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Brockhaus, M., De Sy, V., Di Gregorio, M. orcid.org/0000-0003-2545-217X et al. (4 more authors) (2024) Data and information in a political forest: The case of REDD+. Forest Policy and Economics, 165. 103251. ISSN 1389-9341

https://doi.org/10.1016/j.forpol.2024.103251

Data and information in a political forest: the case of REDD+

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Key words: deforestation, transparency, monitoring, remote sensing, forest governance, politics, power, REDD+

Highlights:

1 We use REDD+ and data on drivers of deforestation and measures of performance to unpack the politics in policy processes.

2. Deciding what is counted (or not) and how regarding deforestation and who does the counting is fundamentally political.

3. Technological advances in remote sensing and beyond are a necessary yet insufficient condition for changing the business as usual of deforestation - and deforestation politics.

4. Examining systematic silences in data and information can enable policy alternatives towards more equitable futures.

Abstract

Data and information are central to policy processes, as they frame the policy problem, the design and the implementation of policy, and evaluation of policy impacts. Better data and information infrastructure is expected to lead to better policies and outcomes, for example, by enabling transparent decision making and enhancing capacity and accountability. However, the collection, selection, representation, framing and application of data are not merely technical and apolitical procedures, but are dependent on the interests represented in the policy processes they aim to inform. Social scientists have pointed to the "politics of numbers" and their effects on forests and trees and on the people relying on them, as well as on those involved in their measurements. We use the case of the Reducing Emissions from Deforestation and Forest Degradation (REDD+) international initiative and focus on the central aspect of understanding drivers of deforestation and measures of REDD+ performance to unpack the politics of policy processes. Data and information are socially constructed, and their interpretations are shaped by the contexts in which they emerge. Dominant beliefs in the transformative power of new data and technologies cannot explain why, often, new information does not translate into policy change and action to halt deforestation. Technological advances in making new and ever larger amounts of data available for analysis are a necessary yet insufficient condition for changing the business as usual in deforestation. Through openness, reflexivity and the tackling of silences in data and information related to the global political economy of deforestation the scientific community can make a key contribution to more equitable policy change.

1. Introduction

Collecting, interpreting and sharing data and information are central features of contemporary policy processes as they can enable learning and policy change across different domains. Data in the form of facts and figures, are organised and contextualised into information, which is then used in all stages of the policy process. This is an inherently political process, particularly so in environmental policy arenas that are characterised by multiple actors, diverse interests and beliefs, and diverse power, operating within and across numerous governance levels (Turnhout 2018, Brockhaus and Angelsen 2012). Forest-based climate change mitigation and the case of Reducing emissions from deforestation and forest degradation in developing countries, and other related activities (REDD+), is such a complex multi-level policy arena. Here, data and how they are transformed in information are fundamental tools that shape the very understanding of what drives deforestation, decisions over which REDD+ policies and measures can best contribute to reducing deforestation and what are useful measures of performance of forest and climate governance in the Global North and South - fundamentally defining who gets paid how much for what activity.

There is a risk that forest and climate policy processes (e.g. REDD+) – like other global forest governance initiatives before – render technical what many scholars consider to be an ultimately political and politico-economic problem: large-scale forest loss in the Global South (Peluso and Vandergeest 2001; Moeliono et al. 2020; Peluso and Vandergeest 2020; Skutsch and Turnhout 2020). In doing so, it hides any question of global justice, especially when data and information is silent about who receives the benefits when trees are cut or kept standing, and who bears the burden of any associated costs (Okereke and Dooley 2010; Brockhaus et al. 2021). We argue that bringing out the political dimensions of information, the 'politics of numbers', on deforestation in the Global South and its drivers can help to address effectiveness, efficiency, and - in particular - equity (the 3Es), when decisions are made on whom to target with policies and measures, what to change, where to implement and what activities to track when tackling deforestation and its drivers and agents.

The purpose of this commentary is to exemplify central aspects of the politics of numbers for the case of the REDD+ policy processes and to critically examine implications of these for the 3Es in REDD+ policy outcomes. We focus on the risks posed by the current politics of data and information on drivers of deforestation. Our choice does not mean we are ignorant of the astonishing technical advances in the field or the increasing capacities in forest monitoring, reporting and verification arguably enabled largely through REDD+ and other policy investments. Rather, we choose this positioning to draw attention to the unbalanced power relations and policy implications of how deforestation data are used in order to put social and environmental justice centre-stage (Klinsky et al. 2017). We conclude by proposing pathways for forest policy and science that take into account and respond to the politics of numbers in the political forest.

2. Data and information as an agent of change?

A commonly held premise is that (new) data and information is a powerful agent of change. Improved knowledge about the state of forests, drivers of forest change, policy options and associated trade-offs can guide policy approaches away from deforestation and forest degradation, for example when tracking the New York Declaration forest goals (Forest Declaration Assessment Partners 2023). The underlying assumption is that new or better data gained through new technologies, improved capacities, data consistency and uniform reporting will increase knowledge, transparency and overall efforts to keep trees and forests standing. This in turn will, presumably, lead to more accountability of government and corporations, and empowerment of Indigenous Peoples and local communities. It should also support better performance of policies and measures, as the assumption goes (Mason 2008; Florini 2007), including in efforts to reduce emissions from the land use sector (De Sy et al. 2018).

This common positive linear techno-economic or techno-ecological framing tend to depoliticize the understanding of science-policy interactions (Myers et al. 2018; Waller et al. 2020). Evidence suggests that reality does not necessarily match this ideal of rational planning and governance (Porter 2020). The setting of research agendas, with data collection and translation into information and disclosure is often biased in favour of the interests of those in power (Mason 2008; Ojanen et al. 2021). Furthermore, transparency of data can be either empowering or disempowering depending on who is engaged in the process and its purpose (Gupta et al. 2014; Romijn et al. 2018). Porter (2020) notes that science is a social construction, and that claims of data and information as being political are often misunderstood – also by those providing the information and data. We argue that acknowledging the political nature of data and information is a first step towards achieving effective, efficient, and equitable policy outcomes – to not do so would hamper learning and a meaningful engagement with the different interests at play. In the following we will explore how politics of numbers related to deforestation in the Global South have evolved with evolving technologies, and have shaped past and present policies, including REDD+.

