
# Status of fire ecology knowledge in Colombia

## Summary of findings & applications

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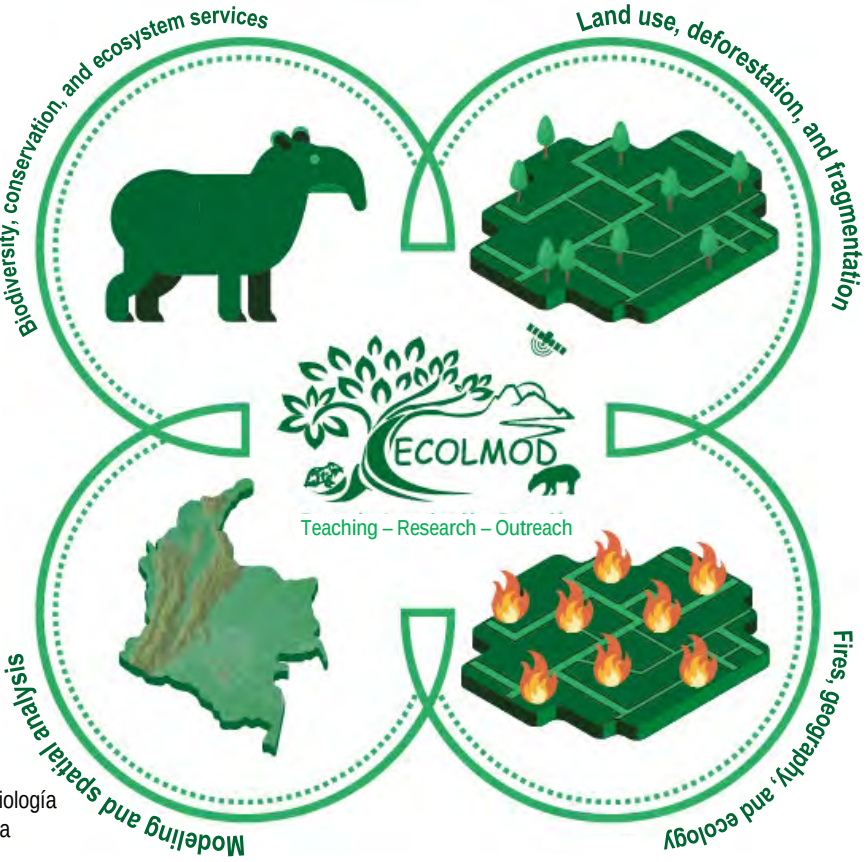
UNIVERSIDAD NACIONAL DE COLOMBIA

# Landscape Ecology and Ecosystem Modeling Research Group – Ecolmod

Research Group – Ecolmod, is an interdisciplinary group that combines the use of tools such as remote sensing and geographic information systems (GIS) with teaching, research, and outreach in applied and landscape ecology, fire ecology, geography, environmental sciences, conservation and planning biology, and land management. It is led by Dr. Dolors Armenteras, Associate Professor with the Biology Department of the National University of Colombia. The group has four lines of research.




Within these lines of research, they have conducted research related to changes in land use, deforestation, fragmentation, and landscape dynamics, incorporating everything into a climate change context. This research has been published in indexed journals such as Nature, Nature Ecology & Evolution, Biological Conservation, Ecological Modelling, Ecological Indicators, Regional Environmental Change, Journal of Land Use Science, Regional Environmental Change, Forest Ecology & Management, Plos One, Environmental Science & Policy, Land Use Policy, Forests, Biotropica, Bioscience, Environmental Geochemistry & Health, Biogeosciences, Remote Sensing, Earth Interactions, Ecological Applications, Atmosphere, Ecosphere, ISPRS International Journal of Geo-Information, Journal of Tropical Ecology, Global Ecology & Conservation, Revista de Biología Tropical, Revista Ecosistemas, Caldasia, Acta Biológica Colombiana, among others.

In addition, it has shared with the general public in notes and reports published in the News Agency of the National University of Colombia, Razón Pública, Mogabay, El Tiempo, and El Espectador.

The group has led more than 25 projects funded by national entities such as the National University of Colombia, the Sciences, Technology and Innovation Administrative Department – Colciencias, the Ministry of the Environment and Sustainable Development, the Institute of Hydrology, Meteorology, and Environmental Studies – Ideam, the Sinchi Amazon Institute of Scientific Research, the Food and Agriculture Organization of the United Nations – FAO in partnership with Ideam. In addition, it has international funding from the United States Agency for International Development – USAID, the Spanish Agency for International Development Cooperation – AECID, the Ibero-American Programme of Science and Technology for Development – CYTED, the U.S. Government National Security Agency – NSA, the Global Challenges Research Fund – GCRF Oxford, the United Nations Environment Programme – UNEP, and the Fulbright program, among others.

Likewise, its director, Dr. Armenteras, has participated in MEA (Millennium Ecosystem Assessment) international ecosystem assessments, GEO Amazonia (report on Environment Outlook in the Amazon), GEOLAC (Latin America and the Caribbean: Environment Outlook) and GEO 5 and 6 (The Global Environment Outlook), is the representative of the Landscape Ecology Group at the International Union of Forest Research Organizations – IUFRO for Latin America, and has been an expert in three task forces of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services – IPBES, particularly in the latest IPBES Global Assessment in Chapter 5, where she was especially in charge of sustainability scenarios at various scales. She has been a Fulbright Scholar for the 2015-2017 period, and in 2019 was elected Vice President of the International Association of Landscape Ecology – IALE. Domestically, she has also provided guidance to the national REDD+ program (Reducing Emissions from Deforestation and Forest Degradation), mainly in matters of deforestation monitoring and modeling, advances in the definition of forest degradation and the incorporation of wildfires.

As of 2019, the group has a postdoctoral researcher, seven doctoral students in science - biology, six master's students in science - biology, a master's student in geomatics and another in geography, a hotbed of undergraduate students in biology, two research assistants, an administrative assistant, in addition to having the participation of national and foreign researchers as collaborators. It has also supported Colombian students in its doctoral committees at Clarks University, University of Minnesota, and Oregon State University, in the United States.

| ACTIVE ECOLMOD MEMBERS AS OF 2019 | | |
|---|---|---|
| MEMBER | | TRAINING |
| Director | Dolors Armenteras Pascual | Biologist, M.S. in Forestry, Ph.D. in Geography |
| Postdoctoral Researcher | Eduardo Molina González | Biologist, M.S. in Environment and Development, Ph.D. in Science-Biology |
| Doctoral Students in Science – Biology | Tania Marisol González Delgado | Biologist, M.S. in Science, and Ph.D. candidate in Science-Biology |
| | William José Agudelo Henríquez | Biologist, M.S. in Wildlife Management, and Ph.D. candidate in Sciences-Biology |
| | Laura Isabel Mesa Castellanos | Biologist, M.S. in Science, and Ph.D. candidate in Science-Biology |
| | Federico Mosquera Guerra | Biologist, M.S. in Continental Hydrobiological Resources, and Ph.D. candidate in Sciences-Biology |
| | Carlos Julián Moreno Fonseca | Biologist, and M.S. in Science-Biology |
| | Oscar Javier Mahecha Jiménez | B.S. in Biology, M.S. in Science-Biology, and Ph.D. candidate in Sciences-Biology |
| | Maria Constanza Meza Elizalde | Forest Engineer and M.S. in Forest Management, Use, and Conservation |
| Master's Students in Science – Biology | Natalia Salazar Latorre | Forest Engineer and GIS Specialist |
| | Joan Sebastián Barreto Rivera | Biologist and Geomatics Specialist |
| | Sebastián Buitrago Gutiérrez | Biologist |
| | Johana Alejandra Villota Mogollón | Biologist |
| | Laura Obando Cabrera | Biologist and GIS Specialist |
| | Sebastián Giraldo Giraldo | Veterinarian |
| Master's Students in Geomatics and Geography | Juan Gabriel Rojas | Cadaster Engineer and Geodesist |
| | Ismael García | Geologist |
| Undergraduate Biology Students | Santiago Ruiz Guzmán | Undergraduate Biology Student |
| Colombian Associate Researchers | Fernando Trujillo González | Marine Biologist, M.S. in Sciences, and Ph.D. in Zoology. Scientific Director of the Omacha Foundation |
| | Henry Daniel Rumbo Fonseca | Biologist |
| | Alejandra Reyes Palacios | Forest Engineer and Specialist in Environmental Education and Management |
| Administrative Assistant | Diana Ayala | |

# Introduction

Vegetation fires have been a natural ecological process present in the tropics since millennia, influencing landscape structure, species makeup, and biological diversity. However, fires have also existed as a land management practice that sometimes leads to anthropogenic disturbances of ecosystems associated with the zones of use where the fire is present. Most of the current fires around the globe are the result of a combination of climate conditions and human activities, and the tropics are no exception. Predicting the response of natural ecosystems in dynamic landscapes such as those found in Colombia requires the combination of different approaches, methodologies and experiences to understand the causes of flammability and carbon emissions related to fires – particularly in tropical forests – and their effects. Making progress in this understanding is fundamental in order to predict where forest degradation at the landscape scale is most likely to occur and, on the other hand, which forests have the most capacity for resistance and resilience before this type of phenomena. It is also important to contribute elements toward better territorial management, where the risk of fire is minimized, and an adequate and controlled use of the various land management options is optimized.

