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Climate injustice and climate debts:
Estimating responsibility for climate change

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Scholarly work on climate change, in both social and natural sciences, has used the term Anthropocene to describe an epoch starting when human activities became a geological force on Earth (e.g., Crutzen 2006; Steffen et al. 2011; Lewis and Maslin 2015). However, attributing climate change to humankind in general—as the term Anthropocene suggests—may mask the unequal distribution of costs and benefits from carbon-based economies. Rather than 'humankind', capacity to alter the climate is disproportionately concentrated in wealthy countries and social groups (Malm and Hornborg 2014). Some countries and groups have overused the atmosphere's capacity to store carbon safely, producing massive negative externalities for the poor and leaving an unpaid 'bill'. Who should be held accountable for this injustice?

This policy brief addresses this question by estimating climate debts for individual countries and suggesting pathways for paying them. It starts by defining climate injustice and presenting a few of its manifestations. Next, it proposes a way of calculating climate debts and discusses how they could be paid.

1 Climate injustice

Climate injustice is one among other instances of environmental injustice, situated at the intersection of climate change and social justice issues. Climate justice belongs to the third generation of environmental justice activism, in which attention is extended to problems requiring international cooperation, and greater emphasis is given to resource distribution (Vanderheiden 2016).[1] Climate injustice spans across four dimensions of justice: distributive, procedural, retributive, and restorative. Among the multiple manifestations of climate injustice, eight are presented here.

1. Developed countries, on a per capita basis, have been the main source of accumulated carbon in the atmosphere, disproportionately exploiting a global common-pool resource and breaching planetary boundaries more than developing countries. The G7 countries have approximately 10% of the global population, but accounted for 33% of the fossil carbon emissions between 1990 and 2021.[2]

2. People in tropical areas, where 40% of the world population live, will suffer disproportionately from extreme weather events, making them more susceptible to food, water, and energy insecurity. For instance, the South American Monsoon Region is projected to experience temperature increases during the hottest days at rates 1.5 to 2 times higher than the global average (IPCC 2021, SPM-20).

3. People in low-income countries are more reliant on agriculture, forestry, and fishing than elsewhere, being thus more dependent on a stable climate.

4. Occupying large parts of the atmosphere with carbon limits others' potential use of fossil fuels, which was central in the industrialization of (currently) developed countries.

5. Developed countries possess greater resources to implement mitigation and adaptation strategies, as well as to absorb external shocks resulting from extreme weather events.

