ADVANCES IN SCIENCE / UNIVERSIDAD DEL ROSARIO / BOGOTÁ, COLOMBIA - Number. 05 – YEAR 2021 – ISSN: 2590-924X

ADVANCES IN SCIENCE

Universidad del Rosario

BOGOTÁ - COLOMBIA - Number. 05 - AÑO 2021- ISSN 2590-924X

***The tree of love*: roots of resilience and reconciliation for the kids of the war**

The key to save the forest lies in the literature

COVID-19, "an opportunity" for corruption

In search of a more effective radiotherapy against cancer

Special Report:

COLOMBIA AND THE CLIMATE CHANGE

Universidad del Rosario

Advances in Science Magazine
Universidad del Rosario
ISSN: 2590-924X
DOI: https://doi.org/10.12804/urosario/2590924X.5

Editor's note: Some images of the *Advances in Science* journal, 05/2021, do not have the usual quality of our publications due to the inconveniences generated by COVID-19.

SUMMARY

Check here the bibliography of this issue

4. Joining disciplines together to improve the quality of life

5. Digital innovation

6. Leadership and social innovation

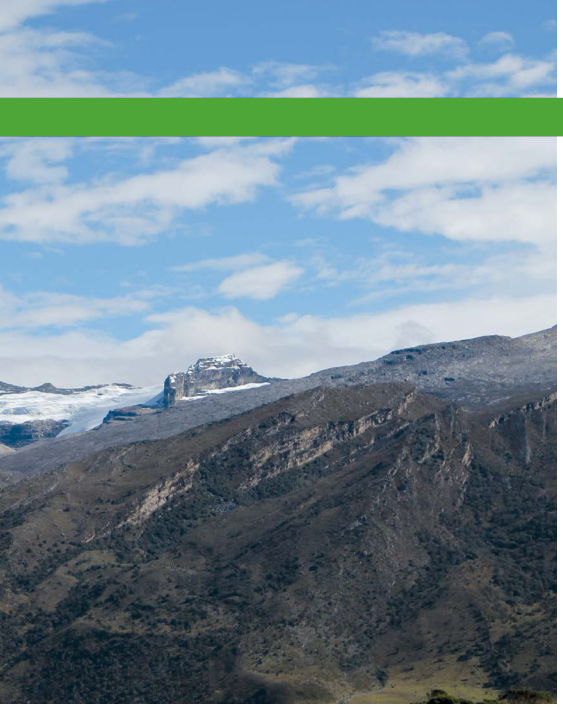
7. Efforts which transcend research

1 Inclusive Research

COLO
and the clim

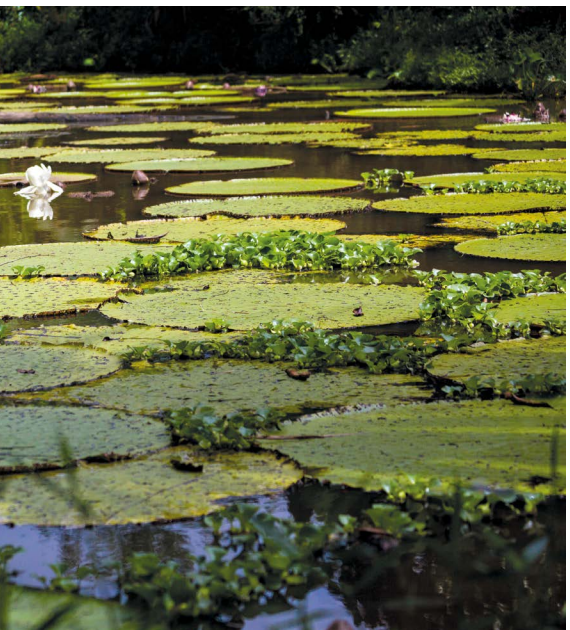
When we talk about climate change in the country, we must make an explicit reference to the consequences that are already visible and recognizable to everyone. This article features the stories of scientists from Universidad del Rosario who dedicate their efforts to study and understand the actions being undertaken in Colombia to fight against the effects of climate change.

By: Juan Manuel Sarasua
Photos: Alberto Sierra, Milagro Castro, Ximena Serrano, and Juan Ramírez



MBIA

ate change



In December 2015, from Paris came some of the most positive news for the health of the planet and all living things that we have ever heard: **the representatives of 196 nations reached a historic agreement binding them to reduce greenhouse gas** (GHG) emissions with the purpose of "limiting the global temperature rise to levels far below 2°C and striving to reach 1.5°C."

The UN Secretary General at that time, Ban Ki-moon, stated in excitement during an interview that "this is a key moment. For the first time, we have a truly universal agreement on climate change, one of the world's most crucial problems."

The Paris Agreement was signed at the Conference of the Parties (COP21) to the United Nations Framework Convention on Climate Change (UNFCCC). The former U.S. President Barack Obama then declared that the agreement "was a powerful signal that the planet was truly committed to a low-carbon future."

It was indeed a signal. A great signal that this was finally happening.

In November 2016, among many other disastrous decisions made in plebiscites and elections around the world in that fatal year for democracy, Americans proclaimed Donald Trump as the president based on the electoral slogan of pulling their country out of the Paris Agreement as soon as he became the president. He did as promised: on June 1, 2017, the United States officially exited the Paris Agreement.

Fortunately, four years later, under a new president (Joe Biden), that country is back on the world stage of a dialog to achieve a transformation of the planet's productive model and try to achieve carbon neutrality by 2050. The adoption of the Sustainable Development Goals (SDGs) of the 2030 Agenda by the member states of the United Nations, "the plan of action

for people, planet, and prosperity" proposed by the UN, which serve as a roadmap in the fight against climate change, must now also be considered.

Colombia made the same commitment: to comply with what was signed in Paris, to work toward the SDGs of the 2030 Agenda, and to take on the challenge of becoming a carbon-neutral nation by 2050. Further, it signed the Escazú Agreement, although not yet ratified, leaving the millions of the country's residents with no protection, without access to information, and without any possibility of participating in environmental decision-making.

Although we are not a "world power" in terms of GHG emissions, we have the responsibility to perform many actions to fulfill our part of the agreement. Our situation, production model, energy matrix, culture, and resources restrict what we can do and, likewise, the role we can play in the global scenario. But above all, it allows us to implement the initiatives that are highly adapted to our environment and, as many specialists say, **to find solutions that will enable us to develop sustainably.**

This article features the stories of scientists from Universidad del Rosario, from different areas of science, who are devoting their efforts to study and understand the actions being conducted in Colombia to fight against the effects produced by climate change. When we talk about climate change in the country, we must make explicit reference to the consequences that are already visible and recognized by everyone.

Climate change will not occur on a specific day at a specific time nor will it be the result of a single event. It is happening right now, while you are reading this text, and it is being caused by many human actions that Colombians must work hard to change.

The perfect times

"When the river communicates with the marsh, there is a lot of fish. And when it doesn't, we are in poverty because there is nothing coming in."

