



Brazilian assessment on biodiversity and ecosystem services: summary for policy makers

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Abstract: Biodiversity and ecosystems are important elements for addressing national and global socioeconomic and environmental crises, since they provide new development opportunities, for example, as source of job and income creation, and reduction in poverty and socioeconomic inequity. Brazilian biological diversity is also expressed in its immense cultural diversity, with a great variety of knowledge holders. These peoples possess vast knowledge on agrobiodiversity, fishing, fire management, natural medicine, among others of commercial, cultural and spiritual value. The main conclusions of this Summary for Police Makers is that land use changes and climate changes have been - and will continue to be throughout this century - the main drivers that result in the loss of biodiversity and ecosystem services in the country. Political interventions at different levels (from local to national, from public to private) and the enforcement of existing laws (regulatory mechanisms and incentives) are required to cope with the mitigation of the negative impacts of biodiversity and ecosystem services loss. Brazil has already a wide variety of policy instruments and socioenvironmental governance options, as well as global commitments (ODS, Aich Targets, Paris Agreement) related to the objective of a sustainable future. However, inefficient management control or lack of incentive to comply with the rules pose risks to consolidating the path to this future. The country has strong and capable institutions, but infrastructural problems, slow processes, inefficient measurements and judicial, social and ecological conflicts obstruct a proficient performance. There is a lack of communication between science and society which needs to be improved by establishing an effective flow that makes communication inclusive and representative, reaching public and private decision makers. Permanent efforts to integrate Science and policy knowledges are desirable to build confidence between policy makers and researchers.

Keywords: Sustainable use, direct and indirect drivers; land use; climate change; policy instrument; global commitments.

Diagnóstico brasileiro sobre biodiversidade e serviços ecossistêmicos: sumário para tomadores de decisão

Resumo: A biodiversidade e os ecossistemas são elementos importantes para enfrentar as crises socioeconômicas e ambientais nacionais e globais, uma vez que proporcionam novas oportunidades de desenvolvimento. Incorporar a biodiversidade na vida cotidiana é uma oportunidade de ouro para promover o uso sustentável da biodiversidade e dos serviços ecossistêmicos. A conservação e a restauração da biodiversidade, dos ecossistemas e de seus serviços associados mostram potencial para um novo desenvolvimento social e econômico, como fonte de geração de emprego e renda, redução da pobreza e da desigualdade socioeconômica. A diversidade biológica brasileira também se expressa em sua imensa diversidade cultural, com uma grande variedade de detentores de conhecimento indígenas e tradicionais. Esses povos possuem vasto conhecimento sobre agrobiodiversidade, pesca, manejo do fogo, medicina natural, entre outros de valor comercial, cultural e espiritual. As principais conclusões deste Sumário para Tomadores de Decisão é que as mudanças no uso da terra e as mudanças climáticas tenham sido – e continuarão sendo ao longo deste século – os principais vetores da perda de biodiversidade e serviços ecossistêmicos no país. Intervenções políticas em diferentes níveis (do local ao nacional, do público ao privado) e a aplicação das leis existentes (mecanismos regulatórios e incentivos) são necessárias para promover a mitigação dos impactos negativos sobre a biodiversidade e a perda de serviços ecossistêmicos. O Brasil já possui uma ampla variedade de instrumentos de política e opções de governança socioambiental, bem como compromissos globais (ODS, Metas de Aichi, Acordo de Paris) relacionados à possibilidade de um futuro sustentável. Entretanto, o controle ineficiente da gestão ou a falta de incentivo para cumprir as regras traz riscos para a consolidação do caminho para esse futuro. O país tem instituições fortes e capazes, mas problemas de infraestrutura, processos lentos, medidas ineficazes e conflitos judiciais, sociais e ecológicos impedem a realização de um desempenho eficiente. Há uma falta de comunicação entre a ciência e a sociedade que precisa ser melhorada por meio do estabelecimento de um fluxo efetivo que torne a comunicação inclusiva e representativa, alcançando os tomadores de decisão públicos e privados. Esforços permanentes para integrar essas duas esferas de conhecimento na sociedade são desejáveis para criar confiança entre os formuladores de políticas e os pesquisadores.