3. Data and (new) information on drivers for policies to halt deforestation?

Only a few decades ago, deforestation in the Global South was assessed mainly by the Food and Agricultural Organization (FAO) through its regular forest resource assessments (FRAs), conducted since 1948 (FAO 2018). Since the early 1950s the international headquarters of the Food and Agriculture Organization (FAO) in Rome, Italy are located in the very same building that in the 1930s during Italy's fascist regime was the seat of the Ministry of Italian Africa, later renamed the Ministry of the Colonies, which was abolished in 1953. FAO's forest resource assessments were criticised for several reasons, beyond the colonial legacy and the symbolic meaning of the building choice. For example, the lack of continuous forest surveys in the countries meant that deforestation rates in the 1980s for most countries in the Global

South were estimated based on the proxy of changes in rural population densities. Unsurprisingly, using those data in statistical analyses of the causes of deforestation led to a perfect fit between deforestation rates and population growth. Scholars and technical personnel often failed to realise the flaw in the data and associated analyses as pointed out by Rudel and Roper (1997), leading to a collective failure to reflect on the implications of these limitations, as a historic review of 70 years of FRA reporting suggested (FAO 2018).

In recent decades, the understanding of the primary drivers of tropical deforestation and forest degradation has shifted away from simplistic Malthusian explanations of deforestation as caused by the needs and poverty of a growing population and perceived low productivity of shifting cultivation and smallholdings. Numerous studies point to the political economy of deforestation and the associated important and often dominant role of (large) commercial actors and growing demand for forest and agricultural products from global markets to the political economy of deforestation. In the literature, a major 'myth-busting' took place at the end of the last century, as more attention was given to underlying causes and distant agents of deforestation, such as global export markets and growing urban demand (Angelsen 1999; Angelsen and Kaimowitz 1999; Lambin et al. 2001; Rudel 2007). Another important turn in the literature examined the "political forest" and how state territorialization of forested land in colonial and postcolonial regimes has laid the basis for the political economy of deforestation (Devine and Baca 2020; Peluso and Vandergeest 2020, Scott 1998). In Latin America and Southeast Asia, agribusinesses (cattle ranching, soybean farming and oil palm plantations) were identified as the main agents of post-1990 deforestation (Rudel et al. 2009; Boucher et al. 2011; De Sy et al. 2015; De Sy et al. 2019). On the African continent, despite continued focus on smallholders as drivers (Curtis et al. 2018), large-scale land acquisitions and forestland conversion are on the rise (Conigliani et al. 2018; Davis et al. 2020; Molinario et al. 2020). The crucial underlying drivers come from an increasingly globalized economy and international demand for forestry and agricultural commodities, and mining for valuable minerals (Pendrill et al. 2019; Giljum et al. 2022).

Technological advances in remote sensing allowed to move away from what at times seemed to be arbitrary or politically driven reporting towards more transparent measures of real-time forest cover of high spatial detail (Hansen et al. 2013; Achard et al. 2014; Reiche et al. 2021; Vancutsem et al. 2021). Such developments make it harder to outright dismiss inaccurate deforestation data, as observed in Brazil during the Bolsonaro regime1. Spatial assessments using remote sensing and ground data (e.g., national forest inventories) can link forest changes to specific land use activities or sectors and thus assess the effectiveness of efforts to curb emissions from forest conversion. While a number of local (Müller et al. 2013; Bos et al. 2020),

[1] https://news.mongabay.com/2019/07/brazilian-amazon-deforestation-surge-is-real-despite-bolsonaros-denial-commentary/ last accessed.7 May 2024.

national (Khuc et al. 2018, Masolele et al., 2022) and continental (De Sy et al. 2019, Song et al., 2021, Popatov et al., 2022) studies have assessed proximate and underlying drivers, appropriate methodologies for national-scale operational monitoring of drivers are still limited (De Sy et al. 2012). In addition, remote sensing cannot fully differentiate land cover (change) from land use (change). For example, remote sensing analysis might show that forest was converted to shrubland, but it will not necessarily give insight into the use of this shrubland (e.g., low intensity grazing versus "idle" land converted for speculation) (De Sy et al. 2019, Pendrill et al., 2021). Recent advances in computing technology and deep learning methods provide opportunities for automated large-scale assessment of land use dynamics following tropical deforestation at more detailed thematic, spatial and temporal scales (Masolele et al. 2021, Masolele et al. 2024), which might help to understand deforestation patterns more coherently, but does not translate directly into an understanding of proximate drivers and more importantly underlying drivers of deforestation, and the question of who is responsible.

Underlying causes, their interactions and relative contributions, need to be analysed and assessed with a combination of spatially explicit socioeconomic data and other empirical evidence (Kissinger et al. 2012; Meyfroidt et al. 2013; Goetz et al. 2015). Spatially explicit assessments of proximate drivers of forest change (De Sy et al, 2019, Masolele et al., 2024) in combination with analyses of underlying drivers can provide better insight into land use change, including emission displacement or leakage (Meyfroidt et al. 2020) and carbon footprints from commodity supply chains (Zaks et al. 2009; Karstensen et al. 2013, zu Ermgassen et al. 2020), as well as avoid misclassifications and misinterpretations of complex land uses such as shifting cultivation (Curtis et al. 2018). However, the causal attribution and quantification of the impact of various sectors and underlying drivers of land use (change) and forest emissions remain major shortcomings. As underlying drivers increasingly influence local land use from afar (Meyfroidt et al. 2020) through trade, investments and complex commodity chains (Henders et al. 2018) and have a global scope (Geist and Lambin 2002; Rudel et al. 2009; Boucher et al. 2011), remote sensing might reach its limits. Consequently, broader monitoring and tracking of drivers at the international level, combined with context-specific information, is vital to understanding the underlying drivers of tropical deforestation and inform policy (Lambin and Furumo 2023).

Yet, gaps and limits in monitoring capacities and in driver-, agent-, and sector-specific understandings can also serve as a convenient excuse to engage in tactics of political inaction and delayed implementation, when missing data and resulting silence is convenient to continue business-as-usual, or when much attention is given to what is not known, rather than advancing action on what is known (Carton et al. 2020), for example regarding action to reduce spillover effects and displacement of emissions from the Global North to the South or efforts to divest from deforestation driving activities.