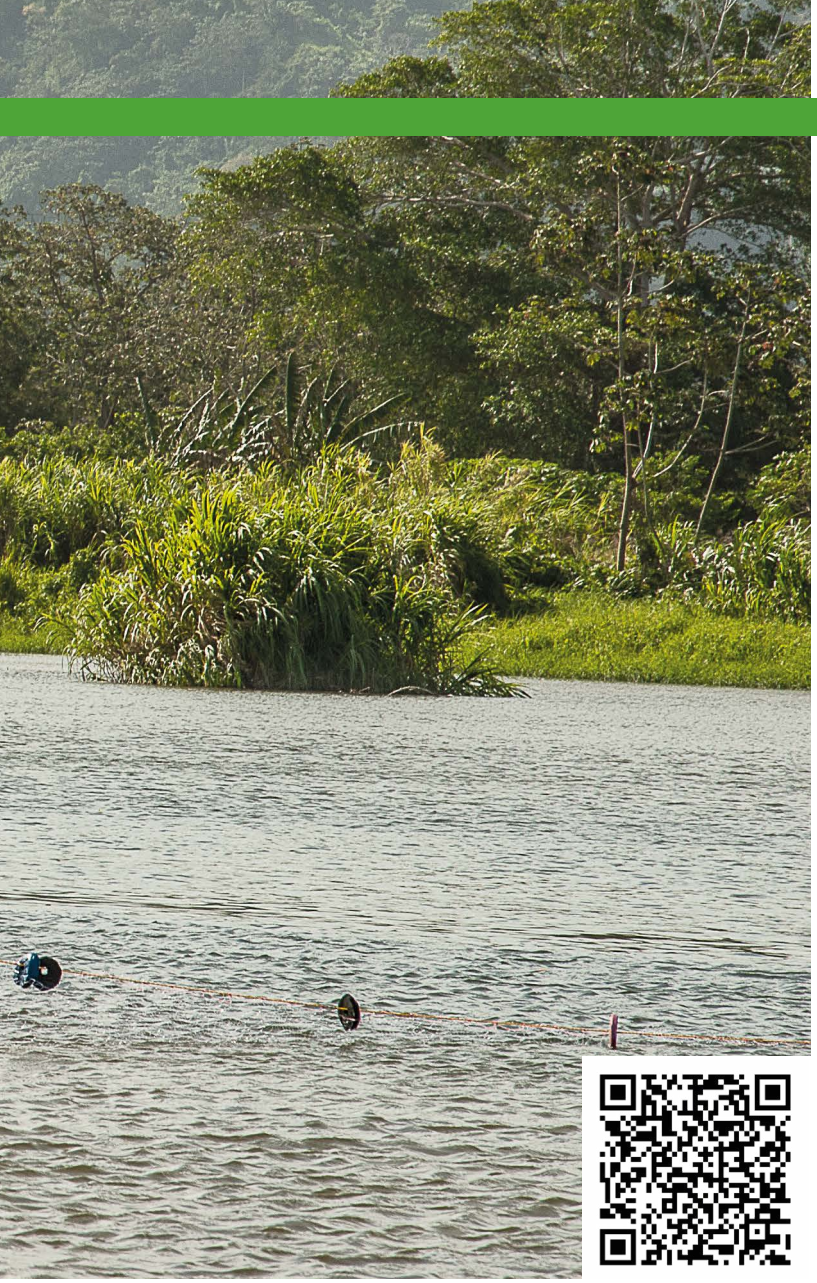
The speaker is **Edgar Meza, a fisherman from the village El Venero, in the marsh La Rinconada, the south of the Magdalena department. He is a part of the community of the marsh that has been involved in the project *Retos de la conservación con gente (Challenges of the preservation with people)*: *Sustainable lifestyles and local water management* coordinated by Diana Bocarejo**, a professor of the School of Human Sciences and a member of the Mutis Group of the Vice President and Provost Office of the Universidad del Rosario, a group of researchers from different schools and faculties that cross analyzes "the dynamics and processes of socioenvironmental transformation."

Despite the neglected situation of many of these areas by the state, the residents of these lands survive thanks to the crops of cassava, maize and, sometimes, beans, and fishing. "The use of land and water in this region has allowed developing different and innovative ways of livelihood management," says Mateo Vázquez, project researcher.

In this project, which has been developing since 2016 along with the Universidad Javeriana and Universidad de Antioquia, the community management strategies of 10 populations of the marsh were examined.

One of its media products is the multimedia special project *Las vidas enmarañadas de La Rinconada, Magdalena,* which features the stories of Edgar and other residents of the area in the context of local traditions, such as the art of fishing, customs of farming and food gathering, community management methods, and collaboration with university researchers, including several from Rosario.

Combined with Grupo Mutis and Fundación Iguaraya, a joint training and discussion process was conducted with the local residents on the importance of propagating and planting native trees, such as *campano,* yellow cedar,



Las vidas enmarañadas de La Rinconada, Magdalena. Source Mutis Group, URosario.

and mangrove (*Symmeria paniculata*), to promote social and environmental well-being. Thus, plant nurseries were created to produce between 10,000 and 20,000 seedlings per year that will be used to provide shade, protect the habitat of a significant part of the fauna eaten by the residents, and preserve a large part of the land for the land for livestock grazing.

In the marsh, water and temperature conditions result in four types of seasonal cycles: summer, late winter, late summer, and winter. These cycles are known and very well used by the inhabitants that have been able to guarantee the livelihood of many generations.

The researchers noted a recurrent use of the expression "the perfect times" to refer to the years prior to the beginning of the 21st century, when the climate behaved in a regular manner and rainfalls came "when they were supposed to come."

However, the stability of the movements of water, human interventions, and the increasingly harsh temperature conditions caused by climate change has drastically affected this balance. "The marsh is the mother that feeds us all, and water is no longer coming in because the pipe has clogged, preventing the fish entering the marsh from the river," Edgar adds.

Not far from there, in the Sierra Nevada de Santa Marta, Bocarejo is involved in another project on the use of water to help strengthen the Water Fund of Santa Marta and the Marsh (FASNM). With the professors Adriana Sánchez of the Biology program at URosario, Andrés Guhl of the Universidad de los Andes, and Jorge Escobar of the Universidad Javeriana, the project has allowed the work of young researchers, such as Natalia Giraldo and Fernanda Preciado, who study the social valuations of nature and community strategies for environmental management.

Further, what Manuel Corredor, a coffee farmer and resident of Sierra Nevada tells us about the changes suffered, demonstrates the uncertainty and challenges that climate change is bringing:

"Today, things are not the same. There have been some changes in the temperature and atmosphere. Certain crops are no longer possible because now many things seem to have been damaged in the atmospheric systems. Nowadays, it rains during the summer months; during the rainy months, there are summer temperatures, so there have been indeed some changes in the temperatures. Nowadays, we do not count very much on the weather, as when my father used to work, the way we used to work in those days in the farms, because everything has undergone changes. So, it is no longer possible to say that a farm is going to produce again those 400 loads of coffee that were produced before; that is no longer possible."

"To the complex reality of our country, under which millions of people live everyday, we must add the consequences that climate change is bringing and will bring in the near future. The solution does not lie in thinking about social or environmental issues separately, but in defining fair strategies and explore all the chances of living better with rivers, forests, or marshes, and begins by recognizing the many local management efforts," Bocarejo highlights.

"Only in the Magdalena River basin, we can see huge problems, such as the changes and loss of biodiversity, sedimentation, and erosion processes that come from the losses of basin coverage, impact generated by hydroelectric plants in the upper areas, oil pollution (as happened in 2018 in the Lizama channel, in Santander), and also pollution from large cities that discharge all their waste into the river. The problems caused by climate change are exacerbated by all these actions."

Water is the gold of our country

Humans affect all the features of the hydrological cycle directly, through agriculture, deforestation, urbanization, the regulation of water basins such as reservoirs and dams, or indirectly through climate change. Fernando Jaramillo, a professor of hydrology and water resources at the Bolin Center for Climate Research at Stockholm University, is studying these issues. **"I am trying to find the 'human footprint' in the hydrological features of all resources. That is, to see whether changes in variables such as water evaporation in basins or runoff in rivers can be attributed to humans or not,"** he explains.

To quantify the total human water consumption *(water footprint)*, Jaramillo and other researchers studied the 100 largest basins on the planet to estimate the human water consumption based on the hydro-climatic changes that have taken place in those basins since the beginning of the 20th century. "Generally speaking, what humans do increases the evaporation of water because most of our activities involve extracting water, often from groundwater, to, for example, irrigate a crop or move water from one place to another, as happens in a dam," he continues.

