









#### **APRIL 2025**

#### **ICLEI - Local Governments for Sustainability**

Rodrigo Perpétuo - Executive Secretary Rodrigo Corradi - Deputy Executive Secretary Keila Ferreira - Technical Coordinator Marília Israel - Regional Technical Coordinator Isabela Barbosa - Institutional Relations and Advocacy Coordinator Isadora Buchala - Resilience Analyst Luisa Acauan Lorentz - Biodiversity Analyst Tiago Mello - Technical Analyst Fernanda Gouveia - Communication Analyst Fernanda Amorim - Regional Assistant for Institutional Relations and Advocacy Rodrigo Nehara - Biodiversity Assistant Jhonathan Freitas - Communication Assistant Gustavo Barbosa - Communication Assistant

#### Collaboration

Bráulio Diaz Gil Scatena Rodrigo Nehara

#### **Municipal Government of Belém, PA**

Igor Wander Centeno Normando - Mayor

Cassio Coelho Andrade - Deputy Mayor

Juliana Nobre Pinheiro - Municipal Environment Secretary – SEMMA

Humberto Bozi Spindola - Municipal Secretary of General Coordination for Planning and Management - SEGEP

#### **Document Review and Finalization Team**

**Ramyle Pontes Soares - SEMMA Superintendent** 

Larissa Rabêlo da Silva - SEMMA Technical Advisor

Jorge dos Santos Pinho - Director of Projects and Landscaping, SEMMA

Naiane Machado dos Santos - Director of Environmental Control, SEMMA

Antonio Carlos de Jesus dos Santos - Communication Advisor, SEMMA /Secom

Ingrid Tatiany Ribeiro de Souza Mendes - Director of Municipal Development, SEGEP

Alice da Silva Rodrigues Rosas - SEGEP

Davina Bernardete Oliveira Lima - SEGEP

#### Document development team

Edmilson Brito Rodrigues João Cláudio Tupinambá Arroyo Christiane Ferreira da Silva Alana Canosa do Nascimento Alexandre de Souza Mesquita Alice da Silva Rodrigues Rosa Ana Luiza de Araújo e Silva Davina Bernadete Oliveira Lima David Figueiredo Ferreira Filho Eliana Bogéa Ellen Karen Borges Bezerra **Ewerton Moraes Aood** José Akel Fares Filho Mauro Gilberto Ribeiro da Costa Nathália Obando Maia Mendes Rubens Fagundes de Vilhena

#### Contributions

Roberta Macedo Cerqueira - HF Herbarium of the Federal University of Pará (UFPA)

Normélia Vasconcelos - UFPA

Marlúcia Bonifácio Martins - Emílio Goeldi Museum of Pará Cândido Ferreira de Oliveira Neto - Federal Rural University of the

Amazon (UFRA)

Marcus Vinicius de Oliveira Magno - UFPA

Sérgio Brazão e Silva - Municipal Forum on Climate Change (FMMCB)

Nathália Obando Maia Mendes - Environmental Engineer

Homero Reis de Melo Junior - Mineral Resources Research Company (CPRM)

#### **Design and illustration**

Jambo Studio

#### Tradução

Amanda Pinho Luisa Acauan Lorentz

Explanatory Note: This document was developed by ICLEI - Local Governments for Sustainability for the Municipal Government of Belém, as part of the Ecosystem Services Diagnosis part of the NBCities project, funded by the Global EbA Fund.

## **DOCUMENT INTRODUCTION**

This document provides a summary of the results obtained during the development of the Ecosystem Services Diagnosis for Belém, as part of the Nature-Based Cities: Biodiversity and Climate Resilience for Urban Development (NBCities) project, implemented by ICLEI South America and funded by the Global Ecosystem-based Adaptation (EbA) Fund.

Located within the Amazon Rainforest and one of Brazil's most important capitals, the city was selected to host the World Climate Conference, COP30, in 2025. Through an Ecosystem-based Adaptation approach, the NBCities project, which started in June 2023, aimed to support evidence-based planning to integrate the climate and biodiversity agendas in the city.

#### **ICLEI - Local Governments for Sustainability**

A global network of more than 2,500 local and regional governments committed to sustainable urban development. Active in over 125 countries, ICLEI's network in South America connects members from eight countries in the region to this global movement. We influence sustainability policies and drive local action for low-carbon, nature-based, equitable, resilient, and circular development.

#### **Municipality of Belém**

The project was carried out in collaboration with the technical team of the Municipality of Belém, with notable support from the Secretariat of General Coordination of Planning and Management, the Municipal Secretariat for the Environment, the Municipal Forum on Climate Change, and the Civil Defense. It also benefited from the collaboration of municipal partners such as the HF Profa. Normélia Vasconcelos Herbarium of the Federal University of Pará (UFPA), the Federal Rural University of the Amazon (UFRA), the Emílio Goeldi Museum of Pará, and the UN Refugee Agency (UNHCR).

#### **Global EbA Fund**

The Global EbA Fund is a catalytic funding mechanism for supporting innovative approaches to EbA to create enabling environments for its mainstreaming and scaling up. The fund is financed by International Climate Initiative (IKI) of the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection (BMUV) and co-managed by the International Union for Conservation of Nature (IUCN) and partners. Learn more about the Fund and apply for a grant through the website: https://globalebafund.org/





#### **BELÉM CITY HALL**

Belém, the capital of the state of Pará, embodies both tradition and modernity. It preserves a rich cultural and historical heritage. Now known as the "Capital of the Amazon," the city stands out for its colonial architecture, with landmarks such as the *Ver-o-Peso* Market and the *Theatro da Paz*, symbols of the peak of the rubber boom that now blend into a cosmopolitan landscape. The local culture is vibrant, centered especially around the Círio de Nazaré, the world's largest religious celebration, held on the second Sunday of October. Belém's gastronomy is recognized worldwide, bearing the title "Belém Creative City of Gastronomy" granted by UNESCO (only four cities hold this title), a testament to its unique cuisine highlighted by dishes such as *açaí*, *tacacá*, and *pato no tucupi*. The city also preserves its natural charms, with areas like the Utinga State Park, the Guajará Bay waterfront, and the Rodrigues Alves Amazon Botanical Garden offering refuge for the region's fauna, flora, and citizens amidst the bustle of urban life.

Belém is the Brazilian city that has received the most public investment in recent years and, in November 2025, will host the 30th United Nations Climate Change Conference (COP-30), one of the world's leading events on the subject. The city is undergoing a moment of transformation, combining its rich cultural and natural heritage with a hub of development, economic growth, and policies of innovation and sustainability, such as the "Green City" project, which aims to plant 10,000 seedlings per year over the next four years to expand the city's urban green areas. Hosting COP-30 in 2025 highlights Belém's global role in the climate change debate and in shaping a sustainable future for the Amazon.

#### Igor Wander Centeno Normando Mayor of Belém

#### **ICLEI ASOUTH AMERICA**

Belém joined ICLEI in 2022, focusing on the development and promotion of public policies and actions for low-carbon development, adapted and resilient to the climate crisis, promoting urban biodiversity and the inclusion of vulnerable populations. The municipality holds a prominent position on the international agenda, having been chosen as the host city for COP30, which highlights the importance of a sustainable development agenda aligned with the needs of Amazonia's diverse contexts, including urban perspectives.

ICLEI is proud to be part of this process through the project Nature-Based Cities: Biodiversity and Climate Resilience for Urban Development (NBCities), implemented by ICLEI South America and funded by the Global Ecosystem-based Adaptation (EbA) Fund. Part of the project, the Ecosystem Services Diagnosis represents a powerful tool that considers Belém's urban reality in its relationships with nature, both within and around the city. The document reflects this diversity and considers both the potential and the challenges of an Amazonian metropolis, serving as a crucial resource to guide not only the Climate Action Plan but all instruments aimed at ensuring a more sustainable and resilient city, including Belém's New Master Plan.

Enjoy your reading!

Rodrigo Perpétuo Executive Secretary, ICLEI South America

# SUMMARY

1. Introduction: The Ecosystem Services Diagnosis and the path towards Nature-Based Cities	04
2. The Development of The Ecosystem Services Diagnosis for Belém	05
3. Main results: The relationship between nature and people in the state capital of Pará	09
3.1 Green Areas in Belém, Pará	12
3.2 Regulating Ecosystem Services Cooling Capacity Carbon Stock	17 17 17
Quantity and quality of freshwater	18
<ul> <li>3.3 Provisioning Ecosystem Services</li> <li>Fishing</li> <li>Food and Agroextractivism</li> <li>Medicinal Plants</li> </ul>	19 19 19 21
3.4 Cultural Ecosystem Services Mental and Physical Health and Social Relationships Cultural Heritage and Spiritual Relationships Ecotourism and the Aesthetic and Inspirational Values of Nature	21 22 22 23
3.5 Threats Urban Expansion and Occupation of Risk Areas Water Pollution Negative Impacts Related to Tourism Monoculture, Deforestation and Resource Extraction Desmatamento.	24 24 25 25 25
4. Integrated analysis	26
5. Illustrated map Illustrated Map of the Ecosystem Services Diagnosis of Belém, PA	27 28
6. Final Observations	29
7. References	30 33

#### 1

# Introduction: the Ecosystem Services Diagnosis and the Path Towards Nature-Based Cities

The current model of urban development has created multiple pressures on the Earth's ecosystems, accelerating the biodiversity loss crisis, which is intertwined with the ongoing climate emergency. The combined impact of these crises creates continuous and increasingly significant challenges for local governments. The negative effects of biodiversity loss, which are still collectively less perceived, are related to the reduction of ecosystems' adaptive capacity, representing significant risks to society. In addition to losses related to quality of life and food security, there are also serious warnings about economic losses across various sectors, as over 50% of the world's GDP (equivalent to US\$44 trillion) depends on nature, its functions, and associated services, and can be affected by its destruction (WEF, 2020).

Pará, a vast and biodiverse state in northern Brazil, faces significant challenges related to climate change and biodiversity loss. Accelerated deforestation compromises its tropical forests, which are vital for global climate regulation. Additionally, changes in precipitation and temperature patterns, associated with shifts in land use, threaten local ecosystems, the lives of traditional communities dependent on the forest, and activities that are important to the state's economy, such as agriculture and livestock farming. The state is pursuing actions to move away from being one of Brazil's largest CO2 emitters to positioning itself at the forefront of climate action. In this context, the bioeconomy emerges as a strategic axis, as forests and biodiversity are leveraged as elements for income generation, social inclusion, and climate change mitigation. The State Bioeconomy Plan thus recognizes the central role of biodiversity in building a low-carbon productive and economic agenda, towards sustainable, inclusive, and equitable development in the state (Pará, 2021).

The state capital, Belém, has also been adopting its own measures to boost this agenda at the municipal level. The city joined ICLEI in 2022 to advance the promotion of public policies and actions for sustainable, socially inclusive development in harmony with nature and resilient to climate change. Belém has been working to strengthen a collective strategy for sustainability and climate compliance, and the Ecosystem Services Diagnosis, conducted with ICLEI's technical support between September 2023 and October 2024, stands as a new resource to support the implementation of these actions.

It is essential to rethink how cities relate to nature, particularly with regards to biodiversity conservation. The concept of Ecosystem Services (ES) helps to highlight the connections between quality of life, health, and public safety in cities and ecosystem conservation (ALCAMO, 2003). Based on this concept, the Ecosystem Services Diagnosis provides public administration with in-depth knowledge of the potential offered by nature within the city limits. This understanding enables the design of efficient strategies to address territorial challenges and promote nature-based development.

Based on the contributions of the Diagnosis, the city has the opportunity to more robustly align itself with international agendas, such as the Sustainable Development Goals (SDGs), the United Nations' New Urban Agenda, the frameworks and parameters of the International Union for Conservation of Nature (IUCN), as well as the new Global Biodiversity Framework. Positioned as a relevant resource for the formulation of Belém's Climate Action Plan, the Diagnosis contributes to a process whose end, materialized in the city's climate regulations, is also proactive, indicating potentials and windows of opportunity, showing that it is possible to innovate within the city's own context.

The role of local governments for nature-based development: While biodiversity and ecosystem degradation lead to socio-economic and environmental crises, their protection and promotion can bring new opportunities for socio-economic development (BPBES, 2019). To harness this potential, however, it is necessary to go beyond sectoral policies, as is the usual practice, and include these elements in a transversal manner, connecting different management scales and reinforcing the need and usefulness of multi-level governance actions.

Since threats to ecosystems and biodiversity stem from problems at various levels, successful mitigation and adaptation to negative impacts require political interventions at all governance scales, from local to international (BPBES, 2019). The involvement of local actors in designing and implementing strategies for biodiversity conservation and ecosystem services is crucial, for example, in prioritizing local protected areas and qualifying them according to the specific characteristics of the territories. Local governments have a much deeper understanding of the potentialities, threats, and pressures in their territories, and are therefore fundamental to achieving global and national biodiversity and climate emergency goals.

#### The Development of the Diagnosis of Ecosystem Services in Belém

**Ecosystem Services** (ES) refer to the direct and indirect benefits that ecosystems provide to human well-being in the form of goods and services (MEA, 2005). They can be categorized into three major groups:



#### **PROVISIONING SERVICES**

Goods or products obtained from ecosystems, such as raw materials, food, freshwater, energy resources, and medicinal, biochemical, and pharmaceutical resources.



