

Presentación de Posters Semana de Facultad 2026 – 1, Facultad de Arquitectura e Ingeniería.

Nombre de la actividad: Presentación de posters.

Curso: Anteproyecto de Investigación.

Docentes: Andrea Tamayo y Carlos Fidel Granda Ramírez.

Programa: Ingeniería Ambiental.

Objetivo de la actividad: Obtener los resultados del proyecto de investigación a través de la aplicación de una metodología rigurosa y acorde a los objetivos definidos

Productos a divulgar y proceso:

- Producto a divulgar: Póster.
- Proceso: Elaboración de la propuesta de investigación y avance en el desarrollo de la investigación en la que se presentan: Problema de investigación, Marco teórico, Objetivos, Metodología, Resultados parciales, Análisis parciales Conclusiones parciales y Referencias bibliográficas. En el proceso de investigación, el grupo de estudiantes está acompañado por un asesor temático experto en el tema.

Application of EPA Positive Matrix Factorization (PMF 5.0) for the identification of sources and contributions of Potentially Toxic Elements in soils affected by gold mining in Antioquia, Colombia

Authors:

Jorge Monsalve, Sebastián López, Laura Carvajal

Thematic advisors: Julián López, Juan David Correa Estrada

Methodological advisor: Andrea Tamayo Londoño

Problematic

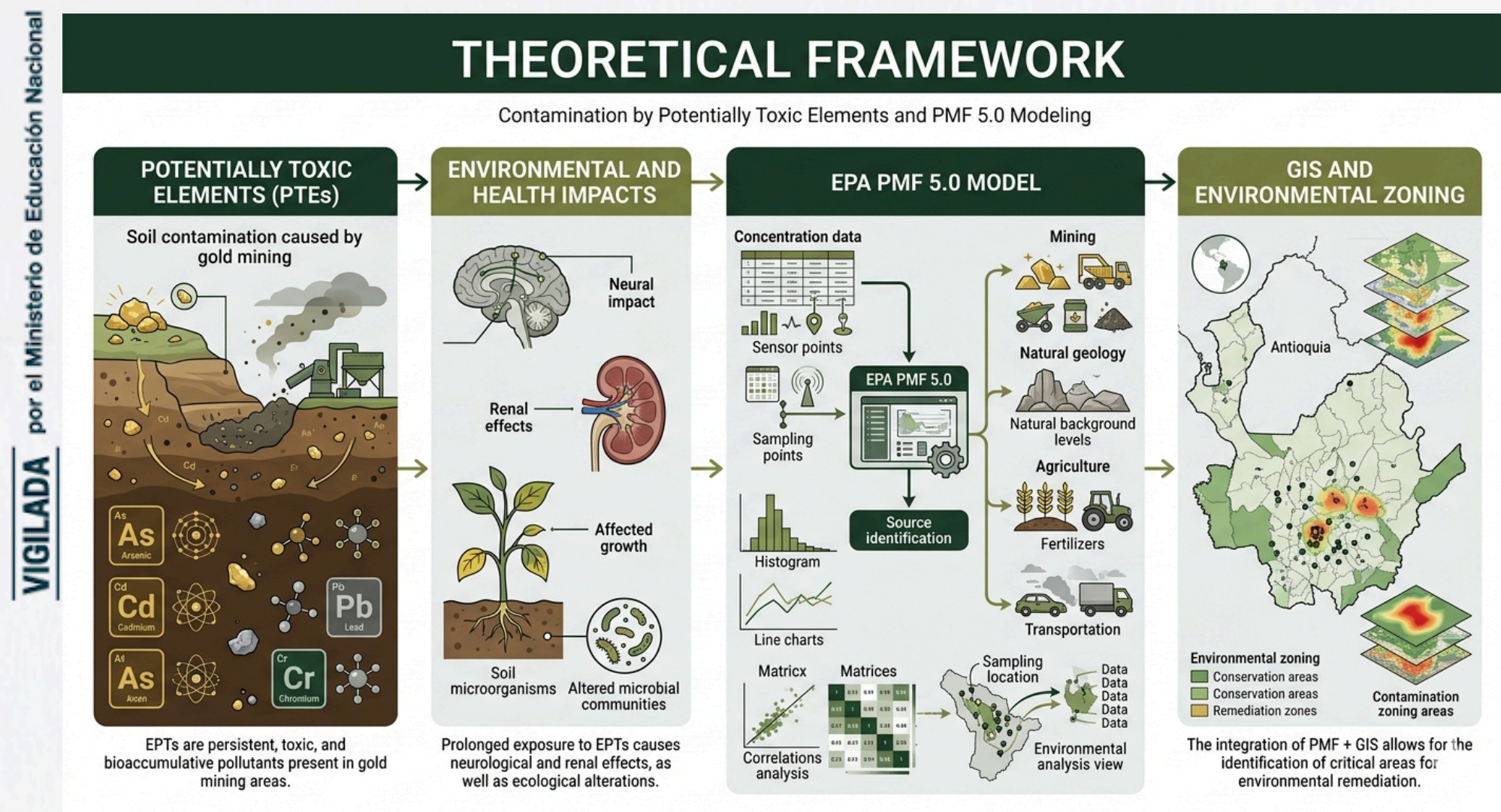
Gold mining in Buriticá, Yalí, and Puerto Berrío has increased levels of arsenic (As), cadmium (Cd), lead (Pb), and chromium (Cr) in the soil. The main challenge is that the total concentrations do not allow for distinguishing what portion is of natural (geogenic) origin and what portion comes from mining or industry, which is vital for accurate environmental management. [1]



Objectives

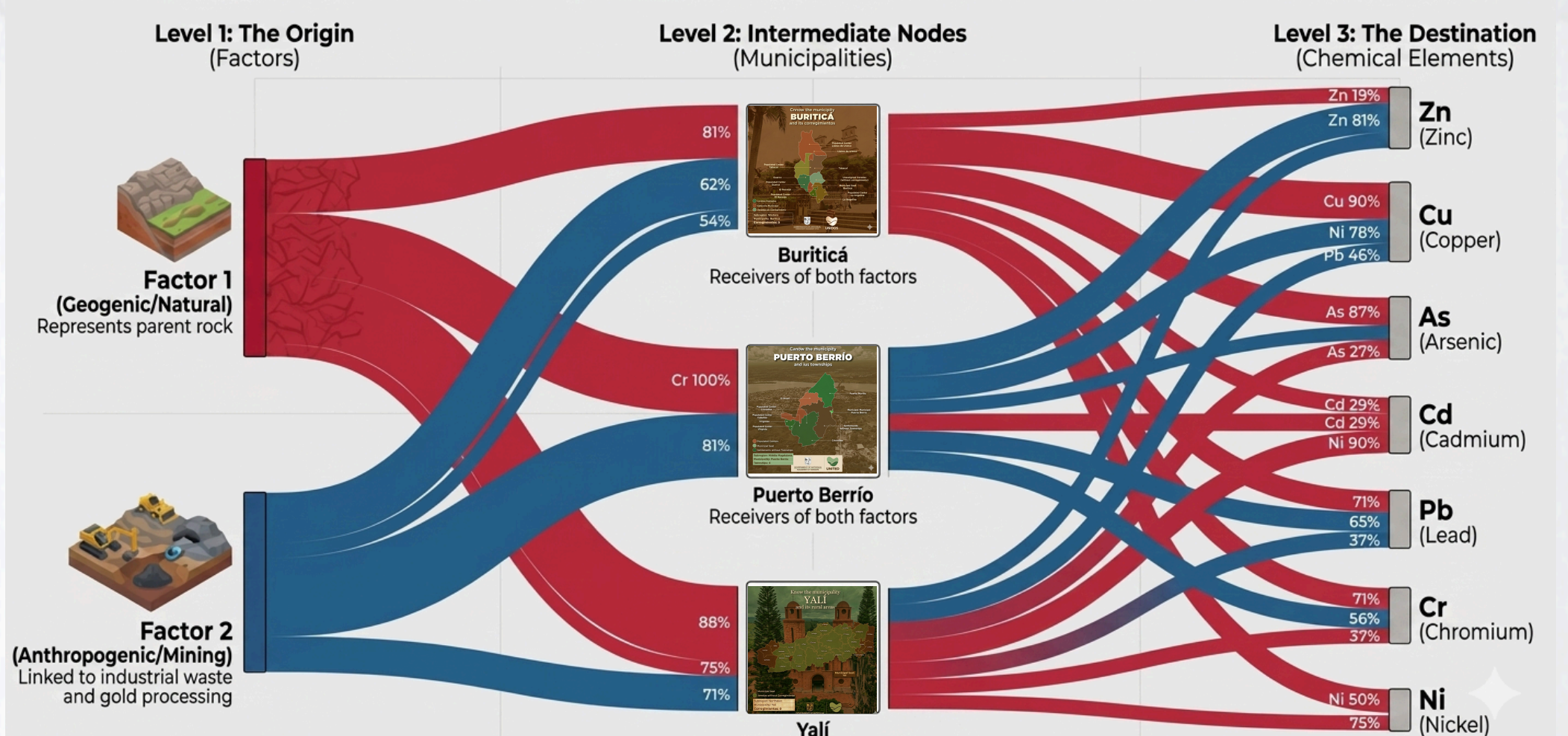
- **General Objective:** To identify the sources and contributions of PTE via the EPA PMF 5.0 model for the environmental zoning of the territory.
- **Specific Objectives:**
 - To apply the EPA PMF 5.0 model to identify potential sources and quantify their relative PTE contributions.
 - To conduct environmental zoning of the territory based on the activities, sources, and PTE contributions defined by the model.

Theoretical framework

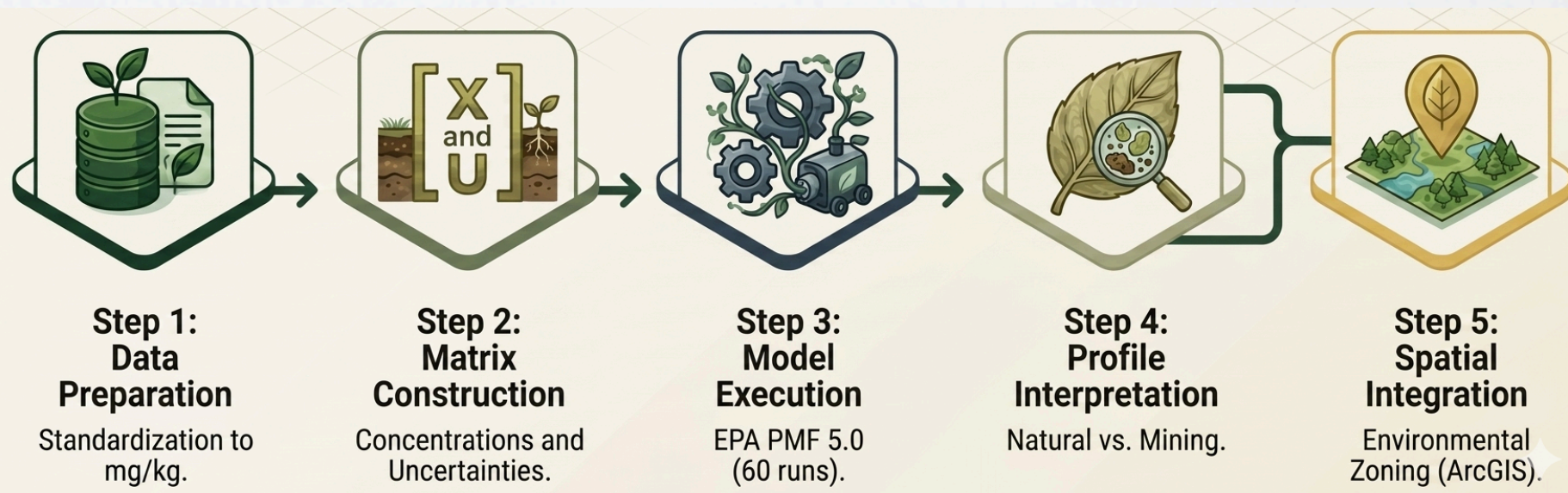


Results

Pollution Footprint: Origin and Flow of Heavy Metals in Soils of Antioquia



Methodology



Conclusions

- The PMF 5.0 model proved to be a robust instrument for distinguishing anthropogenic impact from local lithogenic signatures.
- The prevalence of Arsenic (As) serves as the definitive tracer for mining-induced contamination within the region.
- The resulting zoning enables authorities to prioritize critical areas for immediate environmental remediation.