In that 2015 study, the researchers considered the evapotranspiration rates due to irrigation and reservoirs or dams, a fact that was beyond the estimates conducted previously. They found that the humankind's current global water footprint is 11,000 km3/year, approximately 18 percent more than what was reported in the first half of the 20th century.

This is all water that we humans "evaporate" through our activities worldwide.

To compare, this is as if we were consuming five times the entire volume of the Ciénaga Grande de Santa Marta (which is 2,232 km3) every year.

Let's remember that, with higher temperatures, like the ones we have experienced in recent years due to climate change, evaporation will be higher. As a result, we will see a clear consequence of climate change: **we will experience seasons with increasingly frequent climatic extremes**. We are witnessing extremely high temperatures in areas and at times that are unusual. In some cases, we are uncertain how the planet is going to respond to this.

One example of this temperature increase is evident in páramos, one of our most precious ecosystems. In a study published in 2020 by Jaramillo, with Matilda Cresso, Nicola Clerici, and Adriana Sánchez, all from Rosario, the scientists monitored the rainfall and minimum and maximum temperatures in Chingaza National Park between 1960 and 1990 and made simulations for the years 2041–2060.

Results showed that the increase in the average monthly temperatures and changes in rainfall means that a high percentage of the Chingaza moor will not have the characteristics of this type of ecosystem: in the dry season, between 39% and 52% of the area will not be suitable for these ecosystems, and between 13% and 34% in the rainy season. Jaramillo clarifies, "We don't know very well what type of ecosystems they will become, but we do know that with the rate of GHG accumulation we are experiencing, this is going to happen."

According to studies, the consequences of the Chingaza National Park no longer serving as a moor will be drastic: some biodiversity will be able to migrate, but much of it will disappear because it will not be able to adapt to the new conditions.

The consequences of the Chingaza National Park no longer operating as a moor will be profound: some of the biodiversity will be able to "migrate," but much of it will disappear because it will not be able to adapt to the new conditions. The carbon-rich moor soils will dry out and, instead of being a sink for carbon dioxide (CO2, a by-product of the fusion of carbon burned with oxygen in air and a type of GHG that blocks heat and prevents it from escaping from the atmosphere), they will become the sources of emissions. The ecosystem will lose its capacity to store water and will directly affect the Chingaza–Weiner system, one of the three systems that supply water to more than 10 million people in Bogota and 11 surrounding municipalities.

In other words, if you live in the Bogota Savannah, climate change will directly affect a basic element of your daily life, a key element for survival. Further, you may be alive by the time it happens.

Everything will be affected

"There is currently no doubt that climate change is proven," states **Benjamin Quesada**, a climatologist and the leader of the program Sciences of the Earth System at Universidad del Rosario. According to data from Colombia's 3rd National Communication to the United Nations Framework Convention on Climate Change (2016), 98.33% of the people in Colombia think that climate change is happening, and they are not wrong.

"What many governments and citizens are beginning to realize is that it is a social, economic, and political problem, which goes far beyond a simple increase in temperatures," Quesada adds. "We see the effects in many areas. Across the country, weather extremes are increasing. We have increasingly stronger droughts and intense rainfall that are impacting systematically, and we also have significant maximum hot temperatures that are beginning to affect several ecosystems in the country."

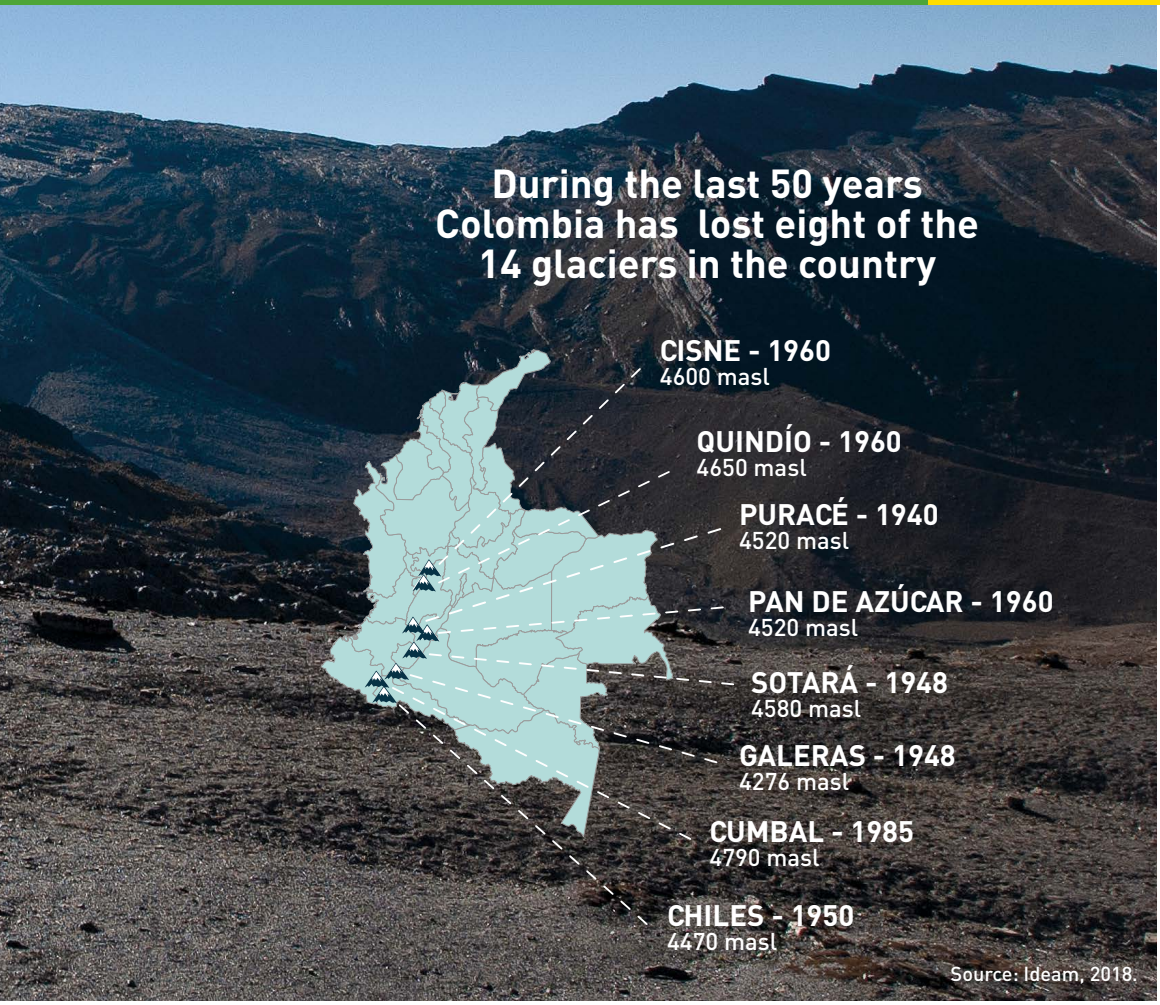
To quote an example, in the last 50 years, we have lost eight of the 14 glaciers in the country. **The country had 374 km² of glaciers at the end of the 19th century, but by 2021, we have only 37 km², a loss of 92%.** By 2040, an average temperature increase of 0.9°C is expected across the country, and rainfall is very likely to decrease by 10%–40% in 32% of our territory.

By that year, 80 percent of the crops currently grown in more than 60% of the areas designated for that use will be affected, and the magnitude of this impact is significant because the vast majority of the country's food producers are small-scale growers, even for important products such as bananas, coffee, and cocoa.

In addition to the increase in temperatures, the Colombian rural areas will experience further water stress (such as the aforementioned retreat of glaciers) and irregular rainfall. Among many other effects, pests, and other diseases will increase considerably in different crops. In the cases of banana, plantain, and potato, they will impact areas of high altitudes, and in the cases of coffee, cocoa, maize, and cassava, they will attack low land more than usual.