#### **REGULATING SERVICES**

Natural processes that regulate climate, hydrological, and biological conditions, helping to maintain environmental balance and quality of life on the planet. Examples include climate regulation, water purification, biological control, pollination, erosion prevention, and the maintenance of soil fertility, air quality, and water quality.



#### **CULTURAL SERVICES**

Often non-material benefits that people derive from their relationship with the environment, such as leisure and relaxation. These services reflect even more so the specific characteristics of each context.

Thus, the Ecosystem Services Diagnosis for Belém provides a comprehensive analysis of several crucial aspects of the benefits provided by ecosystems within the city's territory. Through an integrated approach, the methodology of the Ecosystem Services Diagnosis combines official municipal information, scientific knowledge, and collective and social knowledge by including diverse actors in workshops, meetings, and events to reinforce the complementarity and compatibility between secondary data and the reality of the territory. The methodology is based on six stages. A metodologia<sup>1</sup> baseia-se em 06 etapas

The process includes a moment of training and points out pathways for translating the learnings into the specific local context, resulting in a critical review of municipal planning instruments. The Diagnosys promotes the interface between science and public policies, contributing to the integration of nature into data-based development planning. More than that, it seeks to advance with a broader concept of interface-bridge between knowledge and decision-making, considering multiple actors and scales.

In this sense, validation with local technical bodies consisted of a cross-cutting step in the elaboration process, in addition to specific stages for adaptation, prioritization, and participatory mapping, resulting in scientifically-based knowledge that is co-constructed and reflects local priorities and visions.

#### Figure 1 - Methodological Stages of the Ecosystem Services Diagnosis for Belém



<sup>&</sup>lt;sup>1</sup>Adaptada da proposta utilizada pela GIZ - Deutsche Gesellschaft Für Internationale Zusammenarbeit (GIZ, 2012; MMA e GIZ, 2018), baseada na iniciativa The Economics of Ecosystems & Biodiversity (TEEB, 2010) e de Burkhard (2012).



## Mapping in the Ecosystem Services Diagnosis:

Considering that urban and regional planning involves territorial decision-making processes, mapping proves to be a relevant tool for understanding the spatial distribution of services provided by ecosystems, as well as risks and threats to their supply (TEEB Regional-Local, 2018). The Ecosystem Services Diagnosis of Belém focused on the following spatialized issues:



Provision of Regulating, Provisioning, and Cultural Ecosystem Services



Availability, distribution, and accessibility of green areas



Threats to ecosystem services and biodiversity

Within each group of Ecosystem Services (cultural, provisioning, regulating), there are specific categories to facilitate the identification and quantification process. Their clear definition is important to ensure the consistency of the analyses. After the initial data collection and alignment with the city, the following Ecosystem Services categories were considered for the **Ecosystem Services Diagnosis of Belém**:

	ECOSYSTEM SERVICE	INDICATORS
REGULATING ECOSYSTEM SERVICES	Climate regulation	Carbon sequestration (ton/ha)
		Heat mitigation capacity (HMI)
PROVISIONING ECOSYSTEM SERVICES	Freshwater	Annual water generation capacity (mm)
	Food	Areas used for food systems (industrial agriculture, family farming, and extractivism)
	Raw materials	Areas used for extraction of timber and non-timber forest raw materials
	Medicinal, biochemical, and pharmaceutical resources	Areas for the extraction and/or production of medicinal plants
CULTURAL ECOSYSTEM SERVICES	Social relations	Places where people go to meet and share moments together
	Inspirational and aesthetic values	Places recognized for their aesthetic value, often inspiring forms of artistic expression
	Spiritual and/or religious values	Places related to spiritual and/or religious expressions (including natural areas for ceremonies and/or with symbolic species)
	Ecotourism	Places for nature tourism and/or ecotourism (hiking, canoeing, wildlife observation, etc.)
	Cultural heritage	Locations with high historical and cultural value, related to the city's identity
	Dhysical and	Places for outdoor exercise
	mental health	Places that reduce stress and bring a sense of well-being

In a complementary manner, the green areas in the municipality were also analyzed, given their relationship with the provision of different ecosystem services, including an assessment of the **availability**, **distribution**, and **proximity of the population** to public green areas in Belém. Finally, beyond the benefits derived from ecosystems, it is also essential to assess the threats arising from human actions that may affect the continuity of these positive aspects, in order to identify trends of changes in their supply.

For this, four groups of direct pressures related by the UN to ecosystem changes and, in particular, to biodiversity loss were evaluated. Based on the discussion in the literature, the respective categories of potential underlying causes were identified to facilitate their recognition in the territory, focusing on potentially harmful activities:



Distinguishing threats considering the specific context of each location is essential for designing conservation interventions that are appropriate for the territorial context. In this sense, after a stage of discussion and mapping of the threat categories in Belém, a dynamic was carried out to identify those threats considered a priority for the municipal reality.

The mapping that forms the Ecosystem Services Diagnosis combines two methods, integrating data obtained from geotechnologies and modeling with those related to the knowledge of local social agents.

#### Geotechnologies

The Integrated Valuation of Ecosystem Services and Trade-offs (InVEST) software is a tool that has been widely used for ecosystem service mapping, as it offers a set of models that allow quantification of ecosystem services and their potential benefits to human society (Sharp et al., 2020).

For the analysis of Belém, InVEST assisted in evaluating Urban Cooling Capacity (Urban Cooling Model) and Carbon Storage (Carbon Storage and Sequestration Model), related to the **Ecosystem Service of Climate Regulation**, and the Annual Water Yield Capacity (Annual Water Yield Model), important for understanding the **Ecosystem Service of Water Provision**. The ecosystem service mapping process also benefited from the use of remote sensing technologies. For this study, data obtained from Landsat 8/9 satellites were used, providing high-resolution spatial images.

#### **Participatory Mapping**

In addition to the data obtained from remote sensing and modeling, the Ecosystem Services Diagnosis of Belém included participatory mapping, focused on provisioning and cultural ecosystem services and the identification of threats, according to the perspectives of local actors. Two participatory workshops were held, validation sessions with the City Hall Working Group, and meetings with specialists from the Emílio Goeldi Museum and the Herbarium of the Federal University of Pará (UFPA) to define the flora and fauna collection that reflects the consideration of biodiversity in the Diagnosis, especially in the Illustrated Map that synthesizes the results.

In the first workshop, held in person in December 2023, 55 participants from 15 neighborhoods were present, with gender (50.9% women) and race/ethnicity diversity (56.2% black, mixed-race, and Indigenous). There was also a diversity of sectors, with representatives from academia (9%), civil society (15%), civil defense (6%), metropolitan agency (3%), and professional councils (3%). Although most participants (63.6%) worked for the City Hall of Belém, they were active in different departments, such as Management and Planning, Education, Environment, Sexual Diversity, Sanitation, Urbanism, and Auditing.

Participatory mapping is very useful to complement the modeling approach by integrating the perceptions of local social agents, which allows, for example, the identification of dynamics, phenomena, and processes at the everyday scale that are not identified in other sources of information.

Figure 2 - Participants in the Participatory Mapping Workshop, Belém – PA, Dec/2023. Picture: Marília Israel/ICLEI, 2023



# Main results: the relationship between nature and people in the state capital of Pará

Belém is located in the western Brazilian Amazon northeastern Pará (Figure 3). As the state capital, it is one of the most important cities in the Amazon and forms the Metropolitan Region of Belém (RMB), along with seven other municipalities. The city has 1,059.458 km<sup>2</sup> of territorial extension (around 0.08% of the state's territory).

3

Located on a flat plain, its lowlands lie just 4 meters above sea level, while the highest portions reach 16 meters (Cardoso et al., 2023). With a rainy tropical climate, the city receives an average annual precipitation of 3,308 mm. During the summer months, from January to March, the monthly average exceeds 390 mm, while August and September are the months with the lowest levels of precipitation, with a monthly average below 130 mm (INMET, 2022).

Situated at the confluence of the Guamá River and the Guajará Bay, which is part of the Marajoara Gulf, the city is subject to daily ocean tides and is crisscrossed by numerous watercourses and their associated floodplains (Gonçalves, 2016). Among the most significant rivers in the region are the Maguari, Aurá, Guamá, Murubira, and Pratiquara, in addition to several streams that meet the main watercourses. Additionally, the bays of Marajó, Santo Antônio, and Sol hold considerable importance (Mercês, 1997 as cited in Catete, 2010). The municipality is divided between a continental portion and an island portion. The continental portion accounts for 34.36% (17,378.63 ha) of the total area, while the island portion is made up of 39 islands and corresponds to 65.64% (33,203.67 ha) of the city's total area. Most of these islands are densely forested with low population density. However, Mosqueiro, Caratateua (Outeiro), and Cotijuba are exceptions, featuring urbanized areas and a larger population. In general, the islands play a fundamental role in the city's landscape, reflecting its *ribeirinho* character crisscrossed by rivers, streams, *igarapés*, and tide channels.

The total population of Belém was estimated at 1,303,403 inhabitants (IBGE, 2022). According to the Statistical Yearbook of the Municipality of Belém 2020, although most of the municipality's total area is classified as a rural area (258.11 km<sup>2</sup>), nearly the entire population (99%, according to the 2010 Census) resides in the urban area (250.20 km<sup>2</sup>), primarily located in the continental portion. This highlights the importance of addressing the urban perspective of the Amazon in the debate on sustainable development and urban planning integrated with nature. The city is divided into 72 neighborhoods, organized into eight administrative districts: Belém (DABEL); Benguí (DABEN); Entroncamento (DAENT); Guamá (DAGUA); Icoaraci (DAICO); Mosqueiro (DAMOS); Outeiro (DAOUT), and Sacramenta (DASAC) (Figure 6).





Figure 4 - Some of the main water bodies in Belém, PA



#### Figure 5 - Administrative division of Belém, PA



Belém's natural vegetation fragments are characterized as dryland forests and floodplain forests, both part of dense Ombrophilous vegetation types (Tavares, 2019). At the moment, the proportion of land use and coverage in Belém is distributed as follows: **31% forest formation**, **28% floodplain forest**, **27% urbanized areas**, **9% grassland mosaic**, **3% mangrove**, **2% flooded fields and swampy areas** (Figure 7). There are no significant traces of agriculture (MapBiomas, 2020), which aligns with the relatively small size of the municipality's rural area — approximately 6,000 hectares (Instituto Escolhas, 2022)

A phenomenon common to most large Brazilian cities, the urban expansion over time is evident, as well as the reduction of natural classes of land use and cover. Natural attributes have played a crucial role in the formation and configuration of the city since it was in dialogue and conflict with the forests and, even more significantly, with rivers and bodies of water. As a result, the city's expansion has sometimes occurred at the expense of these attributes and sometimes in adaptation to them, shaping the current territorial, cultural, and socioeconomic characteristics of Belém.

#### PROPORÇÃO DE USO E COBERTURA DO SOLO



Figure 6 - Sankey Chart - Soil usage conversion

In 2021, the city's GDP reached R\$33.4 billion, representing 12.7% of the state's GDP. On the other hand, the Gini index, which measures the degree of income concentration in a given group, has indicated an increase in inequality in Belém. While 0 corresponds to complete equality and 1 represents complete inequality, the city's Gini index value increased from 0.44 in 2003 to 0.61 in 2010. The service sector alone accounted for 53% of the city's economy, tourism being a particularly important activity (FAPESPA, 2021). In addition to religious tourism, with emphasis on the Círio de Nazaré procession, ecotourism has grown, driven by natural resources, including river tourism.

Amazonian biodiversity also plays a significant role in the growing gastronomic tourism in Belém. Since 2015, the United Nations Educational, Scientific and Cultural Organization (UNESCO) has recognized the city as a Creative City of Gastronomy. Regional dishes like pato no tucupi, maniçoba, and tacacá, as well as juices, sweets, and ice creams made from Amazon fruits such as açaí, cupuaçu, and bacuri, exemplify this connection, which is also reflected in local artisanal production. Furthermore, although agriculture does not make a significant contribution to the municipal GDP overall, agroextractive activities serve as a means of subsistence and supplementary income for many families (Gonçalves, 2016; Mesquita, 2017; Instituto Escolhas, 2021).

Therefore, it is clear that ecosystems are a fundamental part of Belem's urban dynamics. The Diagnosis results highlight and deepen the understanding of this connection.



#### Figure 7 - Sankey Chart - Soil usage conversion



#### 3.1 Green Areas in Belém, Pará

Green spaces are essential to urban resilience, since they encourage social interaction and outdoor sports practices. These areas also enhance mental health and reduce stress, loneliness, and depression (WHO, 2017, WRI, 2019). Depending on the environmental characteristics of a given area, urban green spaces can further contribute to increased urban biodiversity, climate change mitigation, and the reduction of atmospheric and noise pollution (WHO, 2015).

Green area metrics help evaluate the quality of urban ecosystem services. These metrics provide direct measures to assess not only the amount of green space available to residents but also its accessibility — a significant factor for evaluating ecosystem services related to human well-being and leisure.

