IMPACT OF BRAZILIAN GRADUATE EDUCATION ON THE 2030 AGENDA:

Contribution of the National System of Graduate Education to COP 30 in the Amazon

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IMPACT OF BRAZILIAN GRADUATE EDUCATION ON THE 2030 AGENDA

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LIST OF ACRONYMS AND ABBREVIATIONS

ANPG	National Association of Graduate Students
AOD	Official Development Assistance
APCN	Evaluation of New Graduate Program Proposals
BLA	Brazil's Legal Amazon
BNCC	National Common Curricular Base
C&T	Science and Technology
CAPES	Brazilian Federal Agency for Support and Evaluation of Graduate Education
CAPES-PRINT	CAPES Institutional Internationalization Program
CES/CFE	Higher Education Council / Federal Council of Education
CNE	National Education Council (MEC)
CNODS	National Commission on the Sustainable Development Goals
CNPQ	National Council for Scientific and Technological Development
COP 30	30th Conference of the Parties to the United Nations Framework Convention on Climate Change
CSO	Civil Society Organization
CTC-ES	Technical-Scientific Council for Higher Education
DAV	CAPES Evaluation Directorate
EDS	Education for Sustainable Development
FAPESP	São Paulo Research Foundation
FOPROP	National Forum of Pro-Rectors for Research and Graduate Education
GHG	Greenhouse gases
HEI	Higher education institution
IBGE	Brazilian Institute of Geography and Statistics
LAC	Latin America and the Caribbean
MDG	Millennium Development Goal

MEC	Ministry of Education (Brazil)
MMA	Ministry of the Environment (Brazil)
NBS	Nature-based solutions
NGO	Non-governmental organizations
OECD	Organisation for Economic Co-operation and Development
PG	*Stricto Sensu* Graduate Education
PNPG	National Graduate Education Plan
PPG	Brazilian *Stricto Sensu* Graduate Program(s)
PROEXT	University Extension Program
PRONEA	National Environmental Education Program
SDG	Sustainable Development Goal
SNPG	Brazilian National System of *Stricto Sensu* Graduate Education
UAB	Open University of Brazil
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WG	Working Group

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FOREWORD

Brazil possesses all the conditions to lead the paradigmatic transition toward more sustainable socioeconomic development. As a pioneering country, it has both the opportunity and the responsibility to guide this transformation on the global stage. In this context, CAPES seeks to make its contribution with the launch of this book: *Impact of Brazilian Graduate Education on the 2030 Agenda*, an initiative aligned with the 30th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 30), which will take place in the Brazilian Amazon in November 2025.

To understand the current challenges, it is important to revisit the concept of sustainable development involving the 17 Sustainable Development Goals (SDGs) of the 2030 Agenda of the United Nations (UN). Among them, SDG 13, which addresses climate change, stands out. The term sustainable development emerged at the United Nations Conference on the Human Environment, held in Stockholm, Sweden, in 1972, and consolidated over the decades as a model of socioeconomic and political development that seeks to meet humanity's needs in the present, in harmony with the environment, without compromising the availability of the natural resources necessary for future generations.

Since then, several intergovernmental initiatives have reinforced this commitment. Fifty-two years after Stockholm, and in light of the current scenario of climate emergencies and structural socioeconomic inequalities, the effective adoption of this paradigm is more urgent than ever. The 2030 Agenda, adopted in 2015 by the then 193 UN Member States, represents a milestone in this trajectory. As a result of discussions from the United Nations Conference on Environment and Development (Rio+20), held in Rio de Janeiro in 2012, this agenda for the planning and management of public policies has the common goal of promoting peace and prosperity for people and the planet, both in the present and in the future.

Comprising objectives, targets, and indicators that are integrated, indivisible, and balanced across social, environmental, economic, and institutional dimensions, the agenda represents an urgent call to action for all countries in a global partnership. Each objective and target results in the construction of indicators democratically agreed upon at multiple scales, the most common

being national, state, and municipal, in addition to other territorialities, involving multiple actors and enabling comprehensive and participatory monitoring.

This book presents additional contributions beyond the 17 goals, including a contribution regarding the recent proposal of SDG 18: Ethnic-Racial Equality, as well as two other proposed new SDGs that remain under discussion.

The 2030 Agenda represents a strong international commitment to eliminating poverty—central theme of the first SDG—and other deprivations, through strategies that improve health and education, reduce inequality, and foster economic growth, all while simultaneously addressing climate change and taking action to preserve our oceans and forests. In other words, it seeks to reduce the impacts of an anthropocentric, short-term vision that is disconnected from the future of younger generations. It is also expected that the 2030 Agenda may trigger a process of raising awareness about the urgent need to combat humankind's depredation of nature, as if it were merely an inexhaustible resource.

In this scenario, Brazil stands out for its credentials in promoting a project of civic education that fosters the training of human talent to face this paradigmatic transition toward sustainable development.

This work reflects CAPES's mission to train highly qualified personnel to confront the global challenges of sustainability, offering a perspective on the integration of Brazilian graduate education into this debate and its contribution to a more equitable society. We hope that this work will inspire and strengthen our commitment to a fairer, more inclusive, democratic, and sustainable Brazil for all those living today and for those yet to come.

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EXECUTIVE OVERVIEW

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This book, *Impact of Brazilian Graduate Education on the 2030 Agenda: Contribution of the National Graduate Education System to COP 30 in the Amazon*, abbreviated as **IBGEd on the 2030 Agenda**, proves to be a contribution of the Brazilian National System of *Stricto Sensu* Graduate Education (SNPG), led by CAPES, on the occasion of COP 30, to be held in the Brazilian Amazon in November 2025.

This work continues a first contribution, published in 2012 by CAPES itself of a bilingual document entitled *Contribution of Brazilian graduate education to sustainable development: CAPES at Rio+20* (Brasil, 2012). Based on that legacy, the initiative was taken to produce evidence that this project remains underway.

The UN 2030 Agenda, composed of the 17 SDGs, 169 targets, and 232 indicators which are integrated, indivisible, and balanced, includes SDG 13: Climate Action.

Climate change is a significant, long-term alteration in the Earth's climatic conditions, such as average temperatures and patterns of precipitation, humidity, and winds (Intergovernmental Panel on Climate Change [IPCC], 2023). Since 1980, each decade has been warmer than the previous one; this phenomenon, known as global warming, results from climate change. The year 2024 was the warmest on record. It was also the first year to surpass 1.5°C of warming of the Earth compared with pre-industrial levels (Copernicus Climate Change Service, 2025).

The Earth's climate has changed naturally throughout its history, but natural causes alone cannot explain the rapid warming observed over the last century. Recent studies show that human activities, such as the burning of fossil fuels and land-use change, are among the main factors contributing to climate change by increasing greenhouse gases in the atmosphere, especially carbon dioxide (CO^2) (Friedlingstein et al., 2023). These gases create a "blanket" effect by trapping thermal energy near the Earth's surface, leading to rising global temperatures (Hansen et al., 2023).

Climate change generates consequences such as environmental impacts: heat waves and heavy rainfall, the rapid melting of glaciers that raise sea levels, and warmer oceans that intensify storms and hurricanes. Ecosystems such as coral reefs suffer from ocean warming and acidification, leading to

bleaching and mortality (Odériz et al., 2022). In addition, there are serious social and economic consequences, including threats to food security, population displacement, increases in disease, and growing costs due to infrastructure damage (Adom, 2024).

The consequences of climate change in Brazil have intensified. In 2024, the state of Rio Grande do Sul faced one of the most severe floods in its history, affecting more than 90% of the state's territory and resulting in 172 deaths (Marengo et al., 2024a). Intense rains associated with the El Niño phenomenon caused significant rises in river levels, leading to widespread flooding. In 2023 and 2024, the Amazon suffered from extreme droughts, reaching historically low levels, impacting the ecosystem and riverside communities (Marengo et al., 2024b). These events highlight Brazil's vulnerability to climate disasters and the need for effective policies for climate change mitigation and adaptation.

Even though the book could address only climate change, an editorial premise was adopted to develop a text with an anticipatory–preventive focus, characteristic of formative processes (Vieira & Sampaio, 2022). In this sense, the objective is to contribute to the understanding of the impact of Brazilian graduate education[1] on the 2030 Agenda, as a public policy that brings a "light at the end of the tunnel" in the face of an already existing climate emergency (Sampaio et al., 2020). As anticipated by our president in the Foreword, we hope that this work will inspire and strengthen our commitment to a fairer, more inclusive, democratic, and sustainable Brazil for everyone living today and for those yet to come.

Twelve years after the publication of the document prepared for Rio+20, the work **IBGEd on the 2030 Agenda** is now presented, highlighting the effort undertaken with the SNPG since 2013. The previous document was prepared with the participation of eight evaluation areas. In this edition, all 50 areas participated, as did the National Forum of Pro-Rectors for Research and Graduate Education (FOPROP), the National Association of Graduate Students (ANPG), and CAPES's technical staff.

[1] When referring to graduate education, it is worth noting that 95% of the scientific research conducted in Brazil originates from graduate programs at public universities (McManus & Neves, 2021).

As established by Ordinance No. 166, of June 4, 2024, 12 meetings were planned for the WG responsible for coordinating the preparation of this book, but nine were held: three two-day in-person meetings and six one-day virtual meetings, in addition to hybrid supplementary meetings when part of the members were gathered at the Technical-Scientific Council for Higher Education (CTC-ES), as well as many message exchanges in the WhatsApp group created for the WG. As an editorial strategy, chapter-level and, in some cases, section-level coordinations were created, led by members of a task force that represented, on an equal footing, the Forum of Area Representations, FOPROP, ANPG, and CAPES's technical staff. Each coordination had a working team composed of Forum members; external thematic advisors, who are specialists in the topics addressed in each chapter/section; and technical advisors, consisting preferably of early career researchers.

The resulting work is organized into three interrelated parts that together offer a comprehensive overview of the contribution of Brazilian graduate education to the 2030 Agenda. Although each section presents its own specificities, all are connected by a common purpose: to understand and enhance the role of graduate education in transforming teaching, research, innovation, and outreach processes, consolidating sustainable practices and promoting the education of critical citizens committed to intergenerational and inclusive development. The structure adopted is not limited to the mere presentation of data or the display of isolated initiatives; it proposes a continuous dialogue among institutional legacies, innovative practices, and critical reflection on future challenges. In this sense, four methodological axes stand out:

» An understanding of the historical and documentary roots that underpin the 2030 Agenda and the evolution of the *Planos Nacionais de Pós-Graduação* (PNPG) in Brazil, showing how environmental debates and social movements influenced the consolidation of the SDGs.

» The application of scientometric methods to extract and analyze data, using mainly the OpenAlex database and CAPES open data, with a focus on the catalog of theses and dissertations. Artificial intelligence techniques, including large language models (LLMs) and machine learning, were employed, together with a proprietary algorithm, to map the relationship between Brazilian research results and the SDGs, enabling descriptive statistical, semantic, and network analyses, as

well as international comparisons that contextualize Brazil's scientific contribution on a global scale.

» The identification of exemplary practices—"Highlights"—that concretely illustrate how graduate education contributes to promoting teaching, research, innovation, and outreach actions with social, environmental, economic, and institutional impacts.

» The development of proposals and next steps that engage with the needs of Education for Sustainable Development (ESD), highlighting the transformative potential of integrating different levels of education and the importance of educating critical citizens committed to sustainability.

The integration of these methodological approaches made it possible to construct a robust, multifaceted framework capable of reflecting the complexity of contemporary challenges in the field of graduate education. The use of a mixed approach—combining quantitative, qualitative, and participatory methods—was essential to capture the diversity of the phenomena analyzed. Moreover, data triangulation, together with the active participation of the various actors involved (coordinators, faculty, graduate students, and managers of the Secretariats of Education), helped validate the information and build an accurate diagnosis of existing advances and challenges. The comparison between national and international data enriched the analysis, demonstrating the role of local science systems in filling thematic gaps often neglected by the international community.

In the first part of the book—from the Introduction through Chapter 3—a historical and institutional overview of the National Graduate Education System is outlined, with emphasis on the evolution of the PNPG and the intersections between advanced training policies and the SDGs. In this section, the methodology combines documentary analysis and the use of keywords with quantitative indicators derived from scientometric methods, allowing a detailed mapping of how historical processes and institutional transformations paved the way for contemporary practices.

The second part highlights, through four chapters (4 to 7), concrete initiatives that exemplify the role of graduate education in achieving the SDGs. The methodological approach adopted was based on a systematic process of information gathering—conducted through online forms and the

application of rigorous evaluation criteria—that combined quantitative and qualitative analyses. This strategy made it possible to identify innovative practices in teaching, research, innovation, and outreach, demonstrating the ability of programs to integrate different dimensions of knowledge and promote coordinated actions.

Finally, the third part invites critical reflection on challenges and future prospects, synthesizing the evidence and debates presented in the previous sections. This section emphasizes the importance of an inter- and transdisciplinary approach that integrates social, environmental, economic, and institutional dimensions. The combination of evaluative methods and case studies reinforces this work's commitment to a robust, multifaceted analysis, indicating pathways to strengthen public policies and academic training committed to sustainability.

Thus, the structure of the book and the methodological design adopted reflect an integrated effort of mapping, analysis, and reflection that seeks not only to understand the legacy of Brazilian graduate education but also to point to new directions for building a fairer, more inclusive, and more sustainable future.

Next, each chapter is presented with emphasis on its specificities, highlighting how the work articulates the trajectory of Brazilian graduate education with the contemporary challenges of sustainable development. The texts show national leadership in achieving the SDGs, exploring historical evolution, innovative practices, and institutional transformations that drive integration among teaching, research, innovation, and outreach. This thematic approach enables a broader understanding of the role of graduate education in building a fairer and more sustainable future and, although the chapters emphasize the relevance and uniqueness of the Brazilian contribution, they also present, when appropriate, an illustrative portrait of the international scenario.

The *first chapter*, the *Introduction*, presents three sections. It begins with the context of the 2030 Agenda in the Brazilian setting. As evidenced in the Foreword, the 2030 Agenda constitutes a public policy. Its governance is established from its **institutional dimension**, represented by SDG 16: Peace, Justice, and Strong Institutions, and SDG 17: Partnerships for the Goals, which demonstrates the commitment of institutions and countries to fulfilling the other 15 SDGs. These, in turn, are distributed across three

other dimensions. The distribution of the SDGs in these four dimensions is illustrated in Figure 1.

FIGURE 1: DIMENSIONS OF THE SUSTAINABLE DEVELOPMENT GOALS

Source: United Nations Sustainable Development Solutions (2017).

In the **social dimension** are SDG 1: No Poverty; SDG 2: Zero Hunger and Sustainable Agriculture; SDG 3: Good Health and Well-Being; SDG 4: Quality Education; SDG 5: Gender Equality; and SDG 10: Reduced Inequalities. In the **environmental dimension** are SDG 6: Clean Water and Sanitation; SDG 7: Affordable and Clean Energy; SDG 12: Responsible Consumption and Production; SDG 13: Climate Action; SDG 14: Life Below Water; and SDG 15: Life on Land. In the **economic dimension** are SDG 8: Decent Work and Economic Growth; SDG 9: Industry, Innovation, and Infrastructure; and SDG 11: Sustainable Cities and Communities.

The *second section*, 1.2, presents the relationship between the PNPG and the SDGs. In this section, six PNPG periods were examined through the extraction and manual analysis of keywords associated with the 17 SDGs of the UN 2030 Agenda; with SDG 18, which complements the Brazilian 2030 Agenda; and with the two proposals under discussion—SDGs 19 and 20—

within the National Commission for the Sustainable Development Goals (CNODS), making it possible to identify the emergence and variation of these terms over time. Within the scope of the SNPG, the PNPG 2025–2029, its most current edition, refers to the 2030 Agenda and the SDGs more emphatically in the chapter "Equity and Diversity in Graduate Education."

The *third section* of the *Introduction*, 1.3, entitled *Evolution and current situation of Brazilian graduate education*, includes a quantitative analysis of CAPES open data and the Sucupira Platform, considering variables related to programs and courses, the activities of students and faculty, demographic characteristics, and scientific output, in order to provide a detailed overview of the evolution of Brazilian graduate education in the period following the document *CAPES na Rio+20*, that is, in the last three four-year cycles (2013–2016, 2017–2020, and 2021–2024).

From the second to the eighth chapter, it is important to highlight that, given the large volume of information produced by CAPES's 50 evaluation areas and the significant number of 17 SDGs, the data were grouped, respectively, into nine major areas and into the four SDG dimensions: social, environmental, economic, and institutional. In the specific case of chapters four to seven, the institutional dimension will include only SDG 16, since SDG 17 will be considered a prerogative in identifying highlight experiences that meet the 2030 Agenda, as it is transversal and essential to achieving the other SDGs.

Chapter 2, *Identification of SDGs in graduate theses and dissertations*, consists of potential impact indicators, that is, indicators that can generate benefits, although without guaranteeing them, illustrated by the correlation between master's theses, doctoral dissertations, and other final graduation works and the 17 SDGs. The methodology adopted followed two main steps. First, the SDG descriptors extracted from the STRINGS[2] project database were translated so that both English and Portuguese versions could be used to search for titles, keywords, and abstracts of works available in the CAPES theses and dissertations database, covering the period from 2013 to 2022. Next, using a cloud-based

[2] STRINGS is the acronym for Steering Research and Innovation for Global Goals, an international university consortium that mapped the global trajectory in science, technology, and innovation related to the SDGs, through the development of standardized descriptor systems. More information at: https://strings.org.uk.

relational database infrastructure, SQL algorithms were developed to extract, index, and correlate the data, enabling the synthesis of the indicators of interest. The approach was validated by comparing the results obtained with the OpenAlex bibliometric database, which aggregates a wide diversity of international scientific outputs, demonstrating the alignment of Brazilian graduate completion works with global trends in sustainable development.

Chapter 3, *Strategies of Brazilian graduate education for the 2025–2028 quadrennium: Contribution to promoting the 2030 Agenda*, presents what the 50 CAPES evaluation areas are planning regarding the induction of the SDGs through key themes that make up their area documents for the 2025–2028 quadrennium. Together, these themes end up playing an inductive role for policies and strategic actions with potential impact that can be adopted by graduate programs in achieving the 17 SDGs in the next quadrennium (2025–2028). To this end, an action research approach was adopted with a participatory and collaborative method, involving all Area Coordinations. Data collection was carried out through a comprehensive questionnaire composed of 11 questions, which achieved 100% participation, allowing the strategies and priorities of the area documents to be accurately captured. The data were then subjected to qualitative and quantitative analyses—using hierarchical clustering techniques (UPGMA method)[3] and the construction of dashboards and word clouds—to identify the key themes related to the SDGs.

The set of the following chapters presents highlight cases that concretely illustrate the impact of teaching, research, innovation, and outreach activities developed within Brazilian graduate education in achieving the SDGs. To this end, chapters 4 to 7 present experiences related to what has been produced in Brazilian graduate education that translates into both real impacts—when originating from evaluation areas closer to the theme of the 2030 Agenda—and potential impacts—as areas are more distant from the theme (Sampaio & Philippi Junior, 2021). These initiatives are carried out by faculty, graduate students, *alumnae* and *alumni*, establishing partnerships with the spheres of the state, market, and organized

[3] The UPGMA method (Unweighted Pair Group Method with Arithmetic Mean) is a hierarchical clustering technique frequently used to identify patterns of similarity among elements. The method constructs dendrograms from distance matrices, iteratively joining the closest pairs based on the arithmetic mean of distances between groups. Its simplicity and clarity make UPGMA a useful tool for exploratory analyses, such as in the mapping of research aligned with the SDGs.

civil society, aiming to address the first 16 SDGs (since SDG 17 is embedded transversally in the others), in addition to the three complementary SDGs.

Data systematization took place through an online form, publicized between September and October 2024, to which 1,058 programs from 251 institutions submitted a total of 1,958 highlight cases related to the SDGs. From this set, the responsible teams selected, for each chapter, nine representative cases based on criteria such as the breadth of the social, environmental, and economic dimensions; the integration of teaching, research, innovation, and outreach; the robustness of the reports; and the maturity level of the initiatives. This collaborative methodology not only ensures the representativeness of the most impactful cases but also establishes a solid evidence base to inspire the replication of the best highlight experiences in achieving the SDGs through Brazilian graduate education, demonstrating that the SNPG can offer practical and innovative solutions.

Starting from the premise that the environmental, social, and economic dimensions are integrated parts of the knowledge of life, as pointed out by *ecossocioeconomies* (Sampaio & Alves, 2019), *Chapter 4* brings together experiences that cover the largest number of SDGs; *Chapter 5* highlights initiatives "From the Amazon for the Amazon," in which local institutions act to benefit their own region; and *Chapter 6* focuses on the leadership of programs in combating climate change (SDG 13).

Chapter 7 emphasizes cases aimed at the complementary SDGs—SDG 18 (Ethnic-Racial Equality), SDG 19 (Art, Culture, and Communication)[4], and SDG 20 (Rights of Indigenous Peoples and Traditional Communities)—which emerged from debates that pointed to the need to meet specific demands of Brazil and other countries of the Global South, which mainly includes Africa, Latin America, the Arab States, and Portuguese-speaking countries. Other countries adopt the strategy of including voluntary SDGs[5], and it was during the development of the *Guia Agenda 2030: Integrando ODS, Educação e Sociedade*[6], published in 2020 through the partnership between Unesp and UnB, that the proposal to include SDGs 18, 19, and 20 arose. SDG 18 was recently incorporated into the

[4] To ensure cultural plurality and freedom, the democratization of art, and inclusive communication for all (Cabral & Gehre, 2020).

[5] Examples: (i) India adopts SDG 18, which refers to "Local empowerment and rural development"; and Costa Rica considers SDG 18 as "Happiness and people's well-being."

[6] Cabral & Gehre, 2020.

Brazilian 2030 Agenda as a voluntary goal, and the proposals for SDGs 19 and 20 continue to be debated within CNODS.

In this chapter, in addition to the presentation of corresponding highlights, an international comparative analysis was also conducted. Using the OpenAlex database, scientific publications were mapped according to their relevance to the complementary SDGs. The mapping was carried out by adopting an approach compatible with that of the aforementioned STRINGS project, adapting the descriptors produced for SDGs 18, 19, and 20 to identify and compare the attention given by Brazil and the rest of the world to these themes.

Although not exempt from criticism, such as the normative character of the 2030 Agenda as a public policy, which presents the challenge of moving beyond merely declaratory intentions toward more objective intentionalities (Alcântara, Sampaio, & Mantovaneli Junior, 2025), the SNPG can demonstrate a more practical plan through the highlight cases that contribute significantly to achieving the Sustainable Development Goals, as set out in Chapters 4, 5, 6, and 7.

Chapter 8, *Impact of Brazilian graduate education on Education for Sustainable Development: Possible pathways*, addresses a challenge, as it does not find immediate resonance in the mainstream of socio-educational currents that graduate education teaching–learning projects present. The chapter encourages reflection based on a tripod of spheres of formation: autoformation[7], heteroformation[8], and ecoformation[9], beginning with basic education, suggesting a gradual decoding of the enigmas of the human condition and seeking to organically reconnect the dimensions of subjectivation, socialization, and ecologization (Vieira & Sampaio, 2022). It is necessary to reverse the unpalatable correlation between the increase in years of schooling in countries with a high Human Development Index (HDI) and consumption patterns based on intensive use of materials, which result in a larger ecological footprint, as

[7] Autoformation is understood as the sphere of the individual's relationship with oneself, where a new sense of identity is constructed that transcends the limits of a dualistic perception of reality.

[8] Heteroformation is characterized as the sphere of interpersonal relationships, where a new sense of otherness is constructed, based on empathy and respect for differences.

[9] Ecoformation is understood as the sphere corresponding to the cultivation of an ecologized relationship with the planetary habitat we share with all living beings.

shown in the latest Human Development Report (United Nations Development Programme [UNDP], 2024).

Chapter 8 uses a methodology based on triangulating data from different sources to understand the impact of Brazilian graduate education on ESD. Information gathering included the analysis of theses and dissertations defended between 2013 and 2022, an examination of the guidelines of the National Common Curricular Base (BNCC), and the conduct of a national survey with State Secretariats of Education between November 22, 2024, and January 9, 2025. The survey received responses from 22 states, covering all regions of the country, and made it possible to identify projects, actions, and barriers related to the inclusion of the SDGs in school curricula. The data were analyzed qualitatively and quantitatively, supported by interactive dashboards, highlighting the role of partnerships with public universities and federal institutes, in addition to revealing challenges and strategies for promoting ESD in Brazil.

A more detailed account of mixed-methods framework adopted in this work is presented in a dedicated methodological article (Brasil, A. et al., 2025), available at https://doi.org/10.5281/zenodo.17294854. That publication elaborates on how quantitative analyses were complemented by qualitative inquiry to provide a richer and more contextualized understanding of the Sustainable Development Goals within the landscape of Brazilian graduate education.

Finally, we have the Afterword, written by Prof. Antonio Gomes de Souza Filho, CAPES Director for Evaluation, and the respective Appendices to Chapters 3 to 8 (in the online version)[10].

It is hoped that this book will be a contribution from the current generations in the world of education and Brazilian science so that future generations on the planet recognize nature as habitat, and not as a mere resource, which makes our lives possible as living beings, human and nonhuman. In view of current challenges and the vision of the 2030 Agenda, this book highlights the efforts of Brazilian graduate education to achieve a fairer and more sustainable development.

[10] Available only in Portuguese, at: https://capes.gov.br/apendices-ipgb-na-agenda-2030.

PART I

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Part I consists of the first three chapters. The first is divided into three sections. The first contextualizes the 2030 Agenda in the Brazilian setting, presenting a historical overview of global and national efforts toward sustainable development. It addresses the evolution of sustainability concepts and the importance of interdisciplinarity for the implementation of the SDGs, highlighting Brazil's role as a relevant actor in this process. It emphasizes that Brazilian *stricto sensu* graduate education can contribute to the territorialization of the SDGs, adapting them to local and regional realities.

The second section shows the evolution of the PNPG over the decades, identifying the connections between these plans and the SDGs. Through a methodology based on keywords, the section maps how the PNPG has incorporated themes related to sustainability, education, innovation, and the reduction of inequalities, highlighting the advances and challenges for the integration of the SDGs in graduate education policy. The third section presents an overview of the Brazilian SNPG through large-scale numbers, demonstrating the vigor of *stricto sensu* graduate education.

The second chapter highlights the presence of the SDGs in graduate education completion works in Brazil, such as master's theses, doctoral dissertations, and other academic outputs. Using a methodology based on descriptors and data analysis, the chapter maps the distribution of the SDGs across different fields of knowledge, emphasizing the most recurrent themes and the gaps that need to be addressed. The chapter also proposes recommendations to expand the integration of the SDGs in the scientific and technical production of graduate education.

The third chapter presents a detailed study on the strategies of Brazilian graduate education for the 2025–2028 quadrennium, with a focus on the contribution to the 2030 Agenda. Through participatory research with the coordinations of the 50 CAPES evaluation areas, it explores how the social, environmental, economic, and institutional dimensions of the SDGs are being integrated into the area documents. In addition, it discusses the importance of interdisciplinary training, knowledge transfer, and internationalization for achieving the SDGs.

This initial part is an invitation to reflection and action. By bringing together analyses, data, and concrete proposals, it seeks to inspire the academic community, public policy managers, and civil society to strengthen the commitment of graduate education to the 2030 Agenda.

1 INTRODUCTION

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1.1. THE 2030 AGENDA IN THE BRAZILIAN CONTEXT

This section outlines a brief social history of this Agenda and its Goals, and of Brazil's connections with it, in order to contextualize the place and role of the SNPG in this process. It indicates that the 2030 Agenda and its SDGs are yet another chapter in the long history of how environmental issues and sustainable development came to be established as matters of public interest in national and international arenas. A mixture of environmental history, environmental law, and international relations, this section revisits agreements, conventions, and

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international treaties that preceded the 2030 Agenda and paved the way for the SDGs. These emerge as a refinement of the notions of sustainability and sustainable development, incorporating dimensions beyond the strict conservation of nature's goods and services, implicating all sectors of society and fields of knowledge in this endeavor. It then explains how Brazil associated itself with this process in a very peculiar manner, adhering to the SDGs through a polycentric, socially based process (Galvão, Bastos Lima, & Ramiro, 2023). This explains the call to Brazilian graduate education to prepare this document, responding to the challenge of interdisciplinarity and confronting the complex dilemmas posed by the 2030 Agenda a decade ago. Such a historical path makes complete sense for understanding its multiple facets and the grouping of the SDGs into social, environmental, economic, and institutional dimensions.

1.1.1. Global efforts

The 2030 Agenda and its 17 SDGs emerged from a long journey of global efforts to consider the relationship between human societies and their integration with (and in) the biosphere, and to act in the face of its main challenges. Drawing on important events throughout the 20th and early 21st centuries that motivated reflections on this relationship—concern with world population growth, food production, industrialization, the consumption of nature's goods and services, issues involving social justice, public policies aimed at social asymmetries, challenges to access to drinking water, food security, and climate change—the 2030 Agenda was designed to guide countries politically according to their realities, becoming one of the most ambitious global governance agendas.

According to Cichoski, Corona, and Mello (2022), among the major international events held throughout the 20th and 21st centuries, some stand out for their significant impact on global discussions leading to the 2030 Agenda. The list compiled by the authors with the "main events linked to socio-environmental issues (20th and 21st centuries)" was supplemented and modified for the purposes of this publication in the following timeline:

Creation of the Club of Rome and the preparation of the Meadows Report (1960–1970): founded in 1968 by scientists, economists, and global leaders, the Club of Rome had the mission of fostering global cooperation in addressing challenges that threatened the planet. An important legacy of the Club was the publication of the Meadows Report in 1972, the result of research conducted by scientists at the

Massachusetts Institute of Technology that discussed "the limits to global growth." The report warned of a possible worldwide economic and environmental collapse in the 21st century, resulting in the proposal of zero growth (Passos, 2009).

Stockholm Conference (1972): the "United Nations Conference on the Human Environment" was the first major global event to address environmental issues, initiating systematic discussions on environment and sustainable development within the UN. The report on the state of the planet prepared for the conference is regarded as the world's first report on the state of the global environment. The Conference promoted discussions among different member countries to reflect on the risks of growth, opposing so-called rich countries, with a neo-Malthusian perspective of defending zero growth (in the style of the Club of Rome), and so-called poor countries, advocating growth at any cost, in a cornucopian perspective (that the supposed scarcity of natural goods and services would be overcome through the articulation of science, technology, and markets, enabling resource substitution and improvements in production processes). A window was also opened for ecodevelopmentalists, who proposed associating the economy with the limits of nature, conserving the global environment for future human well-being. The Conference approved a Declaration containing 26 principles on environment and development, an Action Plan with 109 recommendations, and a Resolution. These documents were long regarded as an environmental manifesto for contemporary times, as they established the foundations for the new UN environmental agenda and the environment as part of the international development agenda, inspiring future global initiatives.

Brundtland Report: *Our Common Future* (1987) was presented by the World Commission on Environment and Development. It formalized the definition of sustainable development as: development that meets present needs without compromising the ability of future generations to meet their own needs (incorporated five years later as a principle at the Earth Summit).

United Nations Conference on Environment and Development (1992): the Rio-92, Eco-92, or Earth Summit, held in Rio de Janeiro, marked the transition from agendas framed in terms of international diplomatic consensus and essentially declaratory in nature, to agendas shaped by the demands of organized civil society and influenced by its mobilization—in a context of the emergence of non-governmental organizations (NGOs) as relevant actors—forcing the recognition of issues deserving attention. Expressions of this were the Global Forum (an event that

organized civil society participation at the Earth Summit, with around ten thousand NGOs and representatives of social movements from various countries) and Agenda 21 (a global action program signed by 179 countries, containing 40 chapters aimed at building sustainable societies, reconciling economic development, social justice, and environmental protection). Two important conventions of the global environmental agenda were adopted: the Convention on Biological Diversity and the United Nations Framework Convention on Climate Change.

Kyoto Protocol (1997): a milestone in combating climate change and global warming, for expressing discussions on such themes, creating the carbon market, and establishing the global commitment to reduce greenhouse gas (GHG) emissions during the initial period from 2008 to 2012. In a second phase, from 2013 to 2020, the Doha Amendment was adopted, subsequently replaced by the Paris Agreement.

United Nations Millennium Summit (2000): established the Millennium Development Goals (MDGs), a set of eight global human development goals[11] (a notion grounded in the ideology of human rights), to be achieved by 2015, whose adoption would lead to the elimination of hunger and extreme poverty and promote sustainable development. The MDGs established global targets and benchmarks to measure results, both for so-called emerging countries and for those providing resources to development programs. All 191 UN member states at the time and 22 international organizations committed to helping achieve them. On that occasion, economist Jeffrey D. Sachs, an important political actor in defining the UN system's development agenda, assumed the role of special advisor for the MDGs and subsequently participated in the creation of the Sustainable Development Solutions Network, the global network that later designed the SDGs (Menezes & Catão, 2018). The government of President Luiz Inácio Lula da Silva capitalized on its leadership role in this agenda, seeking to achieve the proposed MDGs by building national arenas with regionalized efforts, in a context marked by participatory management experiences, with a certain installed methodological capital and people committed to implementing this agenda in society.

[11] Eradicate hunger and poverty; provide quality basic education for all; promote equality between the sexes and women's autonomy; reduce child mortality; improve the health of pregnant women; combat AIDS, malaria, and other diseases; ensure quality of life and respect for the environment; and establish partnerships for development.

Earth Charter (2010): one of the unfinished matters of the Earth Summit, the preparation of the Earth Charter began in 1994 and, after years of consultation, through an institutional architecture involving the Earth Summit Secretariat and Green Cross International, with support from the U.S. government, it was launched in June 2000. "A vision of hope and a call to action," the Charter is a declaration of 16 ethical principles regarded as fundamental for building a just, sustainable, and peaceful global society in the 21st century, seeking to inspire a new sense of global interdependence and shared responsibility for the well-being of humanity, the community of life, and future generations.

Rio+10 (2002): the World Summit on Sustainable Development took place in South Africa and enabled discussions on poverty, environmental impacts, and the urgency of sustainability, based on the advances and limits observed since Eco-92 and Agenda 21. The resulting report instigated discussions and reflections that contributed to the preparation of the SDGs.

Rio+20 (2012): the United Nations Conference on Sustainable Development took place in Rio de Janeiro in June 2012, 20 years after the Earth Summit, to renew environmental commitments among participating countries and build consensus around the SDGs. Brazil's leadership was consolidated, and the country became influential enough to propose the next stage and help bring civil society into the debate, paving the way for consensus around the 17 SDGs and their groupings. On this occasion, CAPES, celebrating its 60th anniversary, launched *Contribution of Brazilian graduate education to sustainable development: CAPES at Rio+20* (Brasil, 2012), the first document to propose an assessment of the SNPG's contributions to achieving a development standard consistent with sustainability principles, which inspired this current document. Based on information from the PNPG 2011–2020 and its sectoral documents, in addition to including texts prepared by experts and consultants, the document summarized the achievements of CAPES and Brazilian institutions, recording the evolution of graduate education in the focus on sustainable development, its historical milestones, the state of the system at the time, and the challenges related to the themes of Rio+20.

TABLE 1: SUSTAINABLE DEVELOPMENT GOALS

Goal 1. End poverty in all its forms everywhere
Goal 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3. Ensure healthy lives and promote well-being for all at all ages
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5. Achieve gender equality and empower all women and girls
Goal 6. Ensure availability and sustainable management of water and sanitation for all
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10. Reduce inequality within and among countries
Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12. Ensure sustainable consumption and production patterns
Goal 13. Take urgent action to combat climate change and its impacts
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

(*) Acknowledging that the United Nations Framework Convention on Climate Change (UNFCCC) is the primary international, intergovernmental forum for negotiating the global response to climate change.
NOTE: For a detailed account of each goal, including targets and indicators, see United Nations (2015), available at https://sdgs.un.org/2030agenda.

Source: UN (2015).

Paris Agreement (2015): the main instrument addressing climate change, replacing the Kyoto Protocol, reaffirming concerns about global warming from COP 21 onward, and renewing the commitment among countries to reduce GHG emissions. It was signed at the time by nearly all UN member states and is still seen as the most recent pillar and reference for climate negotiations.

Thus, also in 2015, with the establishment of the 2030 Agenda, the guidelines of a global governance agenda based on the concept of sustainable development of human societies and conservation of ecosystems became part of the public agenda

of governments, companies, and civil society. Based on the premise of "leaving no one behind," the Agenda presented the 17 SDGs—see Table 1 and Figure 1—bringing reflections that consolidate historical debates related to issues such as the struggle of women, the reduction of social inequalities, quality education, access to decent work, and food security, among others. The environmental dimension, in turn, was refined, integrating issues such as the use of alternative and renewable energies, water management and access to drinking water, the need for terrestrial and marine biodiversity conservation, and its relationship with the continuity of life on the planet, among others.

1.1.2. The SDGs in Brazil and vice versa

As a global guideline, the 2030 Agenda carries the prerogative of territorializing the SDGs, that is, it is possible and desirable to translate into territories—and from these back to the global sphere, in a two-way process—the issues that represent local demands and potentialities. In this regard, an important movement arose in some parts of the world, including Brazil: the appropriation of the SDGs by different societies, adapting and territorializing their issues according to their realities. Galvão, Bastos Lima, and Ramiro (2023) observe that in Latin America and the Caribbean (LAC) as a whole, civil society organizations (CSOs) have played a fundamental role in disseminating and incorporating the SDGs, shaping the formation of a bottom-up regionality in the context of implementing the 2030 Agenda.

Thus emerged the proposal of the *Guia Agenda 2030* (Cabral & Gehre, 2020), a document aimed at encouraging the implementation of the SDGs in educational institutions. By presenting a plan to territorialize the 17 SDGs from the Brazilian and Latin American reality, the *Guia* broadened the discussion and proposed three new SDGs arising from the realities of the Global South: SDG 18: Ethnic-Racial Equality; SDG 19: Art, Culture and Communication; and SDG 20: Rights of Indigenous Peoples and Traditional Communities. Upon the reinstatement of CNODS, the Thematic Chamber for SDG 18 was created, by resolution, to continue discussions and present a work plan in partnership with the Ministry of Racial Equality. In November 2024, Brazil formalized its 18th

SDG[12], on ethnic-racial equality, presenting it at the G20 Leaders' Summit—a forum for international economic cooperation created in 1999 with 19 countries, both so-called developed and emerging, and the European Union. The proposal to create an SDG to promote ethnic-racial equality had been announced in September 2023[13] by President Luiz Inácio Lula da Silva in his speech at the opening of the 78th UN General Assembly.

FIGURE 2: PROPOSED SUSTAINABLE DEVELOPMENT GOALS FOR BRAZIL

Source: www.guiaagenda2030.org.

All this contemporary mobilization is an expression of the prominent role of both the Brazilian government and organized civil society, from the proposal of the SDGs to the implementation of the 2030 Agenda. Since the early years of the Agenda, Brazil was active in engaging to advance the SDGs, including with the creation of CNODS in 2016. Its extinction in 2019 caused the Brazilian State to withdraw from debates on implementing the SDGs for four years.

During this period of governmental absence, however, civil society's strength was consolidated through initiatives of movements and organizations in favor of the SDGs, such as the Civil Society Working Group for the 2030 Agenda for Sustainable Development, which voluntarily continued working on the *Relatório Luz*, presenting annual monitoring of progress or setbacks in relation

[12] See https://www.gov.br/participamaisbrasil/logo-ods18 for more details on the process of creating SDG 18 and its visual identity.

[13] The creation of a new SDG, even if voluntary and restricted to a single country, is not an unprecedented initiative, since, as Martins and Sousa (2023) note, in India an SDG 18 had already been created on local empowerment and rural development, and in Costa Rica an SDG 18 on happiness and people's well-being.

to the process of their territorialization. In October 2024, the VIII *Relatório Luz da Sociedade Civil da Agenda 2030* was launched in Brasília, prepared by 47 civil society organizations and 82 experts. As the main monitoring document of the SDGs in Brazil and the only one constructed by Brazilian civil society, the report aims to offer comprehensive monitoring of the 17 SDGs and their 169 targets, based on official data, in addition to presenting 160 recommendations for implementing public policies that engage with the country's sustainable development. This report clearly demonstrates that little progress has been made in meeting most of the targets.

With the change in principles and orientation made possible by the election of a new federal government, CNODS was reinstated in December 2023, with a parity structure (84 members, half government representatives and half civil society), seeking to rebuild the synergy between state and society that characterized Brazil's advocacy process. In addition, in July 2024, the Office of the President consolidated the *Relatório Nacional Voluntário* on the SDGs, assessing their implementation throughout Brazil between 2016 and 2022 (precisely the period in which the State withdrew from the agenda).

At the same time, subnational governments played an important role, as state and municipal administrations in some states and municipalities continued to advance actively on this agenda, including with initiatives that gained international recognition. This was the case in the state of São Paulo, through the State Commission for the SDGs. Although extinguished under the current state government, it mobilized various efforts and published monitoring reports on the implementation of the 2030 Agenda in São Paulo territory, mobilizing multisectoral partnerships through its multi-year plan.

In parallel, private companies and some public institutions and civil society organizations were also decisive in ensuring the agenda was not abandoned, with educational institutions standing out. From early childhood, elementary, secondary, and technical education through higher education, various institutions appropriated the SDGs as a narrative and institutional policy, acting as strategic agents in the territories. Universities played an important role in amplifying the public debate on the SDGs and their issues, and some adopted institutional policies aligned with this governance agenda during that period. Two strategic initiatives stand out: the creation of the Advisory Commission on Ecological Change and Environmental Justice (Cameja) by the State University

of Campinas (Unicamp), aimed at developing activities to promote sustainability and environmental justice through international events, training courses, and the formulation of institutional guidelines; and the creation of the SDG Education Seal—an initiative coordinated by the *Selo Social* Institute, the Civil Society WG for the 2030 Agenda, and the University of Brasília (UnB)[14].

Galvão and Ramiro (2023) understand this dynamic of implementing the 2030 Agenda in Brazil as marked by an oscillation between governance without government and complex governance with a social emphasis, characterizing Brazil's adherence to the 2030 Agenda as "a polycentric, socially based process." According to the authors, the results of their research indicate the role of the SDGs in guiding local discussions and actions, promoting institutional integration, forming an innovative network, and building a social governance architecture with the presence of local governments and non-state actors.

1.1.3. Current opportunity and future horizon for graduate education

Embracing this process, the Brazilian SNPG has a strategic role in implementing the 2030 Agenda in Brazilian territory and circumstances, given that scientific research is fundamental for advancing all the SDGs. Not by chance, the system was called upon and responded by engaging with the 2030 Agenda and the SDG indicators. This is a singular moment for such reflection, as it is a period marked by imprecations against science, evidence, and consensuses regarding climate change. Science is an important part of the response to these challenges, as it has provided means to make viable the paradigm shift advocated by the 2030 Agenda—which in itself justifies the need to reinforce investment in Brazilian graduate education as a public policy. Institutions dedicated to promoting scientific research become prominent agents of the territorialization of the 2030 Agenda, as they adopt its methodology and adapt it to the country's different realities. The institutional action of the SNPG aligned with this governance agenda amplifies the impact and legitimacy of initiatives developed by numerous universities, though not yet properly recognized as actions that advance the SDGs.

[14] Since 2022, UnB has applied a specific methodology to map, monitor, qualify, evaluate, and mobilize public and private universities and other Brazilian higher education institutions for the implementation of actions aligned with the SDGs (the publication is in its third edition, 2025, with 74 HEIs certified).

This document reflects an optimistic vision: the expectation that the SNPG will increasingly integrate into CNODS and, through this, find a way for the graduate education evaluation model to capture the impacts of training and research at this level of education more broadly. This means incorporating dimensions often undervalued, such as university outreach, that demonstrate how graduate education has transformed society and impacted local and regional realities. By committing to evaluate its aggregate impact, in response to a global consensus built since the preparatory meetings for the Stockholm Conference in 1972, the SNPG takes a significant and relevant step toward aligning itself with the challenges and commitments of the 2030 Agenda.

1.2. THE NATIONAL GRADUATE EDUCATION PLANS AND THE SUSTAINABLE DEVELOPMENT GOALS

In Brazil, the connection between scientific research and the training of master's and doctoral degree holders developed and became institutionalized beginning in the 1950s and 1960s. Before that, research and the conferral of doctoral degrees took place in research institutes or isolated faculties, based on the establishment of professorial chairs, modeled after European countries.

Two important milestones can be highlighted: the creation of CAPES, established in 1951, and the regulation of graduate education through the Sucupira Report (Opinion No. 977, 1965), issued by the then Federal Council of Education. With the gradual development of *stricto sensu* graduate education in Brazil, inspired by the departmental structure of the United Kingdom and the United States, the SNPG was consolidated. Along with it, a public policy for higher education at the graduate level was established.

The first National Graduate Education Plan (PNPG) was prepared for the 1975–1979 quadrennium. In chronological order, Brazil has had five published PNPGs:

- I PNPG: 1975–1979;
- II PNPG: 1982–1985;
- III PNPG: 1986–1989;
- V PNPG: 2005–2010;

» VI PNPG: 2011–2020;

» VII PNPG: 2025–2029.

What could have been the fourth plan, covering the period from 1994 to 2002, was not published, but its guidelines were implemented with the aim of expanding the SNPG and improving the evaluation system of the programs.

The sixth PNPG introduced an innovation: in addition to extending the period of validity to 10 years, it instituted the creation of a Commission for monitoring the plan. The seventh PNPG (2025–2029), published in July 2025, inaugurated a new planning model, with the establishment of a public consultation phase, which involved broad participation from all stakeholders in the academic community and from representative institutions of both the public and private sectors.

The plans gradually gained complexity, accompanying the expansion of the SNPG. In the diagnosis of the first PNPG, Brazil had 50 higher education institutions (HEIs) offering graduate courses: 25 federal, 10 state or municipal, and 15 private. In 1973, 3,500 master's and 500 doctoral degrees were awarded. Based on consolidated data up to 2023, 50 years later, Brazil counts 7,105 courses distributed across 4,659 graduate programs. Currently, the number of master's and doctoral degree holders in Brazil has reached significant levels. In the base year 2023, 66,293 master's and 25,170 doctoral degrees were awarded, reflecting the expansion and consolidation of the national system.

1.2.1. Reflection on the SDGs and graduate education

This section of the report seeks to identify, throughout the six National Graduate Education Plans[15], the existing connections with the SDGs. It begins with the hypothesis that some SDGs, especially those related to education, science, and technology, are significantly addressed in the plans. On the other hand, issues guided by a social policy agenda, such as gender and ethno-racial equality, might be absent.

[15] For the accomplishment of this study, the six national plans were analyzed, following the chronological order previously presented in the text, with the exception of PNPG IV.

To meet the challenge of the complexity of this analysis, a methodology was organized based on the identification of keywords associated with the SDGs in the National Graduate Education Plans. For this purpose, the descriptors of the 17 SDGs were used, in addition to the descriptors of three proposed new goals, according to Brazilian demand, referred to here as complementary SDGs, namely: SDG 18 (Ethno-Racial Equality), SDG 19 (Art, Culture, and Communication), and SDG 20 (Rights of Indigenous Peoples and Traditional Communities). Among the three complementary SDGs, SDG 18 was made official in the Brazilian Agenda, which characterizes it as a voluntary SDG, as in other countries that have taken such an initiative.

Beyond the descriptors, correlated terms were used in the automated search through the RStudio tool and manual search, in order to minimize the occurrence of words located outside the intended context. After refining the list of keywords, the plan documents were analyzed in an attempt to measure the frequency of these words. Since there are differences in the number of descriptors for each SDG, the data were analyzed from the highest level of aggregation, that is, they were analyzed by the themes of the 20 SDGs and not by keyword. In any case, the objective was not to carry out an exhaustive search of keywords and their respective numerical frequencies. The objective of the analysis was to obtain an overview of how the words related to the SDGs appear or disappear in the texts, depending on the period and historical context in which the plans were prepared.

In this regard, it can be observed that the most recurrent SDGs in the six plans evaluated were SDG 9 (Industry, Innovation, and Infrastructure) and SDG 4 (Quality Education). The most recurring keywords in the PNPG search for these SDGs were technology[16] and professional training[17]. It was only from the V PNPG (2005–2010) that the keyword "social technologies," a term related to SDG 1: No Poverty, appeared in the document search.

It is interesting to note the progressive expansion of coverage of keywords related to the 20 SDGs analyzed, with the last PNPG showing the presence of terms related to all SDGs, as detailed in Table 2.

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[16] Defined as equivalent to terms such as Science and Technology System (S&T), scientific and technological development, terms in current use in the SNPG.

[17] Defined as equivalent to human resources training, a term in current use in the SNPG.

TABLE 2: DISTRIBUTION OF THE PERCENTAGES OF KEYWORD FREQUENCY IN RELATION TO THE TOTAL BY SDG AND PNPG

SDG	PNPG1	PNPG2	PNPG3	PNPG5	PNPG6	PNPG7
1	1,04%	1,32%	1,90%	5,33%	4,04%	4,34%
2	0,00%	0,00%	0,00%	0,00%	0,00%	1,51%
3	0,00%	0,00%	0,00%	0,59%	0,37%	1,89%
4	56,25%	28,95%	29,52%	24,26%	26,47%	14,14%
5	0,00%	0,00%	0,00%	0,00%	0,00%	2,07%
6	0,00%	0,00%	0,00%	0,00%	0,00%	0,94%
7	0,00%	0,00%	0,00%	0,00%	0,00%	0,94%
8	3,13%	2,63%	2,86%	2,37%	2,57%	6,22%
9	18,75%	38,16%	39,05%	27,22%	31,99%	32,23%
10	8,33%	2,63%	4,76%	14,79%	11,03%	5,84%
11	1,04%	0,00%	0,00%	0,00%	0,00%	4,81%
12	0,00%	0,00%	0,00%	0,00%	0,00%	3,39%
13	0,00%	0,00%	0,95%	0,00%	0,37%	2,73%
14	0,00%	0,00%	0,00%	0,00%	0,00%	2,92%
15	0,00%	0,00%	0,00%	0,00%	0,00%	3,58%
16	0,00%	1,32%	0,95%	2,37%	1,84%	3,49%
17	2,08%	9,21%	3,81%	8,88%	6,25%	1,04%
18	0,00%	0,00%	0,00%	0,00%	0,00%	0,57%
19	2,08%	0,00%	0,00%	0,00%	0,00%	2,83%
20	7,29%	15,79%	16,19%	14,20%	15,07%	4,52%

Source: Own elaboration, 2024.

* In this heat map, light green represents the lowest values; medium green: the 50th percentile; and dark green: values from the median to the maximum.