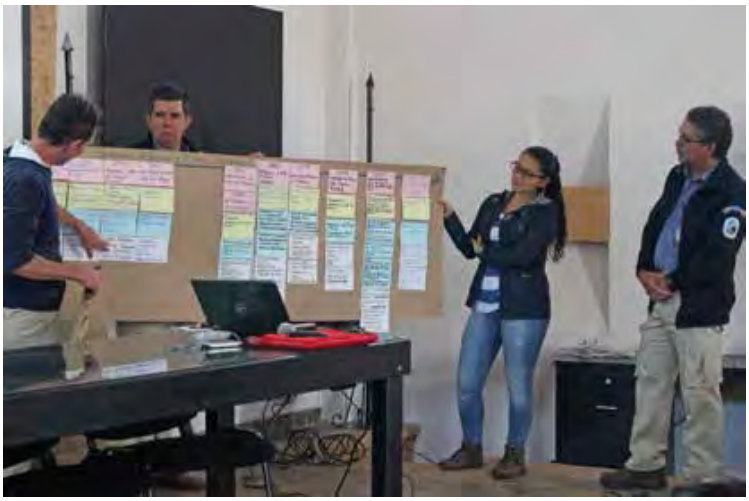
Thanks to the "Degradation of Tropical Forests in Colombia: Impacts of Fire" project, it is possible to address questions about fires and contribute elements to decision-making at the national level. This project was selected in the international call made by Partnerships for Enhanced Engagement in Research (PEER Cycle 5), and is executed by the National University of Colombia in partnership with the University of Colorado Boulder. It is a research project funded by USAID and managed by the National Academies of Sciences, Engineering & Medicine. In the project, two case studies have been addressed about two types of forests that are affected differently by fire, such as Andean forests and gallery forests. In addition, as part of this research, an additional proposal was developed to participatively create a document containing the insight of various stakeholders regarding adequate land management practices to prevent the occurrence of uncontrolled wildfires and thus avoid the degradation of forests and natural ecosystems that may be negatively affected by them.

Photo: Arturo Cortés

# Land-management support workshops

In order to promote the integration of scientific knowledge with local experiences around wildfire prevention, two workshops were conducted within the framework of the "Degradation of Tropical Forests in Colombia: Impacts of Fire" project, where they discussed and generated the inputs for the development of land-management proposals aimed at preventing the occurrence of wildfires and avoid forest degradation as a consequence of wildfires.

One of the workshops took place on May 31 and June 1, 2018, in Villa de Leyva, Boyacá, and had the participation of representatives of eight National Natural Parks of the Northeast Andes territory, the district's aqueduct system, the municipal government of Villa de Leyva, and the Ministry of Environment and Sustainable Development.



▲ Participants of the workshop conducted in Villa de Leyva, Boyacá.

◄ Activities carried out during the workshop conducted in Villa de Leyva, Boyacá.

Photos: Ecolmod

The second workshop took place on September 11 & 12, 2018, in Puerto Carreño, Vichada, and had the participation of National Natural Parks of Colombia (Tuparro, Macarena, Tinigua, and Picachos), the firefighters brigade of Puerto Carreño, forest companies, fire management committees, the municipal government of Puerto Carreño, the Autonomous Regional Corporation of the Orinoco River Basin, and the consortium in charge of preparing the POMCA of the Bita River.

During the workshops, perceptions of fires in forest and other natural areas were addressed, and the causes and drivers that increase the risk of fire were identified. Actions and protocols for fire management by different stakeholders were also discussed.

Participants of the workshop in Puerto Carreño, Vichada. ◄


Activities carried out during the workshop conducted in Puerto Carreño, Vichada. ▼

# Comprehensive fire management: a summary for policy-makers

*"From fire suppression to understanding and comprehensive fire management"*

María Constanza Meza, Tania Marisol González, Dolors Armenteras

## The Fire Paradox

Fire has been an essential tool for land management, and therefore, it is an element that has been present in the evolution of numerous landscapes. In this context it is crucial to promote the maintenance and restoration of landscapes recognizing the positive and negative impacts of fire, incorporating all forms of knowledge, without stigmatizing local and traditional practices associated with the use of fire and promoting scientific and participatory research, but minimizing unwanted negative impacts.

## Fire and Climate Change

International scientific collaborations have shown that it is necessary to coexist with changing fire activity, and that globally, societies need to adapt to climate change and maintain natural and cultural landscapes healthy, resilient, and safe for future generations (IUFR 2018).

In the global workshop of experts on fire and climate change (IUFRO 2018), a call was made to address global challenges in terms of fire management in a world that is warming, noting that:

A vicious cycle is emerging that links fire and climate change, the available data show a tendency to increase the frequency and intensity of uncontrolled fires.

The dynamics of global fire is complex and evolving in unknown proportions, but we know that, uncontrolled, it is generating high costs for biodiversity, ecosystem services, human wellbeing, livelihoods, and national economies.

It has become urgent to invest in social, economic, and environmental monitoring, especially in poorly analyzed areas.

## Shared Social Responsibility

Actions to prevent and control wildfires and manage fire in a comprehensive manner must be adopted and executed jointly and in coordination between the State, civil society and the productive sector, within the framework of the basic requirements for the conservation of ecosystems and their biological diversity.

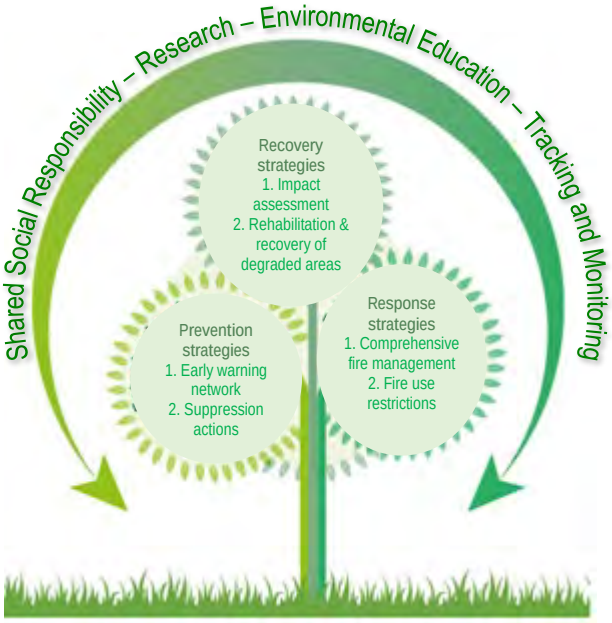
Based on the above, in order to guarantee wildfire prevention and the adequate use of fire in land management, it is necessary to have the support of adequate legislation in coordination with other laws on related subjects. It is worth noting that the transition to a comprehensive fire management policy does not mean abandoning the capacity of public organizations to combat wildfires, on the contrary, they should continue to be strengthened, as it is an unavoidable need.

Ecolmod specifically proposes that the development of public policy be aimed at comprehensive fire management and that control and prevention, as well as response and recovery strategies be considered. Comprehensive fire management actions may include establishing fire barriers and/or green belts, prescribed burnings for fuel reduction, controlled burning for research purposes, controlled burnings in agricultural, livestock, and forestry practices, among others. For this purpose, a deeper knowledge of the ecology of species in fire-prone areas, as well as greater effectiveness in controlling controlled fires are required.

**References:**
IUFRO. (2018). Global Fire Challenges in a Warming World. Summary Note of a Global Expert Workshop on Fire and Climate Change. 60 p.

## Dynamics

Socio-ecosystems are dynamic and multiple biotic, abiotic, and social factors are involved in their operation, which is why it is necessary to have ongoing tracking and monitoring in place, to adapt fire management practices to the needs that may arise in each context



# Impact of fire in gallery forests of the Colombian Orinoco River Basin

Dolors Armenteras, María Constanza Meza, Tania Marisol González

Not all ecosystems react the same way to fire. From an ecological point of view, some are benefited by fire and others are seriously affected. In the case of the ecosystems in the Orinoco River Basin, we can find vast savannahs that consist of **ecosystems adapted to fire or maintained by fire**, where plant species have developed adaptations to respond positively to fire and facilitate their spread; and ecosystems such as gallery forests which are **sensitive to fire**, in which fire is not an important and recurring process, for which reason species lack adaptations to respond to fires. That is why mortality can be very high even when the intensity of the fire is very low.

There are also some transition zones between fire-dependent ecosystems and fire-sensitive ecosystems, such as is the case of the transition zones between the savannahs and the gallery forests, which are considered **fire-influenced ecosystems**; however, the role of fire in these transition zones between the savannahs and the gallery forests has not been sufficiently documented yet, and therefore its role in diversity maintenance is not recognized.

In the case of the Orinoco River Basin landscape, the fires usually originate in the savannah vegetation and then spread in a variable way to the gallery forests, which in principle would be a barrier to fire and there is a great scientific debate about it. nevertheless, this situation gives rise to a paradox since in the savannahs, fire is essential and if it is suppressed or if its regime is altered, the persistence of this ecosystem in the landscape could be affected; on the other hand, if fires break through the edge of the forest and spread into it, they can result in multiple negative impacts on the forest's diversity and function.

In order to assess the impacts of fires on gallery forests we have monitored, over a three-year period, the changes of a forest affected by a wildfire that took place in 2015, and have compared it to forests of the same type and located in the same area that were not affected by the fire.

We are carrying out the work in the Omacha Foundation's Bojonawi Nature Reserve, within the framework of the *Degradation of Tropical Forests in Colombia: Impacts of Fire* project, funded by USAID's PEER Cycle 5 grant. In this research, we established vegetation plots in unburned forest zones and in forests affected by fire.