Palavras-chave: *Uso sustentável, vetores diretos e indiretos; uso da terra; mudanças climáticas; instrumentos de política; compromissos globais.*

About the Summary for Policy Makers

This summary for policy makers (SPM) objectively summarizes the 1st Assessment on Biodiversity and Ecosystem Services (Joly et al. 2019) written by the Brazilian Platform of Biodiversity and Ecosystems (BPBES). The BPBES is an independent group formed by around 100 authors, including professors, researchers, environmental managers and/or decision makers, who have met regularly since November 2015. During the assessment preparation process, sectoral working meetings were held with groups of interest (federal government, non-governmental organizations, companies, indigenous representatives and journalists) to share the main results, as well as hear, discuss and assimilate other points of view and suggestions. The platform receives funding from the CNPq (National Council for Scientific and Technological Development) and the Biota Program/Fapesp, and institutional support from the SBPC (Brazilian Society for Progress in Science), ABC (Brazilian Academy of Sciences) and FBDS (Brazilian Foundation for Sustainable Development).

The report in which this SPM was drawn (Joly et al. 2019) consists of 5 chapters - 1) The context of the Brazilian Assessment on Biodiversity and Ecosystem Services; 2) Nature's contributions to the quality of life; 3) Trends and impacts of degradation and recovery of biodiversity and ecosystem services drivers; 4) Interactions between nature and society: trajectories from the present to the future; and 5) Options for governance and decision-making across scales and sectors – and is available for download at the platform webpage www.bpb.es.net.br/en/.

1. Contextualization

- **The loss of biodiversity caused by the conversion of native ecosystems and the unsustainable use of natural resources threatens essential processes for human well-being. The growing systemic crisis (economic, climatic, hydrological, food and migratory) in Brazil is contrasted by the country's vast range of natural resources and opportunities to address these demands.** Its enormous natural capital provides the conditions needed to transform the conservation and sustainable use of environmental assets into development opportunities capable of dealing with future climate changes, while promoting socioeconomic prosperity. This unusual combination results from the fact that the high potential for economic production (present and future) depends on maintaining biodiversity resources and associated ecosystem services (Figure 1).
- **A prosperous future for the Brazilian population will depend on the choices and measures taken now, in terms of the country's sustainable development.** To construct a sustainable future, it is essential to understand the intrinsic and monetary value of biodiversity and ecosystem services for creating jobs and income, as well as reducing social and economic inequities. This scenario will only be possible, however, if the contribution of biodiversity in achieving social and economic development is recognized and encouraged. Sustainable Brazilian products could

