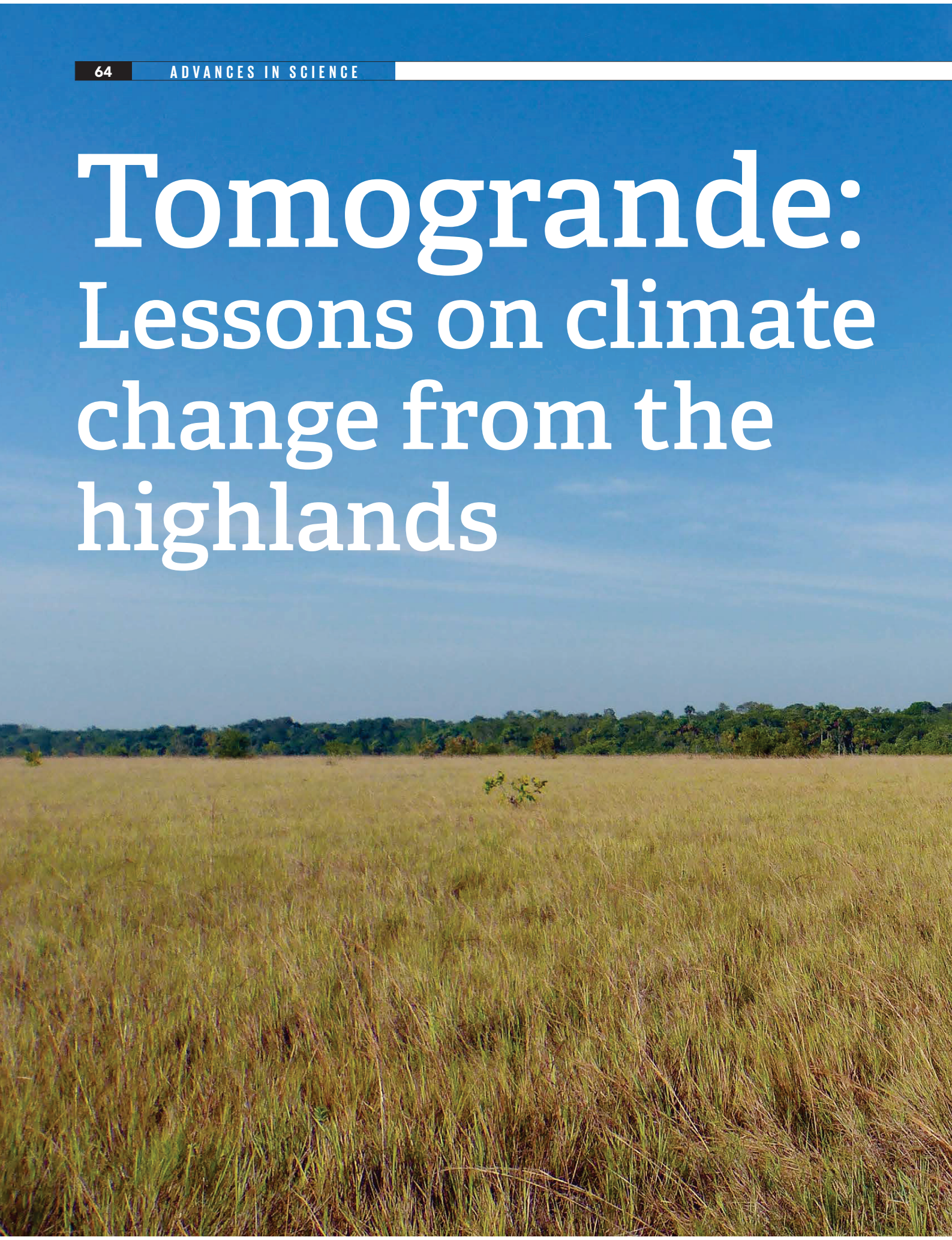
Tomogrande: Lessons on climate change from the highlands



Although it is rarely present in the public imagination and even in public policies, the Colombian highlands has much to say about climate change adaptation and carbon sequestration. The private reserve Tomogrande is a proof of this.

