

## **University of São Paulo researchers show mangroves gain prominence in the fight against climate change**

26 December 2022

Born and raised in the mud, with one foot on land and the other in the sea, sometimes dry, sometimes submerged by the relentless ebb and flow of the tides, the mangrove is an ecosystem accustomed to change and adversity. Not even he, however, is immune to the impact of climate change that is hitting the planet with increasing intensity. “The mangrove can withstand almost anything, but even it has a limit”, says professor Yara Schaeffer Novelli, from USP’s Oceanographic Institute (IO), academic matriarch of mangrove ecology in Brazil. Environmental changes that used to occur over thousands of years are now occurring in a single life cycle, driven by human action. “These are very big changes in a very short time. There is no ecosystem that supports this”, warns the professor to Jornal da USP .

This is bad news not only for the animals and plants of these coastal ecosystems, but also for human beings in general, including those who have never set foot in or plan to one day sink their toes in the mud of a mangrove swamp. Distributed along the fringes of almost the entire Brazilian coastline — from the extreme north of Amapá to the middle of the coast of Santa Catarina — mangroves cover only 0.16% of the Brazilian territory, but they have a socio-environmental relevance that goes far beyond its territorial extension.

Among the many free environmental services they provide to mankind, one that has gained prominence in recent years is their impressive ability to store “blue carbon” — a colorful term used to refer to carbon from marine and coastal ecosystems, in contrast with the “green carbon” associated with forests and other terrestrial ecosystems. Estimates indicate that a hectare of mangroves in Brazil can store between two and four times more carbon than the same hectare of any other biome — including the Amazon rainforest —, according to a study published in early 2022 in the journal *Frontiers in Forests and Global Change* .

Most of this carbon is stored in the muddy soil of the mangroves, where the absence of oxygen delays, or even completely prevents, the decomposition of the organic matter that is buried there. The result is a long-term natural reservoir that can be viewed as either buried treasure or a ticking time bomb waiting to be detonated, depending on what happens to these ecosystems going forward. If the mangroves are protected and that carbon stays in the soil, great! If they are destroyed and that carbon ends up in the atmosphere, it will be like spraying gasoline on the global warming fire.

“It’s a reservoir that needs to be left alone”, summarizes Brazilian ecologist André Rovai, author of the study in *Frontiers in Forests and Global Change* and assistant researcher at Louisiana State University, in the United States. Not only because of what is already stored in it, but because of all the carbon that can still be deposited there. In addition to being excellent guardians, mangroves are also excellent carbon sinks, both through the growth of their forests, which remove carbon dioxide from the atmosphere, and through the accumulation of organic matter that flows down rivers and is deposited in their mud, as if it was a filter. “The mangrove is halfway between land and sea”, describes Rovai. “It produces its own biomass and still stores some of the carbon that flows from within the continent.” Global estimates, according to him, suggest that mangroves can sequester almost 1 billion tons of carbon per year, equivalent to 10% of all carbon emitted annually in the world by the human species (10 billion tons).

“The mangroves are a great carbon hotspot ”, reinforces Professor Roberto Barcellos, from the Department of Oceanography at the Federal University of Pernambuco (UFPE), who in recent years has become intensely dedicated to researching blue carbon. “There is no ecosystem that accumulates as much carbon as they do.” The amount of carbon per hectare can vary greatly from one place to another, depending on the environmental particularities of each location. After all, “each mangrove is a mangrove; no two mangroves are alike”, says teacher Yara. There are many variables that still need further study to fit mangroves with

greater scientific accuracy into national inventories and the global architecture of carbon fluxes, including their natural emissions of carbon dioxide, methane and other natural greenhouse gases.

But one thing that is already very clear in the data, according to experts, is that mangroves are an important piece in the puzzle of global climate change. A piece that needs to be not only protected, but also multiplied. “Preserving the mangroves is essential, but not only that”, Barcellos points out. “It is necessary to restore what has already been lost and create new mangrove areas wherever possible.”

climate threat

Brazil is home to one of the largest mangrove areas on the planet: 1.4 million hectares, according to the Atlas dos Mangroves of Brazil, published in 2018 by the Chico Mendes Institute for Biodiversity Conservation (ICMBio), of the Ministry of the Environment (MMA). About 80% of these ecosystems are concentrated in three states (Maranhão, Pará and Amapá) and 87% are located in some conservation unit, such as parks, reserves or environmental protection areas (APAs). Historically, it is estimated that 25% of the original mangrove areas in Brazil have already been suppressed since the beginning of the 20th century, according to the Atlas.

