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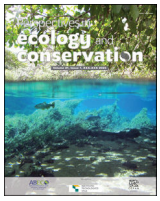

Policy Forums

# Beyond data labor: sowing synthesis science in the Global South

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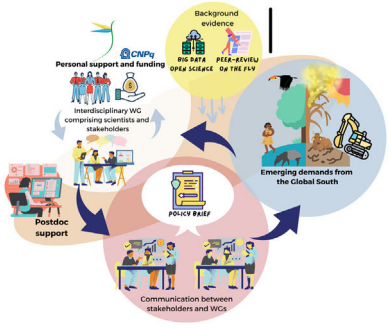
## HIGHLIGHTS

- There is a paucity of synthesis centers in the Global South (GS).
- The Brazilian synthesis program aspires to transdisciplinarity to solve local demands.
- Future calls should consider hiring one or more postdocs with co-production skills.
- We make recommendations for improving Brazilian postdocs' labor conditions.
- We call for an anthropophagic and decolonized synthesis science approach in the GS.

## GRAPHICAL ABSTRACT

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## ABSTRACT

Synthesis science is an emergent research field for harmonizing different data, concepts, and theories to create new insights and endorse novel approaches. Here we provide a brief general overview of synthesis science, emphasize the geographically biased location of synthesis centers, particularly their paucity in the Global South, and highlight the pioneering role of the Synthesis Center on Biodiversity and Ecosystem Services (SinBiose, CNPq) concerning transdisciplinary aspirations in the Global South. Working with the ecosystem service dimension requires breaking discipline boundaries to approach society, stakeholders, and decision-makers, which SinBiose fosters and is rarely found elsewhere. This article features a "Brazilian experience" of synthesis science through the perception of SinBiose's postdoctoral researchers, which have a central role in the workflow as the only professionals dedicated exclusively to the projects. As a conclusion, we present recommendations for improving the support for postdoctoral researchers and arguments for a continued funding of synthesis science in Brazil.



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Synthesis science can be conceptualized as an emergent research field for harmonizing different data, concepts, and theories to create new insights and endorse practices (Pickett et al., 2007; Carpenter et al., 2009). Usually, synthesis science emerges from synthesis centers, i.e., institutional arrangements that foster immersive and collaborative work, with knowledge exchange by interdisciplinary teams (e.g., ecologists, geographers, economists, and social scientists) and, sometimes, government employees, secretariats, and the third sector (hereafter 'stakeholders') (Hackett et al., 2008; Carpenter et al., 2009; Baron et al., 2017). Synthesis products engage stakeholders seeking usable scientific knowledge, aiding decision-making amidst social-ecological complexities (Halpern et al., 2020; Hackett et al., 2021).

Synthesis science in the Global South remains challenging. Up to 2019, there were almost 20 synthesis centers globally (https://synthesis-consortium.org/, Wyborn et al., 2018), none of them active in the Global South (Fig. 1). Due to such asymmetries, Global North's science-based solutions usually guide problem-solving in the Global South (Nakamura et al., 2023). Transference of knowledge often fails to unravel local environmental issues, given the striking social-ecological differences between these regions. In 2019, a strong engagement from the scientific community in Brazil resulted in the creation of the research program "*Centro de Síntese em Biodiversidade e Serviços Ecossistêmicos* - SinBiose" (Synthesis Center on Biodiversity and Ecosystem Services). Headed by the National Council for Scientific and Technological Development (CNPq, Ministry of Science and Technology), SinBiose is the only permanent synthesis initiative in operation in the Global South and the world tropics (Fig. 1). Here we describe its workflow and the main challenges faced by the first group of SinBiose grantees from the perspective of postdoctoral researchers and one SinBiose's employee–professionals dedicated exclusively to projects/program with a central role in the workflow.

## Where is SinBiose placed in synthesis science? How was its workflow?

The multifaceted environmental issues pressing global ecosystems (Steffen et al., 2015; França et al., 2020), especially those from emerging Global South nations, require inter and transdisciplinarity to address context-specific decision-making demands (Lebel and McLean, 2018) (Table 1). Even though synthesis centers interact with each other and share best practices in multidisciplinarity or interdisciplinarity (Baron et al., 2017), transdisciplinarity and connections with society and the decision-making level are often overlooked (Carpenter et al., 2009; Wyborn et al., 2018; but see Davies et al., 2015, and specific calls of NCEAS and sDiv). The proposed active articulation between researchers and stakeholders is a hallmark of SinBiose that goes beyond Global-North approaches (Carpenter et al., 2009; Wyborn et al., 2018).