References

- [1] J. E. López, J. F. Marín, and J. F. Saldarriaga, "Assessing pollution degree and human health risks from hazardous element distribution in soils near gold mines in a Colombian Andean region: Correlation with phytotoxicity biomarkers," *Chemosphere*, vol. 361, Aug. 2024, doi: 10.1016/J.CHEMOSPHERE.2024.142471.
- [2] C. Dong, H. Zhang, H. Yang, Z. Wei, N. Zhang, and L. Bao, "Quantitative Source Apportionment of Potentially Toxic Elements in Baoshan Soils Employing Combined Receptor Models," *Toxics*, vol. 11, no. 3, p. 268, Mar. 2023, doi:10.3390/TOXICS11030268.

Characterization of the flood risk scenario in the rural aqueduct of Buga, Altavista district, Medellín – Antioquia.

Authors: Daniela Andrea Viga Barrios, Esteban Luis Pereira Álvarez, Edwin Alexander González Díaz

Thematic advisor: Sol Ochoa

Methodological advisor: Carlos Fidel Granda Ramírez

Problem: Disaster risk arises when a natural hazard interacts with vulnerable conditions, and in rural areas this situation remains critical. Community aqueducts, such as the one in Altavista, are highly vulnerable to flooding, landslides, and sediment runoff, affecting their vital operation



Theoretical framework: The research is based on disaster risk management applied to rural water supply systems, understood as a preventative process aimed at identifying threats, reducing vulnerabilities, and strengthening community resilience to natural events.

General objective: Characterize the flood risk scenario in the Altavista rural aqueduct, as input for risk management and the protection of community water resources.

Determine the flood risk in the catchment area that encompasses the location and operational zone of the Altavista aqueduct. Identify the exposed elements and their vulnerability to the flood scenario.



Analyze the probability of potential damage or losses in the event of a flood at the Altavista aqueduct.



Propose recommendations for flood risk management at the aqueduct, in accordance with risk management policies and the Sustainable Development Goals

Methodology

1



First, the flood risk will be assessed by collecting climatic, topographic, and hydrological data, as well as through GIS modeling to identify areas susceptible to flooding.

2



Exposed elements will be identified, and the vulnerability of the aqueduct, homes, and roads will be assessed through fieldwork, surveys, interviews, and Geographic Information System (GIS) analysis.

3



A risk analysis will be conducted by integrating threat, vulnerability, and exposure to generate risk maps and estimate potential losses to infrastructure and services.

4

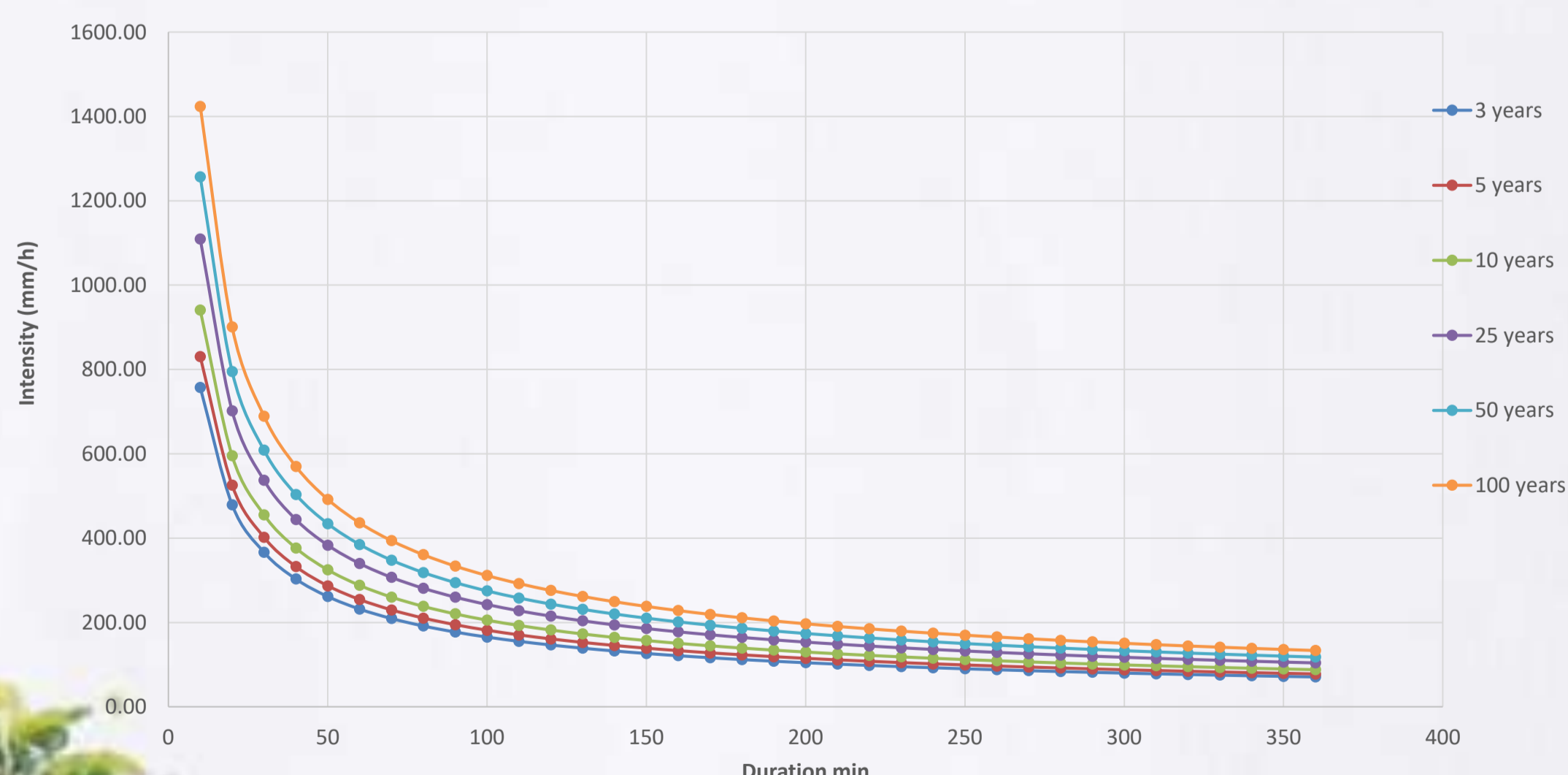


Mitigation and adaptation measures will be formulated, including technical and community-based strategies, which will be validated through participatory workshops with the community and local entities.

