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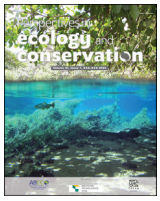

Essays and Perspectives

Business, biodiversity, and innovation in Brazil

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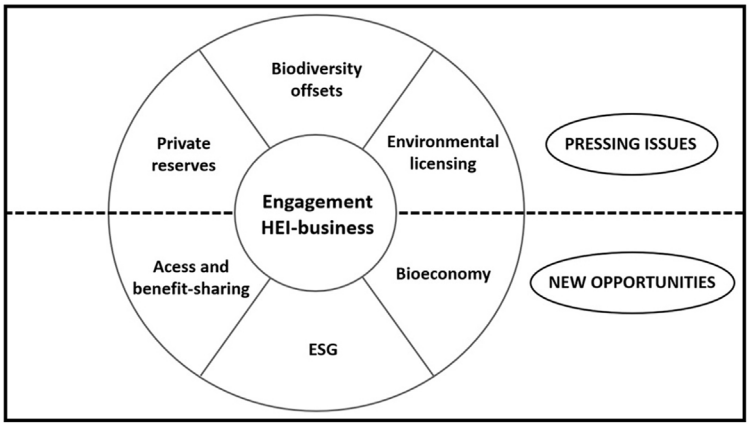
HIGHLIGHTS

- There is room for expansion in the academic engagement with businesses in Brazil, notably in issues related to biodiversity and sustainability.
- To tackle existing issues: offsets, licensing, and private reserves are fronts for engagement between academia and businesses in Brazil.
- To tap into new opportunities: sustainable bioeconomy, access and benefit sharing, and environmental, social, and corporate governance are topics whereby academia-businesses partnerships in Brazil can innovate.
- A mindset shift in academia and corporations will be required to foster sustainable businesses from a biodiversity perspective.

GRAPHICAL ABSTRACT

Biodiversity conservation and management: opportunities for innovation and engagement between academia and businesses in Brazil



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ABSTRACT

Official reports and academic studies call for profound and immediate transformations in how businesses relate to biodiversity. The urgency is such that the first draft of the Post-2020 Global Biodiversity Framework (GBF) of the Convention of Biological Diversity has a specific target aimed at full sustainability in biodiversity practices in businesses by 2030. Brazil—a country with the greatest reservoir of biodiversity and the 12th largest economy on the planet —should be fertile ground for new developments and innovations on this front. However, the shortage of academic engagement with businesses in the country may impede this path. We propose six biodiversity-related innovation fronts and opportunities for engagement between high education institutions and companies in Brazil. We reviewed the literature regarding two sets of practices: pressing issues (including environmental licensing, biodiversity offsets, and conservation in private reserves), and new business opportunities (sustainable bioeconomy, access and benefit sharing – ABS, and environmental and social governance – ESG). Such themes have direct relevance to the Post-2020 GBF business sustainability target and potential national impact. There is plenty

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of room for academic engagement with businesses in all cases. Examples include supporting definition of metrics and standards, providing information systems to increase transparency, among others. In conclusion, we argue that an innovative mindset from corporations and academics will be necessary before Brazilian businesses can move on to develop innovative and sustainable processes and products related to biodiversity.

Introduction

Since shortly before the outbreak of the Covid-19 pandemic, many official reports and academic studies have called for profound transformations in how businesses relate to biodiversity (WEF, 2020; Dasgupta, 2021; IRP, 2021; UNEP, 2021). The European Union agreed upon and launched a Green New Deal (European Commission, 2019), and similar efforts have been proposed in the United States and China (Tagliapietra and Wolff, 2021). The rising awareness about climate change (IPCC, 2021) and the accelerating rates of species extinctions (IPBES, 2019) further increase the pressure for an effective business contribution to solving sustainability challenges. The current economic paradigm, which often considers biodiversity an externality, is no longer an option. Thus, the United Nations Convention on Biological Diversity proposed a business target (#15) in the official "first draft" of the new Global Biodiversity Framework: "all businesses (public and private, large, medium, and small) assess and report on their dependencies and impacts on biodiversity, from local to global, and progressively reduce negative impacts, by at least half, and increase positive impacts, reducing biodiversity-related risks to businesses and moving towards the full sustainability of extraction and production practices, sourcing and supply chains, and use and disposal" (CBD, 2021, p. 106). The draft also notes that "urgent policy action globally, regionally, and nationally is required to transform economic, social and financial models so that the trends that have exacerbated biodiversity loss will stabilize in the next ten years (by 2030)." (CBD, 2021, p. 40).

The need for direct business involvement in resolving the biodiversity crisis (Mace et al., 2018; Smith et al., 2020) is no surprise since the private sector is responsible for 60% of the gross domestic product (GDP) worldwide (Sukhdev, 2012), and 72% of the GDP of countries of the Organization for Economic Co-Operation and Development (OECD; Manyika et al., 2021). Although the private sector strongly depends on biodiversity and ecosystem services (Bishop, 2012; Dasgupta, 2021; UNEP, 2021), it has a significant environmental footprint (Moran and Kanemoto, 2017; Addison et al., 2018).

Locally, government initiatives are pivotal to balancing such forces and promoting pro-biodiversity actions and some countries have designed and implemented policies that seek to regulate the environmental performance of the private sector. However, complying with the national environmental legislation is no longer enough for the private sector. Nowadays, businesses must also build image and brand and respond to ever-increasing local or international demands for sustainable products since all these fronts impact mid- to long-term financial gains (Gradinaru, 2014; Dragomir, 2018). In the international arena, urgent reforms in trade investments and green procurement policies have been promoting fertile ground for sustainable businesses to flourish (Turnhout et al., 2020).

However, transformation requires more than changes in public and private policies. Corporations must be "ethical stewards of shared planetary resources" rather than "as they have been so far, self-interested exploiters of the commonwealth" (Sukhdev, 2012). The gradient between "stewards" and "exploiters" can be defined by the balance between environmental cost/gain for businesses vs. societal impacts that results from a given business action (Bhattacharya and Managi, 2013; Barkemeyer et al., 2015; Boiral and Heras-Saizarbitoria, 2015, 2017), which depends on business size, sector, history, and values. Much innovation is required to move from "exploiters" to "stewards," beginning with a new business mindset.

Transformative change in the private sector requires solid policy measures combined with structural shifts in values and institutions (Turnhout et al., 2020). This transition in the business-biodiversity relationship requires innovation in mindset but also in process, and outcome (Kahn, 2018), related, for instance, to the development of socially inclusive technology (Siddiqi and Collins, 2017) and a new stand on human-nature relationships (Andrade et al., 2020). Academic engagement is central to this process because it has 1) the interdisciplinary knowledge and scientific rigor for the innovative process and 2) the freedom to test new processes, techniques, and products without the economic restrictions imposed on companies by the market. Therefore, higher education institutions (HEI) – such as Universities and Research Centers – can be seen as crucial innovation agents (Perkmann et al., 2021). This is particularly true in emerging economies (Kruss et al., 2015), where HEI can influence the rates of catch-up (for this and other terms, see Glossary in Table 1) in businesses (Lee and Malerba, 2017) and provide technological opportunities for the private sector (Puffal et al., 2021).

Moreover, HEI can often link areas and expertise across society and promote transdisciplinarity (Table 1), making them an expression of social stability, generally with a non-profit orientation that fosters long-term free-thinking, which is crucial to innovation and sustainability (Stephens et al., 2008). Of course, engagement also presents risks to both parties (Durst and Zieba, 2020), such as relational risks for companies (carefully choosing partners and defining protective legal agreements) and academic reputational risks. Non-engagement is also risky for companies (e.g., lack of internal competencies to address specific issues) and HEIs (e.g., distancing from practical matters). Durst and Zieba (2020) suggest that creating a culture of trust and data sharing between partners is one key strategy to make engagements work.

Business innovation that addresses sustainability concerns from a biodiversity perspective demands academic engagement that fosters transdisciplinary approaches (Compagnucci et al., 2021). Public HEI are major innovation centers in Brazil, especially in highly industrialized areas (Póvoa, 2008). Nonetheless, despite some successful cases of HEI-business partnerships in Brazilian technological history (Dutrénit and Arza, 2015; Puffal et al., 2021), such engagement is still incipient compared to other developing economies, such as in Asia (Lee, 2013; Fischer et al., 2019). This is at least partly attributed to the low absorption capacity of technology at the country level, as well as to flawed research and development projects in which HEI acts as a complement to or substitute for businesses in technology development (Póvoa, 2008; Botelho and Almeida, 2011), and to bureaucratic hurdles involved in mutual agreements on research, disclosure, confidentiality, licensing, and eventually even patenting and commercial use (Viana et al., 2018).

Brazil is a large economy where corporations of all sizes operate (Oliva et al., 2019). Since the country is the largest reservoir of biodiversity on the planet (Scarano et al., 2021), businesses are challenged to sustainably manage biodiversity and ecosystem services. At the local level, Brazil has gathered experience in clean development mechanisms that aim for social equity, whereby local

Table 1
Glossary of terms used in this paper in the sequence they appear.

Term	Meaning	Reference
Academic engagement	Knowledge-related collaboration by scientists with non-scientific organizations.	Perkmann et al. (2021)
High Education Institutes (HEIs)	Institutions that produce knowledge while providing education to students, such as universities and many research centers, public or private, for-profit or non-profit.	Perkmann et al. (2021)
Catch-up cycles	Phenomena of successive changes in industrial leadership. They occur when a given industry fails to maintain its superiority in technology, production, and marketing, providing room for a latecomer to catch up and gain leadership.	Lee and Malerba (2017)
Formats of engagement between HEIs and businesses	Engagement can be generic or relational. Generic links: transfer of knowledge or technology via human resource absorption (e.g., recruitment of personnel with graduate training), capacity building (high-level education and training offered to employees), scientific publications, or university-generated intellectual property (e.g., patents and licenses). Relational links: stronger partnerships that emerge from working on specific projects in collaboration or consulting.	Jones and Zubielqui (2017)
Corporate sustainability	We use this term in its broader sense, i.e., the fusion between corporate responsibility (that emerged from ethical concerns with the human component) and business sustainability (that emerged from environmental impact concerns). It also comprises Corporate Social Responsibility (CSR) and Environmental and Social Governance (ESG).	Bansal and Song (2017); Barbosa et al. (2019)
Biodiversity offsetting	Actions that ensure a positive balance for biodiversity, when comparing states before and after a corporate intervention in a natural area. However, some authors refer to it as simply neutralization or compensation of the impact on biodiversity.	Gonçalves et al. (2015)
Conservation incentives	Conservation incentives enable mechanisms whereby beneficiaries compensate providers for the additional provision or maintenance of desired ecosystem services. They can be financial or non-financial. Examples include Payments for Ecosystem Services, REDD+, environmental certification, conservation easements, and sustainable finance instruments.	Scarano et al. (2018b)
Transdisciplinary	A method driven scientific principle focused in societally relevant problems that enables mutual learning processes among actors from and outside academia. It aims to create solution-oriented knowledge, socially robust and transferable to both the scientific and societal practice	Lang et al. (2012)
Payments for Ecosystem Services	Voluntary transactions whereby a provider ensures a specific ecosystem service through a negotiation involving a buyer of this service. They existed in a rudimentary form for decades, but during the 1990s, they expanded as an integrative conservation mechanism.	Wunder et al. (2008)

stakeholders participate in decision-making processes (Benites-Lazaro and Mello-Théry, 2019). Since several Brazilian HEI develop cutting-edge socioecological research (Joly et al., 2019), academic engagement is paramount to ensure the best business practices. In this paper, we discuss fronts in business that demand academic engagement with a transdisciplinary perspective. We divided them into two types: (1) existing business issues related to socioenvironmental licensing; and (2) new business opportunities that emerge on the bioeconomy front.

