as a defense against trespassing from landless migrants. Ranchers, according to Fearnside, are responsible for more deforestation than any other group. Additionally, drug traffickers and money launderers clear land that legitimate businesses avoid. Gold miners play a role by encouraging migration to otherwise unpopulated areas. Finally, agribusiness drives deforestation in certain regions, like Mato Grosso, and incentivizes large infrastructure projects. Fearnside argues that it is critical to consider actors and not just spatial models of deforestation when creating policies to address the issue.
- Moonen et al. (2016) analyzed deforestation in the Central Basin of the DRC at a localized level. They focused on causes of variation in deforestation rates at household and village levels, a first for a major study. The authors found that population density and market

access were the primary determinants of whether a village engaged in significant deforestation. Further, families with lengthy ties to a location and those more integrated with markets were more likely to engage in deforestation. Additionally, the authors found that cultural factors affected the likelihood of deforestation. From this research, they concluded that policies to address deforestation, primarily the REDD+ international initiative, must consider local factors as well as global and national contexts.

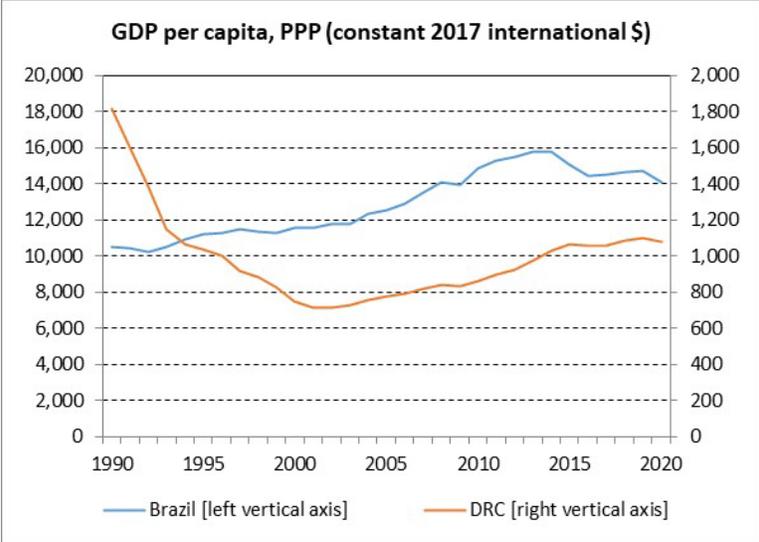
- Lawson (2014) considers illegal logging and trade in the DRC. According to his research, as much as 90 percent of logging in the country is illegal. He argues that most logging is licensed in some way but does not adhere to regulations. The regulatory structure is confusing, and enforcement is scarce. Most of the logging is done for small-scale trade within the country or the region. Progress on reducing illegal logging has been slow because of corruption and a lack of political will. Lawson argues that the government, which instituted a moratorium on new licenses, must keep it in place until a better governing and enforcement structure is created.
- Turubanova, Potapov, Tyukavina and Hansen (2018) demonstrated a method for mapping and monitoring forest loss, an issue they argue deserves attention because of the significant effects of deforestation on the global climate. The authors consider primary forest loss from 2002-2014, focusing on three countries, Brazil, Indonesia, and the DRC. Forest loss in Brazil was five times higher than in the DRC, despite Brazil's success in slowing deforestation along the edge of their forests. The authors emphasize that even though Brazil has made inroads in stopping deforestation, remote areas of the Amazon rainforest remain at risk. Additionally, the DRC faces risks because of an increasing number of small-scale farmers moving closer to intact forests.
- Lawrence and Vandecar (2014) overview the effects of deforestation in the tropics more broadly, without focusing on a specific country. They argue that statistical modeling shows that countries in the tropics will face more warming and less rainfall than other countries. As an extreme example, they show that complete deforestation would have the same global warming effect as all of the fossil fuels burned since 1850. Additionally, they argue that deforestation, which is often done for agriculture, will harm future agricultural productivity. A warming climate will eventually reach a threshold past which rainfall decreases significantly. The warmth and lack of rainfall will increase the frequency of droughts that damage crop production and local economies.

### **III. Socio-Economic Background**

Figure 1 shows purchasing power parity adjusted GDP per capita in constant international dollars in Brazil and the DRC from 1990 to 2020. During this period, Brazil experienced an overall increase in GDP per capita, with small declines in 1997, 2001, 2008, and since 2014. GDP per capita reached a peak in 2013. PPP-adjusted GDP per capita in the DRC over the same period declined slowly but consistently until it began a slow rise in 2010. Additionally, GDP per capita in the DRC is several times lower than in Brazil. On average, it is 13 times lower in the DRC than in Brazil. This reflects the fact that Brazil is more developed than the DRC and enjoys a higher overall standard of living.

