

Ocean Without Mysteries

Blue Carbon of Mangroves



**CONEXÃO
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This publication is part of the “**Ocean Without Mysteries**” collection, developed under the framework of **Conexão Oceano**, an initiative of the Boticário Group Foundation for Nature Protection dedicated to raising awareness of the importance of the ocean and its ecosystems. This study was developed in cooperation with the Cazul Project.

CREDITS

Boticário Group Foundation for Nature Protection: Liziane Alberti (organizer), Janaína Bumbeer, Jorge Olavo Woellner Kintzel, and Omar Duarte Rodrigues. **Cazul Project:** Daniel Machado de Oliveira, Laís Silvéria de Oliveira, Luiz Fernando da Costa Soares, and Wagner Luiz Langer Costa.

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PRESENTATION

Excessive carbon dioxide (CO₂) emissions into the atmosphere significantly contribute to **climate change** caused by global warming. Extreme weather events are becoming increasingly common, bringing major disasters and suffering to entire populations. This reality highlights the importance of understanding these phenomena and finding ways to address them.

Human activities, such as the use of fossil fuels, deforestation, agriculture, and industrial processes, are responsible for a significant portion of CO₂ emissions. Some of **this carbon is captured by vegetation** and stored in its trunks, branches, roots, and leaves, helping to balance the atmosphere and minimize climate impacts. When it occurs in coastal and marine environments, this process is called **blue carbon**. In this context, the carbon sequestration potential of mangroves is extraordinary!

In addition to acting as allies in carbon storage, mangroves play an essential role in **ecological**

balance, coastal protection, maintaining fish stocks, and supporting economic activities such as fishing and tourism.

This publication highlights the **importance of mangroves** from various perspectives, presenting **unprecedented data on the stock and valuation of blue carbon in Brazilian mangroves** and its relationship with the promising carbon credit market. The information presented stems from the results achieved by the **Cazul project**, supported by the **Boticário Group Foundation for Nature Protection** and developed in partnership with the **NGO Guardians of the Sea**. This document also updates data from the first volume of the Ocean Without Mysteries collection, published in 2021, used to illustrate guidelines on communicating scientific content in an accessible and engaging way.

Based on the knowledge generated, this publication seeks to inspire concrete actions towards protecting and conserving this vital coastal-marine ecosystem for the health of the planet and its communities.

Enjoy the content!



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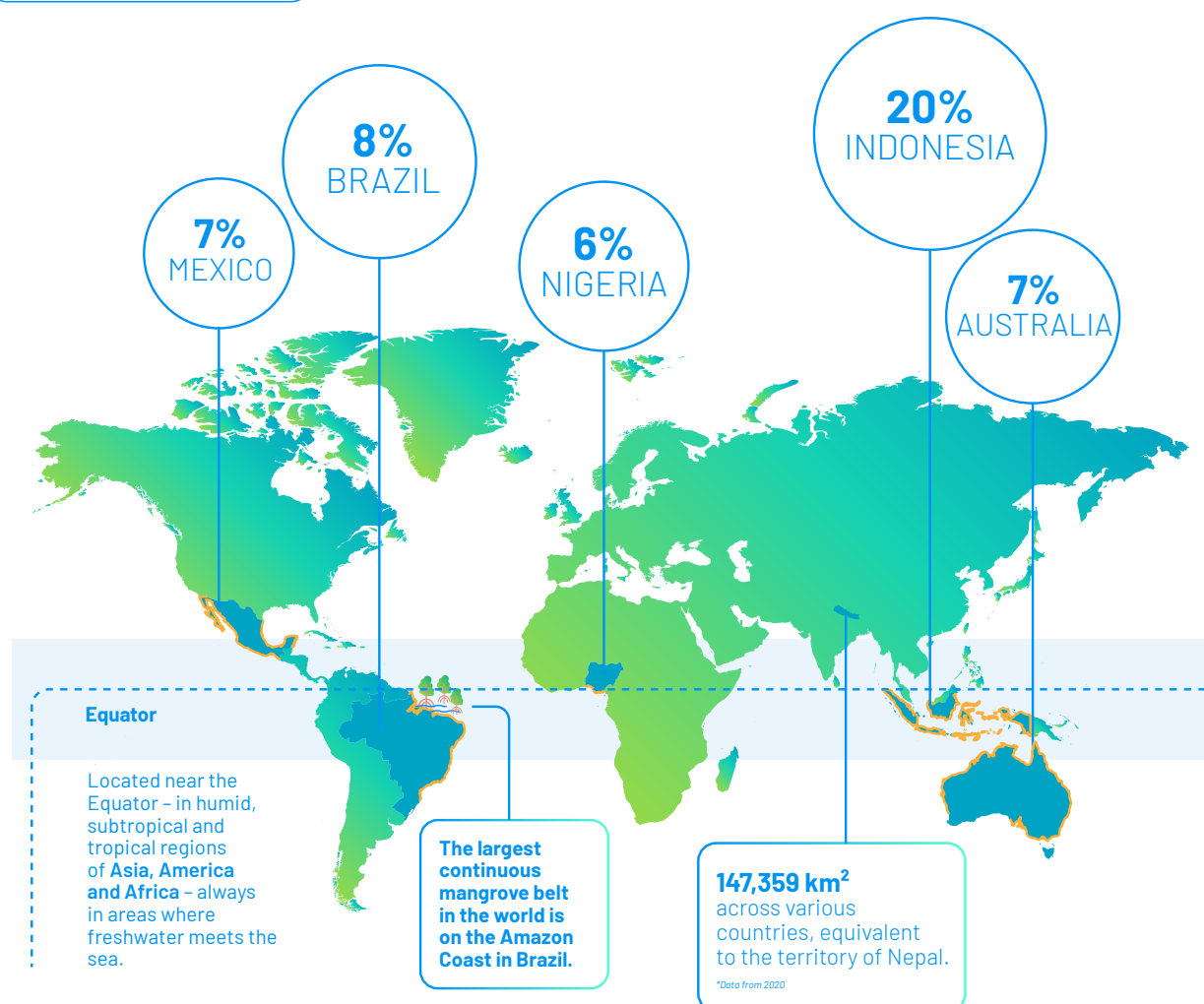
WHERE ARE THE MANGROVES?