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Tomogrande is a reserve located in the southeastern end of the municipality of Santa Rosalía, in the department of Vichada. Its landscape is slightly undulating. On the banks of the rivers Tomo and Caño Grande –hence its name– there are flat areas that flod in some years.

In this reserve, the division between ecosystems is very pronounced: there is a transition between savanna and forest. The savanna is covered with grasses and other herbs, with a few small trees scattered throughout. The gallery forest surrounds all the small streams that rise in the savanna and, to the east, the floodplain forest borders several lagoons adjacent to the Tomo River.

Being so far from the Andes, the Vichada highland has no rivers that bring nutrient-rich sediments, which makes the soils of Tomogrande poor, very acidic and, sandy, causing water to filter quickly. "There is only forest in places where the water table (the upper limit of an underground water layer) is high enough, which is where water accumulates and tree vegetation can exist," explains Sergio Estrada Villegas, an

ecologist who helps coordinate the reserve and scientific station Tomogrande, who is also a professor in the Faculty of Natural Sciences at Universidad del Rosario.

In terms of precipitation, Tomogrande receives between 2 000 and 2 500 millimeters of rain per year; for most of the year, there is sun and wind. The grasses, composed of graminoids and herbaceous plants, have evolved to survive drought conditions. "What grows in the highlands is because it fights hard and manages to survive and reproduce," adds Estrada Villegas.

Then there is the fire. The savanna naturally burns from time to time, when thunderstorms occur without rain. "That is when a spark ignites. That spark sets the savanna ablaze and combusts the vegetation. These are fires that occur naturally, spontaneously, and consume the grass communities that survive the drought," he states.

"Because of these fires, which have ocurred for thousands of years, there are areas completely free of tree vegetation. Some small trees do grow because they can resist the fires, but for the most part, it is grasses and herbaceous plants," he continues.

Understanding how these ecosystems have managed to survive under extreme conditions is what makes the highlands fascinating, especially in times of climate change. With this in mind, Estrada Villegas advocates for increased research efforts in the area.

"We need to understand what is going to happen to these ecosystems, because they may dry out more and begin to turn into xerophytic ecosystems (vegetation adapted to dry environments for various reasons) or deserts, something they have already been! During the Pleistocene, there were huge deserts in large parts of the Colombian Orinoquía, including the highplain. There has been a repeated cycle of desert, savanna, jungle, savanna, and desert...", emphasizes the researcher.

However, there is a difference between what happened in the Pleistocene and what happens now. With the current climate change, which is anthropogenic in origin (due to the release of greenhouse gases –GHGs– from human activities), ecosystems have not had enough time to react and adapt.

How is the highlands coping with the temperature increase? Will fires increase? How quickly can species adapt to these changes? Will it become a desert again?

To find out, science is needed, and that is precisely what the group of biologists in charge of Tomogrande has been doing for the past 10 years.

Biodiversity inventories

Tomogrande is a private nature reserve that also serves as a station for scientific studies. It protects 2 500 hectares of well-drained savannas, as well as flooded and gallery forests. It is part of a group of nine properties that complement conservation efforts beyond the western boundary of the Reserva de la Biosfera de Tuparro (Tuparro Biosphere Reserve), a protected wilderness area.

For a decade biologists have used different research methodologies to know the biodiversity that inhabits or transits through this reserve. In this way, five plots have been established to study vegetation: three in dry land forests and two in floodplains.

Trails have also been established in the dry land forests to record the diversity of plants, birds and mammals, as well as to record the behavior of monkeys. Another of the tasks under-

taken is the trapping with cameras, that is, the installation of recording equipment with motion sensors in the trunks of the trees to record in video or photography what happens there. These were placed at sites far from the trails to maximize data acquisition.

In parallel, studies on birds and bats in the savannas have been conducted, as well as long-term research on the reproductive biology and behavior of migrant and resident populations of savanna kingbird (*Tyrannus savana*). Other projects are assessing the structural dynamics of the scarce woody vegetation growing in the savanna.