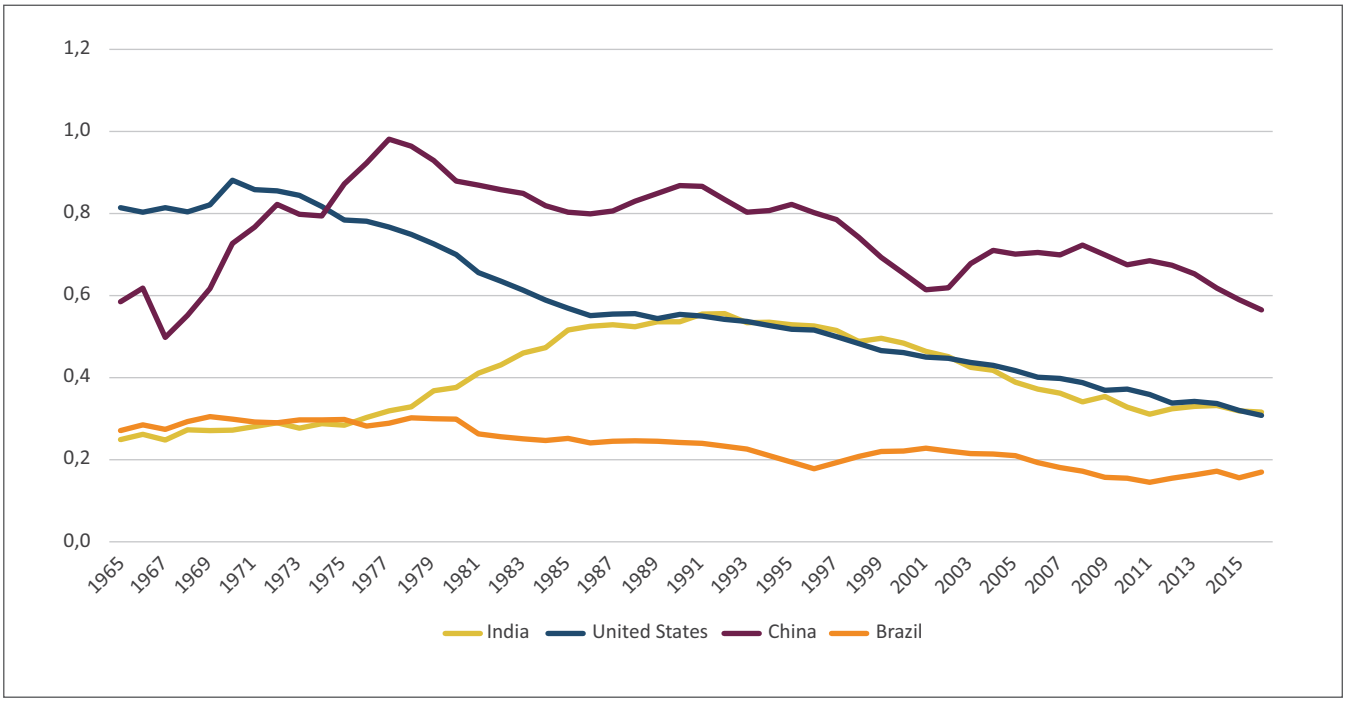
6. As those with fewer resources will be more affected by climate change, the spread of credit and insurance costs among the rich and poor tends to grow. Moreover, the failure of developed nations' governments to adhere to the 'precautionary principle' when there was still uncertainty about the impacts of carbon emissions increased the risk exposure of the poor more than their own.

7. The most vulnerable to the effects of climate change have little influence on policies that affect the climate.

8. Due to a global increase in the efficiency of energy production and use, countries that develop later have a lower carbon footprint per capita and per unit of GDP than those that developed earlier. The development of the United States, for example, had a per capita carbon footprint that Chinese, Indian or Brazilian development are unlikely to ever have. This point is observed in Figure 1, which compares CO_2 annual consumption per unit of GDP produced, showing that the environmental cost of development depends partly on *when* development happens.

FIGURE 1

CO_2 emissions per unit of GDP produced (tonnes of CO_2 per USD billion of GDP)



Note: CO_2 emissions measured per unit of gross domestic product. GDP is adjusted for inflation and cross-country price differences (PPP-adjusted).

Source: Our World in Data.

The main climate change multilateral agreements created since 1992— the UNFCCC, Kyoto Protocol, Doha Amendment, and Paris Agreement—all emphasised the higher burden of climate change on developing countries. However, these agreements have failed to address the *historical* responsibility of those who exploited the atmosphere's carbon storage capacity at the expense of others.

2 Estimating climate debts

The concept of *climate debt* is useful to operationalize the principle of climate justice in regard to compensations for loss and damage. Climate debts are calculated in this policy brief following a three-stage process. First, setting the *remaining* global carbon budget (GCB) in 1990. Given that a GCB of approximately 2,790 $GtCO_2$ is compatible with a 1.5 ºC increase in global average temperatures above pre-industrial levels with a 67% probability (IPCC 2021, SPM-38), and considering that cumulative emissions totalled 1,413 $GtCO_2$ until 1989,[3] the remaining GCB in 1990 was 1,377 $GtCO_2$. Second, calculating country-carbon budgets. This is done by distributing the remaining GCB in 1990 among countries based on their proportion of the global population, with flexibility to adjust for population changes. Third, counting emissions between 1990 and time *t*, and calculating the difference between these emissions and country-carbon budgets. This difference is equivalent to a country's climate debt at time *t*, measured in tonnes of carbon.