These data refer to the mangrove ecosystem as a whole, including its forests (mangrove forests) and other features directly associated with them, such as the floodplains and the apicuns, which are drier areas with less vegetation cover, but which are equally relevant from the ecological point of view of the ecosystem. Looking specifically at forest formations, Brazil has just over 1 million hectares of mangrove forests distributed along its coastal zone, according to the most recent mapping by the organization MapBiomias, which provides updated data up to 2021. Compared to 2001, this represents a 2% reduction. Compared to 1985, however, there was a 4% increase — figures that reflect both the dynamics of natural transformations in mangroves and the anthropic pressures (of human origin) to which they are subjected. Excluding more peripheral losses and gains, MapBiomias estimates that 84% of the mangrove forest cover in Brazil has remained stable over the last 37 years.

“Among the deaths and injuries in Brazil’s environmental scenario, mangroves are a very positive example of resilience”, says MapBiomias’ technical coordinator for mapping coastal zones, Cesar Diniz. Three quarters of these mangrove forests (75%) are within legally protected areas, according to the publication.

The bad news is that none of this is a guarantee of immunity to climate changes that are already underway and tend to get even worse in the coming years. The main threats are the rise in sea level and the increase — both in frequency and intensity — in the occurrence of extreme weather events, such as storm surges, storms and gales, with the capacity to submerge, erode and attack these coastal environments that are occupied by the mangroves.

Ultimately, according to experts, the capacity of mangroves to survive this intense climatic bombardment will depend on the availability of areas to which they can migrate in search of more favorable conditions, as their current territories are redrawn on the map by the advance of tides.

Simplifying things: mangrove trees are the only ones capable of surviving in areas of tidal influence, because of the high salinity of the environment that is flooded by sea water. Any other terrestrial vegetation dies. Therefore, as the sea level rises and the waves advance over the coastline and estuaries, the mangrove occupancy frontier, theoretically, also moves towards the mainland, pulled by the reach of the tides. If on the one hand they can be devoured by erosion, on the other hand they can expand into the continent. That is, if there isn’t a road, industry, condominium, mountain or shrimp pond in the way to block your path. “If the mangrove does not have space to accommodate itself, it ends”, summarized geologist and oceanographer Célia Souza, a researcher at the Environmental Research Institute of the Secretariat for Infrastructure and Environment (IPA-Sima) of the State of São Paulo, in a seminar on the theme held in July this year: Mangroves in the decade of the oceans – Management, recovery and participation of artisanal fishermen and collectors. “Unfortunately, the coastal plains are the best for civil construction”, added the geographer Viviane Buchianeri, a specialist in the management of protected areas and environmental inspection at the Fundação Florestal (FF), linked to the São Paulo government.

That is, the risk of conflict between migrating mangroves and installed human infrastructure is great, especially in the Southeast and Northeast regions of Brazil, where occupation rates in the coastal region are

higher and the remaining areas of mangroves are quite fragmented. On the north coast of the country (Maranhão, Pará and Amapá), where most of the Brazilian mangroves are concentrated, movement tends to be more peaceful, due to the lower population density in the mangrove areas of that region.

“The effects can be varied. It is likely that there will be expansion of mangroves in some places and retraction in others”, observes Clemente Coelho Junior, professor at the Institute of Biological Sciences at the University of Pernambuco. The outcome, according to him, will depend on several climatic, oceanographic and geographic variables. Among them: the degree and speed of sea level rise, the amount of sediment arriving by rivers, sedimentation rates and the topography of each location.

In a large part of the coast of São Paulo, for example, in addition to all the already consolidated human occupation, there is a gigantic natural wall blocking the passage, which is the Serra do Mar. Mangroves are capable of many feats, but they don’t climb mountains. “There, the mangrove is cornered, there’s not much to run for”, says Coelho Junior.

“The mangrove is resilient, yes, but we need to help in this process”, says professor Marília Lignon, from the São Paulo State University (Unesp) in Registro, in the Vale do Ribeira region. In many cases, the exact opposite is happening: “We are greatly worsening the ability of mangroves to adjust to these climate changes”, points out the professor — remembering that changes are happening much faster and more intensely today than in the past.

Lignon leads a large multidisciplinary and multi-institutional research group called Integrated Monitoring of Mangroves, which tracks the health status and ecological dynamics of various mangrove plots in the regions of Iguape and Cananeia, on the south coast of São Paulo.