In general terms, we found a higher mortality rate in fire-affected zones, with the smallest number of live trees located in the edge of the forest, showing fire scarring from the base of the trunk to the treetop. Those trees that were recorded alive in the interior of the forest also showed scarring, but most of them did not exceed 2 m high.

On the other hand, a considerable reduction in plant diversity was evident in the burned areas, recording fewer species of trees with a

Photo: Tania González

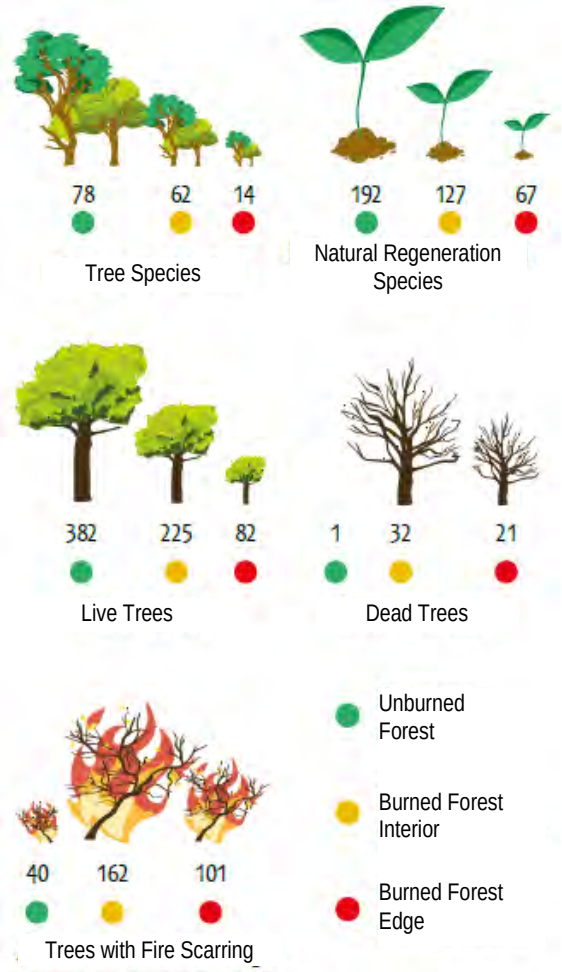
◄ Fire-affected lowlands forest and natural savannahs. Bojonawi Nature Reserve, Department of Vichada.

Unburned forest, Bojonawi Nature reserve

Photo: Williams Beltrán & Sebastián Barreto

Burned forest

Photo: Arturo Cortés




diameter greater than 10 cm, as well as fewer species of saplings in natural regeneration.

The high mortality of trees leads to changes in the structure of the forest, such as for example, the existence of a larger opening in the canopy, which in turn generates changes in the microclimate, since there is more light and sun radiation allowed in, as well as more wind exposure. These conditions lead to a rise in temperature and a drop in humidity. These new conditions affect the species of flora and fauna that were established in these forests before the fire, favoring other, more generalist species that adapt to disturbed environments, such as in the case of sawgrass.

The new microclimate has effects, not only on the makeup of the species, but also in the physiologic processes of plants such as transpiration, photosynthesis, seed germination, flowering, fruit production, and mortality. The above situation affects the ecological processes of forests and consequently, also forest services such as water regulation, air quality regulation, erosion control, among others.

Panoramic of closed canopy before fire. Bojonawi Nature reserve

Photos: Williams Beltrán & Sebastián Barreto

Panoramic of open canopy after fire. Bojonawi Nature reserve

## Effects on forest structure

It was reported that there was growth of herbaceous vegetation on top of the burned and dead trees, which is more flammable and also allows the vertical spread of fire, which makes the fire reach more height in a wildfire.

▶ Changes in the structure of the forest are evidenced that not only affect the diversity and ecosystem services, but also make the forest more vulnerable to new fire events.

◀ ▶ The number of standing dead trees and fallen dead branches increases, which translates into a greater amount of fuel and therefore a higher probability of fires of increased severity and intensity

## Differential response of plants to fire

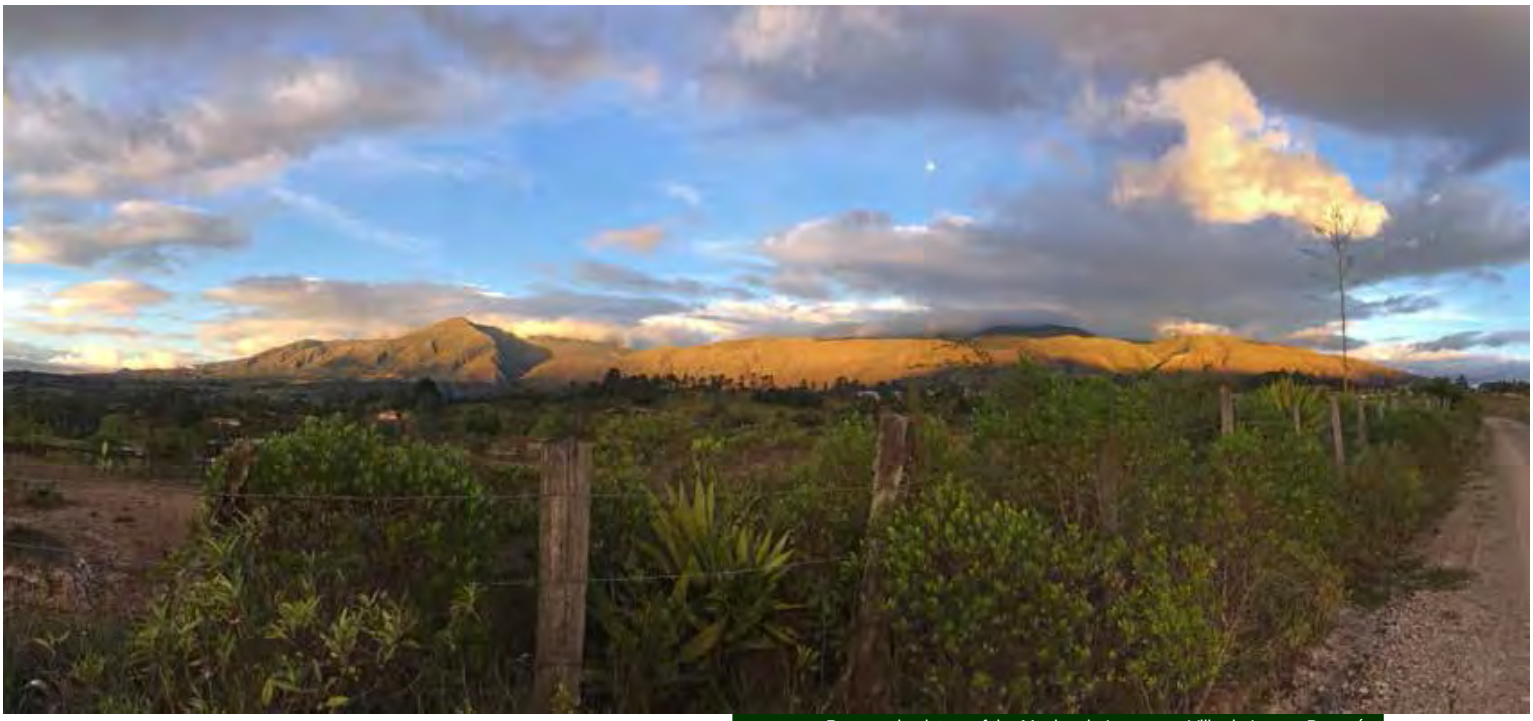
Not all species react the same way to a fire event. Their response will depend on morphologic characteristics such as the thickness of the bark, and physiologic characteristics such as regrowth capacity. Below we indicate the responses we encountered:

▲ After the fire event, most trees dry up and are left more exposed to borer attacks.

▲ Mechanical damages associated with broken limbs and bark detachment were evident after the fire.

▲ Fire scarring at variable heights were identified in most species.

▲ Regrowth at various heights were recorded and quantified in some species.



Panoramic picture of the Macizo de Iguaque – Villa de Leyva, Boyacá

# Response of an oak grove to fire

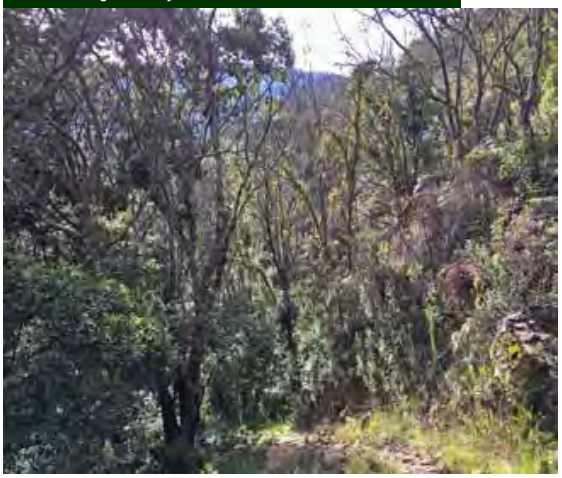
Dolors Armenteras, Natalia Salazar, María Constanza Meza

Within the framework of the project *Degradation of Tropical Forests in Colombia: Impacts of Fire*, funded by USAID's PEER Cycle 5 grant, a pilot research of the research project was carried out in the Iguaque Fauna and Flora Sanctuary, seeking to understand how the oak grove in the protected area responded to one of the fires occurred in the area, specifically, the one occurred in 2015. In order to understand the forest's post-fire dynamics and response, we set up sampling plots in the burned area, as well as reference/control plots in the unburned part of the forest. The structure and makeup of a disrupted forest were compared to those of a forest that has not been affected by fire. To do this, some variables were measured, such as: height of trees, trunk diameter, phytosanitary status, regrowth on trees, as well as natural regeneration in the sampled plots.