** SDG 20 stands out in intermediate values due to the keyword: public policies.

The predominance of SDG 9 over five decades is justified by the understanding that graduate education was—and continues to be—a national strategy for development, especially during periods such as industrialization under the military regime, the opening of the national market to international products, and the development of the oil exploration program, addressed in the sixth plan (2011–2020). The connection between development and sustainability appears only in the last two plans (from 2010 onward), reflecting a shift in the national and international agenda.

Considering the analysis in section 1.1, which identifies the term sustainable development from the Brundtland Report and the importance of the 1992 Earth Summit as a driver for disseminating the environmental theme

in Brazil, it can be stated that the topic of sustainable development was not yet considered important in the context of graduate education policy. The National Graduate Education Plan covering the period 2005–2010 makes reference to issues related to social, economic, and cultural development linked to environmental issues. It is worth highlighting the resumption of the theme of regional asymmetry, which has been repeated since the second PNPG, and the induction of new areas of knowledge and strategic areas, such as Biotechnology, Pro-Botany, Pro-Sea Sciences, Pro-Engineering, Digital TV, and Pro-Defense.

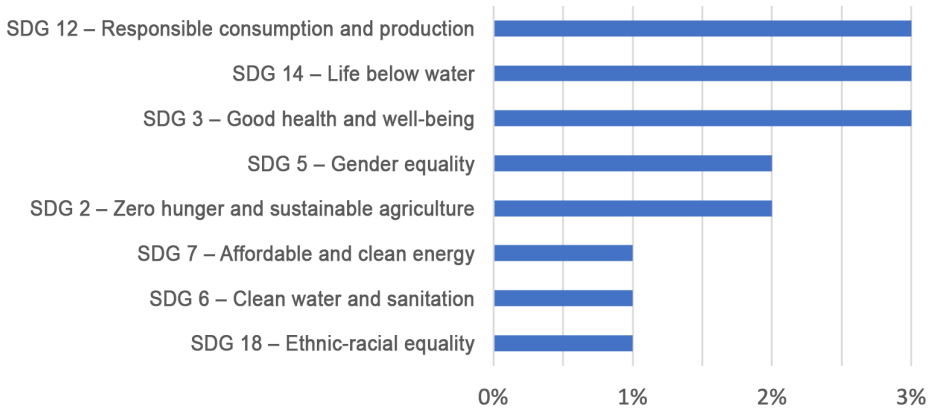
The development of training linked to the theme was driven by evaluation areas that gained relevance over time. Notable examples include the creation of the Interdisciplinary and Biotechnology evaluation areas in 2008, and Biodiversity and Environmental Sciences in 2011, with important intersections with the theme of sustainable development. This movement is aligned with the establishment of the Millennium Development Goals (2000) and the UN Rio+20 Conference.

The sixth PNPG (2011–2020) further expanded the relationship with sustainable development and presented the second largest number of terms related to the SDGs. The plan stands out for citing the sea, water, and the Amazon as strategic themes for Brazil.

The seventh PNPG (2025–2029), approved by the CAPES Superior Council on May 20, 2025, shows the highest recurrence of terms related to the SDGs, with emphasis on concerns about economic, social, cultural, and ecological development. In addition, it strongly addresses regional, gender, and racial inequalities, as well as the importance of Indigenous Peoples, their ways of life, and traditional knowledge.

On the other hand, the SDGs that showed low frequency (Figure 3) are precisely those that are being gradually integrated into the PNPG, in a growing trend that reflects the current moment of visibility and climate emergency, along with social issues advocated by society, which had the possibility of being incorporated into the last National Plan through the public consultation carried out by CAPES.

FIGURE 3: SELECTION OF THE LEAST FREQUENT SDGS
IN THE PNPG IN RELATION TO THE TOTAL



Source: Own elaboration, 2024.

Such themes, although absent or with low recurrence in the plans as specific strategies, may still be addressed due to the multiplicity of research conducted within the scope of graduate education, the result of a formative process that encompasses teaching, research, outreach, and innovation, and which will be analyzed in detail in this working group.

The seventh National Graduate Education Plan provides a very consistent diagnosis of how the resumption of graduate education activities in Brazil after the Covid-19 pandemic required a relevant period of time. The most important topics discussed in the PNPG 2025–2029 are:

» Regional asymmetry and intranational mobility.

» Evaluation of *stricto sensu* graduate education.

» Equity and diversity in graduate education.

» Funding and relations with the industrial sector and society.

» Future of graduates and new entrants.

» Internationalization and global visibility.

» Institutionalized research, outreach, and innovation.

» Graduate education and basic education.

It is possible to affirm that the plan currently in force embraces all the SDGs. The text explicitly refers to the UN 2030 Agenda in its chapter on equity and diversity, which considers that Brazilian graduate education can contribute to the following goals:

- SDG 1: No Poverty.
- SDG 2: Zero Hunger.
- SDG 3: Good Health and Well-being.
- SDG 4: Quality Education.
- SDG 5: Gender Equality.
- SDG 10: Reduced Inequalities.
- SDG 16: Peace, Justice, and Strong Institutions.
- SDG 18: Ethno-Racial Equality.

Furthermore, based on the reading of the Plan's text, it can be added that the SDGs linked to the social dimension (SDG 1, SDG 2, SDG 3, SDG 4, SDG 5, SDG 10, and SDG 18) are articulated in such a way as to integrate all chapters of the Plan and their respective recommendations. The economic dimension (SDG 8, SDG 9, and SDG 11) also encompasses important concerns of Brazilian graduate education, especially in two chapters: those related to relations with industry and those analyzing research, outreach, and innovation. The same can be observed with respect to the environmental dimension (SDG 6, SDG 7, SDG 12, SDG 13, SDG 14, and SDG 15), within which the Network Programs and other structuring formats of graduate training already have thematic focuses related to this dimension, especially sustainability, listed as examples of Brazilian excellence in training, in the Plan in question. In the institutional dimension, it should be emphasized that both SDG 16 and SDG 17 are clearly articulated in the Plan, particularly regarding social justice, internationalization, and global partnerships, which can help develop shared solutions through open science.

1.3. EVOLUTION AND CURRENT SITUATION OF BRAZILIAN GRADUATE EDUCATION

1.3.1. Brief history of CAPES and evaluation

Founded in 1951 as the "National Campaign for the Improvement of higher education personnel"[18] (by Decree No. 29,741), CAPES has always had the purpose of creating conditions for access to improvement opportunities aimed at graduates, as well as ensuring the existence of specialized personnel necessary for Brazil's economic and social development, both in quantity and in quality, and considering the needs of public and private enterprises (Brasil, 1951). In this context, CAPES's actions reflect incentives for research, teaching, and professional training, playing a fundamental role in the training of highly qualified professionals.

This governmental agency is responsible for about 75% of graduate education scholarships in Brazil. Since 2000, it has maintained and updated the Journals Portal, an initiative that expands access for students and researchers across the country to scientific literature. There are also funding actions and programs aimed specifically at the training of basic education teachers, including in distance-learning formats, since the institution also manages the Open University of Brazil (UAB).

CAPES is also responsible for the evaluation of proposals for new *stricto sensu* graduate courses (entry evaluation), as well as for monitoring ongoing courses. The data from the proposals and ongoing programs are collected through the Sucupira Platform, which stores and provides information on all *stricto sensu* graduate programs in the country. The evaluation carried out by CAPES is considered a prerequisite by the National Council of Education (CNE) for national recognition of academic and professional master's and doctoral degrees.

The monitoring evaluation is conducted with the participation of the academic community, through broad committees that follow criteria defined

[18] According to the original wording of Decree No. 29,741, of July 11, 1951, which used capital letters only for the first three words: "national", "campaign", and "improvement".

by each evaluation area in guiding documents. Currently, this evaluation is conducted every four years[19].

It should be emphasized that CAPES's evaluation of graduate courses is one of the earliest in the world, having begun in 1976, as soon as the first movements of scientometrics began to emerge (Borges et al., 2023). Since then, CAPES has sought to update, improve, and consolidate the evaluation process as an important instrument to identify bottlenecks, balance asymmetries, and serve as a reference in the distribution of scholarships and resources for research funding.

In this context, considering the inductive role of evaluation, an important change initiated in the 2004–2006 cycle (evaluated in 2007) was the introduction of the "Social Engagement" criterion (Ribeiro, 2007). Initially with a lower weight compared to other criteria (10%, being 1 among 5 criteria), the inclusion of the criterion was an important signal that the theme would begin to be valued in the monitoring evaluation. In subsequent evaluation forms, the importance of the criterion was expanded, changing its name to "Impact," with weight equal to that of the other two criteria (Program and Training).

1.3.2. The formation and consolidation of the SNPG

The beginning of higher education in Brazil is considered late. It was driven in the early 19th century, mainly with the arrival of the Portuguese royal family in the then colony. Even so, at the Proclamation of the Republic in 1889, there were only six (6) higher education institutions in operation, all public. The legislative changes that occurred thereafter, especially those that removed the exclusivity of the provision of science and higher education by the federal government, helped expand this provision, initiating the creation of research institutes such as the Emílio Goeldi Museum (1885), the Campinas Agronomy Institute (1887), and the Butantan Institute (1899) (Brasil A., 2023).

[19] In the 2025 Quadrennial, the data from 2021–2024 will be considered; in the 2029 Quadrennial, the data from 2025–2028 will be considered.

The first Brazilian university was the Federal University of Rio de Janeiro (UFRJ), established by Decree No. 14,347/1920, as a result of the merger of the Polytechnic School of Rio de Janeiro, the Faculty of Medicine of Rio de Janeiro, and the Faculty of Law of Rio de Janeiro. The indissociability of teaching, research, and outreach, however, was not yet present in the concept of university at the time. This notion became more evident after the University Reform instituted by Law No. 5,540, of November 28, 1968.

With regard specifically to graduate education, activities began in Brazil through spontaneous movements of higher-education faculty and researchers. The emergence of agencies such as CAPES and the National Council for Scientific and Technological Development (CNPq) already indicated some recognition of the relevance of graduate education, although there was not yet a systematized understanding of its characteristics and differences from other improvement courses.

Opinion No. 977, signed by Newton Sucupira in 1965, laid the foundations for graduate education as we know it today and that differentiates master's and doctoral degrees (which grant diplomas and degree titles) from specialization and improvement courses, which grant certificates. The Sucupira Report also presented a comparison of the Brazilian graduate education model of the time with those of other countries. Moreover, it pointed to the more professionally oriented character in the master's degree, while the doctorate prioritized a more academic bias, although both employed scientific foundations to deliver their content and require their outcomes.

In view of the new definitions, there were changes in nomenclature that influenced even the way of accounting for graduate education. Statistics prior to the 1970s, for example, did not distinguish between specializations and master's degrees. The current unit, the "program," did not exist, and only courses were considered separately. This makes it difficult to compare present data with past data on graduate education. Even so, it is possible to perceive the strong expansion that occurred, as well as the regional deconcentration of courses, as will be detailed later.

Table 3, extracted from Borges et al. (2023), presents the history of evaluations from the cycle that began in 2001 and the number of programs in operation in each period considered. Between 2004 and 2021 there was

growth of 148%, from 1,819 *stricto sensu* graduate programs in 2004 to 4,512 programs in 2022.

TABLE 3: DETAILS OF THE EVALUATION CYCLES

Periodicity	**Triennial**	**Triennial**	**Triennial**	**Triennial**	**Quadrennial**	**Quadrennial**
Evaluation cycle	2001–2003	2004–2006	2007–2009	2010–2012	2013–2016	2017–2020
Year conducted	2004	2007	2010	2013	2017	2022
Regulations and norms	Not identified	CAPES website	CAPES website	CAPES website	Ordinance nº 59/2017	Ordinance nº 122/2021
Number of PPG evaluated	1.819	2.255	2.718	3.338	4.175	4.512

Source: Borges et al. (2023, p. 35).

According to the data available on the Graduate Education Observatory Data Panel[20], in 2023, 7,105 master's and doctoral courses were recorded, grouped into 4,659 graduate programs (which may comprise up to two courses—at most one master's and one doctorate—of the same modality, academic or professional)[21].

Using as a basis the 1979–1984 Report prepared by CAPES, it is possible to identify that, in 1979, there were 974 courses, 717 master's and 257 doctoral. The Southeast region housed 93.77% of doctoral courses and accounted for 70% of the total *stricto sensu* graduate courses. The courses that existed at the time belonged to only eight areas: Arts, Biological Sciences, Health Professions, Exact Sciences, Engineering, Human and Social Sciences, Social Professions, and Agro-Industrial Professions, as detailed in Table 4.

[20] Available at: https://sucupira.capes.gov.br/painel. Accessed on: May 27, 2025.

[21] The data from the last ten years will be detailed in the next subsection.

TABLE 4: MASTER'S AND DOCTORAL COURSES, BY AREA AND REGION, IN 1979

	Region										TOTAL	
	North		Northeast		Southeast		South		Center-West			
Areas	M	D	M	D	M	D	M	D	M	D	M	D
Arts	-	-	-	-	1	-	-	-	-	-	1	-
Biological Sciences	4	3	9	-	47	30	14	3	2	-	1	36
Health Professions	-	-	17	-	117	64	18	1	2	-	1	65
Exact Sciences	1	1	18	2	65	44	8	2	6	1	1	50
Engineering	-	-	11	1	63	29	9	-	1	-	1	30
Human and Social Sciences	1	-	20	-	71	24	14	1	7	-	1	25
Social Professions	-	-	12	-	66	35	12	1	10	-	1	36
Agro-Industrial Professions	-	-	17	-	55	15	18	-	1	-	1	15
Total	**6**	**4**	**104**	**3**	**485**	**241**	**93**	**8**	**29**	**1**	**1**	**257**

Source: Brasil (1985, p. 14).

1.3.3. Graduate education in Brazil in the last ten years

In the last 10 years, CAPES has improved the provision of data and information regarding the monitoring evaluation of *stricto sensu* graduate programs. To this end, it created consultation and data-collection channels accessible to every citizen, among which: GeoCAPES, the Open Data Portal, and the Sucupira Platform, which brings together on its portal the Theses and Dissertations Catalog, the Evaluation Memory, and the Graduate Education Observatory.

These improvements stem from the growing need to evaluate the actions of graduate programs and support the development of public policies. In this regard, it is worth highlighting MEC Ordinance No. 13/2016, which provides for the induction of affirmative actions in graduate education and assigned to CAPES the duty to coordinate the census of graduate students.

> Art. 3 The Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES) shall coordinate the periodic preparation of the graduate student census in Brazil, with the aim of providing input for monitoring the inclusion of Black (pretas and pardas), Indigenous, and persons with disabilities in graduate education, as well as for evaluating such actions within graduate programs (Brasil, 2016).

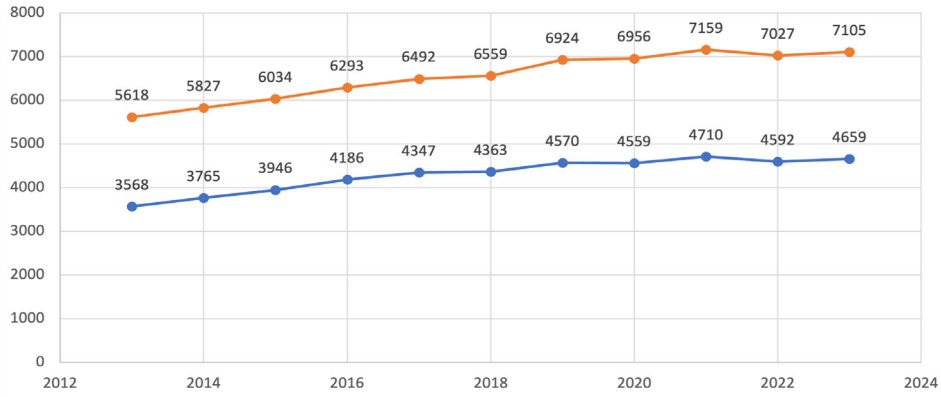
Since 2017, CAPES has collected information to promote affirmative policies and has improved the provision of data securely, in order to meet the need to protect personal and sensitive data, as provided for in the Access to Information Law (LAI) and the General Data Protection Law (LGPD).

Continuing these actions, in 2022, CAPES instituted the creation of a working group, through Ordinance No. 314, to conduct the student census with the objective of mapping the universe of graduate students, in number and in terms of socioeconomic, cultural, and ethnic diversity. The promotion of such initiatives aligns with the global agenda adopted in 2015 in favor of achieving the SDGs.

1.3.3.1. Programs and stricto sensu graduate courses

Between 2013 and 2023, there was an increase in the number of programs (about 30%) and of master's and doctoral courses (about 26%), totaling, in 2023, 4,659 programs and 7,105 graduate courses offered by a total of 550 campuses of 459 higher education institutions in the country[22].

FIGURE 4: TOTAL NUMBER OF MASTER'S AND DOCTORAL PROGRAMS AND COURSES BETWEEN 2013 AND 2023



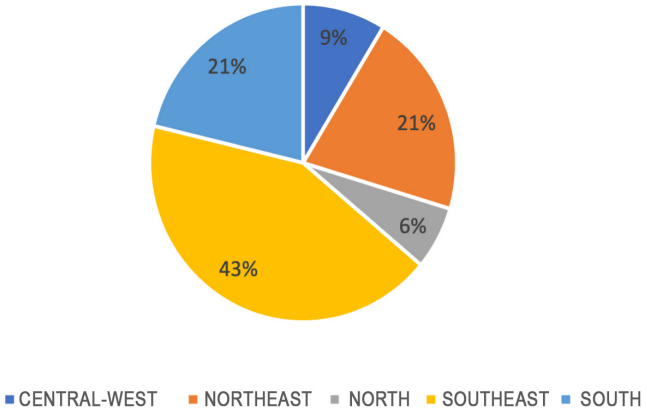
Source: CGPRO/DAV/CAPES. Study based on *Dados Abertos* CAPES from 2023.

[22] According to the Graduate Education Observatory Data Panel (Available at: https://sucupira.capes.gov.br/painel. Accessed on: May 27, 2025).

It should be emphasized that the quantities presented in this and the other sections refer only to programs in operation or in the process of deactivation, not including those not yet started (in the project phase). It should also be noted that the numbers may differ slightly from the total number of programs and courses recognized by CAPES, since the data extraction took place in September 2024, before processing the re-collection of information for 2021 and 2022, in which programs were able to submit pending data or update previously submitted records.

Most programs are located in the Southeast Region (43%), followed by the Northeast and South regions, both with 21% participation. The Center-West and North regions have, respectively, 9% and 6% of the programs.

FIGURE 5: STRICTO SENSU GRADUATE PROGRAMS BY REGION IN 2023



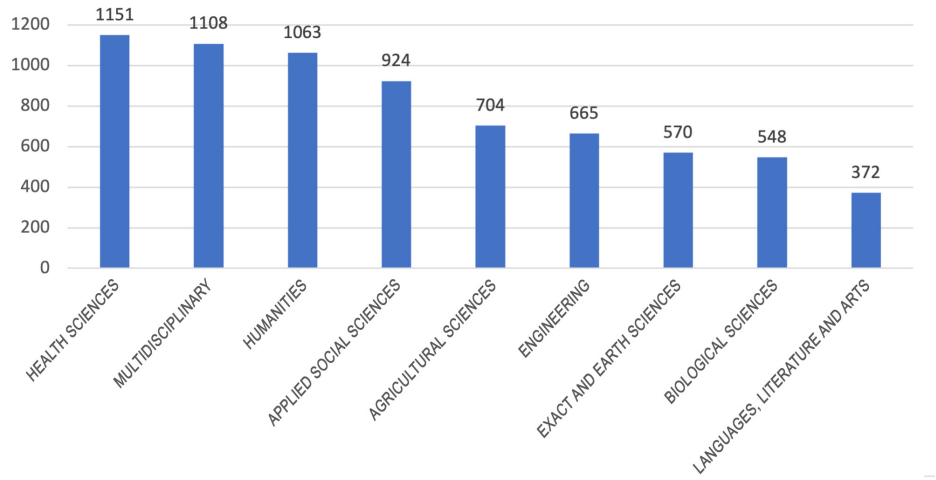
Source: CGPRO/DAV/CAPES. Own elaboration based on *Dados Abertos* CAPES and the CAPES Graduate Education Observatory.

The broad field of Health Sciences[23] comprises the largest set of graduate courses offered in the SNPG in absolute terms (1,151), followed by the broad field Multidisciplinary[24] (1,108) and by Humanities (1,063).

[23] It brings together the following CAPES evaluation areas: Physical Education, Physical Therapy, Speech-Language Pathology and Audiology, and Occupational Therapy, Nursing, Veterinary Medicine, Pharmacy, Medicine (I, II, and III), Nutrition, Dentistry, and Public Health.

[24] It brings together the following CAPES evaluation areas: Biotechnology, Environmental Sciences, Teaching, Interdisciplinary, Materials, and Sciences and Humanities for Basic Education.

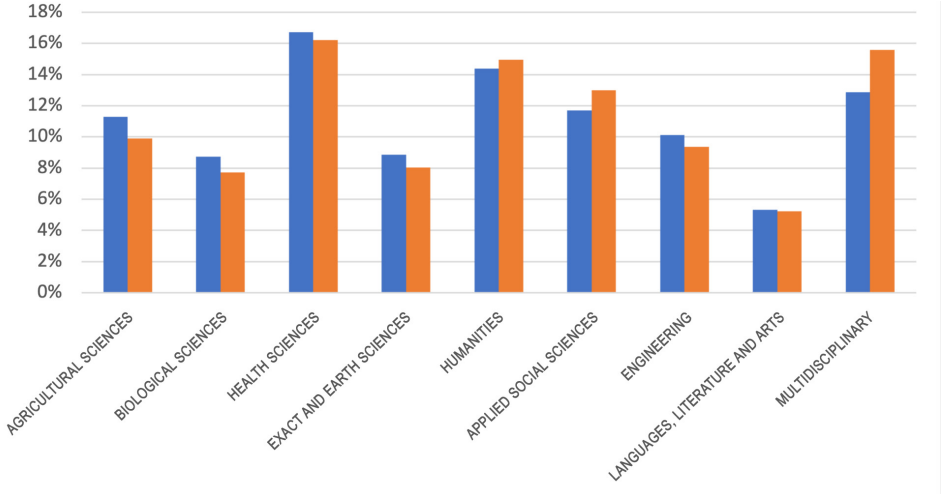
FIGURE 6: BROAD FIELD OF MASTER'S AND DOCTORAL COURSES IN 2023



Source: CGPRO/DAV/CAPES. Own elaboration based on *Dados Abertos* CAPES and the CAPES Graduate Education Observatory.

Over the years between 2013 and 2023, the broad Multidisciplinary field showed the highest percentage growth in the number of courses offered.

FIGURE 7: PROPORTION OF MASTER'S AND DOCTORAL COURSES BY BROAD FIELD IN 2013 AND 2023



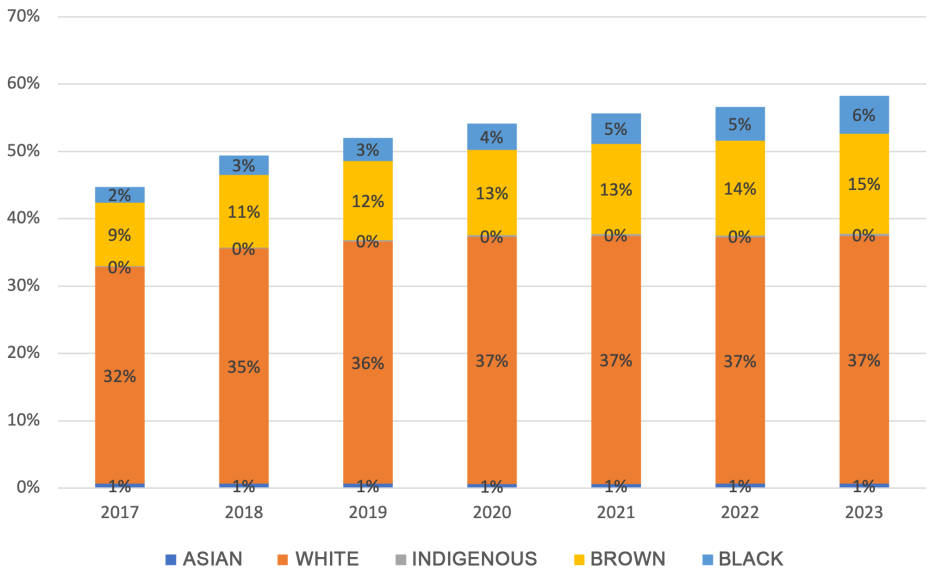
Source: CGPRO/DAV/CAPES. Own elaboration based on *Dados Abertos* CAPES and the CAPES Graduate Education Observatory.

1.3.3.2. Students in the SNPG

As for the number of active students[25] in the SNPG, in 2023, 428,598 student records were collected, a 47% increase compared to 2013. Women constitute the majority in the system (55%).

There is a predominance of students self-declared as white (37%), although between 2017 and 2023 there was an increase in the percentage of students self-declared as brown and black.

FIGURE 8: PROPORTION OF STUDENTS BY RACE/COLOR RECORD (2017–2023)[26]

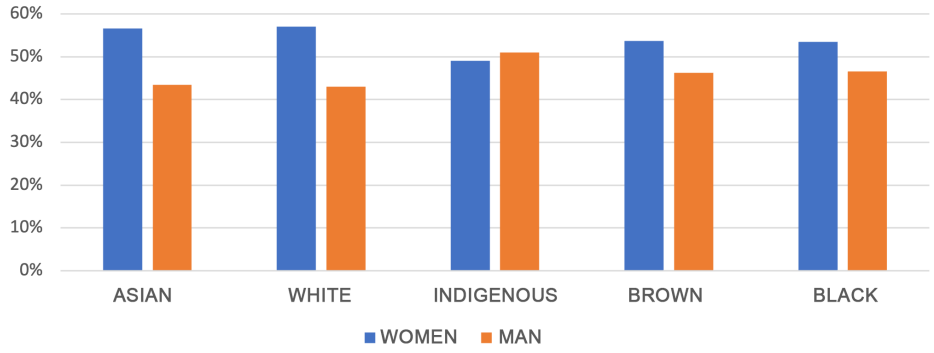


Source: CGPRO/DAV/CAPES. Own elaboration based on *Dados Abertos* CAPES and the CAPES Graduate Education Observatory.

[25] Corresponds to the total number of students reported by graduate programs in 2023. The figure represents the total number of enrollments and not the count of individuals, since a student may participate in more than one program.

[26] It is important to note that these data began to be collected only in 2017 and are non-mandatory information declared by the programs. Thus, many data are still unreported (42%). The expectation is that the Graduate Education Student Census will expand the collection and quality of this information.

FIGURE 9: PROPORTION OF STUDENTS IN 2023 BY RACE AND SEX

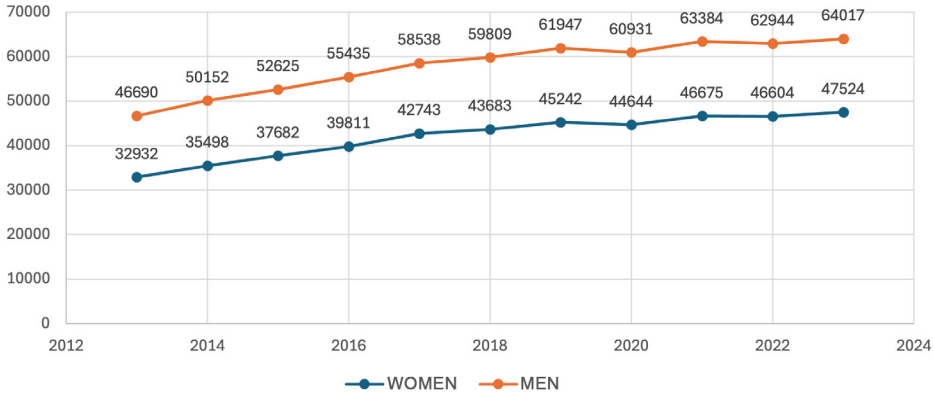


Source: CGPRO/DAV/CAPES. Own elaboration based on *Dados Abertos* CAPES and the CAPES Graduate Education Observatory.

1.3.3.3. Faculty in the SNPG

In absolute numbers, a total of 111,541 faculty members were identified as active in the system in 2023, a 40% increase compared to 2013. In turn, unlike the student profile, there is a larger contingent of male faculty (57%). The predominance of males is maintained across all age groups, with a slight decrease among faculty aged 50 to 59 years.

FIGURE 10: PROPORTION BY SEX OF FACULTY BETWEEN 2013 AND 2023

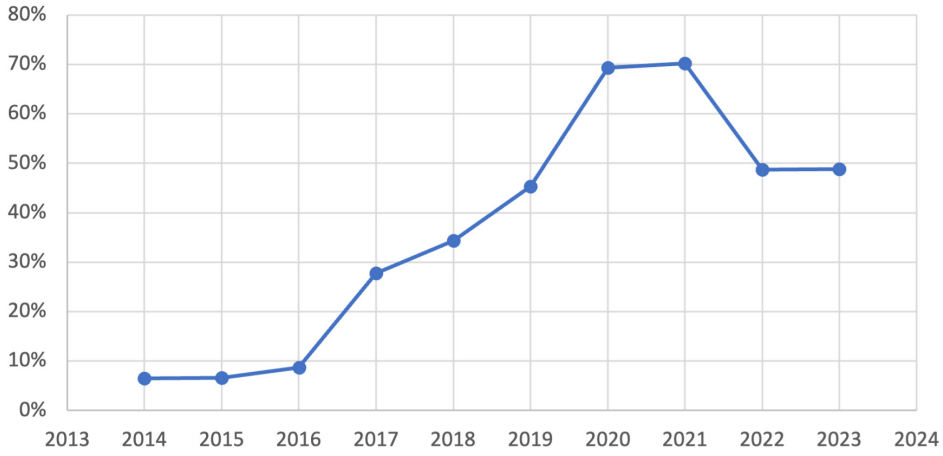


Source: CGPRO/DAV/CAPES. Own elaboration based on *Dados Abertos* CAPES and the CAPES Graduate Education Observatory.

1.3.3.4. Scholarly output

Regarding the universe of scholarly productions authored by faculty, students, and graduates of Brazilian *stricto sensu* graduate programs, considering only articles published in scientific journals, which represent the largest share of production subtypes (28%), it is observed that in 2019 and 2020 there was a significant increase, followed by a decline. The decline observed was probably due to the effects of the Covid-19 pandemic.

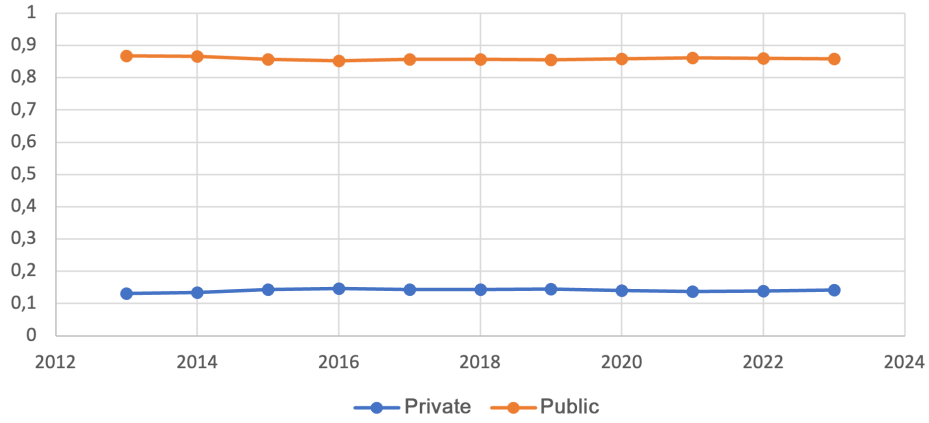
FIGURE 11: DIFFERENCE, RELATIVE TO THE PREVIOUS YEAR, IN ARTICLES PUBLISHED IN JOURNALS BY GRADUATE PROGRAMS BETWEEN 2013 AND 2023



Source: CGPRO/DAV/CAPES. Own elaboration based on *Dados Abertos* CAPES and the CAPES Graduate Education Observatory.

Public higher education institutions are responsible for 86% of articles published in journals in 2023, and this distribution remains throughout the entire period analyzed.

FIGURE 12: PROPORTION OF ARTICLES PUBLISHED IN JOURNALS AND REPORTED TO CAPES BETWEEN 2013 AND 2023, BY LEGAL NATURE OF THE AUTHORS' HEIS



Source: CGPRO/DAV/CAPES. Own elaboration based on *Dados Abertos* CAPES and the CAPES Graduate Education Observatory.

1.3.4. Final considerations

As can be observed, in just over seven decades of existence, CAPES has played a fundamental role in structuring and promoting graduate education in Brazil, always concerned with maintaining the quality of courses, programs, and the professionals and academics trained by them.

Over these decades, the country has consolidated itself as one of the largest producers of scientific knowledge in the world, and public institutions such as CAPES have proved fundamental for the consolidation of the most robust graduate education system in the Global South.

2 IDENTIFICATION OF SDGS IN GRADUATE THESES AND DISSERTATIONS

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The institutionalization of graduate education, from Opinion No. 977 CES/CFE (Higher Education Council/Federal Council of Education), of December 3, 1965 (Sucupira Opinion), and its expansion from the University Reform of 1968 (Alves & Oliveira, 2014), occurred in a period of accelerated economic growth in Brazil, whose social and economic impacts extend to the present day. Thus, since the implementation of the graduate education model, research and the training of highly qualified professionals have, over time, been related to the country's strategic demands (Brasil, 2024a), without losing the goal of consolidating research on a global scale (Shigunov Neto, Trevisol, & Almeida, 2021). In this process, CAPES was decisive in financing and organizing the System, promoting the induction of research and contributing decisively to making the country's position visible on the international stage (Bianchetti, 2009), based on the criteria established by global organizations such as the United Nations Educational, Scientific and Cultural Organization (UNESCO), the United Nations (UN), the Organization for Economic Cooperation and Development (OECD), and the World Bank (Shigunov Neto, Trevisol, & Almeida, 2021).

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Notably, one can cite the partnership established between UNESCO and the Ministry of Education (MEC) in Brazil in promoting access to quality education. Education is a fundamental precept for achieving the sustainable development of countries as an integral part of the three pillar dimensions of social development, namely economic viability, social justice, and environmental conservation. Brazilian graduate education stands out in the generation of new knowledge, technologies, and innovations in management processes, aiming to promote comprehensive education (Brasil, 2012).

Brazil, in view of its human and natural wealth, needs to value a science that ensures and protects its diversity in a systemic manner and is aligned with emerging international themes. The well-being of human societies depends directly on the sustainable use of natural resources and the balanced maintenance of ecosystems and their organisms which, being alive, offer a series of irreplaceable and non-priced ecosystem services. However, population growth, the invasion of undesirable species, and the destruction of habitats have promoted rapid changes in the functioning of ecosystems, with undesirable consequences that spread globally, affecting biological and human populations (Pecl et al., 2017).

Within this breadth of national demands, which extend internationally, the UN defined the SDGs. In this context, in the face of major challenges, this chapter aims to inventory and synthesize the indicators of the SDGs associated with dissertations, theses, and other products resulting from graduate degree completion works by students from different Brazilian graduate programs (PPG). From this survey, by identifying the students' technical-scientific production, the intention is to stimulate, strengthen, and assist in the consolidation of research in thematic areas of the 2030 Agenda, with the perspective of achieving a more inclusive, peaceful, and sustainable future for human populations.

2.1. METHODOLOGY USED

The first stage of the methodology started by identifying the descriptor systems grouped for each of the SDGs. This search was carried out using the database developed by a project that mapped the global trajectory of development in science, technology, and innovation toward the SDGs. The

STRINGS[27] project was conducted by a university consortium[28] supported by the United Nations Development Program (UNDP), with among its objectives the provision of descriptor systems to map and characterize global scientific publication related to the SDGs (Ciarli et al., 2022). From this, the project contributed to establishing an international standard for classifying scientific metadata around open research chains, which makes its application compatible with the objectives of this document.

In this first stage, the descriptors of the seventeen SDGs provided by the STRINGS project in English were translated into Portuguese. To identify graduate degree completion works related to the SDGs, records obtained from the CAPES Open Data system[29], referring to the period from 2013 to 2022, were converted into relational format and made available using Google Cloud's service infrastructure. Since CAPES records include abstracts and keywords in Portuguese and English, both the original descriptors from the STRINGS project and those translated by our team could be used to compose search algorithms in SQL (Structured Query Language). Finally, the mapping of theses and dissertations was enriched with data on graduate programs, allowing multidimensional analyses of the related results and the production of the indexes and indicators of interest.

For purposes of international comparison, the OpenAlex database was used, as it gathers a large volume of works of various types, including articles, conferences, and preprints, in addition to doctoral dissertations (Priem, Piwowar, & Orr, 2022). This database was used based on the data structure developed and

[27] The STRINGS project used data from the Web of Science (WoS) database to map scientific publications related to the Sustainable Development Goals. The methodology was based on the creation of a search system using descriptors associated with each SDG, developed from text mining and manual selection of terms extracted from public policy reports, scientific literature, and institutional documents. The publications were organized into 4,013 thematic clusters, defined by citation patterns, and each cluster was associated with one or more SDGs according to the proportion of articles containing the specific descriptors. The analysis adopted two approaches: a strict interpretation, considering only clusters with a strong connection to an SDG, and a flexible interpretation, also including clusters with a weaker association (Ciarli et al., 2022, p. 52, figure 4).

[28] The consortium includes the participation of the University of Sussex, through the Science Policy Research Unit (SPRU), and the Department of Science, Technology, Engineering and Public Policy of University College London (UCL).

[29] The open data can be accessed at the following address: https://dadosabertos.capes.gov.br/.

publicly made available by the InSysPo project[30], an initiative of the Department of Scientific and Technological Policy (DPCT) at Unicamp. The project also provides, likewise adopting Google Cloud's service infrastructure, open national and international public databases[31].

With the data mapping carried out, the study compiled graduate degree completion works presented by approximately 700,000 graduating students between 2013 and 2022, from more than 4,500 graduate programs, distributed across different fields of knowledge.

2.2. THE MAP OF THE SDGS IN BRAZILIAN GRADUATE EDUCATION OUTPUTS

The results obtained present the research developed in graduate programs, in all fields, covering themes related to the SDGs in dissertations, theses, and other products presented as graduate degree completion works. From these results it is identified that national research converges with research carried out globally. Furthermore, the training of master's and doctoral graduates in Brazilian programs signals, through the identified themes, the search for solutions to contemporary international urgencies. The panorama of the results obtained for the different fields, collegia, temporally and spatially, including the production of knowledge related to the SDGs by state of the Brazilian federation, is presented below.

2.2.1. The use of the SDGs in graduate degree completion works

An increase was found in the use of the SDGs in theses, dissertations, and other graduate degree completion works over the study period (Figure 13A). Although a portion of these works is not correlated with any SDG (Figure 13B), a reduction in the number of such products was observed. The adherence in graduate degree completion works equips society with qualified information for problem-solving and, therefore, increases the chances of "protecting our lands, waters, forests, and future" (Pan-Amazonian Ecclesial Network – REPAM, 2024), improving the quality of life of all people.

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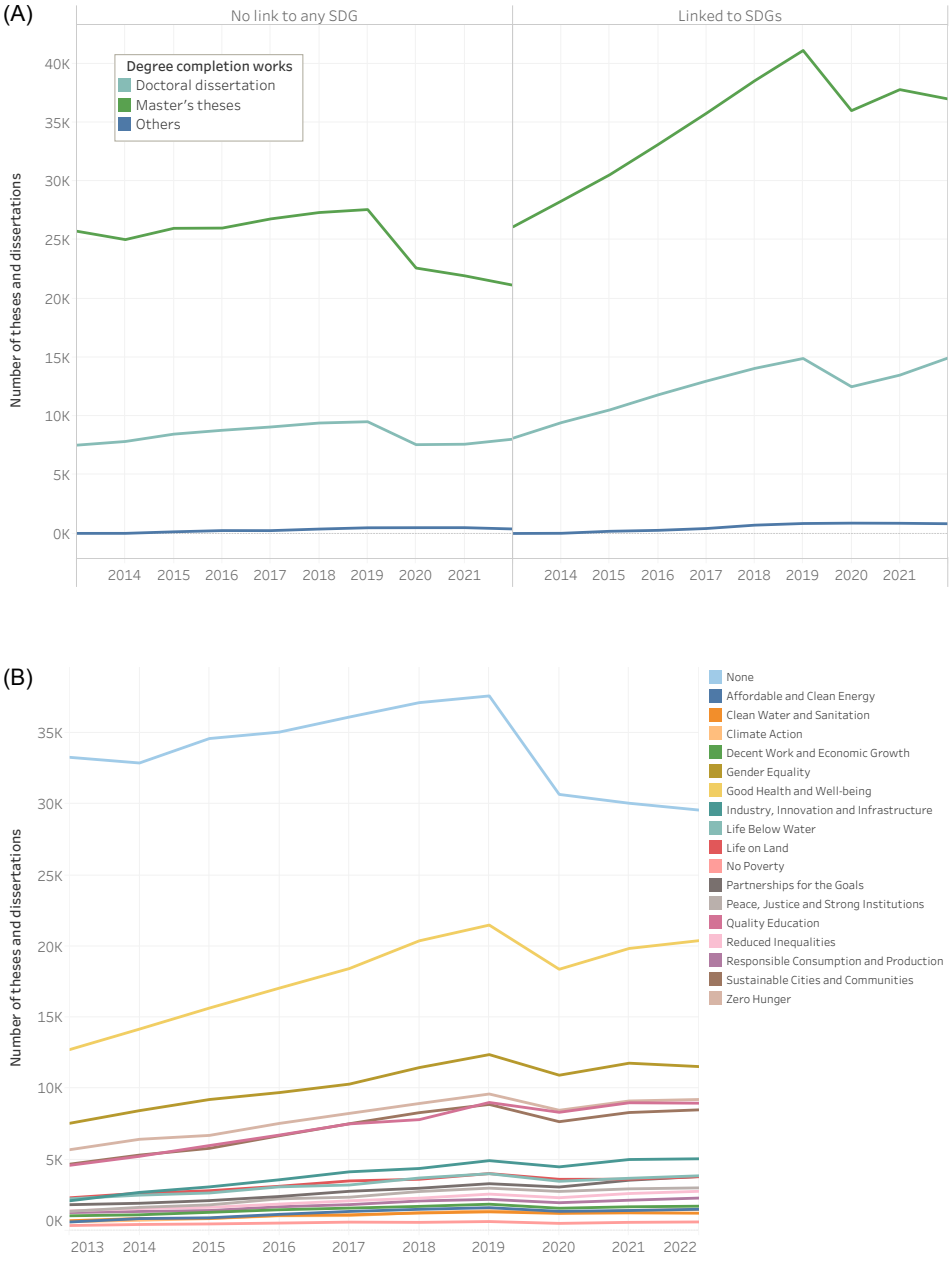
[30] Project website: https://www.ige.unicamp.br/insyspo/.

[31] Chronology of implementation presented in: https://doi.org/10.59350/eqmfk-82y98.

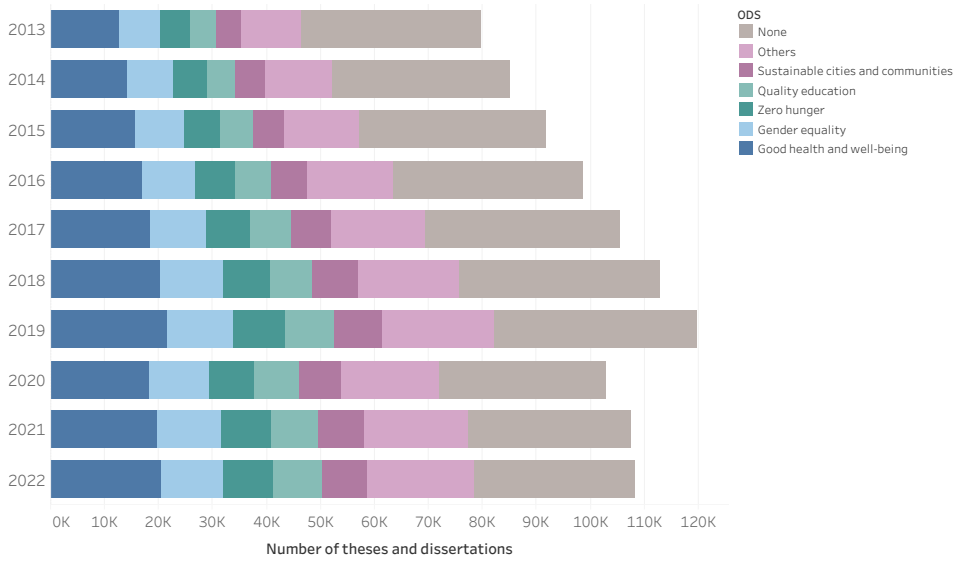
FIGURE 13: TEMPORAL DISTRIBUTION OF DISSERTATIONS, THESES, AND OTHER GRADUATE DEGREE COMPLETION WORKS



Source: Prepared by the authors with data from the CAPES Open Data platform, 2024. Interactive visualizations available at https://capes.gov.br/BookSDG-fig13a and https://capes.gov.br/BookSDG-fig13b.

Among the most cited SDGs in graduate degree completion works, SDGs 3, 5, 2, 4, and 11 stand out, in order of importance (Figure 14).

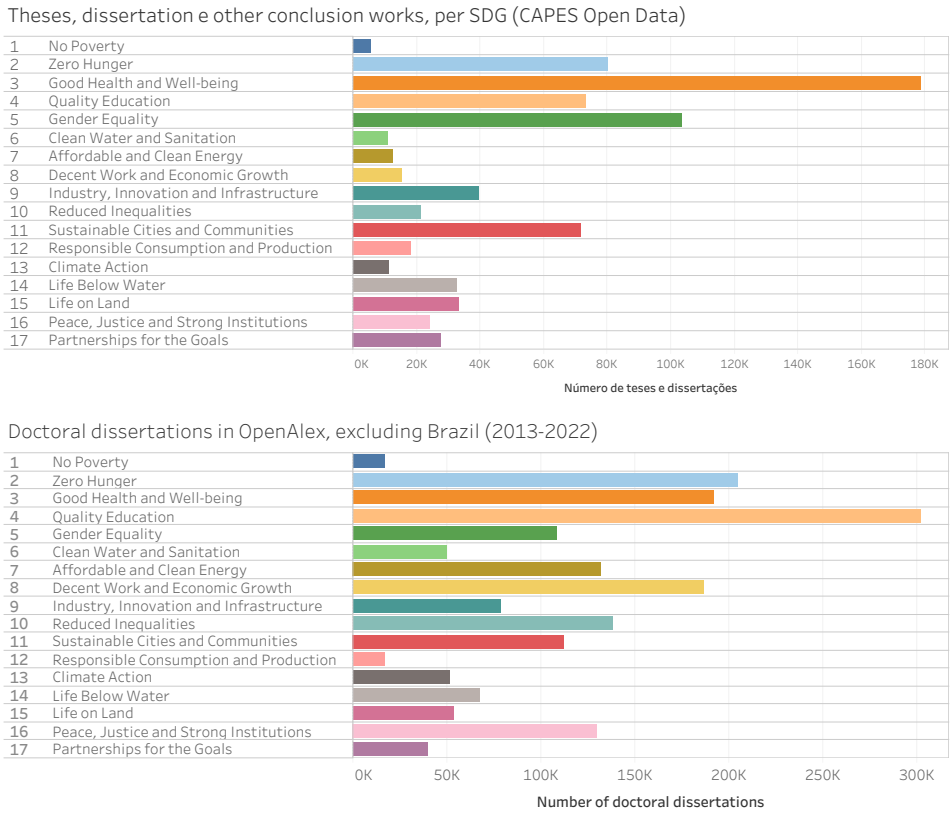
FIGURE 14: TEMPORAL DISTRIBUTION OF THE SDGS MOST FREQUENTLY RELATED TO DISSERTATIONS AND THESES RESULTING FROM GRADUATE EDUCATION COMPARED WITH THOSE NOT RELATED



Source: Prepared by the authors with data from the CAPES Open Data platform, 2024.
Interactive visualization available at https://capes.gov.br/BookSDG-fig14.

When comparing Brazil's graduate degree completion works connected to the SDGs (CAPES data) with the set of about 1.8 million theses and dissertations from other countries also linked to at least one SDG in the OpenAlex database, a similarity is found in the attention given to the different Goals, which indicates that the attention of Brazilian graduate education is in harmony with international issues regarding the 2030 Agenda. However, it should be highlighted that, while in Brazil the most cited SDG in the works is SDG 3 (Good Health and Well-Being), in the OpenAlex database it is SDG 4 (Quality Education) (Figure 15).

FIGURE 15: DISTRIBUTION OF THESES AND DISSERTATIONS RELATED TO THE SDGS IN THE CAPES REPOSITORY AND IN THE OPENALEX DATABASE



Source: Prepared by the authors with data from the CAPES Open Data platform, 2024. Interactive visualization available at https://capes.gov.br/BookSDG-fig15.

2.2.2. Distribution in the collegia of evaluation

Analyzing the number of PPG and outputs by broad area within the CAPES collegia of evaluation (Figure 16), it is observed that the volume of theses and dissertations linked to the SDGs, shown in the bars on the right, presents a proportion similar to the number of PPG in each broad area, shown on the left. Health Sciences, Multidisciplinary, and Humanities correspond to the broad areas with the largest numbers of graduate education outputs addressing the SDGs in their respective collegia. It is possible that in Health Sciences these results reflect the recent and still perceived impacts of the Covid-19 pandemic,

or of other infectious agents and epidemics that affect human populations. It should be noted that the Multidisciplinary broad area encompasses the following CAPES Evaluation Areas: Biotechnology, Environmental Sciences, Teaching, Interdisciplinary, Materials, and Sciences and Humanities for Basic Education.

FIGURE 16: DISTRIBUTION, BY COLLEGIUM AND BROAD AREA, OF DISSERTATIONS, THESES, AND OTHER GRADUATE DEGREE COMPLETION WORKS RELATED TO SOME SDG, IN RELATION TO THE NUMBER OF PPG

Source: Prepared by the authors with data from the CAPES Open Data platform, 2024. Interactive visualization available at https://capes.gov.br/BookSDG-fig16.