Country-carbon budgets are calculated according to a country's population at time *t*, as expressed in equation (1).

$$CB_{it} = Pop_{it} \times 1{,}377 \qquad (1)$$

, where CB_{it} is the remaining carbon budget of country *i* at time *t*; Pop_{it} the share of global population of country *i* at time *t*; and 1,377 the remaining global carbon budget in 1990, measured in $GtCO_2$.

Figure 2 shows the extent to which various countries have spent their carbon budgets. Figure 2a shows data for emissions from fossil fuel and cement production (consumption-based), known in the literature by the acronym E_{FOS}. Figure 2b shows data for E_{FOS} and also for emissions from land use change and deforestation, known in the literature by the acronym E_{LUC} (Friedlingstein et al. 2022). Countries are ranked according to accumulated emissions as of 2021, separating countries with climate debts from those without.

The data encompass countries with the 25 largest populations and/or GDPs in 2021, with climate debts represented in $GtCO_2$.

When considering only E_{FOS} (Figure 2a), data indicate that all major developed countries have climate debts as of 2021 (e.g., all G7 countries). The United States has overspent its carbon budget the most (312%), followed by Belgium (300%), and Canada (254%). When emissions from land use (E_{LUC}) are included (Figure 2b), a few differences emerge, especially for countries with high levels of deforestation. As of 2021, Brazil had consumed 158% of its carbon budget, Indonesia 88%, and the Democratic Republic of Congo (DRC) 70%. These findings indicate the inefficiency of deforestation in producing wealth, but also the potential for rapid reductions in carbon emissions through concerted efforts to address deforestation.

FIGURE 2 (continued on next page)
Carbon budgets, CO_2 emissions, and climate debts