A rise in sea levels will also be noticeable. In recent decades, an average increase of 2.6 mm/year has been observed, although in coastal areas it may be as much as 9.9 mm/year. Sea water will flood the lands with oil palm crops on the Pacific Coast, banana and plantain crops in Urabá, and the grazing lands on the Caribbean Coast.

We are even beginning to see a loss in the climatic suitability (the climate features that allow



The country had 374 km2 of glaciers at the end of the nineteenth century, but by 2021, we only have 37 km2 left: a loss of 92%. By 2040, an average temperature increase of 0.9°C is expected across the country, and rainfall is very likely to decrease by 10%–40% in 32% of our territory.

good growth) of certain crops, such as coffee at altitudes above 1,500 m.a.s.l. or potatoes below 2,500 m.a.s.l.

The temperature increase has been evident since we started burning fossil fuels more than 200 years ago. This burning has increased the CO_2 concentration. Since the beginning of the industrial era, around the year 1750, the CO_2 concentration in the atmosphere has increased from 277 parts per million (ppm) to 407.38 ± 0.1 ppm in 2018, according to data from the **2019 Global Carbon Budget** submitted at the COP25 summit in Madrid.

The COVID-19 pandemic

Perhaps one of the illusions that everyone had at the start of the pandemic was whether the halt of many economic activities that we experienced during the first months of confinement had affected climate change, or at the very least, reduced the temperature increase.

"Climate change was not affected, nor will the pandemic have a large impact on it," Benjamin Quesada continues. "Air pollution, however, was indeed affected as there was a noticeable reduction in transportation; but let's not mistake this with climate change; it doesn't stop."

Prior to the pandemic, CO_2 emissions were increasing by 1% per year throughout the previous decade, despite all efforts and agreements entered into to promote their reduction. The global emissions of fossil CO_2 **fell** by approximately 2.6 gigatons (Gt) in 2020, a 4% decrease from the same period in 2019. "But these differences are entirely due to the fact that there was a lower demand for energy, not for structural reforms, i.e., they are temporary reductions, nothing more," Quesada continues.

"COVID-19 is temporary, whereas climate change is structural and is going to be more harmful to health in the short, medium, and long terms. We are not going to put an end to climate change with quarantines, but what we do now will have an effect in future decades."

However, **the main causes of the increased GHG emissions are the burning of fossil fuels and deforestation**, and it is the latter that paints an alarming picture for the country. "GHG emissions in Colombia are concentrated in the sectors of agriculture, forestry, and change in land-use, and with what is happening with deforestation in the country, in these times post-peace agreement, and in the midst of the COVID-19 pandemic, the situation is really worrying," adds Quesada.

How's Colombia nowadays?

Matías Franchini holds a PhD in International Relations and is a Professor of the International, Political, and Urban Studies School of Rosario University and a member of Mutis Group. Franchini states that "every few years, we go through something colloquially called a 'climate momentum.' As it happened in Copenhagen in 2009, in Paris in 2015, and now, it seems we are in a new climate momentum in which expectations get overrated and many times they turn out to be somewhat unrealistic."

"**Sometimes the fight against climate change conducted in conventions and agreements seems to be the most important one, but in fact, the general logic of the international politics is more important,"** he continues. "The fact that a country like the United States is committed to climate, and that the European Commission's current presidency, which was already interested in fighting against climate change many years ago, flies as its principal flag **the reduction of GHG emissions by 55 percent compared to the 1990 levels,** create a more favorable scene for cooperation against climate crisis." Moreover, the growing economic and geopolitical tensions between the western world and China (the largest GHG emitter) occur in the opposite direction: they hinder cooperation.

Big changes may not occur, but the fact that a country of this caliber is "back in the game" is something we should, at least, be happy about. A few months after starting his mandate, last April 22nd, Joe Biden's administration organized the **Climate Leaders' Summit** to discuss how to fight climate change. At that summit, the United States announced that by 2030, it would cut its GHG emissions up to half of the existing levels in 2005 (almost double the level promised in Paris, 2015) and that it would reach neutrality in carbon emissions by 2050. After China, the United States is the second largest GHG emitter in the world.

At the same event, President Iván Duque announced new National Determined Contributions (NDC), a commitment that each country proposes to face climate change **and which he had already announced in November 2020**: to reduce 51% of GHG emissions projected for Colombia by 2030. According to the Climate Action Tracker (CAT) initiative, this proposal is between 6% and 22% more ambitious than the first NDC announced, presenting only a 20% reduction for that year.

"Many people were surprised, a much less ambitious goal was expected, and it is certainly a very positive thing," Franchini explains. CAT analyzes the "ambition" of each country's NDCs, and if they will help to reach the target set by the Intergovernmental Panel on Climate Change (**IPCC**)**:** that the temperature increase by the end of the 21st century should not be higher than 2°C and as close to 1.5°C as possible.

In the context of the political economy of climate change in Latin America, one of Franchini's areas of expertise, the outlook does not look so dark for the country. Nowadays, compared to the major emitters of Latin America (Brazil, Mexico, and Argentina), Colombia is doing the best for meeting the targets.

"The scenario is not so bad in that sense, at least not in the last five years, from Paris 2015 to **Glasgow 2021** (**COP26**) in November," he adds. "Colombia is not a major emitter in global terms, surely because its economy has little industrial basis and its electrical matrix is based in hydroelectricity, a relatively clean energy source."

It is true that the per capita emissions of the country are not so high; they are below the global average, which is minor compared to the major Latin American emitters. **According to the World Bank data,** the country emitted 1,601 ton/m^3 of CO_2 per capita in 2018, whereas Latin America and Caribbean average was approximately 2,637 ton/m^3.

Policies are another element that encourages optimism, at least in comparison with our Latin American neighbors. "Colombia entered the game late, and only in 2015, it launched the **Colombian Low-Carbon Development Strategy** (**ECDBC, by its initials in Spanish**). Brazil already had a similar law since 2010 and Mexico, since 2012. But, despite this, it has not had major setbacks. All the other big countries stopped or modified their plans, whereas our country has continued, and that is positive," Franchini explains.

Colombia proposed its first NDC, aiming for the highest reduction in the entire region, and its low-carbon strategy in 2015, following the creation of the 2016 National Climate Change System (Sisclima), **2018 Climate Change Law**, and 2018–2022 National Development Plan, which are mainly based on new sustainable policies.

"The country only represents 0.46% of the whole planet's GHG emissions: if everything in the country were to stop tomorrow, that would be the size of the impact. Nevertheless, it is a risky statement to say that Colombia may be a leader in climate change." **Franchini** is referring to the statements made in April this year by the U.S. President's special envoy for Climate Change, John Kerry, who claimed that the United States considered Colombia to be a climate change leader during a video conference with the President Iván Duque.

In the 2010s, Mexico and Brazil were also considered climate leaders; however, mainly since the coming to power of the President Jair Bolsonaro in Brazil and Andrés Manuel López Obrador in Mexico, they have even shown a setback in terms of policies and actions. "Maybe we can be an example for others; an example that a developing country can have a low-carbon strategy without losing economic growth," considers Franchini. "However, we cannot be considered a great climate power with decisive impact on the climate crisis like China, United States, and European Union because of our size compared to these major emitters. At the same time, although leadership demands proposals, laws, and actions for low-carbon development, beyond that, **the big question is whether Colombia will be**

able to effectively implement its policies to reach the ambitious targets to which it has committed."

As an example, Franchini asks this question: "What is the point of promoting electric cars in a country whose energy matrix is still based on fossil fuels?" He comments: "You have to pay attention to both the technology and source. The pace of fossil energy substitution is too slow to ensure that we meet that goal. Therefore, we have to pick up pace, and this can only be achieved if the big countries participate."