Green areas in the city (60%) score at the maximum range on the "Proportion of Natural Areas in the City" indicator from the Singapore Index on Cities' Biodiversity, also known as the City Biodiversity Index.

Although this result is positive, the city should adopt an ambitious approach to expand and qualify not only urban and peri-urban green areas but also its protected and conserved areas. In addition to meeting the **goal of having 30% of terrestrial and marine areas protected by 2030**, as established by the new Global Biodiversity Framework - GBF, adopting a proactive approach towards protecting biodiversity and green areas in the city could bring significant benefits for Belém's urban and socioeconomic development. Potential gains include improved quality of life, increased resilience to climate change, and attracting new investments.

Although green areas — including private ones — contribute to cities' environmental balance and enhance the quality of life, the population mostly feels such benefits from the direct use of these spaces. Therefore, it is essential to contemplate the availability and distribution of public green areas, which deepens the understanding of the population's interaction with nature in the city

Public Green Areas Index values in the city are as follows:

• 13.2 m<sup>2</sup> of public green areas per inhabitant, considering the entire municipal perimeter;



#### **GREEN AREAS:**

Vegetated areas, including forest formations (e.g. floodable forests and mangroves) and non-forest areas (e.g. floodable fields, grasslands). These also include urban afforestation on streets, avenues, and within lots and buildings.

Total proportion of Green Areas in the City:

There are **304.4** km<sup>2</sup> of green areas in the municipality (**60%** of the total municipality area)

• 3.1 m<sup>2</sup> of public green areas per inhabitant, focusing exclusively on the urban macrozone.

The value obtained for the urban macrozone of Belém  $(3.1 \text{ m}^2)$  highlights the importance of better managing the city's green areas. For instance, it indicates the need to expand public green areas within the urban fabric. When applied to the neighborhood scale, this index also offers a comparative view within the municipality, revealing different regional realities that emphasize the need to expand green areas in an even more pronounced way.

#### PUBLIC GREEN AREAS PER INHABITANT



#### PUBLIC GREEN AREAS



CODEM, 2016

The Neighborhoods with the greatest presence of public green areas are **Mangueiras** (1), in the Mosqueiro Administrative District, home to Mosqueiro Municipal Park, and the neighborhoods of **Curió-Utinga** (2), **Val-De-Cans** (3), **Mangueirão** (4), and **Guanabara** (5). These neighborhoods, which show higher positive results, are located in two districts with significant green spaces: the PNM de Mosqueiro and PEUT and Gunnar Vingren, respectively. On the other hand, neighborhoods with the least presence of public green areas are **Guajará Park** (8), in Icoaraci Administrative District, and **Cabanagem** (6), **Green Park** (7), and **Saint Clement** (9), all in the Benguí Administrative District (Figure 6), which has the second-largest population in the city.

These results complement the mapping of urban green areas by neighborhood conducted by Belém's Municipal Department of Environment, highlighting the distribution of green spaces regardless of ownership. This is key from an environmental quality point of view in the different regions of the city. Additionally, DSE's findings also account for understanding the reality of each neighborhood regarding public green areas. To find out more, visit: https://semma.belem.pa.gov. br/areas-verdes/



Access here



Figure 8 - Public Green Areas per inhabitant by neighborhood in the Municipality of Belém, PA

<sup>&</sup>lt;sup>2</sup> There is no scientific consensus on the minimum value for this index. However, the recommendation by the Brazilian Society of Urban Afforestation (Sociedade Brasileira de Arborização Urbana - SBAU) has been applied in Brazil, suggesting a minimum of 15 m<sup>2</sup> per inhabitant for public Green Areas destined for recreation (SBAU, 1996). Additionally, the literature mentions values of 9 m<sup>2</sup> and 12 m<sup>2</sup>, attributed to the World Health Organization, although these have not been formally recognized by the institution (Ramos, Nunes and Santos, 2020; De La Barrera et al., 2022)

#### Green Urban Planning

Rule 3:30:300



This rule reinforces that urban afforestation strategies and public green area creation must complement each other while highlighting the importance of their balanced distribution across the territory.

The World Health Organization (WHO) recommends that urban residents should have access to public green spaces of at least 0.5 hectares within a linear distance of 300 meters (approximately a 5-minute walk) from their homes (WHO, 2017). In Belém, **public green areas within those dimensions include 26 squares, one botanical garden, and four parks**.

Considering an adult with full mobility walking speed (4 km/h), **28%** of the population lives within a **10-minute walk of public green** spaces. However, when applying a specific frame to include vulnerable populations, such as children and the elderly, and reducing walking speed to 2 km/h, the percentage of the population with adequate access to green areas drops to 10%. Therefore, ensuring accessibility for people with reduced mobility requires territorial planning adaptations.

Many of the city's public green areas are located in the south and southwest regions, including larger ones such as the Botanical Garden Bosque Rodrigues Alves (15 ha), the Zoobotanical Park Emílio Goeldi Museum (5.2 ha), the Naturalist Park Mangal das Garças (4 ha) and the Utinga State Park Camillo Vianna (1,393.04 ha). Despite their distribution, these green areas are often situated in neighborhoods that are either not predominantly residential or are classified as mediumhigh to high-income. (Menezes et al., 2021). The map showing income per neighborhood reinforces this distributive aspect (Figure 13).

Neighborhoods with higher income levels, particularly those in the municipality's southern and more urbanized areas, such as Nazaré

and **Batista Campos**, have better access to public green areas. The same applies to neighborhoods in the most urbanized parts of the Entroncamento Administrative District, such as **Mangueirão** and **Val-De-Cans**.

Conversely, lower-income neighborhoods like Águas Negras and **Paracuri** in the Icoaraci District, as well as **São Clemente** and **Benguí** in the Benguí District, are among those with the least accessibility to public green areas. Mosqueiro District's neighborhoods **Murubira**, **Ariramba**, and **São Francisco** present similar results.

Reflection on access to green areas, particularly regarding the differentiation between public and private spaces, is essential when discussing the island regions of Belém. Despite the significant presence of vegetated areas in these regions, findings reveal that few are actually under public ownership. These are precisely the areas that house communities that still preserve traditional ways of life, often tied to the communal use of natural resources.

Ensuring the presence of and democratic access to public green areas is crucial to promote an equal distribution of nature's direct and indirect benefits among all segments of the municipality's population. That said, the importance of private vegetated areas in maintaining the city's environmental balance should not be overlooked. This emphasizes the need for integrated strategies that focus on public spaces and urban landscaping while also encouraging urban afforestation on lots, properties, and buildings

## Cities Biodiversity Index and the importance of coordinated action in favor of biodiversity

The Cities Biodiversity Index (CBI), also known as the Singapore Index on Cities' Biodiversity, is a tool designed to help cities measure and monitor their progress in conserving urban biodiversity. Developed under the United Nations Environment Program (UNEP) in partnership with the City of Singapore, the CBI evaluates three main dimensions:



The CBI supports local governments in monitoring green, protected, and conserved areas, helping assess the health of urban biodiversity. As such, it is an instrument for strengthening the cities' role in achieving global biodiversity protection goals, particularly those from the New Global Biodiversity Framework.

#### The 30x30 Target of the New Global Biodiversity Framework

The 30x30 Target (Target 3) is part of the New Global Biodiversity Framework, adopted during the Convention on Biological Diversity's COP15 that took place in 2022. This Framework intends to protect at least 30% of the planet's land and marine areas by 2030 to address biodiversity loss and strengthen the resilience of ecosystems.

There are other key goals. Target 14, for instance, indicates the importance of integrating biodiversity across different planning strategies. Target 8 aims to increase and improve green and blue spaces in urban areas while ensuring inclusive and sustainable urbanization.

Therefore, achieving global biodiversity and sustainable development goals requires a coordinated effort from stakeholders across various sectors and levels of government.





Figure 10 - Income Distribution and Proximity to Green Areas in the Municipality of Belém - PA



#### 3.2 Regulating Ecosystem Services

The ecosystem service of climate regulation was significantly lower in urban areas, while vegetated locations demonstrated higher values. In this context, the Cotijuba Island area stands out with more positive results when compared to other city areas, as it features better-distributed intra-urban vegetation. It is important to note that even regions with vegetation coverage include fragmented vegetation and grassland areas, which contribute to variations in these values and highlight the issue of forest fragmentation and its impact on the quality of regulating ecosystem services.

The Mosqueiro District and the western part of the Entroncamento District, where the Utinga State Park and the city's Environmental Protection Area are located, contain the largest areas of continuous vegetation. Unsurprisingly, both districts stand out positively regarding provisioning ecosystem services, particularly in regulation, reinforcing the importance of green spaces for maintaining the city's climate balance.

#### **Cooling capacity**

Combu Island, Murutura Island, and Paulo da Cunha Island presented the best urban cooling capacity. These locations are characterized by extensive dense vegetation, limited human activity, and reduced maritime influence. Thus, Combu Island features an Environmental Protection Area (APA), highlighting the importance of territorial planning measures to ensure the conservation and preservation of ecosystems.

Figure 11 - Integrated Map of the Climate Regulation Service in Belém - PA

Findings show a greater cooling capacity within the vegetation, highlighting the need to address fragmentation and prioritize uniform vegetation over simply increasing the number of green spaces. Implementing connectivity strategies, such as ecological corridors and linear parks, is also an approach that contributes to biodiversity conservation while expanding vegetation coverage in the urban fabric. This, in turn, provides benefits associated with cooling capacity

#### **Carbon Stock**

Primary vegetation areas without anthropogenic traces present the highest values of carbon stock. These regions can store from 160 to 180 tons C/ha, while areas of secondary vegetation tend to store 20 tons C/ ha less.

Secondary forests can mitigate climate change due to their high average carbon absorption rates — up to 11 times greater than primary vegetation (Silva Júnior et al, 2020; Nascimento et al, 2021). Furthermore, the growth of secondary forests can prevent biodiversity loss in the Amazon if we account for species variety and flora composition similarity. This indicates the need to integrate climate and biodiversity strategies.

Grasslands without signs of degradation store around 130 tons C/ha, while pastures with moderate or severe signs of degradation store around 110 tons C/ha, predominantly located in Mosqueiro. In these areas, land use recovery strategies, such as Low Carbon Agriculture

## Scale 1:330.000







(ABC) and Crop-Livestock-Forest Integration (ILPF), can contribute to maximizing carbon storage while reaching other conservation and sustainability objectives, such as soil fertility and pollinator attraction.

#### Quantity and quality of freshwater

The Municipality of Belém is located in a region dominated by superficial water courses. Maintaining the quality and quantity of available water are intertwined and essential for public health and the sustainability of local economic activities. Using InVEST's Annual Water Yield model, it was possible to estimate the contribution of various city regions to water supply services provision.

Densely urbanized regions generally show poorer results, except where small green spaces or unbuilt areas are present. Soil impermeabilization, which prevents rainwater infiltration, significantly reduces water retention capacity and increases the risks of flooding and overflow.

Even in areas with better results, it is noticeable how disturbances to the natural landscape — such as vegetation fragmentation, grassland creation, and mineral extraction) impact water availability. For instance, this is evident on Mosqueiro Island and Paulo da Cunha Island, where vegetation loss occurs, as well as on the Utinga State Park region, where the Água Preta and Bolonha Lakes are located. These lakes serve as reservoirs, supplying potable water to approximately 65% of the population in the Metropolitan Region of Belém (Silva et al., 2020, Rodrigues, 2021)





#### Carbon credits and the promotion of sociobiodiversity

Keeping the forest standing and ensuring its conservation enhances the population's quality of life. There is also a growing economic rationale for forest conservation and restoration. For instance, carbon credit initiatives generate positive returns associated with conservation, particularly through the monetary value of climate regulation service benefits from the carbon sequestration provided by ecosystems.

In Belém, a recent study estimated that the carbon sequestration contribution of the Utinga State Park (PEUT) could reach R\$ 121,110,168.11, based on 2018 numbers (Velloso et al, 2024). These returns increase even further when considering that the valuation of carbon credits alone underestimates the economic contributions of conserved areas since they enable activities like ecotourism and extractivism.

However, carbon credit schemes that focus solely on the quantity of carbon and neglect biodiversity may even have negative consequences from a biodiversity-conservation point of view. For example, such schemes may overlook native species in reforestation initiatives (IUCN and CEM, 2023).

Therefore, to effectively leverage carbon credits as tools for advancing conservation agendas, they should incorporate concerns on social development and be inserted into a broader, integrated strategy to promote socio-biodiversity.

#### 3.3 Provisioning Ecosystem Services

Provisioning ecosystem services is crucial to human well-being, as they supply essential natural resources such as food, water, wood, fibers, medicines, and more

#### Fishing

Fishing is an important, traditional activity for the *ribeirinho* or riverside communities of Belém, both for subsistence and sale (Virtanen, 2020). The participatory mapping identified 18 fishing points, most in the municipality's northern portion. Prominent regions are the surroundings of Ilha do Mosqueiro and Marajó Bay, as well as the surroundings of Outeiro/Caratateua (Furo Maguari), associated with the flows in Santo Antônio Bay, pointing to the connection between the city life and its numerous bays, streams, and channels.

