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Title: A lack of clarity on the bioeconomy concept might be harmful for Amazonian ecosystems and its people

Authors: Joice Ferreira^{1*}, Emilie Coudel², Ricardo Abramovay³, Jos Barlow⁴, Rachael Garrett⁵, Alexander C. Lees⁶, Marie-Gabrielle Piketty², Roberto Porro¹, Ima Vieira⁷, Kieran Daniel Withey⁸

Affiliations:

¹ Embrapa Amazônia Oriental, Belém, Pará, Brazil.

² The French Agricultural Research Centre for International Development (CIRAD), Montpellier, France

³ Chair Josué de Castro of the School of Public Health of the University of São Paulo, Brazil.

⁴ Lancaster Environment Centre, Lancaster University, Lancaster, United Kingdom.

⁵ Department of Geography and Conservation Research Institute, University of Cambridge, Cambridge, United Kingdom.

⁶ Department of Natural Sciences, Manchester Metropolitan University, Manchester, United Kingdom.

⁷ Museu Paraense Emílio Goeldi, Belém, Pará, Brazil.

⁸ Federal University of Pernambuco, Recife, Pernambuco, Brazil.

*Corresponding author. Email: joyce.ferreira@embrapa.br

There have been substantial international and domestic commitments to invest in an emerging Amazonian bioeconomy. This includes a major plan for bioeconomy initiatives within the scope of Brazil's presidency of the G20, as well as investments from public agencies such as the Inter-American Development Bank (IDB) and the Brazilian Development Bank (BNDES). The bioeconomy agenda has been embraced by different governmental ministries in Brazil, including the cross-sectoral Ecological Transformation Plan (Brasil, 2023a, 2023b). The reinvigorated Brazilian anti-deforestation policy leans heavily on the bioeconomy as a more sustainable alternative to other outdated models of economic development. NGOs, federal and state governments, as well as private companies are jostling to promote the bioeconomy on the grounds that it will deliver both healthy ecosystems and benefit local people.

However, bioeconomy is a broad term with different meanings (Bugge et al., 2016) and agendas for different stakeholders. For some, bioeconomy encompasses biofuel monocultures such as soybean and oil palm, while for others, it is centered on inclusive value chains for sustainably harvested non-timber forest products; activities with radically different impacts on habitats and local communities.

Such impacts are highly context specific, even for the same forest product. For example, production of the fruit of the açai palm (*Euterpe oleracea* Mart.) — the most prominent bioeconomy product in the region and the first to pass a market value of \$1 billion (IBGE, 2023) — can promote conservation and local empowerment when managed within biodiverse forests. However, rapid expansion has also led to biodiversity erosion (Freitas et al., 2021) and social vulnerability following management intensification (Tregidgo et al., 2020) and cultivation.

As a new field emerges, actors shape new views and narratives which are key in defining resource allocation and associated socio-technical relations (Vivien et al., 2019). Thus, dominating narratives of bioeconomy have the power to define future development strategies and their impacts in Amazonian countries. 1. Bioeconomy: Different definitions and narratives

The term bioeconomy was first proposed by Georgescu-Roegen, and was aligned with early ideas of decoupling economies from the paradigm of perpetual growth, focusing instead on expansion of resource use towards meeting the needs of the most vulnerable people (Vivien et al., 2019). This initiated an important debate which lies at the heart of ecological economics: is greening the current economy enough to guarantee sustainability, or should economic paradigms be reconsidered altogether and defined within socioecological boundaries?

The diversity of this multifaceted term has been aggregated into three alternative visions (i) a biotechnological vision focused on <https://doi.org/10.1016/j.ecolecon.2024.108299>

technological innovation for new industrial applications, (ii) a bioresource vision centered on substitution of fossil fuels, led by the conversion of biomass into energy sources and/or new products, and (iii) a bioecological vision focused on ecological processes that promote biodiversity, avoid ecosystem degradation, and shun monocultures (Bugge et al., 2016). In contrast to the bioecological vision, the biotechnological and bioresource visions focus only on the substitution of unsustainable resources, and give little thought to current economics or consumption models (Giurca and Befort, 2023). In the Global North, bioeconomy is primarily focused on biomass production for replacing fossil fuels and on biotechnological applications. Regardless, in these regions, bioeconomy has also been prone to dispute and appropriation of narratives, such as the different framings of innovation and the substitution of materials in the wood-based sector (Giurca and Befort, 2023).