Brazil has the second-largest expanse of mangroves on the planet. Understanding the importance of this coastal and transitional ecosystem is essential to promoting its protection and ensuring its sustainability.

MANGROVES AROUND THE WORLD

5 countries account for about **50%** of the world's mangrove areas

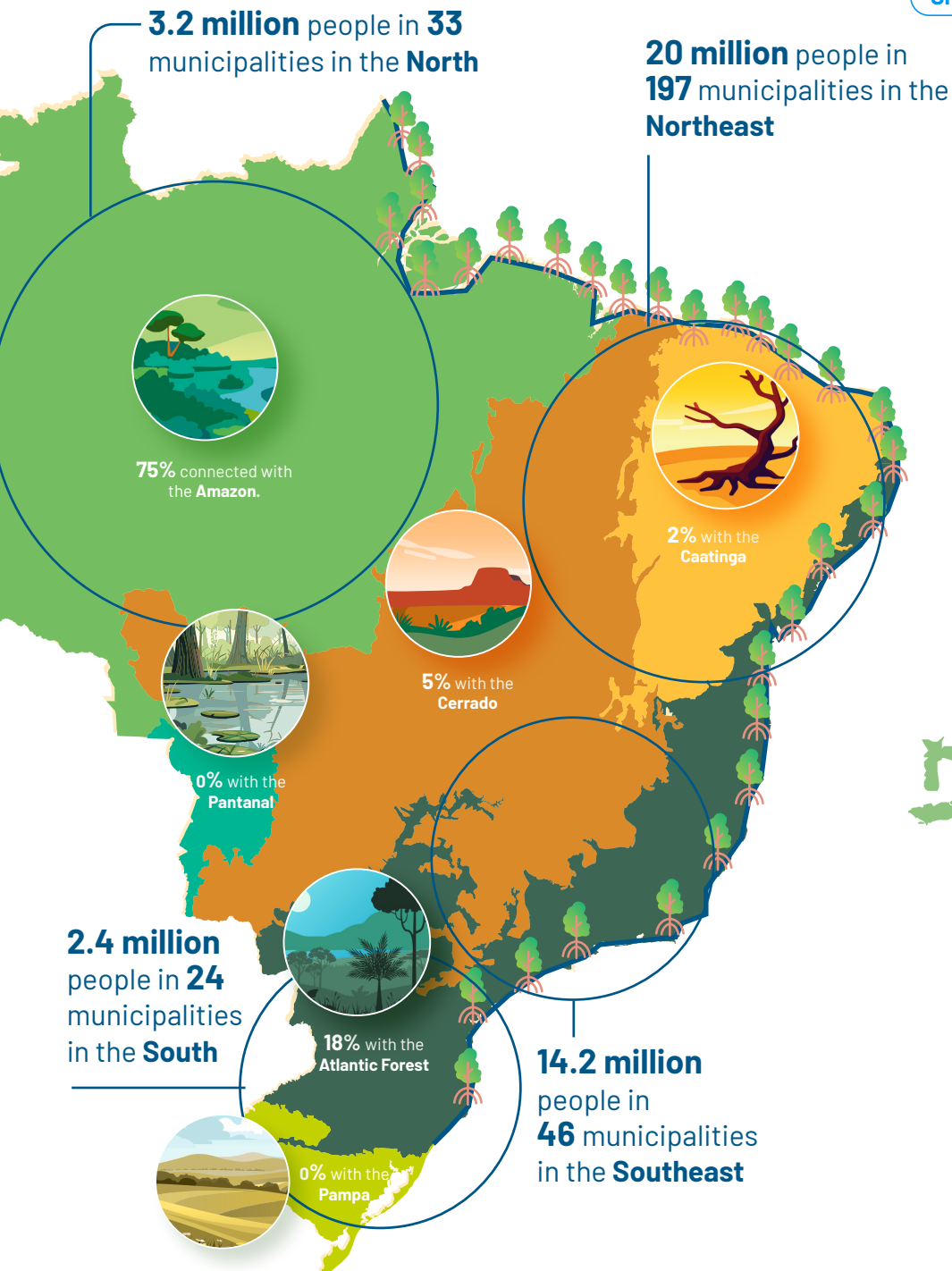
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MANGROVES IN BRAZIL