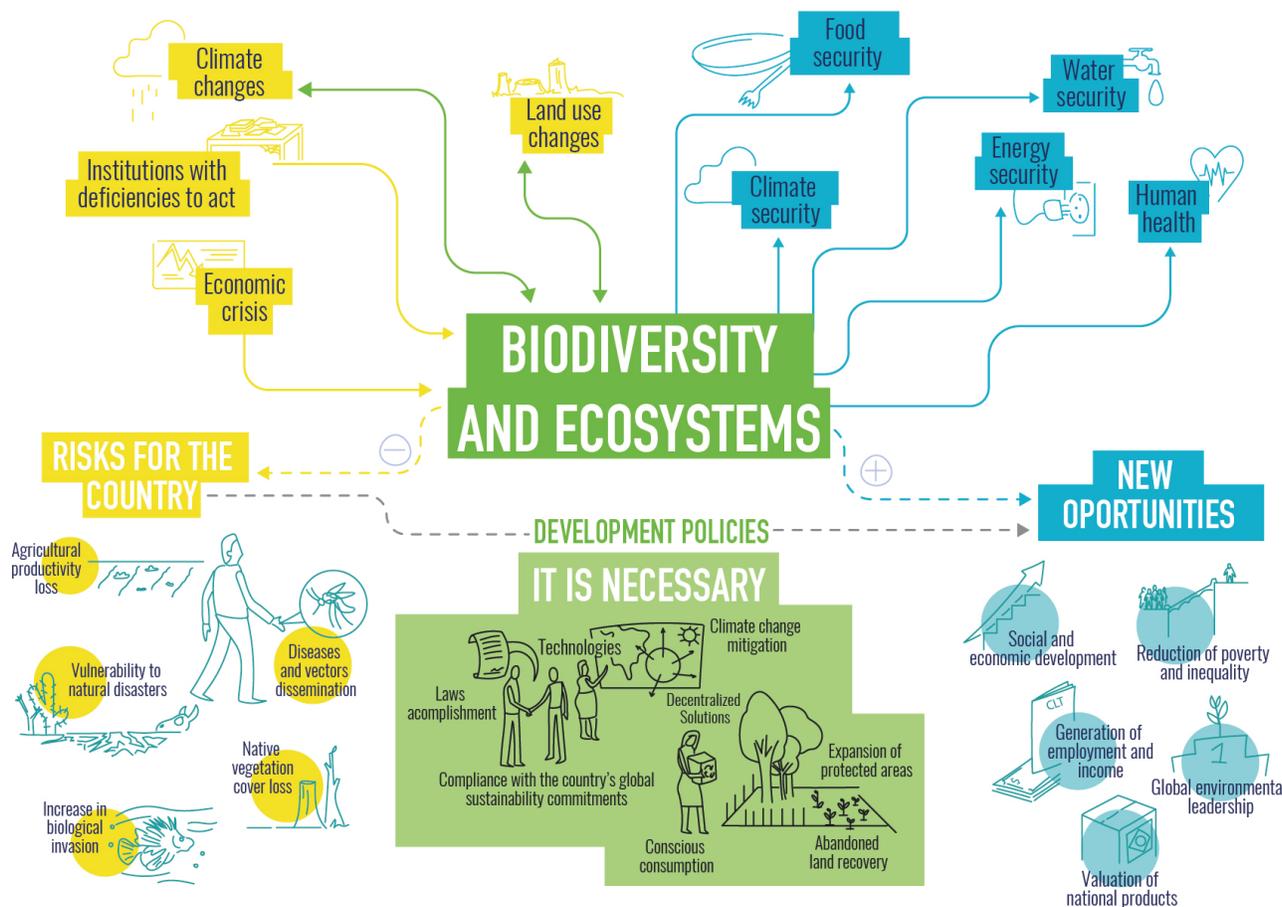


Figure 1. Brazilian Platform on Biodiversity and ecosystem Services framework.

be viewed as unique by using a label such as *made in Brazil*, *environmentally friendly*, for example. It is urgent to halt the current unsustainable use of natural resources, given the various signs of environmental collapse.

- **Land use and climate change are the main pressures that result in loss of biodiversity and ecosystem services.** Due to its nature and the history of agriculture to date, it has been the primary agent of change in land use and the impact on biodiversity and ecosystem services. Given the current global agreements and market demands, the challenge and opportunity is to bring the agricultural sector closer to the biodiversity and ecosystem services agenda, thereby making them major allies.
- **Although Brazil is rich in fresh water, harbouring 12% of the world’s reserves, water availability varies significantly between the subregions. There has been a per capita decline and generalized unsustainable use of surface and subterranean waters in many parts of the country** (see https://www.bpb.es.net.br/wp-content/uploads/2018/11/BPBES_SPM_Agua.pdf). Water quality is declining in most watershed and coastal areas, and dependence on infrastructure for water supply is increasing. In urban areas, especially large centers, around 39% of the places monitored by the National Water Agency exhibited fair, poor or very poor quality. Moreover, despite its overall abundance, freshwater supply

can be scarce locally. This unequal availability, combined with an inadequate distribution infrastructure and inefficient wastewater treatment plants, make water security a problem for a large portion of the Brazilian population, reducing reliable access to sufficient amounts of potable water, with impacts on human health.