The Mosqueiro District is one of the primary fish suppliers in Pará. The island features artisanal fishermen communities whose activity involves a wide diversity of species (Silva et al, 2018). Although Belém rivers are not direct tributaries of the Amazon River, they are ecologically integrated into the Amazon basin region, meaning they carry an essentially highly endemic Amazonian ichthyofauna. The Amazon basin is home to around 85% of the fish species in South America, a habitat for more than 2,400 fish species, with 45% occurring only in this biome (ICMBIo, 2021).

The Amazon shrimp *(Macrobrachium amazonicum)* is one of the most captured shrimp species, usually caught with an artisanal device named *matapi*. This instrument is made from juba *(Astrocaryum spp.* and *Atrix spp.)* or jupati *(Raffia vinifer)* palm trees and the babassu palm tree fruit (Orbignya beautiful), yet another evidence of the intertwined uses of biodiversity and social life reproduction (Bentes et al, 2016).

#### Food and agroextractivism

Regions associated with the ecosystem service of food and raw materials provision are primarily concentrated in the surroundings of the urban area as well as in the island portion of the municipality, where free and vegetated spaces are still found. The participatory mapping brought special attention to plant species of cacao (*Theobroma cacao* L.) and açaí (*Euterpe oleracea* Mart.), consistently to the relevance both have in social life and the local economy.

Both açaí and cacao alone supply a local production chain, generating income for countless riverside families who live from extractivism or planting, primarily in floodplain forest regions (Costa et al, 2021). Açaí is one of the most relevant products in the socio-bioeconomy of Pará, reaching R\$1.3 billion in production value in 2019 (Costa et al, 2021).

Food provision and extractivism areas are complementary, especially in floodplain forest regions and transition regions to dry land. Plant extractivism and agriculture occur together, creating an income diversification strategy adapted to environmental restrictions for many local communities (Mesquita, 2017; Instituto Escolhas, 2022).

Articulations to promote a socially fair and nature-based economy are possible. An example is partnerships around Non-Wood Forest Products (NTFPs) processing for craftwork and, increasingly, for biocosmetics



## The provision of raw materials by ecosystems and the fair sharing of benefits arising from biodiversity utilization

Belém's history with the Amazon rainforest and its resources is long and complex, particularly timber and other forest products. At the end of the 19th century and the beginning of the 20th century, Belém's economy experienced an economic boom primarily due to the extraction of latex from rubber trees (*Hevea brasiliensis Mull. Arg*).

Early in the 20th century, the British disrupted the Brazilian monopoly on rubber production by establishing rubber tree plantations in their colonies in Southeast Asia. This was only possible because the British explorer Henry Wickham carried rubber tree seeds from Brazil to England. Unaware of its potential consequences, the owners of Amazonian rubber plantations freely provided the seeds of the native species. As a result, the English colonies in Asia, like Malaysia, Sri Lanka, and Indonesia, became the world's leading rubber producers, which drove Amazonian cities to an economic crisis (Agência Museu Goeldi, 2016).

The history of latex exploitation highlights an issue currently debated: the protection of the national genetic heritage and the associated traditional knowledge.

Nowadays, various strategies are discussed to protect this heritage and promote a fair sharing of the benefits derived from its use

#### CONVENTION ON BIOLOGICAL DIVERSITY (CBD)

The most relevant international treaty on biodiversity conservation and sustainable use. Since its disclosure in 1992, additional mechanisms have been adopted, including the Nagoya Protocol ((2014) on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization and the recent New Global Biodiversity Framework (2022), which advances this discussion.

#### **BIODIVERSITY LAW (FEDERAL LAW NO. 13,123/2015**

One of the major national instruments regulating research and development activities regarding the genetic heritage of Brazilian biodiversity species and the traditional knowledge associated with it. For more information, see the Biodiversity Law Manual (Instituto Escolhas, 2021)

#### Abelha olho de vidro Trigona pallens Fabricius



Açaí Euterpe oleracea Mart

## Pollination: a crucial regulating service for the provision of food, raw materials, and medicinal resources

The Amazon's floristic diversity offers several benefits to society, including food, raw materials, and medicinal resources. However, many plant species can only deliver such benefits thanks to another essential ecosystem service: pollination.

Pollinator agents like bees, butterflies, bats, and birds ensure the fertilization of plants that produce fruits, vegetables, and seeds — critical for food security. This regulatory service is especially relevant in Belém and Pará, where the economy and culture are deeply intertwined with the forest and its resources.

#### Pollinators: the guardians of açaí

According to a study by the Federal University of Pará (UFPA) and Vale Technological Institute (ITV), the monetary value of pollination services in the production of palm fruits in the Amazon region reaches US\$239.9 million per year in the Legal Amazon (Ferreira, Sabino and Giannini, 2024). Nearly 85% of this value is associated with the production of açaí (Euterpe oleracea).

The diversity of pollinators associated with açaí is remarkable: more than 70 species of insects — including flies, wasps, ants, and beetles — are responsible for transporting plant pollen. Native bees, however, account for over 90% of açaí pollination (Bezerra et al., 2020).

Given the decline in pollinator populations due to deforestation, pesticide use, and climate change, preserving forest areas around plantations remains one of the most effective strategies to contribute to natural pollination and safeguard this vital ecosystem service. This approach supports biodiversity while benefiting producers by reducing the costs of purchasing hives and maintaining artificial colonies

#### **Medicinal Plants**

The Amazon flora is a significant source of active ingredients used in traditional medicine and the pharmaceutical industry. Many plants possess medicinal properties well-known to the riverside and Indigenous populations and are the subject of scientific research for developing new medication. During the participatory mapping, 28 medicinal plant provision points were identified — better distributed across the municipal territory and the intra-urban fabric when compared to previous categories.

This can be attributed to the local importance of productive backyards and urban afforestation, which facilitate the distribution of medicinal plants throughout the city. Additionally, particular attention should be given to the "Quintais Ecopoéticos", an initiative by the Fundação Centro de Referência em Educação Ambiental Escola Bosque "Professor Eidorfe Moreira".

#### 3.4 Cultural Ecosystem Services

Forests, rivers, and urban green areas enhance the city's environmental characteristics while serving as places of leisure, contemplation, and nature connection. This interaction with natural environments boosts well-being and quality of life. It also deepens cultural and historical appreciation, reinforcing local identity and the feeling of belonging. In Belém, 122 points of Cultural Ecosystems Services were identified and allocated into 06 categories (Figure 25).

In contrast to regulating and most provisioning services, cultural ecosystem services present results that are much more spread across the municipal territory. This distribution draws attention to intra-urban nature, often valued for different dimensions than peri-urban green areas.





#### Mental and Physical Health and Social Relationships

Several green urban areas play a vital role in the well-being of residents. The participatory mapping has identified 21 points associated with mental and physical health. The Utinga State Park, one of the largest and most important in the city, offers several hiking and cycling trails as well as canoeing and birdwatching activities. Bosque Rodrigues Alves and Praça Batista Campos also favor physical exercise and moments of relaxation. Emphasis is also given to several coastal public spaces, like Parque Mangal das Garças, Estação das Docas, and Complexo Ver-o-Rio.

The relationship with the coast was particularly evident in the "Social Relations" category — 19 out of the 26 mapped points indicate coastal areas. The connection to rivers, streams, and waterways reinforces the sense of belonging to the region while fostering social bonds. Various waterfront parts in different neighborhoods serve as spaces for community interaction, strengthening social ties. These spaces also play a significant role in attracting tourists, which drives infrastructure development, such as restaurants and outdoor kiosks to support increased foot traffic.

#### **Cultural Heritage and Spiritual Relationships**

The interaction between biodiversity, local ecosystems, and people is reflected in various aspects of a place's cultural identity — like eating habits, clothing, and traditions, the basis of a culture. In Belém, 28 areas related to this category were identified.

The islands and floodplain forest regions are highly relevant and connected to the *ribeirinho* **identity**, operating as a central pillar in Belém's cultural identity. **River beaches** are also a specially valued aspect.

Utinga State Park, Bosque Rodrigues Alves, and Emílio Goeldi Museum must also be highlighted as significant **production centers and knowledge repositories** about local biodiversity. The Paracuri region, where clay is extracted for ceramic production, is another example of **artisanal practices** in the city that reinforce the cultural connection with ecosystems.





## *Arrastão do Círio:* Between Faith, the Big Snake and the Bioeconomy of Belém

One of Brazil's largest and most important religious celebrations, *Arrastão do Círio*, also known as *Arrastão da Cobra Grande*, exemplifies the intersection between culture, bioeconomy, and religiosity. Held yearly in October, the celebration draws thousands of visitors from across the country and the world, boosting the local economy while promoting the culture and traditions of Pará. The procession crosses the historic center of Belém in honor of the patron saint of the state (Mary, the mother of Jesus).

One of the festivity symbols is an immense snake made from miriti fibers, symbolizing traditional and regional craftwork. The celebration relates to one of the narratives surrounding the Círio event, which concerns the snake, also known as "boiúna". As legend has it, a massive snake lies dormant beneath the city of Belém, stretching from the Cidade Velha to the Nazaré neighborhood, with its head beneath the Sé Cathedral and its body ending up in the Basilica. If it ever woke up, the capital of Pará would sink into the river. This belief reflects indigenous worldviews and their enduring influence on local religious syncretism (Alexandria, 2021). Cultural heritage points are often similar to those associated with spiritual or religious values of nature. For instance, this intimate relationship between cultural heritage and spiritual values of nature can be seen in Círio de Nazaré, as mentioned in the participatory mapping. The "Afro-religiosos na cidade de Belém" mapping, as proposed in the Nova Cartografia Social da Amazônia (2006), complements our Diagnosis results and also highlights the relationships between Afro-Brazilian religions and various urban green areas in Belém.

## Ecotourism and the Aesthetic and Inspirational Values of Nature

Among all the mapped ecosystem services categories, ecotourism stood out the most on the islands of Belém: 14 points were identified in the island areas, compared to only 07 on the mainland. In densely urbanized areas, ecotourism points are primarily located near green spaces, such as the Utinga State Park (PEUT) and Parque dos Igarapés. Others reaffirm the connection to coastal areas, such as the Zoobotanical Park Mangal das Garças.

Mosqueiro features more points than any other island of the municipality. This aligns with its territorial dimension and historical importance as a local tourist destination featuring various beaches and river tours (Menezes, Lameira, and Wanzeller, 2010). Other islands have become important tourist attractions later than Mosqueiro — Cotijuba and Ilha Sentinela do Norte in the western part of the municipality and Combu, Murucutu, and Ilha Grande to the south.

Several challenges indicate the need to further align tourist activities with ecotourism principles, allowing it to advance as a socially and environmentally sustainable activity. This is associated with inspirational and aesthetic values of nature, another Cultural Services mapped category.

Both categories intersect at several points, like the islands and the PEUT. This reinforces the significance of conserving the integrity of natural landscapes. Beyond the intrinsic value of biodiversity conservation and the ecological processes that sustain life, there's the aesthetic appeal, offering authentic, captivating, and inspiring views and experiences.

Figure 15 - Distribution of cultural ecosystem service points in Belém - PA.



#### 3.5 Threats

The participatory mapping identified 84 points of threats to biodiversity and ecosystems. Broadly, there is a clear distinction between the challenges faced by urbanized areas and those affecting more densely vegetated peri-urban areas. For instance, the island regions of the municipality face issues such as hunting, invasive exotic species, over-exploitation of resources, overfishing, and logging. In contrast, challenges like air pollution and occupation of risk areas are more prevalent in the urban, continental portion of the municipality.

Beyond these land use and occupation-specific distinctions, there are broader municipal challenges like the irregular disposal of solid waste and water pollution. These issues are also prominent in the urban expansion category when addressing transition areas between the urban fabric and green spaces.

Among the various categories mapped, Water Pollution had the highest number of points identified (13), followed by Occupation in risk areas (11) and Urban Expansion (10). Resource extraction (07), Irregular waste disposal (6), Air pollution (4), and Deforestation (5) are also priority issues according to local community members. This perspective complies with the environmental challenges faced regionally across the Amazon, where deforestation and fire-induced air pollution are closely linked. In Belém, the irregular disposal of solid waste also contributes to air pollution, primarily due to the regionally common practice of waste open burning.

#### Urban Expansion and Occupation of Risk Areas

Regarding urban expansion, areas near or within protected areas require closer attention, such as the Abacatal region within the Environmental Protection Area near the Utinga State Park, the surroundings of Mosqueiro Municipal Park, and the more touristic, bridge-connected islands. (Cardoso et al., 2023).

Urban expansion is directly associated with occupation of risk areas. Historically, urban expansion in Belém can be linked to occupation in environmentally sensitive areas, with constructions advancing over floodplain forest areas (floodable regions close to rivers and streams). Occupation in these areas raises social vulnerability and urban issues in the city, exposing residents to the risk of natural disasters and increasing sanitation problems (Cardoso et al, 2023; Miranda, 2020).

#### Water Pollution

In addition to untreated sewage discharge, issues like disorderly occupation in parts of the city and riparian forest degradation threaten water quality despite the region's abundance (Sobrinho et al., 2022).