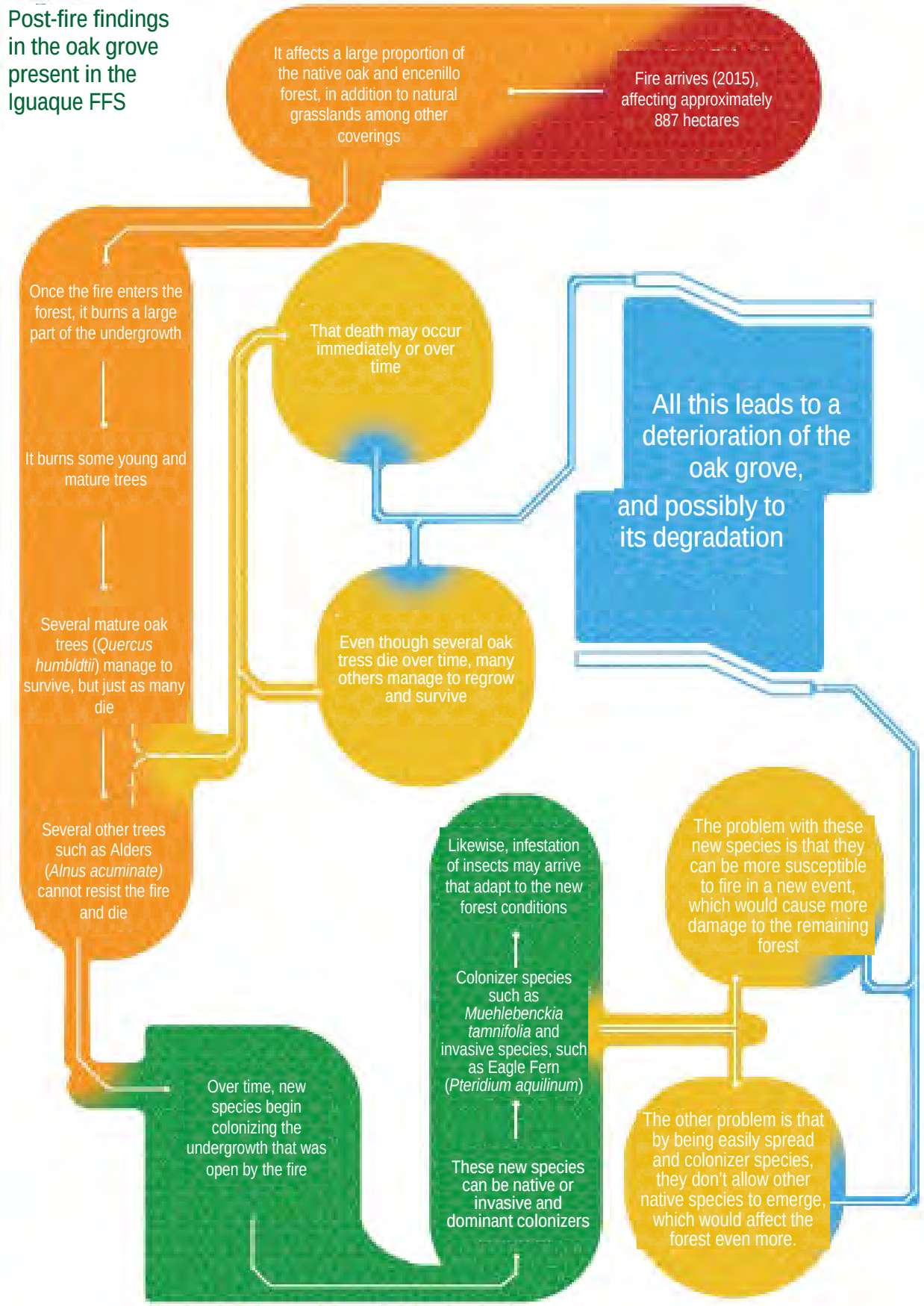
The results obtained show that the burned forests are less diverse areas, where several species that were present in the unburned forest have been lost, in addition to having a less dense forest structure with shorter trees. In addition, a great loss of aerial biomass (biomass above ground level) was observed. On the other hand, a significant presence of herbaceous species was found in the undergrowth, with many of them being fast colonization species and others being invasive species, which over time may worsen damage to the forest. These results show a process of degradation of the remaining oak groves within the Iguaque Fauna and Flora Sanctuary. (See Diagram 1).

Unburned oak grove

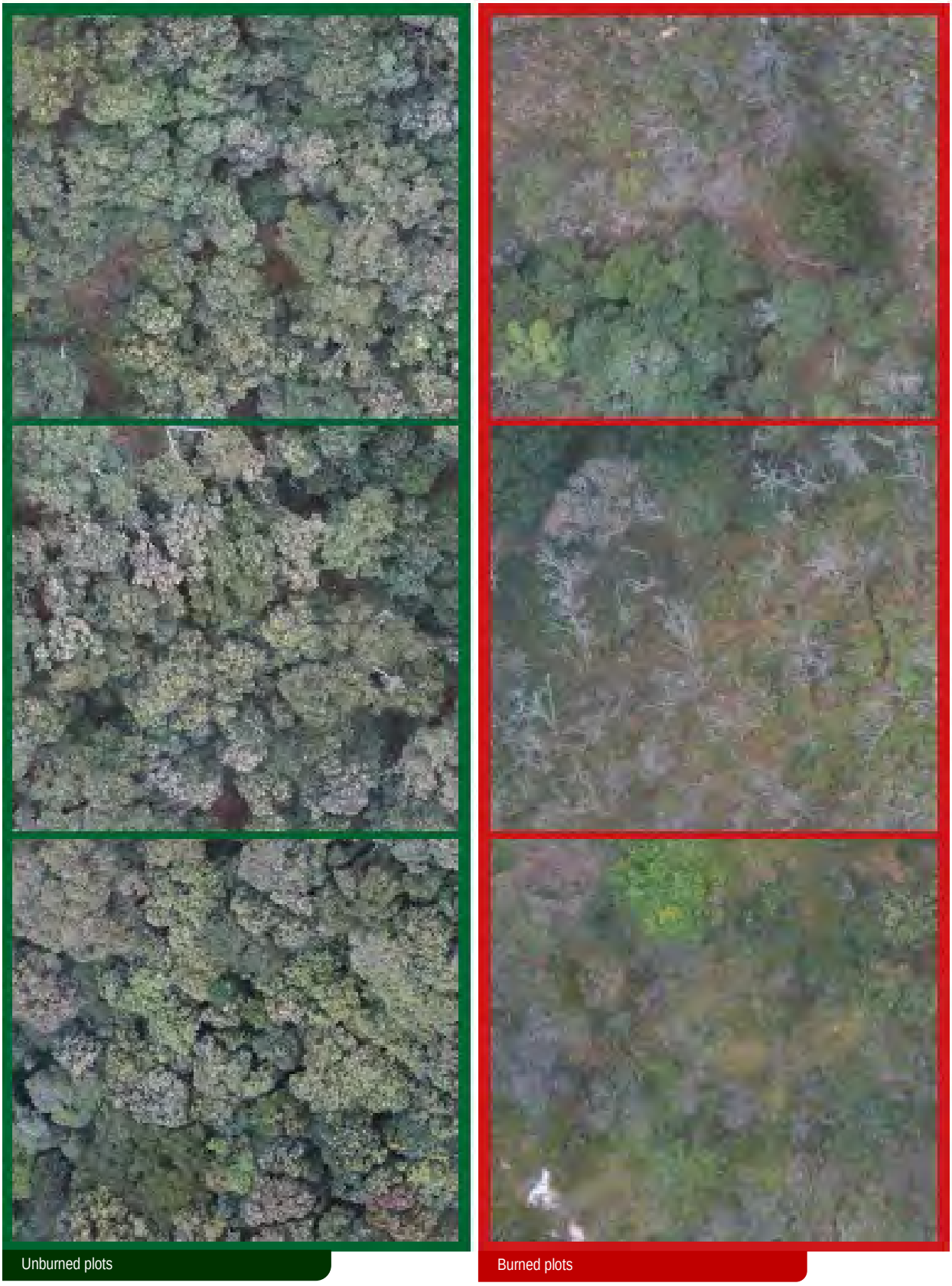
Burned oak grove, 3 years after the disturbance