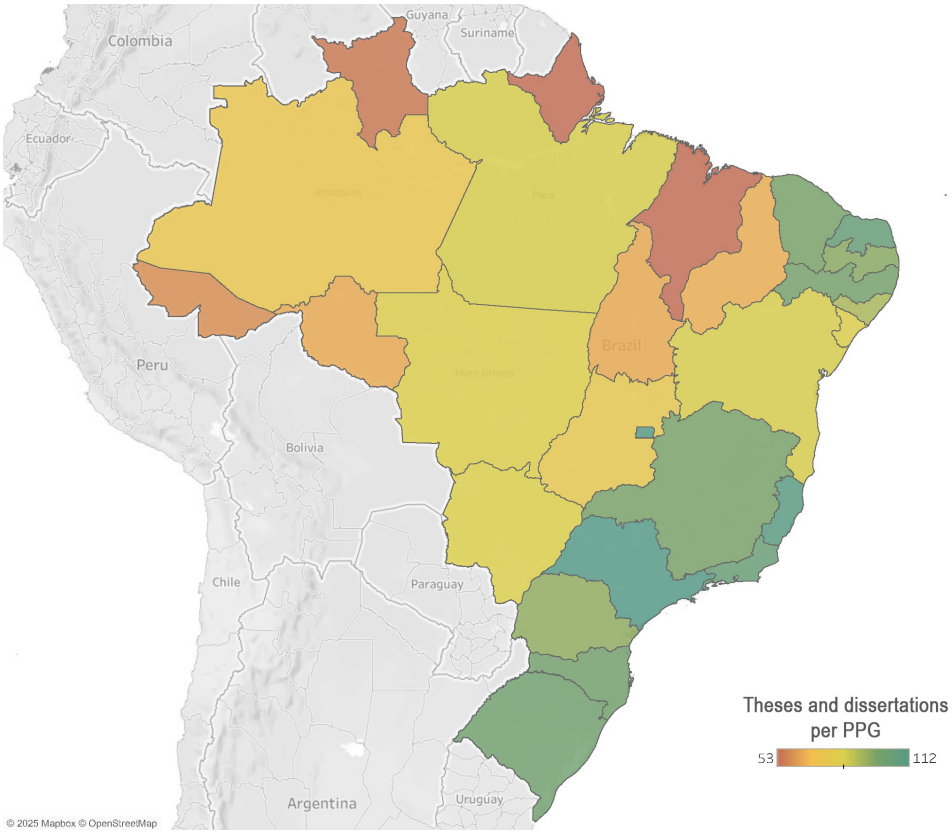
2.2.3. Spatial distribution of the use of the SDGs

Graduate education in Brazil is not evenly distributed. A large part of the higher education institutions that offer master's and doctoral programs

is located on the coast, with high concentration in the Southeast and South regions (Brasil, A., 2020). Therefore, any analysis of the distribution of the absolute numbers of dissertations and theses related to the SDGs in the country would reflect the asymmetries already existing in the system.

However, Figure 17 reveals that the additional attention to the Sustainable Development Goals is still concentrated in the same regions, even when the data are weighted by the number of graduate programs (PPG) in each state. On the map, the number of dissertations and theses related to the SDGs per PPG remains concentrated in the Southeast and South, but also includes some states in the Northeast of the country.

FIGURE 17: DISTRIBUTION OF DISSERTATIONS, THESES, AND OTHER GRADUATE DEGREE COMPLETION WORKS IN THE BRAZILIAN STATES



Source: Prepared by the authors with data from the CAPES Open Data platform, 2024. Interactive visualization available at https://www.capes.gov.br/BookSDG-fig17.

These results obtained, if associated with the more densely populated Brazilian regions, may occupy a relevant position in the 2030 Agenda, by supporting decision-makers in adopting strategies for sustainability assessment and also in facing urban challenges, both in the present and in the future, including, for example, pollution, water quality and availability, depletion of natural resources, scarcity of renewable energy, accumulation of waste, housing deficits, precarious infrastructure services, among others (Ameen & Mourshed, 2019).

In Brazil, the states of Maranhão, Roraima, and Amapá stand out with the lowest relative numbers of products related to the SDGs. It should be noted that, even among the regions where the highest numbers of graduate degree completion works were recorded, regional uniformity was not observed. That is, among the states of the Northeast, the state of Bahia presented the lowest relative numbers of products related to the SDGs. In this regard, Simão, Salles, and Fernandes (2024) reiterate the need for comparative analyses not to be carried out directly and simplistically, but rather for sustainability indicators to be analyzed in a particularized manner in each state and on the most detailed scale possible, with the aim of evidencing, with greater accuracy, the true local realities.

By exploring the interactive map linked to Figure 17, readers can visualize the distribution of research related to the SDGs by PPG, according to each individual SDG and by broad area of evaluation. This analysis demonstrates that the different SDGs receive varying levels of attention in the various regions of the country. Notably, for example, there is a significant concentration of graduate degree completion works focused on climate change in the state of Amazonas. Another example includes the more uniform distribution of studies on zero hunger and sustainable agriculture throughout the country. These patterns show that the thematic distribution of the SDGs partly follows the socioeconomic and environmental contexts of the Brazilian regions.

2.2.4. Grouped evidence

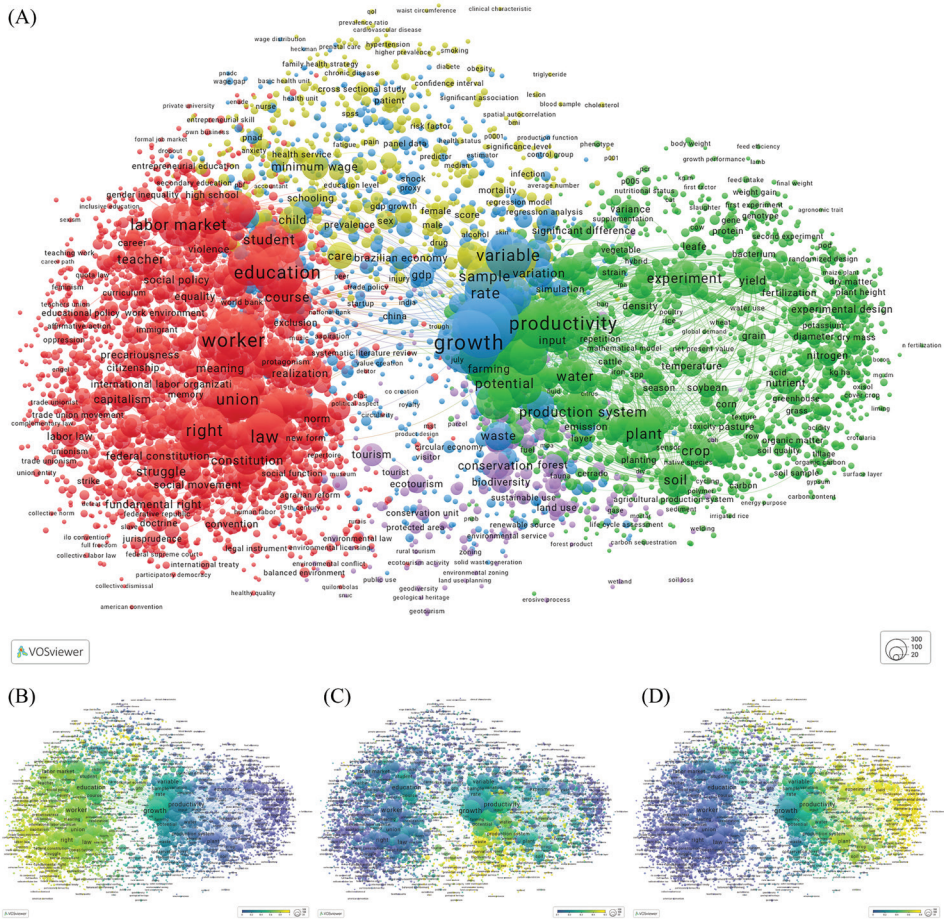
The exploration of data regarding dissertations and theses produced by different graduate programs in Brazil offers analytical dimensions that bibliometric analyses usually cannot capture when based on traditional

databases such as Scopus, Web of Science, or even OpenAlex, despite its broader coverage. Due to the quality of the information collected by CAPES from all PPG in the country, these products provide a highly representative perspective of the research developed in Brazil. A particularly interesting aspect of this analysis in relation to the Sustainable Development Goals is the way in which the different SDGs receive complementary attention from distinct fields of knowledge.

Figure 18A illustrates this point, presenting a semantic map produced from the abstracts of dissertations and theses defended between 2013 and 2022 focused on SDG 8: Decent Work and Economic Growth. A total of 14,916 graduate degree completion works are included in this map, generated with the VOSviewer software. The application uses a specific algorithm to identify noun phrases in the abstracts, having mapped 312,666 different possibilities in the sample considered. By restricting the analysis to terms that appear in at least 10 documents, a total of 9,773 is obtained. Next, a relevance score is calculated, as the algorithm is capable of distinguishing between terms with substantive content and generic terms (such as "discussion," "conclusion," "method"). With a relevance cutoff of 60%, the figure presents 5,864 individual noun phrases, represented by bubbles on the map. The size of each bubble represents the number of documents in which the expression appears, while its position on the map is determined based on the number of documents in which these expressions co-occur.

Finally, a clustering algorithm identifies five groups of terms with affinities. Two of these groups are particularly evident: in the red cluster on the left of the map we see terms such as "labor market," "education," "law," "social policy," characterizing a cluster linked to the Collegium of Humanities; on the right, a green cluster includes terms such as "soybeans," "grains," "production system," indicating a concentration of studies originating from the Collegium of Life Sciences. At the top of the graph, two groupings overlap, suggesting shared interests between the two collegia mentioned. The Collegium of Exact, Earth, and Multidisciplinary Sciences appears with less emphasis on this specific theme, concentrated in the lower portion of the map.

FIGURE 18: SEMANTIC MAP OF GRADUATE DEGREE COMPLETION WORKS RELATED TO SDG 8 (2013–2022)



Source: Prepared by the authors with data from the CAPES Open Data platform, 2024. Interactive versions available at https://capes.gov.br/BookSDG-fig18a, https://capes.gov.br/BookSDG-fig18b, https://capes.gov.br/BookSDG-fig18c, and https://capes.gov.br/BookSDG-fig18d.

In fact, by exploring the interactive semantic map available online, it is possible to add a color layer from the identification of each noun phrase associated with specific graduate programs, highlighting the areas with greater incidence of attention by collegium and broad area. The complementary figures present the highlights of the three collegia mentioned, with the lighter parts evidencing areas of greater attention in the Humanities (18B); Exact, Earth,

and Multidisciplinary Sciences (18C); and Life Sciences (18D), confirming the analysis of the observed output.

2.3. FINAL CONSIDERATIONS

It was found that the outputs of Brazilian graduate education cover a substantial portion of the 169 targets and 232 indicators of the SDGs (UN, 2017). These studies reflect the concerns of social movements that, since the late 1940s, have guided progressive restructurings focused on issues of gender, race, working conditions, and the environment (Salles et al., 2024). Such global challenges demand political, scientific, economic, and social changes, with the aim of ensuring the sustainable development of the planet and the well-being of its inhabitants. To this end, the effective participation of all sectors of society is essential, especially higher education institutions and research institutes (Purnell, 2022). It was observed that the SDGs are distributed unequally among the broad areas of knowledge, highlighting the importance of interdisciplinarity for achieving these targets. This chapter, by identifying graduate degree completion works at all levels of training, recommends the dissemination of the targets related to SDG 18 (Ethnic-Racial Equality) of the Brazilian agenda. The proposals related to SDG 19 (Art, Culture, and Communication) and SDG 20 (Rights of Indigenous Peoples and Traditional Communities) further highlight the richness of Brazilian sociobiodiversity.

Thus, the production of works with themes associated with all the SDGs contributes both to the quantitative increase and to the qualitative improvement of the technical and scientific output of Brazilian graduate education, aligning it with global demands. Furthermore, the inclusion of these targets in graduate degree completion works favors advances in sectors of strategic relevance and promotes the well-being and sustainable development of Brazilian society, encompassing social, economic, and environmental aspects.

3 STRATEGIES OF BRAZILIAN GRADUATE EDUCATION FOR THE 2025–2028 QUADRENNIUM: CONTRIBUTION TO PROMOTING THE 2030 AGENDA

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"Strategies of Brazilian graduate education for the 2029 quadrennium: contributions to the 2030 Agenda" is a study whose objective was to present the profile of CAPES's nine broad areas of evaluation, with cross-cutting attention to the four dimensions of the SDGs: social, environmental, economic, and institutional. In its development, the action-research method was employed, with a participatory and collaborative approach, aiming to generate practical and transformative knowledge on the issues addressed. In this sense, it was possible to access CAPES's 50 Evaluation Areas through the responses of the area coordinations.

Participation reached 100% of the target audience, so as to prompt critical reflection on strategic actions for the construction of each CAPES Evaluation Area's "Area Document" for the 2025–2028 Quadrennium, which were at an advanced stage of drafting (Figure 19). The research was operationalized through the application of a comprehensive questionnaire containing 11 questions (detailed in tables in Appendix A[32]), which enabled the description of the following themes: the presentation of the dimensions in Brazilian graduate education; training in graduate education; products/

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[32] The Appendices of this book are available only in digital format, and in Portuguese, at: https://capes.gov.br/apendices-ipgb-na-agenda-2030.

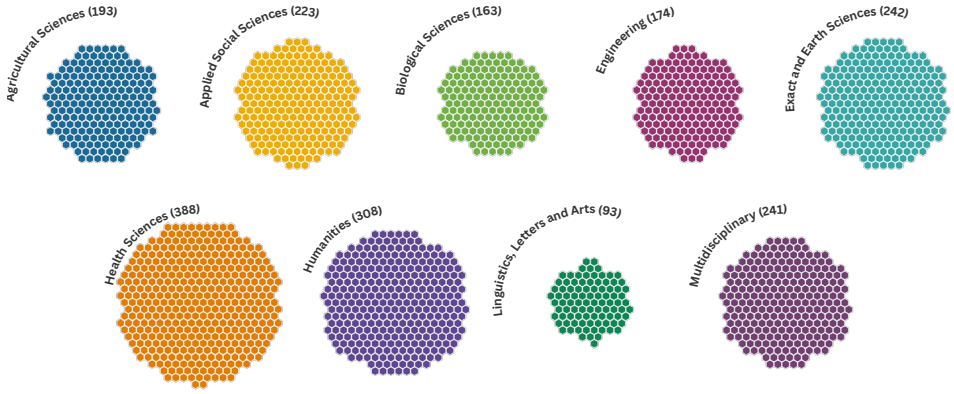
processes of technological and social innovation; intellectual production; interdisciplinarity; basic education; equity and diversity (based on the analysis of affirmative policies, reduction of asymmetries, and solidarity[33]); knowledge transfer/sharing; internationalization; extreme events related to climate change; and prospects for expanding the inclusion of the UN SDGs.

Brazilian graduate education plays a fundamental role in the country's scientific and technological development, training human resources qualified to work in various sectors. Thus, promoting reflections in CAPES's Evaluation Areas' documents guides programs in their actions and goals, since they will be evaluated based on the guidelines listed by the areas. The changes made in these documents, with a view to collaborating with the 2030 Agenda, will have a significant future impact in Brazil and worldwide, by ensuring that training is increasingly aligned with global social, economic, environmental, and institutional needs, reinforcing the commitment to an enhanced concept of citizenship, essential for facing contemporary challenges.

Studies have been conducted worldwide on engagement in the implementation of the SDGs (Laumann, Von Kügelgen, & Barahona, 2020; Persello et al., 2021), such that, considering European universities with a sample from 22 countries, it was shown that most are involved with the SDGs, with more than 30% working broadly or very broadly with them. In European higher education, it was observed that, although there has been progress, inequalities persist in the emphasis dedicated to the SDGs, since while some, such as SDGs 11, 12, and 13, receive greater attention in research, others, such as SDGs 1, 2, 14, 15, and 16, are less explored, both in teaching and research (Leal-Filho et al., 2024). These findings highlight encouraging advances in the implementation of the 2030 Agenda, showing how universities can contribute to meeting the SDGs by addressing challenges and opportunities in integrating these goals through teaching, research, and outreach.

[33] It involves the analysis of how graduate programs promote cooperation, mutual support, and social responsibility.

FIGURE 19: NUMBER OF RESPONSES FROM THE COORDINATIONS OF CAPES'S 50 EVALUATION AREAS



Source: Analysis prepared especially for this work by Brasil, A. (2025). Interactive visualization available at https://www.capes.gov.br/BookSDG-fig19.

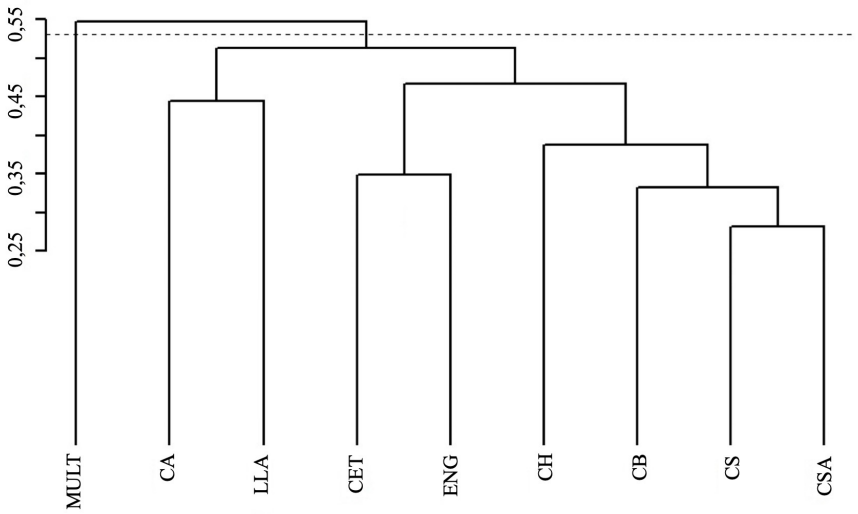
The concept of citizenship, from the perspective of the UN SDGs, can be enhanced to: develop awareness and understanding of what global climate change is; understand and exercise individual and collective responsibility for the planet's sustainability, social justice, and respect for the common good. This concept moves us to participate in decisions that affect the environment and communities, to protect ecosystems, and to work toward reducing inequalities. Climate citizenship requires that all individuals not only know the causes and consequences of climate change, but also take concrete actions to reduce the consumption of natural resources, support public sustainability policies, and participate in mitigation and adaptation movements to climate change (Cripps, 2024).

Solidarity with future generations motivates us to think beyond ourselves, encouraging the abandonment of egocentric postures and the pursuit of practices that strengthen social, economic, environmental, and institutional equity, with special attention to supporting communities most vulnerable to climate change. Citizenship involves sharing the global responsibility of preserving the planet and understanding that we are part of it and not its owners. Education for environmental citizenship can promote responsible environmental behaviors, highlighting the importance of citizens' active participation in environmental protection (Hadjichambis & Paraskeva-Hadjichambi, 2020; Obiagu et al., 2024).

3.1. DIMENSIONS OF THE SDGS IN BRAZILIAN GRADUATE EDUCATION

The area documents contain guiding guidelines, from the Evaluation Areas, that directly or indirectly encompass the dimensions of the SDGs in CAPES's nine broad areas: Agricultural Sciences; Biological Sciences; Health Sciences; Exact and Earth Sciences; Humanities; Applied Social Sciences; Engineering; Languages, Literature and Arts; and Multidisciplinary. Based on the proportion of occurrence of the SDGs, in each dimension, in the area documents, a dendrogram was constructed (Figure 20), in which it is possible to observe the relationships of proximity or similarity among the broad areas, considering the hierarchical organization, in a clustering model.

FIGURE 20: DENDROGRAM PRESENTING THE CLUSTERING OF CAPES'S BROAD AREAS WITH RESPECT TO THE RESPONSES ON THE SDG DIMENSIONS



Source: R Core Team (2024).

* Cluster analysis was used, UPGMA = Unweighted Pair Group Method with Arithmetic Mean, based on standardized average Euclidean distance. Cophenetic correlation coefficient: r = 0.7526. The horizontal dashed line represents the cutoff estimated by Mojena's method (1977). MULT (Multidisciplinary); CA (Agricultural Sciences); LLA (Languages, Literature and Arts); CET (Exact and Earth Sciences); ENG (Engineering); CH (Humanities); CB (Biological Sciences); CS (Health Sciences); CSA (Applied Social Sciences).

Each branch seen in Figure 20 represents a merger between groups of broad areas, based on their similarity or distance. The vertical axis (height) represents the level of dissimilarity, in which higher values indicate lower similarity among the broad areas with respect to the responses on the SDG dimensions. Among the groups formed, clear distinctions exist: one is composed exclusively of the Multidisciplinary area, while another encompasses the other broad areas. The hierarchical analysis indicates that the groups closest to each other have greater similarity. In this context, the Multidisciplinary area appears grouped more distantly, reinforcing its lesser similarity in relation to the other broad areas.

Among the responses, it was observed that Multidisciplinary involved the largest number of SDGs, considering the 17 global ones, compared to the other broad areas, which predominantly encompassed a group of specific SDGs. Agricultural Sciences and Languages, Literature and Arts are closer to Multidisciplinary, likely with greater similarity or interdisciplinary connections, in the context of the analysis conducted. The connections become more distant from Multidisciplinary as more distant subgroups are considered, such as Health Sciences and Applied Social Sciences, which had fewer responses identifying the presence of the SDGs in their respective area documents.

Another analytical approach was carried out using the word cloud (Figure 21) originating from the area documents. The most frequently repeated keywords across all broad areas (Appendix A1) were: "Technology Transfer" and "Environmental Education," appearing in 23 and 13 area documents, respectively. The keywords "Research and Development" and "Reduce Regional Inequalities" are present in 19 area documents. Among the twelve most cited, the following keywords also appear (with their respective numbers of occurrences in parentheses): "Access to Technology and Innovation" (16), "Training and Technical Assistance" (16), "Sustainable Economic Growth" (16), "Regional Development" (14), "Financing for Development" (13), "Promote International Cooperation" (13), "Climate Change" (12), and "Strengthening Institutions" (11). A study by Martínez-Acosta et al. (2023), based on the SDGs, shows that the most recurrent keywords in works for the generation of sustainable cities by higher education institutions were "sustainability," "sustainable development," and "sustainable development goals," which also appeared directly in the different CAPES Evaluation Areas' documents.

FIGURE 21: KEYWORDS OF CAPES'S EVALUATION AREAS' DOCUMENTS

Source: Analysis prepared especially for this work by Brasil, A. (2025). Interactive visualization available at https://capes.gov.br/BookSDG-fig21.

The predominance of the dimension in the broad areas can also be analyzed quantitatively, through the number of keywords corresponding to the area documents. The social dimension differs statistically from the institutional dimension in terms of the number of keywords (Table 5). However, there is no statistical difference among the social, economic, and environmental dimensions. These results indicate that, considering all areas, the documents analyzed contain a greater total number of keywords related to the social dimension compared to the institutional dimension.

TABLE 5: SUMMARY OF THE NUMBER OF KEYWORDS
BY DIMENSION AND CAPES BROAD AREA

Broad Areas	Social Dimension	Economic Dimension	Environmental Dimension	Institutional Dimension	Total
Agricultural Sciences	24	30	35	18	107
Biological Sciences	14	8	9	12	43
Health Sciences	55	25	16	32	128
Exact and Earth Sciences	18	19	28	11	76
Humanities	44	19	23	28	114
Applied Social Sciences	37	37	24	27	125
Engineering	7	13	11	3	34
Language,Literature and Arts	9	6	2	8	25
Multidisciplinary	34	28	29	25	116
Total	**242 A***	**185 AB**	**177 AB**	**164 B**	**768**

Source: Prepared by the authors. Values that contain the same letter (A or B) do not differ statistically by the t test at 5% probability.

3.2. TRAINING IN GRADUATE EDUCATION

Regarding training in graduate education, with respect to the **social dimension**, all CAPES broad areas consider that Programs should develop "teaching methodologies that promote critical thinking and the solving of problems related to the SDGs"; and the "integration of the SDGs into graduate curricula, with specific courses addressing themes such as sustainability, social inclusion, and ethics" (see Table 2, Appendix A2). Investment in social and ethical skills, when combined with technical training, allows professionals to contribute to the shaping of public policies, community projects, and corporate strategies that seek greater inclusion and balance in society.

In the **economic dimension**, all broad areas consider the need for the "establishment of partnerships with companies to offer internships, trainee programs, and collaborative projects, as a way to facilitate the insertion of graduates into the labor market"; the "inclusion of courses focused on the development of technical, managerial, and entrepreneurial skills in graduate programs," as well as the "offering of courses for training and specialization aimed at preparing graduate students for the labor market and leadership

positions" (Table 3, Appendix A2). The creation of entrepreneurship actions that encourage graduate students "to develop their own companies, with support in mentoring, funding, and networking" was not a predominant focus only in the area documents of the Humanities. It is also noteworthy that the "development of teaching methodologies that promote critical thinking and the solving of problems related to the SDGs" was considered by Multidisciplinary and Health Sciences.

"Environmental training and education" was considered by all broad areas of evaluation, in the analysis of the **environmental dimension** (Table 4, Appendix A2). The themes "development of training content that addresses the impacts of climate change and develops mitigation and adaptation strategies," as well as the "inclusion of content on responsible consumption and sustainable production in graduate curricula" and the "inclusion of courses that encourage studies analyzing the effectiveness of environmental policies and proposing innovative solutions to environmental challenges" were considered by almost all broad areas, except Languages, Literature and Arts.

In the environmental dimension, the broad areas also evidenced—except Humanities, Applied Social Sciences, and Languages, Literature and Arts—the need for the "development of training content that addresses terrestrial biodiversity and develops strategies for the conservation of habitats and threatened species"; "the conservation and sustainable management of marine and coastal ecosystems"; and "the creation of technologies and practices for the protection of marine biodiversity and/or the recovery of degraded areas."

Still in the environmental dimension, training that addresses "the sustainable management of water resources, including water quality, wastewater treatment, and desalination technologies" was considered, emphasized mainly in Exact and Earth Sciences; Engineering; Agricultural Sciences; and Multidisciplinary. The "development of training content that addresses renewable energies, such as solar, wind, biomass, and hydropower" is more present in Engineering and Exact and Earth Sciences, highlighting the role of these areas in innovation and in the development of energy solutions that contribute to the global energy transition and environmental sustainability. The development of content on the "creation of solutions for the provision of drinking water and basic sanitation in urban and rural areas" has a greater focus in Applied Social Sciences and in Engineering,

demonstrating a practical and social alignment to face inequalities and structural challenges in these areas. The "offering of courses and training for techniques in ecological restoration and the sustainable management of natural resources" is particularly highlighted in Agricultural Sciences and Exact and Earth Sciences. The absence of, or lesser focus on, some dimensions for Humanities; Languages, Literature and Arts; and Health Sciences may reflect different priorities or gaps that could be better explored for a more integrated approach to environmental sustainability.

In the **institutional dimension**, it was observed that all broad areas consider the need to develop content that emphasizes "governance, ethics, and transparency," with the objective of preparing graduate students to act "in leadership positions with integrity," and they also consider the need for the "inclusion of content on the SDGs and the importance of partnerships for sustainable development in graduate curricula" (Table 5, Appendix A2). Another relevant point in all broad areas was the inclusion of courses that address "human rights, social justice, and conflict resolution." The approaches suggest a commitment to training professionals with a critical vision and the capacity to act in complex scenarios of social conflicts, reflecting an effort to connect academic programs to global sustainability issues.

Higher education institutions need to undertake new actions to help realize the SDGs, including intensified efforts to engage with local society partners for the implementation of the 2030 Agenda. Studies indicate the need to implement curricula for training more aligned with sustainability practices, such as courses that might expand indicator results for the SDGs (Albareda-Tiana et al., 2020; Serafini et al., 2022).

3.3. TECHNOLOGICAL AND SOCIAL INNOVATION PRODUCTS/PROCESSES

CAPES's broad areas encourage: "the development of strategies to evaluate whether products and processes adopt sustainable practices in their life cycle, from production to disposal"; "the development of innovative products and processes accessible to different social groups, including marginalized and low-income communities"; "the development of innovative products and processes that promote the involvement of local communities from the

origin of creation, ensuring that their needs and perspectives are considered"; "products, processes, and technological and social innovations that generate new employment opportunities and promote local economic development," as well as "the establishment of indicators and metrics to assess the impact of products and processes of technological and social innovation related to the SDGs" (Appendix A3). Technologies for social inclusion in Latin America are a recent manifestation of grassroots innovation movements (Smith, Fressoli, & Thomas, 2014).

The broad areas, except Languages, Literature and Arts, also related the relevance of the "development of products and processes that reduce environmental impact, considering aspects such as reducing carbon emissions, conserving natural resources, and minimizing waste." The broad areas, except Humanities and Languages, Literature and Arts, encourage "the development of products and processes and encourage entrepreneurship and the emergence of local startups." The creation of entrepreneurship programs that encourage graduate students to develop their own companies, with support in mentoring, funding, and networking," was highlighted in Health Sciences. The stimulus to the "development of strategies to evaluate whether products and processes adopt sustainable practices in their life cycle, from production to disposal" was highlighted by Agricultural Sciences.

3.4. INTELLECTUAL PRODUCTION

CAPES's broad areas highlight encouragement for the development of studies, research, and projects: on "public policies that promote peace, justice, and effective institutions"; "that have a direct impact on local communities, improving health, education, and quality of life"; "that meet the needs of vulnerable populations"; that "address the sustainable management of natural resources, biodiversity conservation, and climate change mitigation"; that "explore sustainable entrepreneurship and circular economy models, encouraging responsible production and consumption"; "that address themes related to gender equality, reduction of inequalities, and social inclusion"; "that analyze the governance, transparency, and effectiveness of public institutions"; "that explore the possibilities of integrating clean energies into current energy systems"; and "on sustainable business practices and their economic impacts." The areas of Exact and Earth Sciences and Biological Sciences, for the most part, consider, in the area documents, encouraging "the development of innovative products

and processes accessible to different social groups, including marginalized and low-income communities," as well as the development of content related to "governance, ethics, and transparency" (Appendix A4).

Currently, indicators to enable the analysis and mapping of scientific production regarding its contribution to the SDGs can be easily obtained in the Scopus database from its detailing. This database was constructed from an extensive list of keywords and complemented with machine learning to map documents about the SDGs. This fact evidences the possibility of obtaining metrics that make it possible to distinguish scientific production with regard to the type of SDG addressed in its content, which could be considered in the evaluation of graduate education.

3.5. INTERDISCIPLINARITY

The interdisciplinarity of CAPES's broad areas is observed: through "collaboration among different faculty members—core collaborators, permanent and visiting—to develop courses" and joint research projects; in the development of courses that address "the study of real cases […] to solve complex problems"; to develop actions and activities that allow graduate students to analyze "problems in a critical and systemic manner"; in the valuing of "partnerships with other educational institutions, non-governmental organizations, and public and private sectors to promote research and interdisciplinary practices"; through the "involvement of the local community in projects […] that seek to solve local, regional, and national problems, promoting greater engagement and impact that can facilitate the meeting of the social and/or economic and/or environmental and/or institutional dimensions" of the SDGs (Appendix A5).

In the broad area of Agricultural Sciences, in addition to the common aspects, the development of training content was highlighted "that addresses the impacts of climate change and develops mitigation and adaptation strategies"; "that addresses terrestrial biodiversity and develops strategies for the conservation of habitats and threatened species"; "that addresses the conservation and sustainable management of marine and coastal ecosystems"; "that addresses the creation of technologies and practices for the protection of marine biodiversity and the recovery of degraded areas"; and that encourages the "inclusion of content on responsible consumption and sustainable production."

In the broad area of Biological Sciences, in addition to aspects common to all broad areas, the area documents also highlighted information to facilitate meeting the social and/or economic and/or environmental and/or institutional dimensions of the SDGs, such as: "valuing in evaluation partnerships with other educational institutions, non-governmental organizations, and public and private sectors to promote research and interdisciplinary practices"; "the development of training and capacity-building activities for faculty in the development and application of interdisciplinary approaches in their teaching and research practices"; and the existence of initiatives for the "dissemination of the results of interdisciplinary research to a broader audience, including not only scientists but also community organizations and the general public."

The area documents of the Health Sciences areas, in interdisciplinarity, in addition to the common aspects, encourage the "development of products, innovative processes, entrepreneurship, and the emergence of local startups" and those "that promote the involvement of local communities from the origin of creation, ensuring that their needs and perspectives are considered." In addition, they "encourage products, processes, and technological and social innovations that generate new employment opportunities and promote local economic development."

The area documents of the Humanities areas additionally contain "guidelines for the graduate curriculum, considering that course syllabi should address topics to solve problems related to the knowledge developed in a holistic manner. They make clear how the knowledge to be developed will be used to solve problems related to the social and/or economic and/or environmental and/or institutional dimensions of the SDGs."

Interdisciplinarity is addressed in all documents of CAPES's Evaluation Areas and, in practice, is recognized as a hallmark of contemporary knowledge production, and through the intersection between science and society it can lead to a sustainable future (Schmidt, 2021).

3.6. BASIC EDUCATION

In the area documents that will guide the 2029 Quadrennial Evaluation, information is included on the interaction of graduate education with basic education, taking into account different levels of integration and strategic actions, such as:

» **Agricultural Sciences and Biological Sciences:** the two broad areas intensively address programs containing activities such as teaching internships in technical schools, visits to laboratories and science fairs, as well as outreach projects to improve the quality of basic education. Training courses for teachers and scientific literacy projects aligned with the SDGs, such as "Environmental Education in the Countryside" and "Action against Global Climate Change."

» **Exact and Earth Sciences:** the areas value initiatives including teacher training and the development of teaching materials aimed at scientific popularization, addressing themes such as climate change and environmental education, which have a direct impact on reducing educational inequalities and promoting sustainability.

» **Health Sciences:** they seek, for example, to stimulate scientific literacy in the different subareas of the Pharmaceutical Sciences, within basic education as well as in other sectors of society, to improve understanding of the natural world, in addition to promoting actions that connect teaching and research with vulnerable populations, aligned with the goals of health and well-being.

» **Humanities and Applied Social Sciences:** the two broad areas focus on teacher training and the production of content that promotes diversity and inclusion, such as materials aimed at Indigenous and quilombola schools, in addition to interaction with themes such as democracy, citizenship, and human rights.

» **Engineering:** it encourages collaborations with secondary education through initiatives such as research and outreach projects, with the potential to foster technological innovation and stimulate graduate students' participation in topics linked to science and technology. Through the Research Support Foundations (FAP), they play an important role by linking projects with the inclusion of activities that bring basic education and graduate education closer together.

» **Multidisciplinary:** it promotes interaction with basic education through continuing teacher education; the creation of policies for access and retention of educators in master's and doctoral Programs; and the fostering of international cooperation. Such initiatives seek to prepare teachers to work in diverse contexts, contributing significantly to the

dissemination of interdisciplinary knowledge and to strengthening the educational foundations in alignment with the SDGs.

» **Languages, Literature and Arts:** the valuing of teacher training in languages and literature is highlighted, exemplified by initiatives that promote multiliteracies and social inclusion through language.

Considering the interaction of graduate education with basic education, the area documents can contribute to the SDG dimensions by encouraging the improvement of the quality of basic education; the reduction of inequalities; the promotion of social inclusion; and the improvement of teacher qualifications to train professionals for strategic sectors. The guidelines of the Evaluation Areas can also assist in environmental education and in the promotion of sustainable practices in different educational contexts; and in strengthening educational policies through partnerships and cooperation among universities, schools, and communities. It should also be noted that the documents indicate that the interaction, although present, needs to be intensified. Therefore, it is necessary to expand applied and interdisciplinary actions, produce accessible materials, and encourage more frequent collaborations. In addition, the involvement of areas with greater social impact can enhance the reach of the SDGs, strengthening the foundations for inclusive and transformative education.

It was also reported, in the responses to the questionnaire, that, in the future, CAPES's Evaluation Areas may more broadly incorporate actions that connect graduate programs to basic education, promoting alignment with the social, economic, environmental, and institutional dimensions of the SDGs. A first step would be to include indicators that assess the impacts of the graduate programs' actions in initiatives related to basic education, evidencing alignment with the SDGs. Interaction with society and the popularization of science should be evaluated in terms of insertion, visibility, and impact, reinforcing the role of basic education as a space for the construction of knowledge.

Graduate programs should place greater value on implementing collaborative actions between graduate programs and basic education institutions, considering activities aimed at the popularization of science, such as, for example, encouraging the use of medicinal plants, correct practices for the disposal of medications, education on healthy eating and its impact on health, all in a playful manner and contextualized with the SDGs. Projects such as the Institutional Program of Junior Scientific Initiation Scholarships (PIBIC Júnior) can be highlight-

ed as examples of good practices, valuing the mentoring of high-school students and promoting the training of professionals prepared to act in interdisciplinary and practical dimensions.

The inclusion of information on the impact of graduate programs on basic education, in the annual data collection modules of CAPES's Plataforma Sucupira, could be improved by highlighting contributions to the improvement of basic education, whether in intellectual production (bibliographic and technical) or in projects such as science fairs. It would be interesting to create a section dedicated to graduate programs' actions aimed at society, with a focus on the training of people, with integrative and collaborative perspectives, highlighting specific lines of research (such as Educational Psychology), and reinforcing the relevance of disciplines such as Architecture, Urbanism, and Design as tools to work on the SDGs, since interacting with education at the base can direct young scientists to solve future problems.

In the guidelines for upcoming evaluations, the areas should seek to encourage graduate programs to develop strategies to integrate teaching and research with society, promoting the implementation of the SDGs and reporting actions with basic education as an essential part of the evaluation. This inclusion would reinforce the role of Brazilian graduate programs as transformative agents, capable of promoting direct and lasting impacts on education and sustainable development. To develop climate change education strategies and build institutional capacity to implement them, Reimers (2021) advocates more intentional engagement by universities, in partnership with basic education. This would serve the dual role of providing support for schools and universities in advancing climate change education, while at the same time educating higher education students about climate change through problem-based, participatory, and contextually located approaches.

3.7. EQUITY AND DIVERSITY

3.7.1. Affirmative policies

The area documents of CAPES's Evaluation Areas for the 2029 Quadrennial Evaluation highlight the importance of consolidating affirmative policies that promote equity, diversity, and inclusion in graduate education (Table 9, Appendix A6). Among the fundamental actions is ensuring that faculty,

especially women, “have access to adequate maternity and parental leave, without this negatively impacting their performance evaluations,” and “there is a need for an inclusive faculty policy for women in the area in order to promote gender equity and create a more inclusive and egalitarian work environment.” This effort is part of a broader strategy to ensure the inclusion of women in academia, creating a work environment that values gender equity, that is inclusive and egalitarian.

To increase the effectiveness of these initiatives, in the documents of some areas there are guidelines for the development of “action plans based on previous evaluations,” seeking to continuously improve “equity and diversity practices.” Institutions are also expected to report, in detail, “the availability of scholarships and financial support for low-income graduate students and marginalized groups,” in addition to providing quantitative diversity data, such as retention rates, program completion, and distribution of financial benefits.

Accessibility is another central pillar of these policies, so that institutions should report the adequacy of their facilities for people with disabilities, “such as ramps, elevators, and adapted teaching materials,” ensuring that all students have equal conditions of access and learning. In addition, programs are expected to integrate different fields of knowledge to address complex issues related to diversity and equity, promoting an interdisciplinary and comprehensive vision.

The inclusion, in the curriculum of graduate programs, of content on equity, diversity, and inclusion, “such as gender studies, human rights, and social justice,” is necessary, especially in areas that directly study the subject. Programs should report “the existence and effectiveness of mechanisms to combat discrimination and harassment,” creating a safe and respectful environment for all their members. “The availability of psychosocial support services for graduate students, especially those belonging to vulnerable groups,” is another essential element for a healthy educational environment.

To monitor and improve these policies, it is recommended to conduct regular surveys with graduate students, faculty, and staff of graduate programs, assessing “the institutional climate regarding diversity and inclusion.” Finally, programs are urged to implement “admission policies that promote the inclusion of underrepresented groups, such as quotas or affirmative action programs,” reinforcing the commitment to social transformation and the democratization of access to higher education. The importance of highlighting the “existence of channels to receive continuous feedback from graduate

students, faculty, and staff on equity and diversity issues, on affirmative policies," should be emphasized.

These measures aim not only to meet the criteria of the 2029 Quadrennial Evaluation, but also to consolidate a more just and egalitarian educational system, aligned with the values of a democratic and inclusive society. The promotion of equity and diversity in the teaching and evaluation of Brazilian graduate programs is fundamental to foster understanding and the need for advances on the topic, aiming to ensure a just and inclusive society. In the Brazilian context, affirmative action policies have been implemented to expand access for historically marginalized groups, for example, to universities. However, studies indicate that, despite the increase in enrollment, significant inequalities persist in the higher education system, reflecting broader social structures of inequality (Bertolin & McCowan, 2022).

3.7.2. Reduction of asymmetries

CAPES's broad areas of evaluation, in their guidelines for the 2029 Quadrennial Evaluation, highlighted the importance of promoting actions that reduce regional asymmetries in Brazilian graduate education, strengthening equity in the national system of teaching and research (Table 10, Appendix A6). To achieve this objective, differentiated criteria are encouraged that consider geographic inequalities and promote integration among Programs from different regions.

One of the initiatives promoted is the "exchange of students between programs from less developed regions" and consolidated programs, with ratings 5, 6, and 7. This collaboration aims to benefit both sides, potentially generating capacity-building, academic and technological products that strengthen the less favored Program, while promoting the opportunity to carry out supportive practices considering the partner program. Additionally, the areas recognize the relevance of efforts aimed at the "transfer of technology and knowledge," highlighting programs that contribute directly to the development of "local communities."

The valuing of national and international partnerships is also fundamental in this process, so that collaborations between graduate programs from more and less developed regions are encouraged, ensuring that such

interactions promote the sharing of resources and knowledge, in addition to increasing the visibility of less consolidated Programs. In this sense, for the purposes of the Quadrennial Evaluation, some areas consider the creation and maintenance of strategic international partnerships as one of the indicators of internationalization.

The area documents have "differentiated criteria that consider regional asymmetries, taking into account the geographic distribution of the area's graduate programs, ensuring that less developed regions have access to the approval of APCN and the maintenance of graduate programs (PPG)." These measures aim to democratize access to high-level training throughout the country, reducing historical inequality gaps.

Reducing inequalities is SDG 10, and there are several targets, even in other SDGs, that aim to contribute to greater balance, especially of income and opportunities, in society. But, in recent years, mainly as a consequence of the Covid-19 pandemic, income inequalities have increased, reversing progress previously related to the SDGs. This situation makes the United Nations' promise to "leave no one behind" by 2030 an even more challenging task (Van Tulder et al., 2022).

3.7.3. Solidarity

The guidelines of CAPES's broad areas of evaluation highlight the importance of solidarity as a principle to strengthen the integration and social impact of graduate programs (Table 11, Appendix A6). This approach promotes differentiated criteria that value the active involvement of graduate programs in academic and scientific "cooperation networks," both national and international, facilitating the exchange of knowledge, resources, and innovative practices.

Graduate programs are encouraged to participate in "community projects" aimed at solving "local social problems, such as education, health, environment, and sustainable development." This participation strengthens the connection between higher education institutions and the communities in which they are embedded, promoting impacts in meeting social and environmental demands.

Another relevant aspect is the valuing of solidarity among Programs of different levels of development, with efforts directed "toward improving the quality of graduate programs in less favored regions." Collaboration between more consolidated institutions and those located in contexts of greater vulnerability contributes to reducing regional inequalities and strengthening the SNPG.

Finally, "solidarity efforts among programs" are encouraged, aiming at actions that seek to improve the quality of graduate programs in less favored regions, promoting the sharing of good practices and methodologies, in addition to contributing to strengthening the capacity for teaching, research, and outreach in these locations. By valuing solidarity actions, CAPES's policies strengthen institutions' capacity to promote significant changes for the benefit of society.

3.8. KNOWLEDGE TRANSFER/SHARING

CAPES's broad areas of evaluation adopt differentiated criteria to promote knowledge transfer and sharing (Appendix A7), prioritizing several integrated strategies, among them: creation of business incubators and support for startups originating from research projects, promoting the practical application of academic knowledge and job creation; strategies for scientific and technical publication, focusing on articles, technical reports, and educational materials in journals, newspapers, and digital platforms accessible to the public; "mentorship programs that connect students and researchers with experienced professionals, promoting skill development and knowledge transfer"; "intellectual property policies, partnerships, and interdisciplinary collaborations" that enhance "knowledge transfer"; use of social media and digital technologies to "disseminate knowledge widely," including online platforms, apps, and digital tools that facilitate access to information; development of educational projects and events aimed at environmental education and raising awareness about sustainability for students and communities; "collaborations with local companies and industries, promoting the transfer of technology and innovation, with an impact on regional economic development"; "partnerships with local communities and disadvantaged areas," creating "research projects and actions such as events" to meet "social and environmental needs and stimulate local development."

3.9. INTERNATIONALIZATION

These actions integrate and enhance the knowledge produced in graduate education, focusing on its practical application, accessibility, and socioeconomic impact. The integration of the SDGs in higher education is crucial to foster a culture of solidarity and social responsibility among students as well (Avelar & Pajuelo-Moreno, 2024).

CAPES's broad areas evaluate the internationalization of graduate programs (Appendix A8) based on the "Programs' capacity to attract funding from international agencies and institutions"; the "participation of members of the graduate programs in international conferences and publications on diverse themes," such as those of interest to the 2030 Agenda; as well as involvement in "international research projects that address global environmental issues, such as climate change, biodiversity, and the sustainable management of natural resources." In addition, the Evaluation considers the "institutional support of graduate programs for actions related to internationalization, including improvements in infrastructure, allocation of human resources for missions and training abroad," in addition to the financial support necessary for these initiatives.

The broad areas also consider the alignment of the goals and objectives of internationalization actions with the SDGs, such as "economic partnerships" with "foreign companies and institutions" that generate positive impacts "on local and global development," as well as international collaborations that seek solutions contributing to the fulfillment of the SDGs related to the interest of each field of knowledge or with an interdisciplinary focus. Another criterion is the measurement of effectiveness in the "transfer of knowledge and technology between Brazilian and foreign institutions, promoting innovation and economic development."

It was also highlighted that it is relevant to assess the "employability of graduates in international markets," emphasizing the Programs' contribution to training "professionals qualified for the global market." Finally, initiatives for "international exchange and mobility, both of Brazilian students abroad and of foreigners in Brazil," are considered as indicators of the impact of internationalization actions.

The integration of the SDGs in graduate programs has been enhanced by the internationalization of higher education institutions due to the opportunities for the exchange of knowledge and practices related to the topic. This interaction with other countries promotes academic collaborations that transcend national borders, facilitating the implementation of the SDGs in graduate curricula and contributing to the training of professionals capable of facing global challenges for sustainability (Leal-Filho et al., 2019).

3.10. EXTREME EVENTS RELATED TO CLIMATE CHANGE

CAPES's broad areas consider, in their documents, strategic actions aimed at the challenges imposed by extreme events related to climate change (Appendix A9). These actions include encouraging "interinstitutional and international collaboration, promoting cooperation among universities, research centers, and international organizations." This approach aims to develop integrated strategies to mitigate the adverse effects of these events, in addition to enabling the exchange of knowledge and best practices.

The training of human resources is a priority, with the "creation of specific graduate courses and programs" aimed at training professionals able to act in situations of extreme events. This training also seeks to qualify specialists in the "analysis, planning, and management of extreme climate risks," strengthening the technical capacity to face these challenges.

In research and innovation, there is encouragement for the development of technologies and solutions that contribute to the forecasting, monitoring, and mitigation of the impacts of extreme events. Some examples include the creation of "early warning systems for floods and droughts, efficient irrigation technologies, and detailed studies on the impacts of climate change in different regions of Brazil."

The broad areas also promote the integration of sustainability and "resilience to climate change in agricultural and urban practices and in water resource management," which are aligned with the SDGs, such as SDG 13 (Climate Action), SDG 6 (Clean Water and Sanitation), and SDG 11 (Sustainable

Cities and Communities). These guidelines reinforce the commitment to building solutions that ensure a more sustainable future in the face of climate change.

There is a need to align sustainable development agendas with resilience to heat waves, highlighting the importance of educational policies that prepare graduate students to deal with the impacts of climate change. Higher education should promote awareness and the capacity to respond to extreme climatic events, contributing to the training of professionals committed to sustainability and community resilience (Nunes, 2023).

3.11. PROSPECTS FOR THE EXPANSION OF THE SDGS IN THE 2029 QUADRENNIAL EVALUATION

In the area documents of CAPES's Evaluation Areas, between evaluation cycles, a significant evolution was observed in the inclusion of the SDGs, especially when comparing the guidelines that were being considered for the 2025–2028 cycle with those prescribed in the evaluation cycles of 2017–2020 and 2021–2024. Of the 50 Evaluation Areas, 35 highlighted that a clearer and more structured approach to the SDGs can be seen in the documents that will guide the 2029 Quadrennial Evaluation. This indicates progress in both awareness and the operationalization of these guidelines, contributing to the advancement of the 2030 Agenda within graduate programs.

Still in the documents of the 2025 Quadrennial areas, the SDGs had already begun to be explicitly mentioned and more targeted strategies were adopted. Examples include the fact that the theme of gender and racial equity, as well as issues of environmental ethics, gained prominence, aligning with global demands and the debates promoted by the Working Group Impact of Brazilian Graduate Education on the 2030 Agenda. In addition, discussions in the CTC-ES led to initiatives to seek to mitigate inequalities in the SNPG.

In the period evaluated, greater integration between the areas and the SDGs was also observed, with the establishment of specific items, such as the impact of graduate programs on society (item 3.3 of the Evaluation Form). This aspect is reinforced by the recognition that the 2030 Agenda has become more evident in the areas' guiding documents, expanding the leadership of fields such

as Arts, Linguistics, and Environmental Sciences, which have specific demands and sustainability issues aligned with a critical perspective.

Although its dimensions are addressed more broadly, it is observed that some areas address the SDGs only indirectly. For example, while the inclusion of environmental issues is mentioned, the specific detailing of targets is still incipient in some areas. Advances for 2029 include the creation of sections dedicated to alignment with the SDGs and the introduction of indicators to more objectively assess the impact of graduate programs in these dimensions. In doing so, CAPES reinforces its inductive role in incorporating the SDGs into Programs, promoting a more direct alignment between scientific production and society's demands, consolidating the role of Brazilian graduate education in the global agenda for sustainable development.