With the second largest portion of mangroves on the planet, Brazil has about **40 million people** living in **300 municipalities** within this ecosystem.

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1,390,664
HECTARES

of mangroves on the Brazilian coast, especially in Pará, Maranhão, and Amapá.

Mangroves occupy
0.13% OF
THE NATIONAL
TERRITORY



An area equivalent to:



9x the city of São Paulo

11x the city of Rio de Janeiro

25%
OF THE ORIGINAL
VEGETATION

has already been lost.



LIFE IN A HOSTILE ENVIRONMENT

The development in areas where freshwater and seawater meet, the clayey soil rich in salts and poor in oxygen, and the slow decomposition of organic matter present on the surface - with a lower amount of carbon dioxide released - make the mangrove a unique and highly resilient ecosystem, with specific forms of life that can only exist within it.

6 species are found in Brazil. *How to identify them?*

Adapted structures and rapid growth characterize mangrove trees.



RED MANGROOVE: Smooth, light bark that turns reddish when scratched; woody, arched aerial roots to support the tree and anchor it in unstable and flooded terrain; long, pencil-shaped propagules germinating while still attached to the parent plant.

Species: *Rhizophora mangle*, *R. harrisonii* e *R. racemosa*.



BLACK MANGROOVE: Light brown trunk that turns yellowish when scratched; many roots that grow vertically (pneumatophores) around the trunk to capture oxygen; leaves with salt-secreting glands, giving them a shiny appearance; produces fruits for seed propagation.

Species: *Avicennia schaueriana* e *A. germinans*.



WHITE MANGROOVE: Non-functional glands visible as small protuberances; fewer aerial roots; smaller, rounded, drop-shaped propagules.

Species: *Laguncularia racemosa*.

STRUCTURES



RHIZOPHORES
are aerial roots that grow down towards the soil and help to anchor and stabilize the plant.



PNEUMATOPHORES
are aerial roots that grow vertically from the soil, absorbing more oxygen from the atmosphere.



SPECIALIZED GLANDS
excrete excess salt, preventing accumulation in their tissues and ensuring the balance and health of the plant.



PROPAGULES AND FRUITS
disperse seeds, with the former beginning to germinate while still on the plant and the latter when they find a suitable location.

photo Rodrigo Campanário

MAIN THREATS TO MANGROVES

In 24 years, from 1996 to 2020, the world **lost 5,245 km² of mangroves**, decreasing from 152,604 km² to 147,359 km². This area is equivalent to 7 New York Cities (USA) or the Federal District (Brazil) size.

Human activities caused 60% of mangrove losses.

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URBAN DEVELOPMENT
improper construction in mangrove areas.

DEFORESTATION
for charcoal and timber extraction.

COMMODITY PRODUCTION
aquaculture and agriculture modify mangrove areas to farm shrimp, fish, rice, and palm oil.

PREDATORY FISHING TECHNIQUES
trawling and fishing without respecting closed seasons for species.

POLLUTION
caused by chemical waste, pesticides, oil spills, garbage, and sewage.

SEA LEVEL RISE
and other climate-related influences.