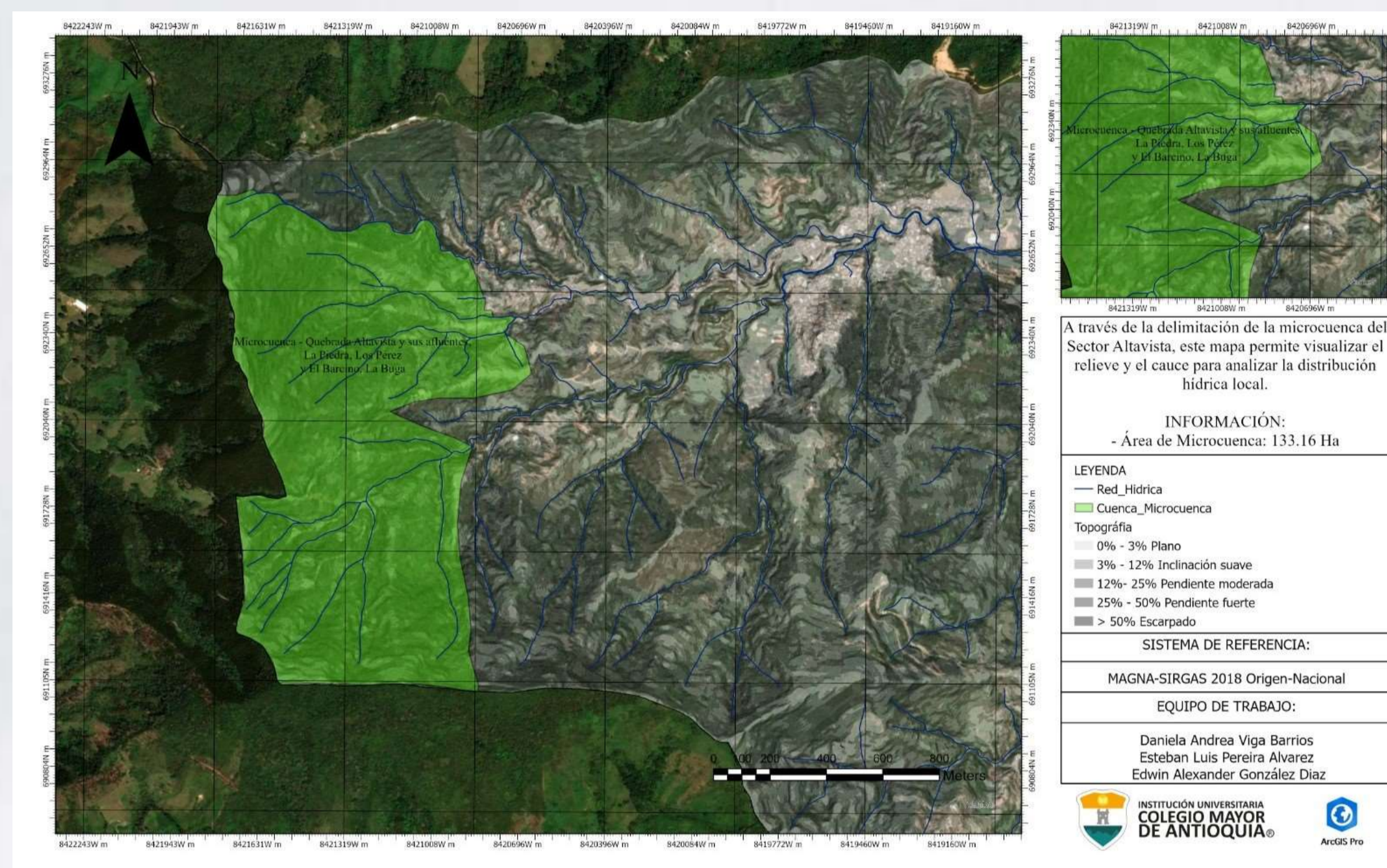
Preliminary results and analysis

IDF (intensity-duration-frequency) curves

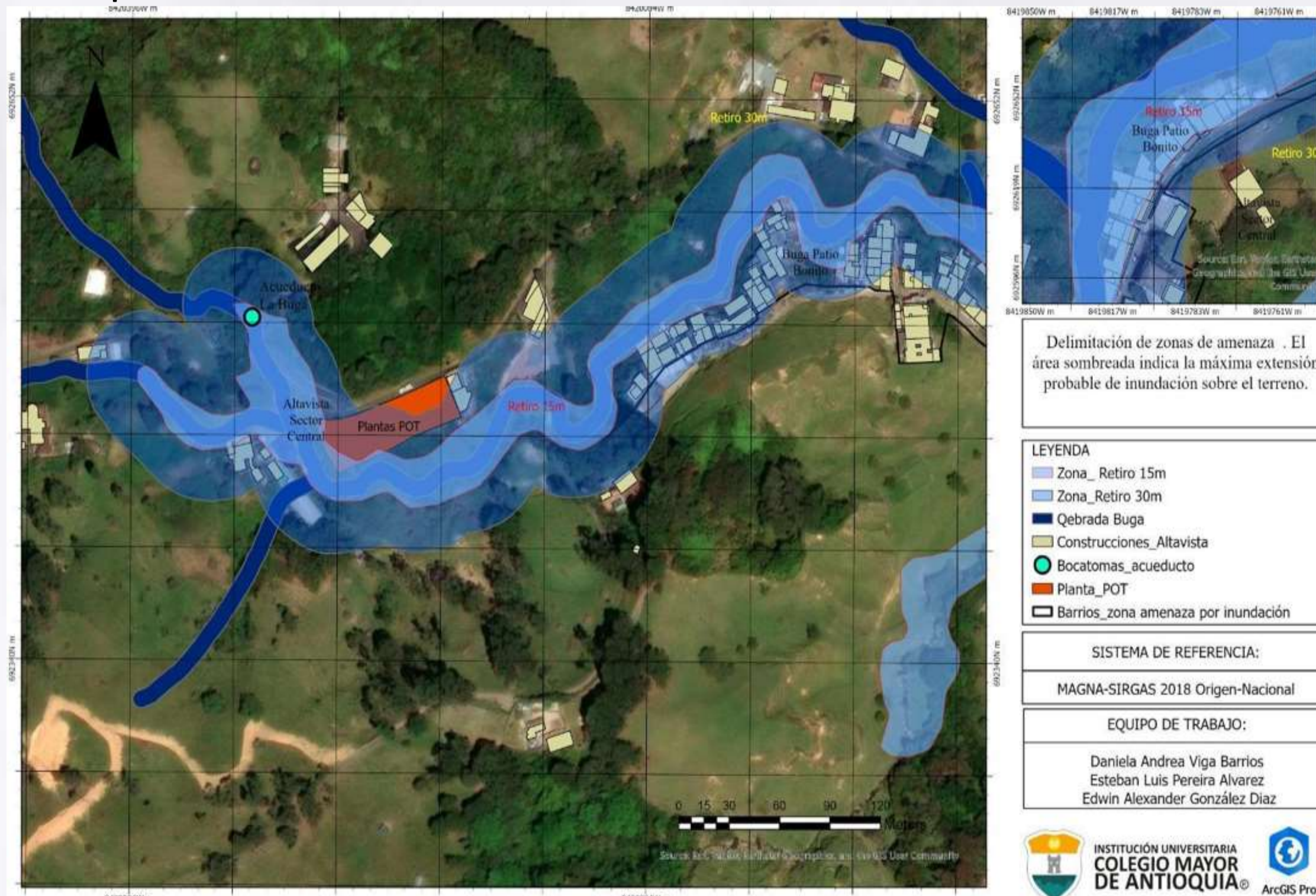
INTENSITY, DURATION, AND FREQUENCY (IDF) CURVES OLAYA HERRERA AIRPORT (MEDELLÍN - ANTIOQUIA) STATION CODE (27015330)



Topographic base map and micro-watershed delineation



Threat Map:



Preliminary conclusions:

- Critical Threat:** The highest-risk scenarios are associated with intense rainfall over short periods (10 to 30 minutes), typical of convective weather systems that rapidly saturate the atmosphere.
- Hydrological Response:** The micro-watershed has steep slopes (12% to >50%) and a dendritic drainage pattern that contributes to flash floods and high erosion potential.
- Exposed Infrastructure:** The intake structure is critically vulnerable because it is located entirely within the 15-meter setback zone (high-risk area), while the treatment plant is exposed to a medium-to-high level of risk.
- Impact on Sustainability:** Flood risk compromises water security (SDG 6) due to sediment contamination and service disruptions, thereby affecting community resilience.

Bibliographic References



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Assessment of the role of above-ground biomass and soil as carbon sinks in urban environments

Female researchers: Luisa Fernanda Correa Usuga, Luisa Fernanda Gómez Sánchez

Advisor: Santiago Vasquez Sogamosa

methodology consultant: Andrea Tamayo Londoño

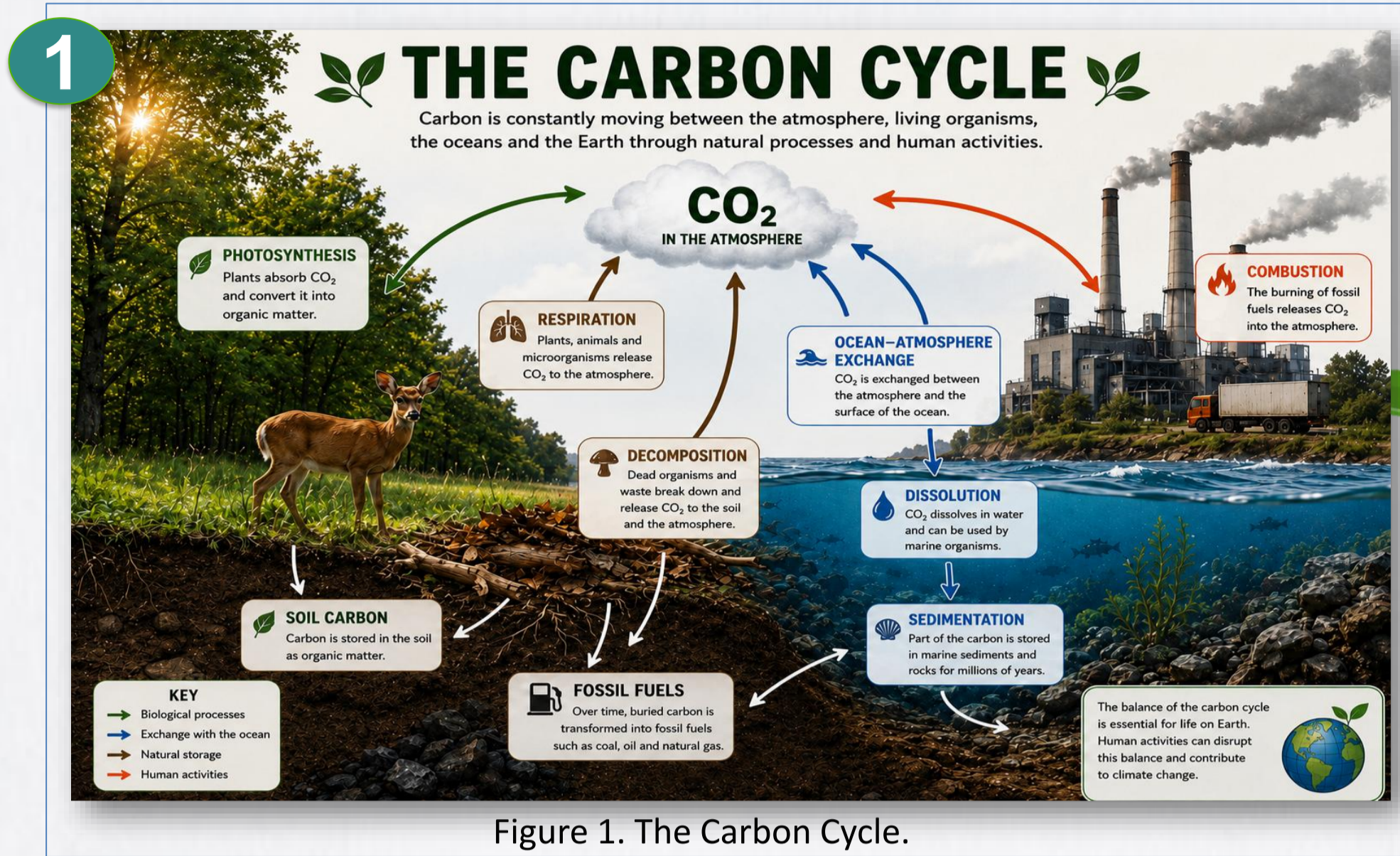


Figure 1. The Carbon Cycle.

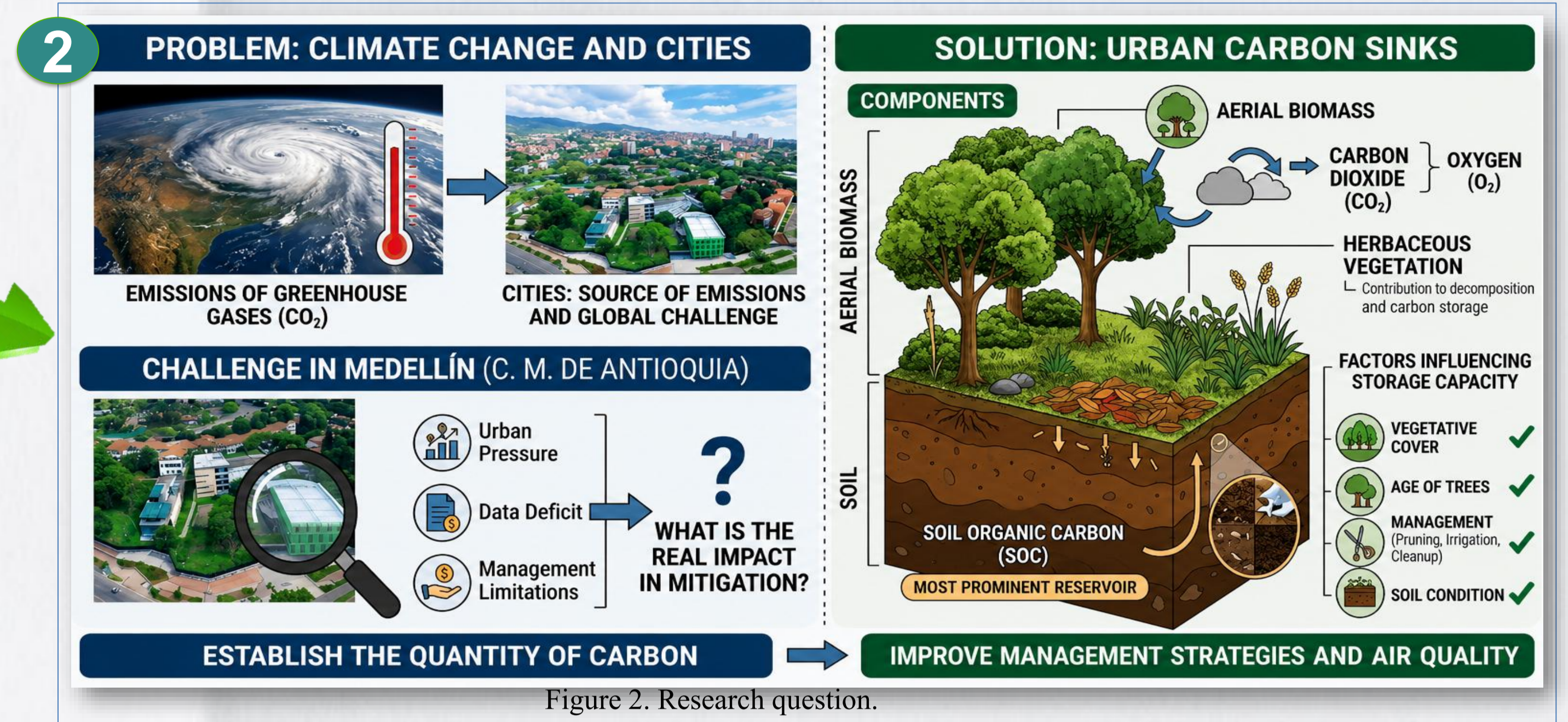


Figure 2. Research question.