The question is fundamental because, in **2018, only 1% of the country's total energetic matrix came from renewable sources** (hydrologic, wind, solar, biomass, and geothermal). By 2022, the country expects the percentage to be approximately 12% to 14% of the total, and **it has already taken steps in that direction,** such as the bid for long-term renewable energy started by the Mines and Energy Ministry in 2019, which is currently in **its third edition**. "This has to be sped up considerably, and it can be done, but it must be done well; there must be a gradual replacement to renewable energies, if possible nonconventional ones, and definitely forget fracking (a technique to extract hydrocarbons that comprises fracturing the ground with a hydraulic fluid to make the most of the deposits trapped in it). If we promote fracking, we give with the one hand and take away with the other," says Franchini.

The importance of reducing fossil fuels is well documented, and **experts on the topic have already warned** that, to limit global warming to 2°C, from 2010 to 2050, one third of the current oil reserves, half of gas reserves, and more than 80% of the coal reserves should not be used. **This way, any increase in hydrocarbon production goes against all the efforts and agreements on climate change.**

A strong legal framework is not enough. One of the country's problems is enforcing the law, not only because of the endemic problems in the exercise of politics, shared by all countries in the world, but also because of the adaptation to new realities or the fight against the powers at play.

Each country has its own reality to be attended to and on which to build a fighting strategy against climate change. Obstacles are, therefore, particular to each region, **and all the interviewed researchers on this matter agree that the biggest problem facing the country at this moment is deforestation.**

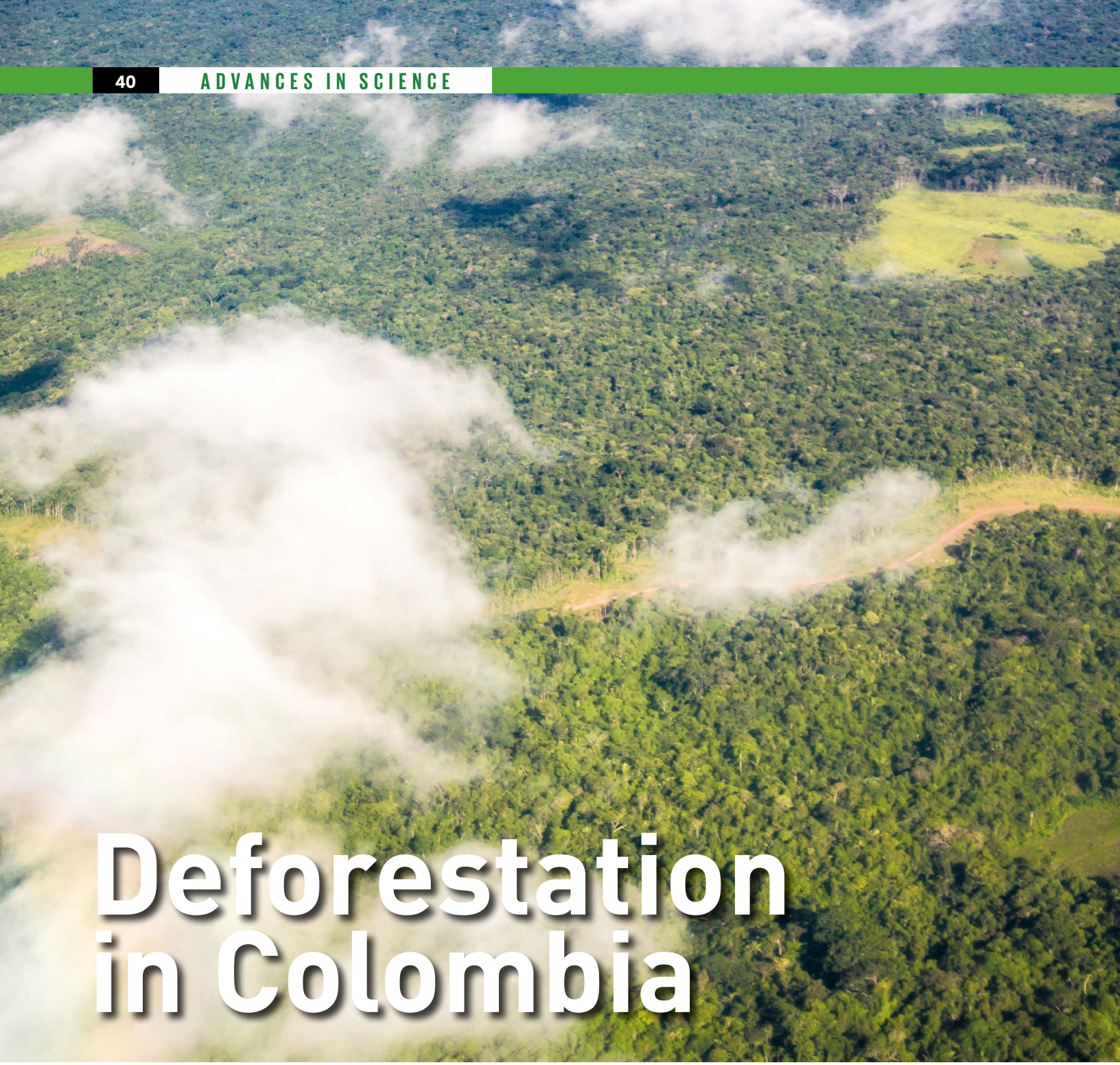
Policies and Politics

In the construction and development of any political initiative, experts speak about two English terms: policies and politics. In Spanish, there is no difference between them. Matías Franchini gives us some clues to understand them better:

"By policies (in this case public policies), we mean, for example, the Climate Change Law in 2018 or Colombian Low Carbon Development Strategy (ECDBC)."

"What we call politics has to do with the whole structure of economic and political powers that eventually may make a public policy viable or unviable, both in its creation and implementation."

"By issuing a policy, such as Colombia's new NDCs for 2030, we are sending a message to everyone stating the way to go, that we have a long way to reach it, but we do not know exactly what that path will be like. This policy is very generic and must generate more specific policies: commitments on deforestation, energetic transition, transportation, etc. These new goals will be confronted and fought by many civil and public bodies, by the economic sectors that are altered, and will even be rejected by some public ministries, which are against new regulations and also, unfortunately, by illegal groups."