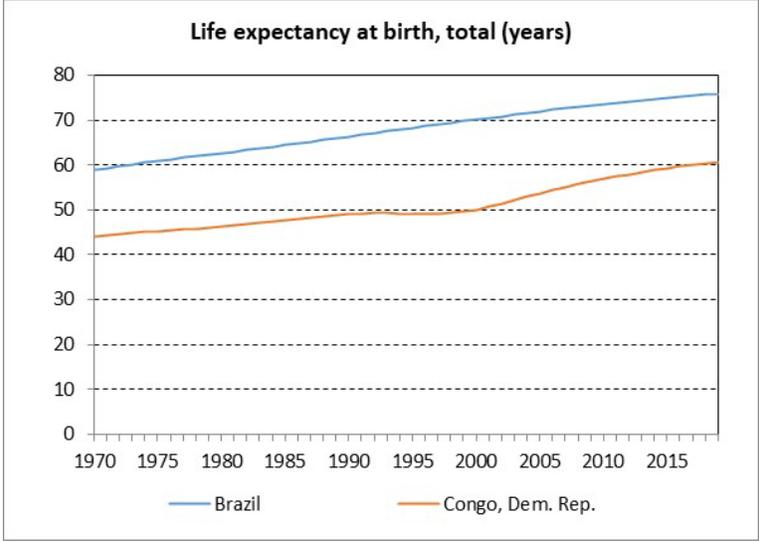
Both Brazil and the DRC have experienced consistent increases in life expectancy at birth. Figure 2 shows this trend from 1970 to 2019. In Brazil, life expectancy at birth has increased from an estimated 59 years in 1970 to 76 years in 2019. In the DRC, life expectancy has increased from about 44 years in 1970 to 61 years in 2019. The DRC experienced a minor decline between 1993 and 1997. Figure 2 shows that for every year between 1970 and 2019, Brazil has had a life expectancy about 34 percent higher than in the DRC.

**Figure 1: GDP Per Capita, PPP (Constant 2017 int. \$) 1990–2020**



Source: Created by author based on World Bank (2022).

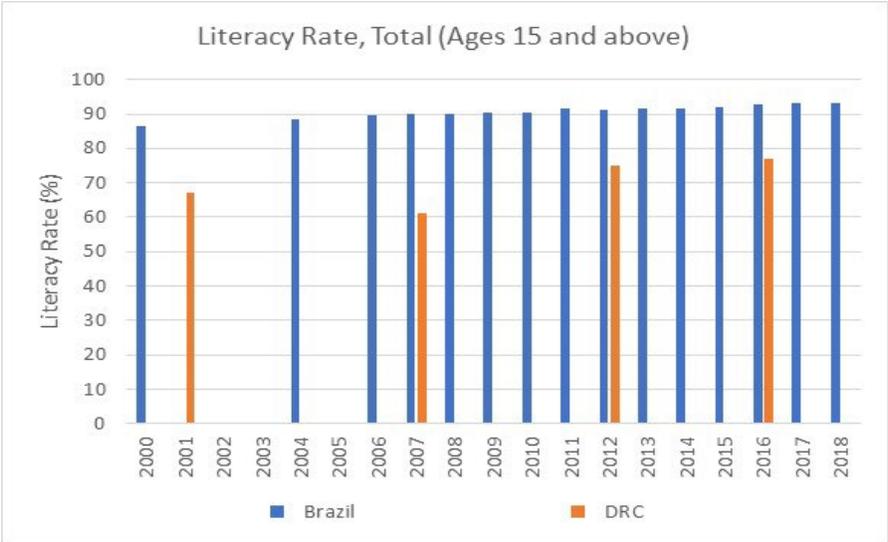
**Figure 2: Life Expectancy at Birth, 1970–2019**



Source: Created by author based on World Bank (2022).

Figure 3 shows the literacy rates in Brazil and the DRC from 2000 to 2018. The World Bank data on literacy rates is sparse and not available every year. The data is more consistently available over this period in Brazil. Brazil has had a relatively high and slowly increasing literacy rate since 2000, rising from about 86 percent to 93 percent. In the DRC, literacy rates were lower in 2007 compared to 2001, but have risen since then to about 77 percent. Across the period, Brazil has had consistently higher literacy rates than the DRC.

**Figure 3: Literacy Rate (ages 15 and above)**



Source: Created by author based on World Bank (2022).

Overall, across all three indicators, Brazil is consistently and significantly higher than the DRC across the entire period. Again, this demonstrates that Brazil is more developed than the DRC and has higher living standards. Further, this indicates that regardless of other facts, Brazil seems to have a stronger overall economy. Additionally, the general decline in GDP per capita in the DRC while Brazil saw increases indicates that Brazil has grown while the DRC has continued to struggle. However, despite the stagnant GDP per capita in the DRC, other indicators, like life expectancy and the literacy rate, have increased.