SOLUTIONS FROM THE MANGROVES

Nature-Based Solutions (NBS) are those in which nature is part of the solution to solve socio-environmental challenges. Mangroves are an excellent example of NBS, offering multiple benefits for coastal protection, carbon sequestration, biodiversity, and sustainable income generation. They are a true ally with effective and economically viable adaptation and mitigation solutions to the effects of climate change.

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SERVICES PROVIDED BY MANGROVES

Conserved nature brings solutions to various economic, social, and environmental challenges. These are called **Nature-Based Solutions (NBS)**.



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BLUE CARBON STOCK

Oxygen-poor soil retains more carbon in its structure due to the slowing down of the decomposition process.



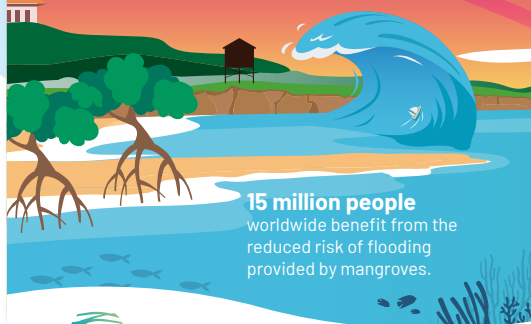
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SHOCK ABSORBERS

They reduce the strength and height of waves, tides, winds, and storms, serving as an obstacle and a first line of defense against floods.

100 METERS OF FOREST = 2/3 LESS WAVE ENERGY



15 million people worldwide benefit from the reduced risk of flooding provided by mangroves.



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ECOSYSTEM ENGINEERS

They contribute to the protection and resilience of coastal communities and urban infrastructure against coastal erosion, sea level rise, and saltwater.

US\$65 billion in property damage is prevented globally each year thanks to the mangroves.



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MAINTENANCE OF FISH STOCKS

Economic Potential
+ Income for local communities
+ Food security



CONEXÃO OCEANO
CONSERVANDO ENLACES, PROTEGENDO

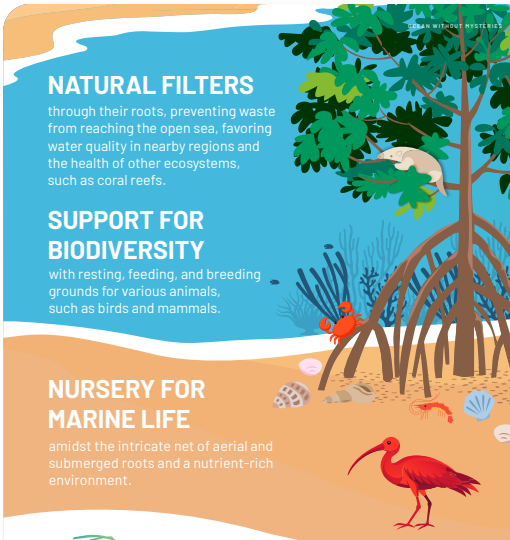
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NATURAL FILTERS
through their roots, preventing waste from reaching the open sea, favoring water quality in nearby regions and the health of other ecosystems, such as coral reefs.

SUPPORT FOR BIODIVERSITY
with resting, feeding, and breeding grounds for various animals, such as birds and mammals.

NURSERY FOR MARINE LIFE
amidst the intricate net of aerial and submerged roots and a nutrient-rich environment.



CONEXÃO OCEANO
CONSERVANDO ENLACES, PROTEGENDO

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CULTURAL CONNECTION WITH ANCESTRAL KNOWLEDGE

It is maintained by traditional peoples (riverine communities, fishermen, crab collectors, indigenous peoples, and quilombolas).

Mangroves inspire festivities, religiosity, gastronomy, folklore, work, and economy. Highlights include the Pernambuco Manguêbeat musical-cultural movement; the festivities of the quilombos of Maranhão; the crab fishing festival on Marajó Island, in Pará; the cults of Yemanjá and Nanã in Candomblé and Umbanda; among others.



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THERE ARE GOOD REASONS TO PROTECT MANGROVES!

Climate change adaptation policies and plans, risk management, and coastal development must include measures to protect, conserve, and restore mangroves. These actions deserve the attention of decision-makers, the private sector, and society as a whole.