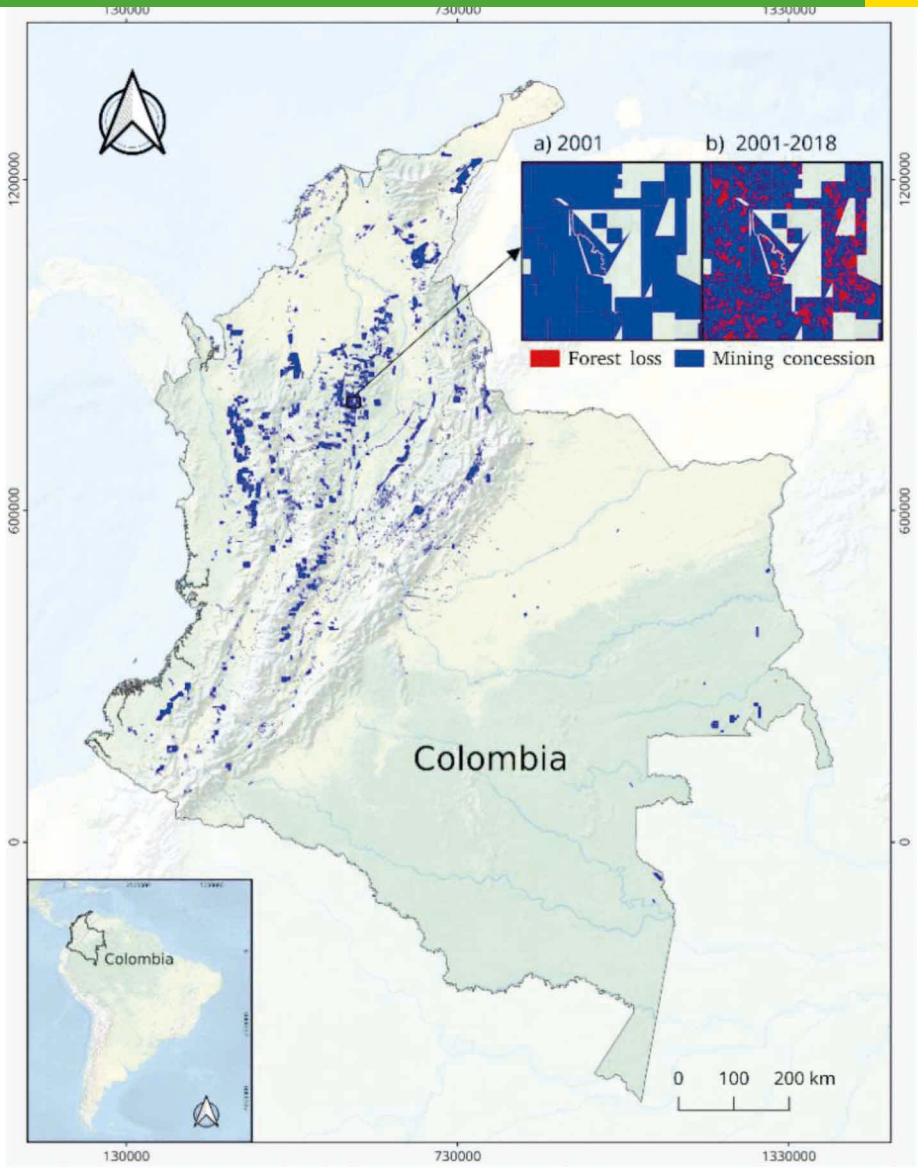


Deforestation in Colombia

"The implications of deforestation in Colombia, or in other countries in the region with high biodiversity characteristics and covered with large tracts of forest, are different from those of other countries," explains **Benjamin Quesada**. "By destroying our forests, we are not only destroying biodiversity, but we are also eliminating our best weapons in the fight against climate change: the forests."

A study published in the journal Nature in July, 2021, coordinated by Brazil's National Institute for Space Research (**INPE**, by its initials in Spanish), found that between 2010 and 2018, the Amazon released more CO_2 than it absorbed, and in its southwest region, an area which has undergone important deforestation processes in the last 40 years, it already acts as a net carbon source (total carbon flow minus fire emissions) to the atmosphere.

The Institute of Hydrology, Meteorology, and Environmental Studies (Ideam) **reported that approximately 1,971.6 km² of forests was lost in 2018, and this loss was reduced to approximately 1,588.9 km² in 2019**. This reduction was interrupted at the beginning of



A map of the mining concessions granted in Colombia (in blue) and the deforested zones inside these areas (in red). Source: Andrés González-González et al. 2021. Environ. Res. Lett. 16 064046.

2020, just as the pandemic started. Early warning bulletins for 2020 show a deforestation increase in Meta, Guaviare, Caquetá, and Putumayo departments, among others.

There are several reasons for the increase in forest loss in the first months of 2020. **There was an intensification of fires** of almost three times with respect to those that happened in 2019, something never seen in this period of the year. Further, the quarantine led to **a pause in the state's intervention in the monitoring of zones**, a fact that illegal actors in the conflict (such as the ELN, Farc dissidents, and paramilitary groups such as the Urabeños and Clan del Golfo) took advantage to deforest indiscriminately. During this period, **more than 280 km of new roads were opened where there used to be forests.**

A **report in July 2021** by the Ministry of Mines and Energy, U.S. Embassy, and United Nations Office on Drugs and Crime (UNODC) confirms that 57 percent of alluvial gold exploitation (Evoa) with machinery on land in the country is considered "illicit exploitation" as it has no mining title. Besides, they discovered that 52 percent of this type of mining activity, corresponding to a total of 52,263 ha, is conducted in the "areas excluded from mining or environmentally protected." Of the rest, 35% is conducted in the "areas permitted for exploitation" and 13% is in the "restricted mining zones." Furthermore, only two departments, Antioquia and Chocó, account for 78% of all gold mining.

The sources of deforestation come not only from illegal actors but also from legal ones. A study published in May 2021 in the journal **Environmental Research Letters**, coordinated by professors Nicola Clerici, Andrés González, and Bejamin Quesada from Rosario University, shows that between 2001 and 2018, legal mining contributed to the destruction of 121,819 ha of forest, out of a total of 400,000 ha deforested, legally and illegally. **Overall, legal mining concessions have contributed to 3.4% of the total forests lost in this period of 17 years**, with a peak of 5.6% of the country's total deforestation in 2017.

"For the first time, we are able to make very precise estimates of the space-temporal dynamics of deforestation within legal mining concessions in Colombia, during the last two decades," explains Clerici in his article.

Why are these data so important? Because, losing forests prevents us from effectively fighting against GHG emissions. In the results of the study, authors confirm that deforestation "is a key factor in the loss of terrestrial biodiversity and ecosystem services, which in turn has possible negative impacts on socioeconomic systems and human well-being." The study also shows that emissions due to deforestation in legal mining areas would contribute to almost the one third of the total emissions of the sector over the period 2001–2015. "The problem of deforestation control in Colombia is something deeply complex because it is mainly about the control of territory. The number of the murders of social leaders in the country does nothing but shows it," explains Franchini.

Increasing contribution to mining in Colombian deforestation. Andrés González-González et al. 2021. Environ. Res. Lett.

How can we achieve development and sustainability to go hand in hand?

How can we do it? Are the legal framework, institutions, and civil society of the country prepared to accept a different development than the one we know?

Gloria Amparo Rodríguez is a lawyer, professor, and researcher at the Faculty of Law of Universidad del Rosario and a magistrate of the **Court for the Peace** of the Special Jurisdiction for Peace (**JEP**, by its initials in Spanish). In her opinion, "we need to rethink the production model and look at other alternatives for development. We have a country with a significant natural heritage and a very important regulatory framework that we must protect. Now we need to strengthen the environmental system, with a consolidated institutional framework, with equally solid organizations, and with a Ministry of Environment and Sustainable Development having resources, not only specialized staff but also the economic resources to make its management possible."

In the legal framework, Colombia has ratified, in Congress, several international treaties on climate and other important issues, except for the Escazú Agreement, a fundamental instrument in the process of educating all citizens on the approach to the consequences of climate change. The **Escazú Agreement aims** to "guarantee the full and effective implementation in Latin America and the Caribbean of the rights of access to environmental information, public participation in environmental decision-making processes, and access to justice in environmental issues, as well as the creation and

strengthening of capacities and cooperation, to contribute to the protection of the right of every person, present and future generations, to live in a healthy environment and within a framework of sustainable development."

The agreement was signed by 24 countries in the region and, so far, only 12 have ratified it in their respective congresses. **Last June, the Colombian Congress stopped the agreement implementation due to problems with the process**. Without this ratification, no activity related to the commitment signed with the rest of the countries in the region can be put into action.

"Rules seek to solve situations, and the environmental law seeks to regulate the relationship of human beings, including their productive and institutional activities, with the environment," explains Rodríguez. "The law must answer to one reality: the environmental deterioration of our resources and increased risk in which we live to ensure that the protection of the environment allows better living conditions for the present and future generations."

Rodríguez adds that if the Escazú Agreement is not implemented, this will go in the opposite direction to where the country, with its regulations and actions, seeks to go. "It is worrying that this happens when the ratification of the Escazú Agreement means the progress of access rights in Colombia, that is, the right to participation, to information, and to environmental justice. It makes no sense to go against an agreement that allows us to face the conflicts related to the environment, even less at a moment when the effects of climate change affect us in such a conclusive way that we lose our own resources and endanger people's lives."