4. Equity, power and deforestation politics at different stages of the policy process

As argued above, the political economy of deforestation shapes and is shaped by information and data in numerous ways. We observe institutional stickiness supporting business-as-usual, rather than policy change in favour of retention of primary forest and support of local people and livelihoods, for example, when colonial rules and benefit structures persist (Assembe et al 2013; Pietarinen et al. 203) and formal power to monitor and report on deforestation and reforestation rests with government structures that are linked to entrenched business-as-usual interests (Brockhaus et al. 2012; Windey and Van Hecken 2019; Dkamela et al. 2014), as was the case for Indonesia's reforestation fund (Barr et al. 2010). Data and information are routinely used selectively to represent and advance specific interests, for example, when choices are made in setting reference levels (West et al. 2023) or regarding the persistent absence of spatial data collection and reporting about new land acquisitions and large-scale land investments (Davis et al. 2020). The choice of performance indicators that measure success in efforts to halt deforestation often reflect stickiness of particular ideas and associated narratives as well as institutions that blame specific social groups and have been dominant since colonial times (Wong et al 2022; Arts et al. 2019; Di Gregorio et al. 2015, 2017). Resulting alleged policy solutions, such as "reducing birth rates of African women" (Searchinger et al. 2019) or the sedentarization of shifting cultivators and pastoralists (e.g. Choudhury et al. 2021) reflect ideas of blame that risk to stigmatise those that in fact often already carry the costs of deforestation (Brockhaus et al. 2021).

We also argued that data and information are crucial elements in REDD+ policy processes across all four critical stages of the policy cycle: (i) In REDD+ problem definition and agenda setting, tropical deforestation is mainly defined as a 'global' policy problem, yet blame most often falls on forest dependent communities, and such views then define policy makers agendas (Skutsch and Turnout 2020; Di Gregorio et al. 2013); (ii) in REDD+ policy design, starting condition, as well as solutions and desired futures are modelled and promoted without transparency over the underlying assumptions and worldviews (Loft et al. 2017, Luttrell et al 2013), (iii) in the implementation of REDD+ policies and measures, rules are enforced on those who are blamed for the problem leading to inequitable burden sharing (Wong et al. 2019) and (iv) in REDD+ policy evaluation stakes are very high because performance measurement determine results-based payments and overestimation of emission reduction have been the norm in unregulated markets (Rifai et al. 2015; West et al. 2023). From this perspective, data and information represent a source of power for powerful business-as-usual interests, but at the same time it can be a potential tool for change in these status quo. The politics of numbers of who counts what and who selects, packages and feeds information and how across all policy stages in environmental policy domains (see Figure 1). They define how environmental problems are understood, and which solutions are deemed the best, what and who is problematised, irrespective of being effective, efficient or equitable. When asking whose

reality counts, Chambers (1986:17) points out that "counting promotes the counter and demotes the counted." Indeed, to paraphrase Albert Einstein, not all that counts is actually counted, nor are those that count necessarily taken into account. Rather, those that 'should' count, for example indigenous people and local communities, are often ignored, or simply overlooked in policy processes (Radcliffe and Radhuber 2020).

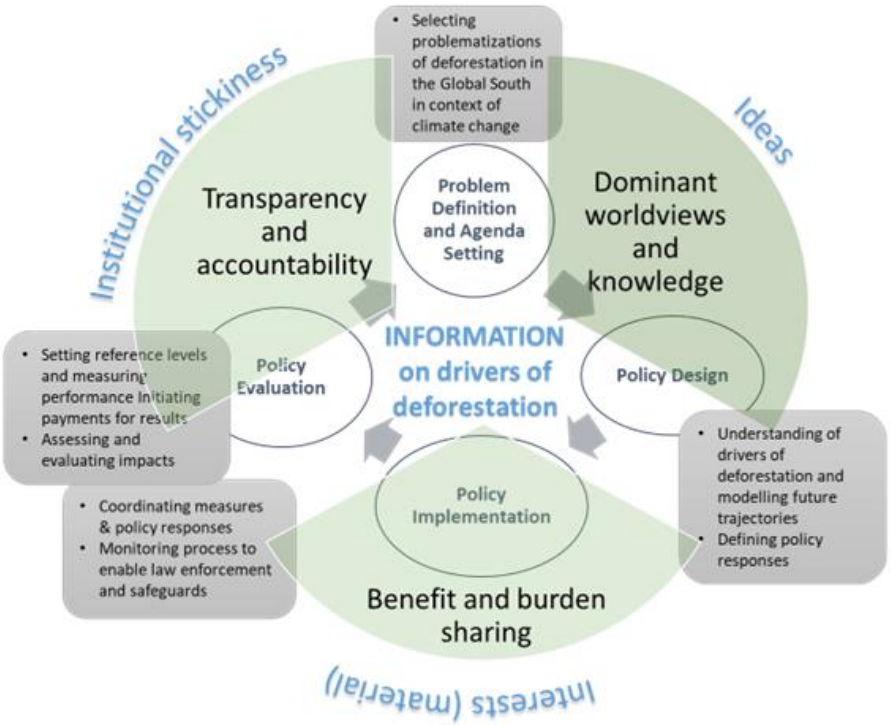

Figure 1: Information, Institutional stickiness, Interests, Ideas and the policy cycle: deforestation policies and underlying equity dimensions