Water pollution is already the greatest environmental pressure on the Água Preta and Bologna Lakes. In this region, eutrophication has been identified as the primary cause of the loss of water surface area, associated with the issue of urban expansion around the PEUT and within the APA (Silva et al, 2020)

#### **Tourism Negative Impacts**

Tourism has become a significant source of income for segments of the population. However, when not properly planned, it can pose a threat to biodiversity and ecosystems. Findings suggest a link between tourism and issues such as urban expansion, irregular waste disposal, and wildlife disturbance. These challenges are particularly evident in the island region, especially on Combu Island (Nascimento and Cattanio, 2023). Beyond the potential impacts on biodiversity, the not-alwayspositive effects on extractive activities and the appropriation of cultural and spiritual practices are also due for some consideration.

#### MOST CITED THREATS IN THE CONTEXT OF THE CITY





Figure 16 - Distribution of threats to biodiversity and ecosystems indicated in the participatory mapping in the municipality of Belém - PA

#### Monoculture

In Belém, the monoculture issue is unique. In response to growing demand, açaí production has expanded and is currently undergoing a shift from sustainable practices to monocultures, negatively affecting biodiversity (Instituto Escolhas, 2022).

Although there is still no substantial evidence of the introduction of intensive açaí cultivation, in several locations — such as Combu — increased production has often been accompanied by the removal of native species (Nascimento and Cattanio, 2023). These cases reflect a broader process of "açaizamento" observed in floodplain forest areas of other Amazon regions, which requires further attention (Gonçalves, 2016).

#### Deforestation

Even though most deforestation in Belém is associated with urban expansion, timber extraction as a means of obtaining economic

resources also occurs, with the potential to negatively impact ecosystems, as observed in Mosqueiro. Therefore, it is necessary to evaluate the different drivers of deforestation, which may require specific contingencies strategies.

In the Amazon context, deforestation associated with the direct exploitation of forest resources, in addition to urban expansion, demands sensitivity to possible cultural motivations, such as those related to the ways of life of Indigenous peoples and traditional communities

Thus, promoting sustainable practices is essential to guarantee the conservation of ecosystems in Belém and the continuity of the benefits they provide while integrating sensitive actions that consider the needs of the local population without disregarding social diversity

4

#### **Integrated Analysis**

Most mapped threats are concentrated in the north region of the most densely urbanized area — in the Icoaraci, Bengui, and part of Entroncamento Districts. Additionally, this area showed the lowest results in terms of provisioning ecosystem services, except Outeiro Island. Icoaraci and Benguí District also feature the lowest presence of public green spaces. Conversely, the urban occupation pattern that includes vegetated areas also demonstrates better results in the analyzed climate regulation services, such as greater urban cooling capacity and carbon stock compared to other city areas. However, urban expansion was identified as a relevant threat in this region.

The Mosqueiro Island also presents a high concentration of threats, particularly urban expansion. This is significant because of Mosqueiro's relevance for cultural ecosystem services — as leisure and ecotourism — but also for provision services — like fishing. Furthermore, the island features conserved ecosystems essential for local biodiversity, such as mangrove and forest areas. Since tourism was prominent in the region, strengthening the ecological character of this service and ecotourism destination are interesting strategies to foster alternative, less-polluting production chains.

Similarly, **in the south islands** like Combu and Murutucu/Murutura, the importance of structuring tourism around a broader sustainability strategy is evident. These regions are particularly significant for provision services, especially in the context of agroextractivism, which is related to and depends on Amazonian biodiversity.

In the part where occupation in the city was historically initiated, public green spaces — like Mangal das Garças, Museu Emílio Goeldi, and Praça Batista Campos — are related to a variety of cultural ecosystem services, including cultural heritage, mental and physical health, and social relationships. However, dense urbanization associated with soil impermeabilization also contributes to this region's poor performance in climate regulation services, especially urban cooling capacity. As a result, the population is exposed to phenomena such as heat islands.

Across different city regions, our findings suggest that green areas are linked with various ecosystem services depending on the type of vegetation, area dimension, and their relationship with the population. More densely vegetated spaces contribute the most to regulating services and support climate regulation, water quality and availability, and protection against extreme weather events.

On the other hand, results also point to the benefits of an integrated strategy, coordinating larger green areas and smaller spaces and urban afforestation, for example. Smaller green regions are also relevant to ecological connectivity, to improve urban thermal comfort, and to provide spaces for leisure, relaxation, and meeting points. The population's relationship with green areas is notably stronger where access is easier and more public facilities are available.



### Analysis of Climate Risk and Vulnerabilities (CRVA) in Belém

In addition to the 11 risk points identified in the participatory mapping, the Climate Risk and Vulnerability Analysis - CRVA (ICLEI, 2024) offers a complementary perspective. The CRVA assesses areas vulnerable to various phenomena, addressing threats that directly impact people's lives in a coordinated manner. This approach expands the understanding of risks, moving beyond occupation in geological risk areas to also consider the effects of climate change and disorderly urbanization on the safety and well-being of local communities.

To learn more, access the study here



#### **Illustrated Map**

An illustrated map of the Ecosystem Services Diagnosis in Belém was designed to summarize our findings. This map addresses land occupation and usage and Belém's vegetation and hydrography, which helps to understand the distribution of ecosystem services in the territory. Additionally, it also features reference points to support readers with better localization. Several illustrations portray ecosystem services in the population's daily lives, including traditional fishing, bathing on river beaches, and açaí and cacao cultivation.

#### The habitants: the biodiversity of Belém

Nine flora and 15 fauna species are also depicted on the map. Their inclusion is a reminder that other forms of life also inhabit Belém in addition to its human population, and together, they form a dense network of relationships among various species.

The selected species aim to offer representativity to various plant and animal groups that coexist in the city, considering their ecological and social importance. The choice was made in collaboration with the city's technical team and supported by partner institutions, including the Museu Paraense Emílio Goeldi, Herbarium Professor Normélia Vasconcelos (HF) from UFPA, and researchers from UFRA.

The Amazon forest region features unparalleled diversity, comprising almost 10% of the planet's biodiversity (Martins and Jardim, 2018). It presents itself as a mosaic of endemic areas that contains a diversity of animal and plant species reflecting the specificities of each biota, commonly encompassed by the largest rivers in the region. The capital of Pará is located amid the Belém Endemism Center (CEB), one of the most biodiverse regions in the Amazon. At the same time, the city faces various challenges in protecting and recovering ecosystems since this is the first human-inhabited area in the Amazon and, therefore, now the most densely populated.

Consequently, the species represented are a small sample of Belém's immense biodiversity. Please find more information on them in the flyer.

Click here to access the folder.



Macaco-de-Cheiro

Saimiri sciureus

#### Diagnosis of Ecosystem Services

# **BELÉM DU PARÁ**

#### The relationships between nature and its inhabitants



On this map, we will find a sample not only of the diversity of that ecosystem but also of the ways in which we already relate to it on a daily basis. The goal is to understand how nature preservation and original and traditional community appreciation can contribute to the well-being of all forms of life.













DAMOS

DAOUT

DABEN



#### Supply of food and raw materials

**Ecosystem Services:** The benefits of nature

Forests and rivers provide the necessary conditions for food production raw materials, medicines, and other essential elements for the maintenance of life. In Belém, agro-extractivism, the close relationship between agriculture, especially family farming, and extractive practices, is a form of sustenance and way of life for many families, especially on the islands of Cotijuba, Ilha Grande, Murutura and Combu. Artisanal fishing is an activity of great importance for the city and is also part of the ribeirinho (riverside population) way of life.

#### Medicinal plants

In Belém, ancestral knowledge is born from the intimate relationship betwee its inhabitants and its rivers and forests. This connection is reflected in the use of medicinal herbs, which are commercialized and represent a means of support for families in the urban, quilombola, and ribeirinho areas of the region. They are used to treat various diseases, as practiced by elderly women who use their fingers wrapped in cotton, honey, and andiroba to heal throats Furthermore, whoever goes to Ver-o-Peso Market, an important commercial and cultural venue in the city, is certainly familiar with the medicinal product stores located next to the Meat Market and the herbal stalls with plants, roots, ointments, and scent baths prepared for any and all illnesses.

#### Physical and mental health

Green areas offer different benefits for physical and mental health. They reduce noise pollution, mitigate heat, and retain pollutants, contributing to more breathable air and a more pleasant environment. They can provide rest and relaxation, reduce stress, and also encourage a more active and healthy lifestyle. Utinga State Park, for example, is a space where the population can enjoy exuberant nature while practicing sports such as cycling, hiking, and canoeing.

#### Cultural heritage, social and spiritual relationships

In Belém, the rivers and the city coastline are related not only to socially strengthening leisure activities but also to the ribeirinho culture and African-based religious practices.Círio de Nazaré is the biggest religious and popular festival in Belém, yet another demonstration that Amazonian boldwersity has a strong presence in the local popular imagination. Legend has it that the Bolúna snake lies dormant beneath the city, with its extremities in the direction of the two churches that mark the beginning and end of the Círio procession.

#### Ecotourism

VLiving in natural environments alongside local communities can raise awareness about the importance of conserving and valuing socio-biodiversity for forests and all forms of life protection. Furthermore, Ecotourism also offers opportunities to strengthen local nature-based development. The Bosque Rodrigues Alves is a piece of the Amazon rainforest in the middle of the city and is known for its ability to create affective memories among children. The Utinga Park and the islands of Combu and Mosqueiro offer tours and trails through the forest for those who enjoy natural landscape immersions.

#### Water regulation

Rivers, mangroves, floodplains, and forests play crucial roles in water supply and regulation. The soil's ability to retain water is fundamental for all forms of life maintenance. It reduces the risk of droughts and desertification, influences precipitation cycles, helps filter pollutants, and promotes natural river purification. The Conservation Units of the Mosqueiro Municipal Park and the Utinga State Park are Belém's most preserved areas and, as such, offer the greatest contributions to water regulation.

#### **Climate regulation**

**CO**<sub>2</sub>

DAENT

The feeling that some neighborhoods are hotter than others is directly linked to how forested different regions are. This happens because very green areas contribute to improving local cooling capacity, making temperatures milder. The Bosque Rodrigues Alves, for example, plays this role. Furthermore, natural environments such as forests, mangroves, and water bodies capture and store the atmosphere's carbon dioxide (CO2), reducing global climate change. The forest areas of Mosqueiro and Combu Islands contribute to this



for people



The Ecosystem Services Diagnosis of Belém indicates that existing ecosystems play crucial roles in regulating the water cycle and the climate. They also ensure conditions for provisioning the population with essential resources regarding basic needs for survival and social benefits. Areas with high urban cooling capacity and carbon stock are generally associated with regions featuring more preserved vegetation. This finding reinforces the importance of green spaces in maintaining **environmental quality and ecological balance**. Food and medicinal plant provisioning points highlight their relevance for food **security and the population's well-being**.

Cultural service points — including ecotourism in the Utinga State Park and on the Combu and Mosqueiro Islands — as well as points associated with cultural heritage and social relations — like Bosque Rodrigues Alves — highlight urban ecosystems' **social and recreational value**. However, the population enjoys these nature-provided benefits in different ways and proportions.

Results show a **disparity in distribution and access to green areas**. Neighborhoods with lower income have fewer accessible and quality green spaces, limiting the ability to enjoy the ecological and social benefits they provide. The lack of green areas in more vulnerable regions directly impacts residents' physical and mental health, reducing opportunities for leisure and contact with nature — both essential for a balanced life. Therefore, it is crucial to prioritize the **expansion**, **connectivity, and accessibility of urban green areas** through public policies that ensure all citizens can equally enjoy the provided ecosystem services.

The Ecosystem Services Diagnosis in Belém highlights the significance of the relationship between the city's population and its waters. However, water pollution, occupation in risk areas, and urban expansion historically related to channelization and soil permeabilization — were identified as priority threats. These issues are interconnected and associated with city water management challenges. Ultimately, they reveal the need to rethink Belém's urban planning. The approach to **reestablishing the connection with the city rivers** should not be seen as a necessity, rather than a **vertical with great potential to reshape urbanization**.

Developing a new urban management agenda for the city could incorporate water bodies as landscape solutions. Instead of suppressing streams and rivers, integrating them as part of green infrastructures combined with the city's gray landscape, thus expanding its potential to support socio-environmental challenges. Another way to address climate change would be implementing water management strategies associated with the expansion of effectively managed intra and periurban green areas.

The Metropolitan Region of Belém (RMB) is expected to be heavily impacted by rising temperatures, changes in rainfall patterns, and the advance of tides. For this reason, stakeholders involved in the city management must work towards developing city resilience. This depends on integrating nature into urban planning and strengthening multilevel articulations to support integrated planning. This approach must consider how biodiversity and ecosystems relate to social, economic, and urban dynamics.

Thus, the Ecosystem Services Diagnosis of Belém reinforces how the city's history and present are intrinsically linked to the forest economy and ecosystem services. The continuity of these benefits provided by ecosystems, and hence Belém's future, depends on effective public policies, the participation of local communities in resource management, and sustainable practices that promote biodiversity conservation while addressing the socio-environmental challenges, particularly those associated with urban realities in the Amazon.