- **Throughout this century, the intensification of climate change will increase the loss of biodiversity and ecosystem services.** Combined with the decline in natural vegetation cover, alterations in temperature and rainfall patterns are forecast in the different regions of the country due to global climate change (see https://www.bpb.es.net.br/wp-content/uploads/2019/01/Relat%C3%B3rioTem%C3%A1tico_ClimaCompleto.pdf). In the case of a “business as usual” scenario, the result will be loss of agricultural production, change in species habitats and distribution - affecting the dissemination of diseases and their vectors - and increasing the aggressiveness of alien species invasions.
- **The official governance of biodiversity and ecosystem services in Brazil is bipolar: on one hand, there are strong and capable institutions; on the other, infrastructural problems, slow processes, inefficient measures and judicial, social and ecological conflicts.** Ability and efficiency also vary, tending to decline from federal to state to municipal levels. The economic crisis forecasts a reduction in funding,

resulting in the loss of organizations and significant layoffs of technical personnel, thereby aggravating the situation.

2. Sustainability: a mandatory and promising path

- The window of time and opportunity to consolidate a sustainable future is rapidly closing. We must at least ensure enforcement of existing laws through regulatory mechanisms and incentives, in line with the global sustainability commitments made by other countries.** Choices for this sustainable future must be made as soon as possible, and scientific knowledge, always in partnership with other forms of knowledge, will be essential for good decision making. Current global and national pressures in the social, economic and environmental fields are numerous and growing, and the current development model is becoming obsolete. A new model is needed to incorporate the challenges of a planet in rapid socioeconomic and climatic transformation.
 - Biodiversity and ecosystems are important elements for addressing national and global socioeconomic and environmental crises, since they provide new development opportunities. As such, they should be incorporated into the country's development policies.** Natural resources are currently being controlled by sectoral policies. Biodiversity and ecosystem services are considered an obstacle or even a barrier to the development process when, in fact, they are the basis for improved global competitiveness. The productive sectors will increasingly depend on inclusive and sustainable practices, circumscribing the challenge of creating a new agenda for the conservation and sustainable use of natural resources.
 - Political interventions at different levels (from local to national) may lead to successful mitigation of the negative impacts on biodiversity.** Given the complexity of issues related to biodiversity and ecosystem services and the numerous possible political interventions, there are a number of different options to follow. For example, the Globio modeling platform to support policies, uses three paths: global technology (large-scale technologically optimal solutions), decentralized solutions and changes in consumption. Using complementary mechanisms to apply these scenarios may minimize the negative impacts on biodiversity, especially those resulting from agriculture and energy production.
 - Investing in the conservation and restoration of biodiversity, ecosystems and their associated services shows potential for new social and economic development, as a source of job and income creation, and a reduction in poverty and socioeconomic inequity.** Equal use and access to natural capital are important elements to overcoming inequities in Brazil. They also guarantee the continuity of the multiple lifestyles and social and ecological systems that represent the cultural and ethnic diversity of the country. In addition, human well-being depends directly on the availability and access to ecosystem services (water, food, climate, culture) and biodiversity conservation creates business opportunities
- for industries including tourism, cosmetics, drug and food. However, there are still considerable obstacles to taking advantage of such opportunities. Manufacturing biodiversity-based products demands investments and a favourable business environment. Restoration, which is technically feasible in Brazil (see https://www.bpbes.net.br/wp-content/uploads/2019/08/SPM_RestauracaoVF_ebook.pdf), has demonstrated greater effectiveness in recovering ecosystem services than biodiversity. However it continues to be a costly process, ranging from R\$800 (\approx USD200) per hectare when natural regeneration is used, to R\$ 17,000 (\approx USD 4,250) per hectare in the case of seedling planting. Achieving 30% plant cover in the Atlantic Forest and maintaining the integrity of vertebrates essential to ecosystem functioning would cost around R\$ 445 million (\approx USD111 million), that is, less than 0.01% of annual GDP in Brazil, or 6.5% of agricultural subsidies.
- Considering the ecological importance of connecting the landscape, recovery of native vegetation is recognized as an important strategy to mitigate the loss of biodiversity and restore ecosystem services, such as pollination and soil formation, which contribute to higher crop yields.** In more degraded biomes, enforcing the Native Vegetation Protection Law (New Forest Code) must provide for recovering native vegetation by implementing the Rural Environmental Registry (CAR) and the Environmental Regularization Program (PRA), with benefits for biodiversity and ecosystem services, including the production and conservation of water and carbon sequestration. It is estimated that enforcing the law would result in around 20 million hectares of restored area, enabling other gains for landowners, including higher yields and new green companies and jobs. Restoration planning should consider multiple functions and ecosystem services, such as planting species that are important for pollinators and contain active ingredients of interest to the pharmaceutical and cosmetic industries, as well as water body protection and soil stability services, in addition to cultural and spiritual services.
 - The land ownership issue and the relationship between agricultural production and conservation are central elements in land use planning, especially if the multiple ecosystem services, future demands and additional limitations caused by environmental changes are considered.** Managing agricultural production, using techniques that reduce carbon emissions and focus on existing deforested areas, has and will further increase the value of Brazilian agricultural products on the national and international market. Such adjustment in production activities will require policies and technologies that allow the occupation and increased yield of these lands, promoting techniques such as agroforestry systems and crop-livestock-forestry integration. An alternative measure would be to transform the agriculture funding system into an integrated model, focusing on the property as a whole and its production and growing system, instead of product-to-product funding as is standard practice today.