The Figure (1) highlights how, in the context of REDD+, the political dimensions of data and information directly affect equity through a wide array of actions (problematising, defining, coordinating, monitoring, reference level setting, and assessing), as well as effectiveness and cost-efficiency. The figure shows the various political dimensions in a stylized REDD+ policy cycle: dominant worldviews and beliefs define what or who is problematized when REDD+ agendas are set and policies are designed; benefits and burdens are determined by both the problem framing and by what is, and what can be, measured as policies are implemented; and transparency and accountability questions come to the forefront when policies and outcomes are assessed and evaluated, including when they are not. For example, countries' efforts to effectively, efficiently and equitably halt deforestation might be jeopardized when dominant REDD+ discourses, policies and measures focus on smallholders, while ignoring large-scale drivers of deforestation (Salvini et al. 2014; Weatherley-Singh and Gupta 2015; Weatherley-Singh and Gupta 2018; Windey and Van Hecken 2019; Pham Thu et al. 2020; Delabre et al. 2020; Skutsch and Turnhout 2020) and when reference level setting becomes arbitrary or

subject to systematic biases (Angelsen 2017). The inherently political decisions over what data and information is produced and used in the policy process, affect both the cost-efficiency and effectiveness of REDD+, supply chain and other anti-deforestation measures (Gardner et al 2019), with clashes of belief systems and habits among those measuring often resulting in shallow implementation rather than transformation (Ochieng et al. 2018; De Sy et al. 2019). However, the biggest concerns regarding data and information on REDD+ relate to equity. Questions such as: "Transparency for whom?" and "Accountability towards whom?" (Forsyth and Walker 2008) reveal just some of the pros and cons in the advancement of remote sensing. Equity comes to the forefront when we ask whose worldviews matter in defining the (il)legality of deforestation, or how international bodies such as the FAO as well as national governments define forests in the first place- e.g. whether they include or not plantations - affects what counts as deforestation and what counts as REDD+ progress. Equity outcomes, beyond effectiveness and efficiency of emission reductions, are co-determined by who decides what is measured, who owns the technology and algorithm employed (Gupta et al. 2012; Gupta and Mason 2016), who is blamed for deforestation and forest degradation and whose voice is the loudest (Brockhaus et al. 2014). What is chosen to be measured contributes to determine the distribution benefits and burden of (REDD+) policies and measures (Dwisatrio et al. 2021; Pham Thu et al. 2020; Delabre et al. 2020; Skutsch and Turnhout 2020; Arts et al 2024).

Investigating these questions leads us into a "political forest", where forest science and expertise serve selected powerful interests that have long benefitted from deforestation especially where scientific forestry models developed in the Global North are promoted in neocolonial regimes (Peluso and Vandergeest 2020; Wong et al. 2022). The political dimensions of data and information are most often overlooked and ignored when policy problems are represented or managed as exclusively technical problems, as has been the case for REDD+ (Li 2007; Myers et al. 2018; Moeliono et al. 2020).

5. Conclusion

New technologies, data and information are necessary yet insufficient conditions for transforming forest and land use policy and practice away from the business-as-usual trends of deforestation. Politics and power relations shape numbers, data and information, and the infrastructures that produce and reproduce them. The physical structures in the making of numbers, the history of organisations and institutions involved, the guidelines and rules used, the funding provided, and the practices applied when data are collected and analysed all reflect selected interests and dominant narratives around forests d in the Global South. They define what is counted, how, when, where and by whom. Data availability is of great importance, but draws attention nearly exclusively to specific time periods (e.g., available satellite images), localities, resolution, and activities for which these data are available. Conversely, politics and power relations also determine the absence of key data and information, implicit decisions over

what not to count and how to interpret silences, complexities, fluidities, and simmering struggles in the political forest.

In this commentary, we have unpacked some of the politics underlying efforts to halt deforestation for the case of REDD+. Information and data both construct and reinforce a political forest and create trade-offs between effectiveness, efficiency and equity throughout the REDD+ policy process, from agenda setting to design, implementation and evaluation. In practice, this means that political will – and willingness to acknowledge and engage with the politics and power asymmetries about what is measured and what is not – requires those providing data and information to have the awareness about and the courage to see themselves within the broader political economy of deforestation. Demonstrating awareness and openness over underlying assumptions and ideas when modelling and measuring deforestation; exercising reflexivity over the implications of current as well as past data collection, analyses, and uses of information; and tackling the silences in data and information related to the complex spatial and temporal connections in global land use systems are initial contributions that the scientific community ought to provide to ensure that REDD+ related information is useful for more effective, efficient and equitable policy change.

Acknowledgements

We are very grateful for the input we received from colleagues throughout the process of writing this manuscript. In particular, we would like to acknowledge Toby Gardner, Moira Moeliono, Mawa Karambiri, and Alizee Ville We would also like to thank Hannah Ehrlichmann for her support in preparing the manuscript. We are especially thankful to the anonymous reviewers for their very helpful comments on this manuscript. This research is part of CIFOR's Global Comparative Study on REDD+ (www.cifor.org/gcs). The funding partners that have supported this research include the Norwegian Agency for Development Cooperation (Norad), the European Commission (EC), the International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), and the CGIAR Research Program on Forests, Trees and Agroforestry (CRP-FTA), with financial support from the donors contributing to the CGIAR Fund. Monica Di Gregorio is affiliated with the Centre for Climate Change Economics and Policy (CCCEP) (ESRC grant number ES/K006576/1). Maria Brockhaus received funding from the Volkswagen Foundation grant no. 96964. Grace Y. Wong received funding from the Research Institute for Humanity and Nature, project no. 14200149.

References

Achard, Frédéric, René Beuchle, Philippe Mayaux, Hans-Jürgen Stibig, Catherine Bodart, Andreas Brink, Silvia Carboni, Baudouin Desclée, François Donnay, and Hugh D Eva. 2014. 'Determination of Tropical Deforestation Rates and Related Carbon Losses from 1990 to 2010'. Global Change Biology 20 (8): 2540–54.

Angelsen, Arild, and David Kaimowitz. 1999. 'Rethinking the Causes of Deforestation: Lessons from Economic Models'. The World Bank Research Observer 14 (1): 73–98.

Angelsen, Arild. 1999. 'Agricultural Expansion and Deforestation: Modelling the Impact of Population, Market Forces and Property Rights'. Journal of Development Economics 58 (1): 185–218.

———. 2017. 'REDD+ as Result-based Aid: General Lessons and Bilateral Agreements of Norway'. Review of Development Economics 21 (2): 237–64.

Arts, B., Brockhaus, M., Giessen, L., & McDermott, C. L. (2024). The performance of global forest governance: Three contrasting perspectives. Forest Policy and Economics, 161, 103165.

Arts, Bas, Verina Ingram, and Maria Brockhaus. 2019. 'The Performance of REDD+: From Global Governance to Local Practices'. Forests. MDPI.