Corporate biodiversity practices in Brazil and globally: contradictions

A growing number of corporations are investing in projects and activities related to biodiversity and ecosystem conservation and restoration, including associations and alliances, to set standards and deliver better results (see global and Brazilian examples in Table 2). In 2017, a global cross-commodity survey showed that out of 718 globally monitored companies, financial success in those committed to reducing deforestation in supply chains was almost three times higher than in companies without commitments (Donofrio et al., 2017). Among these companies, those focused on palm, timber, and pulp products lead the restoration initiatives, whereas the soy and cattle sectors are the main drivers of tropical deforestation. Reasons for concern and scepticism that intentions might not always be translated into actions come with scandals, as in 2015 when the world saw a major multinational motor company cheating carbon emission tests in the United States (http://www.bbc.com/news/business-34324772). Another piece of evidence is the low number of companies that expressed concerns about biodiversity in their mission statements between 1900 and 2014 (Garnett et al., 2016).

In Brazil, there is a similar paradox: recent major environmental disasters, including human casualties in mining (Pires et al., 2017; Magris et al., 2019) and oil sectors (Magris and Giarrizzo, 2020) contrast with some progressive corporate movements and discourses (Table 2). For instance, dozens of companies and private sector federations gathered to address a statement about their concerns with the Amazonia to the Brazilian President in July 2020 (Brazilian Business Council for Sustainable Development, CEBDS, 2020 — see Table 2). The Brazilian Foundation for Sustainable Development (FBDS) and CEBDS also organized workshops gathering representatives from scientific fields and the business sector to settle commitments and provide input for Brazilian chief negotiators from the Ministry of Foreign Affairs before the 15th Conference of the Parties of the CBD (CEBDS and FBDS, 2021). In addition to the growing pressure of the global and regional political agreements, Brazilian consumer consciousness regarding the supply of natural resources and biodiversity conservation is also rising: 93% of consumers in the country have heard about biodiversity, and an even more significant proportion has heard of sustainable development or fair trade (Moon, 2019).

Our argument in this paper is two-fold: (1) HEIs cannot help businesses comply with legislation – that is up to them and for the public authorities to monitor and sanction non-compliance –but can partner with the private sector to turn compliance into a source of gain for business, biodiversity, and society; (2) HEIs can partner with businesses to tap on new opportunities related both to new biodiversity practices or existing best practices. Table 3 summarizes six innovation fronts, three related to each of the arguments (1) and (2), which are discussed in more detail next.

Pressing issues

Environmental licensing, biodiversity offsets, and private reserves are very significant pressing issues in terms of the area cover they affect, and they also synergize with one another and with other fronts (listed in Table 3). The lenience and even incentiviza-

Table 2
Examples of initiatives and opportunities for business and biodiversity globally and in Brazil.

Initiative	Description	Reference
United Nations Global Compact	To date, it gathers 11,500 companies committed to "operate responsibly based on sustainability principles accepted universally".	www.unglobalcompact.org
Consumer Goods Forum	There are 400 member companies across 70 countries, including retailers, manufacturers, and service providers. Net zero deforestation commitment by 2020 through the responsible sourcing of key commodities —soy, palm oil, timber, and pulp and beef.	www.theconsumergoodsforum.com
European Green Deal	It covers all the economic areas and establishes policies for environmental indicators and safeguarding actions for European Union countries, which must be carbon neutral by 2050, and are already hitting targets in 2023. All commercial partners of the EU must follow the same criteria and practices.	European Commission (2019)
Equator Principles	The principles stipulate why and how financial institutions should consider environmental and social issues in their project finance operations. 111 institutions adopt them in 37 countries.	Wright and Rwabizambuga (2006); www.equator-principles.com/index.php/members-and-reporting
CEBDS	The Brazilian Business Council for Sustainable Development (CEBDS, a national branch of the worldwide WBCSD) unites 59 Brazilian corporate groups around common sustainability goals.	www.cebds.org
Life (Lasting Initiative for Earth) Certification	This certification is the only one that applies solely to best management practices related to biodiversity, irrespective of sector, commodity type, or size of the company. It quantifies the impact of specific corporate practices on natural resources and guides conservation actions to compensate for impacts. The UNCBD and the Brazilian Ministry of Environment recognized it as an essential tool. However, its adoption remains shy compared to other sector- or commodity-specific certifications.	www.institutolife.org; Instituto Life (2014); Reale et al. (2018)
ISE	The Brazilian Corporate Sustainability Index (ISE) was created in 2005 and is operated by B3, the Brazilian Stock Exchange. It compares the performance of companies listed at B3 regarding corporate sustainability based on economic efficiency, environmental balance, social justice, and corporate governance. It pays off to invest in the ISE because it does not result in risk investment or disadvantage during challenging market periods.	www.iseb3.com.br; Ortas et al. (2012); Orsato et al. (2015)
Brazilian Climate Emergency Bill	Bill proposed to Brazilian National Congress in July 2020 to approve a National Climate Emergency Response Plan to establish targets for the country to become carbon neutral by 2050 and policies for a sustainable transition.	https://static.congressoemfoco.uol.com.br/2020/07/PL-Emerg%C3%AAncia-Clim%C3%A1tica.pdf

Table 3
Innovation fronts on the biodiversity component of businesses and opportunities for academic engagement in Brazil.

Scope	Innovation front	Business Challenges	Opportunity for academic engagement	References
Pressing issues	Environmental licensing	Political instability around existing legislation; governmental bureaucratic hurdles.	To develop information systems that might increase the transparency of environmental impact assessments; to revisit standards that enhance both quality and speed of licensing process.	Abessa et al. (2019); (2019)
	Biodiversity offsets	To address by intervention rather than company-wide; to account for local communities' perspectives in the decision-making process; absence of offset culture.	To define safeguards, metrics, and methods for inclusion of stakeholders in the decision-making process; to understand the relationship of biodiversity offsetting with the provision of ecosystem services.	Bull and Strange (2018); Souza et al. (2021)
	Private reserves	To decide whether to invest in buying land for protection or in existing protected areas; how to incorporate private reserves in biodiversity, climate, and water offsets of specific interventions.	To provide metrics and information systems that inform government and society about the relevance of such areas for biodiversity conservation; to set conservation and restoration priorities that might inform corporate investment in private reserves.	Kamal et al. (2015); Silva et al. (2021)
New opportunities	Environmental and Social Governance (ESG)	Incorporating, measuring, and reporting impacts (positive and negative) on biodiversity.	To scientifically refine the incorporation of the biodiversity component on ESG metrics.	Miralles-Quirós et al. (2018)
	Access and Benefit Sharing (ABS)	To deal and understand Brazil's position in the global ABS scenario and simultaneously deal at the national level with governmental bureaucratic hurdles and expectations of local communities that, as knowledge holders, are to benefit from this type of arrangement.	To provide safeguards and metrics for benefits and develop participatory methods that define agreements between companies and knowledge holders for ABS; to develop information systems that might increase transparency and monitoring of agreements.	Muzaka and Serrano (2019)
	Bioeconomy	To deal with governmental bureaucratic hurdles; to cope with infrastructural and capacity limitations in some areas where a bioeconomy is more likely to flourish.	To define metrics and standards to track the transition from a conventional economy to a bioeconomy at the local, subnational, and national levels; to assess impacts of change on human well-being and biodiversity conservation.	Valli et al. (2018); Nobre and Nobre (2020); Bastos-Lima (2021)

tion of the Brazilian government (2019–2022) to environmental malpractice have made these issues even more pressing (Abessa et al., 2019).

Environmental licensing

Brazilian procedures regarding environmental licensing are consistent with international best practices, but there are problems with validation, implementation, enforcement, compliance, and corruption (Andalaft, 2019; Oliveira et al., 2019). The environmental impact assessment (EIA) – one of the most widespread tools for project licensing globally – has several problems in Brazil, including a lack of detailed technical guidance for implementers and an absence of public transparency of both the process and the resulting data (Dias et al., 2019). Moreover, there are also queries regarding the quality of many of the EIAs produced. The socioecological mining tragedies are evidence of the flaws of EIAs and the licensing process as a whole (Pena et al., 2017). We argue that a more substantial presence of academia in biodiversity monitoring and reporting during the EIA process and its involvement in the construction of public information systems can make licensing more cost-effective for corporations (e.g., Andalaft, 2019; Dias et al., 2019; Oliveira et al., 2019). Souza and Sánchez (2018) provide a specific example demonstrating for Brazilian vegetation in a limestone quarry that the quality of the EIA is positively related to the quality of the offset, which we examine next.

Biodiversity offsets

Biodiversity offset is a policy tool to compensate for unavoidable adverse impacts of projects and interventions (BBOP, 2012). Licensing legislation demands compensation or "no net loss" (NNL), which is achieved when impacts on biodiversity are balanced out by actions such as conservation, rehabilitation, and restoration (Rainey et al., 2015). When the gains exceed the losses, the project achieves a "net positive impact" (NPI). Therefore, biodiversity offsetting must bring additionality, i.e., a positive balance between the compensatory action results and the moment before the action (Gonçalves et al., 2015). Commitments towards NPI can be advantageous for companies to avoid conflicts with local communities, to secure supply chains related to natural resources, and even to offer access to financial institutions that adopted the Equator Principles (Table 2), with loans conditioned to NNL of natural habitat and NPI in critical habitat (BBOP, 2018). There are technical issues when discerning between NNL and NPI (Bull and Brownlie, 2017) regarding ecological uncertainties related to criteria or measurements that challenge the definition of the threshold between one and the other (Moreno-Mateos et al., 2015) and the definition of the time needed for offsets to provide expected gains (Curran et al., 2014). The proposed offset quality as compared to the pre-impact conditions is also a concern (Weissgerber et al., 2019). Crowe and ten Kate (2010) and Curran et al. (2014) argue that translating such complexity into offset calculations is often limited to targeting just one or few (e.g., species composition, habitat structure, and cultural values) of the multiple dimensions of biodiversity (structural, functional, evolutionary, cultural, economic). Some such difficulties are possibly behind the fact that less than one-third of the 66 global companies that had committed to biodiversity-specific NNL/NPI in 2001 kept such commitments active by 2016, and less than half specified mitigation hierarchy application or reference scenarios (de Silva et al., 2019).