**IV. Analysis of Facts**

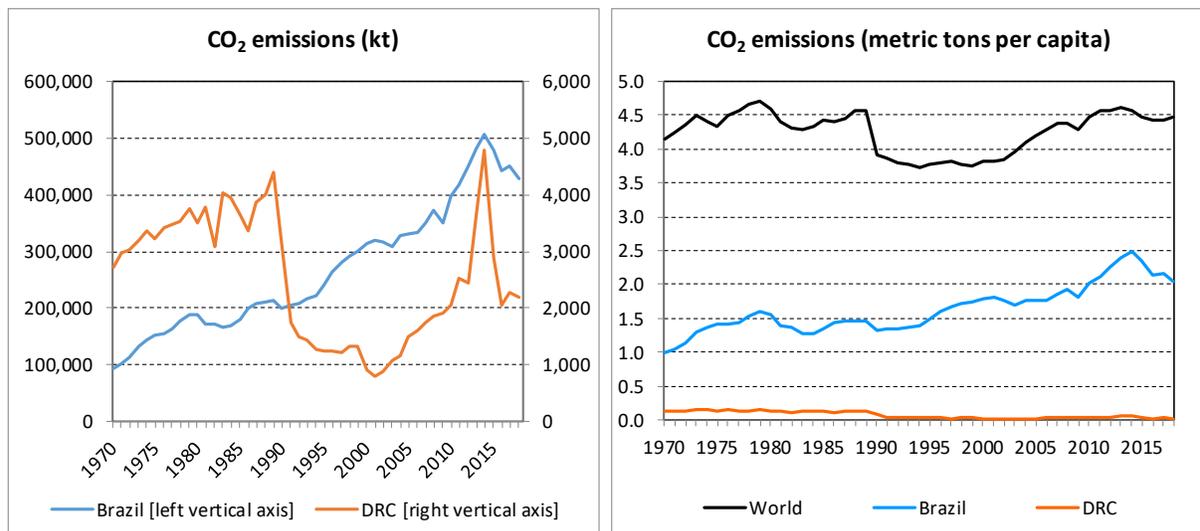
**IV.1. Total and per capita Carbon Dioxide (CO<sub>2</sub>) Emissions**

Given that Brazil has with 212.6 million people in 2020 more than twice the population than the DRC (which stood at 89.6 million in 2020), it can be expected that Brazil’s total carbon dioxide (CO<sub>2</sub>) emissions are larger than that of the DRC’s total CO<sub>2</sub> emissions. Indeed, as Figure 4 shows, during the last five decades, Brazil’s total CO<sub>2</sub> emissions have been about 100 to 200 times higher than the DRC’s total CO<sub>2</sub> emissions. Despite some volatility, Brazil’s total CO<sub>2</sub> emissions have overall increased from 1970 to 2014, and then show a declining trend since 2014. The DRC’s total CO<sub>2</sub> emissions have been far more volatile, showing an overall increasing trend from 1970 to 1989, then a very sharp decline from 1989 to 1991, with a further though more moderate decline from

1991 to 2001. The DRC’s total CO<sub>2</sub> emissions then increased very sharply from 2001 to 2014, after which they decreased equally sharply from 2014 to 2016, and then stabilized around 2,200 kt in 2016 and 2018.

To correct for the different population sizes across times and the two countries, Figure 5 shows the per capita CO<sub>2</sub> emissions for Brazil and the DRC, which are at least 10 times higher for Brazil than the DRC. As a reference point, Figure 5 also includes the average per capita CO<sub>2</sub> emission for the world, which has been about twice that of Brazil during the last two decades and about 150 times that of the DRC during the last two decades. This is important to keep in mind when we examine some ethical aspects of Brazil’s and the DRC deforestation in the next section.

**Figures 4 and 5: Total CO<sub>2</sub> Emissions and per capita CO<sub>2</sub> Emissions, 1970–2018**



Source: Created by author based on World Bank (2022).

According to Ayompe, Davis and Egoh (2020), there is an association between GDPs per capita and CO<sub>2</sub> emissions. In general, a higher GDP per capita is correlated with higher emissions, although there are exceptions. Ayompe, Davis and Egoh (2020) demonstrate an even stronger relationship between low GDP per capita and low CO<sub>2</sub> emissions. Therefore, it is unsurprising that Brazil saw rising emissions while the DRC saw emissions decline. As was shown in Figure 1, GDP per capita has tended to increase in Brazil since 1990 while slowly declining in the DRC. This suggests that Brazil is a larger contributor to climate change than the DRC. Despite this, Paavola, Adger and Huq (2006) argued that less developed countries like the DRC will experience the worst effects of climate change while also having less power to combat it.

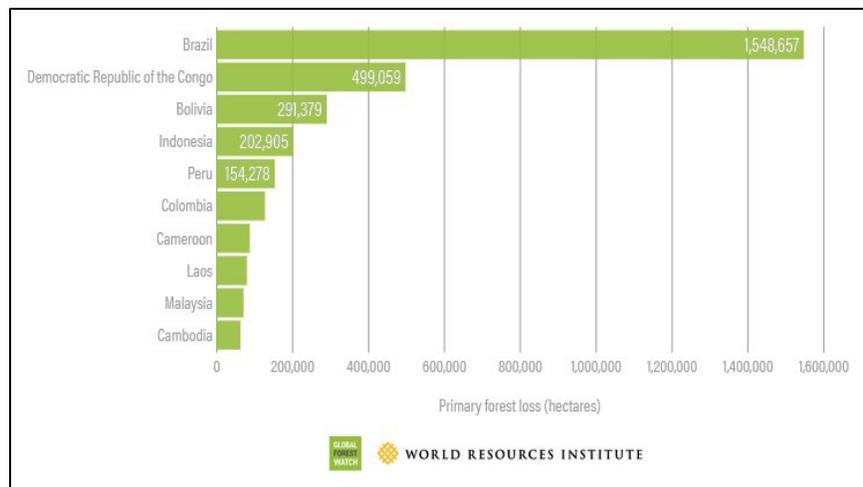
#### IV.2. Deforestation and its Effects

As shown in Figure 6, Brazil was the largest contributor to tropical primary forest loss in 2021, followed by the DRC. Brazil lost about 1.5 million hectares of forest due to deforestation, while the DRC lost about half a million hectares in 2021. Figure 7 shows that in both Brazil and the DRC, deforestation has been steady and significant. Between 1990 and 2020, Brazil lost about

31,000 square km per year on average, accumulating to about 920,000 square km across the period. The DRC has lost about 8,160 square km per year since 1990, totaling about 245,000 square km.