Assembe-Mvondo, S., Brockhaus, M., & Lescuyer, G. (2013). Assessment of the effectiveness, efficiency and equity of benefit-sharing schemes under large-scale agriculture: Lessons from land fees in Cameroon. The European Journal of Development Research, 25, 641-656.

Barr, Christopher, Ahmad Dermawan, Herry Purnomo, and Heru Komarudin. 2010. Financial Governance and Indonesia's Reforestation Fund during the Soeharto and Post-Soeharto Periods, 1989–2009: A Political Economic Analysis of Lessons for REDD+. Vol. 52. CIFOR.

Bos, Astrid B, Veronique De Sy, Amy E Duchelle, Stibniati Atmadja, Sytze De Bruin, Sven Wunder, and Martin Herold. 2020. 'Integrated Assessment of Deforestation Drivers and Their Alignment with Subnational Climate Change Mitigation Efforts'. Environmental Science & Policy 114: 352–65.

Boucher, Doug, Pipa Elias, Katherine Lininger, Calen May-Tobin, Sarah Roquemore, and Earl Saxon. 2011. 'The Root of the Problem: What's Driving Tropical Deforestation Today?' The Root of the Problem: What's Driving Tropical Deforestation Today?

Brockhaus, M., Di Gregorio, M., & Mardiah, S. (2014). Governing the design of national REDD+: An analysis of the power of agency. Forest Policy and Economics, 49, 23–33.

Brockhaus, Maria, and Arild Angelsen. 2012. 'Seeing REDD+ through 4Is: A Political Economy Framework'. Analysing REDD+: Challenges and Choices. Center for International Forestry Research, Bogor, Indonesia, 15–30.

Brockhaus, Maria, Krystof Obidzinski, Ahmad Dermawan, Yves Laumonier, and Cecilia Luttrell. 2012. 'An Overview of Forest and Land Allocation Policies in Indonesia: Is the Current Framework Sufficient to Meet the Needs of REDD+?' Forest Policy and Economics 18: 30–37.

Brockhaus, Maria, Monica Di Gregorio, Houria Djoudi, Moira Moeliono, Thuy Thu Pham, and Grace Y Wong. 2021. 'The Forest Frontier in the Global South: Climate Change Policies and the Promise of Development and Equity'. Ambio 50: 2238–55.

Carton, Wim, Adeniyi Asiyanbi, Silke Beck, Holly J Buck, and Jens F Lund. 2020. 'Negative Emissions and the Long History of Carbon Removal'. Wiley Interdisciplinary Reviews: Climate Change 11 (6): e671.

Chambers, Robert. 1986. 'Normal Professionalism, New Paradigms and Development'.

Choudhury, Dhrupad, Sanjeev Bhuchar, Samuel Thomas, Dhrupad Choudhury, Sanjeev Bhuchar, and Samuel Thomas. 2021. 'Transitioning Shifting Cultivation to Resilient Farming Systems in South and Southeast Asia'. Resource Book. ICIMOD.

Conigliani, Caterina, Nadia Cuffaro, and Giovanna D'Agostino. 2018. 'Large-Scale Land Investments and Forests in Africa'. Land Use Policy 75: 651–60.

Curtis, Philip G, Christy M Slay, Nancy L Harris, Alexandra Tyukavina, and Matthew C Hansen. 2018. 'Classifying Drivers of Global Forest Loss'. Science 361 (6407): 1108–11.

Davis, Kyle Frankel, Heejin Irene Koo, Jampel Dell'Angelo, Paolo D'Odorico, Lyndon Estes, Laura J Kehoe, Milad Kharratzadeh, Tobias Kuemmerle, Domingos Machava, and Aurélio de Jesus Rodrigues Pais. 2020. 'Tropical Forest Loss Enhanced by Large-Scale Land Acquisitions'. Nature Geoscience 13 (7): 482–88.

De Sy, Veronique, Martin Herold, Frédéric Achard, Gregory P Asner, Alex Held, Josef Kellndorfer, and Jan Verbesselt. 2012. 'Synergies of Multiple Remote Sensing Data Sources for REDD+ Monitoring'. Current Opinion in Environmental Sustainability 4 (6): 696–706.

De Sy, Veronique, Martin Herold, Frederic Achard, René Beuchle, JGPW Clevers, Erik Lindquist, and Louis Verchot. 2015. 'Land Use Patterns and Related Carbon Losses Following Deforestation in South America'. Environmental Research Letters 10 (12): 124004.

De Sy, Veronique, Martin Herold, Frederic Achard, Valerio Avitabile, Alessandro Baccini, Sarah Carter, Jan G P W Clevers, Erik Lindquist, Maria Pereira, and Louis Verchot. 2019. 'Tropical Deforestation Drivers and Associated Carbon Emission Factors Derived from Remote Sensing Data'. Environmental Research Letters 14 (9): 094022.

De Sy, Veronique, Martin Herold, Maria Brockhaus, Monica Di Gregorio, and Robert M Ochieng. 2018. 'Information and Policy Change: Data on Drivers Can Drive Change–If Used Wisely'. Transforming REDD+.

Delabre, Izabela, Emily Boyd, Maria Brockhaus, Wim Carton, Torsten Krause, Peter Newell, Grace Y Wong, and Fariborz Zelli. 2020. 'Unearthing the Myths of Global Sustainable Forest Governance'. Global Sustainability 3: e16.

Devine, Jennifer A, and Jenny A Baca. 2020. 'The Political Forest in the Era of Green Neoliberalism'. Antipode 52 (4): 911–27.

Di Gregorio, M., Brockhaus, M., Cronin, T., Muharrom, E., Mardiah, S., & Santoso, L. (2015). Deadlock or transformational change? Exploring public discourse on REDD+ across seven countries. Global Environmental Politics, 15(4), 63–84.

Di Gregorio, M., Gallemore, C. T., Brockhaus, M., Fatorelli, L., & Muharrom, E. (2017). How institutions and beliefs affect environmental discourse: Evidence from an eight-country survey on REDD+. Global Environmental Change, 45, 133–150.