PART II

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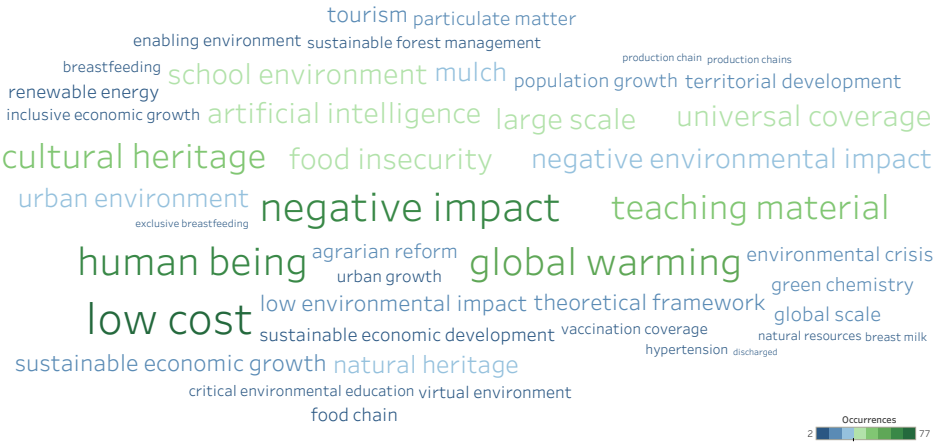
Part II is composed of Chapters 4, 5, 6, and 7, in which the Highlights of Brazilian graduate education are presented, through teaching, research, innovation, and outreach activities, in achieving the SDG, divided into four modalities: Chapter 4: **General SDGs**: addressing the greatest possible number of SDG 1–16; Chapter 5: **From the Amazon for the Amazon**: Amazonian institutions that benefit the region itself; Chapter 6: **Climate change**: featuring leadership in SDG 13: Action against Global Climate Change; and Chapter 7: **Complementary SDGs**: addressing an eminently Brazilian initiative related to SDG 18: Ethnic-Racial Equality, SDG 19: Art, Culture, and Communication, and SDG 20: Indigenous Peoples and Traditional Communities.

As mentioned in previous chapters, currently, in Brazil, 459 institutions offer 4,659 graduate programs, distributed across 50 Evaluation Areas. Of this total, 1,058 programs (22% of Brazil), from 251 institutions (54% of Brazil) and representing all areas, submitted 1,958 highlights of experiences in achieving the SDGs. Interdisciplinary submitted the largest number of highlights, 153, and Religious Studies, three.

Figure 22 shows the most frequent themes with respect to the SDGs involved across all 1,958 highlights, from all broad areas[34]. Based on the results displayed in the word cloud, it is concluded that the most frequent themes are predominantly related to global warming and negative environmental impacts, with a strong link to Environmental Sciences and Ecology. It is also important, however, to identify the significant presence of themes connected to the Humanities and Social Sciences, such as cultural heritage, artificial intelligence, and the school environment. Regarding the Collegium of Life Sciences, the frequency of studies on neonatal mortality, food security, and early warning is noteworthy. The participation of all 50 CAPES Evaluation Areas is considered significant in this first CAPES initiative to gather highlights of Brazilian graduate education in achieving the SDGs, also considering the timeframe for the programs to respond to the online form. There are certainly many other ongoing highlights; nevertheless, this initiative aims to encourage programs to address similar initiatives, as well as to broaden the reach of these activities, so as to enhance their impact on society.

[34] In the online version of the word cloud, it is possible to analyze the different areas, as well as to identify the linkages with the SDGs.

FIGURE 22: WORD CLOUD WITH THE MOST FREQUENT THEMES FOR ALL EVALUATION AREAS, RELATED TO THE DIFFERENT SDGS



Source: Analysis prepared especially for this work by Brasil, A. (2025).
Interactive visualization available at https://www.capes.gov.br/BookSDG-fig22

What follows is the methodology that was jointly constructed by the teams of the next four chapters. An online form with open-ended questions was prepared and sent to program coordinators between September 27 and October 13, 2024, and the initiative was also disseminated to all Offices of the Pro-Rectors for Research and Graduate Education and equivalent bodies. Up to four (4) highlight cases developed within the scope of the program that sought to achieve the SDGs were requested. Each program was invited to submit one highlight case for each of the four chapters of this book, although more than one highlight for the same topic was accepted, up to a total of four. It was clarified that the requested highlight cases would be teaching and/or research and innovation and/or outreach actions of the program, of medium to long term, which could have been initiated in the last three evaluation cycles (in the last 12 years, since 2012), but which currently had an impact on society (the State, organized civil society, and the market).

Initially, the coordination of each area selected its highlights for each of the four chapters/topics. The team members responsible for each chapter then selected, from among these, one for each broad area—listed below in their respective collegia, according to the CAPES classification. In this way, each chapter selected nine highlights, totaling 36 across the four chapters.

- *Collegium of Life Sciences:* Agricultural Sciences; Biological Sciences; and Health Sciences.
- *Collegium of Humanities:* Humanities; Applied Social Sciences; Language, Literature, and Arts.
- *Collegium of Exact, Technological, and Multidisciplinary Sciences:* Exact and Earth Sciences; Engineering; Multidisciplinary.

Among the criteria used by the areas to choose the highlights, the following were considered: I. addressing at least one SDG from each of these three dimensions—social, environmental, economic, in addition to the three complementary SDGs (18–20); II. correlating teaching and/or research/innovation and/or outreach activities; III. robustness of the text; and IV. the initiative's level of maturity. In the selection of highlights by broad area, the following qualitative ecosocioeconomic criteria were considered, whenever possible: (i) there are collaboration networks; (ii) there is an intentionality to carry out concrete actions; (iii) there are educational processes that promote the empowerment of individuals; (iv) there is a conception of society grounded in ethical values; (v) collaboration networks value modes of knowledge, know-how, and appropriate technologies; (vi) there are benefits beyond the members who participate in the networks; and (vii) there are elements that promote territorial well-being.

It is emphasized that this is not a ranking; rather, the examples of highlights below are an attempt to demonstrate the representativeness of the different areas of Brazilian graduate education in their contribution to the United Nations and Brazilian 2030 Agenda, insofar as the complementary SDGs are considered. Area coordinations are encouraged to publicize the highlights received in this call and, on an ongoing basis, to encourage and give visibility to the impacts arising from these actions[35].

[35] The highlights selected by the evaluation areas will be in Appendix B of this work, available only in digital version and in Portuguese at: https://capes.gov.br/apendices-ipgb-na-agenda-2030.

4 HIGHLIGHTS OF BRAZILIAN GRADUATE EDUCATION CASE STUDIES PROMOTING A BROADER RANGE OF SDGS

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This chapter addresses the impact of Brazilian graduate education activities, introduced here through case studies named as "highlights," in the context of the general SDGs, SDGs 1–16[36].

Initially, it contextualizes the origin of the seventeen SDGs, arising from social movements in the construction of the UN 2030 Agenda. Next, it presents the guidelines for selecting the nine highlights from graduate programs, distributed across CAPES's three collegia. Such highlights are presented and analyzed with regard to context, the dimensions involved, and the degree of maturity in achieving the SDG targets. It offers a comparison of the themes involved in the different fields of knowledge within Brazilian graduate education, as well as a comparison with international scientific production, seeking to broaden the outlook toward new possibilities, weaknesses, and potentialities to be explored. Illustrative international examples of science's contribution to the 2030 Agenda are also presented.

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[36] We proceeded from the premise that the highlights should recognize and address, as a foundational and cross-cutting governance element, SDG 17 (Partnerships and Means of Implementation).

Finally, this chapter provides recommendations concerning current and future needs for action by Brazilian graduate education, and its leadership in the search for solutions and pathways to guide society in the coming decades.

4.1. PARTICIPATION OF SOCIAL MOVEMENTS IN THE CONSTRUCTION OF THE SDGS

The civilizational process has been built throughout history, and progressive social movements have driven important social advances, especially regarding ethno-racial, gender, labor, and environmental issues (Salles et al., 2024). Corroborating the position above, Dagnino (2004) also focuses on the creation of new rights, arising from the political struggles of social movements, through concrete practices, causing these rights to be expanded, thus reaching the space of participation and citizenship of the population, especially with respect to autonomy over one's own body, the right to environmental protection, the right to housing, the ethno-racial issue, and the rights of LGBTQIAPN+ people. This redefinition includes not only the right to equality but also the right to difference, which specifies, deepens, and broadens the right to equality, a relevant and cross-cutting issue embedded in the context of the 17 SDGs.

In its genesis, in the seventeenth century, the term "development" was motivated by purely economic issues. However, as social movements and struggles became more frequent and organized, it acquired social hues, including feminism, pacifism, human rights, and environmental concern (Favero, 2003; Gohn, 1997). In this context, the 2030 Agenda, which encompasses the 17 SDGs and 169 targets, brought together important advances arising from historic class struggles, through national and international collaborations, as detailed in Chapter 1 of this book.

Salles et al. (2024) explore the connections between the agendas of social movements, especially from the 1940s to the 1960s, and the SDGs of the 2030 Agenda. These authors highlight that the main movements that influenced and were contemplated in the 2030 Agenda were labor, feminist, identity, environmental, peace-promotion, and ethnic and nationalist movements (Figure 23).

FIGURE 23: SOCIAL MOVEMENTS AND THE SUSTAINABILITY AGENDA

Source: Salles et al. (2024), with authorization from the authors for reproduction.

In Brazil, movements linked to labor are highlighted, such as the leading roles played by the Landless Workers' Movement (MST) and the Homeless Workers' Movement (MTST) in several SDGs. In the Feminist Movement, the important participation at the UN of the researcher Bertha Lutz stands out, fundamental for the inclusion of gender agendas, in alignment with international feminist movements in the 1920s and 1930s, as well as the Comprehensive Women's Health Care Program, created in 1980 as a result of the Brazilian feminist movement's action (Salles et al., 2024).

Salles et al. (2024) analyze the role of different social movements and their influence on the 2030 Agenda. According to these authors, in the Identity Movements, SDG 3 stands out, considering the right to health, linked to Human Rights, essential for the LGBT community. Environmental Movements influenced several SDGs, the result of discussions led by the UN for approximately 50 years on sustainable development and concern with population growth. A relevant premise for Environmental Movements was the need for quality education aimed at expanding and disseminating scientific knowledge about the environment. Nationalist and Ethnic Movements, such as the Indigenous movement, contributed indirectly to several SDGs, with many of their agendas tied to Human Rights and combating extractivism and environmental degradation, while Racial Movements, with very broad agendas, emphasized, in Brazil, social issues, and in particular the Black movement emphasized educational policies and anti-racist laws in the 1990s. Religious Movements, focused on supporting families, contributed to the 2030 Agenda across several SDGs. In Brazil, the role of Basic Ecclesial Communities,

Liberation Theology, and the Catholic Student Youth and their participation in the World Social Forum are noteworthy. The Civil Rights Movement was an important actor in establishing laws that contribute to achieving the SDGs. Finally, Plural Movements, which involve different agendas and groups, with emphasis on student movements and, in Brazil, on the Sou da Paz movement and the Favela Livre movement, were also contemplated in several SDGs. SDG 16 (Peace, Justice, and Strong Institutions) and SDG 17 (Partnerships for the Goals) are encompassed in the actions of these Movements.

Gohn (2011) emphasizes that social movements carry out diagnoses of social reality and construct proposals which, operating in networks, build collective actions that act as resistance to exclusion and fight for social inclusion. They constitute and develop the so-called empowerment of actors in civil society as they create social subjects for this networked action. Both the social movements of the 1980s and those of the present have built affirmative symbolic representations through discourses and practices. They create identities for previously scattered and disorganized groups, as Melucci (1996) aptly stressed. In carrying out these actions, they instill in their participants feelings of social belonging. Those who were excluded come to feel included in some type of action by an active group within the aforementioned social movements (Figure 23).

Therefore, the role of social tensions and demands in articulation with the UN 2030 Agenda is highlighted.

4.2. HIGHLIGHTS OF BRAZILIAN GRADUATE EDUCATION IN PROMOTING THE ACHIEVEMENT OF THE GENERAL SDGS

Within the premises used for selecting the highlights submitted by graduate programs from the 50 Evaluation Areas, as detailed in the presentation to Part II of this book, the initiatives below were selected, one for each of the broad Evaluation Areas, three in each of the three collegia (Life Sciences, Humanities, and Exact, Technological, and Multidisciplinary Sciences), totaling nine highlights.

4.2.1. Collegium of Life Sciences

4.2.1.1. Broad Area Agricultural Sciences

Institution: Federal University of Amazonas	**Program:** Animal Science and Fisheries Resources
Title: Pé-de-pincha Program: 25 years of community-based conservation of chelonians in the Amazon	
SDGs involved: Social: SDG 1, 2, 3, 4, 5, 10; Environmental: SDG 6, 7, 12, 13, 14, 15; Economic: SDG 8, 9, 11; Institutional: SDG 16, Complementary: SDG 18, 19, 20.	
Justification: The need to protect, restore, and manage freshwater/terrestrial ecosystems in a sustainable and participatory way to conserve chelonians, as well as to ensure inclusive education, promote sustainable agricultural practices, and assess the effects of climate change on chelonians.	
Context: The program has been developed since 1999, originating in Terra Santa, a municipality in western Pará, and was nicknamed "Pé-de-pincha" because the tracks of the yellow-spotted river turtle on the sand resemble marks of soda bottle caps (pinchas), the name given by riverside dwellers to that chelonian. At the time, the communities of Lake Piraruacá sought assistance to try to restore the populations of yellow-spotted river turtles on their beaches and confront the environmental conflicts they were experiencing.	
Location: 125 communities in 19 municipalities in Amazonas (Manaus, Iranduba, Careiro, Borba, Barcelos, Novo Airão, Itacoatiara, Boa Vista do Ramos, Maués, Barreirinha, Parintins, Nhamundá, Canutama, Carauari, Itamarati, and Juruá) and Pará (Terra Santa, Oriximiná, and Juruti).	
Objective: Its main objective is to conserve populations of chelonians (tracajás, *Podocnemis unifilis*; iaçás, P. *sextuberculata*; turtles, P. *expansa*; and irapucas, P. *erythrocephala*) in a participatory manner, involving local communities and institutions.	
Indicators used and methodology for data collection and monitoring: The methodology used throughout the program was participatory action research with the introduction of community-based chelonian conservation techniques, training community members in the Pé-de-pincha conservation monitoring protocol and following the protection phases developed by the communities. At each of these phases, environmental education activities are also carried out in the communities. For each action/activity, there are important indicators such as: (i) meetings with managers and number of courses/workshops offered; (ii) number of new temporary chelonian protection zones; (iii) number of breeding sites monitored and number of nests/eggs protected by the communities; (iv) number of population monitoring expeditions carried out; and (v) number of chelonians captured, measured, marked, and released.	
Partnerships involved: Environmental agencies (IBAMA/PQA; ICMBio/RAN; Amazonas State Secretariat for the Environment—SEMA; municipal environmental secretariats), higher education institutions (IFAM, UFOPA), civil society organizations (community associations such as ATAAV, AMARU, ACOPROSA, ASTA, AMECSARA; the Franciscan Sisters Maristela; and Instituto Juruá). The program has acted in networks, taking part in the GAT for the National Action Plan for the Conservation of Amazonian Chelonians of IBAMA and the Scientific Committee of RAN/ICMBio.	

Funding: CNPq; Pro-Várzea/IBAMA/KfW; UFAM; Amazonas Research Support Foundation (FAPEAM); MEC – SESu – Universidade Solidária; Petrobras Ambiental Program; MRN (Mineração Rio do Norte); Embratel-Sustentável; and Instituto Claro.
Planned goals, results, and impacts achieved: Between 1999 and 2024, this program has returned more than 11.5 million chelonian hatchlings to nature, trained more than 2,500 teachers from municipal schools, given talks in schools and communities for more than 179,000 attendees, trained more than 751 volunteer environmental agents and 220 environmental managers; offered courses (104) and workshops (37) on income-generation alternatives for 9,320 people; held 11 drawing workshops for 305 students who produced 14 booklets with comic-book stories on conservation and the environment used in environmental education actions. The total number of people directly mobilized during this period was 179,043, indirectly reaching more than 410,000 people. The Pé-de-pincha Program has strongly assisted in the development of public fauna conservation policies for the state and for the Amazon as a whole. It is one of the largest community-based chelonian conservation and volunteer programs in the world. It decisively influenced, as a technical advisor, the National Action Plan for the Conservation of Amazonian Chelonians – PAN Quelônios (MMA/IBAMA/ICMBio).
Replication potential: The replicability of this protocol of actions has been simplified by the monitors or community volunteers themselves, who act as multiplying agents of this methodology, thereby reinforcing the dissemination of this knowledge and the diffusion of scientific and technical research results applied to chelonian conservation.
Supporting documents: https://pt.atlanteco.eu/ https://cordis.europa.eu/project/id/862923 https://cordis.europa.eu/project/id/862923/results

4.2.1.2. Broad Area Biological Sciences

Institution: Oswaldo Cruz Foundation – Pernambuco	**Program:** Biosciences and Biotechnology in Health
Title: Elimination of lymphatic filariasis as a public health problem in Brazil (EFLB)	
SDGs involved: Social: SDG 3, 10; Environmental: SDG 6.	
Justification: Brazil was a signatory to the Global Programme to Eliminate Lymphatic Filariasis (GPELF) to demonstrate the absence of transmission of the parasitosis as a public health problem by 2020.	
Context: The state of Pernambuco still had endemic areas of lymphatic filariasis in four municipalities of the Recife Metropolitan Region: Recife, Jaboatão dos Guararapes, Olinda, and Paulista, and in other states where there was no evidence of broken transmission. To obtain verification of elimination, Brazil needed to demonstrate the absence of transmission in these areas and in their neighboring municipalities.	
Location: Municipalities in the states of Pernambuco, Maranhão, Alagoas, and Pará.	
Objective: To interrupt the transmission cycle by the year 2020 based on the actions proposed by GPELF/WHO.	

Indicators used and methodology for data collection and monitoring: Graduate students and faculty of the Graduate Program in Biosciences and Biotechnology in Health, in collaboration with local, national, and international institutions, developed projects that conducted entomological surveys, established a diagnostic protocol for infection of Culex quinquefasciatus that proved the break in transmission. Moreover, studies developed in the Program demonstrated the safe and effective use of biological control with Lysinibacillus sphaericus in endemic areas of filariasis. Subsequently, the municipalities adopted this model as the main vector-control agent. The Program also supported Municipal and State Health Secretariats with actions to monitor filarial infection and morbidity in the human population. We also assisted in drafting the dossier sent to GPELF/WHO. Indicators: mosquito density indices, human infection and vector infection indices; socio-environmental risk indicator.

Partnerships involved: Ministry of Health and the Municipal and State Health Secretariats.

Funding: PAHO, Ministry of Health, Municipal and State Health Secretariats, and Funding Agencies. Public calls and internal calls for support: FACEPE, FIOTEC, CAPES, CNPq; Ministry of Health; PAHO and WHO. Student scholarships: FACEPE, CAPES, CNPq.

Planned goals, results, and impacts achieved: We achieved the main goal, which was to break the transmission of lymphatic filariasis in Brazil. Other contributions were the criteria that demonstrated the break in transmission and will support entomological and human (infection and morbidity) surveillance after verification of elimination in the country. Consequently, in 2024 the Ministry of Health received verification of the elimination of lymphatic filariasis from WHO.

Replication potential: The studies developed and published by the Program's students and faculty are available for use in other endemic areas. Several of our graduates participate as technicians in Health Secretariats, the Ministry, and service, research, and teaching institutions. Faculty provide consulting in other endemic areas. Thus, verification of the elimination of lymphatic filariasis was achieved through a task force of the Unified Health System (SUS), academia, research, secretariats, and ministries, demonstrating the efficiency of a collaborative network in favor of the Brazilian population's health.

Supporting documents:

https://doi.org/10.1016/j.exppara.2020.107918
https://doi.org/10.1080/09603123.2022.2109603
https://doi.org/10.1016/j.biocontrol.2019.02.006
https://doi.org/10.1371/journal.pntd.0006816
https://doi.org/10.1371/journal.pntd.0011091
https://doi.org/10.1016/j.biocontrol.2019.02.006
https://doi.org/10.1016/j.biocontrol.2018.03.006
https://doi.org/10.1080/20477724.2019.1623546
https://doi.org/10.1590/S0034-89102013005000010

4.2.1.3. Broad Area Health Sciences

Institution: Federal University of Pelotas	**Program:** PPG in Epidemiology
Title: International Center for Equity in Health (ICEH)	
SDGs involved: Social: SDG 1, 3, 5, 10; Institutional: SDG 17; Complementary: SDG 18 (capacity building for low- and middle-income countries to increase the availability of quality, recent, and reliable data).	
Justification: Since 2009, ICEH has monitored and assessed countries in their progress toward development targets. Its triple mission involves maintaining a mega-database of health indicators related to the SDGs updated with the most recent health surveys, training specialists in global health at the graduate level, and producing innovative knowledge both on health situations and inequities and on new monitoring approaches. To this end, ICEH collaborates intensively with the Countdown to 2030 initiative, with multilateral agencies such as UNICEF and WHO, and with universities in Brazil and abroad.	
Context: ICEH developed a unique analysis platform that allows the production of health indicator estimates for all Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) conducted since the 1990s. These data comprise a mega-database of health indicators covering more than 120 countries and nearly 500 surveys. The quality and size of this indicator collection enable a wide range of analyses published in scientific journals by the Center itself (ICEH has published more than 190 articles in the last 15 years) and by its partners and users (the data are available in WHO's Health Inequality Data Repository). Beyond academic activity, ICEH supports policies and decision-making by collaborating with reports by UNICEF, PAHO, WHO, among others, and directly with ministries of health of countries, including Brazil and 26 African countries through the Countdown to 2030 initiative. ICEH created a standard for equity analyses that has been adopted by numerous agencies and researchers.	
Location: Pelotas, RS; low- and middle-income countries.	
Objective: To monitor progress in reproductive, maternal, newborn, child, and adolescent health, especially in low- and middle-income countries.	
Indicators used and methodology for data collection and monitoring: ICEH reanalyzes national health surveys, producing more than a hundred standardized indicators stratified by dimensions relevant to equity analysis in health. These dimensions include wealth quintiles, maternal age and education, child's sex, urban/rural residence, subnational regions, levels of women's empowerment, religion, and ethnicity. Each estimate has its standard error and confidence interval presented. We also calculate inequality measures for wealth, the concentration index, and the slope index of inequality. These data have been widely used by researchers and international agencies.	

Partnerships involved: ICEH originated from the need for stratified health indicators for equity analyses in the monitoring work of the Millennium Development Goals carried out by the then Countdown to 2015. This partnership endures to the present, with ICEH as a key partner of Countdown in its monitoring and training activities. During its existence, ICEH has expanded its collaboration network to include UNICEF, WHO, PAHO, GAVI, UNFPA, CLAP, Johns Hopkins University (USA), SickKids and University of Manitoba (Canada), American University of Beirut (Lebanon), IDRC (Canada), BMGF, and Gates Ventures (USA). In Brazil we have worked closely with the Ministry of Health, currently with a project to create an observatory of equity in reproductive, maternal, and child health that also has the support of Umane. Since 2017 we have been designated a WHO Collaborating Center for Monitoring Equity in Health.
Funding: DECIT/CNPq, Umane, Bill & Melinda Gates Foundation, IDRC.
Planned goals, results, and impacts achieved: It seeks to highlight health inequities in order to support actions to eliminate them. To this end, updating the mega-database of indicators—essential for monitoring—is underway. The impact of activities can be measured through the numerous scientific publications, the training of graduate-level specialists, many in prominent positions in Brazil and abroad, and the creation of new strategies and methodologies for equity analysis in health. Today, the visualization tool for inequalities, the "equiplot," is used in a large share of publications on the topic, as is the women's empowerment indicator proposed in 2017, SWPER.
Replication potential: National surveys and health information systems are important data sources for monitoring health conditions. Monitoring inequalities in access to health services and in health conditions has the potential to be replicated as routine in countries and health services. Such monitoring is essential for developing more appropriate, evidence-based public policies that promote changes in the population's health and well-being.
Supporting documents: https://equidade.org/

4.2.2. Collegium of Humanities

4.2.2.1. Broad Area Humanities

Institution: São Paulo State University "Júlio de Mesquita Filho"	**Program:** San Tiago Dantas Graduate Program (Unesp, Unicamp, PUC-SP)
Title: Practical Guide for Simulations (Sustainable Development Goals – 2030 Agenda) (GPS)	
SDGs involved: Social: SDG 2, 3, 4, 5, 10; Environmental: SDG 14; Economic: SDG 11; Institutional: SDG 16.	
Justification: The project aims to address all the SDGs throughout its full life cycle, planned until 2026. However, the first two editions of the Guide in question covered those SDGs of greatest interest and with interfaces with academic research within the Graduate Program.	

Context: The Guides are part of the partnership developed among the Representation Office of the Ministry of Foreign Affairs in São Paulo – ERESP, Centro Paula Souza – CPS, and the San Tiago Dantas Graduate Program in International Relations to support and advise the process of training teachers, enabling the implementation of the MONUEM-ERESP Project in the State Technical Schools of São Paulo. Under this umbrella, the guides in question constitute foundational materials of guidance and suggestions to educators on the 2030 Agenda and the SDGs.
Location: The project's territorial scope is the State Technical Schools of São Paulo (ETEC), totaling 228 units.
Objective: The main objective of the Guides is to foster the autonomy of ETEC educators in the state of São Paulo in carrying out didactic activities aimed at organizing international simulations with students, guided by the SDGs. In this sense, the guides provide educators with guidance and suggestions on themes, structures, and formats for the application of active methodologies as pedagogical activities in the classroom that contemplate the 2030 Agenda, including the Model United Nations.
Indicators used and methodology for data collection and monitoring: (i) Collection and monitoring of general aspects of the project, such as number of Project editions and number of materials developed; (ii) collection and monitoring of the training activities, including number of trainings conducted and number of educators trained; (iii) collection and monitoring of the Practical Guides for Simulations, covering, for example, number of Guides developed and number of SDGs covered.
Partnerships involved: San Tiago Dantas Graduate Program in International Relations (UNESP/UNICAMP/PUC-SP) operating in a triangular cooperation with the Representation Office of the Ministry of Foreign Affairs in São Paulo (ERESP) and Centro Paula Souza (CPS).
Funding: To date, there has been no direct funding; however, it relies on faculty and graduate students funded by CAPES scholarships.
Planned goals, results, and impacts achieved: (i) to train, by 2026/1, 50% of ETEC educators in São Paulo; (ii) to assist in improving pedagogical practices and tools in Upper Secondary Education; and (iii) to complete, by 2026/1, the set of Guides capable of covering all SDGs.
Replication potential: The project is capable of and intends not only to be replicated but also to be expanded with the publication of new editions of the guides. Replicability (adapted) also concerns how teachers will make use of the suggested simulated practices, likewise adapting their content and classroom realities.
Supporting documents: Practical Guide for Simulations (1st ed.): https://capes.gov.br/guia-pratico-simulacoes-1 Other materials developed by the Project: Practical Guide for Simulations (2nd ed.): https://capes.gov.br/guia-pratico-simulacoes-2 Impressions Report – MONUEM-ERESP-CPS Project (2021): https://capes.gov.br/impressoes-projeto-montem-eresp-cps

4.2.2.2. Broad Area Applied Social Sciences

Institution: Federal University of Rio Grande	**Program:** Law and Social Justice
Title: Serving the People of the Waters (APA)	
SDGs involved: Social: SDG 4, 5, 10; Environmental: SDG 13, 14, 15; Economic: SDG 8; Institutional: SDG 16; Complementary: SDG 18, 19, 20.	
Justification: Extension project linked to the PPGDJS/FADIR/FURG entitled "Serving the People of the Waters," which originated in 2019 and received a new name in June 2024, seeking to assist various traditional communities dedicated to artisanal fishing carried out in the Patos Lagoon Estuary, Mirim Lagoon, and the São Gonçalo Channel, an estuarine system located in the southern zone of the state of Rio Grande do Sul. The People of the Waters are composed of communities dedicated to artisanal and sustainable fishing, involving around three thousand fishers, only in the Patos Lagoon Estuary, who were severely affected by strong winds and the flood that came in September 2023 and again by the historic inundation of May 2024 that struck all of Rio Grande do Sul. The Project develops actions linked to SDGs 4, 5, 8, 10, 13, 14, 15, 16, 18, and 20 of the 2030 Agenda.	
Context: Since its implementation, the Project has provided legal and social assistance to families of artisanal fishers who were brutally affected by the floods that occurred in 2024 in RS. It is worth noting that, in the 2023 floods, these same families were also affected by climate change that has impacted Brazil and, in particular, RS.	
Location: City of Rio Grande and, specifically in the "Serving the People of the Waters" Extension Project, the Patos Lagoon Estuary, Mirim Lagoon, and the São Gonçalo Channel, which extend across the cities of Pelotas, São Lourenço do Sul, Rio Grande, Santa Vitória do Palmar, and Chuí.	
Objective: To demonstrate the interconnectivity of the SDGs of the 2030 Agenda when Research and Extension Projects are designed and implemented.	
Indicators used and methodology for data collection and monitoring: Field collection was carried out, that is, personal data and facts that prove the need for government assistance for families who lost their homes and their source of income: fishing.	
Partnerships involved: In addition to the support of FURG's graduate programs, CIDIJUS, and LABJUH—both at FURG—partnerships were established with the CAIC/FURG school, the Municipal School of Ilha de Torotama, and the Military Police of Rio Grande.	
Funding: The Project did not receive specific funding, but it was developed as an extension project linked to a graduate program and, therefore, received support from CAPES.	
Planned goals, results, and impacts achieved: In the first stage of the Project, which assisted victims of the floods that occurred in RS, 853 fishers were assisted, and 474 powers of attorney were entrusted to the Project's researchers/extension workers for the filing of unsatisfied social assistance claims. As of September 2024, the Project entered its second phase, with new flooding events and new challenges.	
Replication potential: With funding, the Project can be replicated and more effectively meet the demands.	
Supporting documents: https://repositorio.furg.br/handle/123456789/11603	

4.2.2.3. Broad Area Languages, Literature and Arts

Institution: Pontifical Catholic University of Minas Gerais	**Program:** Graduate Program in Letters
Title: LER Project: Circles of reading and writing with refugees and migrants (LER)	
SDGs involved: Social: SDG 4, 5, 10; Economic: SDG 8; Institutional: SDG 16; Complementary: SDG 19.	
Justification: The situation of forced displacement of millions of human beings on the planet constitutes the deepest humanitarian crisis in recent history. This crisis implies the search for a safe place to live and, unfortunately, the deepening of poverty among the displaced. Young and adult men and women, children and adolescents who come to our country to live, in a context of profound social vulnerability, need to be welcomed in order to overcome the second border of their displacement: learning the Portuguese language, fundamental for the process of intercultural interaction and social emancipation of participants in the community.	
Context: In recent decades there has been a serious deepening of the global crisis of forced international human mobility. In its genesis, the project, implemented since 2018, starts from the recognition of the social—and thereby educational—consequences of the largest exodus ever recorded in the recent history of humanity. In Brazil, 2,223,824 migrants were recorded between 2000 and 2024. In the same period, in Minas Gerais, these numbers reached a record of approximately 80,000 people; the vast majority of migrants and refugees live in cities, in urban centers. In this context, the LER Project has progressively served an ever-growing number of migrants of different nationalities, especially Syrians and Venezuelans.	
Location: In the state of MG, in person, at PUC Minas (Lourdes Unit), and online, asynchronously and synchronously, in addition to WhatsApp contact with the community.	
Objective: The project aims at the process of linguistic reception, intercultural mediation, and social emancipation of migrants and refugees of the most diverse nationalities who recognize Brazil as a place to live and rebuild their lives. It also aims to contribute to the initial and continuing training of teachers, intercultural mediators, and popular educators, in addition to impacting public policies.	
Indicators used and methodology for data collection and monitoring: The project is based on: (i) promoting actions that stem from systematic reflection with learners, to recognize them in their individuality, their dreams and desires, their language, their cultural repertoire, their level of Portuguese language performance, as well as their level of motivation to participate in a community and to develop socio-intercultural competence; (ii) structuring itself in five work fronts, dynamically articulated among themselves: pedagogical; artistic-cultural; human and social development; documentation and research; communication; (iii) developing the Portuguese learning experience in in-person and online modalities and creating strategies and didactic material, digital and non-digital, new and authored, or curated and adapted strategies and material duly evaluated; (iv) promoting initial and continuing training actions for extension students; (v) conducting a systematic process of planning, monitoring, and evaluation of the actions carried out in the field, with a view to qualifying the performance of extension students and researchers in training. Project evaluation takes place systematically through the process of personal and collective critical reflection on the actions carried out and through their material recording and documentation.	

Partnerships involved: Institutions of organized civil society (Jesuit Service to Migrants and Refugees—SJMR; Associação Comunitária Nossa Cidade—ANC; Associação Comunitária Casa Mundii).
Funding: Office of Extension of PUC Minas. PROEX-2018/11957; PROEX-2019/22483; PROEX-2020/25235; PROEX-2021/27339; PROEX-2022/27936; PROEX-2023/29292; and PROEX-2024/31342. Camões Institute, within the scope of the Chair of the Center for Luso-Afro-Brazilian Studies, for holding events, publishing e-books, and participating in events.
Planned goals, results, and impacts achieved: The goals to be achieved with the Project's development are: (i) teaching and learning the Portuguese language to achieve language performance (oral and written) at basic, intermediate, or advanced levels, depending on participants' objectives and desires; (ii) creating a transdisciplinary space of intercultural reception and psychosocial safety for participants; (iii) promoting actions of human, academic, and professional training of researchers and extension students to work on the migration and refuge agenda, at the local, national, and international levels, committed to a culture of peace and the defense of human rights; (iv) raising awareness in the university, companies, and society at large about the pedagogical, social, and cultural challenges of the migration and refuge agenda in Brazil; (v) initial and continuing training of basic education teachers, intercultural mediators, and popular educators. Among the project's results and impacts, the following stand out: (i) For the Project's participants: Learning the Portuguese language and improving communicative skills; (ii) For extension students: Authorial, collective, and collaborative production of didactic material and strategies, in addition to the socialization of students from diverse areas (Letters, Pedagogy, Psychology, Law, Journalism, Cinema) with researchers and volunteers who work with refugees and migrants in Brazil and other countries; (iii) For faculty researchers: Interaction among colleagues from different areas in the process of linguistic reception, from the areas of Letters, Psychology, and Social Work; establishment of a multimodal corpus (in different media), built on methods of ethnographic inspiration, for academic-scientific research purposes by faculty and students who make up the "Studies in Language and Cognition" (eLinC) research group at PUC Minas and other interested parties. These academic-scientific research results have potential incidence on public policies; (iv) At the institutional level: Development of actions of linguistic and cultural reception that help fulfill the objectives assumed in the university's Institutional Development Plan, enabling networked knowledge production and action in the context of migration and refuge, through interinstitutional partnerships.
Replication potential: The process of systematizing the actions developed by the LER Project, documented in the research conducted and in a guidance manual, enables any higher education institutions committed to the migration and refuge agenda to replicate them.
Supporting documents: LER Project – http://www.projetoler.com

4.2.3. Collegium of Exact, Technological, and Multidisciplinary Sciences

4.2.3.1. Broad Area Exact and Earth Sciences

Institution: Federal University of Campina Grande	**Program:** Computer Science
Title: Decision-support platform with environmental indicators for the Amazon Forest – Case study in the state of Acre (PATDIAFA)	
SDGs involved: Social: SDG 1, 2, 3, 4, 5, 10; Environmental: SDG 6, 7, 12, 13, 15; Economic: SDG 8, 9, 11; Institutional: SDG 16; Complementary: SDG 18.	
Justification: The proposed decision-support tool plays an essential role in monitoring and overseeing compliance with the SDGs by providing interactive environmental dashboards that aggregate and analyze relevant indicators. These dashboards allow clear visualization of the targets associated with each SDG, facilitating the identification of critical areas and the tracking of progress, providing support to oversight teams of the Acre State Court of Accounts (TCE-AC).	
Context: TCE-AC has maintained a project development partnership with the Information Systems Laboratory at UFCG for over a decade. In past projects, education and health indicators were developed, leading to the need to develop environmental indicators aligned with the SDGs.	
Location: All municipalities in the state of Acre.	
Objective: Development of a web-based Business Intelligence platform integrated with geoprocessing that allows public managers in the state of Acre to analyze various environmental indicators, so that they can better plan their actions for development aligned with sustainability. The tool had its first version launched in September 2024.	
Indicators used and methodology for data collection and monitoring: Indicators were sought that provide measurable, reliable, and relevant data for analyzing and monitoring environmental conditions in Acre. Indicators include land use, air and water quality, biodiversity, environmental disasters, protected areas, and basic sanitation. It currently includes 96 indicators. The methodology involved integrating information from various sources and institutions, enabling the consolidation of environmental data in a single database and the visualization of data in multiple dashboards. The data are updated periodically, ensuring continuous and reliable monitoring. As a result, the dashboard provides an integrated view of environmental performance, facilitating trend analysis over time and allowing comparisons among different regions (meso and micro) of the state of Acre and different time intervals (historical series).	
Partnerships involved: PPG-CC UFCG; Acre State Court of Accounts (TCE-AC); PPG-ERN-UFSCar; and PPG-CFL-UnB.	
Funding: The project received funding from TCE-AC.	

Planned goals, results, and impacts achieved: The planned goals are: (i) to maintain an overall and integrated view of the environmental situation in Acre; (ii) to identify and prioritize strategic actions to improve environmental quality; (iii) to flag emerging environmental issues; (iv) to verify the effectiveness of public policies aimed at preserving and protecting the environment; and (v) to strengthen the dissemination of environmental information. Among the results already achieved are: (i) implementation of a centralized platform for environmental monitoring, accessible via the web, providing an overall and updated view of the state's main environmental indicators; (ii) identification and prioritization of critical areas that require intervention, facilitating the efficient allocation of resources and efforts for environmental actions; (iii) continuous monitoring of the effectiveness of environmental public policies, enabling adjustments and improvements in governmental strategies. Potential impacts include: (i) improved environmental management at state and municipal levels with more targeted, data-based actions; (ii) increased transparency and accountability regarding Acre's environmental performance, both for public managers and civil society; (iii) greater engagement of society and environmental managers, encouraging active participation in conservation and environmental protection actions; (iv) significant contribution to local sustainability, ensuring that future generations have access to a preserved and healthy environment.
Replication potential: The accessible and scalable technology can be adopted by other federative units, ensuring flexibility, ease of updating, and custom adaptations to the specific needs of different contexts.
Supporting documents: https://indicaacre.tceac.tc.br/

4.2.3.2. Broad Area Engineering

Institution: Federal University of Alagoas	**Program:** Water Resources and Sanitation
Title: Scientific Expedition of the Lower São Francisco (ECBSF)	
Dimensions and SDGs involved: Social: SDG 1, 2, 3, 4, 5, 10; Environmental: SDG 6, 12, 14, 15; Economic: SDG 8, 11; Complementary: SDG 20.	
Justification: The articulation between scientific knowledge and city management is fundamental to meeting the 17 SDGs. Thus, the scientific program of the expeditions contemplates, directly or indirectly, 13 of them, such as poverty eradication, sustainable agriculture, quality education, drinking water, sanitation, etc. In 2022, this initiative was chosen as one of the ten most successful experiences of integration between municipalities and higher education institutions (HEIs) in Brazil by the Sustainable Cities Institute. The project arose from the identified need to generate public policies grounded in scientific data, with participatory and multidisciplinary diagnosis, about the economic, social, and environmental situation of the Lower São Francisco region.	
Context: The program began in 2018, focused on assessing impacts on fishing activity, soil management, agriculture, tourism, municipal water supply, the population's health, and the way of life of traditional communities. It is currently the largest program of environmental biomonitoring in continental waters in Brazil, operating in 35 lines of research, with about 100 researchers and a support team.	

Location: A total of 10 municipalities are served—Piranhas-AL, Pão de Açúcar-AL, Traipu-AL, Gararu-SE, Propriá-SE, São Brás-AL, Igreja Nova-AL, Penedo-AL, Piaçabuçu-AL, Brejo Grande-SE—and the mouth of the São Francisco River.
Objective: To conduct a participatory and multidisciplinary diagnosis of the economic, social, and environmental situation of the Lower São Francisco region, assessing impacts on fishing activity, soil management, agriculture, tourism, municipal water supply, the population's health, and the way of life of traditional communities.
Indicators used and methodology for data collection and monitoring: The indicators used are: Water Quality, Aquatic Biodiversity, Erosion and Siltation, Public Health, Socioeconomics, Sanitation. Methodologies for data collection and monitoring: Water Sampling, Fish and Macroinvertebrate Collection Campaigns, Geomorphological Surveys, Interviews and Application of Questionnaires, Environmental Education Activities.
Partnerships involved: Federal University of Alagoas (UFAL), Ministry of Science, Technology, and Innovation (MCTI), São Francisco River Basin Committee (CBHSF), São Francisco and Parnaíba Valleys Development Company (CODEVASF), Alagoas State Secretariat for the Environment and Water Resources (SEMARH-AL), and Alagoas Research Support Foundation (FAPEAL).
Funding: Federal University of Alagoas (UFAL), Ministry of Science, Technology, and Innovation (MCTI), São Francisco River Basin Committee (CBHSF), São Francisco and Parnaíba Valleys Development Company (CODEVASF), Alagoas State Secretariat for the Environment and Water Resources (SEMARH-AL), and Alagoas Research Support Foundation (FAPEAL).
Planned goals, results, and impacts achieved: With the support of public policies and the participation of local communities, the aim is for environmental monitoring to be continued, as well as the study of fauna and flora, socioeconomic analysis, education and awareness, conservation and sustainability, geology and hydrography, cultural recovery of traditions and ways of life of riverside populations, including traditional knowledge about the river, in addition to increasing the number of agroecological latrines, contributing to the universalization of basic sanitation in the region and the preservation of the São Francisco River. Among the results obtained are the donation of various materials to public schools, as well as the construction of agroecological latrines in rural communities without basic sanitation. The impact on communities is confirmed by local residents, especially riverside dwellers, and is corroborated by local and national media, with more than 400 reports throughout the year. The main impacts achieved include impacts on health and well-being, with increased sanitation rates in the region and environmental quality using simple and accessible technology, in addition to contributing to environmental diagnostics, environmental education actions, health care for the riverside population, conservation of ichthyofauna, scientific production, and public policies.
Replication potential: The program can be replicated in several other river basins, as well as in other stretches of the São Francisco River itself (middle, sub-middle, and upper São Francisco).
Supporting documents: https://ufal.br/ufal/pesquisa-e-inovacao/programas/expedicao-cientifica-do-rio-sao-francisco

4.2.3.3. Broad Area Multidisciplinary

Institution: State University of Londrina	**Program:** Biotechnology
Title: Plant growth-promoting microorganisms aiming at agricultural sustainability and environmental responsibility (MPCPAgro)	
SDGs involved: Social: SDG 1, 2, 3, 4, 5, 10; Environmental: SDG 6, 7, 12, 13, 14, 15; Economic: SDG 8, 9	
Justification: There is strong global demand for greater quantitative and qualitative food production; however, as important as producing more is to consider agricultural sustainability, valuing the recovery of degraded areas, lower greenhouse gas (GHG) emissions, and care to avoid soil and water contamination by agrochemicals, thus optimizing the rational use of inputs. In this context, plant growth-promoting microorganisms (PGPMs) are decisive for agricultural sustainability, with impact on productivity and environmental responsibility.	
Context: INCT-MPCPAgro works to establish the scientific bases for innovative biotechnological development through actions of communication and transfer of knowledge and technologies, human resource training, and research activities, meeting the challenge of maximizing plant growth via the use of microorganisms, their metabolites, and microbial processes, ensuring high yields associated with greater agricultural sustainability and lower environmental impact.	
Location: Nationally scoped research network, comprising research and development actions in 16 states and the Federal District, in more than 30 municipalities across the five Brazilian regions.	
Objective: To conduct basic and applied research for biotechnological development; train human resources; transfer knowledge, products, and technologies to the public and private sectors; increase the use of microorganisms, processes, and biomolecules of microbial origin in Brazilian agriculture, maximizing plant nutrition and crop yields with less input of chemical fertilizers and less environmental impact.	
Indicators used and methodology for data collection and monitoring: Fine characterization of Brazil's microbial biodiversity. Expansion of knowledge about interactions between plants and microorganisms. Monitoring the behavior and impact of using commercial strains in soils of the Cerrado, Amazon Region, and agricultural regions of the South Region. Identification of grain lineages with higher response to interaction with beneficial microorganisms. Development of molecular markers useful for plant breeding. Identification of bean and soybean lineages tolerant to water stress. Expansion of knowledge about physiological and biochemical mechanisms involved in plant nutrition and development under association and symbiosis with microorganisms. Definition of metabolic and enzymatic profiles and mechanisms of phosphorus solubilization by microorganisms. Partnerships with the productive sector for registering and commercializing new bioinputs. Scientific publications and technical recommendations with the project's discoveries and research activities.	
Partnerships involved: Eleven Embrapa units (CNPSo, CNPAB, CPAT, CPAA, CNPAF, CPAC, CPACT, CNPMS, SDI, CPATSA, CPATC); twelve Research Institutions and Public Universities (IDR-Paraná/IAPAR-EMATER, IF Sudeste MG – Barbacena Campus, UEL, UEPG, UFPI, UFPR Curitiba, UFPR Palotina, UNEB, UTFPR, UFSC, ESALQ/USP, FCAT/UNESP).	

Funding: Brazilian Federal Agency for Support and Evaluation of Graduate Education – CAPES; Fundação Araucária; National Council for Scientific and Technological Development – CNPq.
Planned goals, results, and impacts achieved: Through public-private partnerships, strains for inoculation of sugarcane, brachiaria grasses, rice, corn, soybean, and beans were released. Commercial strains are monitored in soils of the Cerrado, Amazon Region, and agricultural regions of the South Region. The products and processes developed resulted in significant savings of nitrogen and phosphate fertilizers; increased productivity of cereals, grains, pastures, and sugarcane; identification of new microbial species and strains with potential for developing bioinputs. A new technology for analyzing soil biological quality—BIOAS—was implemented and is already in use. Together, the technologies provided significant positive impacts on the economy, productivity, the environment, and job creation.
Replication potential: The project's results are available through technical communications/flyers/articles, lectures (many available on YouTube), events for farmers, didactic publications for science popularization, technical courses, graduate-level courses, in addition to the participation of undergraduates and graduate students in activities related to the project.
Supporting documents: http://www.microagro.com.br https://www.instagram.com/microagro.inct/ https://www.embrapa.br/soja/publicacoes/fixacao-biologica-de-nitrogenio

In the **Collegium of Life Sciences**, the *Agricultural Sciences* highlight achieves impact on several SDGs by conserving chelonians in the Northern Region, involving local communities and encouraging volunteerism in topics related to environmental conservation. In *Biological Sciences*, the selected highlight demonstrated a real impact in the Northeast Region, which led Brazil to achieve the elimination of lymphatic filariasis, recognized by WHO, with impact on the social and environmental dimensions of the SDGs. In *Health Sciences*, the initiative that created a unique platform for comparing health indicators, bringing together more than 120 countries and contributing to public policies in dialogue with bodies such as UNICEF, WHO, and PAHO, was highlighted.

In the **Collegium of Humanities**, the *Humanities* highlight represents an interinstitutional action, in drafting guides for achieving the SDGs, aiming to train teachers at 228 state technical schools in São Paulo, initially promoting didactic activities aimed at organizing international simulations with students, guided by the SDGs. In *Applied Social Sciences*, extension activities aimed at legal and social support to families of artisanal fishers affected by the floods that occurred in RS in 2024 stand out. The *Languages, Literature and Arts* highlight

contributes to the social emancipation of migrants and refugees in Brazil in the state of Minas Gerais through Portuguese language instruction.

In the **Collegium of Exact, Technological, and Multidisciplinary Sciences**, the *Exact and Earth Sciences* highlight represents a partnership with the Acre State Court of Accounts, which will support the agency's oversight activities, enabling the development of environmental indicators aligned with the SDGs. In *Engineering*, an extension project with broad reach in environmental biomonitoring of continental waters in Brazil's Northeast stands out, with impact on several SDGs alongside partner communities, in preserving the São Francisco River. Finally, the highlight of the *Multidisciplinary broad area* demonstrates the biotechnological potential in agricultural sustainability, with impact on productivity and environmental responsibility, in a network project among several states in the country, with the development of new products and processes that have reached the market.

4.3. INTERNATIONAL HIGHLIGHTS

The potential contributions of science to achieving the 2030 Agenda targets are immense, and many projects are underway in Brazil and worldwide. In this section, we sought to present international initiatives that have materialized in products and solutions incorporated into the market and society:

TABLE 6: INTERNATIONAL HIGHLIGHTS OF THE GENERAL SDGS BY COLLEGIUM

Collegium of Life Sciences: Community education on Chagas disease: Chagas disease is a public health problem in Argentina. To confront it, a project involving different entities—university, civil-society organizations, artists, and schools—developed educational materials about the disease, including books and pamphlets, as well as outreach actions such as workshops. The action included participants with different expertise, such as molecular biology, entomology, and social sciences. (https://www.conicet.gov.ar/con-micro-y-nanotecnologia-desarrollan-nuevas-alternativas-para-tratar-el-chagas/ & https://ri.conicet.gov.ar/bitstream/).

Collegium of Humanities: Protection of Afghan music: With the return of the Taliban regime in Afghanistan, several musicians fled the country, fearing persecution, and took refuge in the United Kingdom. At the University of Sheffield, through its Department of Music, platforms for sharing Afghan music are being created to assist these musicians. New compositions are also being fostered involving a mix of traditional Afghan instruments with European classics, in addition to promoting concerts mainly in London. (https://www.icfam.info/ & https://www.sheffield.ac.uk/research/features/filling-silence-powerful-music-afghanistans-exiled-musicians)

Collegium of Exact, Technological, and Multidisciplinary Sciences: Energy planning and resilience: There is growing demand for resilience and energy planning, especially in solving limited access in certain communities (such as Indigenous communities) and energy supply in crucial spaces, such as hospitals. To mitigate these problems, researchers at the University of Melbourne, Australia, in collaboration with the government, have identified metrics that assist planning processes, focusing on low-carbon systems. (https://sustainablecampus.unimelb.edu.au/sustainable-research/case-studies/energy-resilience)

These initiatives, which involve researchers from foreign institutions, demonstrate potential and concrete reach in the social, environmental, and economic dimensions, whether through actions that seek to remedy public health problems—many originating in human interaction with the environment—through preservation of peoples' culture and tradition, or through technological solutions to increase the resilience of population clusters in the face of present and future climate challenges.

4.4. REFLECTIVE ANALYSIS

All the highlights described above present relevant characteristics, such as: (i) the formation of collaboration networks among universities, research institutes, government agencies, civil organizations, and/or the market; (ii) they demonstrate an intentionality to carry out concrete actions that go beyond the scientific findings of the originating projects; (iii) there are benefits beyond the

members who participate in the networks, with the involvement of communities and incorporation by government and civil bodies. They also represent continuous and not occasional activities, with high replication potential.