Even in this case, it is difficult to convert what the environmental provisions confirm, "the signed thing," into reality. This is the evidence of the essential difference between the creation of a rule and its application: the difference between *policy* and *politics* mentioned by Matías Franchini (page 39).

An additional obstacle is the difficulty of establishing a dialog among the advocates of different positions. "This is one of the big problems we have to solve: the lack of coordination within the institution and between this one and the social expectations of the regions," Rodríguez explains.

"For example, things are happening here, like the environmental authority making decisions to create a national natural park and the mining authority granting an exploitation title in that same park. We are convinced that there must be a real inter-institutional dialog and, besides, with the communities to move toward sustainability, enabling environmental protection as established in our political charter."

Complying with what was agreed upon

The challenges are immense. At this moment, two major international agreements and commitments guide the country's decisions and actions to fight against climate change: **the Paris Agreement and United Nations 2030 Agenda** (for Colombia, there will be three agreements when the country ratifies the Escazú Agreement, which was signed in December 2019 and came into force last April 22nd). Moreover, the recent joining of Colombia to the Organization for Economic Cooperation and Development (**OECD**) will increase the pressure to comply with the 17 **SDG**s adopted by all the member states of the United Nations in 2015, which are a part of the 2030 Agenda.

Professor **Lina Muñoz Ávila** is a lawyer with a PhD in Law from Rosario University's Faculty of Law. She led the project called "**Perspectives of the 2030 Agenda implementation and Its Sustainable Development Goals in Colombia in the light of the Paris Agreement on Climate Change**," funded by the Science, Technology, and Innovation Ministry of Colombia and involving, among others, professor Manuel Restrepo and predoctoral researchers Estefanía Acosta and Sebastián Senior on behalf of Rosario, with the Stockholm Environment Institute (**SEI**) and United Nations Economic Commission for Latin America and the Caribbean (**ECLAC**).

This research includes, on the one hand, the 2030 Agenda, which, while not a binding agreement, has been accepted by the countries like a roadmap for development and is assisting the country in institutional and ruling topics, and on the other hand, the Paris Agreement, which is legally binding because it comprises the responsibility of the State.

Professor Muñoz says that "nowadays, six years after starting working on these agendas, we need to see how in a country like Colombia we can create synergies among them, which are the national circumstances enabling or impeding their fulfillment, and how can we make the task of the country more efficient and coordinated."

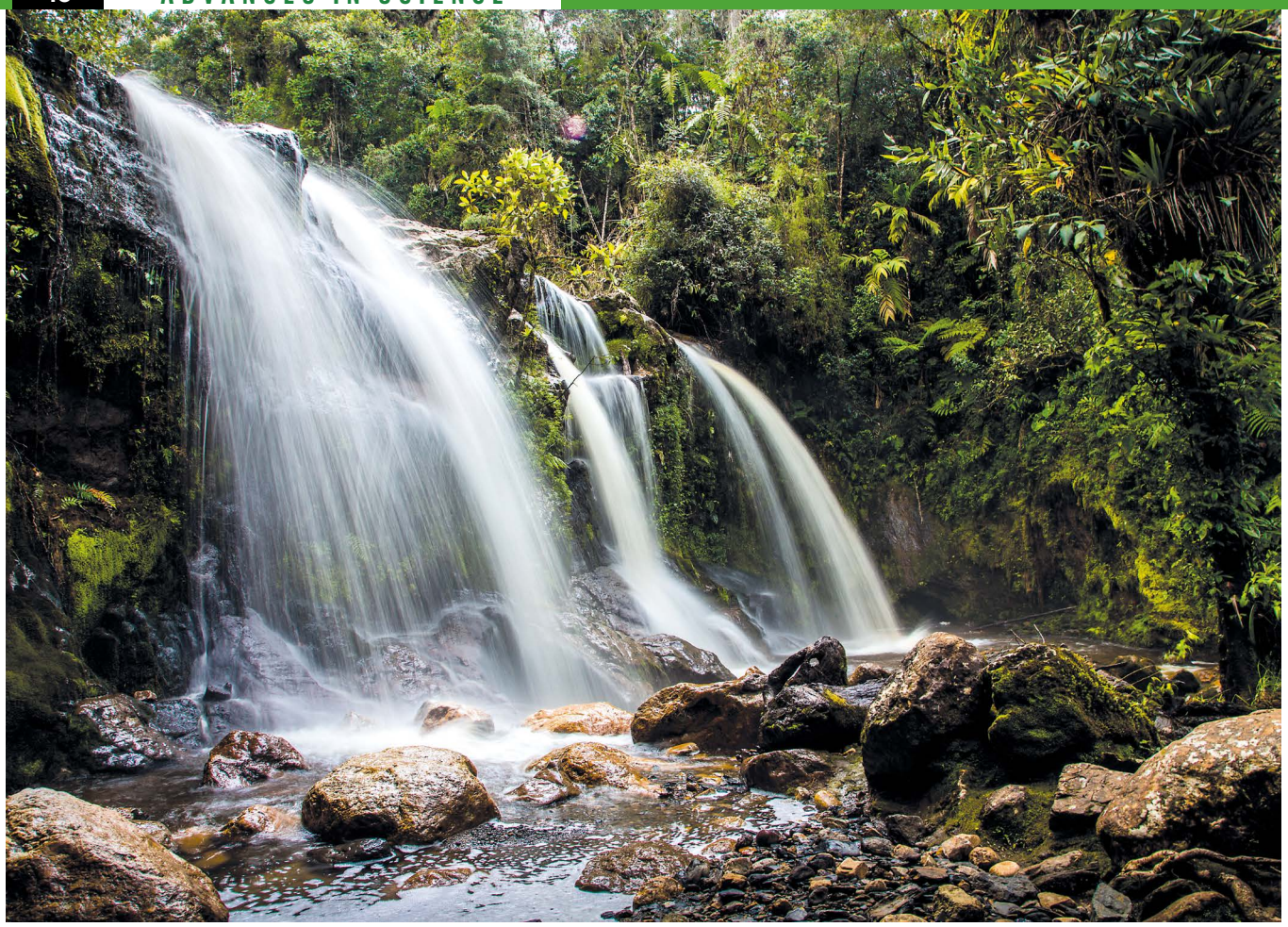
"Although Bogotá is an important place to read the agenda against climate change, because it is the place where all the general guidelines come from, we need to take into account the territorial realities, so we proposed working in Barranquilla, Medellín, and Cali," explains Muñoz. "In these cities, we conducted workshops with the labor unions and private sector, state entities, municipalities, and civil society representatives, such as the academia and NGOs. We asked all of them which factors they considered to be hindering or promoting the implementation of these agreements."

Muñoz explains that "the objective of the project was saying to the country, in a qualitative and quantitative way, which are the opportunities to work more thoroughly. For example, **in October 2020, ECLAC presented the model of three gaps**, trying countries to overcome the great challenge of implementing sustainable development by boosting the economy of the country while protecting the environment."

The model expresses the international system crisis in the social, environmental, and sustainability spheres. Thus, the basic question is: **how is sustainability possible in an area where slow growth, increasing inequality, and environmental emergency prevails?** "This challenge is huge," Muñoz continues. "Our project applied the ECLAC model for the first time, and there is already a first proposal, which will be used as a model for other countries in the region."

The study results were overwhelming. **Corruption is one of the main obstructive phenomena found** (according to International Transparency's 2020 Corruption Index, **Colombia ranks 92nd out of 180 countries**). "Corrupt practices in public management always generate environments threatening democracy and the public budget, a budget which could be invested, among others, in the fight against climate change."

Another obstacle is **poverty**. According to DANE data from 2021, **15.1% of the population is in a situation of extreme monetary**



poverty, and these people are especially vulnerable to the effects of climate change, which has a multiplier effect on the threats that afflict them on a daily basis.