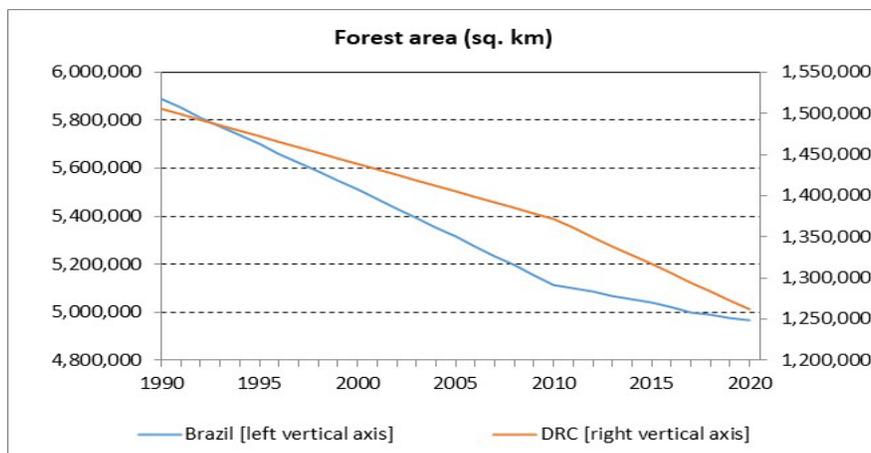
The total area of forest loss in 2021 was lower than the average loss in previous years for both Brazil and the DRC, reflecting the stabilization of deforestation, largely due to government and international attempts to combat the damaging practice. However, Weisse and Goldman (2022) report that since 2016, the amount of forest lost to fires has increased in Brazil while non-fire related loss has slightly declined. While the frequency and intensity of fires are exacerbated by climate change, Greenberg (2022) reports that most fires in the Amazon rainforest are started intentionally to clear land for agriculture. Unlike in Brazil, most deforestation in the DRC is driven by illegal logging and agricultural demands, according to Weisse and Goldman (2022). As Lawson (2014) argues, this is largely because the DRC lacks an effective licensing and regulatory system to encourage legal logging while preventing illegal clearcutting.

**Figure 6: Top 10 Countries for Tropical Primary Forest Loss in 2021 (hectares)**



Source: Weisse and Goldman (2022), Figure 2.

**Figures 7: Forest Area (in square km), 1990–2020**

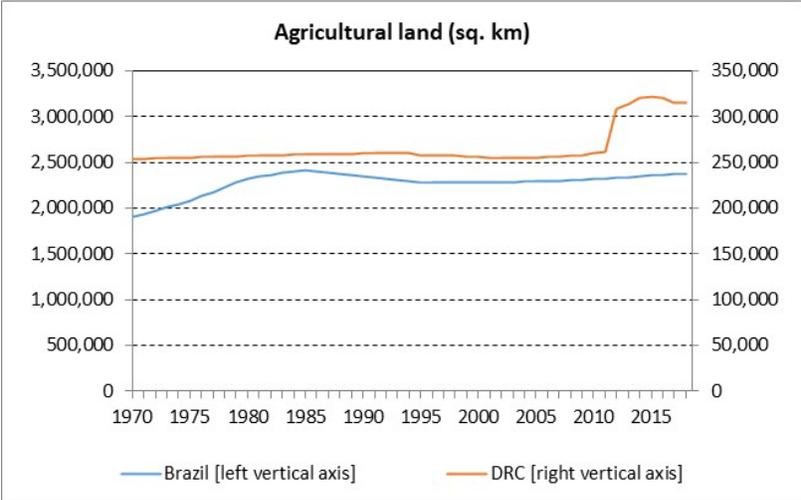


Source: Created by author based on World Bank (2022).

Figure 7 shows the forest areas (in square km) in Brazil and the DRC from 1990 to 2020, using two vertical axes as the forest areas of Brazil are about 4 times the forest areas of the DRC. The Figure shows that the rate of deforestation has declined in Brazil from 2010 to 2020 compared to the previous two decades (1990 to 2010). On the other hand, the rate of deforestation has increased in the DRC from 2010 to 2020, compared to 1990 to 2010. However, “deforestation in Brazil increased in 2020 and 2021, largely due to illegal mining activity and cattle ranching. (...) Without any change to current policies, emissions are expected to continue increasing, again leaving Brazil far from achieving its climate targets.”<sup>2</sup>

Figure 8 shows that the total area of agricultural land has increased in both Brazil and the DRC between 1970 and 2018. Total agricultural land in Brazil has increased by about 24 percent, or 465,000 square km. In the DRC, total agricultural land has increased by about 24 percent as well, totaling 61,500 square km. That total forest loss across both countries is significantly higher than the increase in agricultural land demonstrates the inefficiency of agricultural practices.