The report of the Journal of USP accompanied the teacher’s team on a field trip in August, in the Cananeia estuary; a region of beautiful landscapes and an abundance of impressive wildlife, protected by two state parks (Ilha do Cardoso and Lagamar de Cananeia) and an extractive reserve (Resex do Mandira), where several traditional communities of fishermen, shellfish gatherers coexist and oyster farmers. Almost always working in water or submerged in mud, the teacher and her students measure the height and diameter of hundreds of mangrove trees, spread over a network of previously established monitoring plots. “I’ve been coming here since this mangrove was one meter high; it’s like a child I’ve seen grow up”, describes Lignon, in the middle of a forest formed by red mangrove trees (*Rhizophora mangle*) that reach 10 meters in height. The researchers note the species of each tree, whether it is alive or dead, whole or broken, and measure the salinity of the soil, among other parameters that make it possible to say, for example, whether that forest is growing or withering, gaining or losing biomass (plant organic matter). And as biomass is essentially made of carbon, this also allows inferring whether mangroves are losing or accumulating carbon over time. The diagnosis varies between plots and regions, but an important message that emerges from the data is that the mangroves that are within protected areas and less exposed to human aggression are healthier, more resistant, accumulate more carbon and recover faster from damage caused by extreme weather events such as storms or windstorms,

The work began in the early 2000s, when Lignon was still a graduate student at IO — supervised by Professor Yara Novelli, as well as most of the specialists consulted for this report — and it turned into one of the most important and longest-running projects monitoring of mangroves in Brazil. “We have to understand that mangrove forests are our allies in the fight against climate change and need to be protected. This is essential,” she warns.

Mangroves occupy only 0.1% of the territory of the State of São Paulo, according to the most recent Inventory of Native Vegetal Coverage of the State. There are 24,574 hectares, divided almost exactly between the south coast and Baixada Santista, and only 195 hectares on the north coast. They are ecosystems that live “at a crossroads”, according to Marco Nalon, director of the Technical-Scientific Department of IPA-Sima: while they protect against climate change, they are affected by it. “As if that weren’t enough, there’s human pressure”, highlighted Nalon, at the seminar in July, promoted by the secretariat.

The good news is that 68% of these mangroves in São Paulo are within protected areas, including areas of sustainable use and full protection. Even so, it is a scenario that requires care and constant attention from

the public authorities. According to the criteria of the International Union for Conservation of Nature (IUCN), according to Nalon, the mangroves of São Paulo can be considered ecosystems “in danger of collapse”. It is estimated that more than 50% of the state’s original mangrove cover has already been lost. The most conflictive region is the Baixada Santista, which includes Santos and eight other municipalities in the most central part of the coast of São Paulo, between Peruíbe and Bertioga. The region preserves a large part of its native vegetation still intact, but heavily pressured by human activities, mainly in the surroundings of Santos. The municipality has more than 430,000 inhabitants concentrated on an island of less than 40 square kilometers, almost all of it at sea level and surrounded by ports, marinas, industries and unmet social demands that often lead to the disorderly occupation of areas of mangrove. At one extreme are the stilt houses—favelas built on wooden stilts in the mangrove mud. On the other, tons and tons of concrete and steel from the largest port infrastructure in Latin America.

The loss of these ecosystems has a significant impact on the natural drainage of the island and its ability to withstand the impacts of climate change, according to engineer Eduardo Hosokawa, head of the Climate Change Section of the Environment Secretariat and coordinator of the Municipal Adaptation Commission. to Climate Change (CMMC) in Santos. Under normal conditions, mangroves function as natural barriers to protect against storm surges and mitigate coastal erosion. Without them, the city is more vulnerable to bad weather and still needs to spend fortunes on dredging, drainage and construction of artificial barriers. To understand the problem is easy: just walk along the edge of Ponta da Praia de Santos and see that a large part of the sand strip of one of the city’s most tourist spots has literally disappeared from the map in the last 50 years. “The hangovers, which happened from time to time, are now much more frequent,” says Hosokawa. Not by chance, the protection and restoration of mangroves are one of the strategic actions foreseen in the new Santos Climate Action Plan, launched in January 2022.

“One of the most important services that the mangrove brings is precisely the power that its roots have to retain sediments and, with that, prevent erosion of the estuarine coastline (...) and keep the sedimentary balance of the coastal zone in balance”, he said. researcher Célia Souza, from IPA-Sima, at the seminar promoted by the state secretariat in July. “And then we include the beaches in this too.”