However, weaknesses or aspects to be deepened in these initiatives stand out, such as: (i) greater articulation with elements of promoting territorial *Buen Vivir*; (ii) educational processes that promote the empowerment of individuals; (iii) a conception of society grounded in ethical values; and (iv) collaboration networks that value appropriate ways of knowing, knowledge, and technologies. In other words, it is suggested to broaden participation and enable greater protagonism of society in such activities, highlighting the importance of expanding the scope and partnerships with society so that these initiatives are strengthened and expand their capacity to achieve the greatest possible number of SDG targets.

The role of collaborations and partnerships involved, which resulted in potential and concrete impacts achieved in the examples above, is highlighted. Further, more detailed planning of these actions is suggested, in the sense of identifying which targets of the respective SDGs are impacted, establishing indicators that contribute to their achievement.

Thus, the importance of extension activities in graduate education is emphasized, as a link in the (co)production of knowledge, permeating teaching, research, and innovation and overflowing into extension. Extension enables better communication with society, requiring more accessible language that allows the transfer, receipt, and sharing of knowledge with governmental institutions, civil organizations, the world of work, and civil society and vulnerable people. Beyond language, it requires listening and a gaze sensitive to reality outside the university walls. According to Silveira and Ferreira (2024, p. 3):

> Extension is characterized as a continuous process, permeating all phases of research, transforming it into a dimension that originates in the social context, is nourished by it, and returns to it as a means of promoting transformations.

The examples presented in this chapter compel us to recognize that higher education does not operate in any political, economic, or cultural vacuum. It is in this context that the academic sector's contribution to the SDGs materializes. The conditions present in our society determine the realization of the potential for

positive or negative action. The existence of numerous barriers, from institutional capacity and will to human capacity, with its beliefs and preferences, implies the quality of the contribution to realizing this civilizational agenda agreed upon by countries within the United Nations.

Graduate education has the potential to contribute to achieving the SDGs in three directions: (i) through investigation, data production, innovation for the private sector; (ii) drafting strategies and fostering public policies; and (iii) governmental planning. Investigation and innovation serve both to identify and assess the environmental and social challenges humanity faces, such as analyzing CO2 emissions, biodiversity loss, and social inequality, and to develop solutions and technologies to confront them. In another direction, it contributes decisively to the learning trajectory and training of individuals/students and to a necessary set of values for building sustainability, reinforcing transition mechanisms in this direction. The educational function of universities is fundamental for instilling values of equality, respect for human rights, diversity, and preservation of the natural environment. Finally, extension through community projects and public debates opens space for questioning, influence, changes in society's attitudes, and strengthening governance.

Graduate education is in a privileged position to analyze the different SDGs, ascertain which approaches are most effective in their implementation process, and better understand the interrelations among different goals. It is also a task of graduate education to reveal the growing economic, social, and environmental costs of failing to promote the achievement of the SDGs. The economic cost of distancing from sustainability, largely concealed by traditional economics, needs to be brought into debate, as it decisively affects the very existence of society as we know it today.

Another important front of work is the continuous building of governance. Improving society's governance in all areas must be a permanent objective. Overcoming fragmentations in the decision-making process and in implementing solutions allows the creation of the instruments that the SDGs will require. It is through the articulation of organizations, platforms for implementing processes, and strengthening public, private, and civil society institutional capacities that students and researchers will be able to generate and transmit knowledge. Leaving the strictly academic niche, overcoming isolation, is a challenge beyond

the institutional and demands a new posture of the academic community toward applying solutions with the involvement of various social strata.

In the context of graduate programs and universities embedded in Latin America and the Caribbean, a work agenda for implementing the SDGs can be recommended, associated with the profound challenges we face. This work agenda must consider that opportunities for sustainable development are currently accompanied by a reduction in development possibilities. The promotion of sustainability and climate-change adaptation and mitigation, at the regional level in Latin America and the Caribbean, is based on the understanding that the region's capacity to develop its productive process and be more competitive in current global markets, generating employment and income, fundamentally depends on the environment's capacity to provide water, energy, soil fertility, resilience to climate-change impacts, and sustainable cities. In this sense, the pursuit of a just transition to a sustainable and equitable economy is no longer sufficient, and the future points to the need for an economy that can regenerate its own environmental base for sustainability. To this end, it is necessary to actively promote the regeneration and maintenance of the biophysical infrastructure that supports the economic process. The work agenda for graduate education must promote a regenerative economy.

There are three structural crises that the regional economy is experiencing and that must be incorporated into graduate programs: low growth of production with low productivity; high poverty with growing inequality; and continuous environmental degradation with the unpredictable pressures of climate change, which threaten to destroy the natural systems that sustain the economy and the region's life support. These crises have common elements, such as governments' reduced capacity to regulate and manage market action, a profound governance deficit with growing geopolitical tensions, conflicts that weaken the multilateral system internationally, and the erosion of rights and the legitimacy of democracies domestically. The three crises interact and reinforce one another.

The result of these three structural crises translates into a loss of competitiveness in the external market, worsening a system of inequalities, into inefficient cities, and into a growing deterioration of the environmental base of our economies with very high short- and medium-term costs. At the same time, it is urgent to decarbonize and increase the economy's resilience in its urban and rural dimensions. Drastic reductions in carbon emissions must be

achieved. This should be accomplished through technological and organizational changes in production, in land use, and in energy production, as well as changes in consumption patterns, while avoiding the risk of economic recession and unemployment. Economic development must be decoupled from its material extraction and ecological footprint, with emphasis on reducing carbon emissions and on territorial resilience.

The reframing of the word prosperity, permeating the concept of development, must include the right to a healthy and productive environment, the strengthening of social relations, and efficient and just governance systems.

4.5. FINAL CONSIDERATIONS

The materialization of these recommendations, within the scope of graduate education, occurs insofar as it is oriented toward the scope of the SDGs and is committed to the values that sustain them, demonstrating the important role of the SNPG for the 2030 Agenda and the other targets that will succeed it. The rooting of the university environment in contemporary ideologies and structures of political economy form, in practice, major barriers that make this task a gigantic challenge. Higher education must work not only for the SDGs but also beyond them. It is important that universities play a constructive role, acting not only to achieve what is understood as sustainable development but also to question, deliberate, and progressively reframe the very internationally agreed notion of sustainable development.

5 HIGHLIGHTS OF BRAZILIAN GRADUATE EDUCATION CASE STUDIES: FROM THE AMAZON TO THE AMAZON

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This chapter addresses the impacts of activities in Brazilian graduate education, referred to as "highlights," in the context of the general SDGs, SDGs 1–16, carried out at teaching and research institutions located in the Amazon region and focused on its own problems, referred to as: From the Amazon to the Amazon.

The Amazon basin is a broad region encompassing about 6.2 million square kilometers across eight South American countries and one French territory. The region is as vast as the challenges of studying it, understanding it, and maintaining its socio-biodiversity. The principal research conducted in the region is led by Brazilian scientists from higher education and

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research institutions across the country. Brazil is the country that studies and publishes the most about the Amazon. Researchers located in the region stand out significantly in the development of these studies, the great majority of them within the scope of graduate programs at their institutions. Their importance in studies in and for the Amazon will be presented in this chapter based on the highlights of success cases submitted by the nine broad areas of evaluation.

This chapter begins with the context of the human presence in the Amazon. Their actions, documented over the last 10,000 years, shaped the great forest known today (Nascimento et al., 2022). They opened pathways, selected species, spread seeds, and sought to learn how to live with nature by respecting and understanding it. Indigenous lands and the territories of original peoples are the regions on the planet with the highest levels of preservation, and the Amazon is no different. Discussing knowledge of and for the Amazon cannot be detached from the autochthonous knowledge of the Amazonians. One must know its scale, its definitions—such as the Brazilian Legal Amazon—its ecological and environmental importance, among several other aspects, in order to grasp its global importance and how it interrelates with the SDGs.

Next, an overview is provided of the teaching and research institutions that have courses and graduate programs in the Brazilian Legal Amazon. The role of researchers from the country and from abroad, as well as funding agencies, will also be addressed.

Finally, the chapter presents the guidelines for selecting the nine highlights from the graduate programs of the 50 Evaluation Areas, one from each broad area, with three broad areas in each of the three CAPES collegia. These highlights are presented and analyzed in terms of context, the dimensions involved, and the degree of maturity in achieving SDG targets. National examples are also presented of broad initiatives that resulted in Amazonian regional development and that illustrate the contribution of science to the 2030 Agenda. Finally, this chapter offers recommendations on the current and future needs for the action of Brazilian graduate education, and its leadership in seeking solutions and pathways to guide society in the coming decades.

5.1. THE AMAZON AND THE MAN IN THE AMAZON

Records of human occupation in the Amazon date back more than 12,000 years. The region was possibly visited by Chinese navigators in the early 15th century (or earlier), given its appearance on Chinese maps from 1418, although there is still no consensus among historians on the subject. The first accounts by Europeans in the region date from the late 15th century. Vicente Yañez Pinzón, the commander who led the caravel Niña in 1492, in Christopher Columbus's fleet, visited the Marajó Island region at the end of 1499 and encountered the mouth of the river he called Mar Dulce (Neves, 2017). Today, discoveries at the mouth of the Amazon River still make the news. With large petroleum sedimentary basins being found, to be exploited, generating wealth, greater global warming, or other environmental impacts, research on the Amazon is more current and important than ever.

The name Amazon was recorded during the first documented journey made by Europeans crossing the South American subcontinent west to east along the great river of the region, in search of the Land of Cinnamon, one of the most valuable spices, and El Dorado. Setting out from Quito, in the Andes, in 1541, and reaching Marajó Island the following year, the expedition was led by Francisco de Orellana and Gonzalo Pizarro (Martins, 2007). The chronicler of this expedition, the Spanish Dominican friar Gaspar de Carvajal, reported a region densely populated by fierce Indigenous peoples who waged continuous warfare along the entire river. Carvajal was especially impressed by an encounter with fierce, strong Indigenous people with long hair like women, in the region of the mouths of the Trombetas and Nhamundá rivers. Carvajal compared the Indigenous people (or Indigenous women, as there is disagreement in the literature) to the famous Amazons described by Homer. In his Iliad, 23 centuries earlier, Homer recounts the existence of Amazonian women warriors who fought impetuously. Thus, Carvajal named "river of the Amazons" that Mar Dulce documented by Pinzón half a century earlier. According to historian John Hemming (2011), who has spent the last six decades documenting the region's history and culture based on accounts from first contacts and visits to 45 tribes, the region's population at the time of European occupation would have been about 5 million inhabitants, 3 million in the Brazilian portion.

Currently, the Amazon is the largest tropical forest on the planet, spanning nine South American countries: Brazil, Peru, Ecuador, Colombia, Guyana, French Guiana (a territory of France), Suriname, Venezuela, and Bolivia. It encompasses biomes, ecosystems, and rich biodiversity that, in Brazil, covers about 49% of

the national territory. While the Amazon corresponds to the tropical forest biome and specific ecosystems, the Brazilian Legal Amazon (BLA) encompasses areas beyond the Amazon biome, including transition regions with the Cerrado and the Pantanal. With about 28 million inhabitants (Brazilian Institute of Geography and Statistics – IBGE, 2022), the BLA covers 5.2 million km²—59% of Brazilian territory—and includes states that have part or all of their territories in the Amazon. It fully encompasses the states of the North region—Acre, Amazonas, Amapá, Pará, Rondônia, Roraima, and Tocantins—as well as Mato Grosso and Maranhão to the west of the 44° W meridian, which includes the capital, São Luís.

Whereas Amazon is an ecological and environmental term, BLA is an administrative and development instrument, politically defined for economic and social planning to integrate the Amazon region with the rest of the country. The BLA was legally established by Law No. 1,806 of 1953. Its average Human Development Index is below 0.58. According to the Census (IBGE, 2022), the BLA has about 870,000 Indigenous people, more than half of the country's Indigenous population, across 198 ethnic groups and 49 language families.

Within these 28 million Brazilian inhabitants, home to half of the country's Indigenous population, reside not only feelings of belonging to the Amazon, but also a very rich, ancient, and powerful sociodiversity that challenges traditional concepts of demographic emptiness, the absence of technologies, or development through deforestation and crop replacement. Here, as nowhere else, the SDGs have fundamental action and importance.

The BLA is also responsible for recycling about 7 trillion cubic meters of water per year through the so-called "flying rivers," which irrigate south-central Brazil. This is the greatest environmental service provided to agribusiness, hydropower generation, industry, and sanitation in the country and in the Southern Cone (Baker et al., 2021). Over the last 30 years, land use and energy have accounted for almost 98% of all accumulated emissions in the BLA.

Approximately 23% of the original BLA cover has already been deforested, about 60 million hectares of primary forests and savannas over the last 40 years[37]. The BLA is divided into five distinct zones: Zone 1, Amazon with forest; Zone 2, Brazilian Amazon with forest under pressure[38];

[37] Available at: https://brasil.mapbiomas.org

[38] Regions in the process of deforestation.

Zone 3, deforested Amazon; Zone 4, Amazon with differentiated forests, such as the savannas of Roraima; and Zone 5, urban areas. Zones 2 and 3 already account for 29% and 11% of the entire biome, respectively. Added to the 21% of transition regions (Zone 4) in Roraima, Mato Grosso, Tocantins, and Maranhão, and regions at the mouth of the Amazon in Amapá and Pará, less than 40% of the dense ombrophilous forest (or tropical rain forest) may remain standing in the coming years (IBGE, 2022).

The processes of biome destruction have been driven to a tipping point that has been studied over the last 30 years by Brazilian researchers (Flores et al., 2024). Once past this point, the forest will be unable to regenerate and will begin to release more carbon dioxide than it absorbs. Changes in carbon cycles will make the region a net carbon emitter—that is, its capacity to absorb will be lower than its own emissions (Gatti et al., 2021). Rising temperatures and reduced rainfall frequency already show a direct impact on agriculture, since virtually all planted and pasture areas in the country lack irrigation systems (IBGE, 2022).

We do not even have an approximation of what may be lost in the destruction of the Amazon. The number of animal and plant species in the region is still unknown, but just among the latter, it is estimated there are at least 30,000 to 40,000 species. In the knowledge of traditional Amazonian peoples, diets are highly diversified, with about 270 items used in cuisine, compared to fewer than 30 among non-Indigenous people in the same region. In addition to more than two hundred herbs used for nutritional supplementation or medicinal purposes by Indigenous peoples in the region, there are about 30 insect species that are sources of vitamins and minerals (Nobre et al., 2023).

When it comes to broader societal use of all this biodiversity, studies are still very underdeveloped. Studies on biotechnological utilization and the bioeconomy illustrate how far the region's potential is from being realized. Brazil's trade in one of the region's main products, the Brazil nut, is only 10% of the volume traded by the world's leading producer, Bolivia. For another typical product of the region, cocoa, Brazil's trade is two thousand times smaller than that of Côte d'Ivoire, a small country on the West African coast. Among exotic products, black pepper, introduced by Japanese immigrants, represents only 7% of the world export volume, while Vietnam is responsible for 42% of global trade (Coslovsky, 2022).

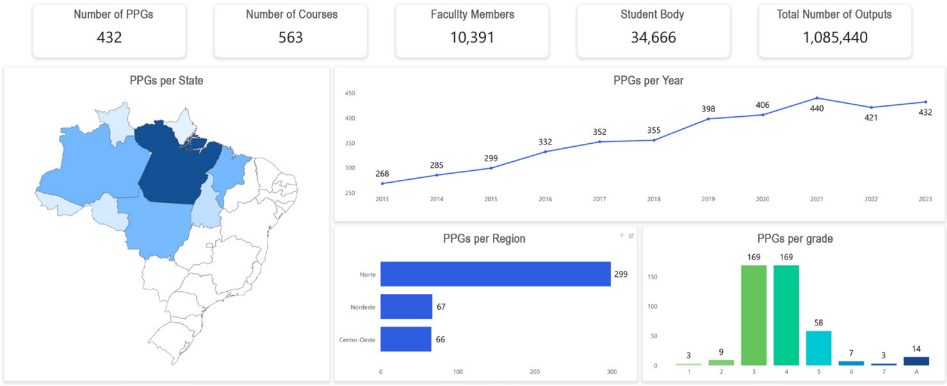
In a systematic keyword search of databases covering the period 2017 to 2021, Rosa and Oliveira (2023) identified 1,070 articles reporting on Amazonian products. In the analysis of raw materials with the highest frequency in the articles, eleven inputs were present in 223 of 621 selected studies: açaí, tucumã, buriti, Piper, Aniba, Brazil nut, andiroba, cupuaçu, Lippia, guaraná, and bacaba. Applications in the 223 articles were differentiated into 14 types, with the main ones being clean energies (18%); green technologies (17%); sustainable construction (17%); uses for cancer treatment (16%); traditional medicine (10%); functional foods (10%); and biopolymers (8%). The diversity of raw materials typical of the region and their multiple sustainable applications highlight the importance of scientific research in the Amazon.

5.2. GRADUATE EDUCATION AND RESEARCH IN THE AMAZON

According to data from CAPES's Sucupira Platform, in 2023 the BLA had 432 graduate programs, 10 of which were considered excellent, with ratings of 6 or 7, the highest marks in the CAPES evaluation system (which ranges from 1 to 7, and A for new courses not yet evaluated). The region saw significant growth in the number of programs over the last decade, adding 164 graduate programs to the 268 that existed in 2013, a 61% increase. Across the 432 graduate programs, 563 master's and doctoral courses are offered, most of them master's programs, with participation by more than 10,000 faculty and nearly 35,000 students. Figure 24 presents a map of Brazil highlighting the BLA, which covers the North region (with 299 graduate programs) and the states of Maranhão (67) and Mato Grosso (66), offering a regional overview, with darker shades of blue in states that have a greater number of graduate programs. Figure 24 also shows the evolution and growth of the total number of graduate programs over the last decade and the distribution of graduate programs by rating, highlighting the predominance of programs rated 3 and 4, still in the process of consolidation.

The state of Pará has 143 graduate programs and nearly 200 courses, with about 13,500 students in 2023, more than one third of the entire Amazon. The Federal University of Pará (UFPR) stands out with 92 graduate programs. Among them, there are seven excellent graduate programs, that is, of quality similar to the best graduate programs abroad.

FIGURE 24: OVERVIEW OF GRADUATE PROGRAMS IN THE BLA



Source. Sucupira Platform. Extraction date: June 5, 2025.

In Amazonas, there are 69 graduate programs and 96 master's and doctoral courses, which, in 2023, resulted in more than 12,000 scientific outputs. The highlight is the Federal University of Amazonas, with 41 graduate programs (one of excellence), as well as the active participation of the National Institute for Amazonian Research (INPA) in Manaus, which has nine graduate programs, one of them rated 7.

In Maranhão there are 81 graduate courses across 67 graduate programs, one of them excellent, in the Collegium of Humanities. The Federal University of Maranhão (UFMA) is the state's main higher education institution, with 43 graduate programs. In Tocantins, at the end of 2023, there were 28 graduate programs and 34 courses, with about 2,250 students. The highlight is the Federal University of Tocantins (UFT), in Palmas, which has 27 graduate programs. In Mato Grosso, there are 66 graduate programs. The vast majority, 36, are rated 4, but there are also seven consolidated graduate programs rated 5. In Acre, there are 15 graduate programs, with a total of 19 courses and about 1,000 students. In Amapá, there are ten graduate programs, with 11 courses and more than 300 active faculty. In Rondônia, across its 18 graduate programs with 22 courses, about 500 faculty are active. In Roraima, there are 16 graduate programs, with about 910 students[39].

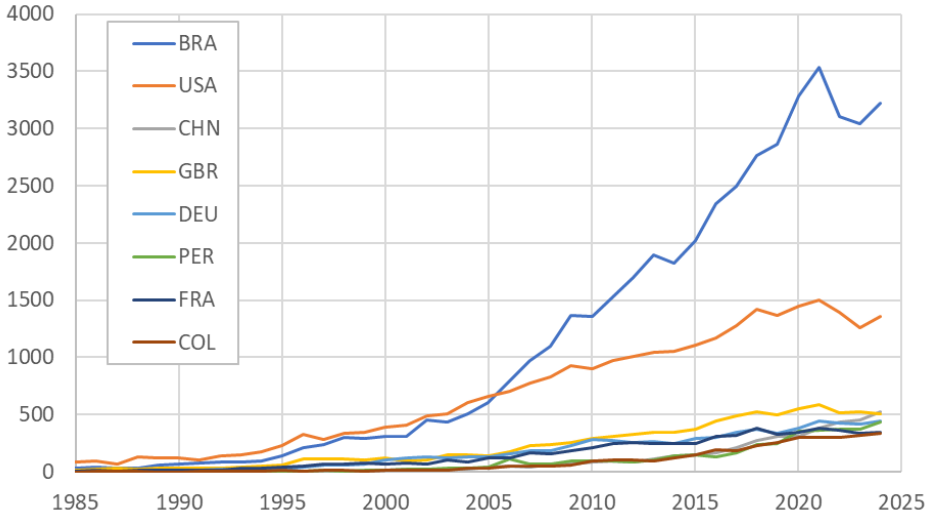
Since 2006, most scientific articles on the Amazon published in journals indexed in the Scopus bibliometric database have had Brazilian authorship, as

[39] Based on the status of the student body at the end of 2023, available in the Graduate Education Observatory Data Panel (https://sucupira.capes.gov.br/painel)

shown in Figure 25. This is very different from 1994, when 15% of the articles were by authors based in Brazil, 27% in the United States, and 7.4% in the United Kingdom. In 2006, for the first time, Brazil surpassed the United States in the number of articles published on the Amazon. Since then, the country has consolidated its leadership in scientific research on the region. In 2024, 48% of scientific articles on the Amazon had Brazilian authorship, 20% were by authors from the United States, and 7.8% from China (Brito Cruz, 2025).

Although it may seem natural that most works would have Brazilian authorship, this only became reality after decades of effort to train a qualified scientific community in the country's graduate programs. It is interesting to note that, in 2024, the number of articles with authors in China surpassed that of the United Kingdom, becoming the third country with the most publications related to the Amazon. Of the articles with authors in Brazil between 2020 and 2024, 36% have coauthors in other countries, mainly the United States, the United Kingdom, France, and Germany (Brito Cruz, 2025). International collaborations are widely encouraged by CAPES in various programs and help national research reach world-class standards.

FIGURE 25: EVOLUTION IN THE NUMBER OF SCIENTIFIC PUBLICATIONS ON AMAZON-RELATED TOPICS, BY COUNTRIES WHERE THE AUTHORS WORK

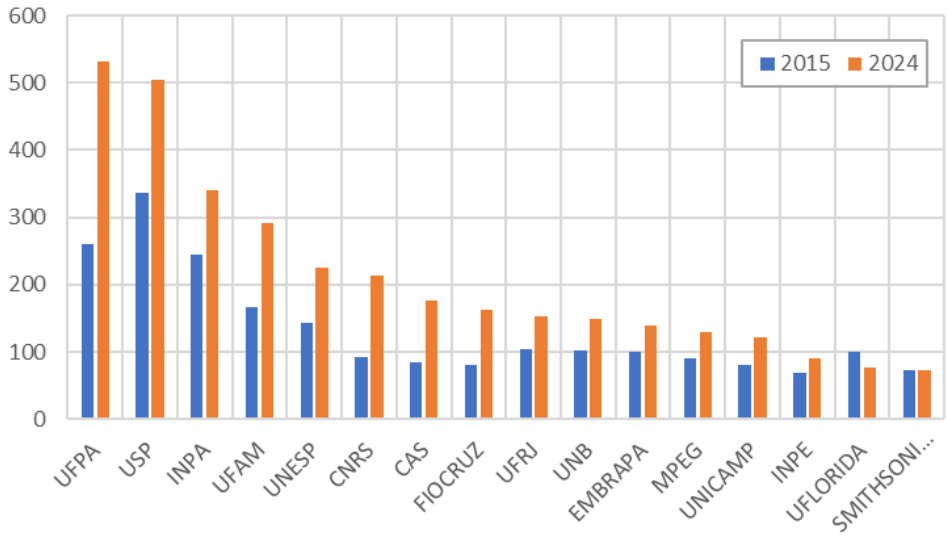


Source: Brito Cruz, 2025 (search specially designed for this book with data from Elsevier's SCOPUS database).

Considering the total number of publications on the Amazon worldwide, in 2024 eight of the ten leading institutions that contributed the most to this body of work are in Brazil, as shown in the survey presented in Figure 26. The Federal University of Pará, with 531 publications, is the institution with the most studies on the Amazon. It is followed by the University of São Paulo (505 publications), INPA (340 publications), the Federal University of Amazonas (292 publications), and the São Paulo State University (225 publications). Thus, among the top five, three are located in the Amazon. Considering the ten institutions with the most publications, there are two foreign institutions: the French CNRS (6th place, 213 publications) and the Chinese Academy of Sciences (7th place, 176 publications) (Brito Cruz, 2025).

The presence of graduate programs located in the BLA and publications in partnership with reference centers across different fields reflect the consolidation of research in this singular territory. There are obstacles that only in situ knowledge can present, and often this is not possible with a cross-sectional study, requiring a deeper understanding of culture.

FIGURE 26: HIGHER EDUCATION AND RESEARCH ENTITIES WITH THE LARGEST NUMBER OF PUBLICATIONS ON THE AMAZON IN 2024 AND IN 2015



Source: Brito Cruz, 2025 (search specially designed for this book with data from Elsevier's SCOPUS database).

The activities of Brazilian graduate education have contributed to communication between the community and sustainable development. It is not always easy to understand that there are communities for whom the Portuguese language is an obstacle. When this perspective is broadened, it can be seen that, in addition to the insignificant percentage of the BLA's potential that has already been explored, there is still a need to deepen what is necessary for studies and discoveries to truly make sense and be applied to the real individuals who will put them into practice.

From the Amazon and for the Amazon precisely reflects the strengthening that research has shown by developing work aimed at improving quality of life, the environment, and global development, without forgetting that Indigenous and traditional populations and original peoples are much more than sources of information. This legitimate concern is most likely to be found when results are experienced. It is in bringing obtained results back to the community that research becomes a reality.

With regard to the origin of research funding behind publications on the Amazon—and still considering the total publications worldwide—in 2024 the three main funders were CNPq, CAPES, and FAPESP. In fourth place is China's National Science Foundation, and in fifth, FAPEAM, the Amazonas State Research Support Foundation (according to Elsevier's Scopus database).

5.3. HIGHLIGHTS OF BRAZILIAN GRADUATE EDUCATION CASE STUDIES CONDUCTED IN THE AMAZON AND FOCUSED ON THE AMAZON

CAPES sent a communication to all graduate programs in the country requesting that each indicate one highlight for this chapter, as well as for other chapters of this book. The coordinations of the 50 Evaluation Areas received the nominations made by the programs in their respective areas, organized selection committees, and forwarded to the organizers of this chapter only **one highlight per area**. Since CAPES organizes these 50 areas into three collegia (**Life, Humanities, and Engineering**), and each collegium brings together **three broad areas**, there is a total of **nine broad areas**. Thus, from the 50 nominations received[40], the organizers of this chapter selected nine highlights, one for each broad area, as listed below.

[40] Available in Appendix B (digital version).

5.3.1. Collegium of Life Sciences

5.3.1.1. Broad Area Agricultural Sciences

Institution: Federal University of Western Pará	**Program:** Animal Sciences
Title: MicrobioAmazon Program – Environmental Biotechnology Solution	
SDGs involved: Social: SDG 2, 4; Economic: SDG 8, 9; Environmental: SDG 14, 15.	
Justification: The project involves seven UN SDGs for 2030, namely: SDG 2: Zero hunger and sustainable agriculture: Ensure food security for all, especially Amazonian communities and cities. SDG 4: Quality education: Ensure quality education at all levels—secondary, technical, and graduate education—reducing Brazil's regional imbalance by training high-level scientists from the Amazon. SDG 8: Decent work and economic growth: We aim to change the notion that the Amazon Forest is rich in biodiversity and poor in products by harnessing the potential of Amazonian biodiversity for sustainable agribusiness growth and the creation of highly qualified jobs in the region. SDG 9: Industry, innovation and infrastructure: Creation of new products based on microorganisms isolated from the Amazon biome to develop national industry and enable sustainable agribusiness. SDG 12: Responsible consumption and production: Reduce diseases and improve aquaculture production with microorganisms with zootechnical potential, enabling a reduction in environmental pollution from chemicals and antimicrobials, and reduce pressure on natural fish stocks. SDG 14: Life below water: Ensure safe production across the entire animal and plant value chain through proper management with reduced use of chemicals and antimicrobials. SDG 15: Life on land: Generate income through microorganisms from the Amazon biome and with aquaculture development in the region, making it possible to keep the forest standing while reducing pressure on the region's fish stocks.	
Context: The MicrobioAmazon Program was born out of the need for innovative and sustainable solutions for agribusiness, leveraging the immense potential of Amazonian biodiversity. In the face of intensifying animal production systems and the growing incidence of infectious diseases, it seeks to develop bioproducts from autochthonous microorganisms to improve animal health, reduce the use of antibiotics, and increase production efficiency.	
Location: Santarém, PA, and Monte Alegre, PA.	
Objective: 1 – Develop and provide innovative technologies and services for the sustainable development of agribusiness through the use of Amazonian microbiota.	
Indicators used and data collection and monitoring methodology: Indicators include efficiency in animal production (SDGs 2 and 12) through reduced antibiotic use, progress in education and scientific training (SDG 4), and the generation of innovation in the Amazon region for sustainable development (SDGs 8 and 9). The project also monitors environmental quality and sustainable practices in cultivation (SDGs 14 and 15) to reduce ecological impacts and valorize biodiversity. Methodology: data collection will be conducted with indicators of technical and zootechnical performance of the products, the effectiveness of bioproducts in replacing antibiotics, and analyses of economic and environmental impact, ensuring alignment with the SDGs to strengthen sustainability and resilience in the Amazonian aquaculture and agriculture sectors.	

Partnerships involved: Federal University of Western Pará (UFOPA). Arctic University of Norway (UiT), Tromsø, Norway. Washington State University (WSU), Washington, United States. Peruvian Sea Institute (IMARPE), Lima, Peru. National Institute for Amazonian Research (INPA). National University of La Plata (UNLP), La Plata, Argentina. University of São Paulo (USP). São Paulo State University (UNESP). Federal University of Santa Catarina (UFSC).
Funding: National Council for Scientific and Technological Development, CNPq / Amazonas Research Support Foundation of Pará, FAPESPA / Brazilian Micro and Small Business Support Service of Pará, Sebrae / Sinapse Biotechnology and Environmental Innovation (Sinapse Bio).
Planned goals, results, and impacts achieved: This project focuses on developing bioproducts using Amazonian microorganisms to improve health and productivity in aquaculture and poultry, with TLR 4-level probiotics for fish (BactAmazon Fish) and other TLR 3 products, such as AmazonPhage Fish (feed with phages), Fagoprevent (phage spray and ice), Biophyago Redux (eutrophication control), Flocobacponia (biofertilizers for aquaponics), and Beepollenbact (probiotic for quail).
Replicability potential: High replicability potential, considering that the model of developing bioproducts from Amazonian microorganisms can be adapted to other regions with unique biodiversity and similar challenges in agricultural production.
Supporting documents: https://www.youtube.com/watch?v=jizMKjGFuO4

5.3.1.2. Broad Area Biological Sciences

Institution: National Institute for Amazonian Research	**Program:** Biological Sciences (Entomology)
Title: Impacts of human alterations on the integrity and biodiversity of Amazonian aquatic ecosystems	
SDGs involved: Environmental: SDG 6, 12, 13, 14, 15; Economic: SDG 11.	
Justification: The studies showed that loss of forest cover altered water quality and reduced biodiversity, jeopardizing access to clean water (SDG 6). In addition, identifying invertebrates as bioindicators helps with water monitoring and conservation of Amazonian aquatic ecosystems. Regarding SDG 13, the impacts of deforestation and urbanization on aquatic ecosystems are assessed. These impacts may have synergistic effects with climate change. Under SDG 14, the protection and conservation of aquatic biodiversity are evaluated. By investigating the response of invertebrates and fish to environmental changes, the studies promote the sustainable management of freshwater ecosystems, which are fundamental for maintaining aquatic life and ecosystem balance.SDG 15 relates to the impacts of forest cover loss on invertebrate and fish communities, and how small changes in vegetation can have major impacts on biodiversity. For SDG 11, the relationship between urbanization and aquatic environments is analyzed, showing its negative effect on water quality and aquatic biodiversity. The relationship with SDG 12 arises from evidence of the impact of human activities, such as deforestation and urbanization, on aquatic ecosystems. The studies suggest that the responsible use of natural resources, such as water and land, is central to the studies mentioned, aligning with the pursuit of sustainability in production and consumption.	

Context: This project emerged to understand and preserve the Amazon's biodiversity and ecological integrity, both in terms of its vast network of aquatic ecosystems and their connections with different land uses. The studies represent a collaborative effort among local and international scientists to generate applied knowledge that supports conservation policies in the Amazon. They provide robust evidence on the importance of preserving riparian vegetation, monitoring water quality, and using responses of invertebrate and fish assemblages as biological indicators to measure the health of Amazonian stream ecosystems.
Location: Manaus, AM, where studies were conducted in urban and peri-urban watercourses analyzing the impacts of urbanization and pollution on aquatic communities. Santarém and Paragominas, PA, where studies were conducted in streams unaffected by and under the influence of cattle ranching and mechanized agriculture.
Objective: Investigate the effects of human impacts on biodiversity and aquatic environments.
Indicators used and data collection and monitoring methodology: The studies developed in this highlight use a variety of indicators and methodologies to collect data and monitor aquatic biodiversity in the Amazon. As indicators, there is primarily Taxonomic Diversity, with metrics such as richness and abundance of invertebrates and fish evaluated, providing insight into ecosystem health. Biological Integrity Indices were also employed to assess the biological condition of streams, integrating multiple metrics of community diversity and composition and sensitivity to deforestation. By assessing thresholds of riparian vegetation loss, it was possible to evaluate its impact on aquatic fish and invertebrate communities.
Partnerships involved: INPA; UFPA; UFOPA; and institutions from different regions of Brazil (e.g., UFLA, UNICAMP, UnB, UFMG) and abroad (Amnis Opes Institute, Oregon State University, Lancaster Environment Centre), as well as non-governmental organizations such as Fundação Vitória Amazônica.
Funding: Universal Call / CNPq. National Institute of Science and Technology – Center for Studies of Aquatic Adaptations of the Amazon (INCT-Adapta II) / CNPq / Fapeam. Institutional Program to Support *Stricto Sensu* Graduate Education – POSGRAD / Fapeam. CNPq Research Productivity Scholarships. Visiting Specialist. CNPq. Integrated systematics of aquatic insects in South America with an emphasis on Diptera (Simuliidae). MCTI/INPA.
Planned goals, results, and impacts achieved: Biodiversity assessment, monitoring of environmental effects, assessment tools, conservation recommendations, local capacity building, scientific publications, database, development of tools and indices to monitor the integrity of aquatic ecosystems.
Replicability potential: It can be considered through standardized data collection methodology with the application of protocols that allow the implementation of the same techniques in different locations.
Supporting documents: https://capes.gov.br/projeto-impacto-alteracoes-humanas https://www.researchgate.net/publication/372457231

5.3.1.3. Broad Area Health Sciences

Institution: Federal University of Pará	**Program:** PPG in Pharmaceutical Sciences
Title: Study of mercury contamination among vulnerable populations of the Amazon	
SDGs involved: Social: SDG 3; Economic: SDG 8; Environmental: SDG 6, 12; Institutional: SDG 16; Complementary: SDG 20.	
Justification: SDG 3: potential impact on reducing the maternal mortality rate and preventable deaths of newborns and children under 5; reducing the number of deaths and illnesses caused by contamination and pollution of air, water, and soil; implementation of the National Policy for the Prevention of Exposure to Mercury. SDG 6: potential impact on improving water quality by reducing pollution and minimizing the release of chemicals and hazardous materials, contributing to mitigating the degradation of water resources. SDG 8: potential impact on promoting safe and secure working environments for all workers. SDG 12: potential impact on achieving environmentally sound management of chemicals and all waste. SDG 17: potential impact on improving regional and international South–South cooperation. SDG 20: potential impact on the occupation of territory and space for social and economic reproduction.	
Context: The highlight originated from the research group's concern about the impacts of mercury contamination on Amazonian riverine communities, especially those located near rivers connected to mining and hydroelectric activities, and from the partnership with the Amazon Network of Human Rights Clinics (RACDH). In addition to assessing mercury contamination in water, fish, and riverine communities, the project also evaluated mercury as a risk factor for cardiovascular and neurobehavioral diseases. "Indigenous peoples and traditional Amazonian riverine communities are the segment of the population most exposed to mercury contamination due to their traditional way of life, strictly linked to the river and the forest, with which they maintain a vital and symbiotic relationship—their only sources of subsistence—yet which may be contaminated by mercury."	
Location: Tucuruí/PA, and the states of Amapá, Amazonas, Rondônia, and Tocantins.	
Objective: Assess the impacts of mercury contamination on the health of the Amazonian population, with emphasis on original peoples and traditional communities, supporting governmental actions and policies aimed at continuous monitoring and the promotion of health and quality of life for affected peoples.	
Indicators used and data collection and monitoring methodology: Concentrations of mercury in water, fish, and residents' hair in the studied regions, as well as genetic susceptibility markers; clinical-laboratory markers of inflammation and of cardiovascular and renal disease; and clinical signs of neurobehavioral changes were assessed.	
Partnerships involved: UFPA (Graduate Program in Pharmacology and Biochemistry, Graduate Program in Genetics and Molecular Biology, Human Rights Clinic/ICJ), Amazon Network of Human Rights Clinics (RACDH), Ufopa, UEA, Unifap, UniR, UNIRG, Ministry of Justice (MJSP), and WWF-Brazil.	
Funding: CNPq, Porticus Foundation, MJSP, FAPESPA, WWF-Brazil, and CAPES.	

Planned goals, results, and impacts achieved: The data produced by the project and the partnership with RACDH created the critical environment that led to the creation of the legislative idea "to adapt Brazilian legislation to the parameters of the Minamata International Convention"; they supported the drafting of the "National Policy for the Prevention of Exposure to Mercury," converted into Bill (PL) 1011/2023, already approved by the Committee on Environment and currently with a favorable opinion in the Committee on Social Affairs. This bill mandates State action for the prevention, diagnosis, monitoring, and treatment of mercury poisoning, in addition to supporting research and training in the area and increasing awareness of the reality of mercury exposure and reducing that exposure. Supporting this initiative, the creation of the Amazon Institute of Mercury (IAMER) brings together the efforts of public Amazonian universities to make feasible the environmental justice actions provided for in the bill based on monitoring and capacity building.
Replicability potential: The data underpinning the highlight, as well as the methods applied, are available in official repositories.
Supporting documents: https://ppgcf.propesp.ufpa.br/ARQUIVOS/dissertacoes/2021_Araújo_AL.pdf https://www25.senado.leg.br/web/atividade/materias/-/materia/156091 https://www.gov.br/mj/pt-br/assuntos/noticias/projeto-apoiado-pelo-mjsp-preve-o-combate-a-contaminacao-por-mercurio-na-amazonia

5.3.2. Collegium of Humanities

5.3.2.1. Broad Area Humanities

Institution: Museu Paraense Emílio Goeldi	**Program:** PPG in Sociocultural Diversity
Title: Challenges of intercultural science: Indigenous and traditional community authorship and coauthorship in collaborative research	
SDGs involved: Social: SDG 4, 5, 10; Complementary: SDG 18, 19, 20.	
Justification: By promoting teaching, research, and extension activities in collaboration with representatives of Indigenous peoples and traditional communities, the project addresses the tradition of collaborative research with Indigenous peoples, extending the scope to the various traditional communities in the Amazon. One of the main challenges that collaborative research poses to anthropological knowledge is the place occupied by Indigenous and traditional community knowledge in academic production in the social sciences, especially in written output (articles, books). The goal is to document and analyze the various ways Indigenous peoples and traditional populations contribute their knowledge and perceptions to the advancement of scientific production, while also analyzing how such Indigenous knowledge is recognized by scientific knowledge.	
Context: The project aligns with Ordinance MCTI No. 6,998 of May 10, 2023, Art. 2, Section IV – social development; § 3, Section V – sustainable and integrated development of the Amazon Region; § 4, Section IV – social and assistive technologies; VI – historically underrepresented populations in the National STI System. Initiatives of this nature are related both to the field of Indigenous ethnology and to anthropological theory, and they pose new challenges for conceiving an intercultural scientific production in	

the human sciences that recognizes Indigenous and traditional population contributions to scientific knowledge on the same level as academic researchers. Critically reflecting on the possibility of an intercultural science and identifying authorship representative of ethnic diversity in representative journals in the field of Humanities in Brazil means contributing to a scientific communication policy that considers Indigenous and traditional community authorship and coauthorship, as well as other forms of Indigenous knowledge expression (orality, art) in scientific communication.
Location: Belém, Pará, as well as specific actions among the Ka'apor people and quilombola communities, with potential extension to other federative units in the Brazilian Amazon region and the Pan-Amazon in countries such as Colombia, Bolivia, and Venezuela, and outside the region in France, Senegal, and the Netherlands.
Objective: Establish a research group with the participation of faculty and students from the Graduate Program in Sociocultural Diversity and other graduate programs in the Amazon (PPGSA/UFPA), as well as international partnerships.
Indicators used and data collection and monitoring methodology: Parity between researchers and authors; number of coauthored articles published; intercultural dossiers published, etc.
Partnerships involved: Indigenous peoples (Mebêngôkre–Kayapó; Awá–Guajá; Ka'apor; Tembé; Guajajara; Karipuna of Amapá; Tikuna; Indigenous Peoples of the Rio Negro and of Acre); Quilombola communities; Traditional Communities; academic institutions (especially the University of Nevada, Reno, USA; Instituto Caro y Cuervo and Universidad Nacional, Colombia; Institut de Recherche pour le Développement, France; UFPA).
Funding: CNPq.
Planned goals, results, and impacts achieved: Two dossiers are planned for publication in the Boletim do Museu Paraense Emílio Goeldi. Ciências Humanas that address the importance of Indigenous, quilombola, and traditional population authorship and coauthorship in consolidating an intercultural science.
Replicability potential: Full potential in other institutions and among other Indigenous peoples (especially the Kamaiurá, Waurá, Kuikuro, Bará, Tuyuca, Tukano, and Desano) and traditional communities.
Supporting documents: Plataforma Chagas, Directory of Research Groups. Search by group leaders by entering the full name of the principal coordinator: Claudia Leonor López Garcés (Lattes: http://lattes.cnpq.br/5655397771707702).

5.3.2.2. Broad Area Languages, Literature and Arts

Institution: Federal University of Pará	**Program:** Graduate Program in Letters: Linguistics and Literary Theory
Title: Portraits of the contemporary: Indigenous languages in Pará's Amazon	
SDGs involved: Complementary: SDG 18, 19, 20.	
Justification: This project set out to show, based on research in partnership with Indigenous university students, how in just the state of Pará, in 2021, 34 Indigenous languages were spoken in different linguistic contexts. Even today, data on these	

languages across the entire country are imprecise and inconsistent. Our objective was not a census, and the results present languages in their social uses: songs, life narratives, contact narratives, ancestral narratives, small rituals. Most Indigenous lands are still located along riverbanks—the main avenues of interaction for these societies. Since the 16th century, the interests of the colonial apparatus have affected their ways of life and their relationship with nature. We know how deeply their linguistic and environmental rights are currently threatened, whether by the poisoning of rivers or by the violent silencing of their memories and words. Within this scenario that threatens human life on the planet, the forest and the flying rivers of the great Amazon biome represent the possibility of the continuity of human life, and Indigenous words are the great defenders of the Amazon and its singular ways of life.

Context: The project conducted research among Indigenous peoples in the state of Pará in 2021. Actions were developed during the pandemic period, between March and September 2021, made possible by the participation of Indigenous students. In this process, we obtained records of Indigenous Lands in all regions of the state, including the Nhamundá–Mapuera and Trombeta–Mapuera ILs, which are in the northwest of the state and are difficult to access. The base cities for the actions were Belém, Marabá, and Santarém. As proposed to the Intangible Cultural Heritage Call – Aldir Blanc Law/2021, this project resulted in the documentary "Between rivers and words: the Indigenous languages in Pará in 2021" and the "Interactive Map of Indigenous Languages in Pará," both available as open access on the web. The documentary set out to make Indigenous languages visible, with the participation of many Indigenous children singing in their languages, but it also highlighted the historical and political processes to which these languages have been and continue to be subjected. In the map, most entries are videos produced by the Indigenous people themselves, especially for this map. They present the social uses of their languages in different ways, through music, storytelling, and displays of festivals or rituals.

Location: City of Belém, state of Pará, but the results are on the web, with free access.

Objective: Identify the Indigenous languages currently spoken in the state of Pará and record the social uses of these languages in cartographic and audiovisual form.

Indicators used and data collection and monitoring methodology: Recordings made during the pandemic period were produced by Indigenous students with their cell phone equipment. They were made available on the Interactive Map in specific entries for each language. To date, there have been more than 25,000 visits to the site (Google Analytics). For the documentary, we listened to Indigenous people and researchers who spoke about strategies for the erasure of Indigenous languages and strategies of resistance. We track access to the documentary through YouTube statistics; to date, there have been about 2,500 full views.

Partnerships involved: UFOPA, UNIFESSPA, UFAP, Estácio College.

Funding: Intangible Cultural Heritage Call – Aldir Blanc Law – State Secretariat of Culture of the State of Pará.

Planned goals, results, and impacts achieved: Support studies interested in Indigenous languages currently spoken in the state of Pará; promote public policies aimed at respecting the linguistic and cultural diversity of Indigenous peoples. Two bills were submitted to the Legislative Assembly of the State of Pará based on the results of this project: the first seeks to co-officialize Indigenous languages alongside Portuguese as the official languages of the state of Pará, and the second proposes the creation of the

State Policy for the Protection of Indigenous Languages in Pará. The actions and results of this project gave rise to the project Indigenous oral poetics in the contemporary: Amazonian cartographies, in partnership with the graduate programs in the fields of Linguistics and Literature in the North Region, approved under CNPq's 2023 Universal Call and already underway.
Replicability potential: https://portal.ufpa.br/index.php/ultimas-noticias2/13107-grupo-de-pesquisa-da-ufpa-lanca-documentario-sobre-as-linguas-indigenas-faladas-na-amazonia-paraense http://ipol.org.br/confira-o-documentario-entre-rios-e-palavras-as-linguas-indigenas-no-para-em-2021/ https://novo.ufra.edu.br/index.php?option=com_content&view=article&id=3029&catid=17&Itemid=121 https://projetocolabora.com.br/ods4/lingua-indigena-como-arma-de-resistencia/
Supporting documents: Interactive Map of Indigenous Languages in the State of Pará https://gedaiamazonia.com.br/linguas-indigenas-no-para/ Documentary "Between rivers and words: the Indigenous languages in Pará in 2021" https://youtu.be/5TP25OXroAc

5.3.2.3. Broad Area Applied Social Sciences

Institution: Federal University of Rondônia	**Program:** PPG in Administration
Title: Environmental governance, the water–energy–food nexus, and the Sustainable Development Goals (SDGs) in Conservation Units in the Amazon	
SDGs involved: Economic: SDG 8; Social: SDG 2; Environmental: SDG 6, 7, 13, 15.	
Justification: SDG 2 is addressed by discussing the interdependence between food security and the conservation of natural resources, essential for traditional and Indigenous communities in the Amazon who depend directly on local ecosystems for subsistence. SDG 6 is contemplated because the water–energy–food nexus highlights the importance of sustainable water management, essential for the operation of Conservation Units (CUs) and the preservation of water resources. SDG 7 appears in discussions about the relationship between environmental conservation and the production of sustainable energy, emphasizing how governance in CUs can balance energy use and minimize environmental impacts. SDG 13 is contemplated in the focus on preserving Amazonian forests to combat climate change and highlighting the role of CUs in containing deforestation. SDG 15 is directly addressed, since the project focuses on CUs—areas essential for protecting biodiversity and terrestrial ecosystems. By integrating environmental governance and the water–energy–food nexus, the study seeks to understand how these interactions occur in Amazonian CUs and how they can contribute to achieving these SDG targets.	
Context: Recognition of the Amazon as an important region for global sustainability, due to its rich biodiversity and natural resources, motivated this study. Environmental governance addresses ecosystem preservation; the water–energy–food nexus comprises essentials for human survival within an understanding of interdependence; and these approaches converge with the SDGs. CUs are protected areas intended to preserve natural resources and promote sustainable use.	

Location: Lago do Cuniã Extractive Reserve, in the municipality of Porto Velho, RO.
Objective: Analyze the integration of the forest with the water–energy–food nexus in the Lago do Cuniã Extractive Reserve in the municipality of Porto Velho, RO.
Indicators used and data collection and monitoring methodology: The methodology adopted in this research is qualitative, exploratory, and descriptive, based on a case study in the Lago do Cuniã Extractive Reserve, in Porto Velho, RO. The main objective is to investigate the interactions among water, energy, food, and forest resources—known as the water–energy–food nexus—in the context of a conservation unit. The variables analyzed included access to potable water, sanitation, energy stability, food production, forest management, and stakeholder participation in resource management.
Partnerships involved: CNPq; ICMBio.
Funding: CNPq.
Planned goals, results, and impacts achieved: The main results of the research highlighted the water, energy, food, and forest security of the local community. With respect to food security, it was identified that residents have access to a diversity of foods, with the reserve being a source of foods such as açaí, Brazil nuts, fish, and alligator meat. Forest security plays an essential role, providing not only food and firewood for energy, but also contributing to the regulation of hydrological cycles and erosion control.
Replicability potential: Replication of this research can be undertaken by following the main methodological procedures used. The study is qualitative, exploratory, and descriptive, focusing on the water–energy–food–forest nexus.
Supporting documents: https://ppga.unir.br/

5.3.3. Collegium of Exact, Technological and Multidisciplinary Sciences

5.3.3.1. Broad Area Exact and Earth Sciences

Institution: Federal University of Tocantins (UFT)	**Program:** Chemistry
Title: Bioactive agents obtained from endophytic fungi isolated from the Brazilian Legal Amazon region for use in agriculture, aiming at biodiversity conservation and sustainable development	
SDGs involved: Social: SDG 2; Economic: SDG 8; Environmental: SDG 12, 15.	
Justification: The southern region of Tocantins, part of the Brazilian Legal Amazon, is a biodiversity hotspot, containing a rich variety of organisms with great biotechnological potential, such as endophytic fungi. These fungi, living in association with plants, can synthesize a range of secondary metabolites that can be exploited to develop agrochemicals with lower environmental impact. The use of endophytic fungi in agriculture is consistent with several SDG targets, especially those aimed at the conservation and sustainable use of biodiversity (SDG 15) and the promotion of sustainable agricultural practices (SDG 12). It is expected that these bioinputs will help increase agricultural productivity without significantly raising production costs for farmers, promoting economic sustainability (SDG 8) and sustainable agriculture (SDG 2).	