**Figure 8: Agricultural Land (in square km), 1970–2018**



Source: Created by author based on World Bank (2022).

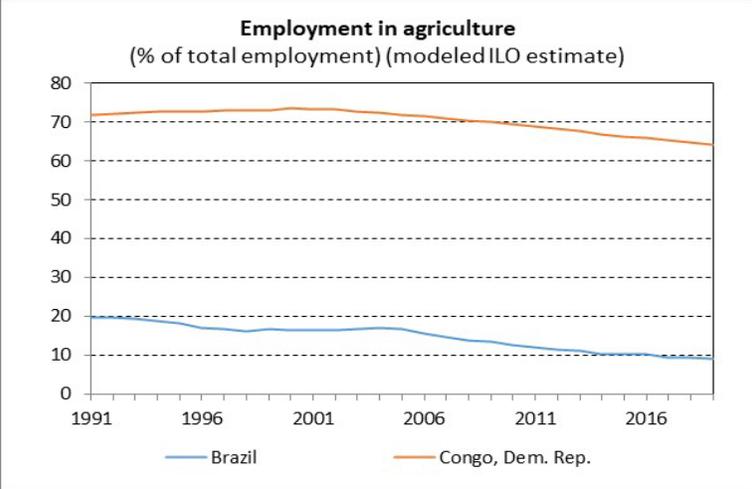
This discrepancy is likely driven by the practice of slash-and-burn agriculture. This method of farming is distinguished by the burning of all vegetation on a patch of land to create a nutrient-rich layer of soil.<sup>3</sup> While this provides quality crop yields for a short period, the nutrients in the soil are quickly exhausted and the land becomes unusable. The widespread use of this practice in countries like Brazil and the DRC helps explain why the increase in agricultural land does not offset the total forest loss. While Kleinman, Pimentel, and Bryant (1995) argue that slash-and-burn agriculture can be sustainable, most farmers fail to or cannot meet sustainability standards. As a result, much of the forest lost—which directly increases CO<sub>2</sub> in the atmosphere and destroys carbon sinks—eventually becomes unusable, driving farmers to continue clearing more forest.

<sup>2</sup> Climate Action Tracker (CAT) (2022), paragraph 4.

<sup>3</sup> EcoLogic Development Fund (2022).

Finally, Figure 9 shows the percent of total employment accounted for by the agricultural sector (including forestry and fishing) in Brazil and the DRC. In the DRC, the percentage of the population employed in agriculture is at about 64 percent in 2019 still very high, even though it declined from about 72 percent in 1991. In Brazil, about 9 percent of the population were employed in agriculture as of 2019, a significant decline from about 20 percent in 1991. Still compared to most industrialized countries, agriculture still provides a lifeline for many people in Brazil and especially in the DRC.

**Figure 9: Employment in Agriculture (percent of total employment) 1991–2019**



Source: Created by author based on World Bank (2022).

## V. Ethical Analysis

### V.1. Ethical Structures and Considerations

Many solutions proposed to combat climate change and deforestation specifically rely on economic rationale and the development of new, sustainable technologies. While these are critical perspectives, they often discount or outright ignore moral and ethical considerations.

Rotman (2013) writes that there is a disconnect between the immediate cost of stopping climate change and the immediate benefits. While climate change has already negatively affected certain parts of the world, as shown for example by the increase in extreme weather events, most of the damage will occur in the future.<sup>4</sup> Yet, the costs of investing in a sustainable future will be borne now. Rotman (2013), in agreement with many economists, suggests the economic practice of “discounting” to balance the immediate cost of a good or service with the value it will provide in the future. Under this framework, significant investments are necessary now to combat climate change, but instead of investing all of the necessary resources immediately, they should be spread out over the coming decades. This makes logical sense, according to Rotman (2013), because an unreasonably high immediate cost would create future costs that counteract the future benefits.

<sup>4</sup> United States Environmental Protection Agency (EPA) (2022).

This framework of utilizing an economic discount rate is an important start, but there are more ethical considerations. Another important question plaguing policymakers and ethicists, according to Paavola, Adger, and Huq (2006), is how the costs of combatting climate change should be distributed among countries. Wealthier, more developed countries contribute the most to greenhouse gas emissions, but less developed countries experience the worst effects. The fact that less developed countries will feel the worst effects of a warming climate incentivizes those countries to invest more to combat it. Similarly, wealthier countries, less affected by the damage they cause, are less motivated to invest in solving the problem. However, Paavola, Adger and Huq (2006), as well as most other ethicists, would agree that those most responsible for creating a problem have a greater responsibility to fix it.

Further complicating the picture, even when considering the damage that less developed countries do to the environment—through practices like deforestation—it is critical to understand the importance of these practices to local economies. Agriculture makes up a significant portion of economic activity in developing countries. Hence, it is a critical tool for raising incomes and ending extreme poverty, and one must consider the hypocrisy of placing the responsibility for ending these damaging practices on those who rely on them as one of a limited number of opportunities to escape poverty. The hypocrisy is further exemplified when considering that wealthier countries often exploit less developed countries (Hickel 2017). This further reduces economic opportunity in developing countries and increases the reliance on agriculture and practices like deforestation.