This initiative resulted in the first species inventory, which was published in the journal *Biota Colombiana* (2022). As a result, Tomogrande is now known to contain 535 species of plants (299), birds (189) and mammals (47). Most species (around 220) have been observed on dry land and in savanna, followed by those found in flooded forests and on forest edges. However, as Professor Estrada comments, we know that there are many more species of these three taxonomic groups that biologists have not yet collected and identified.

"Our species list helps fill data gaps prevalent in the tropical biodiversity of the Orinoco basin and the reserve contributes to ongoing efforts to better understand and protect habitats around and beyond the Tuparro Biosphere Reserve," the scientific article reads.

From this first inventory other questions of a scientific nature arise that must be answered by the research. Many birds, as well as mammals –such as bats and monkeys– func-

tion as seed dispersers, a task that is vital for the maintenance of tropical forests.

These species usually feed and sleep in different places. Through their excreta, these species move the seeds of trees from one side to another, thus favoring the forest to replace vegetation that has already completed its life cycle and even colonize new areas.

Some of the thesis projects that Pablo Stevenson –one of the authors of the inventory– is directing, focus on knowing what the monkeys are eating, with a view to, subsequently, understanding what type of seeds they are moving, what species, where they are depositing them and whether these seeds thrive or not.

This knowledge could help to understand the dynamics of maintaining forests in the highlands and even give way to answer other questions oriented to the role that biodiversity plays in the existence of carbon sinks, for example.

Carbon

At the current rate of GHG emissions, the planet is no warmer thanks to oceans and forests. In the case of forests, through photosynthesis, vegetation captures carbon dioxide (one of the GHGs that causes global warming) and stores it in its biomass (roots, leaves or woody bodies) and even in the soil. That already fixed carbon dioxide is known as carbon.

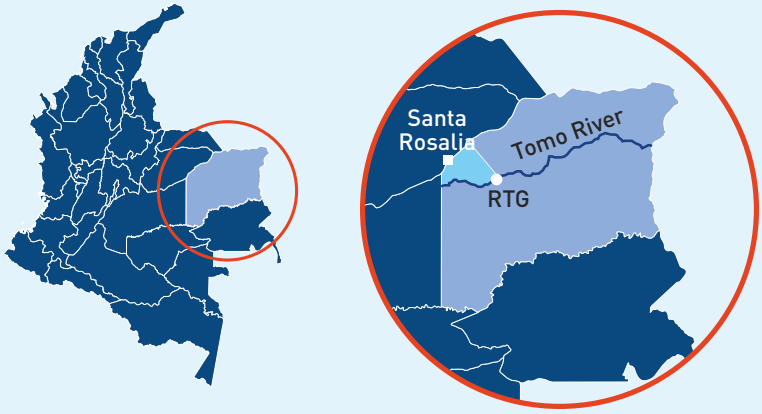
In the case of Tomogrande, it has been possible to quantify how much carbon their forest ecosystems store: the average rate of carbon accumulation in land forests is 0.33 tons per hectare per year (t/ha/year), while in flooded forests is 0.66 t/ha/year, according to a study published in the journal *Forests* (2021).

The researchers –including Ana María Aldana, linked to Universidad del Rosario at the time of publication of the study– found that the amount of carbon in the flood forest is higher than in the dry land forest because the species are different and so is the density of its wood.

Since these trees remain submerged for part of the year, their roots and trunks must withstand very high flood levels and, therefore, their wood is denser; otherwise they would rot. Denser wood means more carbon captured and fixed as biomass. So, despite the fact that the floodplain has fewer trees, the trees that do exist sequester more carbon.

This carbon quantification allowed the reserve to enter an emissions compensation project managed by the Cataruben Foundation. Tomogrande is currently receiving funding for conserving its forests.