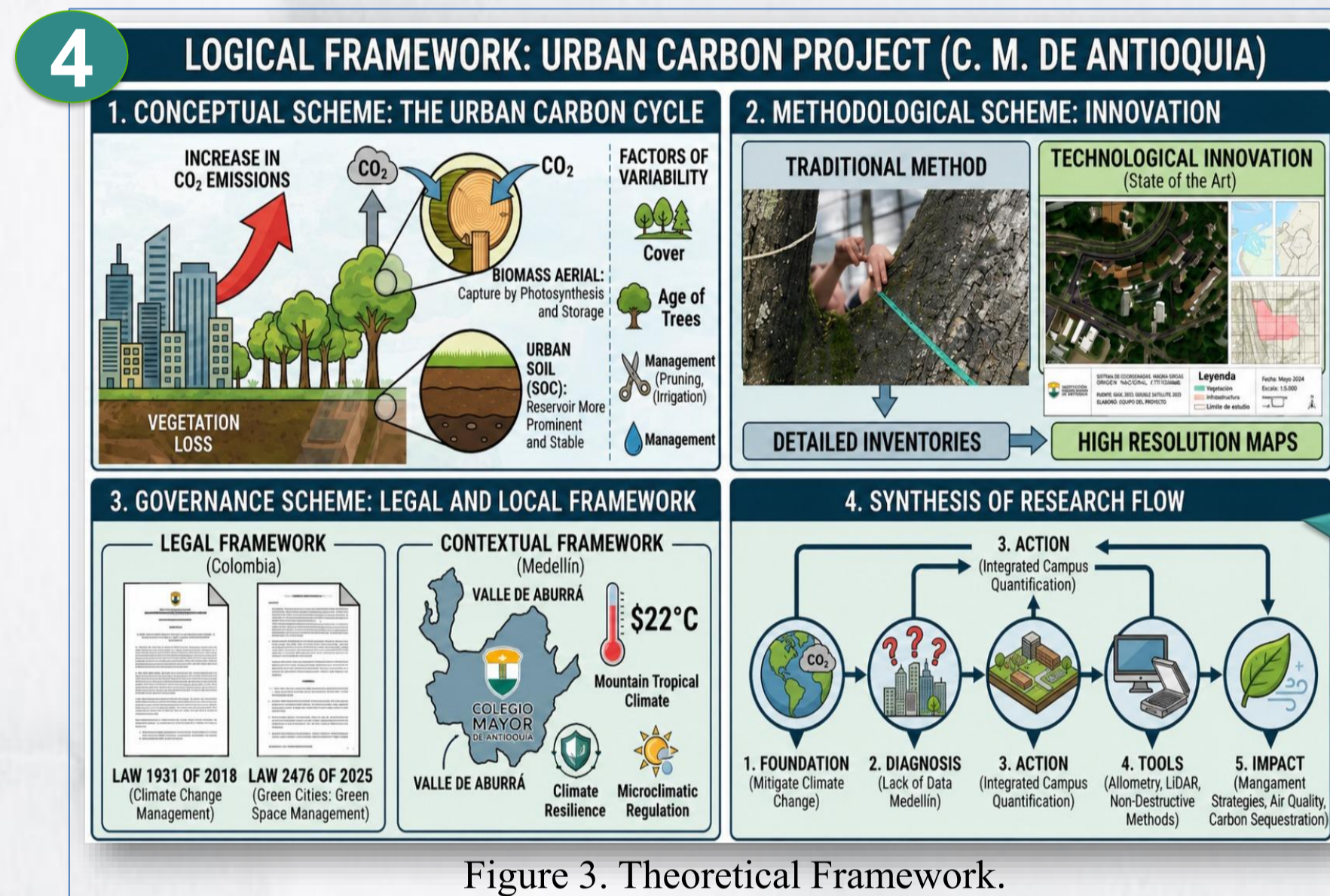
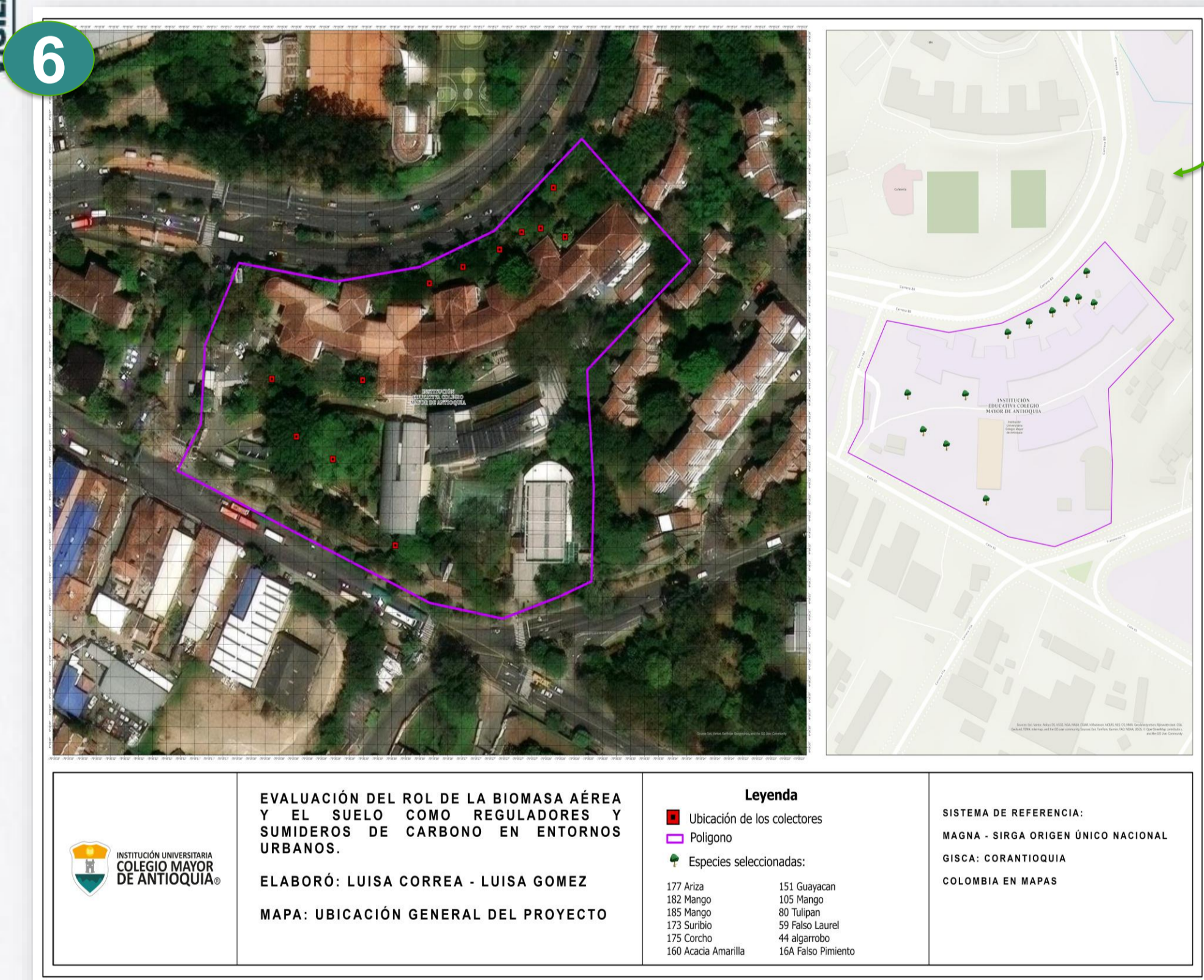


Figure 3. Theoretical Framework.