The idea of bioeconomy has risen rapidly in Amazonian countries and is quickly evolving, both through government, private-sector and grassroots organizations. Specifically in Brazil, an agenda focusing on scientific and technological innovation emerged first, being primarily aligned with the dominant biotechnological and bioresource approaches, particularly for the sustainable production and processing of biomass (Brasil, 2018). The consideration of social issues along with a bioecological perspective was incorporated later by programs specifically targeting sociodiverse activities led by traditional communities and family farmers across the country (Brasil, 2019). This approach resonated well with the socioeconomic context in the Amazon, and soon became central to debates related to bioeconomy in the region (Bergamo et al., 2022; De Assis Costa et al., 2022). However, policy proposals and bills continue to use the bioeconomy concept vaguely, such as the National Bioeconomy and Sustainable Regional Development Strategy of the Ministry of Integration and Regional Development (Brasil, 2023b), to name but one example. Over time, new public policies have been proposed and discussed with opposing perspectives mentioned here. In this clash of narratives, the Brazilian government has recently launched a broad National Bioeconomy Strategy (Brasil, 2024), including sections on the sociobiodiversity economy, bioindustrialization, biomass and agricultural practices; thus, encompassing a large and diverse suite of strategies.

2. Unclear definitions can lead to perverse consequences

Discourses and narratives — such as the bioeconomy in the global forest agenda — shape views, behaviors, cause institutional changes and transform societal realities (Pülzl et al., 2014). Many academics, practitioners and grassroots organizations currently agree that the scope of the bioeconomy has limitations regarding its potential to safeguard the Amazon and other socio-ecologically rich ecosystems (De Assis Costa et al., 2022). Yet, bioeconomy businesses may expand

rapidly, potentially putting these ecosystems at risk. This threat has also been highlighted in other socioecological contexts across the world, where the bioeconomy has been presented as a silver bullet to solve major societal problems. In recent years, critiques have highlighted the different interpretations of bioeconomy and the confusion this can cause (Vivien et al., 2019). However, this vision has to be expanded to encompass the diverse socioeconomic realities of tropical forest-hosting countries (De Assis Costa et al., 2022; Rodríguez et al., 2019). New principles proposed in this expansion go beyond climate change mitigation and include innovations aiming to promote sustainable regional development and opportunities for vulnerable groups, such as indigenous people, women and young people (Garrett et al., 2023; Rodríguez et al., 2019). Yet, the danger lies in the fact that there is a significant delay between these proposals and their implementation, especially when international funding is increasing rapidly. Above all, the bioeconomy is a disputed term that can serve the privileged to maintain power relations over disadvantaged groups. This can happen through the guise of legitimacy afforded to elites, allowing them to accumulate more capital from new extractive products in detriment of collective rights and traditionally occupied lands (Ollinaho and Kroger, 2023). Misapplied international and national resources can result in money being directed towards activities that degrade the environment and harm the livelihoods of local people.

3. Safeguarding bioeconomy investments for a prosperous future

While the expansion of bioeconomy activities has the potential to dramatically alter the Amazon, ensuring positive outcomes for people and nature will depend on rigorous safeguards. First and foremost, definitions and principles underpinning bioeconomy should be standardized (Bergamo et al., 2022; FAO, 2021). Definitions must be supported by consensus on qualifiers in relation to goals and processes, which are required to facilitate clear communication about what is being promoted and to avoid misuse of the bioeconomy concept. In the meantime, a large number of alternative terms for bioeconomy have and will continue to be used without clear definitions. For example, sociobioeconomy, inclusive bioeconomy, socio-biodiversity bioeconomy, sustainable bioeconomy, restorative bioeconomy, bioecological bioeconomy, new bioeconomy, have all been applied inconsistently in an attempt to add more clarity to the term.

The alternative concept sociobioeconomy is increasingly replacing the generic bioeconomy term in many regional contexts related to Amazonian countries (Lesenfants et al., 2024). The term refers to the economy of the forest and its sociobiodiversity, emphasizing equity and the generation of value from the biocultural diversity of the region, including indigenous people and local communities (Garrett et al., 2024). In fact, the term sociobioeconomy should be considered a shortened form of “indigenous, traditional, and local economies based on socio-biodiversity” (Garrett et al., 2024). This sociobioeconomy concept can foster alternative economic systems, in contrast to a business-as-usual approach, as it is aligned with the harmonious relations between indigenous, local and traditional communities and their environment. We put forward sociobioeconomy as the most appropriate approach for the Amazon and its rich socio-biodiverse territories. The National Strategy for Bioeconomy (Brasil, 2024) launched in June 2024 stated values of justice, ethics, social inclusion, conservation of biodiversity, climate balance and traditional knowledge within the concept of bioeconomy. Are those statements enough to guarantee the protection of Amazonian ecosystems and their local communities? Some authors argue that bioeconomy has become so confused that it could not serve sociobiodiverse economies (Ollinaho and Kroger, 2023). We believe using a more precise term, such as sociobioeconomy, along with the adoption of strong principles, including commitments to zero- deforestation, social equity, valuing local cultures and biodiversity (Abramovay et al., 2021; Bergamo et al., 2022; Garrett et al., 2024), could induce the transformative changes that

are so much in need in the Amazon. Such safeguards are crucial to help avoid exacerbating social injustice and support the effective use of investments. Achieving consensus on key terms and principles is not just a question of semantics; it will orient what policy choices are supported and help define the future of some of the world's most important centers of biocultural diversity.

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