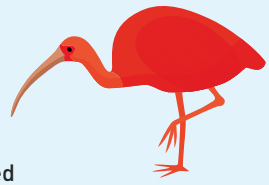
Tomogrande Nature Reserve



Location

It is located at the southeastern end of the municipality of Santa Rosalía, Vichada department. It lies at 124 m.a.s.l., at the confluence of the Tomo River and the Caño Grande River.

There is a pronounced dry season from mid-December to early April. The heaviest rainfall occurs between June and July. The average annual rainfall is 2498 mm and has an average annual temperature of 26 °C.

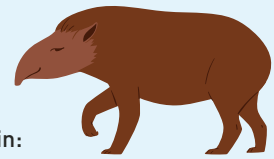


Birds

The characteristic fauna and birdlife of Tomogrande reflects a transition between the flooded savannas of the Llano and the Amazon.

- 37.6% of all species have been observed in wooded habitats (dry land and flooded forests).
- 32.3% of the species have been seen in savannas.
- 15.9% of the species have been sighted on forest edges.
- 14.3% of species have been observed near rivers or lagoons.

Ecosystem



The ecosystem is characteristic of the highplain: a heavily drained seasonal savanna, crossed by dry-land gallery forests and seasonally flooded gallery forests. There are small areas of flooded savanna, especially around the Tomo River.

In total, Tomogrande covers 2 500 ha, of which approximately 1 978 are herbaceous savannas with sparse patches of small trees, while the remaining 522 ha correspond to flooded forests around the two main rivers and to other dry land (gallery forests) around the streams.

Researchers have recorded 535 species of plants, birds and mammals in Tomogrande.

299 species of plants.
189 species of birds.
47 mammal species.

Most species (220) have been seen on dry land and in savanna (49), followed by flooded forests and forest edges.

Plants

The plant community of Tomogrande includes elements typical of biogeographic areas such as the Amazon, the coat of arms of Guyana, the Andean region and the Caribbean. A total of 160 species are designated as of Least Concern by the International Union for Conservation of Nature (IUCN), and the rest have yet to be evaluated.

- The most emblematic species belong to the Amazonian-Guiana area:
- Arracacho or chupaya *(Montrichardia arborescens)*, which is found in open wetlands.
- Moriche *(Mauritia flexuosa)*, which is found in swamps at the headwaters of streams.
- Red saladillo *(Caraipa llanorum)*, which forms a habitat called "saladillales" in flooded savannas.