Figure 4. Photo of the leaf litter trap



Map 1. Location of species and leaf litter traps

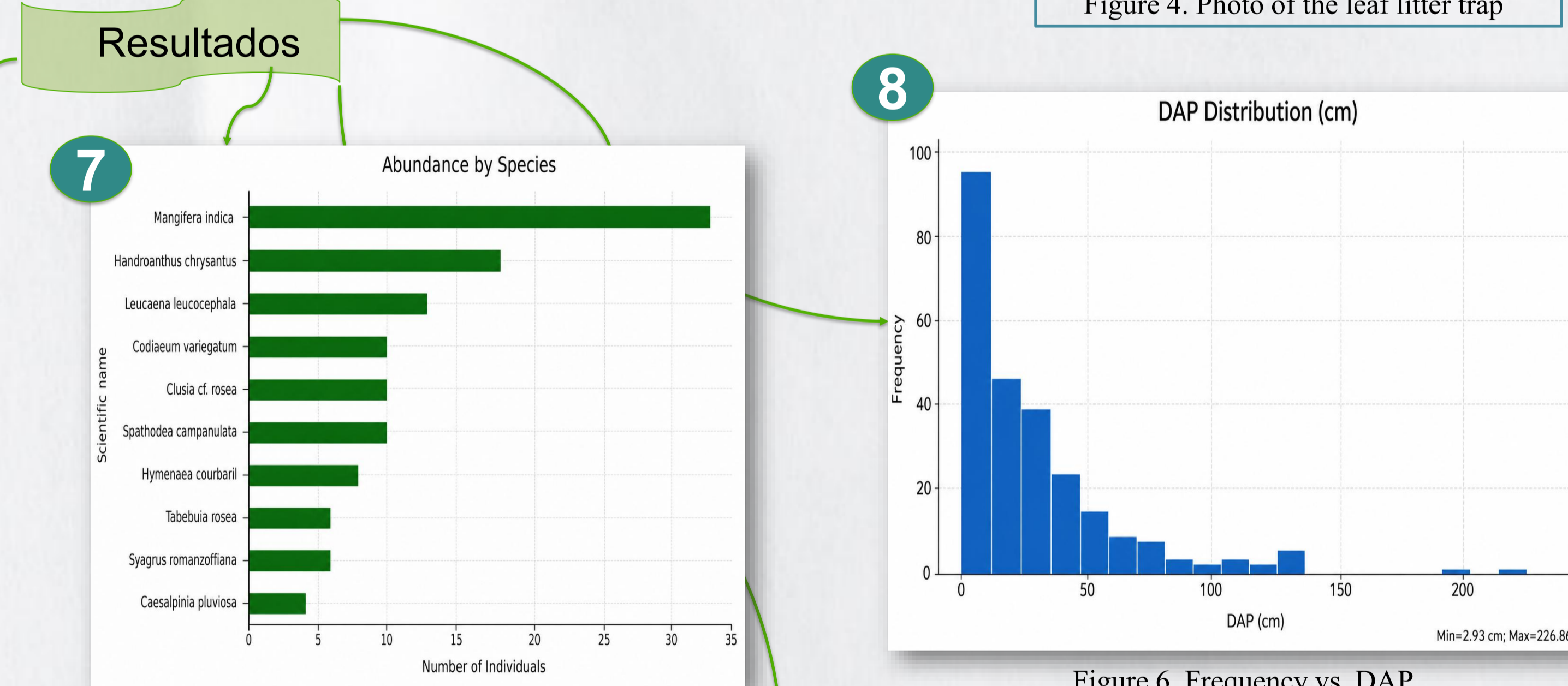


Figure 5. Abundance of the top 10 species

Figure 6. Frequency vs. DAP

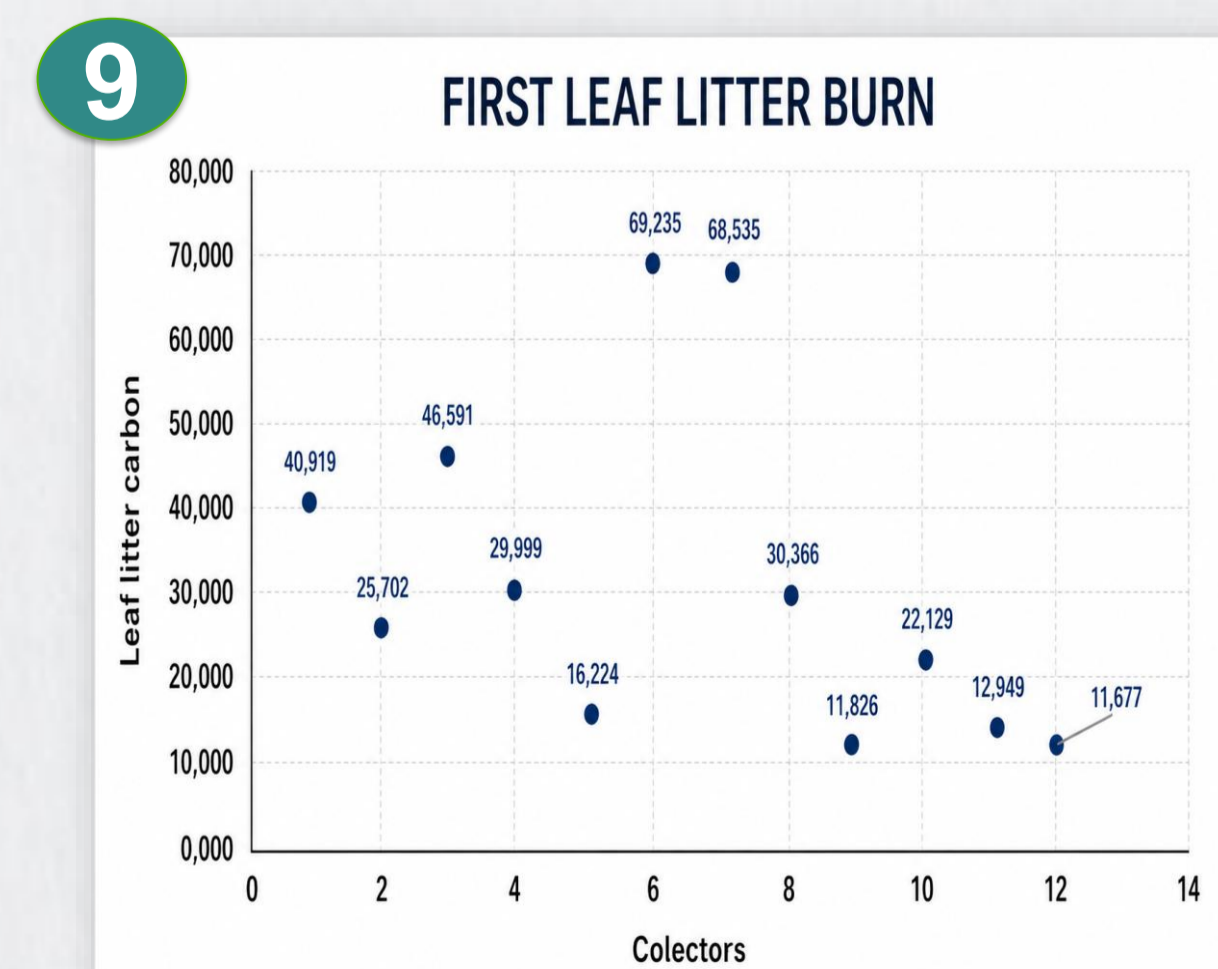


Figure 6. Research question.

10 CONCLUSION

In relation to the first specific objective, the **classification and characterization of the vegetation** present in the green areas of the Colegio Mayor de Antioquia campus made it possible to identify **the structure and composition of the studied environment**. This process provided an essential foundation for understanding the spatial distribution of tree individuals and their potential contribution to carbon storage, in addition to serving as a starting point for subsequent biomass estimations.



Analysis of technologies and plant species for the conceptual design of green walls aimed at reducing air pollutants in Medellín

Daniel Santiago Lopera · Maira Alejandra Palacio · María Alejandra Ramírez · Sandra Milena Sánchez | Environmental Engineering · Colegio Mayor de Antioquia · 2026

Subject Matter Expert: Leydy Catalina Vélez Monsalve · Methodological Advisor: Carlos Fidel Granda Ramírez

1. CONTEXT & PROBLEM

Medellín and the Valle de Aburrá

The basin topography of the Valle de Aburrá limits atmospheric pollutant dispersion. According to AMVA and SIATA, the predominant criteria pollutants are:

PM_{2.5} / PM₁₀ NO_x COVs O₃

Mainly mobile and industrial emission sources [1],[2],[7]

These pollutants affect the respiratory and cardiovascular systems and are linked to premature mortality [3],[5].

2. THEORETICAL FRAMEWORK

The theoretical framework of this research is based on the study of green walls as nature-based solutions for mitigating urban air pollution. It addresses concepts related to air quality, key pollutants (PM_{2.5}, PM₁₀, NO_x, VOCs, and O₃), and the biofiltration and phytoremediation processes carried out by plant species capable of absorbing and retaining pollutants. Additionally, it analyzes vertical greening technologies and their potential to improve the urban microclimate and contribute to environmental sustainability in cities such as Medellín.

3. OBJECTIVES

General Objective

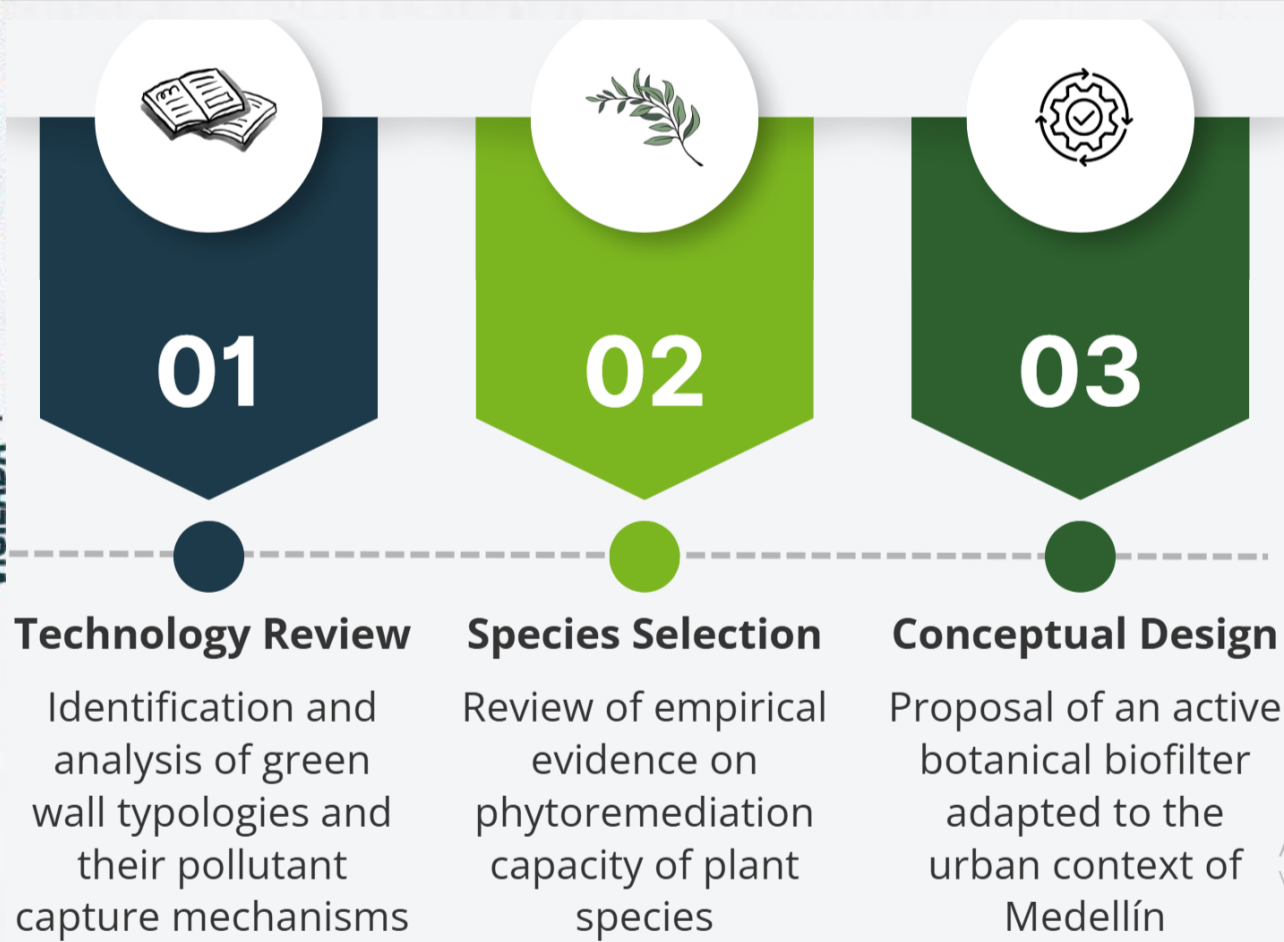
Analyze the absorption of gaseous air pollutants by green walls in the city of Medellín.