This picture emphasizes the need for deeper academic engagement to apply science-based metrics to evaluate corporate performance concerning biodiversity, particularly in Brazil. South America, primarily due to Brazil's contribution, is more dominant in terms of global offsetting area than other continents (Bull and Strange, 2018). Nevertheless, this is not reflected in academic engagement. A survey of 477 papers on biodiversity offsets showed that less than 1% was produced in Brazil (Coralie et al., 2015), and by 2018 Brazil and other Latin American countries, such as Colombia and Mexico, still received less research attention on biodiversity offsets than countries on other continents (Bull and Strange, 2018). This is surprising since Brazil has policies that allow and require offsetting practices, such as EIA, for an environmental license to operate (Villarroya et al., 2014; Gelcich et al., 2017). These patterns suggest that companies committed to offsetting their impacts on biodiversity in Brazil are seldomly interested in going beyond compliance (Souza et al., 2021).

Private reserves and other effective conservation measures

Conservation of natural ecosystems can serve business purposes such as offsetting, Access and Benefit Sharing (ABS) and Environmental and Social Governance (ESG). Worldwide, the establishment of private reserves is becoming widespread in diverse forms (Bateman et al., 2015) to the extent that it now even seems to demand a taxonomy at the IUCN based on the private protected land's tenure and security (Kamal et al., 2015). In Brazil, protected area legislation includes a category of private reserves called RPPNs (Private Natural Heritage Reserves). It consists of stretches of land within private properties voluntarily set aside by the landowners for conservation purposes. Such designation to the ground is permanent and perennial: irrespective of the land sale, the law enforces future owners to protect it. The only incentive landowners receive to register part of their land as RPPNs is an abatement in property taxes. More than 1200 RPPNs cover 8004 km^2 (Silva et al., 2021), *c.* 1.5% of the total covered by public terrestrial protected areas in Brazil (1,530,000 km^2; Vieira et al., 2019). Among those, there is discreet participation of large corporations.

Additionally, other private land types are protected and are not accounted for within the national system of protected areas. For instance, Vale and Votorantim are large companies that hold private reserves where research and conservation occur at different levels. Vale's reserve in Linhares (230 km^2), Votorantim's Legado das Águas (310 km^2), and Votorantim's Legado Verdes do Cerrado in Niquelândia (230 km^2) together cover nearly the equivalent of 10% of the area collectively protected by RPPNs in the country. However, these areas are not considered in national protected area calculations because they do not fit the federal legislation stipulations. Since nearly 53% of the remaining native vegetation in the country lies within private properties (Soares-Filho et al., 2014), including a fraction of that private land in the national panorama for biodiversity and ecosystem services conservation is essential for Brazil and could improve public-private dialogue for conservation.

While RPPNs are an option, there are mandatory areas to be protected within farms, according to the Brazilian Native Vegetation Protection Law (NVPL; a.k.a. the "New Forest Code"; Brancalion et al., 2016). Legal Reserves and Permanent Preservation Areas, as they are called, currently do not account for the conservation budget either (but see Silva et al., 2021). NVPL has created a market for trading native vegetation certificates (CRAs) that allows landowners to compensate for restoration obligations by conserving native vegetation elsewhere (Brancalion et al., 2016). When at full implementation, this scheme could become the largest market for trading native vegetation in the world that generates co-benefits by fostering payment for ecosystem services (PES) programs focused on biodiversity conservation, water security, and climate regulation (Soares-Filho et al., 2016; but see Vieira et al., 2018). We postulate that it is the appropriate time to revisit Brazil's protected area system to promote its expansion and collect and bring private conservation data into its reporting routine to the CBD. This endeavor, again, requires significant involvement of scientists for various

tasks: defining priority areas for private conservation or restoration; cataloging and monitoring species and ecosystems within such regions; estimating ecosystem service flows; developing new techniques for valuing ecosystem services to help determine standards for compensation and offset; and devising new incentive mechanisms (see Meiβner, 2013).

According to NVPL (Soares-Filho et al., 2014; Rezende et al., 2018), the large vegetation debts call for two additional policy instruments that are key to conserving natural areas and demanding engagement between HEI and the private sector: economic incentives for conservation and ecological restoration. The most well-known type of incentive is PES, which can be financial or non-financial, according to several sub-national legislation in Brazil (Young and Castro, 2021). PES existed in a rudimentary form for decades until the 1990s, when it expanded as an integrative conservation mechanism (Wunder et al., 2008). Despite the criticism related to the ethical implications of the economic pricing of nature (Peterson et al., 2010), PES programs have now been implemented in most continents and on different scales: recent accounting registered more than 500 PES schemes (Salzman et al., 2018). Grima et al. (2016) analyzed 40 implemented PES cases in Latin America and showed that projects are started by private sellers (95%, companies, associations, and NGOs). In the case of buyers, there were almost the same number of public (38%) and private buyers (45%) and, less frequently, a mix of public and private buyers (17%). The study concludes that most PES schemes can be considered successful. Among other aspects, positive results were related to compensation, where in-kind contributions (e.g., roads, electricity, and training) seem more effective than cash payments (Grima et al., 2016). Successful PES schemes also flourish in Brazil, especially at the sub-national level (see list of experiences in Scarano et al., 2018b).

Ecological restoration is another sizeable, urgent, and primarily untapped opportunity for corporations in Brazil (Brancalion et al., 2019), although some historic initiatives are often developed as compensation (e.g., Rodrigues, 2009; Scarano et al., 2018a). Reale et al. (2018) showed that of the 11 companies with the best sustainability indices (ISE) in the Brazilian Stock Exchange, only one from the forestry sector demonstrated concern for this component. Auspicious global targets for restoration (such as those set by the biodiversity and the climate conventions) are echoed by Brazil's commitment to the Paris Climate Agreement by restoring 12 million hectares (Scarano, 2017). Recent prioritization efforts for effective restoration to maximize biodiversity, climate gains, and cost-efficiency, both for the planet (Strassburg et al., 2020) and specific Brazilian biomes (Zwiener et al., 2017; Strassburg et al., 2019), provide reliable scientific background for future interventions.

New opportunities

Recent excitement with bioeconomy, ABS, and ESG are related to new business opportunities associated with Brazil's conservation and sustainable use of biodiversity (see summary in Table 3). However, there are gaps in policy, knowledge, and practice that can be gradually circumvented with academic engagement with businesses.

Bioeconomy

Bioeconomy in Brazil has more often been associated with biofuels, mainly derived from the country's breakthrough with sugarcane ethanol use and production (Karp et al., 2021) and with biotechnology applied to agribusiness monocultures (Backhouse, 2021). However, biofuel ethanol has historical issues related to land use, labour, and deforestation (Benites-Lazaro et al., 2020). Biotechnology, in the shape of genetically modified organisms, is associated with socioecological inequalities (Backhouse, 2021). Although biofuel ethanol is not entirely ruled out as an option (e.g., Hernandes et al., 2022), Brazil's contribution to the global bioeconomy comes at a high cost in terms of socioecological issues locally. The shift toward a socioecological fair and just bioeconomy requires a change in the mindset of corporations (Bastos Lima, 2021).

More recently, however, new bioeconomy opportunities have emerged from the potential for sustainable use of agroecological, pharmaceutical, and cosmetic products derived from the sociobiodiversity (Skirycz et al., 2016; Valli et al., 2018) in the Amazon (Shanley et al., 2012; Nobre et al., 2016; Nobre and Nobre, 2020) and elsewhere (Valli and Bolzani, 2019). Several emerging examples follow at least some of those principles in the country. "Symbiosis Investments" (https://symbiosis.com.br/) focuses on sustainable wood products based on 30 native tree species of the Brazilian Atlantic Forest planted in the consortium, and its operations are science-based (e.g., Garuzzo et al., 2021; Santos et al., 2022). In the Amazon, "Belterra Agroforests" (www.belterra.com.br) invests in large-scale agroforests in degraded areas (Abramovay et al., 2021) and is now building a research institute. "Conexsus" (www.conexsus.org), in the Amazon, Cerrado, and Caatinga, makes the links between private socioecological investments with environmental-impact community businesses (Conexsus, 2019; Abramovay et al., 2021; Scarano et al., 2021).

"Re.Green" (www.re.green) is a newly founded company that aims to restore one million hectares of forests, capture carbon, and return the forests to society as protected areas. It partners with research institutes and universities to achieve its goals. The Brazilian Development Bank (BNDES) launched the Living Forest initiative, a public-private partnership that uses ecological restoration to form ecological corridors and to recover river basins throughout the country (https://www.bndes.gov.br/wps/portal/site/home/desenvolvimento-sustentavel/parcerias/floresta-viva). Another exciting example is farmers' cooperatives partnering with businesses, non-governmental organizations, international aid, and academia in agroforestry and oil palm production in what used to be degraded or unproductive areas in the Amazon (Futemma et al., 2020).

Suppose only a fraction of the public investment in science and technology in the agribusiness-oriented bioeconomy (Bastos Lima, 2022) were to be applied in the sociobiodiversity-based economy. In that case, Brazil could leapfrog to become a global power in sustainable bioeconomy (see Table 2 for Brazil's climate emergence bill that awaits congressional review). Despite the apparent potential for this in a megadiversity country (Scarano et al., 2021), Bergamo et al. (2022) argue that four principles should guide the typical extraction approach of forest-based products: zero deforestation, no monocultural practices (with or without native species), equitable benefit sharing with local communities, and strengthening local culture and traditions. When applied to the bioeconomy, all these principles require a scientific background. In this same logic, Scarano et al. (2021), based on an extensive literature review, have listed potential gains and constraints of bioeconomy in megadiversity countries such as Brazil. Improvements include more sustainable use of environmental resources (e.g., in the agricultural and forest-based sectors, in the handling of waste streams and the production of value-added products and bioenergy), renewal of industries, modernization of primary production systems, protection of the environment and enhanced biodiversity by having sustainability and circularity as principles. Potential constraints include the risk of competition between food and bioenergy or biomaterial production causing indirect land use change or deforestation, biodiversity loss, eutrophication, invasive species, high water demand, and risks of subsumption of nature to

Table 4
Prototype of an actionable blueprint for closer engagement between HEIs and businesses concerning biodiversity in Brazil. *Actions* follow the four steps of the policy cycle. *Content* describes the purpose or level whereby the action takes place. *Actors* are examples of stakeholders that could be involved. *Products* are the material results of actions. *Targets* are examples of desirable policy instruments, *references* are comparable experiences, and *existing tools* are elements that already exist in Brazil's science and technology policy framework that can either inspire or be tapped on by HEI-businesses biodiversity initiatives.