Outside the port center of Santos, the Baixada Santista still harbors large extensions of mangrove ecosystems that, in addition to storing carbon, provide a series of other extremely important ecosystem and environmental services for the region. “The Baixada landscape is a very large mosaic. There is everything here, from highly impacted to highly preserved mangroves”, says researcher Ricardo Menghini, PhD in Biological Oceanography from the Oceanographic Institute (IO) of USP and professor at Universidade Paulista (Unip).

One of the main strategies being studied to finance the planting and restoration of mangroves in the region is the sale of credits linked to the carbon that can be absorbed by these ecosystems. If the deal succeeds, “it will be very welcome”, says oceanographer Fabrício Gandini, from the Maramar Institute, a social organization based in Santos. But it is essential that these resources also be reverted in favor of the communities that depend on the mangroves for their survival — theSomething that has not happened effectively, according to him, with the environmental compensation resources coming from the port sector. Despite all the difficulties, according to Gandini, there are about a thousand families who still make a living directly from the mangroves in Baixada Santista, fishing for fish, shellfish and crabs. Like the mangroves themselves, the traditional communities that live in synergy with them are extremely resilient.

“When there are no more people fishing in the mangroves, you can write: this mangrove is doomed”, said environmental consultant Geraldo Eysink, who has been working with mangrove planting and restoration for more than three decades. No effort to recover these ecosystems has a chance of succeeding, according to him, if it does not involve fishermen: “the true bioinformants of the mangrove forest”.

#### **ecosystem services**

Carbon storage is just one of the many ecosystem and socio-environmental services provided to humanity by mangroves. His most famous role, perhaps, is that of marine life nursery.

Scientists estimate that about three quarters (between 70% and 80%) of marine species of commercial value for fishing use the mangroves at some stage of their development (to breed, feed or grow) and, therefore, depend on this ecosystem for survive — even if, at the end of the line, they are fished a long way away. “Don’t cut the mangroves because the life in the sea could die”, says the refrain of a song by educator Carlinhos de Tote, from the Cantarolama group, in Maragogipe (BA), who has been working for the preservation of mangroves for more than four decades in Brazil. ( [Click here to listen to the song](#), presented at the Mangroves in the Oceans Decade seminar .)

Sea bass, mullet and seabob shrimp are some examples of marine species that are raised in the mangroves; in addition to many others that may not have commercial value for fishing, but are equally valuable for the health of coastal and marine ecosystems. The gigantic grouper ( *Epinephelus itajara* ), a critically endangered species in Brazil, for example, spends the first few years of its life in the mangroves before migrating to the ocean in adulthood.

“The mangrove is a different world for us, right? Because everything in the mangrove is created; the fish, the shrimp, the oysters that we eat and sell, everything is raised in the mangroves. It’s our nursery, right?”, says fisherman and tour guide Sergio Neves, a true caçara from Ilha do Cardoso, on the south coast of São Paulo. Even within a conservation unit, with extremely healthy mangroves, Neves clearly perceives the effects of global warming and climate change on the landscape, with direct impacts on the ecosystem and the lives of local communities, which derive their livelihood from nature. Storms, windstorms and other extreme weather phenomena are becoming more frequent, intense and destructive, according to him. The rise in sea level has increased the reach of the tides and the strength of the winds, especially in the cold fronts, which also seem to arrive with increasing frequency. Waves erode the coastline and push sand from the ocean into the estuary, burying the mangroves.

In 2018, the entry of a strong cold front, combined with a full moon tide, sealed the break of a stretch of beach at Enseada da Baleia, at the southern end of the Ilha do Cardoso State Park, which resulted in the opening of a new barra (passage connecting the ocean and estuary) and the death of a large stretch of mangrove just ahead of it. “It was a natural erosion process, but amplified by an extreme event”, evaluates Lignon.