The many ethical considerations surrounding with whom the responsibility of combatting climate change lies should inform any policy proposals. There is no easy answer, but policymakers must work to find solutions that balance immediate costs with future benefits as well as determine which countries or corporations should be obligated to make the necessary financial investments. Additionally, any proposal that would slow or stop a practice critical to developing economies' development should also emphasize and invest in alternatives to prevent those affected from seeing a decline in their standard of living.

## **V.2. Ethical Analysis of Deforestation in Brazil and the DRC**

This section will now turn to how the ethical concepts analyzed above can be applied to Brazil and the DRC, and how they can inform future government policy responses. First, it is important to reiterate that while neither Brazil nor the DRC are considered developed countries, there are significant differences in the socioeconomic conditions between them. For instance, as was shown in Figure 1, GDP per capita in Brazil is about 13 times higher than in the DRC in 2020. Additionally, as was shown in Figure 9, a much larger proportion (about 64 percent) of the DRC's employed population works currently in the agricultural sector, compared to about 9 percent in Brazil.

Since there are major differences between the economic status of these two countries, a cost-benefit analysis of each will yield different answers. Brazil is wealthier and less dependent on agriculture than the DRC. This would suggest that not only does the government of Brazil possess more resources to combat deforestation, but it can afford to incur more immediate costs to realize more future benefits. The DRC, without foreign investment, likely does not have the funds to implement effective policies. Even though it could improve the licensing and regulatory framework, as Lawson (2014) proposed, many loggers and farmers would suffer. There would be

both significant immediate costs and damaging future costs due to a weakened economy, offsetting some of the benefits provided by protecting the environment. As stated by African Renewal (2021), paragraph 7:

*“Exacerbated by extreme poverty, forest loss in the DRC is mainly due to a growing population lacking livelihood opportunities outside the forest and relying mostly on fuelwood for cooking, all that in the absence of land use planning. Any solution proposed to stem forest loss in the DRC must therefore focus on rural development, poverty reduction, and better food security.”*

To elaborate further, the idea of the immediate costs of stopping deforestation can be extended. Consider a hypothetical. If both Brazil and the DRC stopped deforestation practices immediately, many of the 9 percent and 64 percent, respectively, of the population employed in agriculture would lose their jobs. The effects of this would reverberate through each economy, likely causing an immediate recession in Brazil and leading to the collapse of the economy in the DRC. Further, other countries that trade with these two nations would see a decline in economic activity as well. Therefore, while stopping deforestation quickly and completely is necessary to protect the climate, it is not necessarily ethical. A more measured approach must be taken.

As Aguiar, Ometto and Martinelli (2011) report, the Brazilian government made significant progress in combatting deforestation in the early 2000s. The rate of deforestation in the Amazon decreased by 75 percent between 2004 and 2009. While some of the variations in deforestation rates can be attributed to outside economic forces, the Brazilian government also committed to the UN Framework Convention on Climate Change emission reduction plans. Under this agreement, the government agreed to implement policies to reduce greenhouse gas emissions. However, the rise of Jair Bolsonaro to power in 2019 led to the implementation of anti-environment policies. Greenberg (2022) reports that much of the fault for the recent surge in forest fires and deforestation in the Amazon can be attributed to Bolsonaro’s administration. Despite this, Bolsonaro’s recent electoral loss to Luiz Inácio Lula da Silva could reorient Brazil’s environmental policies back toward protecting the Amazon.<sup>5</sup>

In the DRC, Lawson (2014) writes that the government has largely lacked the political willpower to implement effective, wide-reaching policies to combat deforestation. Further, he argues that government corruption has also hampered progress. In particular, Lawson (2014) argues that the government is unable to effectively manage logging licenses, instead allowing widespread illegal logging. According to Lawson, government officials must work to reformulate a regulatory and licensing framework to combat deforestation in the country more effectively.

Overall, while some progress has been made—as demonstrated above by the declining rates of forest loss—the governments of Brazil and the DRC must do more to stop the destructive practice of deforestation before critical thresholds of climate damage are reached. Greenberg (2022) reports that the Amazon rainforest has lost approximately 17 percent of its total area. If total losses reach 20-25 percent of the total area of the rainforest, it will cause irreversible climate damage and the rainforest ecosystem will collapse.

While it is clear that both Brazil and the DRC are inflicting significant damage with their deforestation, Brazil and especially the DRC contribute little to global CO<sub>2</sub> emissions, in both absolute values as well as in per capita terms, as was shown in Figures 4 and 5 above. Comparing Brazil with the DRC, Brazil’s higher per capita income than that of the DRC suggests that,

---

<sup>5</sup> Nicas (2022).

according to the ethical considerations outlined above, Brazil should shoulder more of the burden of combatting climate change than the DRC.

A final ethical consideration will help elucidate a path forward. Brazil's economy was largely built after Portuguese colonizers invaded the country and began extracting timber. The DRC was previously colonized by Belgium. The paths of these countries diverged because, while colonizers stayed in Brazil and grew the local economy through exploitation, the Belgians largely extracted all of the resources and money the country and its people provided. In other words, the money from timber extraction stayed in Brazil, while money from resource extraction in the DRC was sent to Belgium.<sup>6</sup> This difference matters because it is important to consider the full history of a country. In essence, Brazil's history suggests it should bear more of the costs of combatting climate change because the DRC experienced a higher degree of exploitation than Brazil.