FIGURE 2a. Carbon budgets, emissions, and climate debts: EFOS

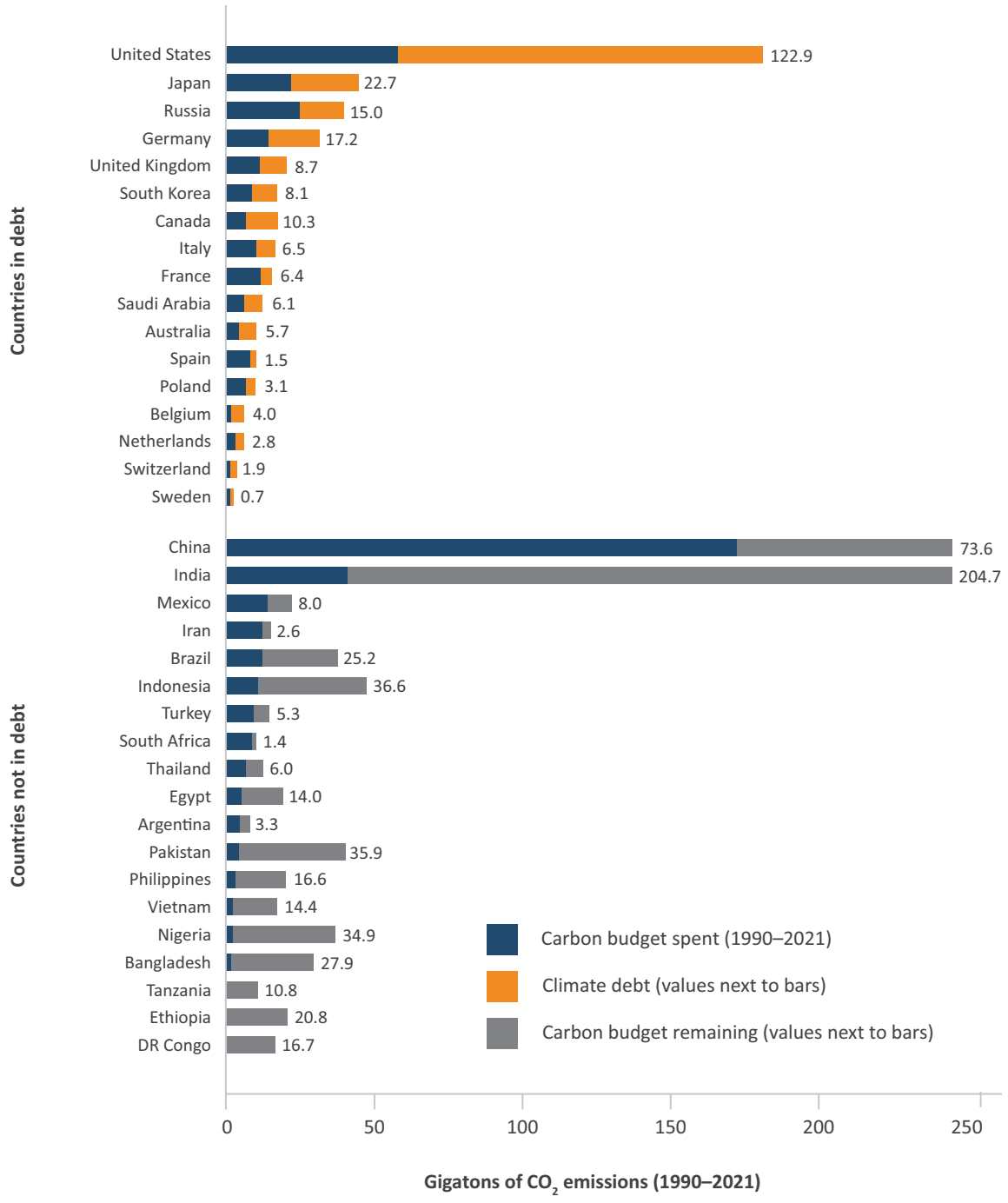
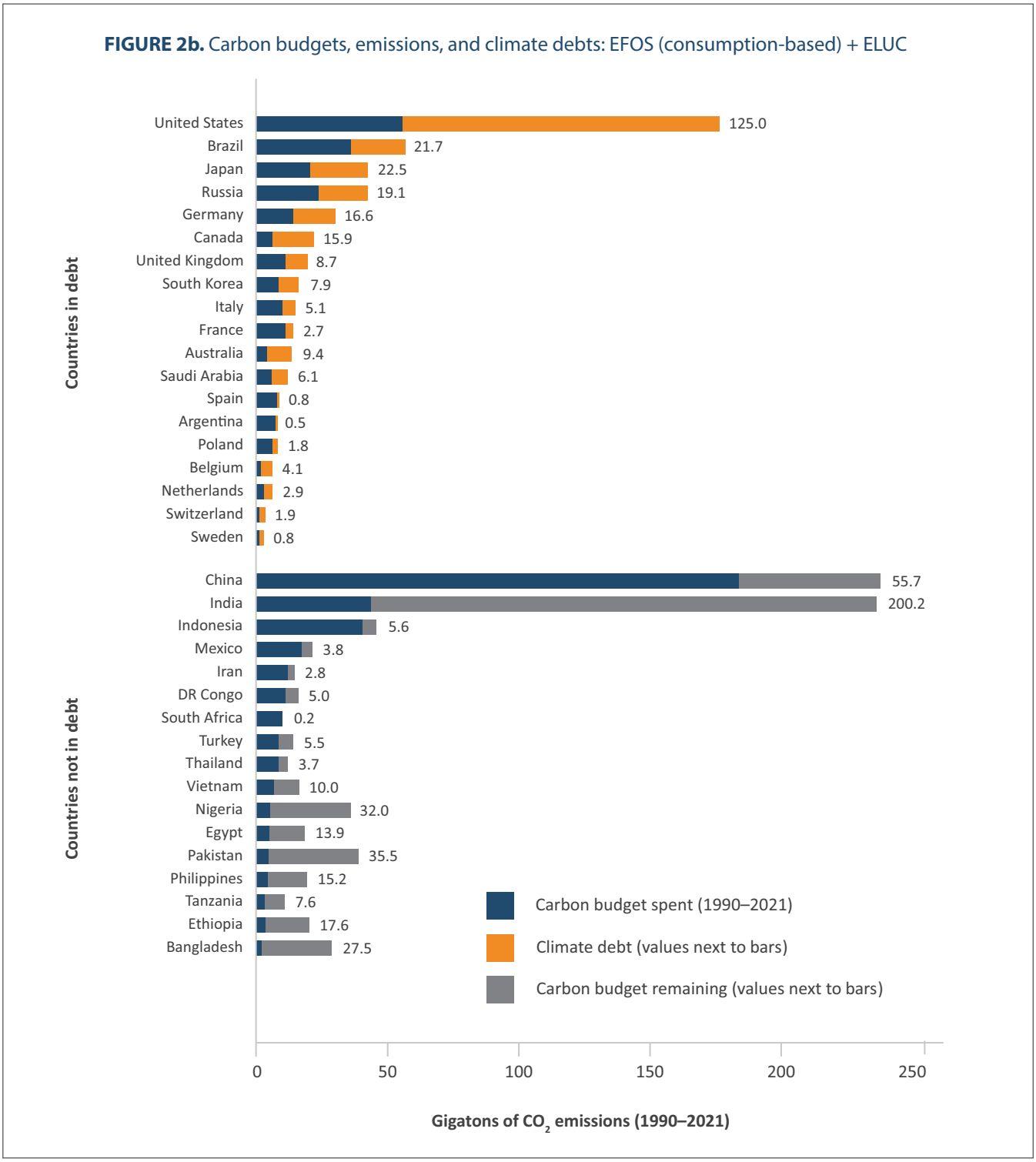