Actions	Content	Actors[a]	Products	Possible targets, references, and existing tools and policies		
Set the agenda	Assessment of current state of knowledge, funding, cases, transparency	Academic (e.g., BPBES, SBPC, ABC) and industry federations (e.g., CNI), and NGOs (e.g., CEBDS)	BPBES assessment report	Other BPBES assessments, IPBES[b] assessments and related action platforms produced by industry or academic federations		
Design	Draft policy(ies) to address business-HEI partnerships in issues such as licensing, offsets, private reserves, bioeconomy, ABS, ESG, and others set by the agenda	Governments and/or CNI, sectoral industry federations, individual companies, academic federations, NGOs	Public policy (national or sub-national) and/or business policy, such as those related to knowledge building, capacity building, data sharing and transparency, and funding	Possible targets: 1. Data and knowledge sharing tool for EIAs 2. Grants for HEI-industry biodiversity partnerships 3. National fund to foster knowledge enhancement on biodiversity	References[c]: 1. Runhaar (2016) 2. GOALI (NSF, USA) 3. Amazon Fund	Existing tools[d]: 1. SiBBr, Portal Bio 2. CNPq-companies partnership 3. Map of Innovation Funding
Implement	Any level: national, sub-national, local, or business level	The above actors, plus participation of local actors of interest, when applicable				
Evaluate	Definition of metrics, monitoring, tracking, mapping, and assessing outcomes of policy implementation, which will occasionally set new agendas. For instance, the Atlantic Forest Pact is an example of industry, NGO, government and academic collaboration that has developed monitoring protocols for restoration (Viani et al., 2017).					

[a] Acronyms: BPBES = Brazilian Platform on Biodiversity and Ecosystem Services (www.bpbes.net.br); SBPC = Brazilian Society for the Progress of Science; ABC = Brazilian Academy of Science; CNI = National Industry Confederation.

[b] IPBES = Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (www.ipbes.net).

[c] Runhaar (2016) provides examples on EIA knowledge systems and their interactions with other systems. GOALI = Grant opportunities for academic liaison with industries of the National Science Foundation, USA (www.nsf.gov/eng/eec/goali.jsp). The Amazon Fund is funding mechanism to curb deforestation in the Amazon (www.amazonfund.gov.br).

[d] SiBBr = Brazilian Information System for Biodiversity (www.sibbr.gov.br) of the Ministry of Science and Technology. PortalBio = Biodiversity Platform (www.portaldabiodiversidade.icmbio.gov.br) of the Ministry of Environment. CNPq = Brazilian Research Council, which has a partnership program with companies (https://www.gov.br/cnpq/pt-br/acesso-a-informacao/acoes-e-programas/programas/ciencia-sem-fronteiras/empresas). Map of Innovation Funding is a tool that maps the mechanisms that support innovation in Brazil.

capital. Scientific engagement with entrepreneurs will be a prerequisite to maximize gains and reduce risks.

Access and benefit sharing

Directly related to the sociobiodiversity-based bioeconomy challenge is the issue of ABS. The Nagoya Protocol of the CBD has governed this theme internationally since it was announced in 2010. It has been set to safeguard fair and equitable sharing of benefits from using genetic resources with traditional knowledge holders (Heinrich et al., 2020). Although having played a key diplomatic role in approving the protocol (Mittermeier et al., 2010), Brazil was the 130th party to ratify it, which only took place in 2021. Although ABS is a reasonably new policy and practice in Brazil, there are already some reported cases of success, especially in the cosmetics sector (e.g., Cassol and Sellitto, 2020; Nobre and Nobre, 2018).

However, several challenges remain. Muzaka and Serrano (2019) see it as a challenge for Brazil to play a global role in ABS while having to overcome its governmental bureaucratic hurdles and attending expectations of local knowledge holders. For instance, Brazil's legislation and policy that addresses ABS defines that governance as participatory and coordinated by the Genetic Heritage Management Council (CGen) at the Ministry of Environment. Since the publication of the so-called "Biodiversity Law" in 2015, participation has been unbalanced, with a predominance of the private sector and federal government actors over local knowledge holders, civil society, and academics (Castro and Santos, 2022). The presence of academics in policy implementation such as this is also strategic. Muzaka and Serrano (2019) trust that academic engagement with businesses can help provide safeguards and metrics for benefits while devising participatory processes that define agreements between companies and knowledge holders for ABS. Moreover, developing information systems that might increase transparency and monitoring of arrangements will also be essential, as already seen in the case of environmental licensing. Finally, Carvalho Ribeiro and Soares Filho (2022) call for investments in research, market niches, infrastructure, and capacity building and propose the creation of a National Benefit Sharing Fund to advance biodiversity knowledge.

Environmental, social, and governance

The United Nations Global Compact (2004)'s report on financial markets to a changing world launched the ESG concept. However, only over the last decade has it become a hot topic among businesses since companies are pressured to implement such practices by investors, consumers, and the market (Martins, 2022). Thus, there are now available metrics for ESG, some of which apply to stock exchange ratings, as in the case of Brazilian B3 and its "S&P/B3 Brazil ESG Index" (Amato Neto et al., 2022). Several recent studies on the relationships between ESG investment by companies and their financial performance show that while in developed countries there is a direct positive relationship, this is not the case for developing countries, specifically in Brazil (Garcia and Orsato, 2020; Duque-Grisales and Aguilera-Caracuel, 2021), although others indicate otherwise (Miralles-Quirós et al., 2018). Regardless of this controversy, among ESG metrics and ratings, biodiversity is one of the environmental parameters (Doni and Johannsdottir, 2020). A PricewaterhouseCoopers (PwC, 2019) report indicated that among 1141 companies from 31 countries and across seven industry sectors, biodiversity Sustainable Development Goals 14 and 15 were those of the least concern. Although Brazil was not part of the survey (Chile, Colombia, and Mexico were the Latin American countries assessed), this has been interpreted as an indication of low priority for biodiversity assessment among ESG indica-

tors (Schleich, 2021). Indeed, biodiversity scientists could make an essential contribution to ESG metrics is refining biodiversity incorporation. Sustainable bioeconomy practices, ABS, biodiversity offsets practices, and others we reviewed here could all be accounted for in the ESG metrics.

Recommendation

Table 4 shows how businesses and HEIs in Brazil could further address biodiversity challenges and opportunities nationally. It is inspired by the heuristic tool often used in science-policy interface studies known as the "policy cycle" (Ojanen et al., 2021) and, therefore, comprises four stages: (1) agenda setting: assessment of the current state of the relationship between businesses and biodiversity (to which we hope this paper contributes); (2) design: actions to be taken based on the assessment; (3) implementation: steps to launch the policy designed; (4) evaluation: tracking and monitoring of the actions implemented. Two products immediately derive from that framework: one assessment report about business-biodiversity relationships in Brazil, and consequently, a policy (or a set of policies) to address existing gaps and issues. Models, examples, and even existing structures can develop the products in both cases. For instance, Brazil has a very active Brazilian Platform on Biodiversity and Ecosystems Services (BPBES) – that periodically produces national and thematic assessment reports by engaging multiple actors (Scarano et al., 2019a, b) – and could lead such an initiative. On the policy front, Brazil has some tools and instruments that could inspire or even absorb needs, such as developing a data and knowledge sharing mechanism for EIA, fostering grants to promote research and development to cover knowledge gaps (such as in offsets or bioeconomy, for instance) or building a fund to incentivize biodiversity research applied to challenges addressed in this paper.

Final remarks

This essay shows much room for more substantial academic engagement between biodiversity scientists and businesses in Brazil. Existing public policies (regarding compensation, offsetting, conservation/restoration within private properties, and ABS) and private sector sustainability policies (including ESG and bioeconomy opportunities) demand scientific backing. While it is encouraging to see several successful initiatives reviewed here, there are still multiple hurdles to building a solid HEI-business relationship that mainstreams biodiversity conservation and best practices into businesses in Brazil. Challenges include policy design and implementation gaps, science and technology, and dialogues through participatory processes. The data emerging from this potential engagement will help refine theory and practice related to fields such as those examined here and provide new insights related to public and private conservation and restoration policies and procedures. Achieving the targets of the CBD's Post-2020 Global Biodiversity Framework, including reducing ecosystem and biodiversity loss rates, will require understanding the threats and risks businesses impose on biodiversity, how fast they change in type and intensity, and how to avert them (Leadley et al., 2022). This cannot be fully achieved if data from private properties and private businesses are not part of the equation (e.g., Joppa et al., 2016), particularly considering the large territory cover that such areas represent. For instance, when and if implemented, the land to be protected by the Forest Code plus existing RPPNs is more than double the land protected by public protected areas (Soares-Filho et al., 2014). Academic engagement and associated scientific publications, alongside enriched biodiversity datasets and databases, would also increase private sector practices' quality and transparency. Before businesses can innovate to deliver sustainable processes and products from a biodiversity viewpoint, companies and HEIs will need to innovate their mindset to build effective partnerships to face the urgent biodiversity challenges that Brazil and the planet now encounter. Thus, academia should see a great frontier where scientific knowledge and practice can be expanded in challenges related to biodiversity in the private sector. In academia, companies should see a necessary partner to tackle biodiversity challenges with seriousness, commitment, and transparency they demand.

Conflicts of interest

None.

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References

Abessa, D., Famá, A., Buruaem, L., 2019. The systematic dismantling of Brazilian environmental laws risks losses on all fronts. Nature Ecol. Evol. 3, 510–511, http://dx.doi.org/10.1038/s41559-019-0855-9.

Abramovay, R., Ferreira, J., Costa, F.A., Ehrlich, M., Euler, A.M.C., Young, C.E.F., Kaimowitz, D., Moutinho, P., Nobre, I., Rogez, H., Roxo, E., Schor, T., Villanova, L., Available at: https://www.aamazoniaquequeremos.org/wp-content/uploads/2022/02/Chapter-30-in-Brief-PT.pdf. (Accessed 3 August 2022) 2021. Uma nova bioeconomia na Amazônia: Oportunidades e desafios para florestas e rios saudáveis. Capítulo 30 em Síntese. Science Panel for the Amazon.

Addison, P.F.E., Bull, J.W., Milner-Gulland, E.J., 2018. Using conservation science to advance corporate biodiversity accountability. Conserv. Biol. 33, 307–318, http://dx.doi.org/10.1111/cobi.13190.