- **Connectivity should be considered when planning the management of biodiversity and ecosystem services.** Managing the natural resources of a particular area (farm, urban center, national park or geopolitical unit), has sometimes led to phenomena such as “leakage” or “spillover”, that is, transfer of the production area to less protected regions from the legal standpoint. These effects are due to “teleconnection” processes – remote associations between different locations, whereby what occurs in one place may affect another – that have been little investigated by scientists in Brazil. Thus, tools such as “a moratorium on certain products”, associated with the Rural Environmental Registry (CAR), may significantly decrease pressure on areas of native vegetation, but at the same time result in conversion in other ecosystems. For example, the success of the Soybean Moratorium in reducing deforestation in the Amazon was marred by the side effect of transferring deforestation to the Brazilian savanna (hereafter *Cerrado*), the neighboring biome. Containing these secondary impacts requires long-term planning and dynamic monitoring of land use.
- **Assessment of the effectiveness and efficacy of implemented policies is crucial to improving them and, in Brazil, there is a wide gap in this area, especially with respect to the scale of biodiversity and ecosystem services.** As an example, there are no studies about the effectiveness of protected areas for nature conservation and for providing direct and indirect socio-economic benefits. A combination of good governance, effective management and community engagement explains the success of some protected areas. Policies, such as Green Stipend (Bolsa Verde), National Plan for Agroecology and Organic Production (Planapo) and the National Benefit Sharing Program (PNRB), including the National Fund for Benefit, need to be reviewed regarding adequacy, degree of implementation and effectiveness.

3. From risk to opportunity: the privilege of a megadiverse country

- **Up to 2030, land use change will continue to be the primary driver for the loss of biodiversity and ecosystem services and will be a key factor during most of the 21st century.** Despite the decline in annual habitat losses caused by deforestation in Brazilian biomes in the last decade, especially in *Amazonia*, the conversion of natural ecosystems remains high, particularly in the *Cerrado* (236,000 km² between 2000 and 2015) and *Caatinga* (45% of original cover). Even in the Atlantic Forest, the deforested area – around 29,000 hectares from 2015 to 2016 – is substantially higher than the area restored in the biome over the same time period. For example, in recent years, forest losses in the country were at least three times greater than the restoration promised area. Implementing land use planning with focuses in combining conservation and production is one of the main strategies

to preserve biodiversity and ecosystem services. However, only recognizing that the future of agricultural production depends on preserving ecosystem integrity will enable a definitive conciliation between socioeconomic growth and environmental conservation.