Mammals

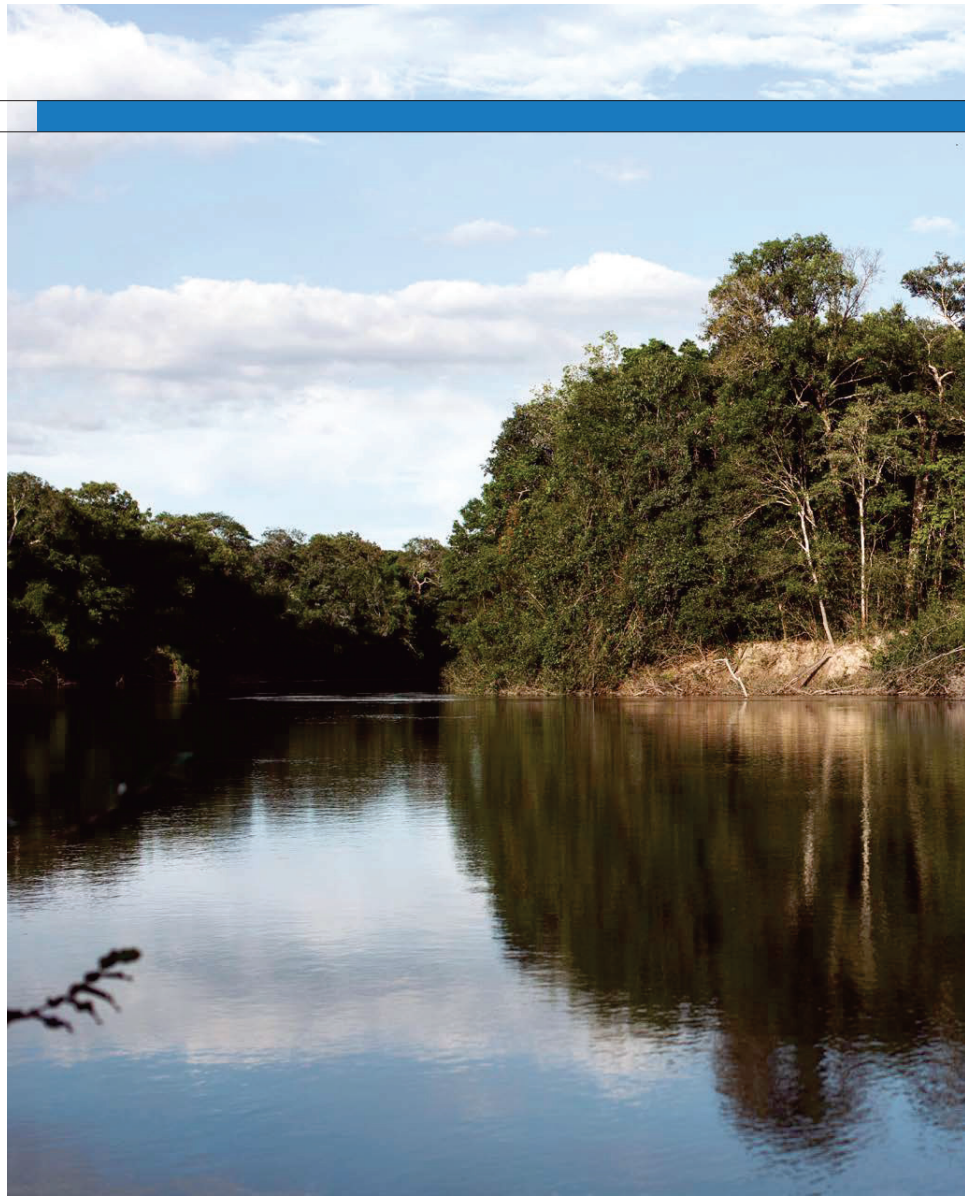
The orders of mammals with the most species are chiroptera (bats, 26 species) and carnivora (5 species).

There are two species considered endangered by the IUCN: the pink dolphin (Inia geoffrensis) and the giant otter (Pteronura brasiliensis), two considered vulnerable, the anteater, or yurumí (Myrmecophaga tridactyla), and the tapir or common danta (Tapirus terrestris).

Where Have They Been Seen?

- 66% of all species have been observed in forest habitats.
- 23.4% of the species have been seen in savannas.
- 6.4% of the species have been sighted on forest edges.
- 4.3% of the species have been seen by rivers or lagoons.

The reserve is also home for the jaguar, the puma, the tayra or tolomuco, the crab-eating fox, the chigüiro or capybara, two species of monkeys and three of artiodactyls.



Currently, the savanna is not part of the compensation project because its grasses are used to support livestock. The reserve has 40 cows that allow the people who live there to continue with the cultural legacy of being 'llaneros', a livelihood that has existed for 400 years in the area.

"You cannot tell a farmer to stop being a farmer and become a biologist and environmentalist. We understood that if we wanted support from locals, in such a remote place, we had to respect their livelihood," the professor says.

On the other hand, cattle there serve self-sustaining, non-commercial functions. Thanks to popular knowledge, "we get used to cows coming to sleep at paddocks that we create around the house. There, the manure mixes with the ground. Thus, we have cassava, plantains, guava, vegetables, etc. They are bringing nutrients from a place, they leave it next to the house and ... well you go and take advantage of that cassava," he adds.

The researcher then states that "another type of dynamic is generated where one understands that the cow is not only to sell it for meat or for breeding, but is also helping to create a moderately closed system to have products for the house."