Amato Neto, J., dos Anjos, L.C., Cavalcante, Y., Jukemura, P.K., 2022. ESG Investing: Um Novo Paradigma de Investimentos? Editora Edgard Blücher, São Paulo.

Andalaft, R.E., 2019. Corporate Social Responsibility in the electricity sector in Brazil. In: Stehr, C., Dziatzko, N., Struve, F. (Eds.), Corporate Social Responsibility in Brazil: The Future is Now. Springer, Cham, pp. 149–172, http://dx.doi.org/10.1007/978-3-319-90605-8_7.

Andrade, D., Pasini, F., Scarano, F.R., 2020. Syntropy and innovation in agriculture. Curr. Opin. Environ. Sustain. 45, 20–24, http://dx.doi.org/10.1016/j.cosust.2020.08.003.

Backhouse, M., 2021. Global inequalities and extractive knowledge production in the bioeconomy. In: Backhouse, M., Lehmann, R., Lorenzen, K., Lühmann, M., Puder, J., Rodríguez, F., Tittor, A. (Eds.), Bioeconomy and Global Inequalities — Socio-Ecological Perspectives on Biomass Sourcing and Production. Palgrave Macmillan, Cham, pp. 25–44, http://dx.doi.org/10.1007/978-3-030-68944-5_2.

Bansal, P., Song, H.-C., 2017. Similar but not the same: differentiating corporate sustainability from corporate responsibility. Acad. Manag. Ann. 11, 105–149, http://dx.doi.org/10.5465/annals.2015.0095.

Barbosa, C.D.F., Francato, A.L., Barbosa, P.S.F., 2019. Towards Brazilian corporations better stock price valuation and operational performance with Corporate Social Responsibility and Environmental Socio Responsibility. In: Stehr, C., Dziatzko, N., Struve, F. (Eds.), Corporate Social Responsibility in Brazil: The Future is Now. Springer, Cham, pp. 129–146, http://dx.doi.org/10.1007/978-3-319-90605-8_6.

Barkemeyer, R., Stringer, L.C., Hollins, J.A., Josephi, F., 2015. Corporate reporting on solutions to wicked problems: sustainable land management in the mining sector. Environ. Sci. Policy 48, 196–209, http://dx.doi.org/10.1016/j.envsci.2014.12.021.
Bastos Lima, M.G., 2021. Corporate power in the bioeconomy transition: the policies and politics of conservative ecological modernization in Brazil. Sustainability 13, 6952, http://dx.doi.org/10.3390/su13126952.
Bastos Lima, M.G., 2022. Just transition towards a bioeconomy: four dimensions in Brazil, India and Indonesia. For. Policy Econ. 136, 102684, http://dx.doi.org/10.1016/j.forpol.2021.102684.
Bateman, I.J., Coombes, E., Fitzherbert, E., Binner, A., Bad'ura, T., Carbone, C., Fischer, B., Naidoo, R., Watkinson, A.R., 2015. Conserving tropical biodiversity via market forces and spatial targeting. Proc. Natl. Acad. Sci. U. S. A. 112, 7408–7413, http://dx.doi.org/10.1073/pnas.1406484112.
BBOP, 2012. Resource Paper: No Net Loss and Loss–Gain Calculations in Biodiversity Offsets. Business and Biodiversity Offsets Programme, Washington, DC.
BBOP, Washington, D.C. 2018. Working for Biodiversity Net Gain: An Overview of the Business and Biodiversity Offsets Programme (BBOP) 2004–2018.
Benites-Lazaro, L.L., Mello-Théry, N.A., 2019. Empowering communities? Local stakeholders' participation in the Clean Development Mechanism in Latin America. World Dev. 114, 254–266, http://dx.doi.org/10.1016/j.worlddev.2018.10.005.
Benites-Lazaro, L.L., Giatti, L.L., Sousa Jr, W.C., Giarolla, A., 2020. Land-water-food nexus of biofuels: discourse and policy debates in Brazil. Environ. Dev. 33, 100491, http://dx.doi.org/10.1016/j.envdev.2019.100491.
Bergamo, D., Zerbini, O., Pinho, P., Moutinho, P., 2022. The Amazon bioeconomy: beyond the use of forest products. Ecol. Econ. 192, 107448, http://dx.doi.org/10.1016/j.ecolecon.2022.107448.
Bhattacharya, T.R., Managi, S., 2013. Contributions of the private sector to global biodiversity protection: case study of the Fortune 500 companies. Int. J. Biodivers. Sci. Ecosyst. Serv. 9, 65–86, http://dx.doi.org/10.1080/21513732.2012.710250.
Bishop, J. (Ed.), 2012. TEEB — The Economics of Ecosystem and Biodiversity in Business and Enterprise. Earthscan, Routledge, London.
Boiral, O., Heras-Saizarbitoria, I., 2015. Managing biodiversity through stakeholder involvement: why, who, and for what initiatives? J. Bus. Ethics 140, 403–421, http://dx.doi.org/10.1007/s10551-015-2668-3.
Boiral, O., Heras-Saizarbitoria, I., 2017. Best practices for corporate commitment to biodiversity: an organizing framework from G.R.I. reports. Environ. Sci. Policy 77, 77–85, http://dx.doi.org/10.1016/j.envsci.2017.07.012.
Botelho, A., Almeida, M., 2011. Overcoming institutional shortcomings for academic spin-off policies in Brazil. Int. J. Technol. Manag. Sustain. Dev. 3, 175–193, http://dx.doi.org/10.1386/tmsd.9.3.175_1.
Brancalion, P.H.S., Garcia, L.C., Loyola, R., Rodrigues, R.R., Pillar, V.D., Lewinsohn, T.M., 2016. A critical analysis of the Native Vegetation Protection Law of Brazil (2012): updates and ongoing initiatives. Nat. Conserv. 14, 1–15, http://dx.doi.org/10.1016/j.ncon.2016.03.003.
Brancalion, P.H.S., Niamir, A., Broadbent, E., Crouzeilles, R., Barros, F.S.M., Almeyda Zambrano, A.M., Baccini, A., Aronson, J., Goetz, S., Reid, J.L., Strassburg, B.B.N., Wilson, S., Chazdon, R.L., 2019. Global restoration opportunities in tropical rainforest landscapes. Sci. Adv. 5, eaav3223.
Bull, J.W., Brownlie, S., 2017. The transition from no net loss to a net gain of biodiversity is far from trivial. Oryx 51, 53–59, http://dx.doi.org/10.1017/S0030605315000861.
Bull, J.W., Strange, N., 2018. The global extent of biodiversity offset implementation under no net loss policies. Nat. Sustain. 1, 790–798, http://dx.doi.org/10.1038/s41893-018-0176-z.
Carvalho Ribeiro, S., Soares Filho, B., 2022. Opportunities of the Nagoya Protocol to nurture the use of native species in Brazil. Environ. Sci. Policy 127, 321–324, http://dx.doi.org/10.1016/j.envsci.2021.10.033.
Cassol, M., Sellitto, M.A., 2020. Socio-biodiversity supply chain: sustainable practices of a Brazilian cosmetic company. Environ. Qual. Manage. 2020, 1–7, http://dx.doi.org/10.1002/tqem.21700.
Castro, B.S., Santos, A.C.C., 2022. Genetic Heritage Management Council and the coordination of the access and benefit sharing policy in Brazil. Ambiente Soc 25, http://dx.doi.org/10.1590/1809-4422asoc20200178r1vu2022L1AO.
CBD, 3 Sep 2021. Available at: https://www.cbd.int/doc/c/abb5/591f/2e46096d3f0330b08ce87a45/wg2020-03-03-en.pdf. (Accessed 3 September 2021) 2021. First Draft of the Post-2020 Global Biodiversity Framework. Convention on Biological Diversity/WG2020/3/3.
CEBDS, 2020. Statement from the Brazilian Business Sector. Centro Empresarial Brasileiro para o Desenvolvimento Sustentável, Available at: https://cebds.org/wp-content/uploads/2020/07/cebds.org-comunicado-do-setor-empresarial-brasileiro-1310-comunicado-do-setor-empresarial-ing.pdf. (Accessed 10 August 2021).
CEBDS, FBDS, 2021. O Engajamento do Brasil nas Negociações da COP15 de Biodiversidade. In: Luz, H., Loyola, R. (Eds.), CEBDS Conselho Empresarial Brasileiro para o Desenvolvimento Sustentável. , 1a edição, Rio de Janeiro, 28 pp.
Compagnucci, L., Spigarelli, F., Coelho, J., Duarte, C., 2021. Living Labs and user engagement for innovation and sustainability. J. Clean. Prod. 289, 125721, http://dx.doi.org/10.1016/j.jclepro.2020.125721.
Conexsus, Available at: https://desafioconexsus.org/mapa-desafioconexsus/. Accessed: 02 Apr 2021 2019. Mapa De Negócios Comunitários Sustentáveis.
Coralie, C., Guillaume, O., Claude, N., 2015. Tracking the origins and development of biodiversity offsetting in academic research and its implications for conservation: a review. Biol. Conserv. 192, 492–503, http://dx.doi.org/10.1016/j.biocon.2015.08.036.
Crowe, M., ten Kate, K., 2010. Biodiversity Offsets: Policy Options for Government. Business and Biodiversity Offset Partnership, Washington.
Curran, M., Hellweg, S., Beck, J., 2014. Is there any empirical support for biodiversity offset policy? Ecol. Appl. 24 (4), 617–632, http://dx.doi.org/10.1890/13-0243.1.
Dasgupta, P., 2021. The Economics of Biodiversity: The Dasgupta Review. HM Treasury, London.
De Silva, G.C., Regan, E.C., Pollard, E.H.B., Addison, P.F.E., 2019. The evolution of corporate no net loss and net positive impact biodiversity commitments: understanding appetite and addressing challenges. Bus. Strategy Environ. 28, 1481–1495, http://dx.doi.org/10.1002/bse.2379.
Dias, A.M.S., Fonseca, A., Paglia, A.P., 2019. Technical quality of fauna monitoring programs in the environmental impact assessments of large mining projects in southeastern Brazil. Sci. Total Environ. 650, 216–223, http://dx.doi.org/10.1016/j.scitotenv.2018.08.425.
Doni, F., Johannsdottir, L., 2020. Environmental Social and Governance (ESG) ratings. In: Leal Filho, W., Azul, A.M., Brandli, L., Özuyar, P.G., Wall, T. (Eds.), Climate Action. Springer, Cham, pp. 435–449, http://dx.doi.org/10.1007/978-3-319-95885-9.
Donofrio, S., Rothrock, P., Leonard, J., 2017. Supply Change: Tracking Corporate Commitments to Deforestation-Free Supply Chains, 2017. Forest Trends, Washington, D.C.
Dragomir, V.D., 2018. How do we measure corporate environmental performance? A critical review. J. Clean. Prod. 196, http://dx.doi.org/10.1016/j.jclepro.2018.06.014, 1124e1157.
Duque-Grisales, E., Aguilera-Caracuel, J., 2021. Environmental, Social and Governance (ESG) scores and financial performance of multilatinas: moderating effects of geographic international diversification and financial slack. J Bus Ethics 168, 315–334, http://dx.doi.org/10.1007/s10551-019-04177-w.
Durst, S., Zieba, M., 2020. Knowledge risks inherent in business sustainability. J. Clean. Prod. 251, 119–670, http://dx.doi.org/10.1016/j.jclepro.2019.119670.
Dutrénit, G., Arza, V., 2015. Features of interactions between public research organizations and industry in Latin America: the perspective of researchers and firms. In: Albuquerque, E., Suzigan, W., Kruss, G., Lee, K. (Eds.), Developing National Systems of Innovation: University–Industry Interactions in the Global South. Edward Elgar, Cheltenham, pp. 93–119.
European Commission, Available at https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_pt. (Accessed 10 August 2021) 2019. A European Green Deal.
Fischer, B., Schaeffer, P., Vonortas, N., Queiroz, S., 2019. Evolution of university-industry collaboration in Brazil from a technology upgrading perspective. Technol. Forecast. Soc. Change 145, 330–340, http://dx.doi.org/10.1016/j.techfore.2018.05.001.
Futemma, C., Castro, F., Brondizio, E.S., 2020. Farmers and social innovations in rural development: collaborative arrangements in Eastern Brazilian Amazon. Land Use Pol. 99, 104999, http://dx.doi.org/10.1016/j.landusepol.2020.104999.
Garcia, A.S., Orsato, R., 2020. 2020. Testing the institutional difference hypothesis: A study about environmental, social, governance, and financial performance. Bus Strat Env, 1–12, http://dx.doi.org/10.1002/bse.2570v.
Garnett, S.T., Lawes, M.J., James, R., Bigland, K., Zander, K.K., 2016. Portrayal of sustainability principles in the mission statements and on home pages of the world's largest organizations. Conserv. Biol. 30, 297–307, http://dx.doi.org/10.1111/cobi.12617.
Garuzzo, M.S.P.B., Nunes, A.C.P., Santos, A.P., Marques, F.G., 2021. Genetic progress in the breeding population of *Zeyheria tuberculosa* (Ipê-felpudo): from theoretical predictions to clonal recombination orchard assembly. Scientia Forestalis 49 (131), e3653, http://dx.doi.org/10.18671/scifor.v49n131.18.
Gelcich, S., Vargas, C., Carreras, M.J., Castilla, J.C., Donlan, C.J., 2017. Achieving biodiversity benefits with offsets: research gaps, challenges, and needs. Ambio 46 (2), 184–189, http://dx.doi.org/10.1007/s13280-016-0810-9.
Gonçalves, B., Marques, A., Soares, A.M.V.M., Pereira, H.M., 2015. Biodiversity offsets: from current challenges to harmonized metrics. Curr. Opin. Environ. Sustain. 14, 61–67, http://dx.doi.org/10.1016/j.cosust.2015.03.008.
Gradinaru, G., 2014. A business perspective of a natural capital restoration. Procedia Econ. Financ. 10, 97–103, http://dx.doi.org/10.1016/S2212-5671(14)00282-2.
Grima, N., Singh, S.J., Smetschka, B., Ringhofer, L., 2016. Payment for Ecosystem Services (P.E.S.) in Latin America: Analysing the performance of 40 case studies. Ecosyst. Serv. 17, 24–32, http://dx.doi.org/10.1016/j.ecoser.2015.11.010.
Heinrich, M., Scotti, F., Andrade-Cetto, A., Berger-Gonzalez, M., Echeverría, J., Friso, F., Garcia-Cardona, F., Hesketh, A., Hitziger, M., Maake, C., Politi, M., Spadafora, C., Spadafora, R., 2020. Access and benefit sharing under the Nagoya Protocol—Quo vadis? Six Latin American case studies assessing opportunities and risk. Front. Pharmacol. 11, 765, http://dx.doi.org/10.3389/fphar.2020.00765.
Hernandes, T.A.D., de Oliveira Bordonal, R., Duft, D.G., Leal, M.R.L.V., 2022. Implications of regional agricultural land use dynamics and deforestation associated with sugarcane expansion for soil carbon stocks in Brazil. Reg. Environ. Change 22, 49, http://dx.doi.org/10.1007/s10113-022-01907-1.
Instituto LIFE, Curitiba 2014. LIFE-BR-TG01-3.0-english. Life Technical Guide e 01 — Definition of Minimum Performance in Biodiversity Conservation Actions - Life Certification Quantitative Approach (N^2 3.0).