Since its conceptualization, SinBiose fostered international cooperation and had the mission of bringing synthesis science into the intersection between research and practice, aiming for transdisciplinarity and fostering knowledge co-production (Table 1). In our opinion, the synthesis experience promoted by the SinBiose breaks paradigms by encouraging interaction between researchers ↔ stakeholders instead of unidirectional transfer of knowledge (researchers → stakeholders), a rare and challenging approach in ecology and conservation (Bertuol-Garcia et al., 2018). In the first SinBiose call, priority was given to diverse working groups (WG) collaborating to utilize existing data to generate evidence for decision-making at the intersection between ecological-social-economical-political sciences (Fig. 2; Table S1). Although the workflow occurred during the COVID-19 pandemic, WG representatives had joint regular virtual meetings with the SinBiose core team and provided each other support on how to deploy the work

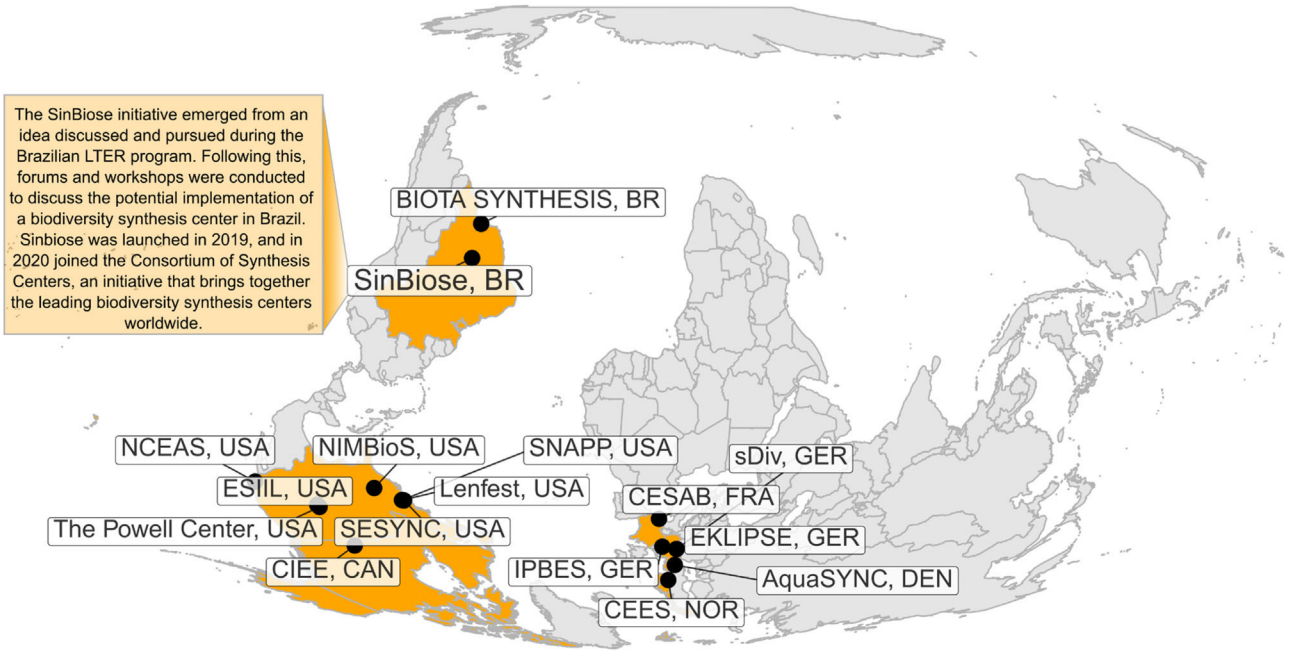


**Fig. 1.** The distribution of active centers and initiatives of synthesis over the world countries. Discontinued synthesis centers and initiatives were not shown in the map. The list of discontinued centers includes: EOS, United Kingdom; CERN, China; ACEAS, Australia; NESCent, United States; Tansley Working Group, United Kingdom; Commission of Inquiry on Peatlands (IUCN UK Peatland Programme), United Kingdom; The UK National Ecosystem Assessment (UK NEA); Millennium Ecosystem Assessment (MEA) (2001–2005). We did not map decentralized initiatives such as the Millennium Ecosystem Assessment (MEA), the Collaboration for Environmental Evidence (CEE) (based in Canada, France, South Africa, Sweden and the United Kingdom, the United States of America, and one international CEE Centre (SEI)), and the World Wide Fund for Nature (WWF) that leads the WWF Global and Regional Policy Hot House (WWF Hot House).The BIOTA SYNTHESIS program was launched in 2022 and will be funded until 2026 (https://biotasintese.iea.usp.br/). The website of the International Synthesis Consortium initiative can be accessed at: https://synthesis-consortium.org/. A map with the all centers that ever existed can be found at https://github.com/andreluza/posdocs_sinbiose. This map is in Mollweide projection, and its orientation is inspired by a drawing of the Uruguayan artist Joaquín Torres Garcia called 'America Invertida'. We choose this format to emphasize the Global South, and represent a decolonial view of the world map of synthesis science initiatives.

virtually. Throughout project development, the SinBiose core team organized workshops with the goal of enhancing the identification of key stakeholders aligned with the knowledge generation objectives of WG. These workshops congregated project members, sowing the seeds for a co-production approach to be independently adopted and expanded by each WG (see example in BOX 1). The exchange between different WGs proved to be very rich in a trust atmosphere, as they had similar problems in spite of different research themes (Table S1).

**BOX 1: The Synthesis experience of The Synthesis on Pollination Intensification (SPIN) Working Group**

Here we describe the SPIN experience in co-production within the SinBiose. The major goal of this WG was to foster pollination intensification via ecological restoration to improve sustainable agriculture in Brazil. Since its submission, the SPIN's project involved 17 academic (assisted by one postdoc) and three non-academic members in order to foster the interaction between researchers and practitioners. Along the project, other three postdocs and two researchers were incorporated into the team. Two out of these three non-academic members are linked to applied research (scientific board member of The Nature Conservancy entity (TNC), researcher at the ABC Foundation (https://fundacaoabc.org/) - a private foundation that advises soybean producers). The third is a representative of the CAMTA cooperative of agroforestry producers (https://www.camta.com.br/index.php/en/).