- **Food, water, climate and energy security depend on ecosystem services, such as pollination, water resource maintenance, climate regulation and control of disease vectors.** Of the 141 crops analyzed in the country, 85 depend on animal pollination. Around 80 families and 469 plant species are grown in agroforestry systems. More than 245 species of Brazilian flora are the source of cosmetics and pharmaceuticals and at least 36 native botanical species are registered as herbal medicines (see https://www.bpb.es.net.br/wp-content/uploads/2019/03/BPBES_CompletoPolinizacao-2.pdf). Over 40% of primary energy production in the country comes from renewable sources, and 2/3 of the electrical energy consumed originates in hydroelectric plants that depend on ecosystem integrity, especially the forests, to continue operating.
- **The concentrated poverty in municipalities with substantial native vegetation cover is a risk that may become a unique opportunity to reconcile conservation with human development.** Approximately 40% of vegetation coverage in Brazil is found in 400 municipalities (7% of the municipalities in the country) where 13% of the most economically underprivileged Brazilians live (Figure 2). Historically, replacing forests with agropastoral activities has not resulted in a significant increase in the human development index (HDI) of individuals living there, which exacerbates the rural exodus. The significant rise in income generation from conserving nature, such as the case of the Policy to Guarantee Minimum Prices for socio biodiversity products, applied to non-wood forest products extracted primarily by traditional populations and family farmers, will be essential to reconciling socioeconomic prosperity with natural resource conservation.
- **In order to address the risks of climate change, which are already impacting natural and social systems, the Ecosystem-based Adaptation Strategy stands out as a significant opportunity for Brazil.** Adapting to the adverse effects of climate change requires an innovative strategic approach, such as that based on ecosystems. With this tool, biodiversity management can improve the flow and quality of water and reduce vulnerability to natural disasters¹ and their consequent impacts, such as landslides and higher sea levels. These practices are less costly than alternatives based on building conventional infrastructure. Ecosystem-based adaptation conserves or restores natural resources, sequesters or stores carbon, and has the potential to reduce poverty.
- **The biological diversity of the country is also expressed in its immense cultural diversity. Incorporating indigenous and traditional knowledge about Brazilian biodiversity into day-to-day society is a golden opportunity for sustainable use of biodiversity and ecosystem services.**

¹ In the last two decades, Brazil has recorded 32,000 natural disasters such as droughts, gradual flooding, flash flooding, tornados, mass wasting, hailstorms and fluvial and coastal erosion.