IPBES, 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. IPBES Secretariat, Bonn. https://ipbes.net/sites/default/files/ inline/files/ipbes_global_assessment_report_summary_for_policymakers.pdf.

IPCC, 2021. Summary for policymakers. In: MassonDelmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J.B.R., Maycock, T.K., Waterfield, T., Yelekçi, O., Yu, R., Zhou, B. (Eds.), Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press (in press).

IRP, 2021. In: Potočnik, J., Teixeira, I. (Eds.), Building Biodiversity: The Natural Resource Management Approach. International Resource Panel, United Nations Environment Program, Paris, France.

Joly, C.A., Scarano, F.R., Bustamante, M., Gadda, T.M.C., Metzger, J.P.W., Seixas, C.S., Ometto, J.P.H.B., Pires, A.P.F., Boesing, A.L., Sousa, F.D.R., Quintão, J.M.B., Gonçalves, L.R., Padgurschi, M.C.G., Aquino, M.F.S., Castro, P.F.D., Santos, I.L., 2019. Brazilian assessment on biodiversity and ecosystem services: summary for policy makers. Biota Neotropica 19 (4), e20190865, http://dx.doi.org/10.1590/1676-0611-BN-2019-0865.

Jones, J., Zubielqui, C., 2017. Doing well by doing good: a study of university-industry interactions, innovationess and firm performance in sustainability-oriented Australian S.M.E.s. Technol. Forecast. Soc. Change 123, 262–270, http://dx.doi.org/10.1016/j.techfore.2016.07.036.

Joppa, L.N., O'Connor, B., Visconti, P., Smith, C., Geldmann, J., Hoffmann, M., Watson, J.E.M., Butchart, S.H.M., Virah-Sawmy, M., Halpern, B.S., Ahmed, S.E., Balmford, A., Sutherland, W.J., Harfoot, M., Hilton-Taylor, C., Foden, W., Di Minin, E., Pagad, S., Genovesi, P., Hutton, J., Burgess, N.D., 2016. Filling in biodiversity threat gaps. Science 352, 416–418, http://dx.doi.org/10.1126/science.aaf3565.

Kahn, K.B., 2018. Understanding innovation. Bus. Horiz. 61, 453–460, http://dx.doi.org/10.1016/j.bushor.2018.01.011.

Kamal, S., Grodzinska-Jurczak, M., Brown, G., 2015. Conservation on private land: a review of global strategies with a proposed classification system. J. Environ. Plan. Manag. 58, 576–597, http://dx.doi.org/10.1080/09640568.2013.875463.

Karp, S.G., Medina, J.D.C., Letti, L.A.J., Woiciechowski, A.L., Carvalho, J.C., Schmitt, C.C., Penha, R.O., Kumlehn, G.S., Soccol, C.R., 2021. Bioeconomy and biofuels: the case of sugarcane ethanol in Brazil. Biofuels Bioprod. Bioref., http://dx.doi.org/10.1002/bbb.2195.

Kruss, G., Lee, K., Suzigan, W., Albuquerque, E., 2015. Introduction. In: Albuquerque, E., Suzigan, W., Kruss, G., Lee, K. (Eds.), Developing National Systems of Innovation: University—Industry Interactions in the Global South. Edward Elgar, Cheltenham, pp. 1–27.

Lang, D.J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., Thomas, C.J., 2012. Transdisciplinary research in sustainability science: practice, principles, and challenges. Sustain. Sci. 7 (Suppl. 1), 25–43.

Leadley, P., Gonzalez, A., Obura, D., Krug, C.B., Londoño-Murcia, M.C., Millette, K.L., Radulovici, A., Rankovic, A., Shannon, L.J., Archer, E., Armah, F.A., Bax, N., Chaudhari, K., Costello, M.J., Dávalos, L.M., Roque, Fde O., DeClerck, F., Dee, L.E., Essl, F., Ferrier, S., Genovesi, P., Guariguata, M.R., Hashimoto, S., Ifejika Speranza, C., Isbell, F., Kok, M., Lavery, S.D., Leclère, D., Loyola, R., Lwasa, S., McGeoch, M., Mori, A.S., Nicholson, E., Ochoa, J.M., Öllerer, K., Polasky, S., Rondinini, C., Schroer, S., Selomane, O., Shen, X., Strassburg, B., Sumaila, U.R., Tittensor, D.P., Turak, E., Urbina, L., Vallejos, M., Vázquez-Domínguez, E., Verburg, P.H., Visconti, P., Woodley, S., Xu, J., 2022. Achieving global biodiversity goals by 2050 requires urgent and integrated actions. One Earth 5, 597–603, http://dx.doi.org/10.1016/j.oneear.2022.05.009.

Lee, K., 2013. Schumpeterian Analysis of Economic Catch-Up: Knowledge, Path Creation, and the Middle-Income Trap. Cambridge University Press, Cambridge.

Lee, K., Malerba, F., 2017. Catch-up cycles and changes in industrial leadership: windows of opportunity and responses of firms and countries in the evolution of sectoral systems. Res. Policy 46, 338–351, http://dx.doi.org/10.1016/j.respol.2016.09.006.

Mace, G.M., Barrett, M., Burgess, N.D., Cornell, S.E., Freeman, R., Grooten, M., Purvis, A., 2018. Aiming higher to bend the curve of biodiversity loss. Nat. Sustain. 1, 448–451, http://dx.doi.org/10.1038/s41893-018-0130-0.

Magris, R.A., Giarrizzo, T., 2020. Mysterious oil spill in the Atlantic Ocean threatens marine biodiversity and local people in Brazil. Mar. Pollut. Bull. 153, 110961, http://dx.doi.org/10.1016/j.marpolbul.2020.110961.

Magris, R.A., Marta-Almeida, M., Monteiro, J.A.F., Ban, N.C., 2019. A modelling approach to assess the impact of land mining on marine biodiversity: assessment in coastal catchments experiencing catastrophic events (SWBrazil). Sci. Total Environ. 659, 828–840, http://dx.doi.org/10.1016/j.scitotenv.2018.12.238.