At the start of the project (1st semester of 2020), they contributed in defining research objectives based on their expectations for the project. During this initial phase, part of the academic team also engaged in the study of transdisciplinary methods. Following that, the entire team was divided into five sub-objectives (2nd semester of 2020 - 1st semester of 2021). Each of the three non-academic members was placed in one of these sub-objectives (of their choice). The work led by one of these subgroups with a non-academic member has already resulted in a publication (Bergamo et al., 2021), and another one is in the process of being submitted. Both academic and non-academic members were involved in defining objectives, databases, variable calculations, analyses, and manuscript revisions. The 2nd semester of 2021 was dedicated to collaborative work by the entire team, developing a theoretical perspective (Bergamo et al., 2023) - everyone participated in discussions and manuscript revisions.

Starting from 2022, a postdoctoral researcher with focus on co-production and transdisciplinarity (Dr. Alice R. de Moraes) joined the WG to maintain an efficient interaction with non-academic members. Her interaction with the entire team, with special attention to non-academic members, informed her work throughout her participation in the WG. She is now leading a manuscript that reports on the co-production experience of SPIN.

The SPIN WG had its in-person workshop in the 2nd semester of 2022, which included two of the non-academic members (TNC and CAMTA). The entire team worked on defining the final manuscripts, objectives, databases, methods, among other tasks. Following the in-person workshop, the team defined a working routine in which each of the postdocs centralized the work on an article. Team members are brought in as needed due to their individual expertise. Additionally, since last year, the WG has been producing short social media videos for rural producers - one has already been completed (https://www.youtube.com/watch?v=u2XwV2cJBII), and two others are in production. The entire team contributes ideas and assists with storyboards, while the video production itself is handled by an audiovisual production company.

**Table 1**
Concepts relevant for the Brazilian synthesis experience.

| Concept | Meaning |
|---|---|
| Interdisciplinarity | Interdisciplinarity goes beyond a multidisciplinary approach as it involves collaboration among researchers and deliberately combines elements of different knowledge fields to solve complex questions (Parra Vázquez et al., 2020). |
| Transdisciplinarity | Although transdisciplinarity is also collaborative and may encompass the same elements of interdisciplinarity, it transcends this field by integrating different perspectives, knowledge systems, worldviews and can be seen as a "crossroads between scientific knowledge and social practices" (Parra Vázquez et al., 2020). |
| Co-production | Co-production is here understood as an approach that enables approximating science, practice and policy through the collaborative work of a broad set of stakeholders (policymakers, researchers, traditional/indigenous communities) (Lemos, 2015) to produce knowledge "in the service of societal and policy change" (Wyborn et al., 2018). Within the SinBiose, co-production was developed autonomously by researchers and stakeholders of each project (see Table S1). SinBiose workshops, in turn, created opportunities for reflection on who are the stakeholders of each project. |