## Post-fire findings in the oak grove present in the Iguaque FFS



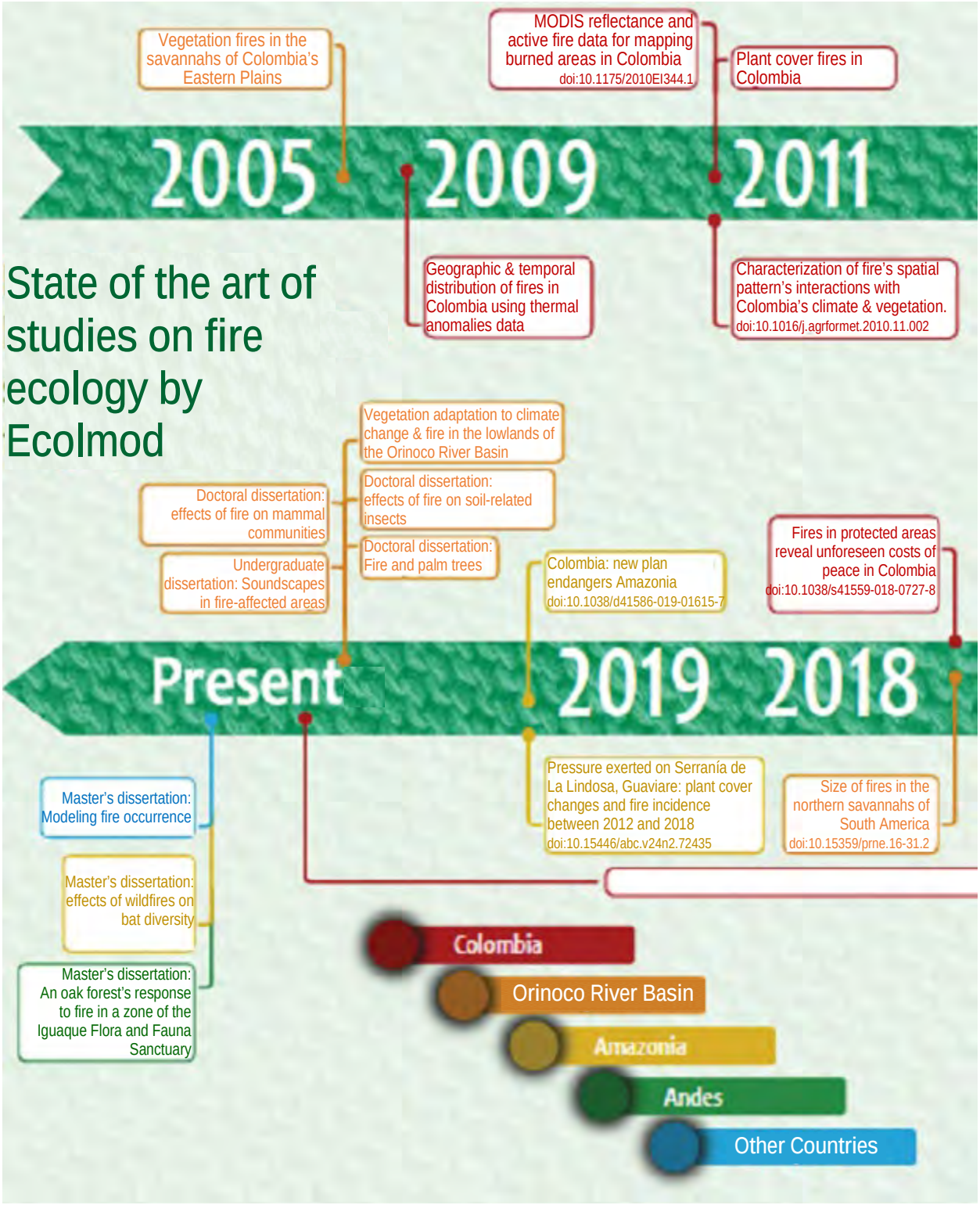
## Drone images of oak forests



Unburned plots

Burned plots

This page's photos: Williams Beltrán & Sebastián Barreto


Vegetation fires in the savannahs of Colombia's Eastern Plains
MODIS reflectance and active fire data for mapping burned areas in Colombia
doi:10.1175/2010EI344.1
Plant cover fires in Colombia
2005
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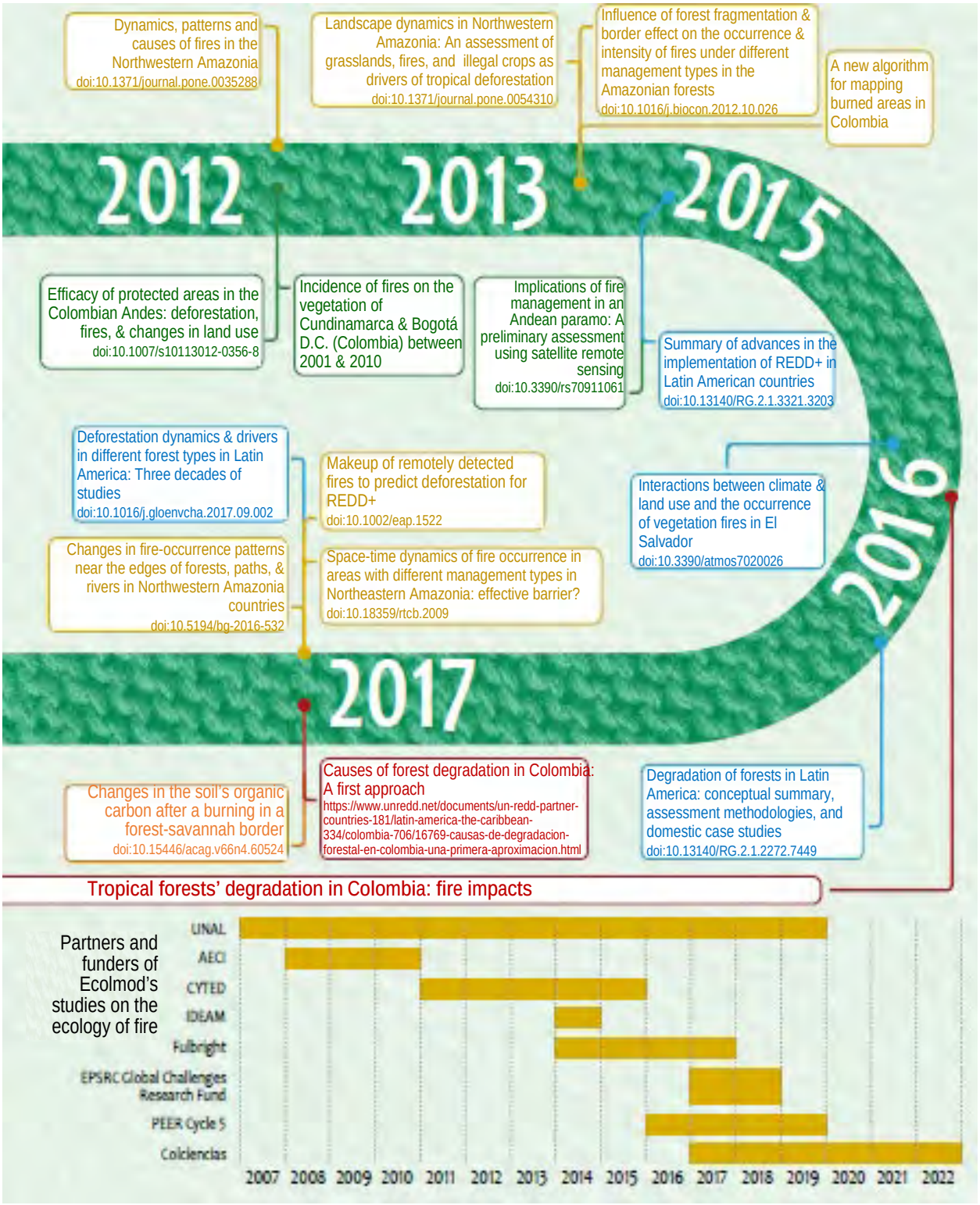
State of the art of studies on fire ecology by Ecolmod
Geographic & temporal distribution of fires in Colombia using thermal anomalies data
Characterization of fire's spatial pattern's interactions with Colombia's climate & vegetation.
doi:10.1016/j.agrformet.2010.11.002
Vegetation adaptation to climate change & fire in the lowlands of the Orinoco River Basin
Doctoral dissertation: effects of fire on mammal communities
Doctoral dissertation: effects of fire on soil-related insects
Undergraduate dissertation: Soundscapes in fire-affected areas
Doctoral dissertation: Fire and palm trees
Colombia: new plan endangers Amazonia
doi:10.1038/d41586-019-01615-7
Fires in protected areas reveal unforeseen costs of peace in Colombia
doi:10.1038/s41559-018-0727-8
Present
2019
2018
Master's dissertation: Modeling fire occurrence
Master's dissertation: effects of wildfires on bat diversity
Master's dissertation: An oak forest's response to fire in a zone of the Iguaque Flora and Fauna Sanctuary
Pressure exerted on Serranía de La Lindosa, Guaviare: plant cover changes and fire incidence between 2012 and 2018
doi:10.15446/abc.v24n2.72435
Size of fires in the northern savannahs of South America
doi:10.15359/prne.16-31.2
Colombia
Orinoco River Basin
Amazonia
Andes
Other Countries