FIGURE 2 (continued)
Carbon budgets, CO_2 emissions, and climate debts



Notes: Climate debts and carbon budgets remaining as of 2021. In Figure 2a, data are consumption-based (except for the DRC, which is production-based). In Figure 2b, data are consumption-based for E_{FOS} (except for the DRC, which is production-based) and production-based for E_{LUC}. The year of 2021 was the last year with reliable data for all countries.
Source: Global Carbon Project (Friedlingstein et al. 2022) for data on emissions.

Looking forward

How could climate debts be paid? Removing carbon from the atmosphere should diminish a country's climate debt by the quantity of carbon removed, rather than by the financial expenditure on an initiative. Carbon removal could be done through reforestation or other carbon capture and storage (CCS) methods.

There should be caution though in planning and implementing large-scale afforestation and reforestation projects. They may have various unintended consequences: displacing communities, altering ecosystems, impacting biodiversity, and producing conflicts over land rights and usage. In addition, such projects do not address the main root cause of climate injustice: the

historical carbon emissions from fossil fuels. Caution is also required with other forms of CCS. For instance, capturing carbon emissions from biomass combustion and storing them underground (BECCS) brings potential biodiversity loss, impacts on food security due to competition with food production, and land-use conflicts. Overall, various CCS technologies require significant investment, which may divert resources away from renewable energy and thus delay the energy transition.

Priority should be given to provision of resources for (i) investment in low-carbon infrastructure and technologies, and (ii) adaptation. The former type of 'payment' would reduce a country's climate debt by the additional amount of carbon that would have been emitted were fossil fuels been used. In other words, the principle of *additionality* should be a guiding criterion.