Specific Objectives

- Literature review on green wall technologies (criteria pollutant absorption)
- Define plant species with proven phytoremediation capacity
- Propose a conceptual biofilter design adapted to Medellín

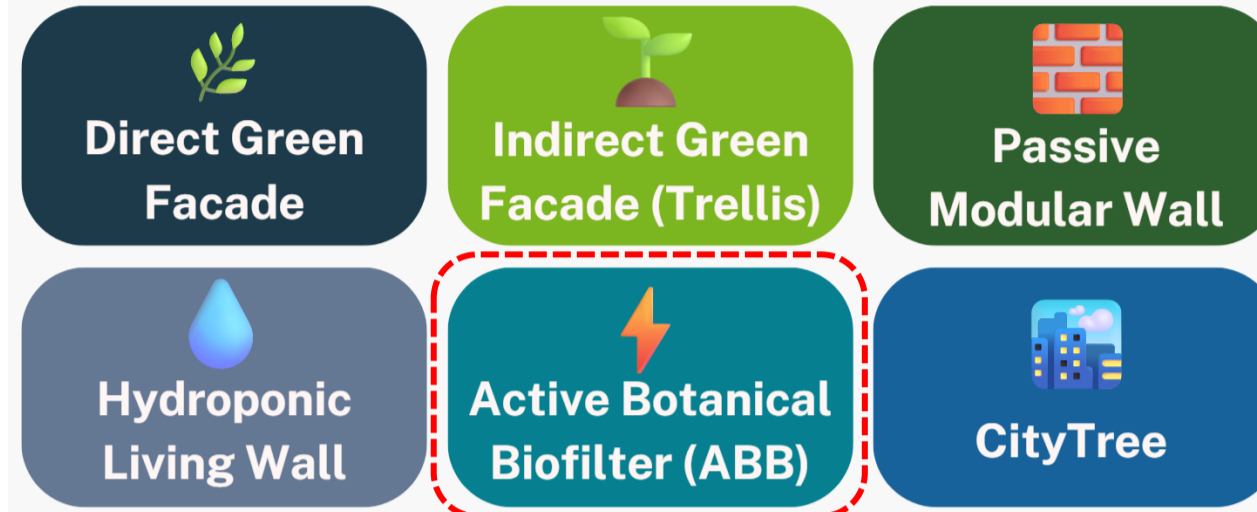
4. METHODOLOGY

VIGILADA por el Ministerio de Educación Nacional

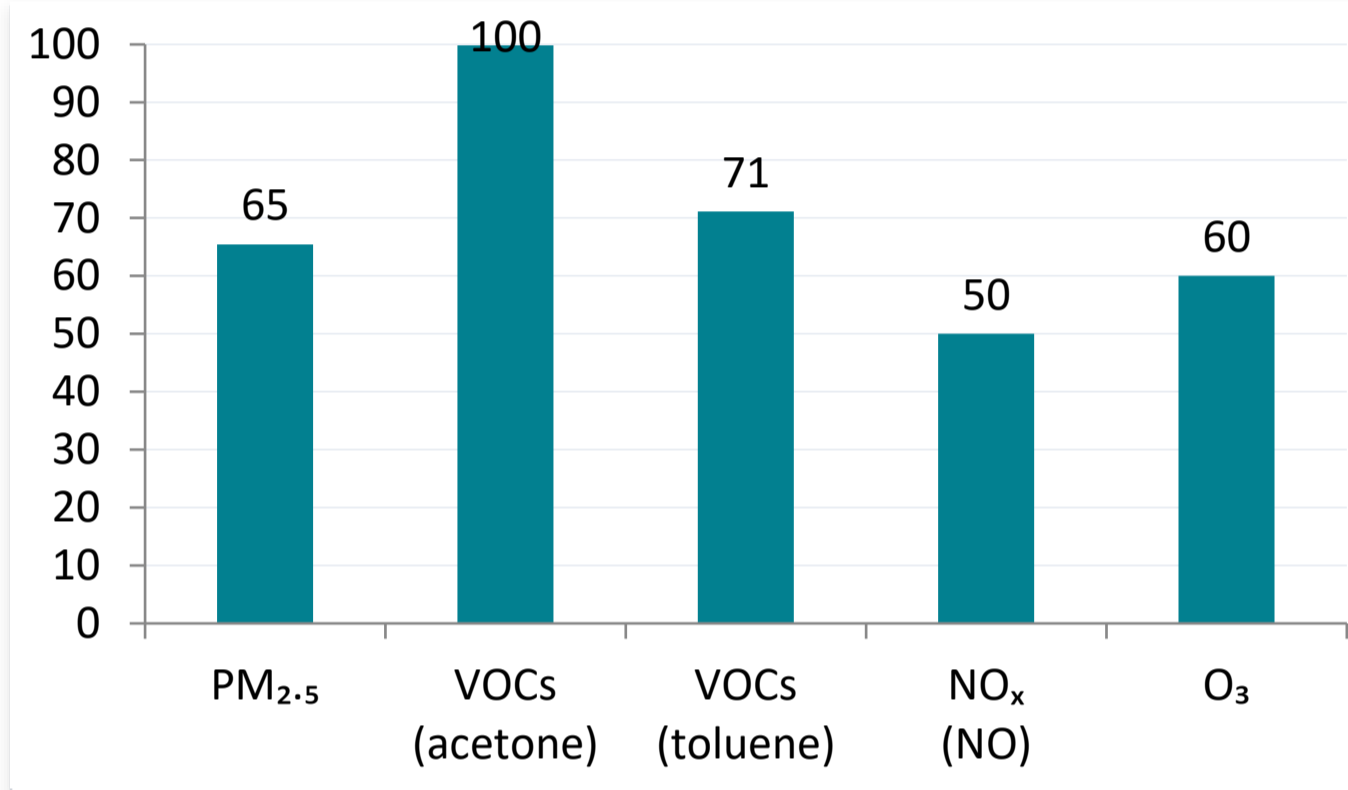


Current progress: Specific objective 1 completed at 100% (25% of total project)

4. GREEN WALL TYPOLOGIES



5. REMOVAL EFFICIENCIES (ABB)



Source: Vitaliano et al. [7]; Montaluís-Mantilla et al. [6]

6. PROTOTYPE SELECTION CRITERIA

- Forced airflow through the substrate [7],[6],[8]
- Biologically active substrate (PUF/coconut fiber) [6],[8]
- Recirculated hydroponic nutrient system [6],[12]
- Modular and scalable facade design [10],[12],[11]
- High-efficiency species: *E. aureum*, *D. fragrans* [7],[6],[9]
- Climatic compatibility: 22–24°C, tropical humidity [12],[14]

7. THE ACTIVE BOTANICAL BIOFILTER (ABB)

Why the ABB?

The ABB is the only typology with quantitative evidence of simultaneously high efficiency against all four project criteria pollutants. It integrates:

Forced Ventilation

Air flows through the substrate (PUF/coconut fiber)

Hydroponic Irrigation

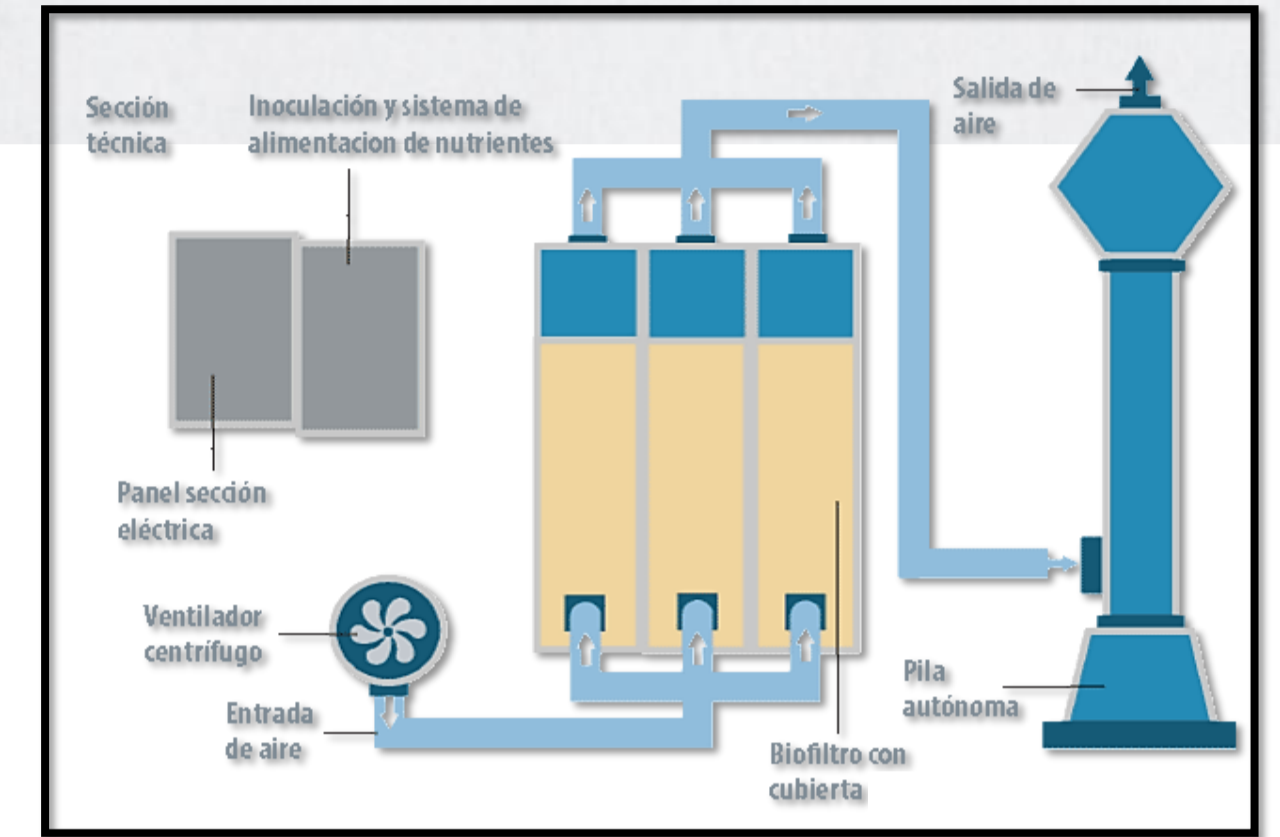
Recirculated nutrient solution + continuous monitoring

Bioactive Substrate

Rhizospheric microbiome degrades non-absorbed pollutants

IoT Sensors

Monitoring of PM, VOCs, NO_x, O₃, RH and temperature



Active Botanical Biofilter (ABB)

8. SELECTED PLANT SPECIES

Epipremnum aureum

(Golden Pothos) [6]

→ COVs: toluene 71.1% / acetone 99.8%
→ PM_{2.5} and formaldehyde



[6]

Dracaena fragrans

(Fragrant Dracaena) [9]

→ PM - Fe: +44% vs control
→ NO_x and aromatic VOCs



[9]