Dynamics, patterns and causes of fires in the Northwestern Amazonia
doi:10.1371/journal.pone.0035288
Landscape dynamics in Northwestern Amazonia: An assessment of grasslands, fires, and illegal crops as drivers of tropical deforestation
doi:10.1371/journal.pone.0054310
Influence of forest fragmentation & border effect on the occurrence & intensity of fires under different management types in the Amazonian forests
doi:10.1016/j.biocon.2012.10.026
A new algorithm for mapping burned areas in Colombia
2012
2013
2015
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2017
Efficacy of protected areas in the Colombian Andes: deforestation, fires, & changes in land use
doi:10.1007/s10113012-0356-8
Incidence of fires on the vegetation of Cundinamarca & Bogotá D.C. (Colombia) between 2001 & 2010
Implications of fire management in an Andean paramo: A preliminary assessment using satellite remote sensing
doi:10.3390/rs70911061
Summary of advances in the implementation of REDD+ in Latin American countries
doi:10.13140/RG.2.1.3321.3203
Deforestation dynamics & drivers in different forest types in Latin America: Three decades of studies
doi:10.1016/j.gloenvcha.2017.09.002
Makeup of remotely detected fires to predict deforestation for REDD+
doi:10.1002/eap.1522
Interactions between climate & land use and the occurrence of vegetation fires in El Salvador
doi:10.3390/atmos7020026
Changes in fire-occurrence patterns near the edges of forests, paths, & rivers in Northwestern Amazonia countries
doi:10.5194/bg-2016-532
Space-time dynamics of fire occurrence in areas with different management types in Northeastern Amazonia: effective barrier?
doi:10.18359/rtcb.2009
Causes of forest degradation in Colombia: A first approach
https://www.unredd.net/documents/un-redd-partner-countries-181/latin-america-the-caribbean-334/colombia-706/16769-causas-de-degradacion-forestal-en-colombia-una-primera-aproximacion.html
Changes in the soil's organic carbon after a burning in a forest-savannah border
doi:10.15446/acag.v66n4.60524
Degradation of forests in Latin America: conceptual summary, assessment methodologies, and domestic case studies
doi:10.13140/RG.2.1.2272.7449
Tropical forests' degradation in Colombia: fire impacts
Partners and funders of Ecolmod's studies on the ecology of fire
UNAL
AECI
CYTED
IDEAM
Fulbright
EPSRC Global Challenges Research Fund
PEER Cycle 5
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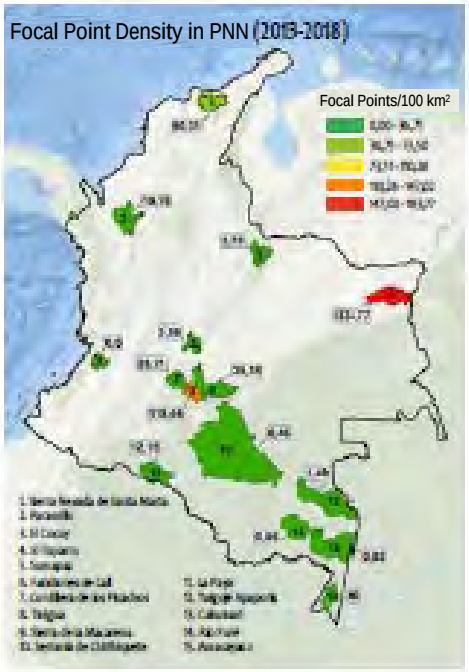
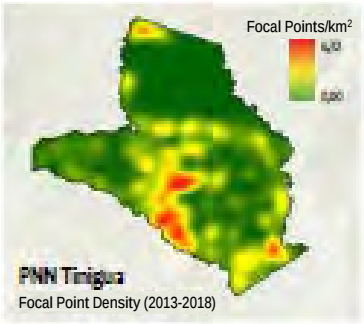
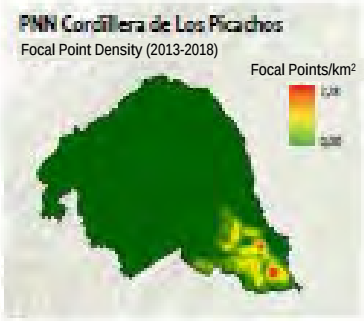
# Deforestation and fires in Colombia's Protected Areas

Sebastián Barreto and Dolors Armenteras

- Colombia has 33 administrative and political divisions (32 Departments and one Capital District)*
- In 2018, the departments of Atlántico, Caquetá, Guavire, and Meta showed an increase in deforested areas compared to 2017
- 30 out of a total of 43 National Natural Parks showed at least one active fire focal point during the 2013-2018 period
- The departments of San Andrés and Providencia were not included in the analysis.



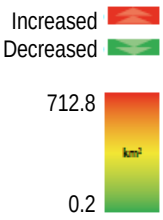



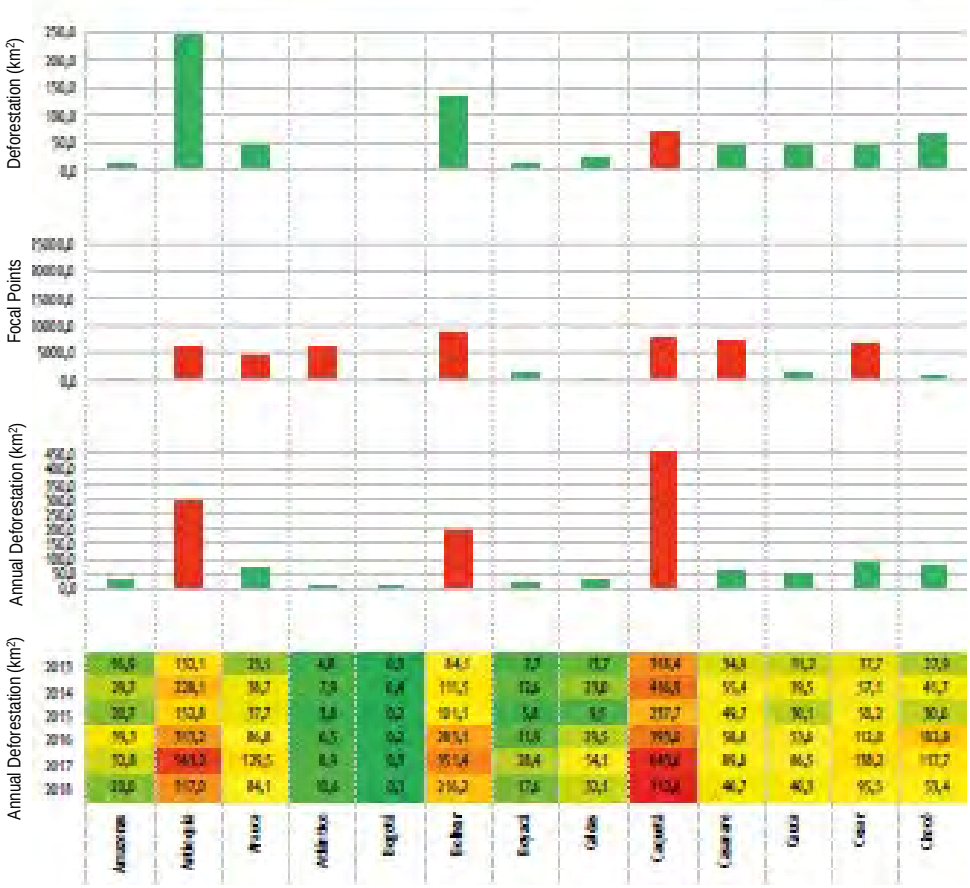

The *Hansen Global Forest Change v1.6 (2000-2018)* dataset was used. This dataset has information on forest cover size, gains and losses from 2000 to 2018, with loss data being assigned annually (Hansen *et al*, 2013). This latest information was the one used to quantify annual deforestation (2013-2018) by department, at the national level.

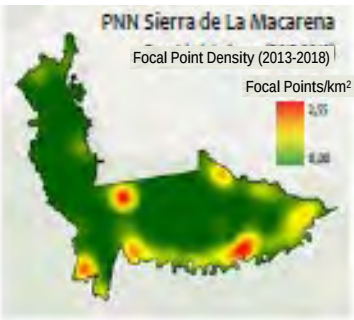
The data on fire focal points were downloaded from the FIRMS (Fire Information for Resource Management System) database. These data have a spatial resolution of 375m and refer to thermal anomalies that are particularly useful to detect small fires (Schroeder, 2018),

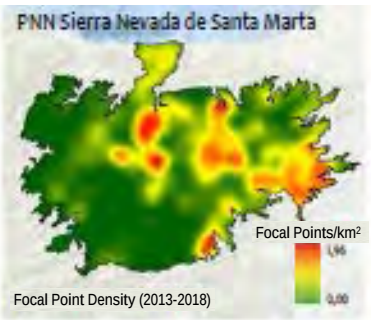
Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S.A., & Tyukavina, A. (2013). High Resolution Global Maps of 21sth Century Forest Cover Change. Science, 134 (November), 850-854.

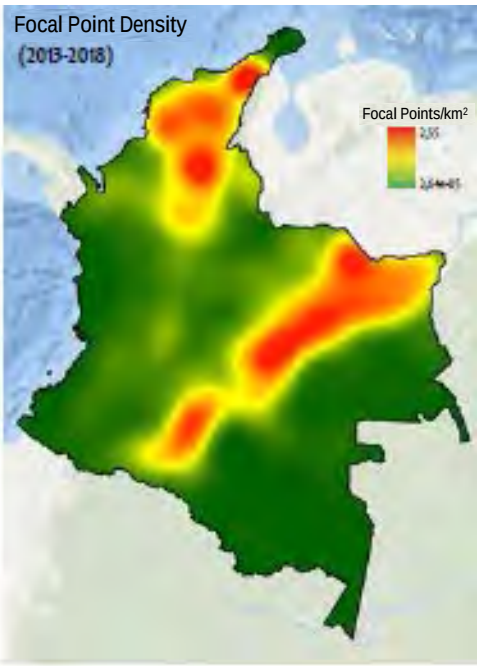
Schroeder, W. (2018). Visible Infrared Imaging Radiometer Suite (VIIRS) 375 m & 750m Active Fire Detection Data Sets Based on NASA VIIRS Land Science Investigator Processing System (SIPS) Reprocessed Data – Version 1 Product User's Guide Version 1.2. (July).