Manyika, J., Birshan, M., Smit, S., Woetzel, J., Russell, K., Purcell, L., Ramaswamy, S., 2021. A New Look at How Corporations Impact the Economy and Households. McKinsey Global Institute, Available at https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/a-new-look-at-how-corporations-impact-the-economy-and-households. (Accessed in 3 August 2022).

Martins, H.C., 2022. Competition and ESG practices in emerging markets: evidence from a difference-in-differences model. Finance Res. Lett. 46, 102371, http://dx.doi.org/10.1016/j.frl.2021.102371.

Meiβner, N., 2013. The incentives of private companies to invest in protected area certificates: how coalitions can improve ecosystem sustainability. Ecol. Econ. 95, 148–158, http://dx.doi.org/10.1016/j.ecolecon.2013.08.015.

Miralles-Quirós, M.M., Miralles-Quirós, J.L., Gonçalves, L.M.V., 2018. The value relevance of environmental, social, and governance performance: the Brazilian case. Sustainability 10, 574, http://dx.doi.org/10.3390/su10030574.

Mittermeier, R., Baião, P.C., Barrera, L., Buppert, T., McCullough, J., Langrand, O., Larsen, F.W., Scarano, F.R., 2010. O protagonismo do Brasil no histórico acordo global de proteção à biodiversidade. Natureza e Conservação 8, 197–200, http://dx.doi.org/10.4322/natcon.00802017.

Moon, C.J., 2019. 'Rio+25', The Global Compact in Brazil and opportunities presented by The U.N. Sustainable Development Goals. In: Stehr, C., Dziatzko, N., Struve, F. (Eds.), Corporate Social Responsibility in Brazil: The Future is Now. Springer, Cham, pp. 3–27, http://dx.doi.org/10.1007/978-3-319-90605-8_1.

Moran, D., Kanemoto, K., 2017. Identifying species threat hotspots from global supply chains. Nature Ecol. Evol. 1, 0023, http://dx.doi.org/10.1038/s41559-016-0023.

Moreno-Mateos, D., Maris, V., Béchet, A., Curran, M., 2015. The true loss caused by biodiversity offsets. Biol. Conserv. 192, 552–559, http://dx.doi.org/10.1016/j.biocon.2015.08.016.

Muzaka, V., Serrano, O.R., 2019. Teaming Up? China, India and Brazil and the issue of benefit-sharing from genetic resource use. New Political Econ. 25 (5), 734–754, http://dx.doi.org/10.1080/13563467.2019.1584169.

Nobre, I., Nobre, C.A., 2018. The Amazonia Third Way Initiative: the role of technology to unveil the potential of a novel tropical biodiversity-based economy. In: Loures, L.C. (Ed.), Land Use: Assessing the Past, Envisioning the Future. Intech Open, Vienna, http://dx.doi.org/10.5772/intechopen.80413.

Nobre, C.A., Nobre, I., 2020. The need of a novel sustainable development paradigm for the Amazon. Bol. Reg. Urb. Ambient. 22, 159–170.

Nobre, C.A., Sampaio, G., Borma, L.S., Castilla-Rubio, J.C., Silva, J.S., Cardoso, M., 2016. Land-use and climate change risks in the Amazon and the need of a novel sustainable development paradigm. Proc. Natl. Acad. Sci. U. S. A. 113, 10759–10768, http://dx.doi.org/10.1073/pnas.1605516113.

Ojanen, M., Brockhaus, M., Korhonen-Kurki, K., Petrokofsky, G., 2021. Navigating the science-policy interface: forest researcher perspectives. Environ. Sci. Policy 118, 10–17, http://dx.doi.org/10.1016/j.envsci.2021.01.002.

Oliva, F.L., Semensato, B.I., Prioste, D.B., Winandy, E.J.L., Bution, J.L., Couto, M.H.G., Bottacin, M.A., Mac Lennan, M.L.F., Teberga, P.M.F., Santos, R.F., Singh, S.K., Silva, S.Fda, Massaini, A.S., 2019. Innovation in the main Brazilian business sectors: characteristics, types and comparison of innovation. J. Knowl. Manag. 23 (1), 135–175, http://dx.doi.org/10.1108/JKM-03-2018-0159.

Oliveira, R.K., Andreoli, C.V., Cavalcante, P.M., 2019. Curbing corruption in Brazilian environmental governance: a collective action and problem-solving approach. In: Stehr, C., Dziatzko, N., Struve, F. (Eds.), Corporate Social Responsibility in Brazil: The Future Is Now. Springer, Cham, pp. 213–240, http://dx.doi.org/10.1007/978-3-319-90605-8_10.

Orsato, R.J., Garcia, A., Mendes-Da-Silva, W., Simonetti, R., Monzoni, M., 2015. Sustainability indexes: why join in? A study of the 'Corporate Sustainability Index (I.S.E.)' in Brazil. J. Clean. Prod. 96, 161–170, http://dx.doi.org/10.1016/j.jclepro.2014.10.071.

Ortas, E., Moneva, J.M., Salvador, M., 2012. Does socially responsible investment equity indexes in emerging markets pay off? Evidence from Brazil. Emerg. Mark. Rev. 13, 581–597, http://dx.doi.org/10.1016/j.ememar.2012.09.004.

Pena, J.C.C., Assis, J.C., Silva, R.A., Honda, L.K., Pagani, M.I., Ribeiro, M.C., 2017. Beyond the mining pit: the academic role in social deliberation for participatory environmental planning. Perspect. Ecol. Conserv. 15, 194–198, http://dx.doi.org/10.1016/j.pecon.2017.06.006.

Perkmann, M., Salandra, R., Tartari, V., McKelvey, M., Hughes, A., 2021. Academic engagement: a review of the literature 2011–2019. Res. Policy 50, 104114, http://dx.doi.org/10.1016/j.respol.2020.104114.

Peterson, M.J., Hall, D.M., Feldpausch-Parker, A.M., Peterson, T.R., 2010. Obscuring ecosystem function with application of the ecosystem services concept. Conserv. Biol. 24, 113–119, http://dx.doi.org/10.1111/j.1523-1739.2009.01305.x.

Pires, A.P.F., Rezende, C.L., Assad, E.D., Loyola, R., Scarano, F.R., 2017. Forest restoration can increase the Rio Doce watershed resilience. Perspect. Ecol. Conserv. 15, 187–193, http://dx.doi.org/10.1016/j.pecon.2017.08.003.

Póvoa, L.M.C., 2008. A crescente importância das universidades e institutos públicos de pesquisa no processo de catching-up tecnológico. Rev. Econ. Contemp. 12, 273–300, http://dx.doi.org/10.1590/S1415-98482008000200004.

Puffal, D.P., Ruffoni, J., Spricigo, G., 2021. Empirical evidence for Brazilian firms in terms of University-industry interaction, public funding and innovation outcome. Int. J. Innov. Manag. 25, 2150040, http://dx.doi.org/10.1142/S1363919621500407.

PwC, 2019. Creating a Strategy for a Better World. Pricewaterhouse Coopers www.pwc.com/sdgchallenge.

Rainey, H.J., Pollard, E.H.B., Dutson, G., Ekstrom, J.M.M., Livingstone, S.R., Temple, H.J., Pilgrim, J.D., 2015. A review of corporate goals of no net loss and net positive impact on biodiversity. Oryx 49, 232–238, http://dx.doi.org/10.1017/S0030605313001476.

Reale, R., Magro, T.C., Ribas, L.C., 2018. Measurement and analyses of biodiversity conservation actions of corporations listed in the Brazilian stock exchange's corporate sustainability index. J. Clean. Prod. 170, 14–24, http://dx.doi.org/10.1016/j.jclepro.2017.09.123.

Rezende, C.L., Scarano, F.R., Assad, E.D., Joly, C.A., Metzger, J.P., Strassburg, B.B.N., Tabarelli, M., Fonseca, G.A., Mittermeier, R.A., 2018. From hotspot to hopespot: an opportunity for the Brazilian Atlantic Forest. Perspect. Ecol. Conserv. 16, 208–214, http://dx.doi.org/10.1016/j.pecon.2018.10.002.