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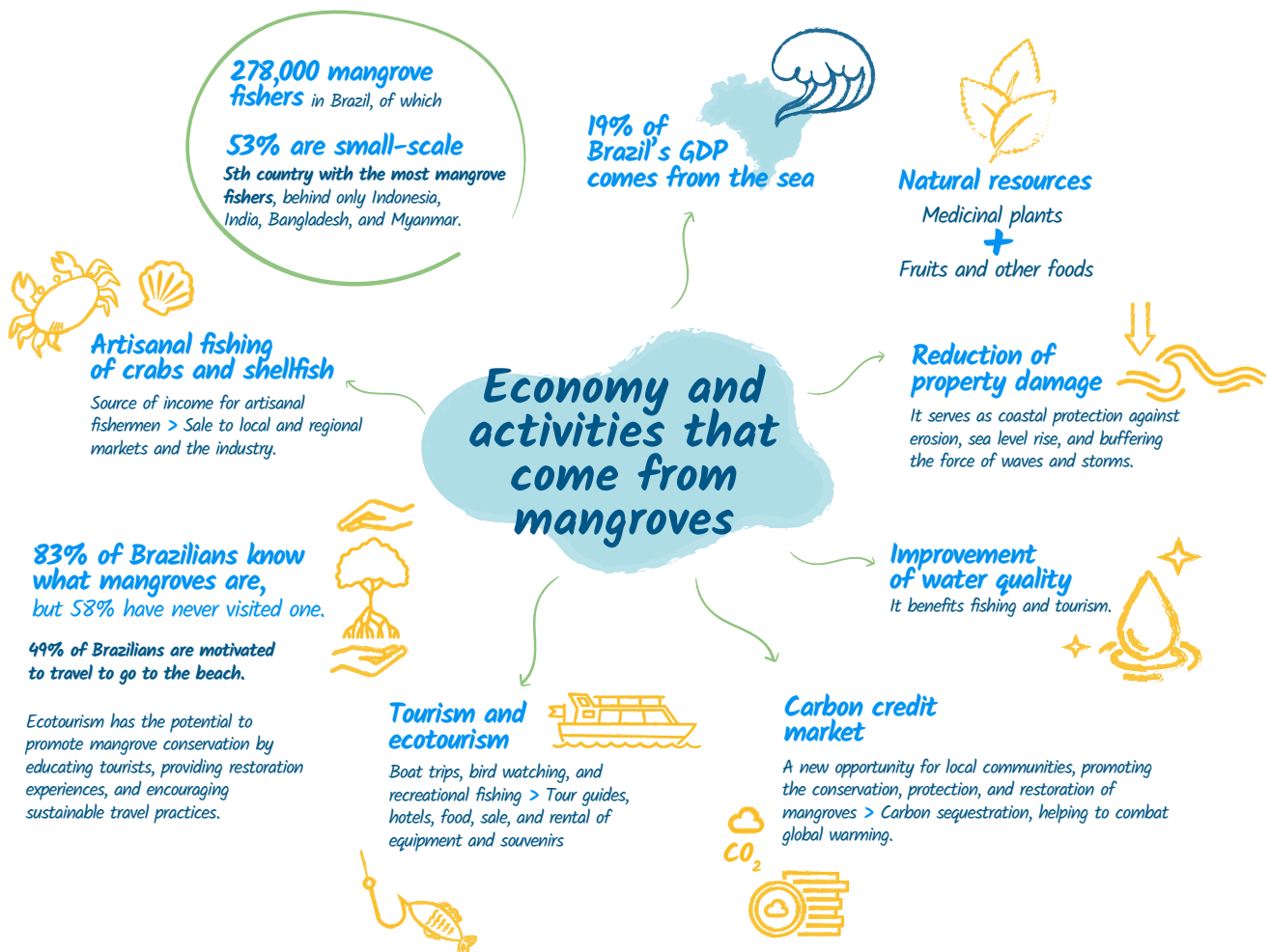
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THE BLUE ECONOMY OF MANGROVES

Economic activities related to or influenced by the sea are part of what we call the **Ocean Economy**. When profit and income generation encompass the sustainable use of ocean resources, we refer to it as the **Blue Economy**. It's certainly connected to you in various ways, through fishing and seafood farming, mineral extraction, renewable energy generation, tourism, sports and cultural activities, crafts, logistics, and transportation of people and goods. This variety of activities benefits local, regional, and even global communities.

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Learn more about **Blue Carbon** in the next pages!

BLUE CARBON

This term describes the carbon captured and stored by coastal and marine ecosystems around the world. In this context, mangroves play a prominent role, contributing to climate regulation by absorbing and retaining large amounts of carbon from the atmosphere.

But how does it work?

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MANGROVE TREES ABSORB CARBON DIOXIDE (CO₂) FROM THE ATMOSPHERE DURING PHOTOSYNTHESIS.

Part of the carbon returns to the atmosphere through the plant's respiration process.