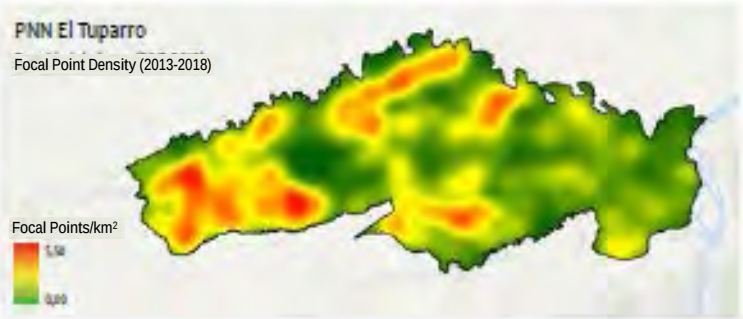


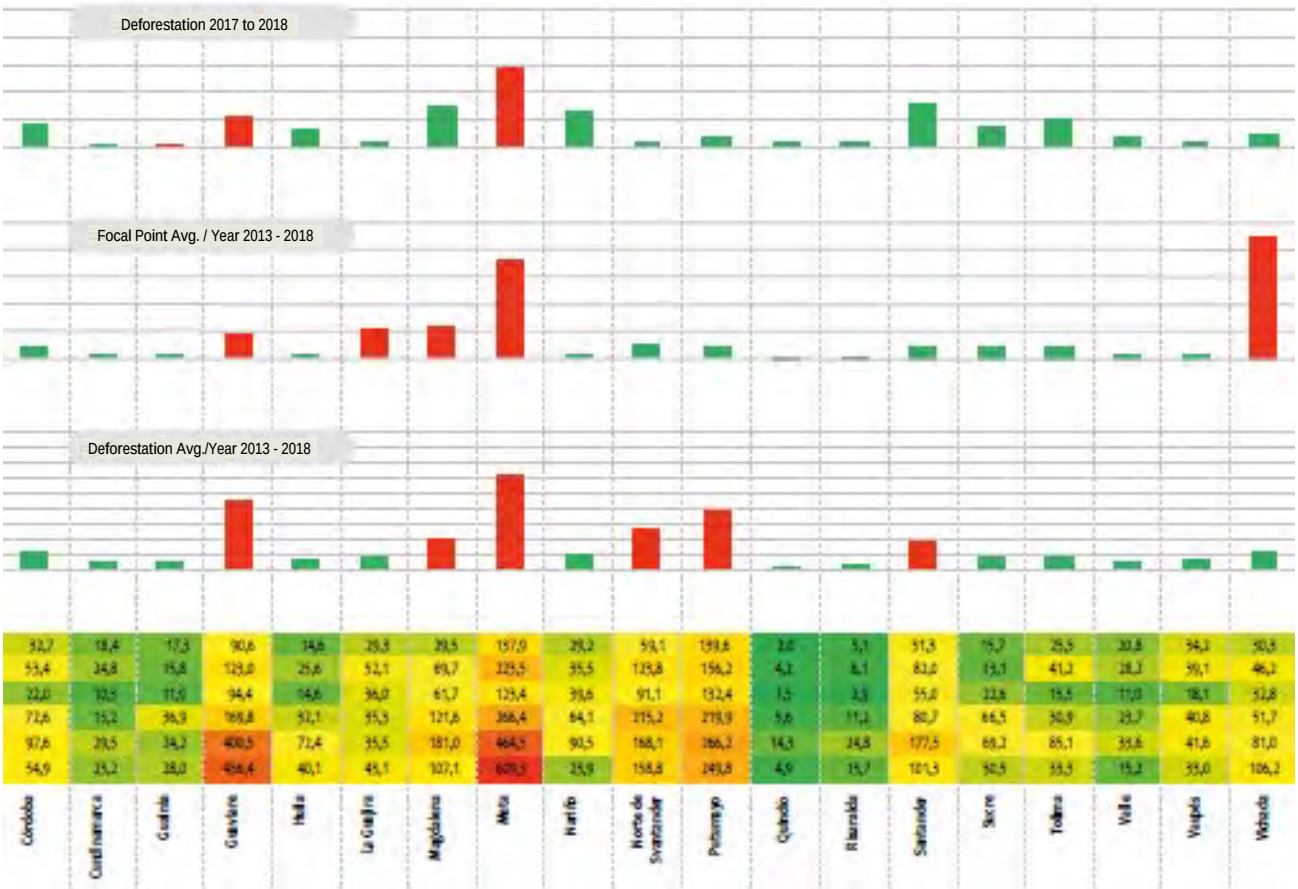




PNN Sierra de La Macarena
Focal Point Density (2013-2018)
Focal Points/km²


PNN Sierra Nevada de Santa Marta
Focal Points/km²
Focal Point Density (2013-2018)


Focal Point Density
(2013-2018)
Focal Points/km²


PNN El Tuparro
Focal Point Density (2013-2018)
Focal Points/km²


Deforestation 2017 to 2018
Focal Point Avg. / Year 2013 - 2018
Deforestation Avg./Year 2013 - 2018
Córdoba
Cundinamarca
Guainía
Guaviare
Huila
La Guajira
Magdalena
Meta
Nariño
Norte de Santander
Putumayo
Quindío
Risaralda
Santander
Sucre
Tolima
Valle
Vaupés
Vichada

# Fire and palm trees

Laura Isabel Mesa and Dolors Armenteras

Palm trees are frequently found in natural ecosystems of the tropical regions all over the world. They are very important to maintain the ecological balance of the areas where they inhabit since they contribute toward atmospheric carbon fixation and the regulation of water cycles, in addition to being a source of food for birds and mammals. On the other hand, aware of the services provided by this group of plants, human communities have nurtured them for millennia in different types of forests, and have used them as a source of raw material for food preparation, construction of dwellings, tool making, in addition to being part of the worldview of several indigenous peoples.

In the Orinoco River Basin region of Colombia, native palm trees are usually found in gallery forests and rocky outcrops. However, following the trend of the entire region, an increase in the number and size of fires has been observed that may be affecting this valuable resource. This is what led to the idea of watching the effects that burnings have on different species of palm trees, with the purpose of guiding strategies for their conservation.

Since 2019, within the framework of a doctoral dissertation, assessments are being carried out in different sectors of the National Natural Park El Tuparro, in the municipality of Cumaribo Vichada, where through ecological evaluations at different biological scales, we expect to expand our knowledge of the relationship between palm trees and fire. So far, we have been able to observe that some species have characteristics that make them slightly more resistant to the effects of fire, but when the fires are too intense, or when they happen too frequently, there are no mechanisms able to help and the species populations are gravely affected, which could lead to their disappearance in the long term, and the subsequent ecological unbalance. Therefore, it is advisable to propose urgent measures for controlling fires within the protected area, where human communities settled in the interior of these areas or in the park's area of influence may participate actively in the proposal and adoption of fire-management actions.

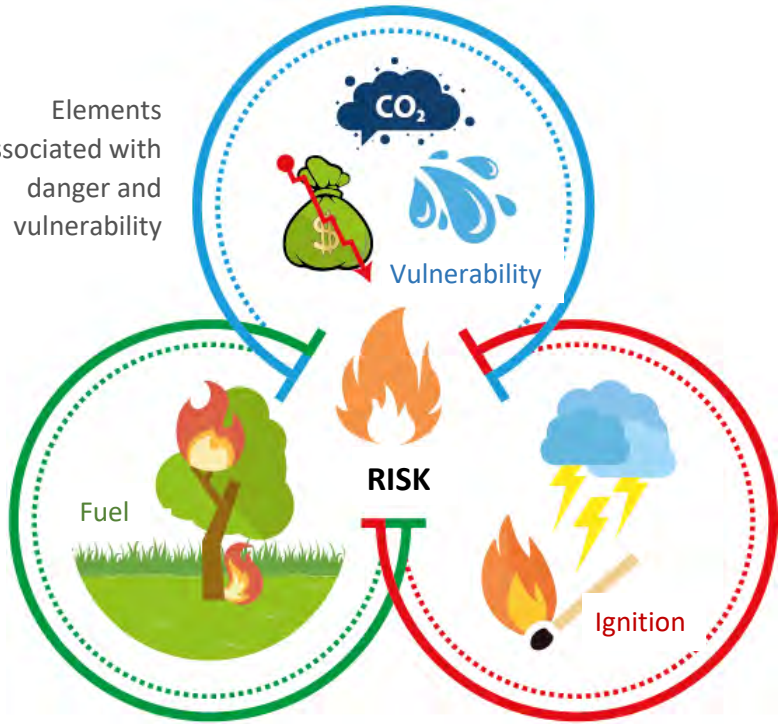
◄ Young moriche palm (*Mauritia flexuosa*) trying to survive after the fire.

Signs of fire in *Mauritia flexuosa* stems. ▼

This page's photos: Laura Mesa

# Fire occurrence modeling

Sebastián Barreto and Dolors Armenteras




While fire is an event that can occur naturally in ecosystems and is a factor that has influenced the development of ecosystems and landscapes at a global scale,[1] it is also considered an important disturbance factor, especially in those ecosystems not adapted to fire, located in tropical and sub-tropical zones.[2] Global warming, climate variability phenomena,[3] changes in land use, and anthropic[4] presentation are some of the factors that greatly increase the incidence of fires, and their frequency and intensity are expected to increase in the next few decades.[5] The analysis of the variables associated with the risk of occurrence of fire, and the modeling of this risk are the primary points of information from which we can identify places and moments with a high risk of fire occurrence that could affect areas of importance for biodiversity. This knowledge provides a management tool to prevent, mitigate, and control this type of events and, therefore, the effects derived therefrom. Likewise, the cartography generated from risk modeling is a basic tool for land management, planning, and protection, especially in natural areas.[6]

In order to evaluate the risk of occurrence of fires,[7] it is important to approach it from danger-related elements (sources of ignition and inherent characteristics of fuel), and vulnerability-related elements (potential damage caused by this type of events).