“With that, what happens is that the abundance decreases, right? Decreases the fish; the shrimp that reproduce there stop reproducing”, explains Neves. “Not having this nursery, it will decrease ( fishing ) in the high seas out there too”, he adds. Words of caçara wisdom, in perfect harmony with science. “The great defenders of the mangroves today, without a doubt, are the organized traditional communities”, who perfectly understand the importance of these ecosystems, says Professor Coelho Junior, from the UPE. That is why the preservation of the mangroves is one of the main management goals of the Costa dos Corais Environmental Protection Area, the largest marine conservation unit in Brazil, which extends over 120 kilometers between the north coast of Alagoas and the south of Pernambuco, the region where Coelho Junior has been working since he finished his postgraduate course at IO, in 2004. In addition to acting as nurseries, the mangroves work as a biological filter, blocking the passage of sediments and pollutants from the mainland that, if they reached the sea, could compromise the health of marine reef ecosystems. Another socio-environmental asset that could be put at risk by climate change is crab hunting, one of the most iconic, traditional, culturally and economically important activities associated with mangroves. Two of the main species targeted by this type of fishing — the guaiamum ( *Cardisoma guanhumi* ) and the mangrove crab ( *Ucides cordatus* ) — depend on the innermost and least flooded areas of the mangroves to live and reproduce.

The guaiamum is an endangered species in Brazil, which lives precisely in this transition zone between the flooded mangrove forests and the terra firme, where the so-called apicuns, or plains, occur. hypersalines, which are part of the mangrove ecosystem, but are less frequently flooded by the tide and do not support large vegetation. These are coveted areas for the construction of shrimp ponds and salt production, among other undertakings. The mangrove crab, on the other hand, lives in the mud of mangrove forests, but also uses these drier transition zones as nurseries, according to biologist Anders Schmidt, professor at the Federal University of Southern Bahia and coordinator of the Monitoring Network of Crab Reproductive Walks .

“That’s where we find baby crabs, the individuals that are arriving in the population”, explains the professor. With the rise in sea level, the tendency is for these apicuns to turn into mangrove forests and for this drier transition zone to move towards the mainland, where the risk of colliding with human constructions and ending up disappearing is huge. “Not having this displacement backup, you could end up losing these little flooded areas, which is where the crab population renews itself”, completes Schmidt. “It is an extremely critical area for the survival of these species.”

According to MapBiomas, the total area of apicuns in Brazil shrank by 14% between 2001 and 2021 – from 63,000 to 54,000 hectares.

The population collapse of these species — as is already happening with the guaiamum, due to overfishing and loss of habitat — would be a disaster for thousands of families of extractivists who depend on these crustaceans for their livelihood. People like Antonio Carlos Borges Amaral, “Toninho” from Ponta de Areia, in Caravelas (BA), who has been fishing and collecting crabs in the mangroves of southern Bahia for over 20 years. “The mangrove is everything to me. My family’s livelihood comes entirely from the mangroves”, sums up the 40-year-old extractivist, married and father of three.

The Jornal da USP report accompanied Toninho on a typical day at work at the Cassurubá Extractive Reserve, a protected area covering 100,000 hectares where only local extractivists can work, in accordance with rules established in a management plan. It is one of the most productive areas for uçá crab fishing in Brazil, where most of the crustaceans that supply markets and restaurants in the region come from.

Toninho is one of the few local extractivists who still prefers to collect crabs using the traditional method, sticking his hand in the mud. He uses a technique known as “hook”, which consists of manipulating a steel rod, bent at the end, to poke the animal deep in the burrow and pull it to the surface — a variation of the more rustic method of “bracing”. , in which the crab is captured directly by hand. (More recently, most extractivists have migrated to a controversial technique known as “redinha”, which uses raffia bag fibers as a trap to ensnare crabs at the entrance to burrows.)

The way in which Toninho reads the signs on the surface of the mud and “feels” the animal inside the burrow is impressive; it’s like the rebar is a tactile extension of his arm. “It’s pinching!”, he announces, panting, when he hears the clicks of the crab’s pincers attacking the hook. Then he keeps poking and pulling, until the animal comes out of the hole — which can reach two meters deep.

The uçá crab is a threatening looking animal, but that Toninho handles with the tranquility of someone holding a stuffed animal. In three hours of work, he catches more than 20 crabs; enough to feed his family and earn a little money. “I’m very proud of what I do”, says Toninho, who lives in a brick house close to the Ponta de Areia pier, where he ties up his battery (a wooden boat with an outboard motor, typical of the region). “If I had another job I wouldn’t have what I have today through the mangrove. Thank God we have this here for us to keep still.”

“This little strip of territory sustains the lives of millions of people”, says Professor Yara, from IO, looking at a map of Brazil’s mangroves. Asked at the seminar in July, in São Paulo, about what would be the highest priority measure for the conservation of mangroves in the State, she answered categorically: “Political will. The rest is already done; the table is set.”

Source:<https://indiaeducationdiary.in/university-of-sao-paulo-researchers-show-mangroves-gain-prominence-in-the-fight-against-climate-change/>