The rest is stored in its stems, trunks, branches, bark, seeds, foliage, roots, and other structures.

40.46%

of the carbon is stored in aboveground structures.

12.81%

is stored in belowground structures, in the roots.

As the plants die and decompose, the accumulated carbon remains in the sediments.

3.55%

remains in pieces of deadwood on the ground with a diameter of at least 10 centimeters.

1.06%

remains in smaller structures that form the litter layer.

Clearing mangrove areas prevents the slow decomposition process from occurring, causing all the carbon stored in the trees to return to the atmosphere. In addition, sediment disturbance, caused by removing mangrove forests, releases more carbon dioxide into the atmosphere.

Due to the low oxygenation of the soil and the influence of tides, decomposition is very slow, and the carbon is retained for long periods, potentially reaching thousands of years.

42.13%

of the carbon is stored in soil organic matter at a depth of up to 30 centimeters.

Mangroves have 3 to 5 times the capacity to store carbon compared to other terrestrial forests, which also increases the potential for emissions in case of deforestation.

New or regenerating vegetation absorbs more carbon during growth, but as it matures, this capacity stabilizes.

FOCUS ON BRAZILIAN STOCKS

Cazul was created to present the potential of mangroves in sequestering greenhouse gases (GHG) to society. It is **the first Brazilian platform to gather data on Blue Carbon and its benefits** for communities and mangroves. Based on this knowledge, it promotes ecosystem conservation actions, strengthening and stimulating sustainable economic chains.

The platform shows all information through interactive map tools, which also present ways to enable multi-sector arrangements and facilitate the mediation of resources from GHG emission reduction projects or Payment for Environmental Services (PES).

Everyone wins: the private sector uses the carbon credits generated by Blue Carbon actions, communities benefit from conserved areas, and the government meets its climate agenda goals.



Want to know more?

ACCESS

Did you know?

The mangroves between Piauí and Maranhão are home to the smallest species of anteater in the world!

CLICK HERE

Watch a documentary about the silky anteater and the importance of protecting mangroves to preserve the species.