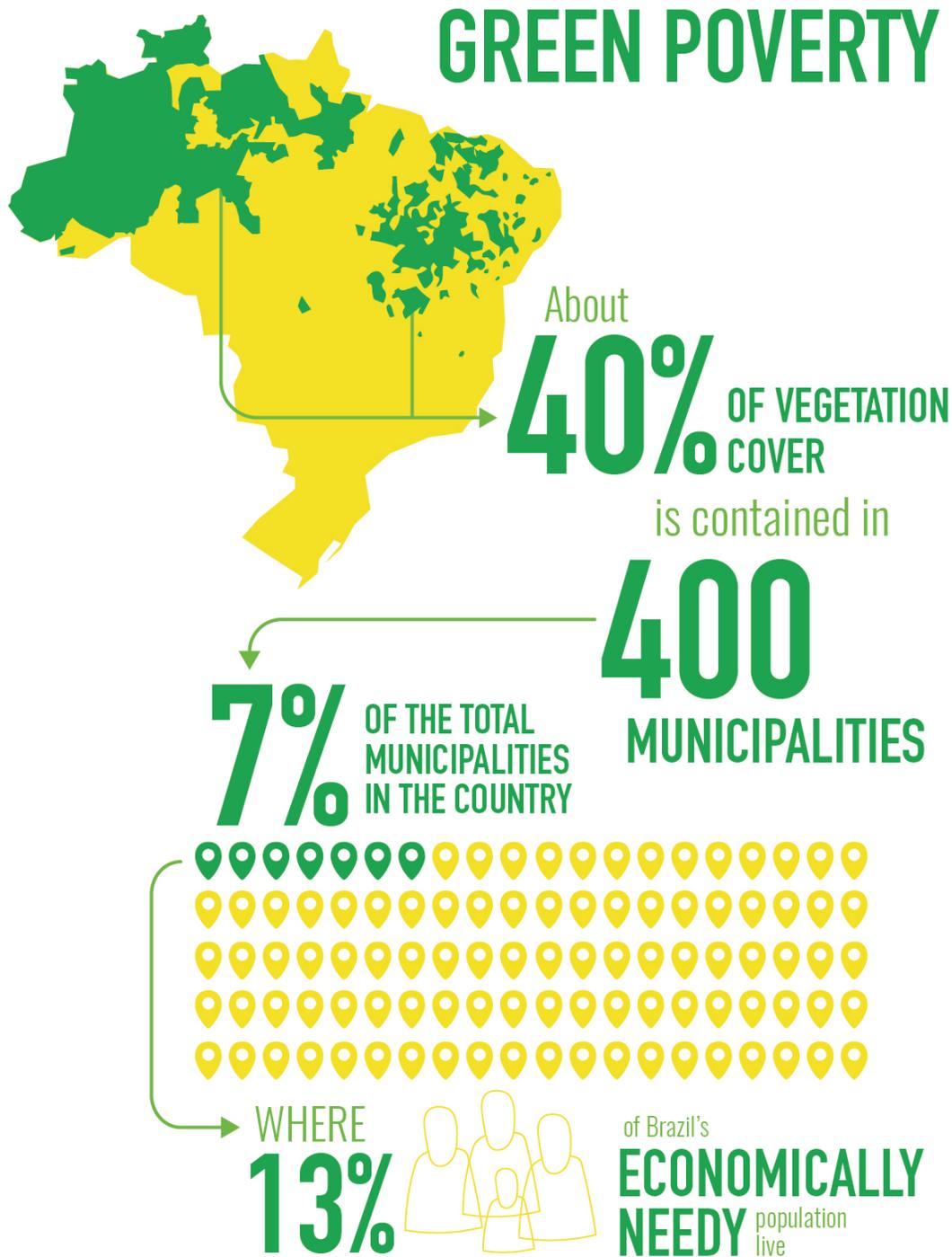


Figure 2. The concentrated poverty in municipalities with substantial native vegetation cover is a risk that may become a unique opportunity to reconcile conservation with human development.

Brazil has more than 500 natural sites associated with multiple cultural manifestations. The country is home to 305 indigenous peoples speaking 274 languages, and dozens of other traditional populations, such as the *Caiçara* (traditional population on the south and southeast coast), *Quilombolas* (people of African origin living in hinterland settlements), rubber tappers, *Ribeirinhos* (riverside dwellers), babaçu coconut shellers, *Pantaneiros* (residents of the *Pantanal* wetlands) and *Vazanteiros* (island or riverbank dwellers), in

addition to historically receiving migratory flows from different parts of the world. These peoples possess vast knowledge of agrobiodiversity, fishing, fire management, natural medicine, among others of commercial, cultural and spiritual value.

- **Brazil has a wide variety of policy instruments and socioenvironmental governance options, as well as global commitments (ODS, Aichi, Paris) related to the possibility of a sustainable future. On the other hand, inefficient management control or lack of incentives to comply**

with the rules pose risks to consolidating this future.

After a period of stagnation, and even a reduction in the area protected by conservation units, 2018 saw a significant increase with the creation of four marine conservation units (two environmental protection areas and two national monuments), an environmental protection area and a national park in the *Caatinga* biome, and three extractive reserves in Maranhão state. The National System of Protected Areas covers more than 15% of Brazilian territory and 561 recognized or regulated indigenous lands, encompassing 12.2% of the country. However, protected areas with low enforcement rates, cancellation of financial conservation incentives to reduce poverty (such as the Green Stipend) and problems with the environmental licensing process of commercial undertakings reflects the lack of policies to ensure effective conservation and the sustainable use of biodiversity and associated ecosystems in the country. Planaveg², the National Plan to Adapt to Climatic Changes and some items of the Native Vegetation Protection Law (LPVN)³, in addition to the National REDD+ Strategy (ENREDD+), among others, bring biodiversity to the forefront of discussions and are in line with the global goals adopted by Brazil, which represents an unprecedented opportunity to implement these policies.