Iberis sempervirens

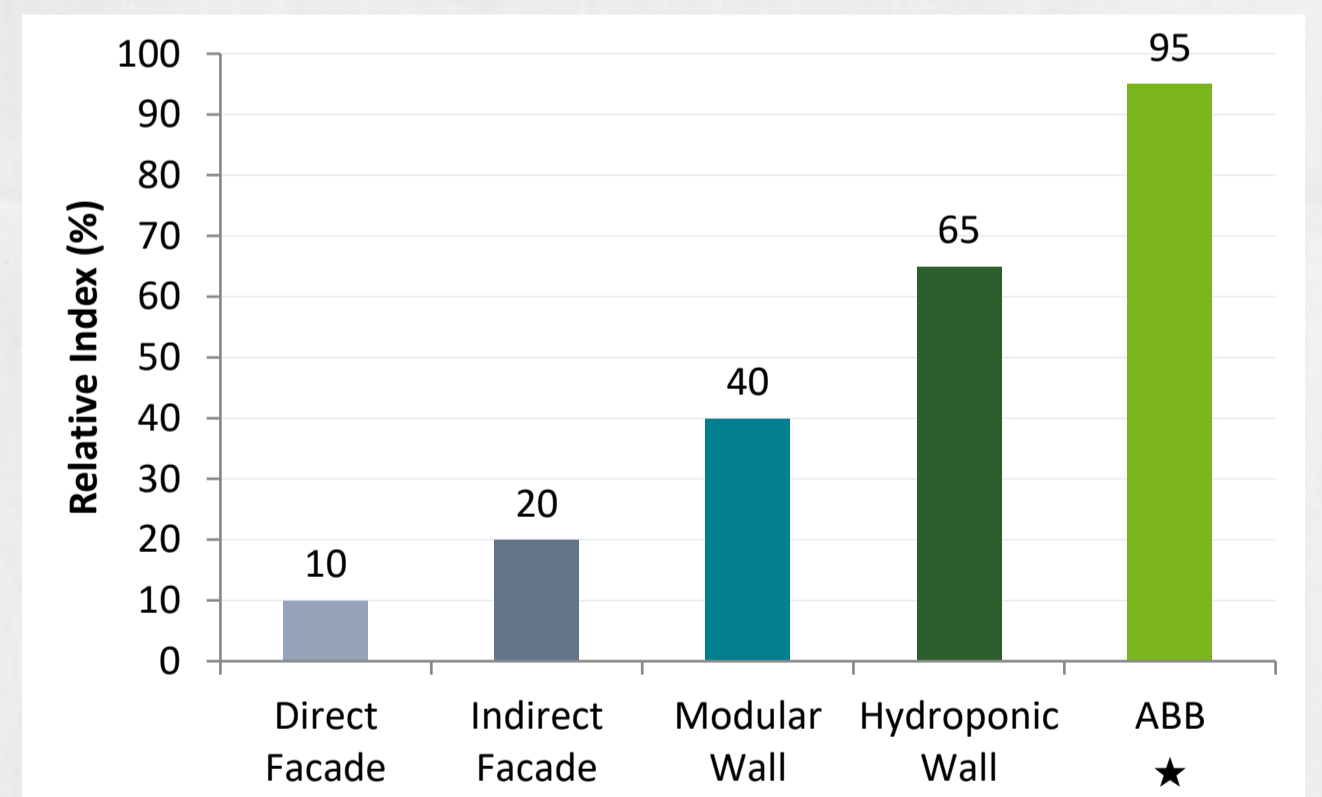
(Evergreen Candytuft) [10]

→ High PM density on leaves
→ Foliar PM₁₀ efficiency: superior



[10]

9. COMPARATIVE PERFORMANCE BY TYPOLOGY



Comparative index built from literature [7],[6],[10],[11]

REFERENCIAS

10. CONCLUSIONES

1. Five vertical vegetation typologies were systematically classified, ordered from lowest to highest criteria pollutant removal capacity.

2. The Active Botanical Biofilter (ABB) is the only typology with quantitative evidence of high simultaneous efficiency against PM_{2.5} (up to 65.42%), VOCs (up to 99.8%), NO_x and O₃.

3. *E. aureum*, *D. fragrans* and *I. sempervirens* are the species with the strongest empirical evidence of removal in active vertical vegetation systems.

4. Identified limitations include: laboratory vs. field conditions, rainfall variability (foliar wash-off), and underestimation in tropical environments.

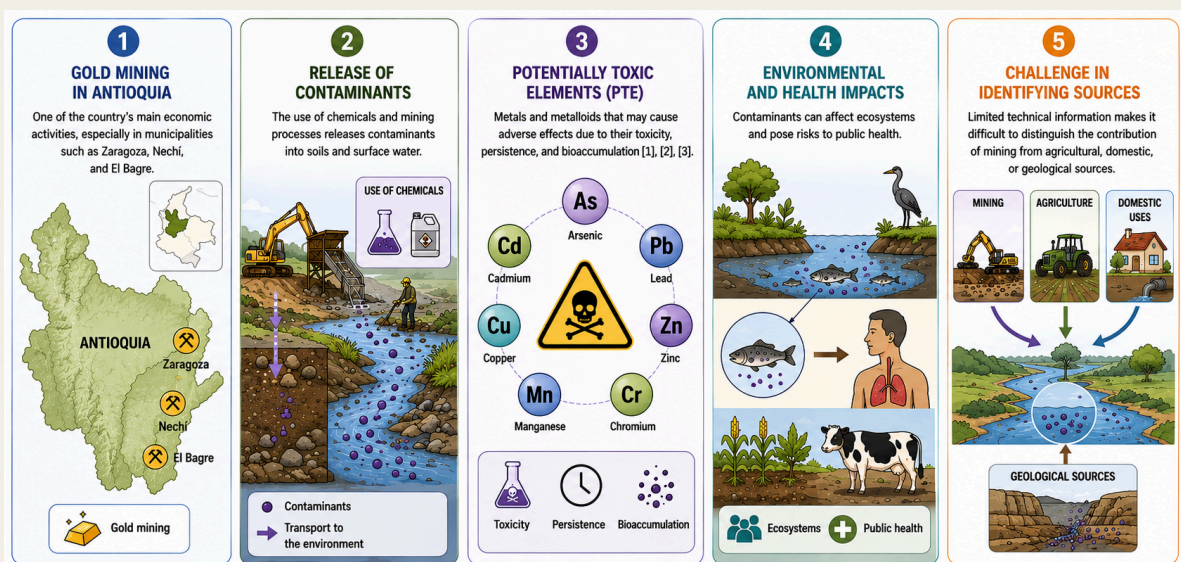


SOURCE-BASED PROBABILISTIC ASSESSMENT OF HUMAN HEALTH RISKS IN AREAS AFFECTED BY GOLD MINING IN ANTIOQUIA, COLOMBIA.

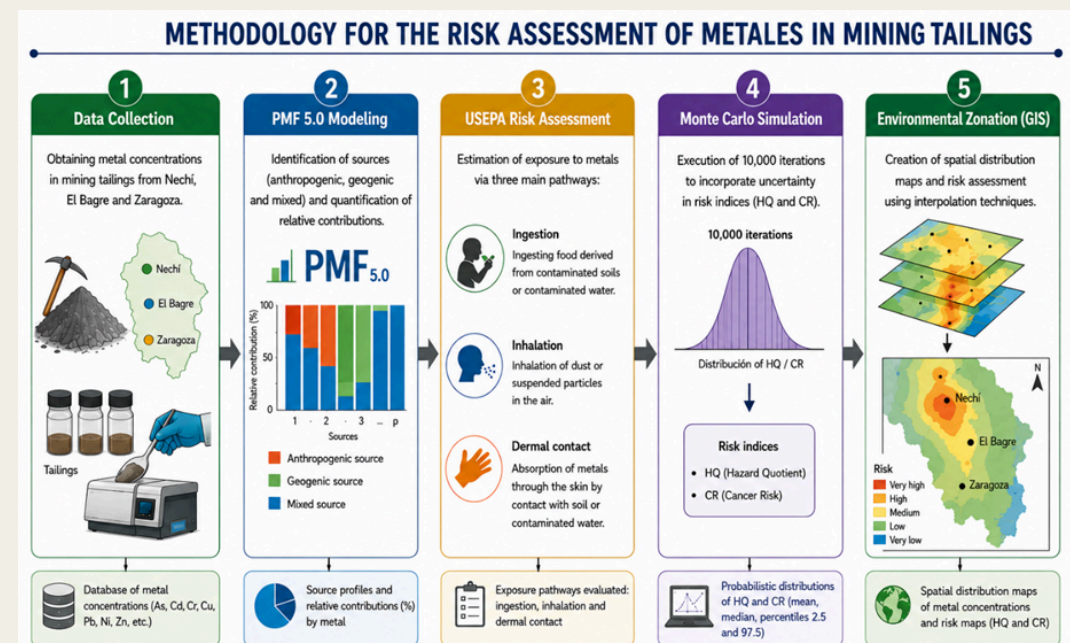
Student Names
Sara Higueta and Juan Pablo Saldarriaga
Thematic Advisor
Julián Lopez - Juan David Correa

PROBLEMATIC

Gold mining in Antioquia, particularly in municipalities such as Zaragoza, Nechí, and El Bague, has caused environmental impacts due to the release of potentially toxic elements (PTEs) into soils and water bodies [1]. Furthermore, the limited technical information available makes it difficult to distinguish the contribution of mining from other sources of pollution and to understand its impact on ecosystems and public health.