These ethical considerations have created a nuanced, but clearer picture. Brazil should be expected to invest more in combatting deforestation because it can better afford immediate costs, will face fewer negative local economic consequences, is responsible for more CO<sub>2</sub> emissions, and has a history of wealth generated through exploitation. While it is critical to stop deforestation in the DRC as well, it may be more ethical—but still potentially problematic—for other countries to invest in the DRC to ease the process. Finally, any proposal to stop deforestation must take a balanced approach, considering climate damage while also not crushing local economies. A positive sign in this regard has been that some of the rich countries agreed at the 26th United Nations Climate Change conference in 2021 to provide \$500 million over the subsequent five years to protect the DRC's forests.<sup>7</sup>

## **VI. Conclusion**

In sum, deforestation is a damaging agricultural practice that directly releases carbon into the atmosphere while also destroying carbon sinks (Lawrence and Vandecar 2014). Countries in the tropics will face more warming and extreme weather than other countries. Additionally, wealthier countries, while contributing more to global climate change, will bear fewer costs and will be better prepared to respond to challenges.<sup>8</sup> Neither Brazil nor the DRC are considered developed countries, but Brazil is significantly wealthier than the DRC. As was shown in Figure 7, both countries have seen significant losses of forest area since 1970 due to intentional deforestation. While the rate of deforestation has stabilized in recent years, burning forests has become a more popular practice in Brazil.<sup>9</sup>

Many ethical aspects must be considered when deciding how to stop deforestation. There is an important disconnect between immediate costs and future benefits. Additionally, wealthier countries like Brazil contribute more to global emissions, suggesting they should pay more to combat climate change. Economic exploitation of less developed countries further weakens their position and opportunities to combat climate change. Finally, both Brazil and the DRC depend on agriculture, but the DRC more so than Brazil.

---

<sup>6</sup> This paragraph is based on Maioli et al. (2020) and Elsayed (2010).

<sup>7</sup> Africa Renewal (2021).

<sup>8</sup> Paavola, Adger, and Huq (2006).

<sup>9</sup> Weisse and Goldman (2022).

Looking to the future, policy solutions must consider these ethical frameworks. At a general level, any policy must find a balance between stopping deforestation fast enough to protect the climate while not stopping it so fast that economies are irreparably damaged. This problem can be further mitigated by investing in sustainable agriculture practices and other employment options for farmers. Additionally, while it may be difficult to encourage cooperation from other countries, it seems as though a majority of the costs of ending deforestation in the DRC should be borne by wealthy countries.

Deforestation is widespread and deeply ingrained in the economies of Brazil and the DRC, but it is not impossible to stop. It will require government action and investment both within these countries and from international partners. It will require a commitment to continuing policies to gradually stop deforestation over a period of years. Government officials will have to prevent corruption and outside interests from influencing policy to their benefit. Finally, strong leaders will have to convince their populations that investments to prevent the largely invisible force of climate change that will wreak havoc in the future are critical today.

## References

- Africa Renewal (2021). COP26: Landmark \$500 million Agreement Launched to Protect the DR Congo's Forest. Africa Renewal, internet resource of December 2021; available at: <https://www.un.org/africarenewal/magazine/december-2021/cop26-landmark-500-million-agreement-launched-protect-dr-congo%E2%80%99s-forest>.
- Ayompe, Lacour M.; Steven J. Davis; and Benis N. Egoh (2020). Trends and Drivers of African Fossil Fuel CO<sub>2</sub> Emissions 1990–2017. *Environmental Research Letters*, Vol. 15, No. 12; available at: <https://iopscience.iop.org/article/10.1088/1748-9326/abc64f>.
- Climate Action Tracker (CAT) (2022). Brazil. Country Summary. Climate Action Tracker (CAT), internet resource of September 5, 2022; available at: <https://climateactiontracker.org/countries/brazil/>.
- EcoLogic Development Fund (2022). Our Impact: Slash and Burn Agriculture: Ecologic Development Fund. EcoLogic Development Fund, internet resource; available at: <https://www.ecologic.org/our-impact/challenges/slash-and-burn-agriculture>.
- Elsayed, Samah (2010). Deforestation in the Democratic Republic of the Congo. All African People's Development & Empowerment Project (AAPDEP), internet resource of February 17, 2010; available at: <https://developmentforafrica.org/deforestation-in-the-democratic-republic-of-the-congo/>.
- Fearnside, Philip M. (2008). The Roles and Movements of Actors in the Deforestation of Brazilian Amazonia. *Ecology and Society*, Vol. 13, No. 1; available at: <https://doi.org/10.5751/es-02451-130123>.
- Greenberg, Chris (2022). The Amazon - and Our Future - Is Being Burned for Profit. Greenpeace International, internet resource of October 23, 2022; available at: <https://www.greenpeace.org/international/story/55533/amazon-rainforest-fires-2022-brazil-causes-climate/>.
- Hickel, Jason (2017). Aid in Reverse: How Poor Countries Develop Rich Countries. *The Guardian*, Guardian News and Media, internet resource of January 14, 2017; available at:

<https://www.theguardian.com/global-development-professionals-network/2017/jan/14/aid-in-reverse-how-poor-countries-develop-rich-countries>.