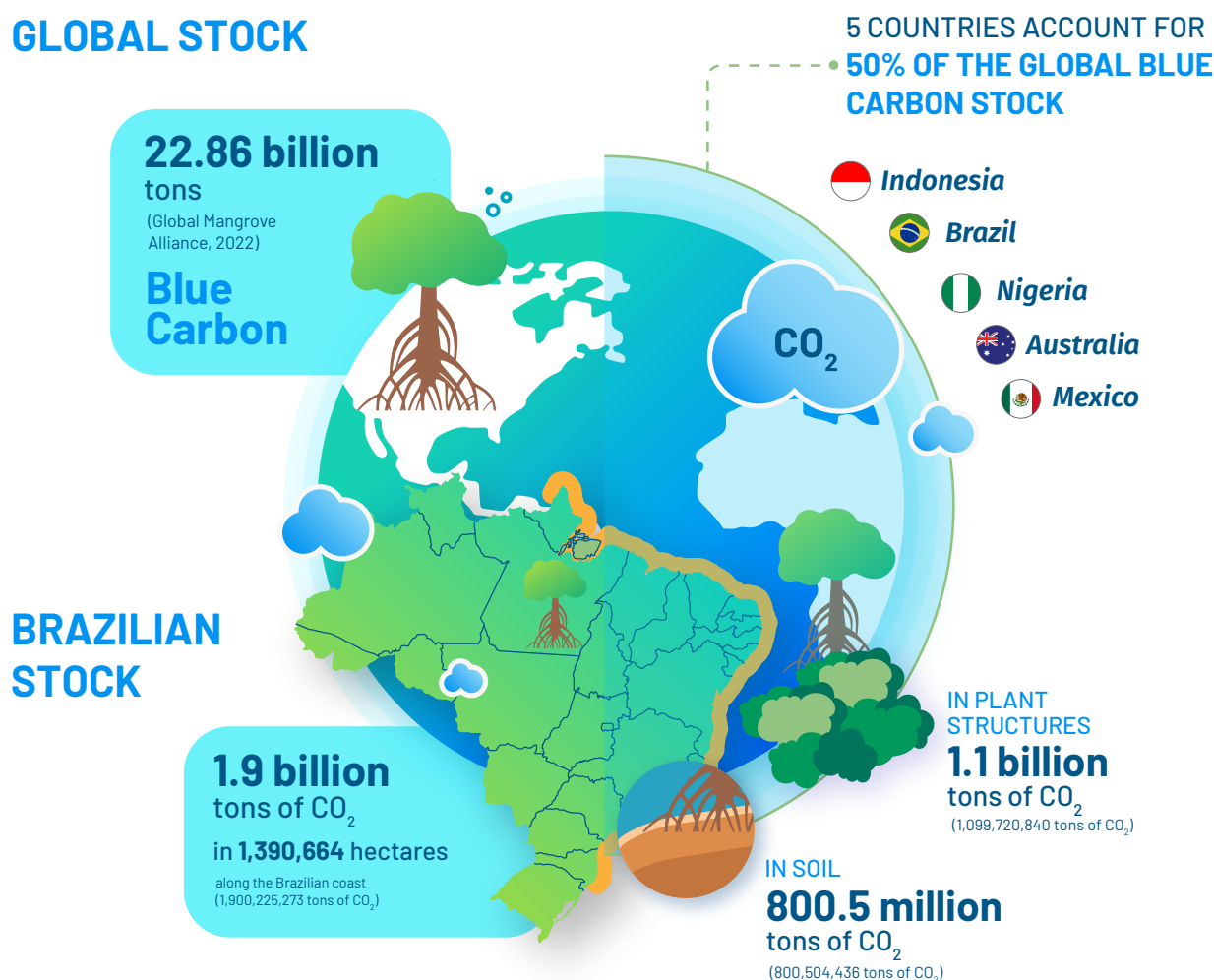


BLUE CARBON STOCKS

By **adding the carbon stocks** in the vegetation and compacted soil of mangroves and considering their relationship with the **current market prices for carbon**, it is possible to estimate **the value of the stock we have in Brazilian mangroves**, highlighting the importance of their conservation and restoration.

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GLOBAL STOCK



ESTIMATED EVOLUTION

Historical data used as a reference* indicate that the carbon stock in mangroves has grown by **78.5 million tons of CO₂ in 27 years or 2.9 million tons per year.**

*Considering data from the National Greenhouse Gas Emissions Communications for the Forestry and Land Use Change and Forestry Sector carried out in 1994 by FUNCATE.

UNDERSTANDING THE CARBON MARKET

Holding the second largest carbon stock in mangroves on the planet, Brazil has an opportunity in the blue carbon credit market to generate income for local communities through conserving this ecosystem. Understand how this activity works:

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LOOKING TO THE FUTURE

HOW MUCH IS BLUE CARBON WORTH? LET'S DO THE MATH!

The value of a carbon credit varies widely. For example, in the Brazilian voluntary market, a ton of CO₂ has been traded for **US\$ 4.6 (R\$ 25.85)**. However, this value is desired to reach **US\$ 100 (R\$ 562)** per ton of CO₂ to transition to a low-carbon economy. Therefore, considering these two scenarios, the stock of 1.9 billion tons in Brazilian mangroves is valued at:

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1.9 BILLION TONS OF CO₂ IN BRAZILIAN MANGROVES



Sources: Opportunities and Challenges for a Regulated Carbon Market in Brazil; #Frontend - Laura Albuquerque; Opportunities for Brazil in Carbon Markets (2021, 2022, and 2023) ICC Brasil and Way Carbon

METHODOLOGY Understanding the Study

(1) Mangrove areas were identified through visual interpretation and automatic classification of satellite images based on 2018 occurrence data from IBAMA/MMA. (2) Using temporal images from the Google Earth Engine platform, parameters were drawn to assess the conservation status of the areas and the associated vegetation index to assist in carbon stock calculations. (3) The value of the carbon credit was obtained by analyzing the economic viability of the stocks and the practices adopted.

STOCKS AND VALUATION IN THE STATES

RANKING	STATE	TONS OF CO ₂ (MILLIONS OF TONS)	VOLUNTARY MARKET		DESIRED MARKET	
			US\$ (MILLIONS)	R\$ (MILLIONS)	US\$ (MILLIONS)	R\$ (MILLIONS)
			X US\$ 4.6	X R\$ 25.85	X US\$ 100	X R\$ 562
1º	PARÁ	574.7	2,643.7	14,857.5	57,471.3	322,988.8
2º	MARANHÃO	561.7	2,583.6	14,519.8	56,165.3	315,648.7
3º	AMAPÁ	312.1	1,435.5	8,067.7	31,207.4	175,385.5
4º	BAHIA	141.8	652.2	3,665.2	14,177.6	79,678.1
5º	PARANÁ	47.6	219.0	1,230.7	4,760.7	26,755.3
6º	CEARÁ	40.7	187.4	1,053.4	4,074.7	22,900.0
7º	SÃO PAULO	39.3	180.8	1,016.3	3,931.3	22,093.8
8º	SERGIPE	38.0	175.0	983.4	3,804.1	21,379.1
9º	RIO GRANDE DO NORTE	25.2	116.0	651.9	2,521.6	14,171.7
10º	PERNAMBUCO	24.9	114.7	644.6	2,493.3	14,012.3
11º	RIO DE JANEIRO	21.3	97.9	550.4	2,129.2	11,966.2
12º	PARAÍBA	20.4	93.7	526.4	2,036.3	11,443.7
13º	SANTA CATARINA	17.5	80.7	453.5	1,754.3	9,859.2
14º	ESPÍRITO SANTO	13.8	63.6	357.3	1,382.1	7,767.5
15º	PIAUÍ	12.9	59.3	333.2	1,288.8	7,243.0
16º	ALAGOAS	8.2	37.9	213.1	824.5	4,633.7