In the last part of their development, each working group independently produced a decision-making-oriented deliverable policy brief (see Data Availability Statement and Table S1). The policy brief was the result of the WG collaboration with the SinBiose communication team, and covered a wide range of topics. Then, at the culmination of the projects' term, an outreach event was organized by the Center staff, where the policy briefs were presented to a larger audience, including decision-makers on different levels of federal management structure (e.g., Ministry of the Environment, Ministry of Agriculture and Livestock, Chico Mendes Institute for Biodiversity Conservation) and NGOs (e.g., World Wide Fund for Nature). This first series of SinBiose policy briefs should be seen as engaging or dialogue-inviting instruments, with a potential for influencing decision-making and public policies at various levels in Brazil.

## Recommendations for leveraging synthesis science in Brazil

We see SinBiose as an important initiative towards the inclusion of inter- and transdisciplinary approaches and knowledge co-production in synthesis science. Incorporating inter- and transdisciplinarity fully into the scope of SinBiose still presents challenges. To enhance the co-production process within SinBiose, several improvements can be made. Although there is no "recipe" for how transdisciplinarity and co-production should be implemented (Chambers et al., 2021), some general principles for high-quality outcomes need to be considered (Norström et al., 2020). First, the early involvement of stakeholders and decision-makers should be prioritized. The first call fostered interactions between distinct stakeholders, consolidating working relationships for future projects (BOX 1). Second, a broader range of stakeholders, particularly from traditional communities, should be invited to contribute actively throughout the projects. One way to better address such challenges is to integrate postdocs and professionals specifically trained in co-production and interdisciplinarity into working groups, from the beginning (Fig. 2), which could be requested upon the funding call. These professionals play a vital role in enhancing interaction and integration between academic