Di Gregorio, Monica, Maria Brockhaus, Tim Cronin, Efrian Muharrom, Levania Santoso, Sofi Mardiah, and Mirjam Büdenbender. 2013. 'Equity and REDD+ in the Media: A Comparative Analysis of Policy Discourses'. Ecology and Society 18 (2).

Dkamela, G. P., Brockhaus, M., Djiegni, F. K., Schure, J., & Mvondo, S. A. (2014). Lessons for REDD+ from Cameroon's past forestry law reform: a political economy analysis. Ecology and Society, 19(3).

Dwisatrio, B., Said, Z., Permatasari, A. P., Maharani, C., Wijaya, A., Lestari, A. A., Yuwono, J., & Thuy, P. T. (2021). The context of REDD+ in Indonesia.

Florini, Ann. 2007. 'The Battle over Transparency'. In The Right to Know: Transparency for an Open World, 1–16. Columbia University Press.

Food and Agriculture Organization of the United Nations. 2018. 1948-2018: Seventy Years of FAO's Global Forest Resources Assessment. Rome, Italy.

Forest Declaration Assessment Partners. (2023). Off track and falling behind: Tracking progress on 2030 forest goals. Climate Focus (coordinator and editor). Accessible atwww.forestdeclaration.org.

Forsyth, Tim, and Andrew Walker. 2008. Forest Guardians, Forest Destroyers: The Politics of Environmental Knowledge in Northern Thailand. University of Washington Press.

Gardner, T. A., Benzie, M., Börner, J., Dawkins, E., Fick, S., Garrett, R., Godar, J., Grimard, A., Lake, S., & Larsen, R. K. (2019). Transparency and sustainability in global commodity supply chains. World Development, 121, 163–177.

Geist, Helmut J, and Eric F Lambin. 2002. 'Proximate Causes and Underlying Driving Forces of Tropical Deforestation: Tropical Forests Are Disappearing as the Result of Many Pressures, Both Local and Regional, Acting in Various Combinations in Different Geographical Locations'. BioScience 52 (2): 143–50.

Giljum, Stefan, Victor Maus, Nikolas Kuschnig, Sebastian Luckeneder, Michael Tost, Laura J Sonter, and Anthony J Bebbington. 2022. 'A Pantropical Assessment of Deforestation Caused by Industrial Mining'. Proceedings of the National Academy of Sciences 119 (38): e2118273119.

Goetz, Scott J, Matthew Hansen, Richard A Houghton, Wayne Walker, Nadine Laporte, and Jonah Busch. 2015. 'Measurement and Monitoring Needs, Capabilities and Potential for Addressing Reduced Emissions from Deforestation and Forest Degradation under REDD+'. Environmental Research Letters 10 (12): 123001.

Gupta, Aarti, and Michael Mason. 2016. 'Disclosing or Obscuring? The Politics of Transparency in Global Climate Governance'. Current Opinion in Environmental Sustainability 18: 82–90.

Gupta, Aarti, Eva Lövbrand, Esther Turnhout, and Marjanneke J Vijge. 2012. 'In Pursuit of Carbon Accountability: The Politics of REDD+ Measuring, Reporting and Verification Systems'. Current Opinion in Environmental Sustainability 4 (6): 726–31.

Gupta, Aarti, Marjanneke J Vijge, Esther Turnhout, and Till Pistorius. 2014. 'Making REDD+ Transparent: The Politics of Measuring, Reporting and Verification Systems'. Transparency in Global Environmental Governance: Critical Perspectives, 181–201.

Hansen, Matthew C, Peter V Potapov, Rebecca Moore, Matt Hancher, Svetlana A Turubanova, Alexandra Tyukavina, David Thau, Stephen V Stehman, Scott J Goetz, and Thomas R Loveland. 2013. 'High-Resolution Global Maps of 21st-Century Forest Cover Change'. Science 342 (6160): 850–53.

Henders, Sabine, Madelene Ostwald, Vilhelm Verendel, and Pierre Ibisch. 2018. 'Do National Strategies under the UN Biodiversity and Climate Conventions Address Agricultural Commodity Consumption as Deforestation Driver?' Land Use Policy 70: 580–90.

Karstensen, Jonas, Glen P Peters, and Robbie M Andrew. 2013. 'Attribution of CO2 Emissions from Brazilian Deforestation to Consumers between 1990 and 2010'. Environmental Research Letters 8 (2): 024005.

Khuc, Quy Van, Bao Quang Tran, Patrick Meyfroidt, and Mark W Paschke. 2018. 'Drivers of Deforestation and Forest Degradation in Vietnam: An Exploratory Analysis at the National Level'. Forest Policy and Economics90: 128–41.

Kissinger, G M, Martin Herold, and Veronique De Sy. 2012. 'Drivers of Deforestation and Forest Degradation: A Synthesis Report for REDD+ Policymakers'. Lexeme Consulting.

Klinsky, Sonja, Timmons Roberts, Saleemul Huq, Chukwumerije Okereke, Peter Newell, Peter Dauvergne, Karen O'Brien, Heike Schroeder, Petra Tschakert, and Jennifer Clapp. 2017. 'Why Equity Is Fundamental in Climate Change Policy Research'. Global Environmental Change 44: 170–73.

Lambin, E. F., & Furumo, P. R. (2023). Deforestation-free commodity supply chains: myth or reality?. Annual Review of Environment and Resources, 48, 237-261.

Lambin, Eric F, Billie L Turner, Helmut J Geist, Samuel B Agbola, Arild Angelsen, John W Bruce, Oliver T Coomes, Rodolfo Dirzo, Günther Fischer, and Carl Folke. 2001. 'The Causes of Land-Use and Land-Cover Change: Moving beyond the Myths'. Global Environmental Change 11 (4): 261–69.

Li, Tania Murray. 2007. The Will to Improve: Governmentality, Development, and the Practice of Politics. Duke University Press.

Loft, Lasse, Thuy Thu Pham, Grace Yee Wong, Maria Brockhaus, Dung Ngoc Le, Januarti Sinarra Tjajadi, and Cecilia Luttrell. 2017. 'Risks to REDD+: Potential Pitfalls for Policy Design and Implementation'. Environmental Conservation 44 (1): 44–55.