AGÊNCIA MUSEU GOELDI. **Seringueira**, a planta que sustentou uma região. 31 ago. 2016. Available at: <a href="https://www.museu-goeldi.br/noticias/seringueira-a-planta-que-sustentou-uma-regiao-1">https://www.museu-goeldi.br/noticias/seringueira-a-planta-que-sustentou-uma-regiao-1</a>

AGÊNCIA BELÉM. Escola Bosque completa 25 anos e se consolida como referência em educação ambiental. 03 set. 2024. Available at: <a href="https://agenciabelem.com.br/Noticia/219607/escola-bosque-completa-25-anos-e-se-consolida-como-referencia-em-educacao-ambiental">https://agenciabelem.com.br/Noticia/219607/escola-bosque-completa-25-anos-e-se-consolida-como-referencia-em-educacao-ambiental</a> Acesso em 10 ago. 2024.

ALCAMO, J., et al. **Ecosystems and human well-being: a framework for assessment**. Washington, D.C: Island Press & Millenium Ecosystem Assessment, 2003. Available at: <a href="https://www.millenniumassessment.org/en/Framework">https://www.millenniumassessment.org/en/Framework</a>. <a href="https://www.millenniumassessment.org/en/Framework">https://www.millenniumassessment.org/en/Framework</a>.

ANA - Agência Nacional das Águas. Estudos Hidrogeológicos para a Gestão das Águas Subterrâneas da Região de Belém/PA: Relatório Final/Agência Nacional de Águas. Vol. 2, t 1. Hidrogeologia dos sistemas aquíferos da região de Belém/ PA: Resultados em hidrogeologia. Elaboração e Execução: Profill Engenharia e Ambiente S.A. Brasília: ANA, 2018. Available at: <https://metadados.snirh.gov. br/geonetwork/srv/api/records/4e560d0e-9534-44e2-8e19-31ba5fb3596a/ attachments/RF\_ANA\_BELEM\_VOL2\_TOMOI.pdf>

ASCOM/UFPA - Assessoria de Comunicação Institucional da Universidade Federal do Pará. **Ilha de Mosqueiro é um dos principais destinos durante o verão**. ASCOM/UFPA, 21 jul. 2015. Available at: <https://ascom.ufpa.br/index. php/banco-de-pautas/80-ferias/123-ilha-de-mosqueiro-e-um-dos-principaisdestinos-durante-o-verao>

AVIZ, M. D. D. et al. Sensoriamento remoto como ferramenta da estimativa do estado trófico de lago urbano na Amazônia (Belém, PA). **Revista Ibero-Americana de Ciências Ambientais**, v. 13, n. 4, p. 95–107, 2 jul. 2022.

BARCELONA CITY COUNCIL - Area of Ecology, Urban Planning and Mobility. Resilience Atlas. Barcelona, 2017. Available at: <a href="https://coneixement-eu.bcn">https://coneixement-eu.bcn</a>. cat/widget/atles-resiliencia/index-eng.html>

BENTES, Bianca et al. A pesca do camarão-da-Amazônia, perspectivas futuras no litoral paraense. Ciência e Cultura, v. 68, n. 2, p. 56-59, 2016. AGÊNCIA PARÁ. **Mosqueiro e Cotijuba**: roteiros turísticos que unem beleza e história. Agência Pará, 01 jul. 2017. Available at: <a href="https://agenciapara.com.br/noticia/1661/mosqueiro-e-cotijuba-roteiros-turisticos-que-unem-beleza-e-historia">https://agenciapara.com.br/noticia/1661/mosqueiro-e-cotijuba-roteiros-turísticos-que-unem-beleza-e-historia</a>

BEZERRA, L.A et al. Pollen Loads of Flower Visitors to Açaí Palm (Euterpe oleracea) and Implications for Management of Pollination Services. **Neotrop Entomol**, vol. 49, 482–490, 2020. Available at: <a href="https://link.springer.com/article/10.1007/s13744-020-00790-x>">https://link.springer.com/article/10.1007/s13744-020-00790-x></a>

BORDALO, Carlos Alexandre. O paradoxo da água na região das águas: o caso da Amazônia brasileira. **GEOUSP Espaço e Tempo** (Online), São Paulo, Brasil, v. 21, n. 1, p. 120–137, 2017. Available at: <a href="https://revistas.usp.br/geousp/article/view/107531">https://revistas.usp.br/geousp/article/view/107531</a>>

BORDALO, Carlos Alexandre. O paradoxo das águas: o caso da Amazônia brasileira. **Revista GeoUSP** (Online), vol. 21, nº 1, 120-137, 2017. Available at: <a href="https://revistas.usp.br/geousp/article/view/107531">https://revistas.usp.br/geousp/article/view/107531</a>

BPBES - Plataforma Brasileira de Biodiversidade e Serviços Ecossistêmicos. 1 ° Diagnóstico Brasileiro de Biodiversidade e Serviços Ecossistêmicos. São Carlos: Editora Cubo, 2019. Available at: https://www.bpbes.net.br/wp-content/ uploads/2019/09/BPBES\_Completo\_VF-1.pdf

BRASIL. Lei nº 6.666. Institui, no âmbito do poder executivo federal, a Infraestrutura Nacional de Dados Espaciais - INDE, e dá outras providências. 27 de novembro de 2008. Available at: <a href="https://www.planalto.gov.br/ccivil\_03/\_">https://www.planalto.gov.br/ccivil\_03/\_</a> ato2007-2010/2008/decreto/d6666.htm> BURKHARD, Benjamin et al. Mapping ecosystem service supply, demand and budgets. **Ecological indicators**, v. 21, p. 17-29, 2012.

CÂMARA, Gilberto; DAVIS, Clodoveu; MONTEIRO, Antônio M.V. Introdução à ciência da geoinformação. São José dos Campos: INPE, 2001.

CAMARGO, Suzana. **Bagres migratórios da Amazônia entram em lista de proteção internacional**. Mongabay, 06 mar. 2024. Available at: <a href="https://brasil.mongabay.com/2024/03/bagres-migratorios-da-amazonia-entram-em-lista-de-protecao-internacional/">https://brasil.mongabay.com/2024/03/bagres-migratorios-da-amazonia-entram-em-lista-de-protecao-internacional/</a>

CARDOSO, A. et al. Cinturas periféricas na periferia do capitalismo: os casos de Belém e Manaus. **Revista de Morfologia Urbana**, v. 11, n. 1, 17 abr. 2023.

CINTRA, Ana Luísa. **Confira os 5 novos parques que Belém deve ganhar para a COP 30**. Belém Negócios, 28 ago. 2024, https://www.belemnegocios.com/post/ confira-os-5-novos-parques-que-belem-deve-ganhar-para-a-cop-30. Acesso em 3 set. 2024.

COSANPA - Companhia de Saneamento do Pará. **Relatório de Administração** - **2023**. Disponível em: <a href="https://www.cosanpa.pa.gov.br/wp-content/uploads/2024/05/RELATORIO-DE-ADMINISTRACAO-E-BALANCO-2023.pdf">https://www.cosanpa.pa.gov.br/wp-content/uploads/2024/05/RELATORIO-DE-ADMINISTRACAO-E-BALANCO-2023.pdf</a>

COSTA, Aelton Dias; RODRIGUES, Eliana Teles; OLIVEIRA, Rita Denize de. Quintais urbanos: uma cartografia das estratégias de reprodução dos modos de vida tradicionais na cidade de Belém/PA, Brasil. **Manduarisawa - Revista Discente do Curso de História da UFAM**, volume 6, ano 1, 2022. Disponível em:<https:// periodicos.ufam.edu.br/index.php/manduarisawa/article/view/10901>

COSTA. F. A., et al. **Bioeconomia da sociobiodiversidade no estado do Pará**. Brasília, DF: The Nature Conservancy (TNC Brasil), Banco Interamericano de Desenvolvimento (BID), Natura, IDB-TN-2264, 2021. Available at: <a href="https://www.tnc.org.br/content/dam/tnc/nature/en/documents/brasil/projeto\_amazonia\_bioeconomia.pdf">https://www.tnc.org.br/content/dam/tnc/nature/en/documents/brasil/projeto\_amazonia\_bioeconomia.pdf</a>

CPRM - Serviço Geológico do Brasil. **Levantamento de áreas com alto ou muito alto risco geológico em Belém, distritos e ilhas.** Belém: CPRM, 2021.Available at: <https://defesacivil.belem.pa.gov.br/riscos-geologicos/>

DA COSTA, J. H. B.; RODRIGUES, M. C. G.; DA SILVA S. S. Diagnóstico Técnico-Ambiental do Processo Produtivo de Cerâmica Artesanal do Distrito de Icoaraci em Belém do Pará. 57° Congresso Brasileiro de Cerâmica, 5° Congresso Iberoamericano de Cerâmica, 19 a 22 de maio de 2013, Natal, RN, Brasil. Available at: <a href="https://abceram.org.br/wp-content/uploads/area\_associado/57/">https://abceram.org.br/wp-content/uploads/area\_associado/57/</a> PDF/13-065.pdf>

DE ALEXANDRIA, Lissa. Lenda da cobra grande ressurge na memória popular durante festividades do Círio de Nazaré. G1, 30 set. 2021. Available at: <a href="https://g1.globo.com/pa/para/cirio-de-nazare/2021/noticia/2021/09/30/lenda-da-cobra-grande-ressurge-na-memoria-popular-durante-festividades-do-cirio-de-nazare.ghtml">https://g1.globo.com/pa/para/cirio-de-nazare/2021/noticia/2021/09/30/lenda-da-cobra-grande-ressurge-na-memoria-popular-durante-festividades-do-cirio-de-nazare.ghtml</a>

DE LA BARRERA, Francisco et al. Comparing green spaces provision and accessibility indicators over a latitudinal gradient and multiple climate zones. Urban Forestry & Urban Greening, vol. 79., January, 2023. Available at: <a href="https://www.sciencedirect.com/science/article/abs/pii/S161886672200334X">https://www.sciencedirect.com/science/article/abs/pii/S161886672200334X</a>

DUMMETT, Cassie; BLUNDELL, Arthur. Illicit harvest, complicit goods: The state of illegal deforestation for agriculture. **Forest Trends**, Forest Policy Trade And Finance Initiative, Report | May 2021. Available at: <a href="https://www.forest-trends.org/wp-content/uploads/2021/05/Illicit-Harvest-Complicit-Goods.pdf">https://www.forest-trends.org/wp-content/uploads/2021/05/Illicit-Harvest-Complicit-Goods.pdf</a>>

EMBRAPA. (n.d.). **Carapa guianensis Aubl**. Agência de Informação Tecnológica. Available at: <<u>https://www.embrapa.br/agencia-de-informacao-tecnologica/</u>tematicas/especies-arboreas-da-amazonia/carapa-guianensis-aubl> FAPESPA. **FAPESPA lança dashboard do Produto Interno Bruto (PIB) dos 144**  **municípios**. Governo do Pará, 2024. Available at: <a href="https://www.fapespa.pa.gov">https://www.fapespa.pa.gov</a>. br/2024/06/28/fapespa-lanca-dashboard-do-produto-interno-bruto-pib-dos-144-municipios/.>

FERREIRA, J.C., SABINO, W.d. e GIANNINI, T.C. Valuation of agricultural production and pollination services in palm trees (Arecaceae) in the Amazon forest. Arthropod-Plant Interactions, vol 18, 425–437, 2024. Available at: <a href="https://link.springer.com/article/10.1007/s11829-024-10044-x>">https://link.springer.com/article/10.1007/s11829-024-10044-x></a>

FITZ, Paulo R. Geoprocessamento sem complicação. São Paulo: Oficina de Textos, 2008.

FU, Bo-Jie et al. Double counting in ecosystem services valuation: causes and countermeasures. **Ecological research**, v. 26, p. 1-14, 2011.

GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Biodiversidade e Serviços Ecossistêmicos: Desafios e Oportunidades para o Brasil. Sumário para Tomadores de Decisão. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. Brasília/DF: 2019. 56 p. Available at: <a href="https://www.bivica.org/files/6321\_2019\_Sist%20Exper%20TEEB\_Sum%20">https://www.bivica.org/files/6321\_2019\_Sist%20Exper%20TEEB\_Sum%20</a> Toma%20Decisao.pdf>

GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. **Integração de Serviços Ecossistêmicos ao Planejamento do Desenvolvimento**: um passo-a-passo para profissionais com base na iniciativa TEEB. Brasília: GIZ, 2012. Available at: <http://www.aboutvalues.net/es/data/six\_steps/integr\_ ecosys\_serv\_in\_dev\_planning\_pt.pdf>

GOMES, Fátima de Cássia Oliveira; DE RESENDE MACHADO, Ana Maria; ANDRADE, Vinícius Moura. Determinação dos compostos orgânicos e caracterização microbiológica e química da planta medicinal Pariri (ARRABIDAEA CHICA). In: 14<sup>a</sup> Semana de Ciência & Tecnologia 2018-CEFET-MG. 2018.