Context: Brazil has faced challenges related to the excessive use of highly toxic and persistent pesticides in the environment. The search for more sustainable solutions for agriculture has become a priority and is consistent with the SDGs, with respect to preserving life on land and encouraging sustainable agricultural practices. Among microorganisms with biotechnological potential, endophytic fungi have stood out; they occupy ecological niches similar to those of phytopathogens, allowing them to compete with, antagonize, and even parasitize organisms harmful to agriculture. In addition, they can produce secondary metabolites with antifungal, herbicidal, and insecticidal action, offering an effective, low-impact solution for pest management.

Location: The research project is underway in the city of Gurupi, TO.

Objective: New potential bioactive agents to be used in agriculture as agrochemicals; and implement rational studies of endophyte chemistry associated with plant species in regions of the Brazilian Legal Amazon for biodiversity conservation.

Indicators used and data collection and monitoring methodology: Biological assays conducted with isolated endophytic fungal strains and their crude extracts, assessing in vitro antagonistic and allelopathic activity; in vivo assays to evaluate effects on pre- and post-emergence of Cucumis sativus plants. The active crude extracts were subjected to chemical evaluation and the isolation of various compounds.

Partnerships involved: Unesp; UFR; UFV.

Funding: No external funding was obtained for this project.

Planned goals, results, and impacts achieved: Endophytic fungi isolated from Cochlospermum regium and Clitoria guianensis showed significant antagonistic activity against several strains of phytopathogenic fungi. This antagonistic effect highlights the great potential of these endophytes as effective biocontrol agents for the sustainable management of phytopathogens. The endophytes Phomopsis sp. Cr32 and Neopestalotiopsis sp. CGF13 yielded a promising bioproduct with bioherbicidal activity, demonstrating potential for use in the pre-emergence of weeds. The crude extract of Phomopsis sp. Cr32 showed strong in vivo activity in both pre- and post-emergence assays, showing phytotoxicity, suggesting that this extract can be explored as a potent bioherbicide for application in agriculture, contributing to the reduction of synthetic herbicide use. The extract from the endophyte Coriolopsis rigida Cr1 exhibited potent antioxidant and allelochemical activity. Chemical analysis identified a new natural product and three unprecedented compounds with potential for agricultural or pharmaceutical applications.

Replicability potential: The methods used for identifying and cultivating endophytic fungi and for efficacy testing are well described and standardized. This allows replication in other regions with similar climates and ecosystems. Control of experimental conditions is also essential for replicability. Another important aspect is technology transfer: the techniques used are accessible and scalable, focusing on developing low-cost, easy-to-implement methods, enabling application in different agricultural and research contexts.

Supporting documents:
Articles published in scientific journals with some preliminary results:
http://dx.doi.org/10.20873/DEZ_23_09
https://doi.org/10.20873/jbb.uft.cemaf.v12n2.17691
https://doi.org/10.1080/14786419.2022.2115492
https://doi.org/10.1080/14786419.2021.1892098

5.3.3.2. Broad Area Engineering

Institution: University of the State of Amazonas (UEA)	**Program:** Electrical Engineering
Title: Development of a device for real-time sensing of water quality parameters in the Amazon River for drafting a management plan	
SDGs involved: Social: SDG 3; Environmental: SDG 6, 12, 14; Institutional: SDG 16.	
Justification: SDG 3 – Ensure access to collected data for the general community as well as to the points where devices were installed, thus enabling access to information on water quality. SDG 6 – Monitor water quality parameters in the Amazon River, enabling preventive actions against pollution and supporting integrated water resource management at all levels. SDG 12 – Through the data collected, promote sustainable action plans with society, minimizing the risks of environmental impacts in water bodies. SDG 14 – Identify, through collected data, possible changes in water quality parameters that could threaten aquatic life, making it possible to take preventive and corrective actions. SDG 16 – Promote guidance and education programs.	
Context: The conservation of Amazonian rivers is crucial for preserving the region's unique biodiversity and for the well-being of communities that depend on these resources. Threats arising from deforestation, mining, and agricultural activities have negatively impacted water quality and the health of aquatic ecosystems. The development of a device for real-time sensing of physical, chemical, and biological parameters in the Amazon River is grounded in the growing need for monitoring and sustainable management of water resources.	
Location: Parintins, AM.	
Objective: Develop a Data Collection Platform for monitoring surface water quality in the Amazon River, consisting of a probe/hardware/firmware prototype with communications that will generate a database and software for transmission, control, and storage. Develop hardware with firmware to receive sensor data, as well as a long-distance communication system to transmit data collected remotely from the river, and develop a cloud service for database storage to generate useful information for decision-makers and a control software for operational adjustment of the probe.	
Indicators used and data collection and monitoring methodology: Water and air temperature; pH; electrical conductivity; dissolved oxygen; turbidity; total dissolved solids; salinity.	
Partnerships involved: Embedded Systems Laboratory; Diebold Nixdorf; National Professional Master's Network in Water Resources Management and Regulation (ProfÁgua).	
Funding: Diebold Nixdorf.	
Planned goals, results, and impacts achieved: Real-time monitoring of water quality; a prototype capable of remaining fully in the water; a prototype with integrated energy harvesting; a web platform for data visualization. Results include proposing technical and methodological guidelines for the effective and integrated implementation of data-driven management strategies aimed at conserving and rehabilitating water quality and biodiversity in Amazonian rivers. Capacity building and environmental education are also fostered, promoting awareness and engagement of local communities, stakeholders, and decision-makers regarding the importance and benefits of using real-time sensing technologies to conserve Amazonian rivers.	

Replicability potential: The prototype can be installed at different points, requiring only a point with internet access for sending data, thus enabling replication.
Supporting documents: https://dieboldnixdorf.com.br/diebold-nixdorf-anuncia-apoio-ao-projeto-de-monitoramento-da-qualidade-das-aguas-da-bacia-do-rio-amazonas/

5.3.3.3. Broad Area Multidisciplinary

Institution: Federal University of Acre (UFAC)	**Program:** Environmental Sciences
Title: Capacity building and knowledge exchange for environmental governance and socio-environmental entrepreneurship in the Upper Juruá Basin	
SDGs involved: Economic: SDG 11; Complementary: SDG 20.	
Justification: Building on the formalization of the Academic Cooperation Agreement signed between the Graduate Program in Environmental Sciences (PPGCA/UFAC) and PROCAM/USP, the project titled Multistakeholder Knowledge Exchange and Capacity Building for Environmental Governance and Entrepreneurship in the Upper Juruá River Basin was implemented in partnership with Instituto Fronteiras, PROCAM/IEE–USP, and the Tropical Conservation and Development Program at the University of Florida (TCD/UF), an initiative that contributed significantly to SDG targets 17.16 and 17.17. The project promoted a global partnership for sustainable development by mobilizing and sharing knowledge, expertise, and financial resources to train 30 people in community entrepreneurial leadership in the Upper Juruá Basin (Acre).	
Context: The initiative emerges from the efforts of the Research Group Regenerative Frontiers in the Amazon (dgp.cnpq.br/dgp/espelhogrupo/8633909997429529) to strengthen the goal of its research line in Transformative Learning, which is to "promote and document epistemic dialogues involving traditional knowledge and scientific knowledge aimed at solving socio-environmental problems in the Amazon from a local perspective." From this interest, an Academic Cooperation Agreement was negotiated and implemented between PPGCA/UFAC and PROCAM/USP with the objectives of "joint development of research and extension projects," "joint development of extension programs and projects," and "offering shared courses and subjects," which, complemented by the current Technical Cooperation Agreement between UFAC and Instituto Fronteiras—created to provide "opportunities for curricular internships and participation in projects and extension activities in the institution's various areas of activity"—made it possible to establish the partnerships needed to raise financial resources from the Embassy of the United States of America in Brazil for implementing the project Multistakeholder Knowledge Exchange and Capacity Building for Environmental Governance and Entrepreneurship in the Upper Juruá River Basin, executed within the scope of these current cooperation agreements.	
Location: Municipalities of Cruzeiro do Sul, AC, and Mâncio Lima, AC.	
Objective: Train at least 15 people in facilitative leadership and establish the Juruá Community of Practice.	
Indicators used and data collection and monitoring methodology: Capacity building and training in transdisciplinary participatory research for local researchers (8 teachers), early-career Environmental Sciences researchers (5 master's students and 1 doctoral student), and 8 extension students. A total of 50 people from traditional	

communities were impacted in the practical immersion module; media coverage in the regional press of the situation reported during immersion in the artisanal fishing community of Olivença (Portal Amazônia Real).
Partnerships involved: Graduate Program in Environmental Sciences at USP (PROCAM/USP); Tropical Conservation and Development Program/University of Florida (TCD/UF); Instituto Fronteiras.
Funding: USD 25,000.00 from the U.S. Embassy in Brazil; CAPES PDPG Amazônia Call.
Planned goals, results, and impacts achieved: Twenty-four hours of theoretical classes were delivered and made available on the project's YouTube channel; training for 8 teachers and 3 students in Transdisciplinary Participatory Research in the Amazon (total workload: 270 hours); mobilization of 30 people in the artisanal fishing community of Olivença for the practical immersion module; mobilization of 20 people in the Puyanawa Indigenous community for the practical immersion module.
Replicability potential: High.
Supporting documents: https://www.youtube.com/playlist?list=PL-xNtgu8Mh5tdleOKPXdPLfZpqfrlaJlx Materials used in classes: https://capes.gov.br/MQBxZ & https://capes.gov.br/MiY2g Indirect impacts arising from decisions made during the immersion with the artisanal fishing community of Olivença: https://amazoniareal.com.br/depois-da-cheia-ribeirinhos-enfrentam-a-seca-no-acre/

In the **Collegium of Life Sciences**, the highlight in *Agricultural Sciences* went to a project aimed at developing bioproducts from autochthonous microorganisms to improve animal health, achieving impact across various SDGs in the interior of Pará. In *Biological Sciences*, the selected highlight was a project anchored at INPA in Manaus that analyzes the impact of human alterations on the integrity and biodiversity of Amazonian aquatic ecosystems and involves several national and foreign institutions. In *Health Sciences*, a study was highlighted on the impact of mercury contamination on vulnerable populations of the Amazon, in Amapá, Amazonas, and Roraima.

In the **Collegium of Humanities**, the highlight in *Humanities* went to research that challenges science to be intercultural, featuring Indigenous and traditional community authors and coauthors, such as quilombola communities in the region. In *Applied Social Sciences*, the highlight went to a project focused on sustainability actions in the Lago Cuniã Extractive Reserve in Porto Velho (RO), centered on the water–energy–food nexus with an emphasis on water, food, energy, and forest security for the local community. The highlight in *Languages, Literature and Arts* went to research aimed at identifying the Indigenous languages currently spoken in the state of Pará, including hard-to-access Indigenous lands in the region and involving several federal universities.

In the **Collegium of Exact, Technological and Multidisciplinary Sciences**, the highlight in *Exact and Earth Sciences* concerned the search for unprecedented bioactive substances in endophytic fungi in the southernmost region of Tocantins. In *Engineering*, the highlight was the development of a device for real-time remote sensing of water quality parameters in the region's rivers, with immense impact for the population, including the formulation of a water resources management plan. The highlight in the broad area *Multidisciplinary* was a project in western Acre, in partnership with national and foreign universities, aimed at training socio-environmental entrepreneurs to build capacities for regional environmental governance.

5.4. FINAL CONSIDERATIONS

In the Brazilian Legal Amazon, many activities of graduate programs are related to innovation and extension projects, reaching and impacting society. Education for Sustainable Development plays a central role in research in the region, together with a focus on valorizing the socio-bioeconomy through knowledge appropriation by local populations. The SDGs are at the core of discussions on sustainability and preservation of the Amazon, even when there is no specific focus on the targets established in the SDGs. The participation of Brazilian scientists as the main authors of research and publications on the Amazon worldwide since 2006 also deserves mention.

Important highlights include actions oriented toward a forest-based bioeconomy, such as Geographical Indications for ornamental fish in Barcelos (AM), cassava flour from Cruzeiro do Sul (Acre), guaraná from Maués (AM), açaí from Codajás (AM), among others. In these actions, innovative research on the characteristics of biological materials is accompanied by knowledge of their specificities and peculiarities.

Ranging from the development of sensors to carry out remote georeferencing and detect changes in the characteristics of the region's various rivers; to capacity-building programs in the environmental field; and to innovative research on sources of uncommon bioactive substances, the various actions carried out by graduate programs deserve to be highlighted. In particular, "From the Amazon," valorizing local and regional knowledge; and "for the Amazon," with the purpose of solving challenges characteristic of this vast region.

6 HIGHLIGHTS OF BRAZILIAN GRADUATE EDUCATION CASE STUDIES ADVANCING SDG 13: CLIMATE ACTION

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This chapter focuses on the impacts and contributions of the activities of Brazilian graduate education to Sustainable Development Goal 13: Action against Global Climate Change (SDG 13), with a view to the 2030 Agenda. It begins with a literature review that defines and categorizes climate change, as set forth in SDG 13, and presents the main constitutive elements of that change, offering arguments that demonstrate it as well as its manifestations on the planet. In addition, it discusses climatic, economic, social, and cultural consequences, and actions for adaptation to and mitigation of climate impacts, including the contributions of Brazilian researchers.

The nine representative highlights of Brazilian graduate education are presented in three blocks according to their main theme: mitigation, adaptation, and response to climate emergency. Each block is preceded by an example of an international experience.

Finally, the chapter presents, within a comprehensive perspective, considerations and recommendations, with the expectation of their effective applicability across various fields of study, notably in the comprehensive and

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integrated inclusion of the climate change theme in graduate programs at Brazilian institutions, aiming to contribute to the achievement of the ultimate propositions of the 2030 Agenda (UN, 2015)

6.1. FUNDAMENTAL CONCEPTS ON CLIMATE CHANGE

Climate change is characterized by long-term changes in temperature and weather patterns, caused mainly by human activities that release gases responsible for the greenhouse effect (GHG). These gases form a layer in the atmosphere that acts like a blanket, trapping the sun's heat.

The most significant GHG generated by human activities is carbon dioxide (CO2), produced mainly by the burning of fossil fuels—notably in the transport sector—by deforestation, and by various industrial processes. In addition, methane (CH4) plays a relevant role, being emitted mainly by agricultural activities, such as cattle ranching, and by landfills. Another important gas is nitrous oxide (N2O), originating mainly from agricultural and industrial activities and sewage treatment. Finally, fluorinated gases, used in refrigeration and air conditioning systems and in some industrial processes, are also potent GHGs, although present at lower concentrations in the atmosphere.

Although the greenhouse effect is a natural process essential for life, the excess of gases in the atmosphere intensifies this effect, warming the planet in a troubling way (UN, 2024). According to NASA, the average surface temperature of the Earth in 2023 was the highest recorded since 1880 (NASA, 2024). This accelerated warming triggers a series of interconnected impacts on climate, biodiversity, and continental and marine ecosystems, which directly affect human society, generating threats to food security and human settlements, water scarcity, health risks, and economic disruptions.

The signs of climate change are increasingly evident. Rising temperatures intensify heat waves, droughts, and forest fires; alter precipitation patterns, causing floods in some regions and prolonged droughts in others—and often both effects in the same area. The melting of polar caps and glaciers and the thermal expansion of the oceans raise sea levels, threatening coastal communities and

ecosystems. In addition, the excess carbon dioxide absorbed by the oceans is causing their acidification, harming marine life. Extreme weather events, such as storms, hurricanes, and cyclones, are also becoming more frequent and intense, further amplifying global challenges.

The UN considers climate change one of the greatest challenges of our time which, together with pollution and biodiversity loss, constitutes the so-called triple planetary crisis (UN, 2022). The severity of the problem, associated with the irreversibility of some of its impacts, places us at a stage of climate emergency.

At COP 21, held in Paris in 2015, world leaders agreed to substantially reduce global GHG emissions in order to limit the temperature increase by 2100 to well below 2°C above pre-industrial levels, while making efforts to limit the increase to 1.5°C (UN, 2023). In this context, SDG 13 calls for urgent action to confront climate change and mitigate its impacts.

The Brazilian government has committed to reducing GHG emissions by 50% by 2030 and achieving net-zero emissions by 2050 (Glasgow […], 2021). To this end, Brazil is committed to: (i) ending illegal deforestation by 2028; (ii) restoring 18 million hectares of forests by 2030; (iii) recovering 30 million hectares of degraded pastures; (iv) reaching a 45%–50% share of renewable energy in the country's energy matrix by 2030; and (v) promoting the expansion of the railway network.

6.2. STRATEGIES TO COMBAT CLIMATE CHANGE

Combating climate change is multifaceted, encompassing mitigation strategies to reduce greenhouse gas emissions and sequester carbon and adaptation strategies to cope with inevitable impacts (UN, 2024).

The transition to renewable energy sources such as solar, wind, and hydropower, together with grid modernization and improved energy efficiency, forms the basis of mitigation. At the same time, carbon capture and storage technologies aim to retain emissions from significant sources. In Brazil, deforestation control strategies across all biomes are crucial given the relevance of emissions associated with land-cover and land-use change in the country. Nature-based solutions, such as ecosystem restoration and conservation and

sustainable agriculture, harness the power of ecosystems to absorb carbon dioxide. In addition, the adoption of circular economy principles—with an emphasis on reducing, reusing, and recycling materials to minimize waste and pollution—is essential to reducing the carbon footprint of production and consumption. This strategy also includes actions that increase the provision of collective urban transport services in comparison to individual motorized transport, reducing total emissions and heat production, as well as actions to improve the quality of these services.

Adaptation strategies focus on building resilience against the effects of climate change. This includes creating robust infrastructure, developing early warning systems, implementing water management techniques such as the use of drought-resistant crops and efficient irrigation, and protecting vulnerable communities, such as coastal populations, with measures like the protection of ecosystems such as mangroves, sea barriers, and planned retreats. In urban environments, nature-based solutions are among the most relevant to mitigate the effects of rising temperatures, both those resulting from global climate change and those caused by the formation of heat islands, improving thermal comfort and reducing energy consumption for air conditioning. These solutions are also important to make cities more resilient to flooding (including the protection of communities in risk areas), as well as to protect strategic water sources for supply. Public health initiatives also play a crucial role in preparing for and responding to the spread of diseases, such as protecting vulnerable populations during heat waves and during and after extreme precipitation events.

Moreover, disaster risk management plans and protocols are fundamental. These plans should include preparedness measures such as evacuation drills and emergency response training, as well as strategies for post-event recovery and reconstruction.

Policy and international cooperation are essential, with measures that may include carbon pricing mechanisms, regulations, and global agreements such as the Paris Agreement, promoting systemic changes. In addition, individual actions, supported by public policies, also play a crucial role in the decarbonization process. Choices such as reducing energy consumption, adopting sustainable means of transport, and supporting environmentally responsible companies contribute significantly to the collective effort.

In the face of climate change, the combination of technological innovation (Macêdo, 2024; Sociedade Brasileira de Computação – SBC, 2024), the adoption of appropriate policies and financial mechanisms that incentivize the transition to a low-carbon economy, individual responsibility, transition to a circular economy, and efficient disaster management offers the best hope for mitigating its effects and adapting to a changing world. Effective climate action must also be anchored in principles of justice and equity, with special consideration for historical social and economic inequalities in Brazil.

Finally, it is worth highlighting nature-based solutions (NBS) for their great potential in Brazil to mitigate and adapt to climate change. These practices include ecosystem restoration, forest conservation, and sustainable management of agricultural lands, promoting biodiversity and environmental resilience. The recovery of degraded areas, in addition to sequestering carbon, improves soil and water quality. Mangroves and wetlands function as natural barriers against flooding and erosion. With its rich biological diversity and vast natural resources, Brazil can lead in the implementation of NBS, benefiting communities and contributing to a more sustainable planet.

6.3. CONTRIBUTION OF BRAZILIAN GRADUATE EDUCATION

The fight against climate change requires a multifaceted approach that encompasses mitigation, adaptation, and emergency response strategies. Nine works, one from each broad area, were selected to illustrate the contribution of Brazilian graduate education to SDG 13. The diversity of this contribution is recognized by the main focus of each:

In the scope of **Mitigation:**

1. Agricultural Sciences: Reduction of methane gas emissions in livestock.
2. Biological Sciences: Cleaner technologies for the oil sector.
3. Engineering: Contribution to the energy transition, and green hydrogen.

In the scope of **Adaptation:**

4. Health Sciences: Understanding and preparing for health impacts.
5. Humanities: Analysis of vulnerability and adaptation strategies in communities.
6. Languages, Literature and Arts: Potential to address the adaptation of cultural landscapes to climate change.

In the scope of **Responses to Climate Emergency:**

7. Applied Social Sciences: Design and architectural solutions for adaptation.
8. Exact and Earth Sciences: Monitoring tools and response to emissions intensified by climate change.
9. Multidisciplinary: Monitoring systems for forecasting and alerting to extreme weather events.

The following sections present a synthesis of the highlights and their importance in the Brazilian context, organized into the three above-mentioned dimensions: Mitigation, Adaptation, and Responses to Climate Emergency. Each is preceded by a single highlight of external experience, acknowledging, however, the enormous quantity and variety of actions already undertaken on the planet.

6.3.1. In the scope of mitigation of climate impacts

From international experience in mitigation, the Copenhagen Urban Mobility Plan stands out. For 2025 it imposed important targets for reducing GHG emissions: carbon neutrality in transport emissions and for 75% of total trips to be made on foot, by bicycle, or by public transport. In addition, it drives territorial changes by requiring that 50% of home–work trips be by bicycle. (Martínez, 2016).

In the Brazilian experience, the highlights focused on technological elements of diverse natures with a common element: increasing productivity while respecting the environment.

The **Agricultural Sciences** broad group brings the strategy of using natural resources—introducing high-quality forage in hot and cold seasons in a subtropical climate—into diets for dairy cows, which proved able to reduce the carbon footprint of these production systems by up to 4%. The method, promising for a country that has the second-largest cattle herd in the world with nearly 240 million animals (IBGE, 2025), can be applied in all regions with a subtropical climate, as well as in tropical and temperate areas at specific times.

From the **Biological Sciences**, the highlight aims at advanced oil recovery, reducing extraction waste through the new technology of applying microbial biopolymers and the search for new biocides that are non-toxic, sustainable, and environmentally friendly for the sector.

Engineering focused on improving hydrogen storage conditions, which provides energy flexibility and helps balance the supply and demand of intermittent energy, improving the resilience of the electrical system and enabling large-scale integration of renewable sources. Important for the decarbonization of sectors such as transport, industry, and power generation, it can help reduce GHG emissions and ensure energy during natural disasters, keeping hospitals and communication systems functioning.

6.3.1.1. Broad Area Agricultural Sciences (Collegium of Life Sciences)

Institution: Santa Catarina State University	**Program:** Animal Science
Title: Strategies for mitigating greenhouse gas emissions in dairy production systems	
SDGs involved: Environmental: SDG 13; Social: SDG 2.	
Justification: Strategies to reduce greenhouse gas emissions from dairy production systems were investigated.	
Context: Regions with a subtropical climate, such as southern Brazil, have well-distributed rainfall throughout the year and the potential to produce high-quality forage in hot and cold seasons. However, the potential for using these natural resources in planning animal production systems with lower environmental impact still needs further investigation.	
Location: Lages (SC) and throughout southern Brazil, and other subtropical regions.	
Objective: A series of studies have been conducted to propose alternatives that make it possible to reduce the emission of greenhouse gases—and their consequences in climate change—without reducing the supply of protein of high biological value for the human population. The introduction of high-quality forages into animal diets played a prominent role.	

Indicators used and data collection and monitoring methodology: Measurements of enteric methane emissions in dairy cattle subjected to different dietary situations.
Partnerships involved: UC Davis, California, USA.
Funding: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brazil (CAPES) – Finance code: 001; Conselho Nacional de Desenvolvimento Científico e Tecnológico – Brasil (CNPq) – Finance code: 311107/2022-2; and Fundação de Amparo à Pesquisa e Inovação do Estado de Santa Catarina (FAPESC) – Finance code: 2023 TR 242.
Planned goals, results, and impacts achieved: The introduction of grazed forage into diets for dairy cows proved able to reduce the carbon footprint of these production systems by up to 4%.
Replicability potential: All regions with a subtropical climate, as well as tropical and temperate areas at specific times.
Supporting documents: https://doi.org/10.1007/s11250-017-1374-9 https://doi.org/10.1017/S1751731116000628 https://doi.org/10.3168/jds.2020-18894 https://doi.org/10.1016/j.jclepro.2021.127693 http://dx.doi.org/10.1016/j.scitotenv.2022.153982 https://doi.org/10.1016/j.anifeedsci.2019.05.009 https://doi.org/10.1016/j.livsci.2019.04.015 http://dx.doi.org/10.3168/jds.2015-10396 http://dx.doi.org/10.1017/S1751731119003057 https://doi.org/10.3390/atmos13020283 https://doi.org/10.1371/journal.pone.0234687

6.3.1.2. Broad Area Biological Sciences (Collegium of Life Sciences)

Institution: Federal University of Rio de Janeiro	**Program:** Sciences (Microbiology)
Title: R, D & I in green polymers and biocides for advanced oil recovery	
SDGs involved: Environmental: SDG 13.	
Justification: The project developed at UFRJ in partnership with Shell sought to develop technology for the application of microbial biopolymers for advanced oil recovery and to research new biocides that are sustainable, biodegradable, non-toxic, and environmentally friendly. It proposed introducing effective, economically viable bioproducts and developing innovative technologies for their production, which are not currently found internationally. The project aligns with technological policies and the country's efforts to improve oil recovery, while developing green and economically viable solutions for the Oil & Gas sector.	
Context: Climate change brings interest in environmentally friendly solutions. Green strategies have been adopted along the production chain to reduce environmental impact, and the project on biopolymers encapsulates one of the strategies for the use of green products applied to this sector. Additionally, significant challenges have been found in the sustainable recovery of oil under extreme conditions, such as those encountered in pre-salt fields. Conventional Enhanced Oil Recovery (EOR) techniques often rely on synthetic polymers and other chemical agents that	

can be harmful to the environment and are not effective under the high-salinity and high-temperature conditions characteristic of these fields. The partially hydrolyzed polyacrylamide (HPAM) polymer used in EOR and in hydraulic fracturing is a toxic polymer that persists in water for a long time and has a slow degradation rate, contaminating groundwater and surface waters. There is a significant gap for alternatives that are efficient and environmentally responsible. The new biocides developed also have potential to be introduced with a new biotechnological solution that prevents the degradation of biopolymers and biosurfactants used in EOR without toxicity.
Location: Rio de Janeiro, RJ.
Objective: Generate the development of technology for the application of microbial biopolymers for advanced oil recovery and of new biocides that are non-toxic, sustainable, and environmentally friendly for the sector.
Indicators used and data collection and monitoring methodology: Of the patents obtained in 2023: INPI patent BR 10 2023 001085 7: Use of Essential Oils and other substances as Biocides. Alane Beatriz Vermelho, Verônica da Silva Cardoso, Jacqueline Elis de Souza, Sabrina Martins Lage Cedrola; INPI patent BR10202301944: Method of production of microbial biopolymers and their use.
Partnerships involved: Shell Brasil Petróleo Ltda.
Funding: Shell Brasil Petróleo Ltda.
Planned goals, results, and impacts achieved: Filing of 2 patents and publication of 4 scientific articles
Replicability potential: Through the patent and publications.
Supporting documents: https://doi.org/10.1016/j.talanta.2020.121238 https://doi.org/10.1039/D0AY01585G https://doi.org/10.2118/209579-PA

6.3.1.3. Broad Area Engineering (Collegium of Exact, Technological and Multidisciplinary Sciences)

Institution: Federal University of São Carlos (UFSCar)	**Program:** Materials Science and Engineering
Title: Design of multicomponent alloys in the Ti–V–Nb–M system (M = Cr, Co, and Ni) for hydrogen storage	
SDGs involved: Environmental: SDG 7, 13.	
Justification: Development of materials for hydrogen storage that can be crucial for the transition to sustainable energy matrices and the reduction of fossil fuel use in the country, contributing to the reduction of the effects of climate change.	
Context: Brazil holds a prominent position in clean energy production, with 85% of its energy matrix coming from renewable sources, and this brings the possibility for the country to become a leader in the production of green hydrogen or low-carbon hydrogen, resulting in reduced fossil fuel use and contributing to the deceleration of global warming. However, the implementation of hydrogen as an energy vector brings	

complex technological challenges: how to store and transport large amounts of hydrogen efficiently, safely, and economically, allowing its use in industry, public services, and everyday life. Materials capable of storing hydrogen through the formation of metal hydrides will allow greater storage in smaller volumes, at low pressure and at room temperature. Additionally, the project demonstrates that it is possible to design materials with optimized properties to meet the specific demands of different applications and technologies for hydrogen production or conversion.
Location: São Carlos – São Paulo.
Objective: Develop materials with optimized properties for application in hydrogen storage, thus enabling the storage and transport of green or low-carbon hydrogen. Furthermore, the project aimed to demonstrate the possibility of controlling the properties of these materials so as to adapt to the demands of different technologies for hydrogen production and/or conversion.
Indicators used and data collection and monitoring methodology: Project visibility through scientific dissemination.
Partnerships involved: ICMPE – Institut de Chimie et des Matériaux Paris-Est, l'Université Paris-Est Créteil, Thiais, France.
Funding: FAPESP, Instituto Serrapilheira, CAPES/COFECUB.
Planned goals, results, and impacts achieved: The development of materials suitable for application by industrial partners operating in the area of hydrogen production and/or conversion is anticipated, thereby generating a positive impact on the country's energy transition.
Replicability potential: High: High replicability potential.
Supporting documents: https://repositorio.ufscar.br/handle/20.500.14289/18225 https://doi.org/10.1016/j.jallcom.2021.158767 https://doi.org/10.1016/j.actamat.2021.117070 https://doi.org/10.1016/j.ijhydene.2023.05.032

6.3.2. In the scope of adaptation to deal with inevitable impacts

The MOSE [*Modulo Sperimentale Elettromeccanico*] project, in Venice, Italy, is an important example of adaptation (Giupponi et al., 2024). It is an electromechanical system composed of 78 movable barriers against floods, designed to protect the city from increasingly high tides caused by sea level rise. This ambitious engineering project aims to safeguard the cultural heritage of Venice with innovative adaptation solutions.

In this dimension, the Brazilian highlights reveal how indispensable in-depth knowledge of information and data is. They show the need for coordination across society, notably between academic and traditional knowledge, as a requirement for designing public policies more consistent with local realities.

Health Sciences provide a response to the scarcity of monitoring of air pollutants and their effects on human health. A multidisciplinary approach involving monitoring, predictive modeling, and community actions in small and medium-sized cities, in different contexts, with scarce or non-existent monitoring, using satellite data and low-cost sensors. Among other results, a reduction is expected in the burden on public health systems and in disruptions across broad social sectors. Moreover, they can also support the understanding of some extreme events, helping to identify heat and cold islands, such as those that have occurred in recent decades.

From **Humanities** comes a networked research project that aims to establish Centers of Science and Knowledge in traditional communities, understood as social spaces for the coordination and production of related knowledge. With more than 20 years of actions articulating the knowledge of traditional peoples and communities with new academic knowledge, they guide political intervention by social agents belonging to these peoples and contribute to the economic, social, cultural, and political autonomy of their social agents, as well as to confronting the presence of sectors of mining, agribusiness, and hydro-business with irregular occupations in traditionally occupied lands. The project is more than 20 years old and brings together researchers from seven Brazilian public universities and three foreign ones.

Seeking awareness of the environment and environmental protection and preservation through an alliance between academic knowledge and practices in arts, science, and communication and the knowledge and wisdom of diverse communities and cultural groups is the central motivation of the highlight in the broad area of **Languages, Literature and Arts**. Drawing on installations, paintings, performances, photographs, sculptures, artist's books, the exhibition seeks to align the arts, sciences, and technologies as political acts. It invites one to "enter a forest of living compositions between sensitive media and thoughts."

6.3.2.1. Broad Area Health Sciences

Institution: Federal University of Rio Grande	**Program:** Health Sciences
Title: Impacts of climate change on air quality and its consequent effects on health: a Brazilian overview	
SDGs involved: Social: SDG 3; Environmental: SDG 13; Economic: SDG 11.	
Justification: The research of the Environmental Health Group at FURG contributes to SDGs 3, 11, and 13 by investigating the impacts of air pollution on health and the environment. Under SDG 3, the group analyzes mortality due to pollution (metric 3.9.1), and under SDG 11, it uses low-cost sensors and satellite data to monitor pollutants in areas outside major urban centers. Under SDG 13, it models climate scenarios to predict the effects of temperature on air quality and health, addressing morbidity and mortality and providing input to strengthen public policies.	
Context: air pollution—composed of PM2.5, PM10, ozone—impacts health and the environment and can be aggravated by climate change. The research carried out by the FURG group analyzes these effects in different contexts, such as cities with little monitoring (small and medium-sized cities) and regions affected by forest fires. The Southern Air Project, for example, uses low-cost sensors and satellite information to improve monitoring and support public policies.	
Location: in RS: the capital and medium- and small-sized cities; in MT: Sinop; and in PE: Recife, in addition to data from air quality monitoring stations in different federative units.	
Objective: Investigate and mitigate the impacts of air pollution and climate change on health and the environment through monitoring, predictive modeling, and community actions. The studies use artificial intelligence and low-cost sensors to improve air quality analysis and support public policies.	
Indicators used and data collection and monitoring methodology: Collection of meteorological data (INMET), pollution data (IEMA, CAMS), and health data (DataSUS, IBGE); low-cost sensors for PM10, PM2.5, and temperature. Methodology: data are organized, corrected, and stratified by season and age groups. Health impact assessment follows the WHO method. Machine learning models simulate scenarios of increased temperature and pollution.	
Partnerships involved: USP, UNIPAMPA, UFPEL, UFSM, UFFS, UFRGS.	
Funding: The Environmental Health Research Group at FURG has funding from CNPq, CAPES, and FAPERGS, with ongoing projects totaling more than R$ 1 million.	
Planned goals, results, and impacts achieved: The Group's goals include expanding awareness of the impacts of air pollution, increasing the monitoring network with low-cost sensors, and fostering ESG responsibility practices in companies. The group has already achieved important results, such as publishing more than 40 articles, offering a course on climate change, and promoting outreach activities such as the "Air Patrol" project.	
Replicability potential: The group's research has high replicability potential, using low-cost sensors, satellite data, and accessible methodologies. Outreach actions focused on schools and communities are also highly replicable, requiring mainly human resources and low-cost materials.	
Supporting documents: https://capes.gov.br/8dFJR	

6.3.2.2. Broad Area Humanities (Collegium of Humanities)

Institution: Federal University of Rio Grande do Norte (UFRN)	**Program:** Graduate Program in Social Anthropology (PPGAS)
Title: Network project: Coordination of knowledge, resistance, and impacts of large enterprises in traditional communities in BA, RN, PE, MG, and ES	
SDGs involved: Social: SDG 10; Environmental: SDG 15; Complementary: SDG 18, SDG 20.	
Justification: This project stems from a network of researchers from different regions of the country, with experience in actions and research with traditional peoples. This network aims to establish Centers of Science and Knowledge in traditional communities, understood as social spaces for coordinating and producing knowledge in communities strongly impacted by large mining, wind power, agribusiness, and hydro-business enterprises.	
Context: It originated from the Project New Social Cartography of Traditional Peoples and Communities, with more than 20 years of activity in AM and MA, coordinated by Prof. Alfredo W. B. de Almeida. In 2015, a specific project began in the Northeast Region (BA, PE, RN), and later expanded to MG and ES, coordinated by professors Franklin Carvalho (UFRB) and Rita Neves (UFRN).	
Location: They operate in 60 municipalities in the states of PE, RN, BA, AL, SE, PI, MG, and ES.	
Objective: Listen to, record, and narrate the memories that constitute the principle of the social organization of the groups and that assist in the process of social identification and in the mobilization of collective actions, forming Centers of Science and Knowledge aimed at valuing memory and cultural heritage in traditional communities impacted by the Covid-19 pandemic and by large enterprises.	
Indicators used and data collection and monitoring methodology: They use ethnographic and cartographic description instruments. Knowledge is not produced vertically but results from research relations that consider academics and social agents as researchers in the coordination of knowledge.	
Partnerships involved: The network is composed of six teams of faculty and students from seven public universities (UFRN, UFPE, UPE, UFRB, UNEB, UNIMONTES, and UFES).	
Funding: 2015 to 2024: Ford Foundation (UFRB); 2022 to 2026: CNPq (UFRN).	
Planned goals, results, and impacts achieved: 1. Cultural dimension: Establishment of centers of knowledge; 2. Sociopolitical dimension: Generation of knowledge and new understandings. 3. Environmental dimension: Valuing memory and disseminating collective practices of nature preservation. 4. Science: Coordination and learning of distinct forms of academic and traditional knowledge.	
Replicability potential: There are three levels of replicability: 1 – Consolidated website of the New Social Cartography Project; 2 – Booklets, Notebooks, and Bulletins. These are publications that incorporate what social agents say and do; 3 – Books and articles – Ethnographic experiences resulting from theses and dissertations written by researchers.	
Supporting documents: http://novacartografiasocial.com.br/apresentacao/	

6.3.2.3. Broad Area Health Sciences (Collegium of Life Sciences)

Institution: Federal University of Rio Grande do Sul	**Program:** PPG in Visual Arts
Title: Actions at the level of research, teaching, and outreach of the research project Cultural landscape: between innovation and preservation	
SDGs involved: Social: SDG 3, 4, 5; Environmental: SDG 6, 13, 15; Complementary: SDG 19, 20.	
Justification: SDGs 3, 4, 5, and 19 are addressed by the access provided by the research to quality and inclusive technical, vocational, and higher education, which foresees the exchange of artistic, scientific, and ancestral knowledge with groups in situations of vulnerability, including Indigenous and quilombola populations, as well as broad female and LGBTQIA+ participation. During the residencies Fazer-floresta I and II and the exhibition Tierra (Manaus and Campinas); the G20 Meeting (Manaus); the exhibition "À Beira do Dilúvio" at Rio-Encontro (Porto Alegre); as well as the 2nd Integration Meeting INCT ONSE Adapta (João Pessoa), actions were developed that seek to articulate networks of international collaborators to encompass the complexity of the theme of cultural landscape amid climate change (SDG 13). SDGs 6 and 15 are addressed by the aforementioned events that aim to protect water and life on land. It is through artistic awareness in dialogue with traditional communities that the research addresses SDGs 19 and 20 in confronting the crisis.	
Context: It investigates artistic practices that forge alliances among art, science, education, and traditional knowledge with a focus on the theme of cultural landscape amid climate change. It aims to produce reflections on artistic activity as a strategy for activating, revealing, and reframing cultural and natural heritage. From this multidisciplinary landscape-thinking, the research develops methodologies to confront climate urgencies. As a result, forms of interlocution between art and society are produced in favor of planetary health.	
Location: Porto Alegre/RS, Campinas/SP, Manaus/AM, João Pessoa/PB.	
Objective: Awareness-raising for environmental preservation and planetary health through art in the context of alliances with science, education, and traditional knowledge.	
Indicators used and data collection and monitoring methodology: published website of the University Journal covering the exhibition À Beira do Dilúvio at Rio-Encontro, which addresses the floods in Rio Grande do Sul – National Observatory of Water Security – CNPq; Catalogs of the exhibition Tierra (Gaia Gallery – Unicamp) and Morada Floresta (Fazer-Floresta Residencies – FAPESP); articles and dossiers of the journal CLIMACOM; qualitative indicators with interviews, mappings in residencies, exhibitions and meetings, application of outreach forms in workshops.	
Partnerships involved: PPGAV-IA/UFRGS, INCT Communication, Culture and Art – ONSEADApta. National Observatory of Water Security and Adaptive Management – CNPq; Labjor-Unicamp; Research project "Perceber-fazer-floresta: alliances between arts, sciences and communications in the face of the Anthropocene" (supported by FAPESP); Amazon Face; INPA; GEMARS.	
Funding: PPGAV, PROREXT/UFRGS, CAPES, FAPESP, CNPq.	
Planned goals, results, and impacts achieved: exhibitions, website, articles, editorial of an academic journal, books, exhibition catalogs, workshops, lectures, artistic residencies, webinars.	

Replicability potential: Traveling exhibitions and associated educational actions and materials, such as catalogs, books, interviews, and educational and scientific dissemination materials.
Supporting documents: https://capes.gov.br/Cn95a

6.3.3. In the scope of responses to climate emergency

The Africa Adaptation Acceleration Program (AAAP) is a partnership between the African Development Bank and the Global Center on Adaptation, with the objective of mobilizing US$ 25 billion to accelerate climate adaptation. It aims to build resilient food systems (with support from digital technologies), close infrastructure gaps, support young entrepreneurs, and attract green investments for climate adaptation (Banco Africano de Desenvolvimento, 2021) In Brazil, important action is observed in gathering information and developing instruments that monitor and issue alerts in emergency situations.

Supporting families who lost their homes and belongings due to environmental disasters is the central target of the highlight in **Applied Social Sciences**. Coordinating various productive, academic, and social segments and adopting high technology, alternative materials, tried-and-true and traditional techniques, it addressed the design, planning, and fabrication of low-cost furniture that is easy to execute and less susceptible to the effects of contact with water, intended to support families who lost their homes and belongings due to the flooding of May 2024 in the state of Rio Grande do Sul. These are recovery and reparation actions after extreme events, aimed at the most vulnerable social strata who are severely affected and are families with few financial resources or means to cope with such significant losses.

Exact and Earth Sciences bring a highlight aimed at constructing an integrated structure with various institutions in Brazil and abroad to estimate sources and sinks of GHG and Short-Lived Climate Pollutants (SLCPs) in the São Paulo Metropolitan Region (RMSP) and surroundings, to carry out measurements and assess the impact on air quality. Large metropolises are exposed to high emissions of gases and inhalable particles that are harmful to human health. Vehicular emissions demand attention from the scientific community to understand their consequences for human health through advanced measurement and analysis techniques and through monitoring and modeling, to achieve the SDGs in a collaborative and effective way.

The **Multidisciplinary** field is the origin of the project Monitoring the Climate–MT, of the Graduate Program in Environmental Physics at the Federal University of Mato Grosso (UFMT), which arises from the realization that there is a lack of climate and air quality data in that state as well as in most Brazilian states. It thus aims to generate scientific data to support public policies, promote environmental education, and engage the population in understanding and confronting climate change.

In harmony with the previous highlight, it creates a low-cost monitoring infrastructure to track climate variables and air quality in real time in a Brazilian state, involving schools, institutions, and local communities. The project mobilizes teachers and students in the creation of weather stations with low-cost technologies, 3D printing, and free hardware and software components. The stations are installed in each of the state's 141 municipalities, in partnership with schools, public institutions, and local communities, creating a broad monitoring network.

This monitoring is fundamental to implementing climate change mitigation and adaptation policies. The stations collect climate variables and air pollution levels continuously and automatically. The data are recorded in real time and transmitted to an online platform, becoming available for public consultation and scientific analysis. The interest, therefore, lies not only in data collection but also in promoting environmental education and increasing awareness about climate change and its consequences.

6.3.3.1. Broad Area Applied Social Sciences (Collegium of Humanities)

Institution: Universidade do Vale dos Sinos	**Program:** Graduate Program in Design
Title: ReMakeRS Challenge	
SDGs involved: Social: SDG 1; Environmental: SDG 13.	
Justification: ReMakeRS works to strengthen the resilience of populations in situations of vulnerability, helping to reduce their exposure and susceptibility to extreme weather events and to economic, social, and environmental shocks and disasters. In addition, the project proposes the adoption of urgent measures to combat climate change and its impacts.	
Context: ReMakeRS emerged in response to the floods that devastated RS in May 2024. Faced with the urgent need for reconstruction for families who lost their homes and belongings, several universities and FabLabs joined forces to organize an Emergency Design Challenge, with the objective of developing low-cost furniture that is easy to fabricate and assemble. Unisinos, through the Graduate Program in Design and Professor André Canal Marques, worked on the project's design and	

coordination. Projects were selected, produced, and distributed to affected people. The projects were made available free of charge in open access, enabling their production and large-scale replication.
Location: Porto Alegre, RS.
Objective: Meet the demands of people who lost their belongings during the May 2024 floods in Rio Grande do Sul, offering solutions that can be implemented quickly.
Indicators used and data collection and monitoring methodology: The project was developed through a specific call on the ReMakeRS website, inviting designers to submit proposals. The projects were evaluated by a committee of specialists with experience in the topics addressed. The selected projects were made available in a public-access repository, allowing their replication and production in different contexts.
Partnerships involved: The project benefited from the collaboration of FabLabs, academic institutions, organizations, and networks from the innovation and design ecosystem, involving: UNISINOS, UFRGS, PUC-RS, UFCSPA, Centro Design Brasil, ApDesign, Rede Lens, Rede FabLab Brasil, SindMóveis Bento Gonçalves, Movergs, FabLab Barcelona, and Pacto Alegre, among others.
Funding: The project had no specific funding.
Planned goals, results, and impacts achieved: The project's goals were established to mitigate the impacts of the floods that hit RS in May 2024. ReMakeRS sought to develop open design projects, including: traditional fabrication, digital fabrication, alternative materials, mobility, and portability. The selected projects were made available for production and application in the reconstruction of affected areas.
Replicability potential: The projects were made available under the Creative Commons CC BY-SA license, ensuring open access and facilitating replication. The digital repository remains accessible to companies and partners, allowing the models to be fabricated, expanding the initiative's impact to other emergency and reconstruction situations.
Supporting documents: https://remakers2024.com https://remakers2024.my.canva.site/ https://capes.gov.br/rmbdA

6.3.3.2. Broad Area Exact and Earth Sciences (Collegium of Exact, Technological and Multidisciplinary Sciences)

Institution: University of São Paulo	**Program:** Meteorology
Title: METROCLIMA- Sao Paulo Metropolitan Area, Jointly Tracking Climate Change and Air Quality	
SDGs involved: Social: SDG 3; Environmental: SDG 7; Environmental: SDG 13; Economic: SDG 11.	
Justification: The project directly contributes to improving public health (SDG 3) by studying and quantifying the concentration of atmospheric pollutants and their impacts. The project is related to the use of clean energy (SDG 7), by investigating the impact of fossil fuels and biofuels on the formation of atmospheric pollutants. Air quality modeling and the monitoring of greenhouse gases contribute to more effective and	

sustainable urban planning, which is one of the main focuses of SDG 11. The project is directly related to SDG 13, since it monitors and models GHG emissions and their impacts on climate change.
Context: Led by the University of São Paulo, the METROCLIMA Project, indicated as a Highlight, received support from the Fundação de Amparo à Pesquisa do Estado de São Paulo as a Thematic Project, with funds exceeding 5 million reais, and has obtained relevant results since 2019. This project is coordinated by Prof. Dr. Maria de Fátima Andrade, Full Professor in the Department of Atmospheric Sciences at the Institute of Astronomy, Geophysics and Atmospheric Sciences of the University of São Paulo (IAG-USP).
Location: São Paulo – São Paulo.
Objective: This project aims to examine the role of Greenhouse Gas (GHG) emissions and Short-Lived Climate Pollutants (SLCPs) in the São Paulo metropolitan region and surroundings by implementing a network (www.metroclima.iag.usp.br) for continuous measurements of these compounds.
Indicators used and data collection and monitoring methodology: The initiatives of the Highlight METROCLIMA Project are intrinsically associated with the scientific research promoted in graduate programs at national and international partner institutions, but mainly within the main institution (IAG-USP, Graduate Program in Meteorology of the Department of Atmospheric Sciences).
Partnerships involved: from USP (IPEN, IQ, IF, IGc), UNIFESP, UFABC, UNICAMP, University of Surrey, North Carolina State University, NOAA-USA, JPL-Caltech.
Funding: Main funding by the state funding agency FAPESP as a Thematic Project, through Process 2016/18430-0.
Planned goals, results, and impacts achieved: Development of an integrated structure to estimate sources and sinks of GHG and SLCP; development of integrated Chemical Transport Model tools to describe air quality and the emissions, transport, and fate of GHG; assessment of the impact of climate change on air quality in São Paulo; dissemination of results to governmental institutions and to the community at large.
Replicability potential: High: The methodologies developed in the HIGHLIGHT can be applied in any municipality exposed to excessive concentrations of pollutants derived from vehicular emissions and other anthropogenic sources.
Supporting documents: http://www.metroclima.iag.usp.br

6.3.3.3. Broad Area Multidisciplinary (Collegium of Exact, Technological and Multidisciplinary Sciences)

Institution: Federal University of Mato Grosso	**Program:** Environmental Physics
Title: Monitoring the Climate – MT	
SDGs involved: Environmental: SDG 13.	
Justification: The Monitoring the Climate–MT project contributes to SDG 13 by creating a low-cost monitoring infrastructure to track climate variables and air quality in real time in Mato Grosso. In addition to providing scientific data for policies aimed at mitigating and adapting to climate change, the project promotes environmental	

education and social awareness, involving schools, institutions, and local communities. In doing so, it strengthens citizen science, encourages sustainable practices, and broadens the population's understanding of the climate crisis and its impacts.
Context: Monitoring the Climate–MT arose from the lack of climate and air quality data in Mato Grosso. Faculty and students from the Graduate Program in Environmental Physics at UFMT developed an accessible monitoring network based on low-cost sensors, 3D printing, and open technology. The project foresees the installation of weather stations in all 142 municipalities, with active participation by schools, public institutions, and communities. In addition to generating scientific data to support public policies, the initiative strengthens environmental education and social engagement in confronting climate change.
Location: Cuiabá, Mato Grosso
Objective: The main objective of the Monitoring the Climate–MT project is to expand the collection of climate and air quality data in Mato Grosso, promoting environmental awareness and social engagement.
Indicators used and data collection and monitoring methodology: The project adopts low-cost weather stations, based on accessible sensors, 3D printing, and open technology, to monitor temperature, humidity, wind, precipitation, solar radiation, and air quality. Installed in 142 municipalities in Mato Grosso, in partnership with schools, public institutions, and communities, these stations carry out automatic and continuous data collection, which are transmitted to an online platform, ensuring public access and fostering scientific research and climate policies.
Partnerships involved: Public and private schools and Federal Institutes in the State of Mato Grosso.
Funding: Fundação de Amparo à Pesquisa do Estado de Mato Grosso (FAPEMAT) and Federal University of Mato Grosso (UFMT).
Planned goals, results, and impacts achieved: Install weather and air quality stations in the 142 municipalities of MT, covering urban and rural areas; make data available in real time, promote environmental education, and encourage sustainable practices in schools and communities. Support academic research and public policies on climate change. Results achieved: The project consolidates an active monitoring network, expanding awareness and social engagement, with the involvement of schools and federal institutes; it strengthens climate education and ensures the initiative's sustainability.
Replicability potential: High potential for replication in other Brazilian states, thanks to its low-cost technology, model of citizen participation, and public availability of data. Its innovative and accessible approach facilitates expansion to different regions.
Supporting documents: https://gpfma.ufmt.br/mclima/MT/

6.4. FINAL CONSIDERATIONS

Climate directly impacts human health. Changes in hydrological regimes and hotter years such as 2023 and 2024 increase the risk of diseases such as dengue, leptospirosis, and malaria. Air pollution, an international public concern, is especially present in large urban–industrial agglomerations and during periods of fires that result in the massive burning of biomass and constitutes a global threat.