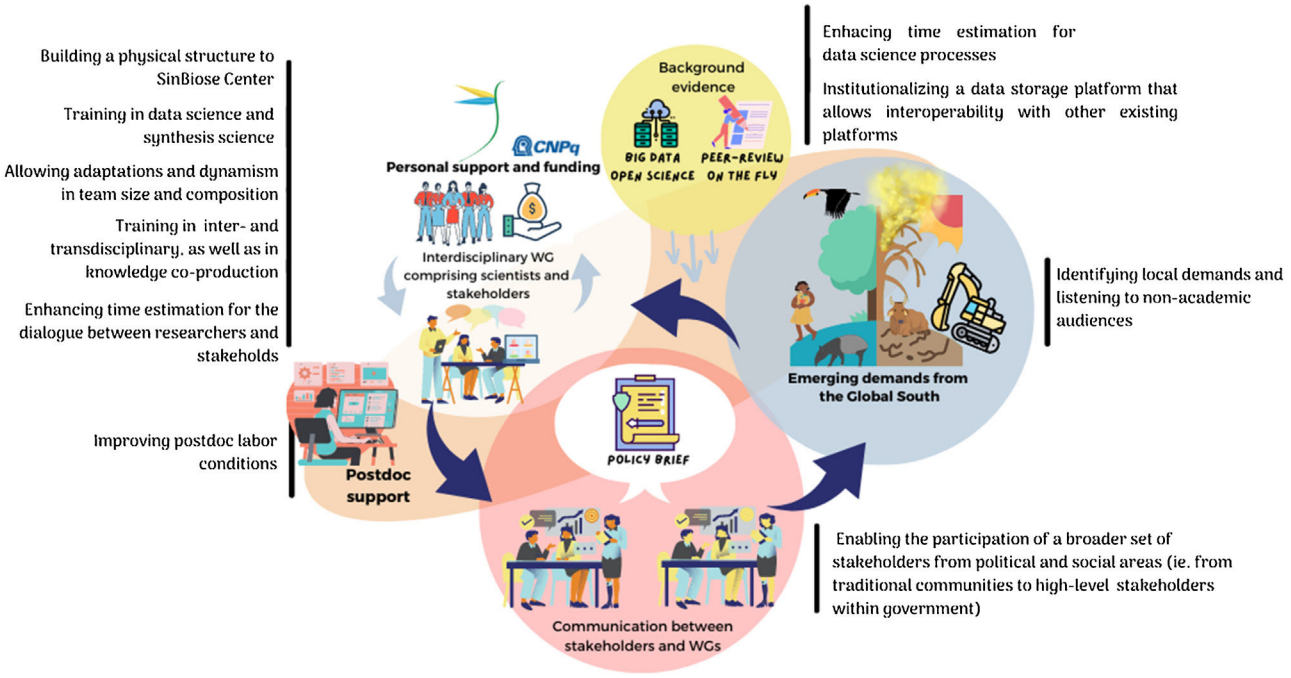


**Fig. 2.** The workflow of the *Centro de Síntese em Biodiversidade e Serviços Ecossistêmicos* (Synthesis Center on Biodiversity and Ecosystem Services - SinBiose, CNPq) is presented, highlighting the challenges and lessons learned during the first call. The SinBiose workflow is visualized through five interconnected spheres, each representing specific aspects of the process. The workflow started with the interaction between the SinBiose management crew and the working groups (WGs, white sphere), engaged in working with emerging issues and demands (depicted by the blue sphere). These demands were then processed, incorporating principles of big data and open science and utilizing synthesis science ingredients, such as peer review on the fly and inter-transdisciplinarity; this led to the formulation of background evidence for the WGs (represented by the yellow sphere). The output from these three spheres involves communication and exchange of ideas with a broader set of stakeholders (beyond those already in the WGs, depicted by the red sphere), with the aim of in the future involving high-level stakeholders of political arenas. Postdocs play a vital role in providing extensive support for synthesis science and co-production (represented by the orange sphere in the background). The ultimate goal is to have positive impacts towards sustainability on decision-making, management actions and economic growth policies, resulting in improved environmental quality for people (illustrated by the healthy ecosystem within the blue sphere). The policies formulated in the present are expected to shape the future, with synthesis science serving as a valuable tool for generating evidence for future policies.

and non-academic participants, maximizing co-production opportunities.

Funding for building physical structures or equipping existing ones within public universities, with high-performance computing technology to deal with big data (Michener and Jones, 2012), is a need that arose from the virtual experience. The experience during the COVID-19 pandemic makes it clear that a physical structure for in-person collaboration, data analysis, creativity, serendipity, and reviews on the fly is essential for synthesis (Hackett et al., 2008). Although the experience with entirely virtual meetings showed that it is possible to maintain the collaborative network and WG cohesion, it prevented in person interactions and constrained intensive brainstorming and serendipity (Srivastava et al., 2021), causing delays in certain WG outcomes.

Incorporating inter- and transdisciplinarity fully into the scope of SinBiose takes time. Sustained funding and effective structuring of the center are crucial for future WG to take advantage of the collaborative atmosphere, as well as training in synthesis science, inter and transdisciplinarity, and knowledge co-production (Fig. 2). We have good home examples of the benefits of sustained and long-term funding, such as the Brazilian LTER, whose scientific production increased exponentially with project age (Cordeiro et al., 2022), and the BIOTA FAPESP Program, launched in 1999, which has funded research to generate knowledge for supporting the use and conservation of biodiversity in São Paulo State, Brazil (Joly and Bicudo, 1999). Sustained funding enables cutting-edge research to align with Brazil's political agenda and societal demands, positioning the country as a leader in synthesis science in the Global South. It is vital for maintaining local synthesis center structures (Fig. 1), and establishing a regular schedule of calls for new WG, proposals, and visiting fellows. Additionally, funding allows hiring personnel for data science and knowledge co-production support.

SinBiose was a great opportunity for early-career scientists, such as postdocs, who face several obstacles in Brazil (Silva Junior et al., 2021; Guedes et al., 2023). Postdocs had a pivotal role in the WG, as the majority of their members, including principal investigators, are full professors primarily with many teaching and mentoring activities. Postdocs offered essential technical support in monitoring WG operations (e.g., meeting organization and tracking), engaging with stakeholders, and contributing to the data compilation, analysis, and report writing. These efforts establish the empirical foundation for WG products (Fig. 2). During the project's development in social isolation, unutilized financial resources designated for face-to-face meetings were reallocated to hire new postdocs in multiple WG. This considerably improved the workforce and workflow, and brought diversified skills to WG. Early recruitment of two diverse-skilled postdocs (e.g., data science and co-production) is strongly recommended for effective WG objective attainment, schedule adherence, and enhanced transdisciplinary development.