GOMES, G. da S. et al. Caracterização Química e Mineralógica do Material Argiloso do Polo Artesanal de Icoaraci, Belém – PA. XXVIII Encontro Nacional de Tratamento de Minérios e Metalurgia Extrativa, Belo Horizonte - MG, 4 a 8 de novembro de 2019. Available at: <https://www.entmme2019.entmme.org/ trabalhos/076.pdf>

GONÇALVES, Amanda et al. **Belém e Abaetetuba**. In.: ALVES, Fábio (Org.). A função socioambiental do patrimônio da União na Amazônia. Brasília: IPEA, 2016. HAMEL, Perrine et al. Mapping the benefits of nature in cities with the InVEST software. **Urban Sustainability**, v. 1, n. 1, p. 25, 2021.

ICLEI - Governos Locais pela Sustentabilidade. **O papel dos governos locais na preservação da biodiversidade**. 23 abr. 2021[b]. Disponível em: <a href="https://americadosul.iclei.org/o-papel-dos-governos-locais-na-preservacao-da-biodiversidade/">https://americadosul.iclei.org/o-papel-dos-governos-locais-na-preservacao-da-biodiversidade/</a>>

ICLEI - Governos Locais pela Sustentabilidade; WWF - World Wide Fund For Nature. **Novo Acordo pela Natureza e para as Pessoas - Ficha Técnica**: Unidades de conservação, áreas protegidas e conectividade. 2021[a]. Disponível em: <https://americadosul.iclei.org/documentos/nanp-ficha-tecnica/>

ICMBIO - Instituto Chico Mendes de Conservação da Biodiversidade. **PAN -Plano de Ação Nacional para Conservação das Espécies Ameaçadas**: Peixes Amazônicos. Sumário Executivo. Brasília: ICMBio/MMA, 2021. Disponível em: <https://www.gov.br/icmbio/pt-br/assuntos/biodiversidade/pan/pan-peixesamazonicos/1-ciclo/pan-peixes-amazonicos-sumario.pdf>

IDSM - Instituto de Desenvolvimento Sustentável Mamirauá. Bagres Migradores. **Macaqueiro Kids**, ano XXII, nº 85, jan/abr 2022, Tefé, AM. Disponível em: <https://mamiraua.org.br/documentos/dee294e23dfcc3521361f0615cae94f1. pdf>

IMAZON - Instituto do Homem e Meio Ambiente da Amazônia. Plano de Manejo do Parque Estadual do Utinga (PEUT). Belém: Governo do Pará, 2013. Disponível em:<https://pt.slideshare.net/slideshow/plano-de-manejo-do-parque-estadual-do-utinga/32501475>

INSTITUTO NACIONAL DE METEOROLOGIA (INMET). Normais Climatológicas

do Brasil: período 1991-2020. Brasília: INMET, 2022. Available at: https://portal. inmet.gov.br/.

INSTITUTO ESCOLHAS. Os Desafios e o Potencial da Agricultura Urbana e Periurbana em Belém. São Paulo: Instituto Escolhas, 2022.

INTECAB/PA - Instituto Nacional da Tradição e Cultura Afro-Brasileira. **Afro-religiosos na Cidade de Belém**. Projeto Nova Cartografia Social da Amazônia. Belém: Fundação Ford/PPGSCA-UFAM, 2005. Available at: <a href="http://novacartografiasocial.com.br/download/03-afro-religiosos-na-cidade-de-belem/">http://novacartografiasocial.com.br/download/03-afro-religiosos-na-cidade-de-belem/</a>

IUCN - International Union for the Conservation of Nature; CEM - Commission on Ecosystem Management. Climate Mitigation and Biodiversity Conservation: Technical Brief. UNFCCC, COP 28, November 2023. Available at: <https://iucn.org/sites/default/files/2023-11/iucn-cop-28-technical-brief-cem-climate-mitigation-and-biodiversity-conservation.pdf>

KONIJNENDIJK, Cecil C. Evidence-based guidelines for greener, healthier, more resilient neighbourhoods: Introducing the 3–30–300 rule. J. For. Res., 2022. Available at: https://doi.org/10.1007/s11676-022-01523-z

LIMA, Dula Maria Bento de; GOMBERG, Estélio. Cultura, patrimônio imaterial e sedução no Arraial do Pavulagem, Belém (PA), Brasil. **Textos escolhidos de** cultura e arte populares, Rio de Janeiro, v.9, n.2, p. 53-67, nov. 2012. Available at: <a href="http://www.tecap.uerj.br/pdf/v92/dula\_maria\_bento\_de\_lima\_e\_estelio\_gomberg.pdf">http://www.tecap.uerj.br/pdf/v92/dula\_maria\_bento\_de\_lima\_e\_estelio\_gomberg.pdf</a>>

LORENZI, H., MATOS, F.J.A. Plantas medicinais do Brasil nativas e exóticas. Nova Odessa-SP: Instituto Plantarum, 2002. p.215-6, 480-4.

MANES, Stella et al. Nature as a solution for shoreline protection against coastal risks associated with ongoing sea-level rise. **Ocean & Coastal Management**, v. 235, p. 106487, 2023.

MARTINS, Marlúcia Bonifácio et al (Ed.) **Reflexões em Biologia da Conservação**. Belém: Museu Paraense Emílio Goeldi, 2020.

MARTINS, Patrícia Cristina; DA SILVA, Charlei Aparecido. Turismo de Natureza ou na Natureza ou Ecoturismo? Reflexões e contribuições sobre um tema em constante debate. **Revista Turismo em Análise**, v. 29, n. 3, p. 487-505, 2018.

MARQUES, Luis C. et al. Phyllanthus niruri (quebra-pedra) no tratamento de urolitíase: Proposta de documentação para registro simplificado como fitoterápico. 2013.

MEA - Millennium Ecosystem Assessment. **Ecosystems and Human Well-Being**: Synthesis. Washington: Island Press, 2005. Available at: <a href="https://www.millenniumassessment.org/en/Reports.html#">https://www.millenniumassessment.org/en/Reports.html#</a>

MENDES, Ana Vitória et al. Variáveis meteorológicas e o número de internações por infarto agudo do miocárdio em Belém/PA. **Revista de Geociências do Nordeste**, Caicó, vol.7, n.2, Jul-Dez, p. 153-161, 2021, Disponível em: <a href="https://periodicos.ufrn.br/revistadoregne/article/view/24543/14730">https://periodicos.ufrn.br/revistadoregne/article/view/24543/14730</a>]

MENESES, A. R. S. D. et al. O acesso equitativo a parques urbanos como promoção da saúde em Belém. **The Journal of Engineering and Exact Sciences**, v. 7, n. 1, 30 mar. 2021.

MENEZES, Gerlei A.; LAMEIRA, Wanja Janayna de M.; WANZELLER, Claudionor dos Santos. Na rota do turismo: Análise do turismo na Ilha de Mosqueiro mediante a elaboração de mapas ambientais. Available at: <a href="http://mosqueirando.blogspot.com/2011/06/na-rota-do-turismo-analise-do-turismo.html">http://mosqueirando.blogspot.com/2011/06/na-rota-do-turismo-analise-do-turismo.html</a>>.

MESQUITA, Osvaldo. Usos de Produtos Florestais Não Madeireiros – PFNMs nas Ilhas de Belém, Pará, Brasil. Dissertação (mestrado em Agriculturas Familiares e Desenvolvimento Sustentável) - Programa de Pós Graduação em Agriculturas Amazônicas, Núcleo de Ciências Agrárias e Desenvolvimento Rural, Universidade Federal do Pará. Empresa Brasileira de Pesquisa Agropecuária – Amazônia Oriental. Belém, PA, 2017.

MIRANDA, Thales Barroso. A ilusão da igualdade : natureza, justiça ambiental

e racismo em Belém. Dissertação (Mestrado) - Programa de Pós-Graduação em Arquitetura e Urbanismo, Instituto de Tecnologia, Universidade Federal do Pará. Belém, 2020.

MMA-Ministério do Meio Ambiente; GIZ–Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH. **Mapeamento de Serviços Ecossistêmicos no território**: Cartilha metodológica segundo a experiência de Duque de Caxias – RJ. Projeto Conservação da Biodiversidade através da Integração de Serviços Ecossistêmicos em Políticas Públicas e na Atuação Empresarial – TEEB Regional–Local. Brasília: MMA/GIZ, 2018. Available at: <https://www.bivica.org/files/6221\_2018%20 Comp%20Pol%20Pub\_Cartilha%20Met%20SE%20Planej%20Territ%20%20 Duque%20Caxias%20RJ.pdf>

MORAES, B. C. et al. Crescimento Urbano e Suas Implicações para o Tempo e Clima da Região Metropolitana de Belém do Pará. **Revista Brasileira de Geografia Física**, v. 15, n. 4, p. 2042–2057, 19 jul. 2022.

MOURA, Arthur; SILVA, Evandro Ferreira da; ORLANDA, José Fábio França. Dinâmica da Expansão Urbana na Ilha de Outeiro/PA. **Revista Equador** (UFPI), Vol. 12, N° 1, Ano, 2023, p. 54 - 70. Available at: <a href="https://revistas.ufpi.br/index.php/equador/article/view/13879/8584">https://revistas.ufpi.br/index.php/equador/article/view/13879/8584</a>>

NASCIMENTO, Alexandre F. Estoques de carbono e emissões de gases de efeito estufa de floresta secundária na transição Amazônia-Cerrado. Sinop: Embrapa Agrossilvipastoril, 2021. Available at: <a href="https://www.embrapa.br/busca-de-publicacoes/-/publicaco/1130175/estoques-de-carbono-e-emissoes-de-gases-de-efeito-estufa-de-floresta-secundaria-na-transicao-amazonia-cerrado">https://www.embrapa.br/busca-de-publicacoes/-/publicaco/1130175/estoques-de-carbono-e-emissoes-de-gases-de-efeito-estufa-de-floresta-secundaria-na-transicao-amazonia-cerrado>

NASCIMENTO, Thaylana; CATTANIO, José Henrique. A relação sociedade-natureza na área de proteção ambiental Ilha do Combú, Belém, Pará, Brasil. **Revista Ibero Americana de Ciências Ambientais**, v.14, n.3, p.62-81, 2023. DOI: http://doi. org/10.6008/CBPC2179-6858.2023.003.0006

NELSON, Erik et al. Modeling multiple ecosystem services, biodiversity conservation, commodity production, and tradeoffs at landscape scales. Frontiers in Ecology and the Environment, v. 7, n. 1, p. 4-11, 2009.

NUNES, Thainá Guedelha; FURTADO, Lourdes de Fátima Gonçalves. A ilha do Combu: ensaio sobre turismo e lazer em intenso crescimento. **Novos Cadernos NAEA**, v. 26, n. 1, abr. 2023. Available at: <a href="https://periodicos.ufpa.br/index.php/ncn/article/view/11121">https://periodicos.ufpa.br/index.php/ncn/article/view/11121</a>

OJEA, Elena; MARTIN-ORTEGA, Julia; CHIABAI, Aline. Defining and classifying ecosystem services for economic valuation: the case of forest water services. **Environmental Science & Policy**, v. 19, p. 1-15, 2012.

OLIVEIRA, Rita; LOPES DA SILVA, José Augusto. Associativismo e extensionismo: proposta de ecoturismo e reprodução de quintais produtivos na Ilha de Caratateua, Belém–PA. **Fórum Ambiental da Alta Paulista**, Vo. 17, nº 2, 2021. Available at: <a href="https://publicacoes.amigosdanatureza.org.br/index.php/forum\_ambiental/article/view/2973/2813">https://publicacoes.amigosdanatureza.org.br/index.php/forum\_ambiental/article/view/2973/2813</a>

PARÁ. **Plano de Bioeconomia do estado do Pará**: O que é importante. Belém: Estado do Pará, 2022.

PARACCHINI, Maria Luisa et al. Mapping cultural ecosystem services: A framework to assess the potential for outdoor recreation across the EU. **Ecological indicators**, v. 45, p. 371-385, 2014.

"Parque Igarapé São Joaquim." GSR Escritório de Arquitetura, 2024, https://gsr. arq.br/portfolio/parque-igarape-sao-joaquim/. Acesso em 3 set. 2024.