The increase in ocean temperatures and climate changes, aggravated by deforestation, generate extreme events. Droughts in the Amazon (2023 and 2024) and intense precipitation in Brazilian cities (RS, Northeast) exemplify these extremes. IPCC reports (AR5 and AR6) indicate that regions of Brazil will be dominated by semi-arid environments in the near future, affecting vulnerable populations.

It is crucial to develop studies and research to ensure the security and continuity of life. Brazilian graduate education across its various fields plays a decisive role in confronting the climate crisis by promoting research, innovation, and solution-oriented thinking. Technological advances, such as water resource management and energy efficiency, are essential. Social actions and awareness are vital, in addition to the significant contribution of Brazilian graduate education to mitigating climate change.

In this regard, it is recommended to align academic practices and research priorities with the urgency of climate action. As strategies for this engagement, the following are suggested:

- Offer courses that connect sustainability to the specific focus of each field.
- Encourage research topics related to climate action, with theses and dissertations addressing environmental challenges.
- Foster projects that integrate various fields from a trans/multi/interdisciplinary perspective.
- Encourage student participation in participatory research or environmental education programs with regional and local communities.

- Promote works and technological innovations focused on reducing the "carbon footprint" and on confronting climate challenges, such as biodiversity loss, water management, and pollution monitoring.
- Support environmentally responsible research practices, establish partnerships with national and international institutions, and develop research on adaptation to climate change in urban and rural environments.
- Promote research on the impacts of climate change on water resources, considering different biomes and environments.
- Develop low-carbon and sustainable mobility systems and infrastructures.
- Promote renewable energy solutions, such as solar, wind, and biomass.
- Decarbonize industrial processes with innovations in energy efficiency and the use of sustainable materials.
- Use Information and Communication Technologies (ICT) for climate monitoring and resource optimization.
- Develop strategies to minimize the environmental impacts of the manufacture, use, and disposal of digital technologies.

By integrating sustainability into the core of graduate education, promoting research focused on the climate emergency, and encouraging projects with practical impact, graduate programs can contribute significantly to solving the climate crisis. These efforts not only align academia with global environmental goals but also empower students to lead the transition to a sustainable future.

7 HIGHLIGHTS OF BRAZILIAN GRADUATE EDUCATION CASE STUDIES ADVANCING COMPLEMENTARY SDGS TO THE 2030 AGENDA

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This chapter turns to the impact of the activities of Brazilian graduate education, represented by case-study "highlights," in the context of SDGs 18, 19, and 20, according to the proposal presented in the *Guia Agenda 2030* (Cabral & Gehre, 2020). In November 2024, during the G20 Social, an event preceding the G20, the federal government launched SDG 18: Ethnic-Racial Equality, arising from coordination among: the Ministry of Racial Equality (MIR), the Ministry of Indigenous Peoples (MPI), the Ministry of Human Rights and Citizenship (MDH), the Office of the Chief of Staff to the Presidency of Brazil, the National Bank for Economic and Social Development (BNDES), and the Institute for Applied Economic Research (IPEA). SDGs 19 and 20 are still configured as proposals.

After contextualizing the origin of the proposal of these three complementary SDGs and the state of the discussion, the core of this chapter

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is the selection and analysis of successful experiences in the context of graduate programs (PPG) in all CAPES evaluation areas, seeking practices that indicate impact—real or potential—and that are concurrently related to teaching, research, innovation, and outreach activities. For each of CAPES's nine evaluation broad areas, one practice that met the complementary SDGs was highlighted, aiming for a balanced representation of evaluation areas, regions and institutions, and themes relevant to SDGs 18, 19, and 20. Finally, it provides a comparison of the themes involved in the different fields of knowledge within Brazilian graduate education, as well as a comparison with international scientific production, seeking to broaden the perspective toward new possibilities, weaknesses, and potentialities to be explored.

7.1. SDGS 18, 19 AND 20

The proposal for these SDGs takes shape within an interinstitutional project between two Brazilian universities, São Paulo State University (Unesp) and the University of Brasília (UnB). The project "Unesp 2020: integrating science, diversity, and a culture of non-violence on the Bauru-SP campus," funded by the Unesp/Santander Agreement, in partnership between Unesp and UnB, through the UnB 2030 Strategic Program, has as one of its products a guide titled *Guia Agenda 2030: integrando ODS, educação e sociedade* (Cabral & Gehre, 2020), and is coordinated by Professor Raquel Cabral, from Unesp, and Professor Thiago Gehre, from UnB, who contribute to this chapter. The guide presents key questions for each of the 17 SDGs, in addition to good practices aligned with each one. There is also an important contribution in relation to critical analyses of the 2030 Agenda, as the guide presents "themes that are not expressly represented in the iconography of the 17 SDGs, but which certainly constitute issues that are highly relevant for Brazil and the world in terms of development and sustainability" (Cabral & Gehre, 2020, p. 163). Furthermore, it proposes complementing the Agenda with three SDGs that point to issues emerging from Brazil and Latin America, as shown in Table 7:

TABLE 7: COMPLEMENTARY OBJECTIVES FOR BRAZIL

The focal axis presented here as SDG 18, "Promote racial equality by confronting all types of racism," denotes the importance of addressing the problem of racism in consonance with the Sustainable Development Goals of the 2030 Agenda. The theme is inscribed in a 'cross-cutting' manner across the other SDGs, implying that the success of the Agenda depends on indispensable advances in relation to this violence. There are different ways to contribute to confronting prejudice, racial discrimination, and racism and to promoting racial equality in Brazil. It is hoped that this guide will assist in the implementation of the 2030 Agenda and the SDGs in Brazil, and that it can promote the denunciation and confrontation of all kinds of racism, which still remain present in contemporary social structures. Thus, the important role of education, culture, and science in building a more egalitarian world should be highlighted. The contribution of universities in this process is a key element, especially for developing proposals for affirmative action public policies, because we can only confront this multidimensional violence with an intersectional approach, and ethnic-racial relations are a determining factor for this approach (Cabral & Gehre, 2020, p. 165).

The focal axis presented here as SDG 19, "Ensure cultural plurality and freedom, the democratization of art, and inclusive communication for all," analyzes the social impact of artistic movements at the individual and collective core, in the mobilization of different social groups and new perceptions of the world, in the construction of knowledge about the social dynamics and understandings of the reality that surrounds us. Art, as a mechanism of social critique, crosses political, economic, cultural, scientific, ethnic, gender, and class boundaries, among others, constituting one of the essential elements in consolidating communication that inspires a culture of sustainability. Consequently, it operates transversally to the 2030 Agenda and its principles, pervading all SDGs, since it is essential to understand this global development agenda as a narrative that seeks to communicate and generate mobilization and social engagement through new and inspiring imaginaries of the future. Therefore, Culture, in its broadest sense, will encompass Art and Communication, denouncing violence that affects human communities and other environmental ecosystems, and proposing solutions to confront disinformation, denialism of all kinds, and hate speech, which produce countless victims and setbacks to the advancement of the SDGs and climate justice (Cabral & Gehre, 2020, p. 173).

Sustainable Development Goal 20, "Guarantee the rights and promote the culture of indigenous peoples and traditional communities," is supported by international markers such as: International Labour Organization (ILO) Convention No. 169 on Indigenous Peoples (1989), which established the right of traditional peoples to participate in the management and conservation of their territories, compensation and protection against eviction, in addition to the understanding of indigenous lands as the entire environmental extent of the areas occupied or used by indigenous peoples, securing social, cultural, and economic rights to the land; and the United Nations Declaration on the Rights of Indigenous Peoples (2007), which emphasized respect for their "social structures […] their cultures, spiritual traditions, histories, and philosophies" and the "rights inherent to indigenous peoples […] especially to their lands, territories, and resources." SDG 20 seeks to highlight the necessary cultural preservation, including the valuing of ancestry and traditional knowledge, and the guarantee of rights of indigenous peoples, quilombola communities, riverside communities, geraizeiros, extractivists, terreiro peoples, and forest peoples and other population groups self-identified within these historicized categories (Cabral & Gehre, 2020, p. 181).

7.1.1. Complementary SDGs: the state of the discussion in the respective ministries

This item benefited from the collaboration of representatives of the Ministries of Racial Equality, Culture, and Indigenous Peoples, in the capacity of Thematic Advisors, who contributed by presenting the state of the discussion on each of the complementary SDGs within their respective ministries.

7.1.1.1. SDG 18: Ethnic-Racial Equality and SDG 20: Indigenous Peoples and Traditional Communities[41]

Considering that racism is a structuring element of Brazilian society and that this issue is not adequately addressed in the structure of the 2030 Agenda, Brazil voluntarily adopted SDG 18: Ethnic-Racial Equality with the goal of eliminating racism against indigenous peoples, Afro-descendants, and other population groups affected by multiple forms of discrimination and exclusion and

[41] Collaboration: Edvaldo Batista de Sá, Head of the Division of Public Policy Monitoring, Brazilian Ministry of Racial Equality.

promoting ethnic-racial equality. SDG 18, proposed by the Brazilian government, has 10 targets that address the elimination of racism in the workplace, of all forms of violence and xenophobia; guaranteeing access to justice, representativeness, adequate housing and shelter, health care, and quality education; autonomy and self-determination; and the right to memory, truth, justice, and reparation for indigenous and Afro-descendant peoples.

7.1.1.2. SDG 19: Art, Culture and Communication[42]

Given that, in the 2030 Agenda, the theme of culture is mentioned textually in only seven of the 169 targets and in a strategy of six SDGs, the Ministry of Culture supports the proposal submitted to the UN by UNESCO that, in the post-2030 Agenda, a specific SDG on culture be created. Meanwhile, efforts are underway to expand society's understanding that culture contributes directly or indirectly to the achievement of all 17 SDGs—as well as to SDG 18, on ethnic-racial equality, officially and voluntarily adopted by Brazil.

With regard to the SDGs in the social dimension of the 2030 Agenda, a series of studies demonstrates the transformative capacity of culture, through access to cultural assets, heritage, and public funding, contributing to human development, the eradication of poverty and inequalities, and the expansion of opportunities. In the economic dimension, culture represents 3.11% of Brazil's gross domestic product (GDP) and 7% of the world's GDP, proving to be a strategic sector in job and income generation, with creativity and innovation as its raw materials.

In the environmental dimension, culture contributes to the essential understanding of the relevance of the sustainable use of natural resources and the preservation of habitats, and to disseminating and building values and habits of conscious consumption and environmental protection. Noteworthy is the contribution of knowledge systems and environmental management practices of indigenous peoples and traditional communities to environmental preservation and to confronting the effects of climate change.

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[42] Collaboration: Márcia Rollemberg, Secretary for Citizenship and Cultural Diversity, Brazilian Ministry of Culture.

Finally, in the institutional dimension, culture promotes intercultural dialogue and peace by expanding tolerance for difference and understanding among people, and contributes significantly to reducing all forms of violence and corruption.

7.2. HIGHLIGHTS OF BRAZILIAN GRADUATE EDUCATION FOR ACHIEVING SDGS 18, 19, 20

Within the set of chapters devoted to experiences in graduate education articulated with the SDGs, this chapter records and analyzes the highlights that present impacts related to SDGs 18, 19, and 20. Within the premises used for selecting the highlights submitted by graduate programs from the 50 evaluation areas, the initiatives below were selected.

7.2.1. Collegium of Life Sciences

7.2.1.1. Broad Area Agricultural Sciences

Institution: Federal University of Goiás	**Program:** Animal Science
Title: Actions of the PPGCA for Sustainable Development in the Kalunga Quilombo	
SDGs involved: Social: SDG 1; SDG 2; SDG 3; SDG 10; Environmental: SDG 13; SDG 15. Economic: SDG 8; Complementary: SDG 18; SDG 20.	
Justification: The Kalunga Project promotes the social and economic inclusion of the quilombola community through the reintroduction of Curraleiro Pé-Duro cattle, generating income from meat and milk production. Training activities in sustainable management also create jobs and improve local living conditions. This initiative values sustainable agriculture practices by reintroducing autochthonous breeds resistant to Cerrado conditions, strengthening food security. It promotes racial equality by strengthening the economy and self-sustenance of the historically marginalized Kalunga community, valuing its traditional practices.	
Context: With the goal of conserving Brazilian autochthonous breeds, especially Curraleiro Pé-Duro cattle, in quilombola territories of the Cerrado, such as the Kalunga Quilombo, at the community's own request, the project began. The PPGCA expanded this initiative, bringing sustainable management actions, animal health, and strengthening the local economy. Research on cattle resistance to local environmental conditions and outreach actions with the community were also carried out.	
Location: Kalunga Historical and Cultural Heritage Site, in the municipalities of Cavalcante, Monte Alegre, and Teresina de Goiás, in the state of Goiás.	

Objective: Reintroduce and conserve autochthonous cattle breeds, such as Curraleiro Pé-Duro, in quilombola territories in order to preserve local biodiversity, promote sustainable economic development, and recover cultural practices associated with traditional livestock raising. Implement modern management practices, strengthening food security and climate change mitigation. Recognize the toxic and phytotherapeutic potential of Cerrado plants.

Indicators used and data collection and monitoring methodology:
- 81 head of cattle donated to the Kalunga community.
- Increased meat and milk production: production and commercialization by the quilombola community.
- Animal health and herd sanitation: periodic exams and prevention actions carried out.
- Number of families involved in the project and trained in sustainable management.
- Monitoring the recovery of degraded areas and the impact of reintroducing autochthonous breeds on the local ecosystem.
- Information on medicinal and toxic plants of the Cerrado.

Partnerships involved:
- National partnerships: Federal University of Goiás (UFG), Embrapa, São Paulo State University (UNESP), Federal University of Minas Gerais (UFMG), Federal University of Bahia (UFBA), Goiás State Research Support Foundation (FAPEG), and the Ministry of Agriculture.
- International partnerships: United States Department of Agriculture (USDA).

Funding: CNPq and CAPES.

Expected goals, results, and impacts achieved: Reintroduction of autochthonous breeds, training of families in the Kalunga community, and promotion of economic autonomy through the production of quality meat and milk. Economic strengthening of the community with increased production and sale of meat and milk, generating income for several quilombola families. Training of 20 families in sustainable management and practices for conserving autochthonous breeds. Improved animal health conditions with preventive actions and frequent veterinary care.

Potential for replicability: Application in quilombola and traditional communities, especially in areas of the Cerrado that share similar biodiversity characteristics and socioeconomic challenges. It can be adapted to different rural contexts and traditional peoples in other parts of Brazil.

Supporting documents:
Theses and dissertations in Animal Science and in Health Sciences, Federal University of Goiás.
Articles: PAIM et al., 2023. Historia Ambiental Latinoamericana y Caribeña (HALAC), 13, 309–320, 2023. https://www.halacsolcha.org/index.php/halac/article/view/737 and PAIM et al., 2021. Plantas tóxicas do Cerrado: Expedição ao Sítio Histórico e Patrimônio Cultural Kalunga. In: 71º CNBOT, 2021, Goiânia. Anais do 71º CNBOT, 2021. 1, 436.

7.2.1.2. Broad Area Biological Sciences

Institution: Fluminense Federal University	**Program:** PPG Neurosciences
Title: Girls in the Sciences	
SDGs involved: Social: SDG 4; SDG 5; SDG 10; Economic: SDG 9; Institutional: SDG 16; Complementary: SDG 18; SDG 19; SDG 20.	
Justification: The project addresses SDGs 4, 5, 9, and 10 by promoting the inclusion of girls and women in the sciences, encouraging learning, academic training, and female participation in innovation and technological infrastructure. SDGs 18, 19, and 20 are addressed by focusing on the inclusion of Black, Indigenous, and other minority women, and on producing cultural and communication content that reflects this diversity. This collaborative network promotes social justice and equal opportunities (SDG 16).	
Context: The Girls in the Sciences project emerged in response to the low representation of women in the sciences and engineering, aiming to combat gender stereotypes that affect girls' self-perception from childhood. Inspired by the original initiative of Prof. Daisy Luz, of the Institute of Physics at Fluminense Federal University, the new version seeks to broaden its reach by interviewing girls and women from across Brazil to share their trajectories, challenges, and achievements in the sciences. In doing so, it seeks to raise awareness about the importance of removing invisible barriers that hinder the progress of girls and women in science, enabling them to pursue their goals and dreams and inspiring others to do the same.	
Location: Dissemination on streaming platforms and on the YouTube channel, in addition to social networks (Instagram and Facebook). Science outreach events in public places such as the Niterói Arboretum (Horto de Niterói). Public schools in the municipality and state of Rio de Janeiro.	
Objective: Encourage girls and women to pursue careers in the sciences by providing visibility for researchers and students at different stages of their trajectories and expanding the reach of their stories and contributions. – Creation of a support network and combatting gender inequality in scientific environments.	
Indicators used and data collection and monitoring methodology: Use of tools such as YouTube Analytics, Instagram Insights, and Spotify for Podcasters to track follower growth, views, likes, and shares. Analysis of qualitative feedback on social networks.	
Partnerships involved: Fiocruz Bahia.	
Funding: Support for Extension Projects from PROEX-UFF 2020. SIGProj No.: 359222.1927.86178.07102020.	
Expected goals, results, and impacts achieved: Expand the visibility of women in the sciences, increase audience on digital platforms, strengthen partnerships with academic institutions and NGOs, create educational materials, carry out educational activities in public schools, develop in-person events, and expand the team of collaborators. The objective is to continue promoting inclusion and encouraging women in science, both in Brazil and internationally. The project has generated significant results in encouraging female participation in the sciences. The impact goes beyond follower counts or views; the project has provided a space for women to share their experiences, demystifying stereotypes and inspiring girls who often do not see role models like themselves in the scientific field. The inclusion of intersectional themes such as race, gender, class, and sexuality strengthens the project's social impact.	

Potential for replicability: The flexible, online format favors the expansion of the "Girls in the Sciences" project to other universities, schools, and interest groups that wish to promote gender equality and the inclusion of women in scientific fields. Other factors such as a focus on diversity and inclusion; a simple implementation methodology; the creation of collaboration networks; and customization for different realities reinforce the project's replicability potential. The content can be adapted to address the specific challenges of each context, such as the lack of resources in more remote regions or cultural barriers that still restrict female participation in scientific fields.
Supporting documents: https://capes.gov.br/fOzPY

7.2.1.3. Broad Area Health Sciences

Institution: University of São Paulo	**Program:** PPG in Fundamental Nursing
Title: Training primary care professionals in the context of diversity, equity, and inclusion in Brazilian health: an international cooperative study	
SDGs involved: Social: SDG 4; SDG 10; Institutional: SDG 16; Complementary: SDG 18; SDG 19.	
Justification: Cooperation among Brazil's diverse regions and international partners offers many opportunities for learning in different social and cultural contexts. Developing a training program for professionals on Diversity, Equity, and Inclusion (DEI) in Primary Health Care (APS), understood as Assistive Technology, aims to increase understanding, recognition, respect, and valuing of differences among people. Inclusion goes beyond mere tolerance and seeks to create environments in which everyone feels valued, respected, and has equal access and care.	
Context: Despite Brazil's strong social and cultural diversity, and laws and principles such as universality in the Unified Health System (SUS), which ensure inclusion and respect for diversity, the challenge of innovating how these are realized in health environments still prevails. Primary care operates with insufficient resources and literacy on contemporary DEI issues and tends to reproduce old patterns of exclusion and inequality. Policies and programs geared toward DEI literacy are valuable strategies for the professional training of human resources capable of managing the existing diversity in health institutions. The 1988 Federal Constitution of Brazil and Law No. 8.080 of 1990 provide guidance on the wholeness of the individual, the integration of actions, and intersectoral activities across the entire geopolitical territory. In Brazil, the Unified Health System (SUS) contributes to achieving the SDGs by considering primary care as a guarantee of improvements in sustainable health, society, and environmental outcomes when supported by strong public policies and aligned efforts in the economic, political, and social domains.	
Location: Belém (PA), Florianópolis (SC), Recife (PE), and Ribeirão Preto (SP).	
Objective: Develop, validate, evaluate, and disseminate a training program for primary care professionals focused on diversity, equity, and inclusion in the health context.	
Indicators used and data collection and monitoring methodology: The project has two stages: (1) Methodological study with the construction and validation of the training program and support technologies; and (2) Quantitative, comparative, and analytical study, with a quasi-experimental before-and-after design, in which the intervention	

participants are their own control group. At the end, an educational video synthesizing the program development process will be recorded, serving as support material for replicating and disseminating the study.
Partnerships involved: - International collaborating university: Argentina – Universidad Católica de Santa Fé. Portugal – Escola Superior de Enfermagem do Porto, Escola Superior de Saúde de Santa Maria, Escola Superior de Saúde Atlântica. Germany, TU Dortmund. - National collaborating institutions: Federal University of Pará (UFPA), University of Pernambuco (UPE), Federal University of Pernambuco (UFPE), Centro Universitário Maurício de Nassau – Recife, and Federal University of Santa Catarina (UFSC).
Funding: CNPq (445089/2023-7).
Expected goals, results, and impacts achieved: Bringing researchers and society closer together, mediated by primary care demand and by the dissemination of results on a secure portal with clear and reliable information, according to the demands of society in Brazilian regions and in the countries involved, which will be kept active even after the research concludes. Human resource training, exchange of national and international experiences, and possibilities for inclusion, with exchange of culture, languages, and solutions. Availability of a training program for primary care professionals with a focus on diversity, equity, and inclusion. Scientific contribution with the possibility of increasing the life expectancy and quality of life of vulnerable populations resulting from greater acceptance of these individuals at all levels of health care. Empowerment and participatory governance of people in situations of vulnerability in enhancing health and social policies, strategies, and practices.
Potential for replicability: The scientific knowledge produced will be translated into English, German, and Spanish, using accessible and easy-to-understand language. The results and the educational video developed will be available on the research groups' social networks and on the D+Informação Portal. Scientific publications in journals of national and international relevance.
Supporting documents: http://memoria2.cnpq.br/web/guest/chamadas-publicas

7.2.2. Collegium of Humanities

7.2.2.1. Broad Area Humanities

Institution: State University of Londrina	**Program:** Master's in Social History
Title: A PEROBA	
SDGs involved: Social: SDG 4; SDG 5; SDG 10; Complementary: SDG 19.	
Justification: A PEROBA is a weekly radio program created to mitigate disparities in digital access among students in the History program at UEL at the onset of the COVID-19 Pandemic, in May 2020. In parallel, the program also serves to reaffirm History's commitment to truth and to combating fake news by presenting various methodologies for researching and investigating facts, versions, and narratives.	

Context: Due to the exceptional developments in the context of the SARS-COV-2 pandemic and the impossibility of continuing in-person faculty and student activities as determined by a normative act of the rectory of the State University of Londrina.
Location: Londrina, PR.
Objective: The project aims, through radio media, to comprise part of the teacher education activities in the modality of distance education, intended for faculty in the teacher licensure programs in History at the State University of Londrina. This content will be developed with a view to the broad reach achieved by UEL radio, encompassing, as its target audience, the entire Londrina region.
Indicators used and data collection and monitoring methodology: Number of listeners collected on the program's digital broadcast platforms (Spotify and Radio UEL).
Partnerships involved: Radio UEL.
Funding: None.
Expected goals, results, and impacts achieved: Promote the consolidation of a Public and Digital History.
Potential for replicability: Easily replicable.
Supporting documents: https://podcasters.spotify.com/pod/show/aperoba

7.2.2.2. Broad Area Applied Social Sciences

Institution: São Paulo State University "Júlio de Mesquita Filho" – UNESP	**Program:** Graduate Program in Information Science – Unesp, Marília Campus
Title: Ethical principles and legal foundations for handling data and digital objects of indigenous peoples	
SDGs involved: Complementary: SDG 20.	
Justification: Researching topics related to ethical principles and legal foundations applied to the handling of data and digital objects of indigenous peoples makes it possible to broaden discussions on governance and the sovereignty of indigenous peoples over their historical-cultural heritage and to raise researchers' awareness of the need for ethical and respectful treatment of these peoples' worldviews and rights. On the other hand, it enables indigenous peoples to be equipped regarding digital technologies, as well as their rights when participating in research processes and in the provision of objects that make up their cultural heritage in information environments.	
Context: Technological development and the growing discussion about open data, whether governmental or research, culminated in the theoretical-practical development of solutions that enable the handling of such data so that they are easily located, understood, processed, and reused. However, it is necessary to consider that data involving human beings require caution, especially people and communities who are or may become vulnerable due to their use. In this regard, the project engages in dialogue with indigenous peoples, aiming to discuss permissible ways of collecting, storing, handling, and sharing data, considering their governance and sovereignty.	

The research surveyed Brazilian digital repositories, linked to federal and state public institutions, that make available digital objects related to Brazilian indigenous peoples. A comparative mapping was conducted in relation to Australia, New Zealand, and the United States. The project intends to advance the production of a Metadata Application Profile that may assist professionals dealing with the theme.
Location: The actions of this project are carried out at IBICT. The results will be disseminated in publications, lectures, and courses within UNESP.
Objective: Map digital repositories related to the theme in Brazil and three other countries. Develop a Metadata Application Profile that contributes to the goals stated.
Indicators used and data collection and monitoring methodology: The project is being developed through a non-linear approach, enabling the investigative path to be determined by research findings. The project's methodological path is grounded in bibliographic research and, when necessary, documentary research.
Partnerships involved: The researchers involved in the research project are members of São Paulo State University (Unesp), the Federal University of Technology – Paraná (UTFPR), the University of Marília (Unimar), the Law School of the University of São Paulo (USP), the Brazilian Institute of Information in Science and Technology (IBICT), and Mid Sweden University (Sweden).
Funding: The initial stage was funded by the research project "Preservation and Risk Analysis in Institutional Repositories," linked to the Brazilian Institute of Information in Science and Technology (IBICT).
Expected goals, results, and impacts achieved: Conduct bibliographic surveys and studies on the topic; conduct theoretical studies on the ethical, legal, and technical aspects of the problem, including the application of CARE and FAIR principles in information environments and digital memory objects of indigenous peoples; map storage sources of digital objects, as well as object types, in different institutions; map the metadata standards used by the environments analyzed, especially descriptive and preservation standards; understand the application of TK and BS labels in the context of the identified digital objects, investigating applicability in the Brazilian scenario (aims to bring TK and BS labels already used internationally closer to the handling of such digital objects in Brazil); study forms of collecting, storing, displaying, and digitally preserving the software used by the mapped information environments, as well as available output communication protocols. In this way, it will be possible to identify how the software investigated relates to the OAIS reference model; identify ethical, legal, and technical aspects for reusing research data and digital objects in the long term (diagnosis of practices adopted by the information environments investigated).
Potential for replicability: The Metadata Application Profile may be applied in digital information environments related to the theme in, for example, museums, libraries, and archives, with the possibility of customization for other countries. The project contributes to the management and preservation of the aforementioned data and objects in relation to specific communities, such as indigenous peoples, riverside communities, and quilombolas.
Supporting documents: https://capes.gov.br/8NCD8

7.2.2.3. Broad Area Languages, Literature and Arts

Institution: Federal University of São Paulo	**Program:** Art History
Title: Toward a decolonial art history in Brazil	
SDGs involved: Social: SDG 5; SDG 10; Complementary: SDG 18; SDG 19; SDG 20.	
Justification: Toward a decolonial art history in Brazil analyzes 22 artworks, including paintings, photographs, drawings, installations, performances, films, and sculptures. These are case studies that, on the one hand, scrutinize in a decolonial manner 11 canonical works of Brazilian art history, and, on the other, weave discussions about 11 works by Afro-descendant and indigenous artists, considered decolonial due to their questioning of coloniality based on their non-European epistemological context. The book thus constructs a counterpoint between analyses of classic and in many cases canonized artworks, inserted in a Eurocentric white master narrative associated with colonial power, with analyses from decolonial perspectives that grapple with the colonial legacy: epistemic racism, genocide, epistemicide, etc.	
Context: The project arose from a course in the PPGHA and another in the undergraduate Art History program. Several students joined together to offer an extension course and later began organizing the book.	
Location: Department of Art History, PPGHA, undergraduate program. The book's authors are above all young art historians—bachelors, master's graduates, doctoral candidates, master's students from the Departments of Art History and Philosophy at UNIFESP—who interrogate coloniality, treading decolonial paths by exploring non-hegemonic epistemologies. Our hope is that the book will contribute to a decolonial Art History in Brazil and inspire other works in this direction.	
Objective: Through juxtaposing analyses of colonial and decolonial works, the book seeks to develop a new gaze and a pluriepistemological basis for Art History in Brazil. It understands that the discipline's epistemology intentionally excluded other arts and cultures and, when it integrates them, does so according to its own worldview. Brazil, like many other colonized countries, molded its knowledge production by looking to Europe, importing its concepts, values, and methodology. It created its canons of works and artists, studied through two key criteria: style and period. This legacy has perpetuated—and still perpetuates—the exclusion and diminishment of the artistic production of those considered "other," racialized by the color of their skin, their physical features, their supposed ethnicities, and their cultures considered "primitive" or marginal.	
Indicators used and data collection and monitoring methodology: Literature review, critical analysis.	
Partnerships involved: An extension course was offered via SIEX, UNIFESP; a presentation at the UNIFESP Congress in 2021; a course at MASP; and a talk at the Museu AfroBrasil.	
Funding: No funding.	
Expected goals, results, and impacts achieved: Publication of a book and offering courses (CEP, Sesc, São Paulo, Museu AfroBrasil), book launches in cultural spaces in the periphery, a course at Fundação Casa, etc.	

Potential for replicability: The European epistemology of Art History initially led to the exclusion of the cultural and artistic production of the descendants of enslaved Africans and of the native population. In Brazil, in the studies conducted, it was either pathologized or folklorized. As one of the legacies of colonialism, to this day this production is framed as the opposite of urban art, being either labeled folk art (a highly problematic concept only understandable in historical terms) or viewed within the ethnoracial context as Afro-Brazilian art or Indigenous art. Neither is considered an integral part of Brazilian Art History. This Highlight aims to change that.
Supporting documents: https://masp.org.br/masp-escola/historia-arte-decolonial-brasil https://caecgua.unifesp.br/eventos-menu/o-decolonial-em-questao-dialogos-em-quatro-temas

7.2.3. Collegium of Exact, Technological, and Multidisciplinary Sciences

7.2.3.1. Broad Area Exact and Earth Sciences

Institution: Federal University of Santa Catarina	**Program:** PPG in Physics
Title: Open Platform of Official Racial Statistical Data – Center for Studies and Data on Racial Inequalities	
SDGs involved: Social: SDG 1; SDG 3; SDG 4; SDG 5; SDG 10; Environmental: SDG 6; Economic: SDG 8; SDG 11; Institutional: SDG 16; Complementary: SDG 18; SDG 20.	
Justification: There are large disparities between whites and Blacks and in relation to Indigenous peoples in income, work, housing, and schooling. Favelas and urban communities proportionally have far more Black people than whites; urban dignity is a right for all. School institutions, the judiciary, and companies need to implement protocols for gender and racial equality. It is necessary to recognize inequalities with data in order to eradicate them. Educational data on Indigenous peoples are much less favorable in relation to other groups (Blacks and whites), as is school infrastructure. Recognition is the first step to overcoming inequality. Disseminating these data and taking action with responsible agencies, in partnership with other institutions and social movements, can help to reduce these inequalities.	
Context: Although Brazil has enormous ethnoracial inequalities, data are needed to make them clear. However, data will still be insufficient if they are not made available in an organized and user-friendly way. This was the genesis of the Open Platform of Official Racial Statistical Data.	
Location: Available online at https://cedra.org.br, it generated a set of partnerships and actions at the national level.	
Objective: Make the enormous racial inequality in income, housing, work, and schooling transparent, focusing on young Black women and the Quotas Law.	

Indicators used and data collection and monitoring methodology: IBGE data – 2010 Census, PNAD 2012–2022, National Health Survey, National School Health Survey, in addition to the School Census/INEP/MEC and the Live Births National System. Website access is one of the indicators. Incidence in policies such as the National Policy on the Education of Ethnic-Racial Relations and Quilombolas (PNEERQ/SECADI/MEC), as well as other public agencies and partnerships with civil society organizations.
Partnerships involved: CEDRA has partnerships with the Observatório da Branquitude, SECADI/MEC in PNEERQ (evaluation and monitoring), Open Government (Data on racial affirmative policies), Instituto de Água e Saneamento, Instituto Alana, Simbiose (philanthropy and incentive laws), BAIN & Co, Daniel Advogados, AWS (Amazon).
Funding: Fundação Itaú, Banco Itaú, Instituto Çarê, Associação Bem-te-vi, Instituto Galo da Manhã, Instituto Ibirapitanga, B3 Social.
Expected goals, results, and impacts achieved: 3,000 accesses/year, dissemination of racial data in various domains (congresses, organizations funded by partners, new indicators of racial inequalities adopted by other organizations), impact on the official dissemination of racial data by the Brazilian government.
Potential for replicability: Other audiences with a racial cut: older adults, favelas and urban communities, educational and environmental entities.
Supporting documents: https://cedra.org.br

7.2.3.2. Broad Area Engineering

Institution: Federal University of Goiás	**Program:** Geotechnics, Structures, and Civil Construction
Title: Conversations between girls and women engineers	
SDGs involved: Social: SDG 5; Complementary: SDG 18.	
Justification: Studies addressing the intersectionality of gender–race–class to understand the reasons for gender and ethnoracial exclusion can underpin the implementation of public policies related to SDG 5 (Gender Equality) and SDG 18 (Ethnic-Racial Equality) and support the studies and careers of girls and women who wish to work in the areas of Science, Technology, Engineering, Economics, and Mathematics (STEEM).	
Context: Distinctions in social treatment and basic school life have, as one of their consequences, the fact that women rarely opt for training in Engineering. When they overcome these barriers and choose the exact sciences and Engineering in higher education, it is common for female students to be pressured to abandon their programs or to restrict their professional options. Actions carried out: the Free Core course Women and Gender Equality in Engineering; a book on gender entitled "Conversation between Girls and Women Engineers: sowing gender opportunities in science." Projects undertaken: "Conversations between girls and women engineers: sowing gender equality opportunity in science," with the aim of sparking the interest of female students from three basic education schools in Goiânia-GO in Engineering; "Let's head into the EECA/UFG Laboratories"; "Conversation between Girls and Engineering"; "Conversations between Girls and Women Engineers: Building Networks."	
Location: Engineering programs at the Federal University of Goiás, Goiânia, Goiás.	

Objective: Present the initiatives already consolidated by the group, provoke reflections for creating pathways that lead to the effective participation of women in Engineering, and sensitize girls that engineering, technology, and the exact sciences are a field of knowledge and a professional field for both sexes and all races.
Indicators used and data collection and monitoring methodology: Training activities both in UFG environments and in partner public schools; scientific immersion in laboratories linked to PPGGECON and PPGEAS; an undergraduate course taught on the theme of gender; communication and outreach activities; academic production.
Partnerships involved: Public schools participating in the outreach action; faculty and students from various UFG programs and various Engineering subfields; University of Brasília (UnB), Pontifical Catholic University of Goiás (PUC-GO), Brazilian Association of Soil Mechanics (ABMS), Federal Institute of Brasília – Samambaia Campus (IFB), University of Brasília / School of Technology – FT (FT/UNB), Federal University of Piauí – Center of Technology (CT/UFPI), Federal University of the South and Southeast of Pará – Institute of Geosciences and Engineering (IGE/UNIFESSPA), and Federal University of Roraima (CCT/UFRR).
Funding: 2018 – CNPq (R$ 55,200.00), 2019 – CREA-GO (R$ 10,000), 2019 – Furnas (printing and disseminating the book), 2023–2024 – CETENE/CNPq (PPE and ICJ scholarships); 2024 – FAPEG (R$ 95,000.00); 2024 – CNPq (R$ 1,186,440.00) – approved in preliminary result.
Expected goals, results, and impacts achieved: Promote Engineering in public schools through lectures and scientific and technological exhibitions with a predominantly female team; improve female students' performance in the exact sciences through study groups; carry out scientific immersions of public-school students at EECA/UFG; retain undergraduate students in Engineering programs through the course Women and Gender Equality in Engineering; disseminate the activities developed during the project.
Potential for replicability: High, as the experience can be developed in any state in Brazil.
Supporting documents: https://gecon.eeca.ufg.br/p/18785-publicacoes https://cehige.eeca.ufg.br/p/44368-livros-e-cartilhas https://capes.gov.br/hcwNm

7.2.3.3. Broad Area Multidisciplinary

Institution: Santa Casa de Misericórdia of Pará Foundation (FSCMPA)	**Program:** Management and Health in the Amazon
Title: Outreach project for care of ethnically diverse peoples	
SDGs involved: Complementary: SDG 20.	
Justification: Improving care for indigenous and quilombola peoples in the most complex cases referred to the high-complexity service network, involving maternal and child health, in the teaching and research hospital, Santa Casa de Misericórdia of Pará Foundation (FSCMPA), a reference in maternal and child health; and discussing aspects related to the challenges of access and permanence of these traditional communities, allied to cultural customs and traditional knowledge.	

Context: Project developed by the Graduate Program in Management and Health in the Amazon – PPGGSA/FSCMPA and the medical and multiprofessional residency programs, with interinstitutional and intersectoral articulation in outreach, teaching, and research. It involves universities and public institutes, constituting an interdisciplinary, interprofessional, and strategic support network to confront health issues.
Location: Santa Casa de Misericórdia of Pará Foundation (FSCMPA), Belém, Pará (PA).
Objective: Improve care and the experience in a specialized health service for indigenous and quilombola patients, critically reflecting on initiatives for developing outreach projects in welcoming, promoting, and educating for the health of traditional communities.
Indicators used and data collection and monitoring methodology: The methodology is to describe aspects of the importance, characteristics, functioning, and care provided by this hospital, which is singular in specialized maternal and child care for the health of traditional peoples in the state of Pará. In addition to promoting events and care activities, with an emphasis on the participation of graduate students (master's students and residents) and undergraduate health students, it involves graduate and undergraduate outreach projects focused on welcoming, promoting, and preventing health issues for indigenous and quilombola patients.
Partnerships involved: Federal University of Pará (UFPA), Pará State University (UEPA).
Funding: Institutional self-funding.
Expected goals, results, and impacts achieved: Promote educational activities, with two events per year, so as to address the care, educational, and scientific dimensions; provide learning moments with exchange of experiences, valuing the relationship between health professionals and patients in a culturally differentiated context; promote care and care activities for the health of traditional peoples, allied with cultural customs and traditional knowledge, reflected in the development of outreach projects in welcoming, promoting, and educating for the health of traditional communities.
Potential for replicability: The project has broad scope, including possibilities for replicability in different contexts without the need for adaptations.
Supporting documents: https://mestrado.santacasa.pa.gov.br/2019/08/04/formacao-para-assistencia-a-povos-etnicamente-diversos-sera-tema-de-encontro/

The highlights from the three collegia of evaluation areas exemplify impactful actions for SDGs 18, 19, and 20 in promoting diversity, equity, and inclusion, in dialogue with the other SDGs. In the **Collegium of Life Sciences**, work with quilombola communities, as illustrated in the Highlight of the broad area Agricultural Sciences, is of fundamental importance for income generation, recovering cultural practices associated with traditional livestock raising using autochthonous species, strengthening food security, and promoting ecosystem conservation. In the **broad area Biological Sciences**, the

highlight brings an important initiative to encourage girls and women to pursue careers in the sciences, in addition to creating a support network and combating gender inequality in scientific environments. The initiative in the **broad area Health Sciences** works directly tied to the Unified Health System (SUS) in an international collaboration network to train primary care professionals for diversity, equity, and inclusion in the health context.

In the **Collegium of Humanities**, producing reliable, high-quality information free from intolerance and discrimination becomes increasingly essential in the face of one of the most striking social phenomena of our time: the use of new communication technologies to disseminate disinformation and denial of science on a massive, international scale.

The highlight of the **broad area Humanities** reveals the need for university communities themselves to create public communication channels that are creative and can better disseminate scientific knowledge. The radio program established in the Londrina region during the pandemic is a concrete example of what can be done, encouraging the establishment of similar initiatives on various other communication platforms and in different geographic realities.

The highlight of the **broad area Applied Social Sciences** details the ethical and legal problems present in the use of data and digital objects related to indigenous communities. The digital material present in various repositories needs to be produced and used respectfully, promoting the sovereignty and rights of these communities regarding the digital materials generated based on their life and culture. There is, therefore, an articulation between SDGs 19 and 20.

The highlight of the **broad area Languages, Literature and Arts** seeks to revisit the production and dissemination of understandings about Brazilian art, pointing to the distortions and stereotypes that the colonial legacy has generated in much of the conventional view on the subject. The colonial focus contributed to deprecating ethnicities, cosmologies, and ways of life present in the complex formation of Brazilian society, contributing to ethnoracial inequality and prejudice against indigenous peoples, which are addressed in SDGs 18 and 20.

The three highlights selected in the **Collegium of Exact, Technological, and Multidisciplinary Sciences** are descriptions of projects underway that address themes related to women and education in the Exact and Technological Sciences, racial inequalities, and care for indigenous and quilombola peoples whose respective objectives are: in the broad area Exact and Earth Sciences, to render transparent the racial inequality in income, housing, work, and schooling with a focus on young Black women through an open data platform on racial inequalities; in the broad area Engineering, the effective participation of women in Engineering, creating concrete perspectives that sensitize girls regarding professional engagement in these areas of knowledge; in the broad area Multidisciplinary, to improve care in a specialized health service for indigenous and quilombola patients to promote and educate for the health of traditional communities in the state of Pará through the participation of graduate students.

7.3. MAPPING PUBLICATIONS ON THE COMPLEMENTARY SDGS

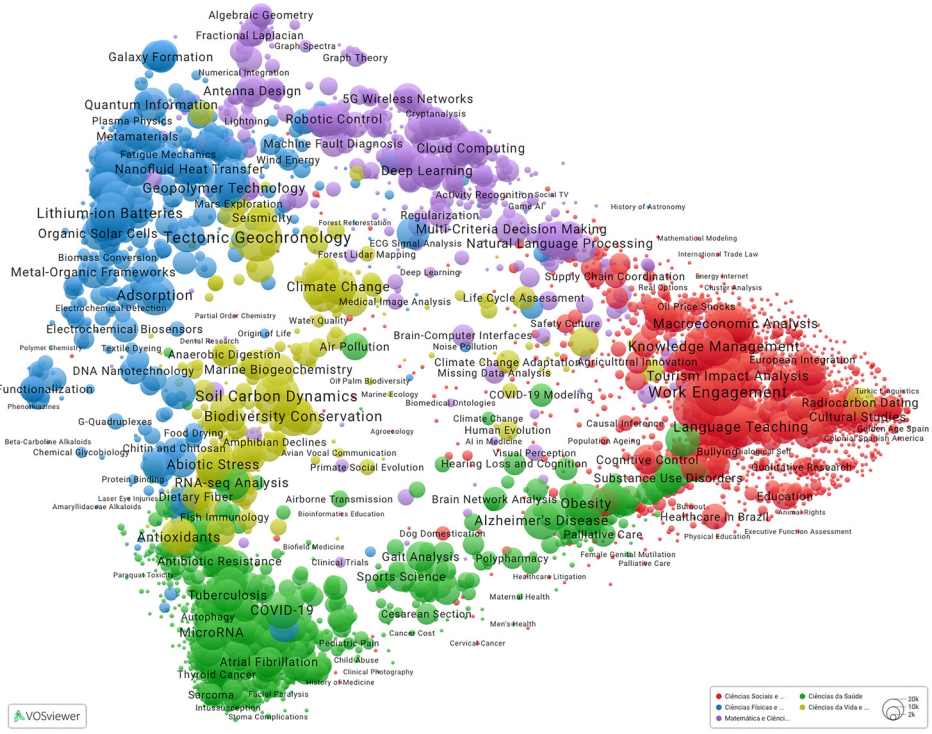
Although previous chapters are devoted to the impacts of research experiences articulated with the SDGs and the present chapter focuses on the complementary SDGs proposed in the Brazilian context, it is essential to assess whether the objects of attention established by them also spark international interest. To that end, this section presents an approach based on the analysis of scientific publications available in the OpenAlex database.

The period analyzed covers the years 2012 to 2022, during which approximately 75 million publications were collected from the database. Using the Leiden Algorithm (Traag et al., 2019), the selected collection of scientific articles was organized into 4,521 clusters generated from citation relationships and article abstracts. The resulting visualization, presented in Figure 27, reflects the proportional distribution of articles across the various mapped groupings.

The science map presented can be explored in detail in an interactive version accessible via the provided link. However, even the static view allows us to understand how world research is organized, primarily based on the grouping of the various clusters into five large color-coded sets: **Social**

Sciences and Humanities (red); **Health Sciences** (green); **Life and Earth Sciences** (yellow); **Physical Sciences and Engineering** (blue); **Mathematics and Computer Science** (purple).

FIGURE 27: MAP OF PUBLICATIONS USING DATA FROM THE OPENALEX DATABASE (2012–2022)



Source: Prepared by the authors. Interactive version available at https://capes.gov.br/BookSDG-fig27.

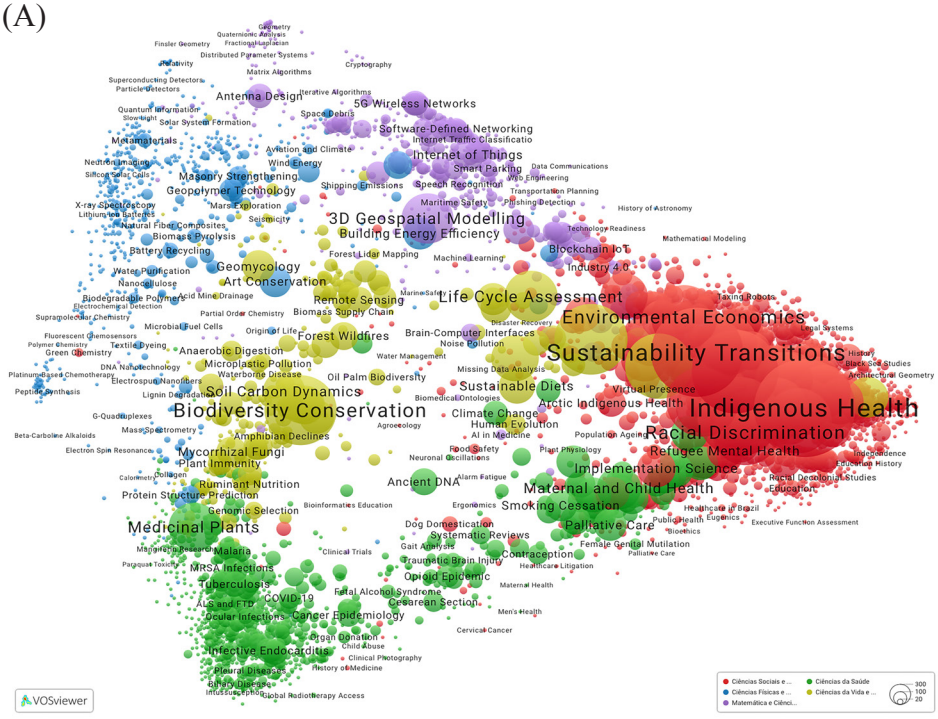
Based on this global mapping of science, a sub-collection was extracted from queries of publication abstracts and titles, considering the specific themes of SDGs 18, 19, and 20. This process allowed the identification of a set of about 600,000 articles produced by the international community, without considering output from Brazilian research institutions. This perspective of global scientific production was overlaid onto the science map presented earlier, and its results are shown in Figure 28A.

As expected, there is a high incidence of research in the areas of Social Sciences and Humanities, reinforcing the eminently social and cultural character of these SDGs. There is also considerable attention from Life and Earth Sciences, as well as from Health Sciences. To a lesser extent, Mathematics and Computer Science also contribute to this picture.

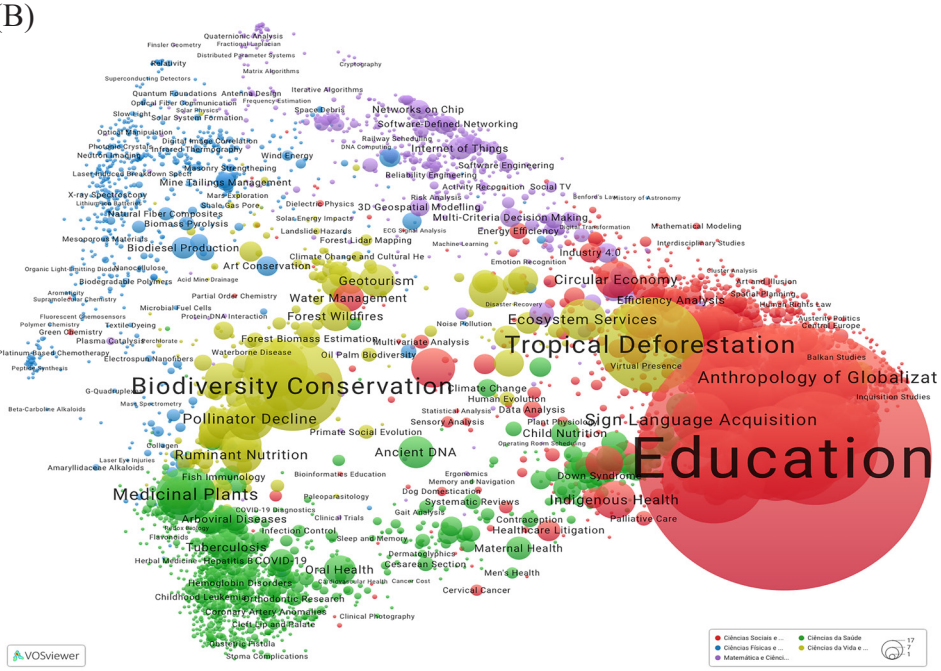
The most prominent topics can be explored interactively via the provided link, but it is worth highlighting some themes directly relevant to the complementary SDGs, such as indigenous health, environmental economics, transitions to sustainability, biodiversity and conservation, etc. These themes demonstrate the wide interdisciplinary reach of research focused on the challenges contemplated by SDGs 18 to 20.