Luttrell, C., Loft, L., Gebara, M. F., Kweka, D., Brockhaus, M., Angelsen, A., & Sunderlin, W. D. (2013). Who should benefit from REDD+? Rationales and realities. Ecology and Society, 18(4).

Masolele, Robert N, Diego Marcos, Veronique De Sy, Itohan-Osa Abu, Jan Verbesselt, Johannes Reiche, and Martin Herold. 2024. 'Mapping the Diversity of Land Uses Following Deforestation across Africa'. Scientific Reports 14 (1): 1681.

Masolele, Robert N, Veronique De Sy, Diego Marcos, Jan Verbesselt, Fabian Gieseke, Kalkidan Ayele Mulatu, Yitebitu Moges, Heiru Sebrala, Christopher Martius, and Martin Herold. 2022. 'Using High-Resolution Imagery and Deep Learning to Classify Land-Use Following Deforestation: A Case Study in Ethiopia'. GIScience & Remote Sensing 59 (1): 1446–72.

Masolele, Robert N, Veronique De Sy, Martin Herold, Diego Marcos, Jan Verbesselt, Fabian Gieseke, Adugna G Mullissa, and Christopher Martius. 2021. 'Spatial and Temporal Deep Learning Methods for Deriving Land-Use Following Deforestation: A Pan-Tropical Case Study Using Landsat Time Series'. Remote Sensing of Environment 264: 112600.

Mason, Michael. 2008. 'Transparency for Whom? Information Disclosure and Power in Global Environmental Governance'. Global Environmental Politics 8 (2): 8–13.

Meyfroidt, Patrick, Eric F Lambin, Karl-Heinz Erb, and Thomas W Hertel. 2013. 'Globalization of Land Use: Distant Drivers of Land Change and Geographic Displacement of Land Use'. Current Opinion in Environmental Sustainability 5 (5): 438–44.

Meyfroidt, Patrick, Jan Börner, Rachael Garrett, Toby Gardner, Javier Godar, Krisztina Kis-Katos, Britaldo S Soares-Filho, and Sven Wunder. 2020. 'Focus on Leakage and Spillovers: Informing Land-Use Governance in a Tele-Coupled World'. Environmental Research Letters 15 (9): 090202.

Moeliono, Moira, Maria Brockhaus, Caleb Gallemore, Bimo Dwisatrio, Cynthia D Maharani, Efrian Muharrom, and Thuy Thu Pham. 2020. 'REDD+ in Indonesia: A New Mode of Governance or Just Another Project?' Forest Policy and Economics 121: 102316.

Molinario, Giuseppe, Matthew Hansen, Peter Potapov, Alexandra Tyukavina, and Stephen Stehman. 2020. 'Contextualizing Landscape-Scale Forest Cover Loss in the Democratic Republic of Congo (DRC) between 2000 and 2015'. Land 9 (1): 23.

Mueller, Robert, Till Pistorius, Sophia Rohde, Gerhard Gerold, and Pablo Pacheco. 2013. 'Policy Options to Reduce Deforestation Based on a Systematic Analysis of Drivers and Agents in Lowland Bolivia'. Land Use Policy 30 (1): 895–907.

Myers, Rodd, Anne M Larson, Ashwin Ravikumar, Laura F Kowler, Anastasia Yang, and Tim Trench. 2018. 'Messiness of Forest Governance: How Technical Approaches Suppress Politics in REDD+ and Conservation Projects'. Global Environmental Change 50: 314–24.

Ochieng, Robert M, Bas Arts, Maria Brockhaus, and Ingrid J Visseren-Hamakers. 2018. 'Institutionalization of REDD+ MRV in Indonesia, Peru, and Tanzania'. Ecology and Society 23 (2).

Ojanen, Maria, Maria Brockhaus, Kaisa Korhonen-Kurki, and Gillian Petrokofsky. 2021. 'Navigating the Science-Policy Interface: Forest Researcher Perspectives'. Environmental Science & Policy 118: 10–17.

Okereke, Chukwumerije, and Kate Dooley. 2010. 'Principles of Justice in Proposals and Policy Approaches to Avoided Deforestation: Towards a Post-Kyoto Climate Agreement'. Global Environmental Change 20 (1): 82–95.

Peluso, Nancy Lee, and Peter Vandergeest. 2001. 'Genealogies of the Political Forest and Customary Rights in Indonesia, Malaysia, and Thailand'. The Journal of Asian Studies 60 (3): 761–812.

———. 2020. 'Writing Political Forests'. Antipode 52 (4): 1083–1103.

Pendrill, Florence, Toby A Gardner, Patrick Meyfroidt, U Martin Persson, Justin Adams, Tasso Azevedo, Mairon G Bastos Lima, Matthias Baumann, Philip G Curtis, and Veronique De Sy. 2022. 'Disentangling the Numbers behind Agriculture-Driven Tropical Deforestation'. Science 377 (6611): eabm9267.

Pendrill, Florence, U Martin Persson, Javier Godar, Thomas Kastner, Daniel Moran, Sarah Schmidt, and Richard Wood. 2019. 'Agricultural and Forestry Trade Drives Large Share of Tropical Deforestation Emissions'. Global Environmental Change 56: 1–10.

Pham Thu, Thuy, Moira Moeliono, Grace Y Wong, and Maria Brockhaus. 2020. 'The Politics of Swidden: A Case Study from Nghe An and Son La in Vietnam'. Land Use Policy 99: 103050.

Pietarinen, N., Koh, N. S., Ville, A., Brockhaus, M., & Wong, G. (2023). Can REDD+ finance compete with established and emerging land investments? The case of Mai-Ndombe, Democratic Republic of Congo. CIFOR.

Porter, Theodore M. 2020. Trust in Numbers: The Pursuit of Objectivity in Science and Public Life. Princeton University Press.

Potapov, P., Turubanova, S., Hansen, M. C., Tyukavina, A., Zalles, V., Khan, A., ... & Cortez, J. (2022). Global maps of cropland extent and change show accelerated cropland expansion in the twenty-first century. Nature Food, 3(1), 19-28.

Radcliffe, Sarah A, and Isabella M Radhuber. 2020. 'The Political Geographies of D/Decolonization: Variegation and Decolonial Challenges of/in Geography'. Political Geography 78: 102128.