The latter type of 'payment' would reduce a debt by the estimated value of damage averted. These resources are critical because low-income and various middle-income countries lack the financial and technical resources necessary to adapt to climate change. The lower the resilience to climate change, the higher the likelihood that climate change will exacerbate poverty and hinder development efforts. Resources could be used, for example, for developing early warning systems, climate-resilient infrastructure, agricultural diversification, and cash transfers. Building resilience would contribute to various other efforts, such as poverty reduction and improved health outcomes.

Moreover, reducing poverty and improving health are themselves adaptation measures, making people and communities more resilient to climate change.

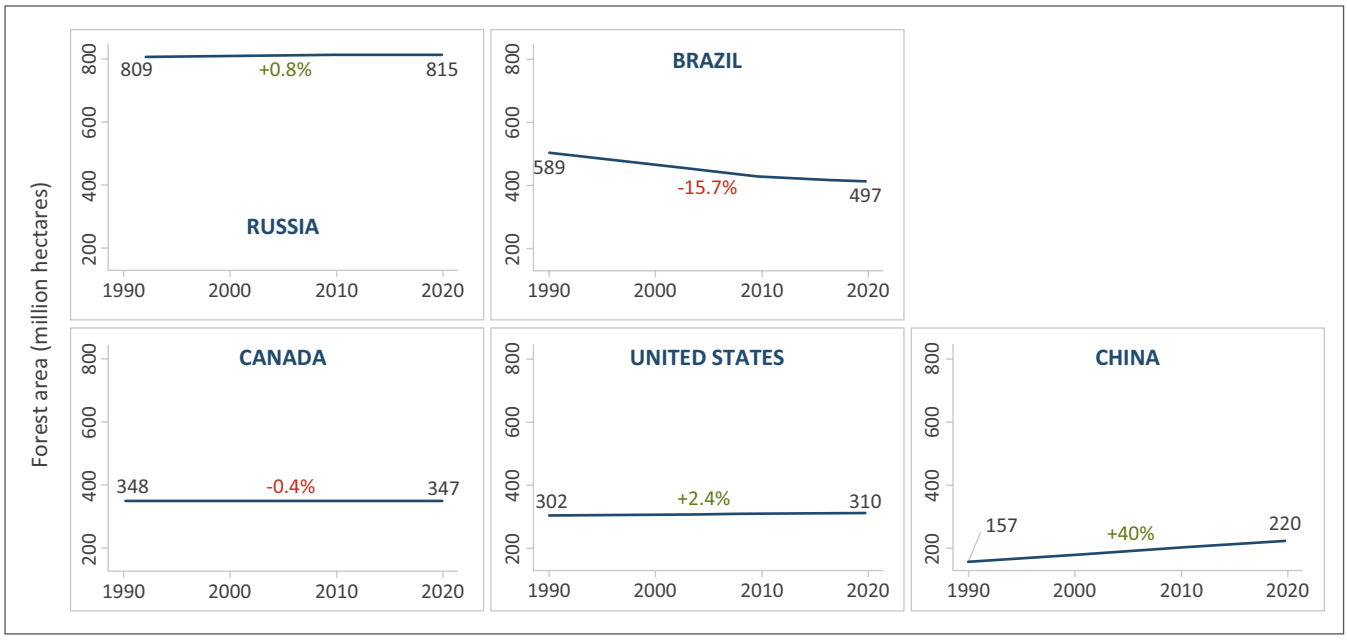
Existing organisations or funds—whether multilateral, regional, or bilateral—can be used as references for how to operationalize climate debt payments. Multilaterally, a boosted version of the UN Green Climate Fund (GCF) would combine the accountability, reach, and mobilization capacity of a mechanism within the UNFCCC architecture. The GCF finances climate change mitigation and adaptation efforts in middle- and low-income countries while also functioning as a repository of technical expertise for project formulation and implementation. The GCF can work as the hub of a network mobilizing expertise from governments, international organisations, corporations, research centres, and civil society groups. The GCF's portfolio reached USD13.5 billion in 2023.[4] This is limited for what is needed, but should change if the notion of compensations for loss and damage becomes progressively accepted as a norm.