COVID-19, in turn, has also provoked almost every area of law in the country to react to its effects: the states of emergency created by the government, tax reform necessary to handle the economic urgency, employment laws to mitigate the effects of business closures, protection of individual rights during quarantines, and need to place the environment at the heart of post-pandemic economic recovery.

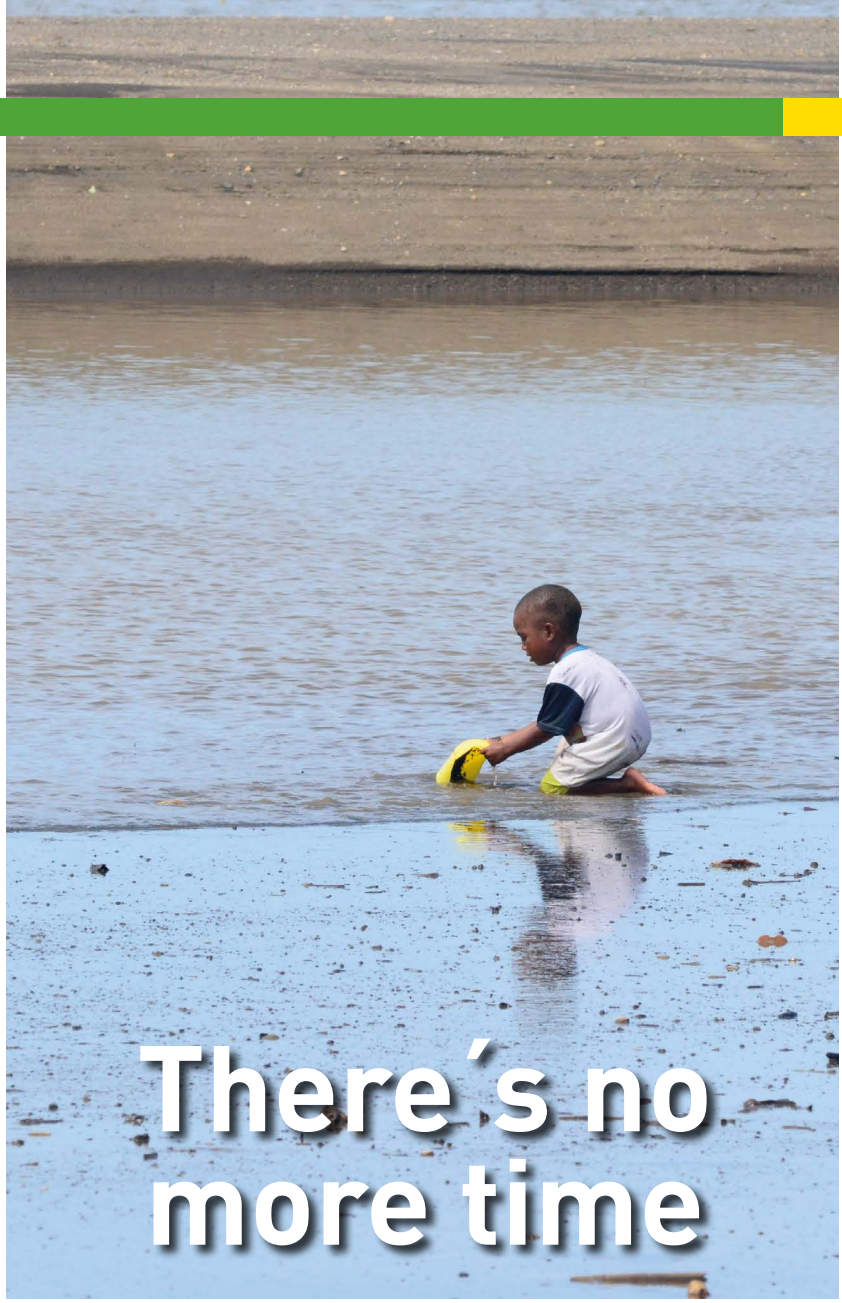
Further, the **armed conflict** is clearly an obstructive factor because "there are areas that do not count on the state presence and many are under the control of illegal groups. In several municipalities, thinking about SDGs implementation is still a utopia."

Citizenship education and culture from an early stage in children and youth was voted as the most enabling factor by participants. "Participants said that if children and young people do not clearly know what climate change is, how it affects them, and how it can be fought, it will be very difficult for the adults they will become to take effective actions like the ones the planet is asking us for now," explains Muñoz. "A large number of Colombians even ignore the SDGs and consequences of climate crisis; all of this continues to be controlled by selected elites with access to this knowledge."

The Escazú Agreement strives to implement another enabling factor, which is **environmental democracy**. "In our project, there is a chapter in which we show how the ratification and implementation of Escazú, through information, participation, and justice rights in environmental matters, enhances the other international commitments of the country," continues Muñoz.

"We found that when there is more information, there is greater transparency—something that helps to fight corruption—and also, when there is greater participation, confidence among different national actors is promoted."

Making existing regulations effective and correcting those that already exist are added to the enabling factors. Finally, strengthening sustainable development and climate change capacities "not only in new generations but also in the public civil service and private sector. Ignorance and the lack of information about transcendental topics exists in all areas and ages." This is a key point in the fight against discoordination and disarticulation among our entities, within a management model that is bureaucratic and highly segmented, where no permanent inter-institutional dialog and participation exists.



There´s no more time

From Benjamin Quesada's perspective, Colombia has some particularities, which will enable the implementation of new effective actions in the fight against climate change. "But to do so, it is necessary to 'land' the climate emergency in its territory, make it known, understand its effects, and dominate the tools, which will be used. It is necessary to be very clear and say how climate change will affect our reality, tourism, and food security, in short, all the production areas."

Quesada adds that "the country is in a favorable position in many aspects. We have an evolving legal framework and stable commitments over time. Our geographic location and the number of forests we have allow us to become a true carbon drain. We have experience in reforestation and, for some years now, tools to advance the mapping of ecosystem service in depth, so that our territory can be well monitored. We need to scale up the implementation, and we need the support of all political, economic, and social forces in the country to do so."

Changes in seasonal cycles, temperature increase, CO_2 production and retention, methane production from waste decomposition, dumping sites and ruminant digestion, nitrous oxide from the use of fertilizers and burning of fossil fuels, the use of chlorofluorocarbons (CFCs), and effects on the impact of solar radiation, among others, are just some of the phenomena that researchers worldwide are studying and monitoring closely to obtain a better understanding of climate change.

Without exception, all the variables explained here have a common cause: human beings. All data collected in this text has been measured, studied, and published by researchers worldwide. However, the problem cannot be addressed as if it were a single variable, a single piece of data. Climate change must also be tackled in its human dimension, one in which it is clear how it will affect our way of life, a way that we have wanted and permitted to be created, and we need to drastically change to ensure a sustainable future, with healthy human beings growing in fair and efficient societies.

The Conferences of the Parties, or **COP26**, bringing together all 196 signatory countries of the Paris Agreement, will take place **from October 31st to November 12th, 2021,** in the city of Glasgow (Scotland). It is the first political meeting since the agreement came into force, and its main goals are as follows: **ensuring a carbon-neutral economy by 2050 and limiting global warming by 1.5°C**, assisting vulnerable communities and protecting their habitat, securing at least USD$100 billion a year to finance this transformation, and accelerating all actions to address climate crisis with collaboration between governments, companies, and civil society.

Although the planet is just one, climate change will affect each country, and even each person, in a different manner. Our resources, our geographic location, our current industrial development, and our position in the great global economic market will condition us to face such a drastic and deep problem as climate change is setting out. Moreover, our decisions, our behavior at all society levels, the energy sources we use, our agricultural and livestock production practices, our global role in the field of preventing and fighting against climate change, our participation in global agreements and the approval of laws regulating and committing to such participation, and our ability to demand actions and responsibilities from all citizens, all this makes our future conditional. The future of new generations.