4. The role of science: dialogue and knowledge serving society

- **There is a lack of communication between science and society. This process needs to be improved by establishing an effective flow that makes communication inclusive and representative, reaching public and private decision makers.** In addition to credibility, science should present legitimacy and ability to produce relevant results (easy to understand and of collective and political interest) for society and decision makers. Synthesis Centers on Biodiversity and Ecosystem Services are an option for promoting these transdisciplinary studies, conducted in coproduction with other actors.
- **Public and private research funders in Brazil should be more active in promoting transdisciplinary science, which involves policy makers and other actors at its conception, to solve problems.** Open calls funding are essential in promoting basic research, but there is still a serious gap in promoting research aimed at addressing the problems and specific challenges faced by the Brazilian population. To bridge this gap, adequate scientific and technological policies are needed to address the challenges of sustainability. It is important to create a funding model and assess the impact of research aimed at generating support and contributions in order to improve

conservation policies and sustainable use of biodiversity and ecosystem services.

- **The last decade saw significant advances in the sharing and transparency of public data and information on biodiversity and ecosystem services that allow qualified decisions.** However, serious gaps remain, such as the lack of knowledge about less represented taxa and with different degrees of endemism, making it difficult to incorporate science into the decision process. Repatriations of knowledge on Brazilian biodiversity, associated with advances in compiling species lists, including endangered and invasive ones, and in understanding the functioning of natural systems, in addition to the use of free-access geospatial tools, are more common today, but still needs incentives.
- **Understanding the interactions between biodiversity, ecosystem services and human well-being is a pre-requisite for promoting the agenda of a number of multilateral environmental agreements and global goals. However, studies that assess these inter-relations remain scarce.** While in developed countries the proportion of studies that analyze the relation between biodiversity and ecosystem services and discuss human well-being is around 5%, in Brazil it is half that value. Analysis of more than 220 studies published in national and international journals shows that around 42% of investigations that explore the relation between biodiversity and ecosystem services in the country are focused on biological processes and more than 77% examined biodiversity from the native vegetation standpoint. The few studies that seek to value national biodiversity are concentrated primarily on material goods, pollination services and water and climate regulation. Little is known about the non-material values of biodiversity that generate well-being for the population, such as those related to ecotourism, scenic beauty and spiritual and cultural aspects.
- **Some biomes remain poorly studied in terms of land use changes and their impacts on biodiversity.** The *Caatinga*, *Pampa*, *Pantanal* and coastal and marine zones are systems that require more studies, especially the peculiarity in Brazil of the continued use of traditional agricultural practices. Taken together, these biomes account for 35% of the studies on the relation between biodiversity and ecosystem services in the country.
- **Scientific research and policy have different response times. Permanent efforts to integrate these two spheres of knowledge are needed to build confidence between policy makers and researchers.** It is important to explore the potential of science, technology and innovation to induce cooperation between government entities. It is also recommended that research funding agencies require a “summary for policy makers” as an output in their calls.

² National Plan of Native Vegetation Recovery = is the main implementation instrument of the National Policy for Native Vegetation Recovery (Proveg – Decree 8972 of 01/23/2017). Its objective is to broaden and strengthen public policies, financial incentives, markets, good agricultural practices and other native vegetation recovery measures.

³ Native Vegetation Protection Law (LPVN – no. 12.651 of 05/25/2012) – substituted the Forest Code of 1965 and is in the regulatory phase at federal and state level, but the constitutionality of some of the changes is still being questioned.

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Conflicts of interest

The authors declare that they have no conflict of interest related to the publication of this manuscript.

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