PIMENTEL, Edyrll et al. Disposição a pagar pela conservação do parque municipal da Ilha de Mosqueiro, Belém/PA. **Revista Ibero Americana de Ciências Ambientais**, v.11, n.5, p.409-422, 2020. Available at: <a href="https://www.sustenere.inf.br/index.php/rica/article/view/CBPC2179-6858.2020.005.0038/2213">https://www.sustenere.inf.br/index.php/rica/article/view/CBPC2179-6858.2020.005.0038/2213</a>

PMB - Prefeitura Municipal de Belém. **Plano Municipal de Saneamento Básico de Abastecimento de Água e Esgotamento Sanitário de Belém – Pará.** Volume I - Concepção técnica e proposições. Belém: PMB, 2014. Available at: <http:// ww3.belem.pa.gov.br/www/wp-content/uploads/PMSB-Bel%C3%A9m-PA\_ Volume-I2.pdf>

R., Douglass J., Wolny S., Arkema K., Bernhardt J., Bierbower W., Chaumont N.,

Denu D., Fisher D., Glowinski K., Griffin R., Guannel G., Guerry A., Johnson J., Hamel P., Kennedy C., Kim C.K., Lacayo M., Lonsdorf E., Mandle L., Rogers L., Silver J., Toft J., Verutes G., Vogl A.L., Wood S, Wyatt K. (2020). InVEST 3.8.9.post3+ug. ga09d7ca User's Guide. The Natural Capital Project, Stanford University, University of Minnesota, The Nature Conservancy, and World Wildlife Fund. Available at: https://storage.googleapis.com/releases.naturalcapitalproject.org/ invest-userquide/latest/index.html

RAMOS, Helci Ferreira; NUNES, Fabrizia Gioppo; SANTOS, Alex Mota dos. Índice de áreas verdes como estratégia ao desenvolvimento urbano sustentável das Regiões Norte, Noroeste e Meia Ponte de Goiânia-GO, Brasil. **Cuad. Geogr. Rev. Colomb. Geogr.**, Bogotá, v. 29, n. 1, p. 86-101, Jun 2020. Available at: <a href="http://www.scielo.org.co/scielo.php?script=sci\_arttext&pid=S0121-215X202000010008">http://www.scielo.org.co/scielo.php?script=sci\_arttext&pid=S0121-215X20200010008</a> 6&lng=en&nrm=iso>

RIBEIRO, Willame; COSTA, Maria Augusta; TAVARES, Maria Goretti. As Práticas Turísticas na Orla Oeste da Ilha de Mosqueiro, Região Metropolitana de Belém, PA. **Rosa dos Ventos**, vol. 5, núm. 3, jul/set, 2013, pp. 528-544. Available at: <https://www.redalyc.org/pdf/4735/473547094013.pdf>

SALES, Gil Mendes. Paisagem Cultural da Ilha do Mosqueiro: Evolução Espaço-Temporal (1986 - 2016). **Caminhos de Geografia**, Uberlândia, v. 19, n. 65, p. 204– 217, 2018. Available at: <https://seer.ufu.br/index.php/caminhosdegeografia/ article/view/38320>.

SEGEP - Secretaria Municipal de Planejamento. **Anuário 2020**: Anuário Estatístico do Município de Belém. Mapas. Belém, 2020. Available at: <a href="https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.pa.gov.br/mapas/superscript-style="https://anuario.belem.pa.gov">https://anuario.belem.gov.br/mapas/superscript-style="https://anuario.belem.gov"/>https://anuario.belem.gov.br/mapas/superscript-style="https://anuario.belem.gov"/>https://anuario.belem.gov.br/mapas/superscript-style="https://anuario.belem.gov"/>https://anuario.belem.gov.br/mapas/superscript-style="https://anuario.belem.gov"/>https://anuario.belem.gov</a>)

SEMMA - Secretaria Municipal de Meio Ambiente. Localização das Áreas Verdes do Município de Belém. Belém, 2022. Available at: <a href="https://semma.belem">https://semma.belem</a>. pa.gov.br/areas-verdes/>

SILVA JUNIOR, Celso H. et al. Benchmark maps of 33 years of secondary forest age for Brazil. Scientific Data, v. 7, n. 1, p. 269, 2020. Available at: <a href="https://www.nature.com/articles/s41597-020-00600-4.epdf?sharing\_token=WP7ma\_6Sw\_ab8hbaTOuF\_NRgN0jAjWel9jnR3ZoTv0PgHKLtT200sbP5XF-SMUfh5XNAhf\_mL3VRKyWKOV1HV1LM7-ZEa3\_RCIqOc5Zd9htY\_y3vtmLaqd0\_ LxQvKw82DgHUVwBAfCoyJbBnv9-g6YFnJMHz1t3wLrj8zm8xbrk%3D>

SILVA, D. F. D. et al. Pressões ambientais sobre serviços ecossistêmicos hídricos em um manancial em Belém, Pará, Brasil. **Research, Society and Development**, v. 9, n. 8, 15 jul. 2020.

SILVA, Francisca Araújo et al. 2018. Estudo Comparativo de Espécies Comercializadas na Ilha de Mosqueiro, Belém - PA. **Revista Valore**, vol. 3, 2018. Available at: <a href="https://revistavalore.emnuvens.com.br/valore/article/view/491">https://revistavalore.emnuvens.com.br/valore/article/view/491</a>

SOARES, André Araújo Sombra; CARVALHO, André Cutrim. Plano de renaturalização de trechos de canais urbanos de Belém-Pará-Brasil: contribuições para o planejamento urbano sustentável, e para o tratamento das inundações urbanas. **Revista Caribeña de Ciencias Sociales**, on line, v. 11, p. 1-10, nov. 2018. Available at: <a href="http://repositorio.ufpa.br/jspui/handle/2011/13528">http://repositorio.ufpa.br/jspui/handle/2011/13528</a>

SOBRINHO, Alexandre et al. Cidades sustentáveis para a água: as políticas públicas de retificação e saneamento do canal da Providência, em Belém (Pará-Brasil). **Research, Society and Development**, v. 11, n. 12, 2022.

SOUZA, Mayane P. de et al. Amazonian Fruit Mari-Mari (Cassia leiandra Benth.): Identification of Flavonoids and Antioxidant, Antimicrobial and Antiproliferative Properties. Journal of the Brazilian Chemical Society, v. 34, n. 3, p. 325-332, 2023.

TAVARES, Paulo et al. **Corpos Hídricos nas Cidades Amazônicas**: Estudo sobre a Provisão de Serviços Ecossistêmicos em Áreas Urbanas Sessão Temática: Biodiversidade, serviços ecossistêmicos e valoração. XIII Encontro Nacional da Sociedade Brasileira de Economia Ecológica, Campinas-SP, 23 a 26 de setembro de 2019. Available at: <htps:// www.ecoeco2019.sinteseeventos.com.br/arquivo/downloadpublic?q= YToyOntzOjY6InBhcmFtcyI7czozNDoiYToxOntzOjEwOiJJRF9BUIFVSVZPIjtzOjM6 IjcyNyI7fSI7czoxOiJOIjtz OjMyOiIwZjA2YzU4ODgzODdjMGJkZDdhY2QwNWY3Y TE2NDQ2OSI7fQ%3D%3D>

TEEB - Iniciativa The Economics of Ecosystems and Biodiversity. A economia

dos ecossistemas e da Biodiversidade: Integrando a economia da natureza. Uma síntese da abordagem, conclusões e recomendações do TEEB. Elaborado por Pavan Sukhdev et al. TEEB, 2010. Available at: <a href="https://www.teebweb.org/wp-content/uploads/Study%20and%20Reports/Reports/Synthesis%20report/">https://www.teebweb.org/</a> wp-content/uploads/Study%20and%20Reports/Reports/Synthesis%20report/ TEEB\_Sintese-Portugues.pdf>

TEEB - Iniciativa The Economics of Ecosystems and Biodiversity. A Economia dos Ecossistemas e da Biodiversidade para Formuladores de Políticas Locais e Regionais. Editado por Heidi Wittmer e Haripriya Gundimeda. Londres: Earthscan, 2011. Versão traduzida Available at: <a href="https://smastr16.blob.core.windows.net/portaleducacaoambiental/sites/201/2020/09/teeb-para-formuladores-de-politicas-locais-e-regionais.pdf">https://smastr16.blob.core.windows.net/portaleducacaoambiental/sites/201/2020/09/teeb-para-formuladores-de-politicas-locais-e-regionais.pdf</a>

TEEB. The Economics of Ecosystems and Biodiversity: Mainstreaming the Economics of Nature.. A Synthesis of the Approach, Conclusions and Recommendations of TEEB. TEEB, 2010. Available at: <a href="https://teebweb.org/publications/teeb-for/synthesis/">https://teebweb.org/publications/teeb-for/synthesis/</a>

UNEP-WCMC - United Nations Environment Programme World Conservation Monitoring Centre; SCBD - Secretariat of the Convention on Biological Diversity. Best Policy Guidance for the Integration of Biodiversity and Ecosystem Services in Standards. CBD Technical Series No. 73. Montreal: UNEP-WCNC/ SCBD, 2012. Available at: <https://www.cbd.int/doc/publications/cbd-ts-73-en. pdf>

VELLOSO et al 2024. A importância de ativos naturais na produção de serviços ecossistêmicos e geração de bem-estar social na percepção da população local: o caso do parque estadual do Utinga em Belém/Pará 2018. Revista **Observatorio De La Economia Latinoamericana**, Curitiba, vol. 22, nº. 7, p. 01-26, 2024. Available at: <a href="https://ojs.observatoriolatinoamericano.com/ojs/index.php/olel/article/view/6014/3861">https://ojs.observatoriolatinoamericano.com/ojs/index.php/olel/article/view/6014/3861</a>

VIRTANEN, Pekka. Áreas Protegidas e Urbanização: O Caso da APA da Ilha do Combú, Belém-PA. Cadernos de Estudos Sociais, v. 35, n. 2, 30 dez. 2020. WEF - World Economic Forum. New Nature Economy Report II - The Future Of Nature And Business. Genebra: WEF, 2020. Available at: <a href="https://www3.weforum.org/docs/WEF\_The\_Future\_Of\_Nature\_And\_Business\_2020.pdf">https://www3.weforum.org/docs/WEF\_The\_Future\_Of\_Nature\_And\_Business\_2020.pdf</a>

WEF - World Economic Forum. **The Global Risks Report 2024**, Insight Report. Genebra: WEF, 2024. Available at: <a href="https://www.zurich.com.br/-/media/project/zwp/brazil/docs/grr/sumario-executivo-relatorio-de-riscos-globai-2024.pdf?rev=17def67b81824dc789aff1e7dd24f8f1">https://www.zurich.com.br/-/media/project/zwp/brazil/docs/grr/sumario-executivo-relatorio-de-riscos-globai-2024.pdf?rev=17def67b81824dc789aff1e7dd24f8f1</a>

WHO - World Health Organization. Reducing Global Health Risks Through Mitigation of Short-lived Climate Pollutants. Scoping report for policymakers. Geneva: WHO, 2015. Available at: <a href="https://iris.who.int/bitstream/handle/10665/189524/9789241565080\_eng.pdf?sequence=1">https://iris.who.int/bitstream/handle/10665/189524/9789241565080\_eng.pdf?sequence=1</a>

WHO - World Health Organization. **Urban green spaces:** a brief for action. Copenhagen: WHO, 2017. Available at: <https://iris.who.int/bitstream/hand le/10665/344116/9789289052498-eng.pdf?sequence=1>

WORLD BANK GROUP. A Roadmap for Countries Measuring Multidimensional Poverty. Washington: World Bank, 2021. Available at: <https://documents1.worldbank.org/curated/en/529491623166773607/pdf/ A-Roadmap-for-Countries-Measuring-Multidimensional-Poverty.pdf>

WRI - World Resources Institute. **Resiliência e infraestrutura natural para garantir o futuro – e o presente – das cidades**. 03 mai. 2019. Available at: <https://www.wribrasil.org.br/noticias/resiliencia-e-infraestrutura-naturalpara-garantir-o-futuro-e-o-presente-das-cidades>

#### List of acronyms

AEM - Millennium Ecosystem Assessment ANA - National Water Agency APP - Permanent Preservation Area APA - Environmental Protection Are ARVC - Climate Risk and Vulnerability Analysis **BPBES** - Brazilian Platform on Biodiversity and Ecosystem Services CEB - Belém Endemism Center **CNP** - Contributions of Nature to People **CNUC** - National Register of Conservation Units CODEM - Development and Administration Company of Belém's Metropolitan Area **COSANPA** - Pará State Sanitation Company ESD - Ecosystem Services Diagnosis FMMCB - Belém Municipal Forum on Climate Change GHG - Greenhouse Gasses WG - Working Group IBGE - Brazilian Institute of Geography and Statistics HF - Herbarium Professor Normélia Vasconcelos **IDHM** - Municipal Human Development Index **INPE** - National Institute for Space Research InVEST - Integrated Valuation of Ecosystem Services and Trade-offs ITV - Vale Technological Institute **IUCN** - International Union for Conservation of Nature LBSAP - Local Biodiversity Strategy and Action Plan LPUOS - Land Parceling, Use, and Occupation Law MMA - Ministry of the Environment MMIB - Women's Movement of the Belém Islands NDVI - Normalized Difference Vegetation Index SDG - Sustainable Development Goal NGO - Non-Governmental Organization **UN** - United Nations GDP - Gross Domestic Product PPA - Multi-Year Plan PDE - School Development Plan PDUI - Integrated Urban Development Plan **PEUT** - Utinga State Park PLAC - Local Climate Action Plan **PFNM** - Non-Timber Forest Products RMB - Metropolitan Area of Belém SbN - Nature-Based Solution SE - Ecosystem Services SEC - Cultural Ecosystem Services SEEG/OC - Greenhouse Gas Emissions Estimate System of the Climate Observatory SEGEP - Municipal Secretariat for General Planning and Management Coordination SESMA - Municipal Health Secretariat SEMMA - Municipal Secretariat for the Environment GIS - Geographic Information Systems UC - Conservation Unit UFPA - Federal University of Pará UFRA - Federal Rural University of the Amazon





Financing







based on a decision of the German Bundestag

Supp



Acknowledgements





Implementation







**MUSEU GOELDI** 