THE BLUE CARBON VALUE IN BRAZILIAN BIOMES

Most of the Brazilian blue carbon is stored in mangroves connected to the Amazon, followed by the Atlantic Forest, Cerrado and Caatinga. Check the appreciation of blue carbon in each of the biomes, considering the values of the Brazilian voluntary market (R\$ 25.85 per ton of CO₂) and the desired pricing for a low carbon economy (R\$ 562 per ton).

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AMAZON

1.043 million
hectares of mangroves

1.3 billion
tons of CO₂
(753.6 million tons in vegetation
and 617.1 million tons in soil)

R\$ 35.4 billion
in blue carbon in the
Brazilian voluntary
market

R\$ 770.3 billion
in desirable price

ATLANTIC FOREST

246.7 thousand
hectares of
mangroves

384.6 million
tons of CO₂
(258.3 million tons in vegetation
and 126.2 million tons in soil)

R\$ 9.9 billion
in blue carbon in the
Brazilian voluntary market

R\$ 216 billion
in desirable price

CERRADO

70.7 thousand
hectares of
mangroves

77.7 million
de toneladas de CO₂
(35.3 million tons in vegetation
and 42.3 million tons in soil)

R\$ 2 billion
in blue carbon in the
Brazilian voluntary market

R\$ 43.6 billion
in desirable price

CAATINGA

29.4 thousand
hectares of
mangroves

67.2 million
de toneladas de CO₂
(52.3 million tons in vegetation
and 14.9 million tons in soil)

R\$ 1.7 billion
in blue carbon in the
Brazilian voluntary market

R\$ 37.7 billion
in desirable price

Source: Azul (2021)

MANGROVES: (IN)VISIBLE IMPORTANCE

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US\$65 billion in property damage is prevented globally each year thanks to the action of mangroves.



22.86 billion tons is the estimated blue carbon stock in the world's mangroves. **1.9 billion tons of CO₂ are in Brazil.**



15 million people worldwide benefit from the reduced risk of flooding provided by mangroves.



They occupy 147,359 km² worldwide of which **13,906 km² are in 300 municipalities in Brazil** where **40 million people live.**



80% of small-scale fishers depend on mangroves, totaling **4.1 million mangrove fishers** worldwide.



According to voluntary market pricing, **US\$ 8.7 billion (R\$ 48.9 billion)** is the estimated value of the blue carbon stock in Brazil.

15 ACTIONS TO TAKE FOR MANGROVES



Companies



Decision makers



Society

1



Invest in research to understand, protect, and manage mangroves effectively.

2



Support public policies that protect and strengthen mangroves.

3



Incorporate Nature-Based Solutions into public policies.

4



Promote projects to restore degraded mangrove areas.

5



Strengthen the creation or implementation of Conservation Units in regions with mangroves.

6



Promote environmental education programs to raise public awareness about the importance of mangroves.

7



Encourage community participation in mangrove conservation and monitoring projects.

8



Learn about the importance of mangroves and share this knowledge with friends and family.

9



Always collect your trash and dispose of it properly.

10



Practice conscious consumption, reuse products, and give preference to companies that care for the environment.

11



Choose to consume native fish species and value the work of local fishermen.

12



Practice responsible tourism, taking care of the environment you are visiting and contributing to the local community.

13



Exercise your rights as a citizen by demanding effective measures from decision-makers to conserve mangroves.

14



Support institutions and projects working on mangrove conservation and restoration.

15



Empower local communities by purchasing blue carbon credits from areas that they protect.

MORE ABOUT THE OCEAN AND MANGROVES

Explore other publications in the **Ocean Without Mysteries collection**



[Access](#)



[Access](#)



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