Rodrigues, R.R., 2009. On the restoration of high diversity forests: 30 years of experience in the Brazilian Atlantic Forest. Biol. Conserv. 142, 1242–1251, http://dx.doi.org/10.1016/j.biocon.2008.12.008.
Runhaar, H., 2016. Tools for integrating environmental objectives into policy and practice: what works where? Environ. Impact Assess. Rev. 59, 1–9, http://dx.doi.org/10.1016/j.eiar.2016.03.003.
Salzman, J., Bennett, G., Carroll, N., Goldstein, A., Jenkins, M.M., 2018. The global status and trends of payments for ecosystem services. Nat. Sustain. 1, 136–144, http://dx.doi.org/10.1038/s41893-018-0033-0.
Santos, A.P., Nunes, A.C.P., Garuzzo, M.S.P.B., Corrêa, R.X., Marques, F.C., 2022. Genetic variability and predicted gain in progeny tests of native Atlantic Forest timber species: *Cariniana legalis*, *Cordia trichotoma*, and *Zeyheria tuberculosa*. Ann. For. Res. 65 (1), 85–96, http://dx.doi.org/10.15287/afr.2022.2106.
Scarano, F.R., 2017. Ecosystem-based adaptation to climate change: concept, scalability and a role for conservation science. Perspect. Ecol. Conserv 15, 65–73, http://dx.doi.org/10.1016/j.pecon.2017.05.003.
Scarano, F.R., Bozelli, R.L., Dias, A.T.C., Assireu, A., Capossoli, D.J., Esteves, F.A., Figueiredo-Barros, M.P., Nunes, M.F.Q.S., Roland, F., Sansevero, J.B.B., Rajão, P.H.M., Reis, A., Zamith, L.R., 2018a. Twenty-five years of restoration of an Igapó Forest in Central Amazonia, Brazil. In: Myster, R. (Ed.), Igapó (Black-Water Flooded Forests) of the Amazon Basin. Springer, Cham, pp. 279–294, http://dx.doi.org/10.1007/978-3-319-90122-0_15.
Scarano, F.R., Garcia, K., Diaz-de-Leon, A., Queiroz, H.L., Rodriguez Osuna, V., Silvestri, L.C., Diaz, M.C.F., Perez-Maqueo, O., Rosales, B.M., Salabarria, F.D.M., Zanetti, E.A., Farinaci, J.S., Chapter 6 2018b. Options for governance and decision-making across scales and sectors. In: Rice, J., Seixas, C.S., Zaccagnini, M.E., Bedoya-Gaitan, M., Valderrama, N. (Eds.), IPBES: The IPBES Regional Assessment Report on Biodiversity and Ecosystem Services for the Americas. Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn, Germany, pp. 521–581.
Scarano, F.R., Queiroz, H.L., Farinaci, J.S., Almeida, T.H.M.P., Castro, P.F.D., Dalcin, E., Drucker, D.P., Gonçalves, L.R., Landeiro, M.P., Monteiro Filho, C.J., Padgurschi, M.C.G., Vogt, N., Loyola, R.D., Melo, F., Cervone, C.O.F.O., Strassburg, B.B.N., 2019a. Opções de governança e tomada de decisão através de escalas e setores. In: Joly, C.A., Scarano, F.R., Seixas, C.S., Metzger, J.P., Ometto, J.P., Bustamante, M.M.C., Padgurschi, M.C.G., Pires, A.P.F., Castro, P.F.D., Gadda, T., Toledo, P. (Eds.), 1° Diagnóstico Brasileiro de Biodiversidade e Serviços ecossistêmicos. Editora Cubo, São Carlos, pp. 250–290.
Scarano, F.R., Padgurschi, M.C.G., Pires, A.P.F., Castro, P.F.D., Farinaci, J.S., Bustamante, M., Metzger, J.-P., Ometto, J.-P., Seixas, C.S., Joly, C.A., 2019b. Increasing effectiveness of the science-policy interface in the socioecological arena in Brazil. Biol. Conserv. 240, 108227, http://dx.doi.org/10.1016/j.biocon.2019.108227.
Scarano, F.R., Aguiar, A.C.F., Mittermeier, R.A., Rylands, A.B., 2021. Megadiversity. In: Scheiner, S. (Ed.), Encyclopaedia of Biodiversity 3. Reference Module in Life Sciences. Elsevier, Amsterdam, http://dx.doi.org/10.1016/B978-0-12-822562-2.00013-X.
Schleich, M.V., 2021. Do ESG Metrics Impact Financial Performance in Brazil? Professional Masters Dissertation. Getúlio Vargas Foundation, São Paulo.
Shanley, P., Silva, M.S., Melo, T., Carmenta, R., Nasi, R., 2012. From conflict of use to multiple use: forest management innovations by small holders in Amazonian logging frontiers. For. Ecol. Manag. 268, 70–80.
Siddiqi, A., Collins, R.D., 2017. Sociotechnical systems and sustainability: current and future perspectives for inclusive development. Curr. Opin. Environ. Sustain. 24, 7–13, http://dx.doi.org/10.1016/j.cosust.2017.01.006.
Silva, J.M.C., Pinto, L.P., Scarano, F.R., 2021. Toward integrating private conservation lands into national protected area systems: lessons from a megadiversity country. Conserv. Sci. Pract. 3, e433, http://dx.doi.org/10.1111/csp2.433.
Skirycz, A., Kierszniowska, S., Méret, M., Willmitzer, L., Tzotzos, G., 2016. Medicinal bioprospecting of the Amazon rainforest: a modern Eldorado? Trends Biotechnol. 34, 781–790, http://dx.doi.org/10.1016/j.tibtech.2016.03.006.
Smith, T., Beagley, L., Bull, J., Milner-Gulland, E.J., Smith, M., Vorhies, F., Addison, P.F.E., 2020. Biodiversity means business: Reframing global biodiversity goals for the private sector. Conserv Lett 13, e12690, http://dx.doi.org/10.1111/conl.12690.
Soares-Filho, B., Rajao, R., Macedo, M., Carneiro, A., Costa, W., Coe, M., Rodrigues, H., Alencar, A., 2014. Cracking Brazil's Forest Code. Science 344, 363–364, http://dx.doi.org/10.1126/science.1246663.
Soares-Filho, B., Rajão, R., Merry, F., Rodrigues, H., Davis, J., Lima, L., Macedo, M., Coe, M., Carneiro, A., et al., 2016. Brazil's market for trading forest certificates. PLoS One 11 (4), e0152311, http://dx.doi.org/10.1371/journal.pone.0152311.
Souza, B.A., Rosa, J.C.S., Siqueira-Gay, J., Sánchez, L.E., 2021. Mitigating impacts on ecosystem services requires more than biodiversity offsets. Land Use Pol 105, 105393, http://dx.doi.org/10.1016/j.landusepol.2021.105393.
Souza, B.A., Sánchez, L.E., 2018. Biodiversity offsets in limestone quarries: investigation of practices in Brazil. Resour. Policy 57, 213–223, http://dx.doi.org/10.1016/j.resourpol.2018.03.007.
Stephens, J.C., Hernandez, M.E., Román, M., Graham, A.C., Scholz, R.W., 2008. Higher education as a change agent for sustainability in different cultures and contexts. Int. J. Sustain. High. Educ. 9, 317–338, http://dx.doi.org/10.1108/14676370810885916.
Strassburg, B.B.N., Beyer, H.L., Crouzeilles, R., Iribarrem, A., Barros, F., Siqueira, M.F., Sánchez-Tapia, A., Balmford, A., Sansevero, J.B.B., Brancalion, P., Broadbent, E.N., Chazdon, R.L., Oliveira-Filho, A., Gardner, T., Gordon, A., Latawiec, A., Loyola, R., Metzger, J.P., Mills, M., Possingham, H.P., Rodrigues, R.R., Scaramuzza, C.A.M., Scarano, F.R., Tambosi, L., Uriarte, M., 2019. Strategic approaches to restoring ecosystems can triple conservation gains and halve costs. Nature Ecol. Evol. 3, 62–70, http://dx.doi.org/10.1038/s41559-018-0743-8.
Strassburg, B.B.N., Iribarrem, A., Beyer, H.L., Cordeiro, C.L., Crouzeilles, R., Jakovac, C.C., Junqueira, A.B., Lacerda, E., Latawiec, A.E., Balmford, A., Brooks, T.M., Butchart, S.H.M., Chazdon, R.L., Erb, K.-H., Brancalion, P., Buchanan, G., Cooper, D., Díaz, S., Donald, P.F., Kapos, V., Leclère, D., Miles, L., Obersteiner, M., Plutzar, C., Scaramuzza, C.A.M., Scarano, F.R., Visconti, P., 2020. Global priority areas for ecosystem restoration. Nature 586, 724–729, http://dx.doi.org/10.1038/s41586-020-2784-9.
Sukhdev, P., 2012. The corporate climate overhaul. Nature 486, 27–28, http://dx.doi.org/10.1038/486027a.
Tagliapietra, S., Wolff, G.B., 2021. Form a climate club: United States, European Union and China. Nature 591, 526–528, http://dx.doi.org/10.1038/d41586-021-00736-2.
Turnhout, E., McElwee, P., Chiroleu-Assouline, M., Clapp, J., Isenhour, C., Kelemen, E., Jackson, T., Miller, D.C., Rusch, G.M., Spangenberg, J.H., Waldron, A., 2020. Enabling transformative economic change in the post-2020 biodiversity agenda. Conserv. Lett. 14 (4), e12805, http://dx.doi.org/10.1111/conl.12805.
United Nations Environment Programme, Nairobi 2021. Making Peace With Nature: A Scientific Blueprint to Tackle the Climate, Biodiversity and Pollution Emergencies. https://www.unep.org/resources/making-peace-nature.
United Nations Global Compact, 2004. Who Cares Wins: Connecting Financial Markets to Changing World. United Nations Department of Public Information, Available at: https://d306pr3pise04h.cloudfront.net/docs/issues_doc%2FFinancial_markets%2Fwho_cares_who_wins.pdf. (Accessed 3 August 2022).
Valli, M., Bolzani, V.S., 2019. Natural products: perspectives and challenges for use of Brazilian plant species in the bioeconomy. An. Acad. Bras. Ciênc. 91 (Suppl. 3), http://dx.doi.org/10.1590/0001-3765201920190208, e20190208.
Valli, M., Russo, H.M., Bolzani, V.S., 2018. The potential contribution of the natural products from Brazilian biodiversity to bioeconomy. An. Acad. Bras. Ciênc. 90 (1 Suppl. 1), 763–778, http://dx.doi.org/10.1590/0001-3765201820170653.
Viana, L., Jabour, D., Ramirez, P., da Cruz, G., 2018. Patents go to the market? University-industry technology transfer from a Brazilian perspective. J. Technol. Manag. Innov. 13 (3), 24–34, http://dx.doi.org/10.4067/S0718-27242018000300024.
Viani, R.A.G., Holl, K.D., Padovezi, A., Strassburg, B.B.N., Farah, F.T., Garcia, L.C., Chaves, R.B., Rodrigues, R.R., Brancalion, P.H.S., 2017. Protocol for monitoring tropical forest restoration: perspectives from the Atlantic Forest Restoration Pact in Brazil. Trop. Conserv. Sci. 10, http://dx.doi.org/10.1177/1940082917697265.
Vieira, R.R.S., Ribeiro, B.R., Resende, F.M., Brum, F.T., Machado, N., Sales, L.P., Macedo, L., Soares-Filho, B., Loyola, R., 2018. Compliance to Brazil's Forest Code will not protect biodiversity and ecosystem services. Divers. Distrib. 24, 434–438, http://dx.doi.org/10.1111/ddi.12700.
Vieira, R.R.S., Pressey, R.L., Loyola, R., 2019. The residual nature of protected areas in Brazil. Biol. Conserv. 233, 152–161, http://dx.doi.org/10.1016/j.biocon.2019.02.010.
Villarroya, A., Barros, A.C., Kiesecker, J., 2014. Policy development for environmental licensing and biodiversity offsets in latin America. PLoS One 9 (9), e107144, http://dx.doi.org/10.1371/journal.pone.0107144.
WEF, 2020. The Future of Nature and Business. World Economic Forum, Geneva.
Weissgerber, M., Roturier, S., Julliard, R., Guillet, F., 2019. Biodiversity offsetting: certainty of the net loss but uncertainty of the net gain. Biol. Conserv. 237, 200–208, http://dx.doi.org/10.1016/j.biocon.2019.06.036.
Wright, C., Rwabizambuga, A., 2006. Institutional pressures, corporate reputation, and voluntary codes of conduct: an examination of the equator principles. Bus. Soc. Rev. 111, 89–117, http://dx.doi.org/10.1111/j.1467-8594.2006.00263.x.
Wunder, S., Engel, S., Pagiola, S., 2008. Taking stock: a comparative analysis of payments for environmental services programs in developed and developing countries. Ecol. Econ. 65, 834–852, http://dx.doi.org/10.1016/j.ecolecon.2008.03.010.
Young, C.E.F., Castro, B.S., 2021. Financing mechanisms to bridge the resource gap to conserve biodiversity and ecosystem services in Brazil. Ecosyst. Serv. 50, 101321, http://dx.doi.org/10.1016/j.ecoser.2021.101321.
Zwiener, V.P., Padial, A.A., Marques, M.C.M., Faleiro, F.V., Loyola, R., Peterson, A.T., 2017. Planning for conservation and restoration under climate and land use change in the Brazilian Atlantic Forest. Divers. Distrib. 23, 955–966, http://dx.doi.org/10.1111/ddi.12588.