FIGURE 28: DISTRIBUTION OF (A) INTERNATIONAL AND (B) BRAZILIAN PUBLICATIONS RELATED TO THE COMPLEMENTARY SDGS

(A)



(B)



Source: Prepared by the authors. Interactive versions available at https://capes.gov.br/BookSDG-fig28a and https://capes.gov.br/BookSDG-fig28b.[43]

The map in Figure 28B focuses specifically on publications by authors affiliated with Brazilian institutions, for which just over 40,000 articles were mapped between 2012 and 2022. The comparative analysis reveals a distribution similar to that observed in the global distribution of publications, but with some notable differences. In Brazil's case, there is a slight reduction in representativeness in the sets of clusters at the top of the map, but emerging fields that receive significant attention from Brazilian researchers also appear.

Among the most evident themes in the Brazilian context, one notes the emergence on the map of topics such as the anthropology of globalization, tropical deforestation, and pollinator decline, reflecting concerns that receive proportionally more attention from the national research community. In addition, there is an even stronger emphasis on issues related to biodiversity conservation, as well as topics that also receive global attention, such as medicinal plants.

[43] At the link, additional breakdowns of the publication data presented can be accessed, including separate visualizations of the publications linked to SDGs 18, 19, and 20.

However, the most significant discrepancy between global and Brazilian scientific production is the prominence that research in Brazil assigns to education within these themes. This difference suggests that, in Brazil, there is a pronounced concern with training and disseminating knowledge in educational contexts aimed at historically marginalized populations and at promoting socio-environmental sustainability.

From the analysis of the relationship between research conducted in Brazil and in the rest of the world on SDGs 18, 19, and 20, both in relation to the overall science landscape and among themselves, some fundamental conclusions can be drawn. First, the themes proposed as new SDGs are not restricted to exclusively Brazilian issues. On the contrary, the significant presence of international research on these topics demonstrates that there is considerable alignment between the interests of the global scientific community and the concerns expressed in the Brazilian proposals.

However, it is also possible to identify themes that attract more intense attention from Brazilian researchers and the national scientific community. These distinctions reflect the importance of a global research ecosystem that is at once capable of dealing with broad and cross-cutting issues aligned with the state of the art in different disciplines and of dedicating efforts to specific and locally relevant challenges.

The complementarity between global and local approaches not only enriches the diversity of scientific production, but also contributes to a more inclusive and representative panorama of knowledge. This balance between universal perspectives and regional particularities is deeply aligned with the overarching vision of the SDGs, which seek to promote equitable and sustainable development, taking into account the multiple socioeconomic and environmental realities around the world.

7.4. SDG 18: OTHER INTERNATIONAL EXPERIENCES

Report No. 5 of the Ministry of Racial Equality records that this Brazilian proposal for new SDGs is not an unprecedented initiative: “In India, an SDG 18 on local empowerment and rural development was created, and in Costa Rica, an SDG 18 on people’s happiness and well-being” (Brasil, 2024b, p. 6). There are also the experiences of Laos, which,

in 2016, institutionalized SDG 18: "Lives Protected from Unexploded Ordnance (UXO)," and Cambodia, which, in 2020, created an SDG 18 aimed at ending the negative impact of mines/ERW (Explosive Remnants of War) and promoting victim assistance.

In addition to these, one notes awareness of the proposal for an SDG 18 "Por el derecho a atender de las personas" by some communication-related institutions in Spain, aimed at seeking clear, ethical, and responsible communication, which directly dialogues with Brazil's proposed SDG 19. Complementarily, another proposal for an SDG 18 is also known, also by some institutions in Spain, focused on "Calidad del Cielo Nocturno y Acceso a la luz de las Estrellas," which aims to sensitize the international community to the risks and threats of the abusive and inappropriate use of artificial lighting, which produces light pollution, resulting directly in significant changes to "habitats, ecosystems, species, alters the biological cycles of plants and affects the relationships, orientation, reproduction and physiology of many animal species."[44]

All these proposals demonstrate an unprecedented global movement in which people, in distinct socioeconomic realities, political contexts, and cultures, and from different worldviews, appropriate this narrative, which is the 2030 Agenda, translating it to their territories in the search for another future for the planet and engaging with their local demands.

7.5. FINAL CONSIDERATIONS

> Social inequality is quite marked in the Brazilian reality, from the Colonial period to the present, arising from the historical relationship between antagonistic social classes in capitalist society. Understanding these historical inequalities is essential to recognizing that groups that represent numerically the majority of the population (Black people, Indigenous peoples, and quilombolas) do not have access to basic rights such as, for example, education, health, employment, housing, food, etc. The Racial Inequalities Report (2022), prepared by GEMAA, indicates that even with a general increase in the population's educational level in Brazil and an attenuation of racial inequality present in formal education,

[44] Description from https://ods18.org.

> inequalities remain, and Black and Indigenous people still show the worst indicators in schooling, work, and income, and the highest unemployment rates. (Grupo de Trabalho Equidade e Redução de Assimetrias na Pós-Graduação, 2024, p. 28).

The various proposals that indicated the need to construct these complementary SDGs are supported by the importance of these objectives for Brazil, Latin America, and the Global South, and are based on the motto "leave no one behind." This motto mirrors one of the most important guidelines of the PNPG 2025–2029, which is the pursuit of equity and the reduction of asymmetries in Brazil's graduate education system. As the working group that addressed this theme in the 2021–2024 quadrennium pointed out, in the excerpt above, sustainable development in Brazil cannot be detached from issues such as gender equity, ethnic-racial equality, inclusion, and sexual diversity.

The proposition of complementary SDGs also converges with important movements in the field of Education, such as the pursuit of other epistemologies, the curricularization of outreach, and the importance of valuing science in educational spaces and processes. The highlights selected for this chapter constitute—in conjunction with the highlights of Chapters 4, 5, and 6—an interesting panorama of experiences whose impact converges toward achieving the 20 SDGs. Access to the highlights shared by graduate programs across all evaluation areas makes it possible to affirm that the SNPG plays a fundamental role in stimulating education that promotes sustainable development.

> What I have learned over these decades is that everyone needs to awaken, because, if for a time it was we, the indigenous peoples, who were threatened with rupture or with the extinction of the meanings of our paths, today we are all facing the imminence of the Earth not being able to bear our demand (Krenak, 2020, p. 45).

PART III

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Brazil's National System of *Stricto Sensu* Graduate Education (SNPG) is among the most robust in the world. Composed of higher education and research institutions from different segments—Federal, State, Community, and Private—the SNPG has, in recent years, been guided by the need to strengthen networks of interinstitutional graduate programs, propose strategies to reduce regional and intraregional asymmetries in research, enhance actions for inclusion, gender equity, and the democratization of scientific knowledge, and ensure that the training of master's and doctoral degree holders engages with contemporary realities and is committed to environmental preservation and the reduction of every type of inequality. Nevertheless, the challenges to achieving these goals are numerous. They range from the need for an adequate budget and stability in government policies aimed at graduate education to operational issues related to evaluating an intrinsically heterogeneous system in a continental country as complex as Brazil.

Part III is composed of Chapter 8, entitled "Impact of Brazilian graduate education on Education for Sustainable Development: possible pathways." The chapter addresses the challenges of Education for Sustainable Development (ESD) and proposes steps and recommendations for public policies, teaching, research and innovation, in addition to university outreach actions. The transversality of ESD across school curricula is essential for the education of students and teachers. The chapter draws on the National Common Curricular Base, on research results from Brazilian graduate education, and on actions of the country's Secretariats of Education, as well as on official documents from different agencies and bodies that address the theme.

Sustainable development encompasses, in an interconnected and interdisciplinary manner, the social, environmental, economic, and institutional dimensions. As a UN signatory, Brazil has implemented initiatives in teaching, research, innovation, and outreach that reflect the pressing demand for education aimed at planetary citizenship. At least since the mid-twentieth century, education has faced substantive challenges in the era of information technologies and the profusion of data in a hyperinformation and spectacle society. The fragmentation of teaching into self-contained disciplines is not capable of adequately addressing inter- and transdisciplinary approaches that consider local, regional, and global problems. Liberating education that is genuinely oriented toward sustainability, in all its aspects, demands the formation of autonomous citizens capable of contextualizing and reframing the knowledges constructed in the school environment. Educating for sustainable development must aim to enable the connection among personal learning, social interactions, and the understanding of each person's role within the environmental context.

8 IMPACT OF BRAZILIAN GRADUATE EDUCATION ON EDUCATION FOR SUSTAINABLE DEVELOPMENT: POSSIBLE PATHWAYS

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[3] Federal Institute of Amazonas (IFAM), AM, Brazil
[4] University of Brasília (UnB), DF, Brazil
[5] Federal University of Pará (UFPA), PA, Brazil
[6] Pontifical Catholic University of Rio de Janeiro (PUC-Rio), RJ, Brazil
[7] Brazilian Federal Agency for Support and Evaluation of Graduate Education (CAPES), DF, Brazil
[8] Centre for Science and Technology Studies (CWTS), Leiden University, The Netherlands
[9] University of the State of Amazonas (UEA), AM, Brazil

In the last chapter, the challenges of Education for Sustainable Development (ESD) are discussed and steps and recommendations are proposed, both to suggest public policies and for teaching, research, innovation, and university outreach actions to guide an education that is transversal to course disciplines and present throughout the entire educational trajectory of students and teachers. The premise is that it is not possible to undertake steps toward ESD without starting with basic education. To this end, an attempt was made to triangulate results in teaching, research, innovation, and outreach from Brazilian graduate education, definitions from the National Common Curricular Base (BNCC)—which guides basic education—and examples of actions reported by State Secretariats of Education in the country—received through a survey conducted at the end of 2024—on what has been carried out in different Brazilian states, as well as the theoretical foundation in various authors and official documents, among which texts from the UN and UNESCO.

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As observed throughout the chapters of this book, sustainable development is a complex theme precisely because it considers the different dimensions of the SDGs: social, environmental, economic, and institutional. This does not mean, however, that there are no other dimensional unfoldings, such as political, cultural, technological, etc. There is transversality in the themes, and they are interdependent for understanding development and, above all, for its concrete realization, so as to generate impact from Education for Sustainable Development.

As a signatory country of the United Nations and, therefore, one of the Parties to the COP, Brazil has undertaken various initiatives and assessed what has been occurring, as earlier chapters of this book make clear by highlighting the teaching, research, innovation, and outreach of Brazilian graduate education across different areas of knowledge. But what education is desired, at different levels, to train generations committed to an intergenerational ecosocioeconomic balance that endures? It is hoped that, throughout this chapter, approximations will be made that provide answers to the question presented.

> The UN understands quality education as the targets of SDG 4, which highlight guaranteeing universal access to early childhood education with quality care; to basic education; to technical, vocational, and higher education; that all youth and adults be literate and possess basic mathematics knowledge; and that gender inequalities in educational institutions be eliminated. It also considers that quality education can help reduce poverty and promote health and social well-being, contributing to the building of peace and social inclusion.

Education is understood in its broad sense, considering the potential of Brazilian graduate education to contribute and establish partnerships to leverage ESD through teaching, research, innovation, and outreach actions for different sectors of society.

Graduate education has a relevant impact on ESD, encompassing all areas of knowledge through teaching, research, innovation, and outreach, valued by CAPES in its quadrennial evaluations. Its potential contributes to the formation of attitudes and values oriented toward sustainability in the various dimensions of the ecosocioeconomy, promoting quality education.

The steps/recommendations proposed here are not intended as prescriptions for Education, but to contribute to educational public policies

and actions of Brazilian graduate education aimed at sustainable development and the formation of planetary citizenship, as defined in Chapter 3 (p. 85), "to develop awareness and understanding of what global climate change is, to understand and exercise individual and collective responsibility for the planet's sustainability, social justice, and respect for the common good," one of the major challenges for advancing local and global ecosocioeconomic and intergenerational sustainability (Vieira & Sampaio, 2022).

8.1. CHALLENGES OF CONTEMPORARY EDUCATION IN THE FACE OF PLANETARY CLIMATE CHANGE

Contemporary society is that of technology, (hyper)information, and communication. Information is a raw material that knowledge must master and integrate, but, as Morin (2003) notes, knowledge must be permanently revisited by intentional thought, which characterizes reflection, defined as such by Dewey (1976) since the mid-twentieth century, contributing to the formation of the critical and responsible citizen in the face of the world in which one lives.

Education, at all levels, from basic to higher, has a great potential for socioenvironmental, economic, and technological transformation. Although traditionally structured in disciplines that organize knowledge in a fragmented way, there is an opportunity to promote practices that integrate knowledges and foster more reflective and meaningful learning in pursuit of forming knowledge, attitudes, and values that expand from the local to the global. We therefore face a great challenge: that of globality, which includes increasingly complex problems. However, as Morin (2003, p. 9) states: "There is an ever more extensive, profound, and serious inadequacy between separate, fragmented knowledges compartmentalized among disciplines and, on the other hand, realities or problems that are increasingly polydisciplinary, transversal, multidimensional, transnational, global, planetary."

These reflections lead us to understand that teaching and learning are complex acts. Beyond the particularities of the teacher and the student, there are knowledges and methodologies constructed by Science, in different areas, and by tradition, which need to be considered. At present, the methodologies that seek to make a difference, practicing interdisciplinarity and transdisciplinarity, are

those that promote student protagonism in learning, favoring the development of critical thinking and reflection on complex issues, contributing to the capacity for decision-making. Some of these methodologies are described in Appendix C1 – Methodologies of this chapter (available only in digital version[45]).

Such methodological approaches aim to develop competencies and skills in a practical and reflective manner, helping students to understand and act on sustainability issues and other topics, forming conscious and engaged citizens and developing a deep understanding of socioeconomic, socioenvironmental, and technological issues so as to become agents of change in their communities.

This challenge—one of globality—prompts teachers to look at education, teaching, and learning as interconnected, interdependent, and therefore complex phenomena. It is not possible to approach content in a meaningful way without a view to context, considering, at the same time, the local and the global, as Santos (2003) notes. This challenge implies designing Education with an expanded vision, local and planetary, perceiving the multiple relationships present in a phenomenon or problem. In other words, it is necessary to help students to develop integrally, to develop capacities and multiple intelligences. Morin (2003, p. 11) considers that "the aptitude to contextualize and integrate is a fundamental quality of the human mind," and that, therefore, it is the function of the educational process to develop this capacity in students, from the earliest age, making them capable of articulating different knowledges.

To develop minds capable of understanding the local and global context, it is essential to stimulate the natural curiosity of children and adolescents, often repressed by teaching focused solely on the transmission of content. Although this process is important, it can limit students' critical thinking and creativity. Innovation, therefore, must be present in teaching, encouraging the formulation of questions, the search for solutions, and the observation of the surroundings. Education, especially oriented toward Sustainable Development, must teach how to question and guide the search for answers, promoting the problematization of knowledge and the formulation of hypotheses to face current and future challenges (Gonçalves, 2012).

[45] Available at: https://capes.gov.br/apendices-ipgb-na-agenda-2030

In contemporaneity, a serious planetary problem is sustainable development. Including the challenge of ESD in educational processes is the greatest contemporary challenge of Education. Veiga (2005) equates the desire for sustainable development with the desire for justice, peace, and freedom, which leads us to project ESD into various sectors of society, both in educational institutions and in environmental, economic, social, technological, and cultural enterprises.

Education is a right of all people and must be projected toward the future, looking to new generations, technological development, and the formation of critical, responsible, and globally connected citizens (central objectives of Brazilian Education), thereby transforming itself into a space for changes in values, attitudes, and lifestyles. For this very reason, the knowledges to be taught are presented by Brazilian legislation as scientific, procedural, and attitudinal knowledge.

It is understood, therefore, that a major pedagogical movement for the construction of an Education for Sustainable Development is to place the student at the center of the educational process, as the protagonist of learning, from the beginning of schooling. In this sense, Delors (2002) presents four pillars of contemporary Education: (i) learning to be; (ii) learning to live together; (iii) learning to do; and (iv) learning to learn. From these pillars emerge the four competencies that young people, to be autonomous, supportive, and competent, must develop: (i) personal competence (learning to be); (ii) social competence (learning to live together); (iii) productive competence (learning to do); and (iv) cognitive competence (learning to learn).

Gonçalves (2012) stresses that the development of such competencies requires institutions to reach beyond their walls, with activities developed by integrating the surrounding community, so that students identify themselves as social, collective, and supportive beings, perceiving the interdependence between people and other social sectors that constitute the environment.

For the development of projects and actions that address the SDGs, 75% of the Secretariats of Education in Brazil reported having established partnerships, chiefly with Federal and State Public Universities, as well as with Federal Institutes, in some cases developed in collaboration with more than one institution (for information on the actions and projects developed, see Table 16 of Appendix C2).

In the Brazilian sphere, articulated with the international, the National Environmental Education Program (ProNea/MMA/UNESCO) has had, in the educational context, objectives of ensuring the balanced integration of the multiple dimensions of sustainable development—social, environmental, economic, and institutional, in all of which ethics, culture, territoriality, and politics are included—resulting in greater well-being and quality of life for the population, as a right of all.

In view of the various challenges raised above, new and immense challenges are imposed to face the great demands and hopes placed on ESD, at its different levels: (i) which topics to prioritize for teaching and research and innovation in Brazilian graduate education?; (ii) which social, environmental, economic, and institutional problems to prioritize in order to propose university outreach activities, seeking to socialize research results and contributing to the development of specific communities and to education for sustainability in its broad sense?; (iii) what kind of teacher needs to be trained?; (iv) what working conditions does the teacher need in order to carry out quality work, as the protagonist of his or her own practice?

In the different areas of knowledge, people and professionals are trained for different scientific and technological fields, both in basic and technical courses and in undergraduate and graduate education. In all these spaces, the teacher's role is crucial, and graduate education stands out, offering research and innovation results and integration actions and the training of citizens, in institutional partnerships of different natures. For this, society itself must be conceived with a new paradigm, in the pursuit of sustainability.

According to Morin (2003), the reform of thought can be considered the "challenge of challenges" for the multi–poly–inter– and transdisciplinary understanding of local and global problems. This reform of thought will be capable of linking scientific and humanistic culture. Thus, a virtuous cycle would be established, in which the reform of thought and of teaching would be intimately interwoven, each generating the other, also in the field of teaching. In the author's words, the "reform of teaching must lead to the reform of thought, and the reform of thought must lead to the reform of teaching" (Morin, 2003, p. 20).

It is understood that only by establishing this virtuous cycle in contemporary society will it be possible to advance toward the formation of planetary citizenship, successfully confronting the ongoing climate crisis. However, this reform of thought must occur at all levels and in all social spheres, which includes the political, governmental, and business environments, so as to create decent working conditions for teachers and learning conditions for students. All this urgently requires broad conditions for improving the initial and continuing education of teachers, which requires the restructuring of public policies that induce and finance ESD.

By training teachers and students capable of connecting knowledge to life, the interdependence between human beings and nature is valued; and through the application of the knowledge acquired in building a more just, supportive, and sustainable world, reflective planetary citizens are formed, with the capacity for self-knowledge and continuous (trans)formation.

> Self-knowledge is also necessary for a person to make future plans for herself or himself, which is often lacking among students in Brazilian basic education. In the face of the adversities that shape their lives from childhood, upon reaching adolescence they have difficulty planning a life project, often showing themselves unable to foresee a successful future or to have the courage to face the difficulties ahead, which are even greater than those they have confronted in their daily lives (Pineau, 1988).

This training is continuous, lifelong, and increasingly understood as self-formation, as Josso (2004) teaches. By human nature, we are always inconclusive, as Freire (1999) states, and it is necessary to be aware of human incompleteness in order to invest in teachers and students.

Consistent with what was discussed about the complexity of real and essential problems (Morin, 2003), it is necessary to rethink teacher education in a comprehensive and interdisciplinary way, developing self-knowledge based on reflection on one's own practice, considering the local and global context, discussing specific themes and the reach of the SDGs in the teaching that one carries out, whatever one's area of knowledge. For the intended training, the tripolar theory of Gaston Pineau is employed, which highlights three poles of training: autoformation, heteroformation, and ecoformation.

According to Moraes (2007), in considering the challenges of contemporaneity from complex thought (Morin, 2003), tripolar theory (Pineau, 1987), and eco-systemic thought, proposed by the author herself, the need for comprehensive and inter–transdisciplinary training is highlighted, articulating autoformation, heteroformation, and ecoformation.

Autoformation, essential for personal and professional development, promotes autonomy, self-knowledge, and internal transformation, being relevant from basic education to teacher education. It involves practices such as critical reflection, records of lived experiences, and collaborative projects, connecting to the socioenvironmental space (ecoformation) and to social interactions (heteroformation).

Heteroformation highlights the influence of interpersonal relations on learning and development, emphasizing the exchange of knowledges in formal and non-formal educational environments. This practice strengthens competencies such as empathy, teamwork, and leadership, in addition to values and professional practices, which are essential for comprehensive training.

Ecoformation, in turn, considers the impact of the physical, social, and technological environment on learning, promoting ecological sensitivity, sustainability, and an understanding of human interdependencies with the environment. It stimulates pedagogical practices aligned with socioenvironmental, economic, and technological ethics and with sustainable development.

Together, autoformation, heteroformation, and ecoformation, synthesized in Figure 29, constitute an integrated and dynamic formative process, fundamental for building an education that encompasses individual, economic, social, technological, and environmental aspects, adapting to contemporary demands and promoting the transformation of Education in view of Sustainable Development. These three processes are interdependent and integrated, composing the comprehensive education of the individual, that is, constituting the dimensions of subjectivation, socialization, and ecologization (Vieira & Sampaio, 2022).

FIGURE 29: SYNTHESIS OF THE DIFFERENCES BETWEEN AUTOFORMATION, HETEROFORMATION, AND ECOFORMATION

Synthesis of the differences between autoformation, heteroformation, and ecoformation.

Formation type	DEFINITION	MAIN FOCUS	PROCESSES
AUTOFORMATION	Internal process of self-knowledge and personal transformation.	The individual is the protagonist of their own formation.	Individual reflection, autonomy, introspection, and personal development.
HETEROFORMATION	Formation mediated by economic, social, and cultural interactions.	Learning from others.	Interpersonal exchanges, socialization, influence of educators, peers, and groups.
ECOFORMATION	Influenced by the physical, technological, social, and cultural environment.	Relationship with the environment.	Environmental conditions, sociocultural and economic context, technologies, and sustainable practices.

Source: Own elaboration.

Given the complexity of local and planetary problems, the interdependence of knowledges, and the linkage of social and cultural knowledges related to learning in general and teacher education in particular, it is understood that education systems need to abandon traditional fragmented models and adopt inter- and transdisciplinary approaches that consider the complexity of life, of the local and planetary environment, as well as of traditional knowledges and scientific and technological knowledge, thus promoting conditions for innovation and wealth generation, which will foster the formation of the virtuous circle of quality Education in Brazil at various levels of schooling and the training of professionals in different areas of knowledge, especially in graduate education, as the previous chapters have shown.

It is understood that the recommendation in the previous paragraph implies changes in educational policies, curricular alterations, and teacher protagonism for the development of teaching practices that can promote meaningful and transformative student learning, with students also considered protagonists of their learning and formation as critical and responsible planetary citizens. In this sense, graduate education has much to contribute, which is projected in this chapter by proposing steps toward ESD.

According to the 2023/2024 Human Development Report of UNDP (2024), the pandemic period produced great losses in previously obtained advances

in terms of the HDI, especially in developing countries. Although also affected by the pandemic, developed countries recovered quickly. In 2023, while these had recovered from the impacts of the pandemic, only 49% of developing countries had managed to reach pre-pandemic levels. Another important impact pointed out by UNDP was the increase in political polarization and global uncertainty, which have hindered collective action and effective governance.

The document highlights as the main challenges of the present the confronting of the climate crisis, which continues to increase inequalities and threats to human security, especially for populations in situations of socioeconomic vulnerability, among them those with mobility and vision disabilities (Gomes, Marquezine, & Sato, 2022), among others with needs for special attention. The situation is further aggravated by the existing stagnation in international cooperation in critical areas such as food security, biodiversity, and responses to considerable losses resulting from the Covid-19 pandemic.

Despite ongoing technological advancement, especially in artificial intelligence and technological culture, which is reshaping global interdependence, a digital revolution would be necessary; but the technology available, especially for education and social welfare, lacks regulation and equitable investment, which exacerbates socioeconomic disparities. The report proposes a focus on public goods (considering the possibility of concurrent use by several people, with it being difficult to exclude others from its use) that are digital and promote global inclusion.

> Developed countries have achieved a high Environmental Sustainability Index (ESI), good quality education, and social well-being, with a low ecological footprint. However, others do so at high environmental cost. Meanwhile, countries such as Costa Rica and Bhutan, considered developing, achieve quality education and high levels of social well-being associated with appropriate care for the environment. Others, in similar socioeconomic conditions, such as Rwanda and India, have implemented successful strategies by deploying digital platforms in the field of Education (UNDP, 2024).

The 2023/2024 Human Development Report (UNDP, 2024) proposes recommendations in areas such as Education, Culture, Environment, Technology, Health, and Well-Being, aligned with the idea of "reimagining international cooperation," highlighting: (1) global cooperation to address climate change, biodiversity, and pandemics; (2) balanced financing mechanisms and technology

transfer; (3) overcoming digital exclusion in vulnerable regions; (4) investment in digital educational infrastructure; and (5) post-pandemic learning recovery programs. These actions, made possible by partnerships among universities, graduate programs, and institutions such as Secretariats of Education, Environment, and Science and Technology, can strengthen Education for Sustainable Development.

Concluding this section, it can be said that the concerns, steps, and theoretical aspects that undergird this chapter are aligned with UNDP's (2024) diagnosis, perspectives, and recommendations and converge with the teaching, research, innovation, and outreach efforts of Brazilian graduate education.

UNDP's (2024) recommendations are aligned with initiatives of the State Secretariats of Education and the National Common Curricular Base (BNCC) highlighted in this chapter. In this regard, noteworthy are successful experiences put into practice by these Secretariats (see Table 16, Appendix C2).

8.2. SDGS IN TEACHING, RESEARCH, INNOVATION, AND OUTREACH IN BRAZILIAN GRADUATE EDUCATION

In this section, results are reported from the analysis of theses and dissertations and of the highlights indicated by the coordinations of graduate programs in the period 2013–2022, which are directly related to the SDGs. Unlike the previous chapters, in this section a percentage analysis of the works is conducted by CAPES collegia—Life Sciences, Exact and Earth Sciences, and Exact and Earth Sciences[46].

Considering the data analysis of graduate degree completion works in Brazilian graduate education from 2013 to 2022, SDG 3: Good Health and Well-being was the most researched by the Life Sciences Collegium (40% of the works) and the Exact and Earth Sciences Collegium (15%), whereas in the Humanities Collegium, the SDG most emphasized in research was SDG 4: Quality Education (14%), followed by SDG 19: Art, Culture, and Communication (14%).

[46] The related figures can be accessed in interactive dashboards developed exclusively for this work and available at: https://capes.gov.br/BookSDG-dashboard.

Within the Life Sciences Collegium, the field of Health Sciences, more specifically Dentistry, stood out the most with works related to SDG 3: Good Health and Well-being (65%), followed by Biological Sciences II (60%), which encompasses courses related to Biophysics, Biochemistry, Pharmacology, Physiology, and Morphology, and Medicine I, with 59% of the works produced in this field. The same SDG accounted for 34% of the output in Chemistry, 33% in Biotechnology, followed by Engineering II (25%), which includes Chemical Engineering, Mining Engineering, Nuclear Engineering, Metallurgical and Materials Engineering, and Textile Engineering.

In the Humanities Collegium, SDG 4: Quality Education was most addressed in the field of Education (39%), followed by Arts (14%) and Social Work (11%) of the works produced. Considering the fields of Education, Teaching, and Interdisciplinary, it is observed that in Education, 39% of the works produced were related to SDG 4: Quality Education, followed by SDG 19: Art, Culture, and Communication (16% of the works produced). In Teaching, in turn, 33% of the works are related to SDG 4: Quality Education, followed by SDG 3: Good Health and Well-being (11%). In the Interdisciplinary field, the most addressed was SDG 3: Good Health and Well-being (17%), followed by SDG 19: Art, Culture, and Communication (11%).

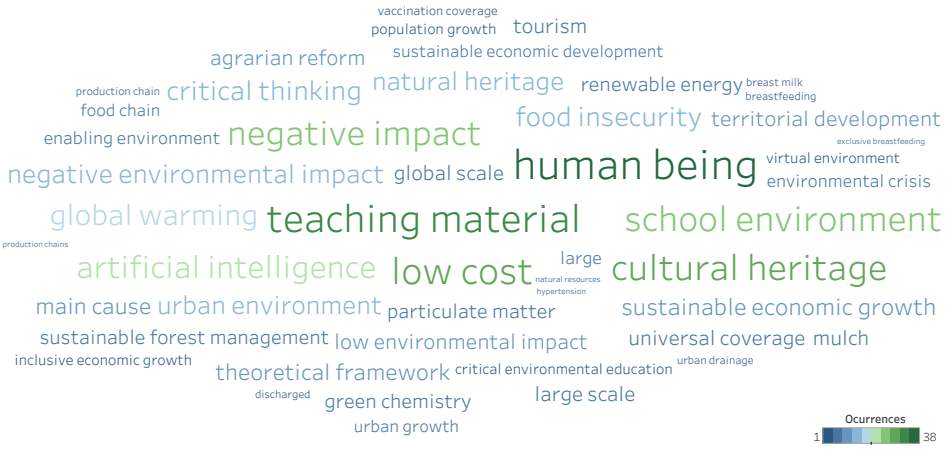
Although Good Health and Well-being was the SDG with the greatest prominence in two collegia, it is essential to stress the importance of research and the development of critical–reflective thinking in the formative process of children and youth on topics relevant to the country, considering the specificities of the regions. For example, No Poverty is one of the least researched SDGs in the works developed, regardless of the region of the country, which is serious when considering the territorial extent of Brazil and the socioeconomic problems that plague the Brazilian population, especially in the North and Northeast Regions (IBGE, 2024). In the North Region, SDG 6: Clean Water and Sanitation, SDG 20: Indigenous Peoples, and SDG 13: Climate Action are still little explored, considering the climate and socioeconomic emergency and the sustainability of Brazil's fauna and flora itself.

The South and Southeast regions, recognized as the most industrialized in the country, with emphasis on basic, petrochemical, automotive, and food industries, still show little expressiveness of research

in SDG 9: Industry, Innovation, and Infrastructure, SDG 7: Affordable and Clean Energy, and SDG 12: Responsible Consumption and Production. The Center-West, in turn, which stands out for the country's grain production, has little expressiveness in the production of works focused on SDG 13: Climate Action and SDG 12: Responsible Consumption and Production. All this points to the work that still needs to be invested in the research developed and the feedback of this into schools with regard to training people committed to planetary citizenship.

When observing SDG 4: Quality Education, from a word cloud with the 50 terms with the highest relevance scores in research conducted by graduate programs (Figure 30), the absence of terms related, for example, to gender equality (target 4.5), teacher qualification (target 4.c), and scholarships (target 4.b) is observed. It is observed that terms related to adequate institutional infrastructure for persons with disabilities are non-existent in the cloud, which points to the need to emphasize research aligned with the targets set for this SDG.

FIGURE 30: WORD CLOUD WITH THE 50 MOST RELEVANT WORDS FOR SDG 4: QUALITY EDUCATION



Source: Own elaboration based on thematic analysis of the highlights reported by graduate programs. Interactive visualization available at https://www.capes.gov.br/BookSDG-fig30.

8.3. PROPOSITION OF POSSIBLE PATHWAYS TOWARD EDUCATION FOR SUSTAINABLE DEVELOPMENT

Brazilian graduate education has historically contributed to society through teaching, research, innovation, and outreach. To strengthen its role in Education for Sustainable Development, public policies are needed that induce, expand, and finance actions, programs, and projects aligned with the four dimensions of the SDGs: social, environmental, economic, and institutional.

In this section, steps are presented for an Education that drives sustainable development, relating actions highlighted by Brazilian graduate education in teaching, research, innovation, and outreach, as well as public policies as a federal, state, and municipal governmental commitment, considering that local and regional specificities need to be adequately addressed for global effects to be achieved[47].

8.3.1. Social dimension

The dimension addressed assesses the satisfaction of human needs, quality of life, and social justice, with indicators linked to demography, employment, health, education, and violence, aligned with SDGs 1 to 5 and 10, in addition to the complementary SDGs 18, 19, and 20 and, especially, SDG 4 (Quality Education). Graduate education plays a central role in training critical and reflective citizens (Hardoim & Batista, 2024) through research, outreach, and educational activities, preparing them to face global and local challenges. This training, which encourages questioning and curiosity, can be expanded to undergraduate and basic education, enabling students to be agents of transformation in their communities.

However, despite the recognized importance of the SDGs in education and research, data from Brazilian graduate education analyzed exclusively for this study and a survey conducted with State Secretariats of Education highlight the need for a more integrated and contextualized approach that

[47] In Appendix C, the steps are presented by thematic categories, making explicit the various interrelated SDGs, in the form of tables.

considers local and regional particularities. This approach is essential to prepare students in higher and basic education to face contemporary challenges in a critical and reflective manner. Brazilian graduate education has the potential to expand programs and projects that connect regional problems to global issues, aligning with the SDGs and contributing to the eradication of poverty and hunger and the reduction of inequalities, as well as promoting quality education, access to clean water, sanitation, and clean energy. These initiatives can integrate graduate students, undergraduates, and basic education through creative actions such as science outreach, campaigns, exhibitions, and fairs, bringing graduate education closer to society and strengthening its social impact.

Brazilian graduate education can play a fundamental role in reviewing and updating the BNCC, integrating the SDGs into basic education and aligning it with the UN 2030 Agenda. With its expertise, it contributes to social justice, the reduction of inequalities, and the strengthening of the university–society relationship. This includes coordinated research and actions on/for the education of youth in situations of social vulnerability, human rights, citizenship, and ethics, promoting inclusion and accessibility.

> In the BNCC – Secondary Education, the recommendation is clear that contemporary themes related to Environmental Education must be addressed transversally across the various curricular components, underscoring the alignment of the document's content with the 2030 Agenda.

Graduate education can also harness the results of its research—generally restricted to journals and academic events—into teaching materials, digital technologies, and active teaching methods, bringing the SDGs closer to students' reality. This involves the development of interdisciplinary and collaborative practices that promote critical–reflective thinking, problem-solving, and civic formation, with a focus on themes such as gender equality, ethno-racial equity, and biotechnology. In addition, graduate education can foster science initiation in basic education through science outreach events aligned with the SDGs, with mentoring by graduate students, strengthening scientific thinking and combating misinformation.

It is recommended that graduate programs institutionalize Education for Sustainability actions, such as lectures, practical classes, and workshops that connect graduate students to society. In the context of SDG 3 (Good

Health and Well-being), these actions may include topics such as healthy eating, sanitation, vaccination, and sports practices, promoting physical and mental well-being and socioemotional skills. By bringing the university closer to society, graduate education expands its social impact, benefiting communities and reinforcing human dignity.

Brazilian graduate education can expand its role in combating climate change and promoting intergenerational awareness through academic and science outreach events, such as workshops and theoretical–practical short courses, that engage teachers, students, and the community at large, fostering sustainable attitudes and values. This effort can be strengthened with the development and implementation of interdisciplinary curricula that integrate the SDGs and the National Environmental Education Policy, with the participation of graduate education researchers. This approach contributes to the formation of citizens committed to sustainable lifestyles and agricultural practices, essential for eradicating poverty and hunger. To enable these actions, it is essential that funding agencies such as CNPq, CAPES, and State Research Foundations issue calls that finance projects focused on research, intergenerational training, and knowledge dissemination, ensuring the sustainability and social impact of these initiatives.

> For Cabral & Gerhe (2020, p. 11), the "implementation of the dialogic relationship of impacts on society and the university brings about fundamental transformations in the way the academic process is developed" and impacts the student's education, consolidating the process of knowledge production in which the "Sustainable Development Goals find fertile ground for aspirations and practices that can leverage the construction of a 'Citizen University' based on a dialogic conception (academy–society) and committed to social transformation."

8.3.2. Environmental dimension

The environmental dimension is linked to SDGs 6, 7, and 12 to 15, with the transversality of SDG 4. Brazilian graduate education can strengthen research on climate change, biodiversity, and the eradication of hunger and poverty, especially in the North and Northeast. With support from CAPES and CNPq, it can produce a positive impact on Basic and Undergraduate Education.

Outreach projects, such as the University Outreach Program (PROEXT), can lead to good sustainability practices, essential for environmental conservation and the inclusion of traditional knowledges, which may lead, among other things, to the development of community gardens and materials recycling.

In the face of social changes generated by globalization and irresponsible consumption, actions such as ecological "hazing" and ecosystem restoration projects encourage the active and sustainable participation of students and communities. These initiatives align the training of new professionals with contemporary demands, promoting sustainable practices and reinforcing the social impact of graduate education on society.

The implementation of public policies to make the aforementioned actions feasible and other actions necessary for sustainability, such as water monitoring, responsible land use, creation of green areas in schools, and ecosystem restoration projects, must be guided by graduate education research, avoiding the commitment of public resources to actions without scientific evidence.

Critical Environmental Education fosters sustainable practices, such as the 5R and the circular economy. Graduate programs (PPG) in Environmental Sciences can train teachers for interdisciplinary teaching on climate change.

Brazilian graduate education can promote research that integrates resilience to climate change into agricultural, urban, and water resource management practices, conserving biomes (such as the Amazon, Cerrado, Atlantic Forest) and ecosystems in freshwater and coastal areas, aligned with SDG 13 (Climate Action), SDG 6 (Clean Water and Sanitation), and SDG 11 (Sustainable Cities and Communities). In addition, the rational use of biodiversity for the development of pharmaceuticals and medicines, combined with sustainable technological innovation, represents another front of action, integrating studies on biotechnology, environmental health, biosafety, and bioterrorism.

To expand its impact on society and contribute to Education for Sustainable Development, graduate education nevertheless needs public calls that finance research and innovation projects on climate change, conservation of natural resources, and local and global environmental issues (Tozoni-Reis, 2007). These initiatives must involve faculty, graduate students, basic education, and the

[48] 5R: rethink, reduce, refuse, reuse, and recycle.

community in activities such as the recovery of degraded areas, interdisciplinary courses for teachers, and actions based on inverted symmetry[49] (Brasil, 2002).

The creation of Collaboration Networks between higher education institutions and schools is an essential public policy, facilitating the exchange of good practices and experiences. Consortia among universities, schools, and secretariats of education can strengthen educational projects aimed at ESD, such as creating teaching materials and teacher training programs, strengthening initial and continuing teacher education with a focus on interdisciplinarity, which is fundamental to Education for Sustainable Development.

8.3.3. Economic dimension

The dimension addressed is directly linked to SDGs 8 (Decent Work and Economic Growth), 9 (Industry, Innovation, and Infrastructure), and 11 (Sustainable Cities and Communities), with the transversality of SDGs 1, 4, 16, and 17. The global economic model, which encourages excessive consumption, often places sustainability in conflict with economic interests, especially due to the high initial cost of sustainable practices, such as solar energy and eco-friendly products, making them inaccessible for populations in situations of social vulnerability. This reinforces the need for public policies that make these practices viable and inclusive.

Brazilian graduate education can contribute through professional training and continuing education actions, preparing individuals to adapt to technological changes and to the labor market, with a focus on decent work and the creation of formal jobs. In addition, graduate education can foster research on the bioeconomy and the creative economy, aligning sustainability, self-knowledge, and future life projects.

It is recommended to finance projects that integrate academic research with market demands, promoting innovation and economic development with an intergenerational vision. These projects should include strategies for science

[49] Inverted Symmetry is a concept that expresses the necessity that individuals involved in training processes experience situations similar to those they will undertake when assuming responsibilities after completing their training.

outreach and the incorporation of financial education and entrepreneurship into school curricula, with the participation of graduate students. Theoretical–practical actions, such as courses and workshops, can result in innovative socioeconomic initiatives for the local economy, such as cooperatives and other forms of collective or individual organization.

Economic policies should promote sustainable growth, the creation of dignified jobs, and social inclusion. To this end, it is essential to encourage the formalization of work, support micro and small enterprises—especially those led by women and youth—and create specific funding mechanisms, such as credit portfolios. In addition, it is recommended that graduate programs work on business incubation in partnership with university initiatives, such as, for example, UFPA's "Business Incubator."

8.3.4. Institutional dimension

The dimension addressed is directly linked to SDG 16 (Peace, Justice, and Strong Institutions) and SDG 17 (Partnerships for the Goals), with the transversality of SDG 3 (Good Health and Well-being), SDG 4 (Quality Education), and SDG 13 (Climate Action). International cooperation is fundamental for sharing technologies, knowledges, and good sustainability practices, with programs such as Science without Borders and CAPES-PRINT driving the internationalization of Brazilian graduate education. These initiatives promote collaborative research on global themes such as health, education, and climate change, in addition to strengthening public–private partnerships to expand sustainable infrastructure and innovation.

It is crucial to avoid the "bystander effect" and strengthen partnerships with funding agencies to ensure resources and calls that encourage projects aligned with the SDGs, especially those developed by master's and doctoral students. In terms of internationalization, as stated in Chapter 3, it is possible for graduate programs (PPG) to advance with clear criteria for raising funds and financing from international institutions. In addition, effective governance, transparency, and social participation are essential for the implementation of the SDGs, with the creation by HEIs of advisory councils composed of representatives from academia, civil society, and business, with democratic participation.

8.3.5. Integration of the dimensions

In Figure 31, an infographic is presented that illustrates integration between the broad goals to be achieved and the necessary centrality of ESD in society, with the collective effort of the educational chain—graduate education, undergraduate education, basic education—in close interaction with communities and institutions, to enhance teaching, research, innovation, and outreach actions. It is incumbent upon federal, state, and municipal managers to consolidate the commitments of public policies for achieving Sustainable Development.

FIGURE 31: INFOGRAPHIC ON THE INTEGRATION BETWEEN THE BROAD GOALS FOR SUSTAINABLE DEVELOPMENT

Source: Prepared by designer Marcella Sarah Filgueiras de Farias, under team guidance.

ESD, at all levels, especially connected with Brazilian graduate education, has significant potential for integrating and popularizing knowledges and technologies that disseminate strategies for achieving the SDGs, especially through the development of reflective and interdisciplinary thinking, in pursuit of forming attitudes and values that move from the local to the global. In addition, monitoring, follow-up, and evaluation systems must ensure the transparency and effectiveness of policies that drive ESD.

8.4. FINAL CONSIDERATIONS

Public policies are essential to induce and finance educational actions that promote auto-, hetero-, and ecoformation from childhood, integrating environmental themes into basic education curricula and teacher education. It is the responsibility of the Federation, States, and Municipalities to induce and finance, and of education systems to adhere to and meet the demands of local and regional communities. This involves participatory diagnosis and planning, with the school and extra-school community, for actions that form planetary citizens, promoting health, well-being, reduction of inequalities, student protagonism, conflict minimization, and partnerships for the execution of collective pedagogical practices.

The implementation of the Technology Facilitation Mechanism[50] must occur through multisector collaboration, accompanied by a review of educational paradigms, including curricula, pedagogical practices, and continuing educator training. For Brazilian graduate education to enhance its impacts on basic and higher education, it is required that teaching, research, innovation, and outreach actions be combined and supported by strategic public policies that finance actions integrating the four dimensions of the SDGs.

Research, innovation, and outreach can ensure social participation and rely on continuous monitoring, strengthening Brazil as a reference in Education for Sustainable Development. In this context, Applied Research plays an essential role in the search for solutions to the challenges of globality, involving graduate students in projects that address local issues and that can be implemented in schools, forging connections with broad local–regional and global issues such as climate change.

It is suggested to create and implement platforms for follow-up, monitoring, and evaluation, both of teaching, research, innovation, and outreach actions and of public policies, in order to ensure transparency to society regarding the knowledges and results generated. In the same way, it should support decision-making on partnerships and the allocation of public resources for ESD.

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[50] UN Technology Facilitation Mechanism, an online platform that helps countries achieve the SDGs, available at: https://capes.gov.br/aYRCZ.

Finally, differentiated criteria are considered necessary to address regional asymmetries, taking into account the geographic distribution of graduate programs (PPG), ensuring that less developed regions can have their own Programs and manage to maintain them, as mentioned in Chapter 3. The creation of professional master's and doctoral programs focused on sustainability, encouraging the participation of public-school teachers in the construction of sustainable educational environments, is a relevant alternative. In addition, the implementation of programs similar to the Pedagogical Residency is suggested, tutored by graduate education and aligned with the SDGs. Another contribution of the graduate programs (PPG) would be participation in public calls for interdisciplinary training and teaching innovation, promoting applied research on sustainability with direct impact in the classroom. This approach is essential for ESD to become a State investment in Brazilian graduate education and a continuous commitment of formal and non-formal education throughout the country.

AFTERWORD

The book *Impact of Brazilian graduate education on the 2030 Agenda: Contribution of the National Graduate Education System to COP 30 in the Amazon* represents a contribution of the National Graduate Education System to the theme of sustainability. The work revisits a similar initiative carried out in 2012 and reflects the efforts of the 50 evaluation areas, the National Association of Graduate Deans (FOPROP), ANPG, and the CAPES technical staff.

Although the COP's main objective is to lead the fight against climate change, the concept of this work adopts an anticipatory focus, characteristic of educational processes. It begins with the recognition that we are living through a climate emergency, which requires a revision of current ways of life and production. To this end, it is essential to invest in the education of people capable of leading decision-making processes in all spheres—State, Market, and Organized Civil Society—and in their interrelations, generating positive impacts for sustainable development.

The preventive approach runs counter to the prevailing short-term vision, which seems to take as its parameter the biological time of a human generation, as if there were no others. It is necessary to incorporate a medium- and long-term perspective that considers the intergenerational dimension and the continuity of life, encompassing not only human beings but also nonhumans. After all, humanity is dependent on nature and part of it. Only from this perspective is it possible to confront the rationality of the economic model that irrationally exploits natural resources and degrades the environment.

In this sense, the work has a formative character by offering a contribution on the impact of Brazilian graduate education on the 2030 Agenda, as a public policy that offers an alternative pathway in the face of the growing crisis of climate emergencies. As the CAPES president highlighted in the Foreword, this publication represents yet another contribution of the SNPG to building a better Brazil, an inclusive Brazil for all people, present and future.

It is an effort that gives continuity to a previous contribution that involved eight evaluation areas in the last benchmark publication on the topic, entitled *Contribution of Brazilian graduate education to sustainable development: CAPES at*

Rio+20. That document was produced as a result of the United Nations Conference on Sustainable Development, held in 2012 in Rio de Janeiro.

The book contextualizes the SDGs as the result of a historical process in which the socio-environmental issue is an essential presupposition to ensure the well-being of current and future generations. The SDGs represent efforts in multiple spheres—geopolitical, sectoral, and of social movements—and are the fruit of more than 50 years of dialogues among different international, national, state, and municipal spheres. Therefore, they are not merely pragmatic goals. Based on the guidelines of the PNPGs, including the current one (2025–2029), efforts to achieve the SDGs are mapped, as well as the design of strategies for their implementation, as established in the documents that guide the 50 CAPES evaluation areas for the 2025–2028 quadrennium. The potential impacts of master's dissertations, doctoral theses, and other graduate degree completion works defended over the last 12 years are also analyzed.

In addition, the work presents about 2,000 highlights of experiences submitted by approximately 1,010 graduate programs (22% of the 4,766 in existence), encompassing 251 institutions (54% of the 461 that offer PPG in Brazil). These experiences are developed through teaching, research, innovation, and outreach activities aligned with the SDGs, especially at the territorial level. The highlights demonstrate concrete impacts that go beyond the potentialities suggested in theses and dissertations. These are not perfect experiences or an idealized world, but real actions carried out in diverse contexts, where educational institutions are embedded and where people live. Under these conditions, meeting the SDGs becomes an impact indicator capable of offering responses to concrete challenges and a dimension for evaluating graduate programs in the 2025–2028 cycle.

The last chapter presents a work agenda resulting from the book's collective effort, indicating the steps necessary to generate effective socio-environmental impact. Concepts and perspectives present in the ESD literature are discussed, with an emphasis on knowledge building throughout the entire educational chain—from basic to higher education—with graduate education as the final stage which, in addition to educating people, generates knowledge that reorients the practices and content of the other levels of training.

Among graduate education activities, interaction with society is still underestimated, with great potential for ensuring that the knowledge chain does not end with knowledge generation, but that it is implemented and shared with

the various sectors that make up the social fabric. However, in a society marked by inequalities and more frequent situations of climate emergency, the interaction of graduate programs with society plays a strategic role. This two-way street goes beyond merely transferring knowledge; it is an effective sharing of knowledges.

Demonstrating the impact capacity of graduate education is fundamental, especially in the training of teachers. The tables that highlight the relevance of basic education—through the curricular bases and research conducted in partnership with Secretariats of Education—show the importance of this stage. For graduate education to generate effective impacts, it is essential that basic education be aligned with the principles of Sustainable Development, making it possible to implement concrete steps. Although the focus of this book is the impact of graduate education, the pathway to Sustainable Development becomes longer if education for that end does not begin at the basic level. From this perspective, an education is needed that prepares people capable of moving among different fields of knowledge and of offering solutions to contemporary challenges without, however, creating new problems.

Humanity faces a great challenge in promoting education for sustainability. Studies show that actions carried out within the scope of climate education still have little effectiveness in people's daily practices. Therefore, one of the main indicators for assessing whether education is, in fact, oriented toward sustainable development is the capacity, in the near future, to establish a direct relationship between educational advances and the reduction of environmental impacts.

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IMPACT OF BRAZILIAN GRADUATE EDUCATION ON THE 2030 AGENDA:

Contribution of the National System of Graduate Education to COP 30 in the Amazon

This book examines the impact of Brazil's stricto sensu graduate education on the United Nations (UN) 2030 Agenda, drawing on a curated set of case study highlights from projects and initiatives across the nine broad areas of knowledge. It also identifies themes related to the Sustainable Development Goals (SDGs) that appear in the guiding documents of the 50 evaluation areas that structure Brazil's evaluation system. In addition, it offers a historical overview of the National System of Stricto Sensu Graduate Education and the National Graduate Education Plans, and presents indicators of graduate education output (theses, dissertations, articles, and other intellectual products). Finally, it proposes pathways to advance Education for Sustainable Development.

CAPES
MINISTÉRIO DA EDUCAÇÃO
GOVERNO DO BRASIL
DO LADO DO POVO BRASILEIRO