However, the question of how much carbon the savanna captures is intriguing to Tomogrande's biologists. "My next dream is to do some experiments to see how much carbon is in the soil and how much is in the roots of the pastures," Estrada Villegas admits.

Perhaps carbon, in such a unique ecosystem, can make the highplain more valuable in terms of making it visible to promote its conservation. "It is a carbon issue. It is a biodiversity issue and it is also a cultural landscape issue. We must not forget that indigenous and 'llaneros' groups live there," he emphasizes.

Opportunity

Colombia has set a target of a 51 percent reduction in emissions in order to comply with the provisions in the Paris Agreement. For the update of Nationally Determined Contribution (NDC), which synthesizes climate change commitments, the country plans to include the contribution of ecosystems such as mangroves, wetlands and savannas beyond forests. "In the NDC update, for the next period we will explore issues associated with biodiversity and ecosystems other than forests. The Climate Action Law, aims to create emission baselines to clarify what to account for and how to do it. Specifically, it is about determining what the country can realistically commit to," emphasizes María Alejandra Garzón, an official from the Directorate of Climate Change of the Ministry of Environment and Sustainable Development.

"It will take many years to achieve all of these emission baselines by ecosystem. One of the strategies that has worked for us, and that could be replicated, is the pay-for-success programs provided by the Green Climate Fund (GCF). Through this funding, the enabling conditions of the Institute of Hydrology, Meteorology and Environmental Studies (in charge of Ideam) would be worked on. Also, academia is one of the key players in this exercise. Other research institutions have already begun to make progress on some points, and that will improve our national inventories," she adds.

For Garzón, carbon accounting can be advanced both in natural ecosystems and in agroforestry structures where agricultural activities are combined with arborization and forest conservation. Such efforts, framed in a landscape-sensitive territorial vision, can support low-emission development. "Personally, I think that a comprehensive view of the landscape is much more strategic and at the same time allows the actions that will be carried out in the territory to take into account that there are other ecosystems that should not be harmed," she states.

"We need to understand what is going to happen to these ecosystems, because they may dry out more and begin to turn into xerophytic ecosystems (vegetation adapted to dry environments for various reasons) or deserts, something they have already been! During the Pleistocene, there were huge deserts in large parts of the Colombian Orinoquía, including the highplain. There has been a repeated cycle of transitioning from desert to savanna to jungle to savanna to desert...", emphasizes the researcher Sergio Estrada Villegas, an ecologist who helps coordinate the Tomogrande reserve and scientific station, professor in the Faculty of Natural Sciences at Universidad del Rosario.

With this she refers specifically to the highplain. The challenge focuses on designing management measures that avoid intervening in the savannas for carbon capture (for example, by promoting afforestation with exotic species), respecting the dynamics of the ecosystem.

"It is, in short, to prevent measures from becoming a perverse mechanism for the savannas to be intervened; it is necessary to start from the fact that they are an environmental determinant, that they are strategic ecosystems in the regional structure, which must be protected," highlights the official.

This is where the efforts to comply with two international conventions –climate change and biodiversity– must be harmonized. Colombia included nature-based solutions in its National Development Plan. The projects are intended to link actions against the ravages of climate change with measures to protect biodiversity. However, that is not enough. There is also a need to work on minimizing threats.

Like other savanna ecosystems around the world, the highplain is threatened by the desire to convert it into arable land, especially for extensive monocultures. "If the transformation of the land of the Colombian Llanos remains unregulated, the integrity of the ecosystem may be lost due to irreversible changes in the composition of its biodiversity," warned the biologists of Tomogrande in the article that presented the inventory.

In this sense, Estrada Villegas and his colleagues advocate for better landscape planning and for making sustainable practices mandatory in the area, in order to protect both biodiversity and the livelihoods of the people who inhabit this region.

"The economic growth of the highlands must be planned to benefit not only agro-industry, but also the multiple stakeholders in an equitable manner. It is urgent to establish a regional plan to preserve large areas of savanna and most riparian forests, with the aim of avoiding a catastrophic loss of biodiversity," the study states.