- Kleinman, P. J. A.; D. Pimentel; and R. B. Bryant (1995). The Ecological Sustainability of Slash-and-Burn Agriculture. *Agriculture, Ecosystems & Environment*, Vol. 52, Nos. 2–3, pp. 235–249; available at: [https://doi.org/10.1016/0167-8809\(94\)00531-i](https://doi.org/10.1016/0167-8809(94)00531-i).
- Lawrence, Deborah and Karen Vandecar (2014). Effects of Tropical Deforestation on Climate and Agriculture. *Nature Climate Change*, Vol. 5, No. 1, pp. 27–36; available at: <https://doi.org/10.1038/nclimate2430>.
- Lawson, Sam (2014). Illegal Logging in the Democratic Republic of the Congo. Energy, *Environment and Resources (EER)*, Policy Paper (PP), No. 2014/03 (April); available at: [https://www.chathamhouse.org/sites/default/files/home/chatham/public\\_html/sites/default/files/20140400LoggingDRCLawson.pdf](https://www.chathamhouse.org/sites/default/files/home/chatham/public_html/sites/default/files/20140400LoggingDRCLawson.pdf).
- Maioli, Veronica; Stefanie Belharte; Marcela Stuker Kropf; and Catia Henriques Callado (2020). Timber Exploitation in Colonial Brazil: A Historical Perspective of the Atlantic Forest. *Historia Ambiental, Latinoamericana y Caribeña*, Vol. 10, No. 2, pp. 46–73; available at: [https://www.environmentandsociety.org/sites/default/files/key\\_docs/422-texto\\_del\\_manuscrito-1410-2-10-20200831.pdf](https://www.environmentandsociety.org/sites/default/files/key_docs/422-texto_del_manuscrito-1410-2-10-20200831.pdf).
- Moonen, Pieter C. J.; Bruno Verbist; Jarrik Schaeffer; Marcel Bwama Meyi; Anton Van Rompaey; and Bart Muys (2016). Actor-Based Identification of Deforestation Drivers Paves the Road to Effective REDD+ in DR Congo. *Land Use Policy*, Vol. 58, pp. 123–132; available at: <https://doi.org/10.1016/j.landusepol.2016.07.019>.
- Nicas, Jack (2022). Brazil Ejects Bolsonaro and Brings Back Leftist Former Leader Lula. *The New York Times*, internet resource of October 31, 2022; available at: [https://www.nytimes.com/2022/10/30/world/americas/lula-election-results-brazil-bolsonaro.html?name=styl%20n-brazil-election%20%AEion=TOP\\_BANNER&block=storyline\\_menu\\_recirc&action=click&pgtype=LegacyCollection&variant=show&is\\_new=false](https://www.nytimes.com/2022/10/30/world/americas/lula-election-results-brazil-bolsonaro.html?name=styl%20n-brazil-election%20%AEion=TOP_BANNER&block=storyline_menu_recirc&action=click&pgtype=LegacyCollection&variant=show&is_new=false).
- Ometto, Jean Pierre; Ana Paula Aguiar; and Luiz Antonio Martinelli (2011). Amazon Deforestation in Brazil: Effects, Drivers and Challenges. *Carbon Management*, Vol. 2, No. 5, pp. 575–585; available at: <https://doi.org/10.4155/cmt.11.48>.
- Paavola, Jouni; W. Neil Adger; and Saleemul Huq (2006). Multifaceted Justice in Adaptation to Climate Change, in: W. N. Adger, J. Paavola, S. Huq and M. J. Mace (eds.) *Fairness in Adaptation to Climate Change* (Cambridge, MA: The MIT Press), pp. 263–277.
- Turubanova, Svetlana; Peter V. Potapov; Alexandra Tyukavina; and Matthew C. Hansen (2018). Ongoing Primary Forest Loss in Brazil, Democratic Republic of the Congo, and Indonesia. *Environmental Research Letters*, Vol. 13, No. 7, Article 074028; available at: <https://doi.org/10.1088/1748-9326/aacd1c>.
- United Nations Children’s Fund (UNICEF) Democratic Republic of Congo (2021). Children in DRC at ‘Extremely High Risk’ of the Impacts of the Climate Crisis. UNICEF, internet resource of August 20, 2021; available at: <https://www.unicef.org/drcongo/en/press-releases/children-drc-extremely-high-risk-impacts-climate-crisis>.

- United States Environmental Protection Agency (EPA) (2022). Climate Change Indicators: Weather and Climate. United States Environmental Protection Agency (EPA), internet resource of August 1, 2022; available at: <https://www.epa.gov/climate-indicators/weather-climate>.
- Weisse, Mikaela and Elizabeth Goldman (2022). Forest Pulse: The Latest on the World's Forests. World Resource Institute, internet resource; available at: <https://research.wri.org/gfr/latest-analysis-deforestation-trends>.
- World Bank (2022). *World Development Indicators* (Washington, DC: The World Bank); as posted on the World Bank website: <http://data.worldbank.org/data-catalog/> (downloaded on January 3, 2022).