Bilaterally and regionally, a potential model is the Amazon Fund (*Fundo Amazônia*), created in 2008 and managed by Brazil's National Development Bank (BNDES). As of 2024, the fund has received donations totalling USD1.5 billion. Donations have come from Norway (USD1.3 billion), Germany (USD106 million), the United States (USD53 million), the United kingdom (USD49 million), Switzerland (USD6 million), Japan (USD3 million), and Brazilian company Petrobras (USD8 million). Resources are earmarked for forest conservation and sustainable development promotion, primarily in the Amazon region.[5]

Specifically on deforestation, the BRICS can give a contribution, leveraging the experience of its members. While Brazil's efforts to curb deforestation have fluctuated over the past two decades, China and Russia have maintained consistent policies. Figure 3 shows the forested areas in Russia, Brazil, Canada, the United States, and China, which accounted for 54% of the global forested area in 2020. Policies in the BRICS countries could be adapted for the other BRICS and non-BRICS countries.

FIGURE 3

Forest areas: 1990–2020



Source: FAO; Our World in Data. Data for Russia are for the 1992–2020 period.

The limited capacity of low-income countries to tackle deforestation during the analysed period should be considered. A potentially equitable solution involves forgiving the climate debts of low-income countries, as well as debts linked to subsistence activities. In cases where deforestation is due to subsistence agriculture or use of traditional fuels for cooking and heating, associated debts should be pardoned. Similarly, emissions stemming from wildfires caused by climate change itself or those that could not be reasonably prevented or mitigated should also be exempted. Climate debts should thus be limited to deforestation due to large-scale cattle ranching, commercial agriculture, industrial logging, and land-grabbing. Readers should also consider three other issues: (i) the shorter carbon cycle of emissions from LUCF, (ii) the greater uncertainty in LUCF emissions estimates relative to those for emissions from fossil fuels; and (iii) data for LUCF emissions presented in this brief are production-based.

3 Conclusions

The analysis presented in this policy brief shows that major developed countries have overspent their carbon budgets. This injustice underscores the need for mechanisms to address historical responsibilities and compensate for the unequal distribution of costs resulting from carbon-intensive economies.

The estimates presented in this brief should be seen as a minimum because they do not fully capture carbon costs, and, consequently, climate injustice. Examples of costs outside this brief's scope are the loss of cultural identity, risks of violent social conflict, forced displacement, extinction of species, feedback loops that amplify impacts of carbon emissions, and impacts over the very long-term, whose quantification is not possible or at best very imprecise.

Looking forward, paying climate debts requires an approach that combines investment in low-carbon infrastructure, and support to climate change adaptation among vulnerable people and in vulnerable regions. Leveraging existing organizations and funds, such as the UN Green Climate Fund, multilateral development banks, national development banks, and the Amazon Fund, offers pathways for operationalizing climate debt payments.

Deforestation is a major source of carbon emission and an environmentally inefficient form of producing wealth, meaning that addressing it is a critical opportunity to cut emissions and move towards more efficient forms of producing wealth.

1. In the first generation, campaigners focused on the injustice faced by poor communities due to local environmental problems. In the second generation, campaigners demanded greater participation of vulnerable groups in decision-making and the overall reduction of hazardous wastes, replacing a 'not in my backyard' approach with a 'not in anyone's backyard' approach (Vanderheiden 2016).
2. Consumption-based emissions. Source: Global Carbon Project.
3. Source: Global Carbon Project.
4. Available at: <https://www.greenclimate.fund/annual-report-2023>.
5. Source: Fundo Amazônia. Available at: <https://www.fundoamazonia.gov.br/pt/doacoes>. Up to 20% of resources from the Amazon Fund can be used to tackle deforestation in other Brazilian biomes or tropical rainforests in other countries.

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