Postdoctoral researchers, who are highly skilled early-career scientists, often seek positions in academia (Guedes et al., 2023) and are therefore instrumental in establishing the practice of synthesis science in Brazil. Currently, university curricula lack integrated training in data analysis, synthesis, co-production, and political science. While data analysis and political science are in the curricula of disparate courses, synthesis and co-production are in fact new and not structured areas, which make training and integration with other disciplines much more challenging. Looking ahead, postdocs from SinBiose will play a crucial role in disseminating these

concepts, as they assume positions at universities, research institutions, and governmental agencies nationwide. However, ensuring the development of a new generation of researchers equipped with these collaborative skills requires a substantial increase in federal-level investment to improve the overall working conditions of postdoctoral researchers.

Current working conditions for postdocs in Brazilian institutions are precarious, lacking labor rights, and often offering salaries that fall behind inflation rates (Silva Junior et al., 2021). Furthermore, prospects for viable career opportunities within the academic field are limited. The current work arrangement primarily consists of an Agreement to Accept Scholarship Nomination (*Termo de Aceitação de Indicação de Bolsista*) provided by CNPq and CAPES. While this agreement acknowledges regulations such as CAPES Ordinance No. 086/2013, which sets guidelines for grant duration, implementation criteria, and postdoc and CAPES responsibilities, it unfortunately neglects to address postdoc rights. In countries such as the USA (National Academy of Sciences, 2000) and UK (Stanford, 2020), postdocs can have access to dental and vision insurance, short-term leave, life insurance, and retirement funds depending on their position. Even though this is not a specific situation of postdocs of SinBiose and synthesis science in Brazil, it brings up labor-right necessities for postdoctoral researchers, who play a pivotal role in driving scientific progress.

Finally, we argue that colonialism should be abandoned as a hallmark of Brazilian universities. The "publish or perish" rationale pushes researchers towards pursuing fashionable scientific fields dictated by dominant theories that contribute little to effectively address national demands. Colonial science often diminishes and regards as of l̈ocal interestẅhat is produced in and for the Global South interests. This creates an expectation for postdocs to publish in themes outside the scope of Global South challenges. The postdoc's role in SinBiose was also to produce synthesis science connected with Brazilian demands, which were relevant to global discussions in the interface between biological and social sciences (Table S1). While it is important to note several recent calls for decolonized scientific research in the Global South (Trisos et al., 2021; Castro-Torres and Alburez-Gutierrez, 2022; Nakamura et al., 2023), much needs to be done before we can say that the Global South has overcome its colonial past and present (Santos, 2022; Nakamura et al., 2023). South America's urgency and local/regional problems surpass the Global North scientific agenda, and engaging non-academic audiences can bring significant benefits in addressing these challenges. Although such an inclusive approach requires proper time and effort, the potential benefits to addressing local and regional problems are substantial. In this way, SinBiose has an avant-garde, perhaps even anthropophagic, foundation resembling the Brazilian modernist movement (Nist, 1967; Cabral and Jacques, 2018; Johnson, 2018), with the same aim of d̈igestingänd assimilating ideas from diverse cultural contexts while preserving our knowledge and culture. These properties empower Brazilian synthesis programs to create innovative solutions for the challenges of the Global South.

## Conclusion

The SinBiose initiative, with its innovative approach, presents a remarkable opportunity to create the scientific background to tackle local and global environmental challenges. The pivotal role of postdocs in the synthesis process and the unwavering commitment to transdisciplinarity within working groups exemplify the aspirations driving this collaborative endeavor. To enhance this role, we recommend improvements for postdoc careers to keep these professionals in the country and attract postdocs from abroad. By bridging the gap between science and society, and by effectively conveying robust scientific evidence to stakeholders, SinBiose has the potential to yield significant returns on investment, especially during a time marked by scientific skepticism and the recovery from recent setbacks in national scientific policy.

## Author contributions

AL Luza, AL Giles, and M Mamede wrote the first version of this manuscript. All other authors contributed substantially to improve it, and were sorted alphabetically by the last name in the list of authors.

## Conflict of interest

We have no conflict of interest to declare.

## Data availability statement

The data used to produce Fig. 1 are available at https://github.com/andreluza/posdocs_sinbiose. Portuguese and English versions of the policy briefs cited in the text can be assessed at https://www.gov.br/cnpq/pt-br/acesso-a-informacao/acoes-e-programas/programas/sinbiose-1/policy-briefs-1.

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## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.pecon.2023.09.003.

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