Reiche, Johannes, Adugna Mullissa, Bart Slagter, Yaqing Gou, Nandin-Erdene Tsendbazar, Christelle Odongo-Braun, Andreas Vollrath, Mikaela J Weisse, Fred Stolle, and Amy Pickens. 2021. 'Forest Disturbance Alerts for the Congo Basin Using Sentinel-1'. Environmental Research Letters 16 (2): 024005.

Rifai, Sami W, Thales A P West, and Francis E Putz. 2015. '"Carbon Cowboys" Could Inflate REDD+ Payments through Positive Measurement Bias'. Carbon Management 6 (3–4): 151–58.

Romijn, Erika, Veronique De Sy, Martin Herold, Hannes Böttcher, Rosa Maria Roman-Cuesta, Steffen Fritz, Dmitry Schepaschenko, Valerio Avitabile, David Gaveau, and Louis Verchot. 2018. 'Independent Data for Transparent Monitoring of Greenhouse Gas Emissions from the Land Use Sector–What Do Stakeholders Think and Need?' Environmental Science & Policy 85: 101–12.

Rudel, Thomas K, Ruth Defries, Gregory P Asner, and William F Laurance. 2009. 'Changing Drivers of Deforestation and New Opportunities for Conservation'. Conservation Biology 23 (6): 1396–1405.

Rudel, Thomas K. 2007. 'Changing Agents of Deforestation: From State-Initiated to Enterprise Driven Processes, 1970–2000'. Land Use Policy 24 (1): 35–41.

Rudel, Tom, and Jill Roper. 1997. 'The Paths to Rain Forest Destruction: Crossnational Patterns of Tropical Deforestation, 1975–1990'. World Development 25 (1): 53–65.

Salvini, Giulia, Martin Herold, Veronique De Sy, Gabrielle Kissinger, Maria Brockhaus, and M Skutsch. 2014. 'How Countries Link REDD+ Interventions to Drivers in Their Readiness Plans: Implications for Monitoring Systems'. Environmental Research Letters 9 (7): 074004.

Scott, James C. 1998. Seeing like a State: How Certain Schemes to Improve the Human Condition Have Failed. Yale University Press.

Searchinger, Tim, Richard Waite, Craig Hanson, Janet Ranganathan, Patrice Dumas, Emily Matthews, and Carni Klirs. 2019. 'Creating a Sustainable Food Future: A Menu of Solutions to Feed Nearly 10 Billion People by 2050. Final Report'. WRI.

Skutsch, Margaret, and Esther Turnhout. 2020. 'REDD+: If Communities Are the Solution, What Is the Problem?' World Development 130: 104942.

Song, X. P., Hansen, M. C., Potapov, P., Adusei, B., Pickering, J., Adami, M., ... & Tyukavina, A. (2021). Massive soybean expansion in South America since 2000 and implications for conservation. Nature sustainability, 4(9), 784-792.

Turnhout, Esther. 2018. 'The Politics of Environmental Knowledge'. Conservation and Society 16 (3): 363–71.

Vancutsem, Christelle, Frédéric Achard, J-F Pekel, Ghislain Vieilledent, Silvia Carboni, Dario Simonetti, Javier Gallego, Luiz E O C Aragao, and Robert Nasi. 2021. 'Long-Term (1990–2019) Monitoring of Forest Cover Changes in the Humid Tropics'. Science Advances 7 (10): eabe1603.

Waller, Laurie, Tim Rayner, Jason Chilvers, Clair Amanda Gough, Irene Lorenzoni, Andrew Jordan, and Naomi Vaughan. 2020. 'Contested Framings of Greenhouse Gas Removal and Its Feasibility: Social and Political Dimensions'. Wiley Interdisciplinary Reviews: Climate Change 11 (4): e649.

Weatherley-Singh, Janice, and Aarti Gupta. 2015. 'Drivers of Deforestation and REDD+ Benefit-Sharing: A Meta-Analysis of the (Missing) Link'. Environmental Science & Policy 54: 97–105.

———. 2018. '"Embodied Deforestation" as a New EU Policy Debate to Tackle Tropical Forest Loss: Assessing Implications for REDD+ Performance'. Forests 9 (12): 751.

West, Thales A P, Sven Wunder, Erin O Sills, Jan Börner, Sami W Rifai, Alexandra N Neidermeier, Gabriel P Frey, and Andreas Kontoleon. 2023. 'Action Needed to Make Carbon Offsets from Forest Conservation Work for Climate Change Mitigation'. Science 381 (6660): 873–77.

Windey, Catherine, and Gert Van Hecken. 2019. 'Contested Mappings in a Dynamic Space: Emerging Socio-Spatial Relationships in the Context of REDD+. A Case from the Democratic Republic of Congo'. Landscape Research 46 (2): 152–66.

Wong, Grace Y, Minda Holm, Niina Pietarinen, Alizee Ville, and Maria Brockhaus. 2022. 'The Making of Resource Frontier Spaces in the Congo Basin and Southeast Asia: A Critical Analysis of Narratives, Actors and Drivers in the Scientific Literature'. World Development Perspectives 27: 100451.

Wong, Grace Yee, Cecilia Luttrell, Lasse Loft, Anastasia Yang, Thuy Thu Pham, Daisuke Naito, Samuel Assembe-Mvondo, and Maria Brockhaus. 2019. 'Narratives in REDD+ Benefit Sharing: Examining Evidence within and beyond the Forest Sector'. Climate Policy 19 (8): 1038–51.

Zaks, D P M, C C Barford, Navin Ramankutty, and J A Foley. 2009. 'Producer and Consumer Responsibility for Greenhouse Gas Emissions from Agricultural Production—a Perspective from the Brazilian Amazon'. Environmental Research Letters 4 (4): 044010.

Zu Ermgassen, Erasmus K H J, Javier Godar, Michael J Lathuillière, Pernilla Löfgren, Toby Gardner, André Vasconcelos, and Patrick Meyfroidt. 2020. 'The Origin, Supply Chain, and Deforestation Risk of Brazil's Beef Exports'. Proceedings of the National Academy of Sciences 117 (50): 31770–79.