Photo: Arturo Cortés

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◄ Prevention strategies

▲ Marsupial present in the forests of the Bojonawi Reserve

# Effect of fires on mammal communities

Tania Marisol González and Dolors Armenteras

The Colombian Orinoco region, in addition to providing multiple ecosystem services, is an area deemed to be highly biodiverse. However, this is one of the country's most affected by Climate Change, causing there to be increasingly more periods of extreme draught. It is also a zone where various productive activities take place, which require preparation or clearing of the soil by using fire as a management tool. There are times and conditions that create an environment ripe for burnings – that had originally been planned as controlled – to get unintentionally out of control, as is the case in this region; there are also intentional fires. Both kinds can affect forests and the animals present there. It is common for there to be loss of species, changes in communities, there may be mortality of individual [animals], or when their ability to move allows them to escape a fire, animals are forced to move to areas other than those they used to inhabit.

▲ *Oecomys sp.* Present in unburned forests in the Bojonawi Reserve

▲ Young *Zygodontomys brevicauda.* Present in burned forests in the Bojonawi Reserve

This page's photos: Tania González

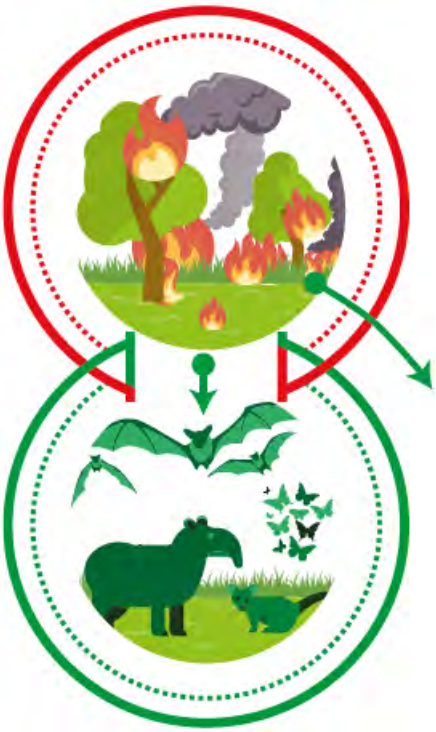
The environmental impacts of fires on tropical ecosystems are largely unknown. Non-flying small mammals are species that belong to the rodent group, mainly possums, and they fulfill very important functions in the forests, such as seed dispersal. In order to understand how fire affects them, as part of a doctoral dissertation, information is being gathered on these animals and on the vegetation of fire-affected forests as well as of unaffected forests of the Bojonawi Nature Reserve, in Puerto Carreño, Vichada.

So far, we have found greater species diversity in unburned forests. These are arboreal species that feed on insects and fruits. On the other hand, the *Zygdontomys brevicauda* species is abundant in burned areas, with sightings reported in grasslands, clearings, and intervened areas. The study of vegetation has indicated a simplification of its structure and makeup in burned areas. In general terms, the patterns observed indicate that non-flying small mammals preferred undisturbed forests, where vegetation structure is complex.

This project is contributing to the characterization of the biodiversity of small mammal communities, and to the understanding of the relationships between fires and mammal diversity. The information gathered can be useful to strengthen the design of informed and adaptable management and conservation strategies in the Vichada region.

This research is funded by several grants and scholarships granted by the National University of Colombia, Ecolmod, the Sciences, Technology, and Innovation Administrative Department – Colciencias, the Rufford Foundation, L'Oreal- Unesco for Women in Science, Colombia, and The Latin America student field grant 2017 granted by the American Society of Mammalogists, in addition to some equipment donated by Idea Wild and Neotropical Grassland Conservancy.

## Fire effects on forests and fauna

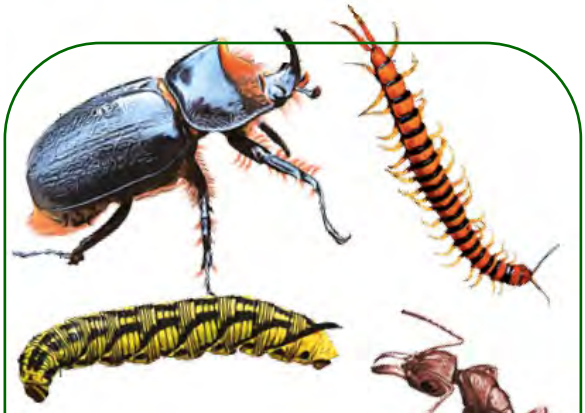


### Forest Fires

- Loss and/or degradation of forests
- Carbon emissions
- Soil degradation
- Reduced water-retention capacity
- Socio-economic impacts

### It affects animals:

- Mortality
- Displacement of organisms to other areas
- Affected or reduced food and other resources
- Increase competition for food and refuge
- More depredation pressure



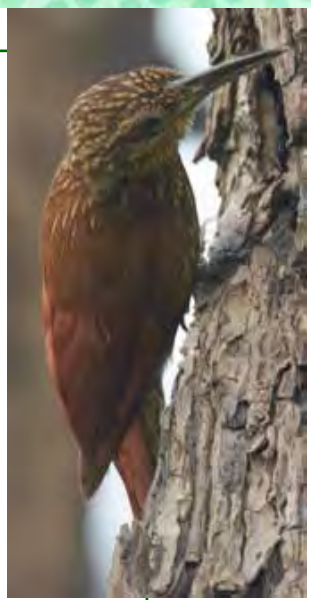
# Effect of fires on soil-related insects

Carlos Julián Moreno and Dolors Armenteras

Another doctoral dissertation within the framework of the project is making progress in learning how soil-related insects react to fires in the ecosystems of savannas and gallery forest. This biological group will be used as proxy to learn the status of the above mentioned natural systems. It is also important to know and to highlight some of the services and resources they provide to the human populations of the area, and how this contribution changes in the presence of fire, especially in order to highlight the importance of knowing the role of the soil in the ecosystem's interaction with fire. The knowledge gained from the study is expected to facilitate the understanding of the ecological roles of fauna in environments where fires is a common element, and that will in turn allow planning conservation strategies for the area's natural resources.

# Soundscapes in fire-affected areas

Santiago Ruiz and Dolors Armenteras



buff-throated woodcreeper (*Wiphorhynchus guttatus*) searching for food in burned trunk

Wildfires have recently become a significant issue given their high impact on ecosystems, and despite their prevalence, their effects n wildlife continue to be little known, especially in tropical regions. The analysis of the soundscape – understood to be the set of sounds produced by the various sound entities present in a landscape (birds, insects, weather phenomena) – allows us to effectively investigate fauna dynamics and its behavior, especially when their habitats are modified, fragmented, or destroyed. This is an area of landscape ecology that incorporates methodologies from several disciplines. In this specific research study, we are proposing comparing the acoustic bird community (sound-emitting birds) from a burned gallery forest to that of a highly conserved gallery forest of the Orinoco River basin. This study seeks to gain more information about the influence of fires on such a highly diverse and ecologically important group as birds are. In addition, we hope this study will become an input that will strengthen management efforts in the conservation of fire-affected ecosystems.

# Effect of fires on bat diversity

Laura Obando and Dolors Armenteras

Wildfires are growing in size and frequency in the tropics, affecting the makeup and structure of their forests. However, not only is vegetation structure affected by fires, but also the fauna of these forests is both directly and indirectly affected. Keeping in mind this serious issue, a master's degree dissertation study is going to analyze the response of the fauna to this disturbance. The research focuses specifically on the effect of wildfires on the diversity of bats in a tropical forest. Analyzing bats' response to wildfires is very important since they are a highly diverse taxonomic and functional group, with ample distribution, that provide essential services to ecosystems, such as seed dispersal, pollination, and pest control. The loss or modification of these ecosystem services resulting from modifications to bat diversity in response to wildfires, may trigger a chain of negative, neutral, or positive processes that will be analyzed during the research. So far, most studies that evaluate bat response to wildfires have been carried out in temperate forests, with few of the studies carried out in tropical forests where, largely and unlike in temperate areas, forests have an anthropogenic origin and are not part of the ecosystems' natural processes. In Colombia, this is the first study to address the subject, and it is expected that the results obtained from the study will help to understand bat response to a highly frequent disturbance, which will allow the adoption of appropriate management and conservation measures.

# Acknowledgements

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- Pisba National Natural Park (PNN-PIS)
- Catatumbo Barí National Natural Park (PNN-CAT)
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- La Macarena National Natural Park (PNN-MACARENA)
- Tinigua National Natural Park (PNN-TINIGUA)
- Cordillera de los Picachos National Natural Park (PNN-PICACHOS)
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- Departmental Disaster Risk Management Coordinating Office (Vichada)
- Municipal Disaster Risk Management Coordinating Office (Puerto Carreño)
- Municipal Agricultural Technical Assistance Unit (UMATA-Puerto Carreño)
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- Puerto Carreño Municipal Government
- Puerto Carreño Municipal Council
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- CANAPRO Forest Company
- InverBosques Forest Company
- La Paz Reforestation Forestry Company
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