METHODOLOGY



PARTIAL RESULTS

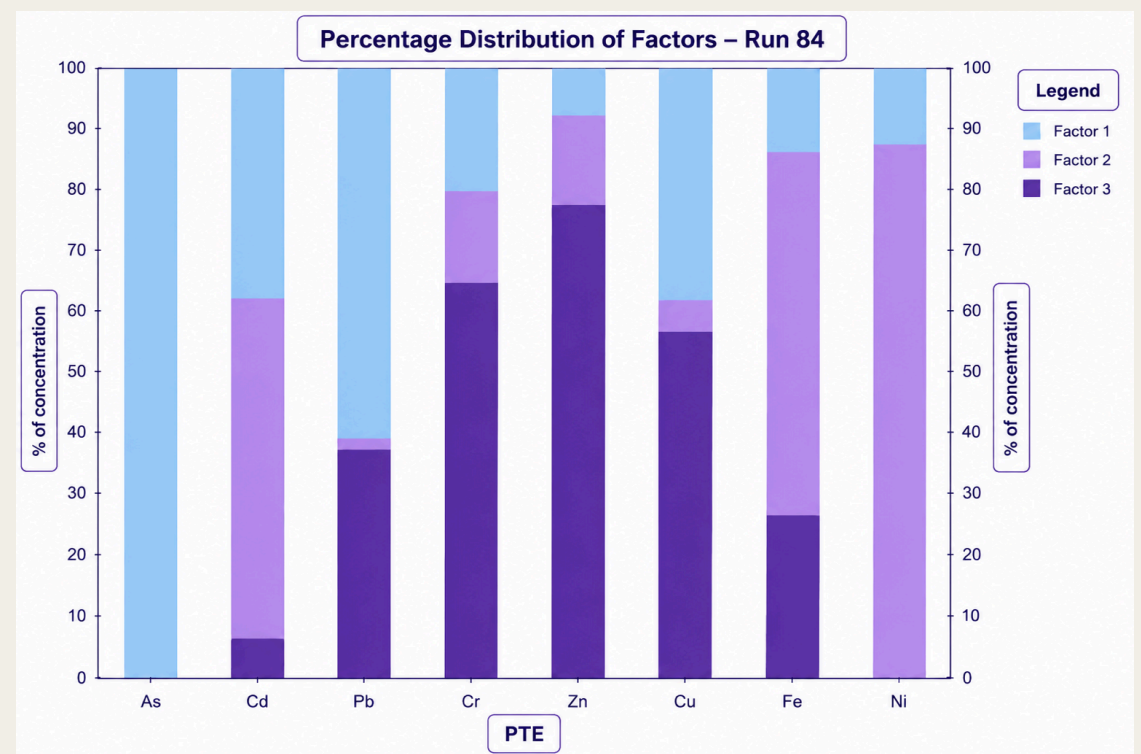


Figura 1

PRELIMINARY CONCLUSIONS

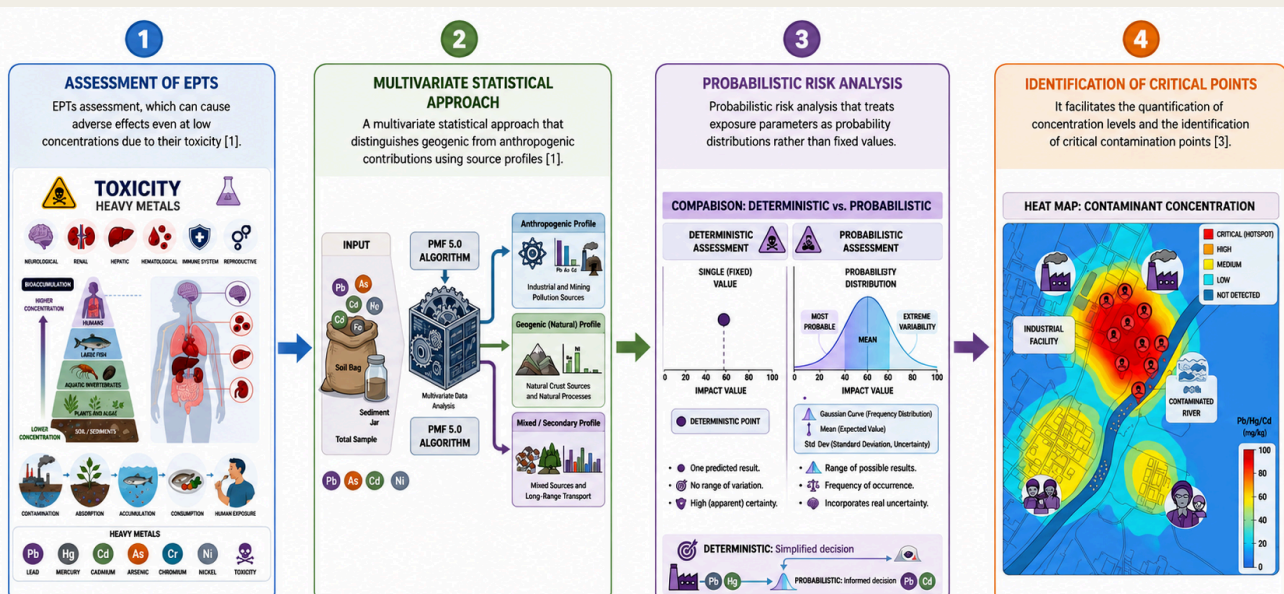
The PMF model identified three factors associated with the presence of heavy metals in the analyzed samples, which could correspond to anthropogenic, geogenic, and mixed contributions. However, it is not yet possible to determine with certainty which of the identified factors is specifically associated with each type of source.

The results showed that potentially toxic elements exhibit distinct behaviors and distribution patterns within the analyzed samples. This suggests that their mobility, accumulation, and potential environmental dispersion are influenced by various physical, chemical, and geochemical conditions.

REFERENCES



THEORETICAL FRAMEWORK



AIMS

General:

To assess the risk to human health associated with the presence of TPPs in areas impacted by gold mining in Antioquia, Colombia, using a probabilistic and source-oriented approach.

Specific:

- 1) To apply the EPA PMF 5.0 model to identify sources and quantify their relative contributions in mine tailings across the three municipalities.
- 2) To analyze the probabilistic risk to human health from exposure to PTE in mine tailings using Monte Carlo simulation.
- 3) To develop an environmental zoning plan integrating the contribution of identified sources and PTE concentration levels in mine tailings.

Bleaching of kaolin using *Aspergillus niger*

Authors:
Maria Fernanda Zapata Sanchez-Yan Carlos Uparela Hoyos
Thematic Advisors:
Laura Osorio-Bedoya - Fidel Granda-Ramírez
Methodological Advisor:
Fidel Granda-Ramírez

Research problem

Impurities in kaolins have traditionally been removed using inorganic acids such as sulfuric and hydrochloric acids. Although effective, these acids are highly corrosive, pose risks to human health, and have negative environmental impacts, including the generation of hazardous waste, contamination of water bodies, and the emission of polluting vapors that disrupt ecosystems.

Furthermore, their handling requires strict controls due to their hazardous nature and the fact that they can be used as chemical precursors in the illicit manufacture of narcotics.

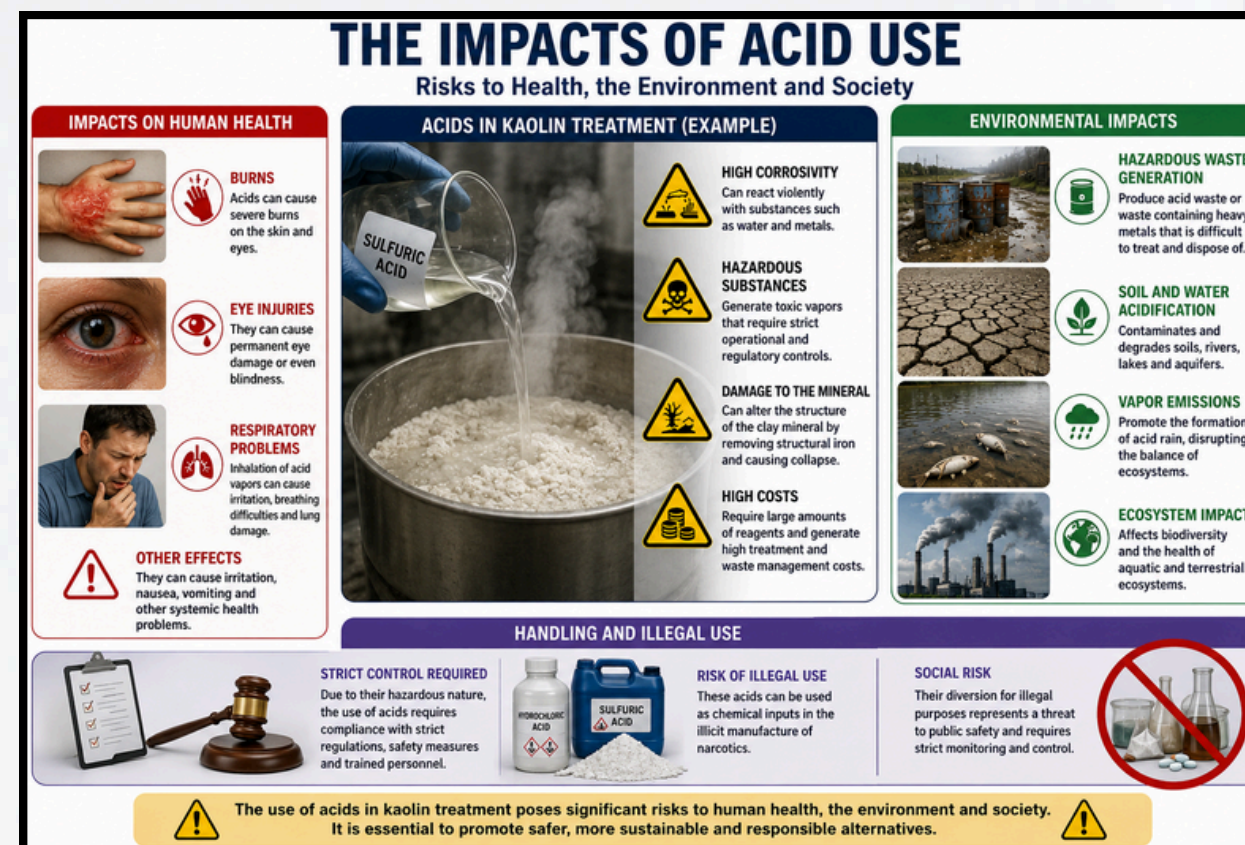


Figure N°1. the impacts of acid use

Methodology

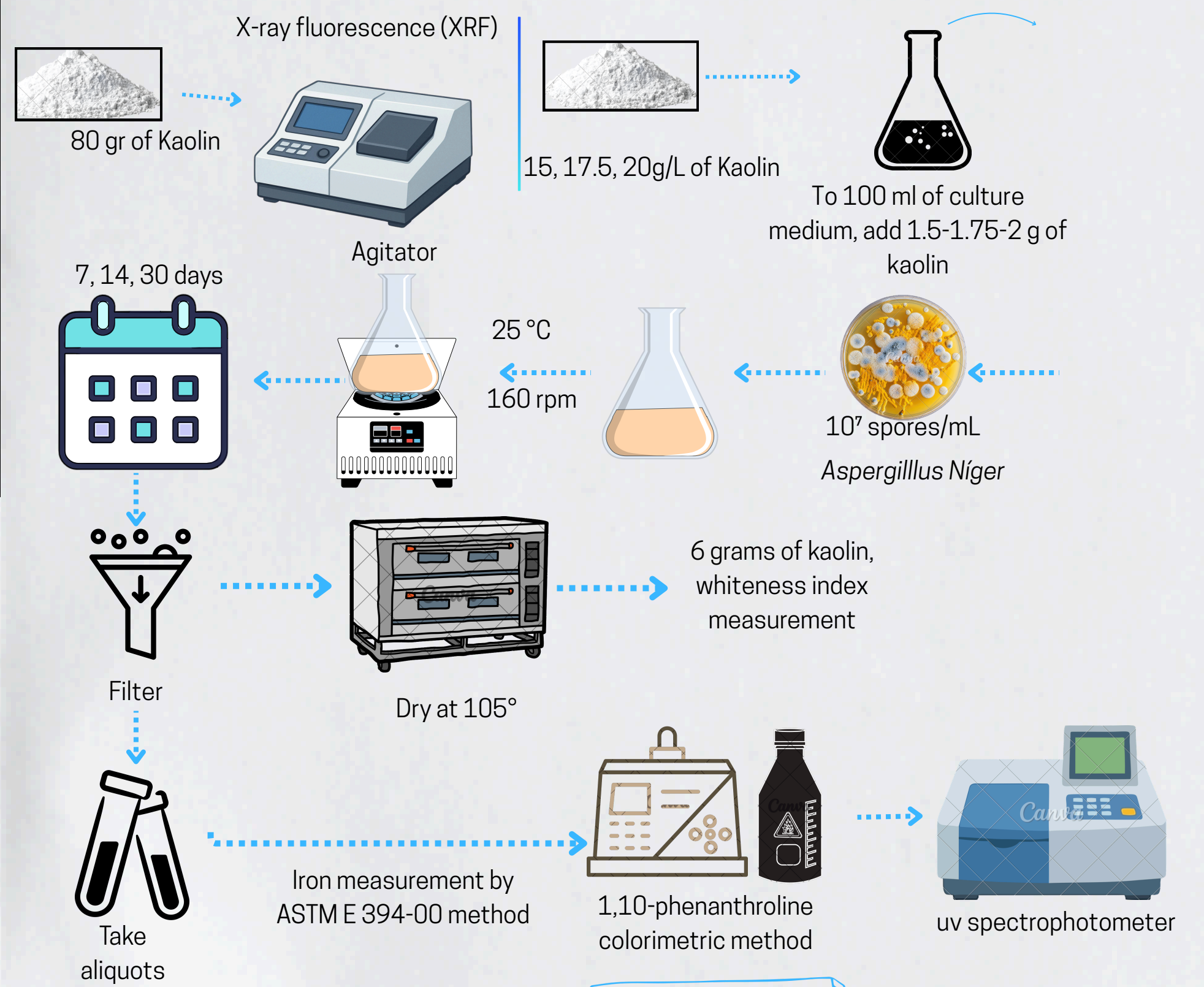


Table N°1. Chemical Analysis by FRX

SAMPLE DESCRIPTION	SiO ₂	Al ₂ O ₃	Fe ₂ O ₃	TiO ₂	CaO	MgO	K ₂ O	P ₂ O ₅	SO ₃	Ambient temperature PPI at 1000°C
Kaolin for Industrial Use	45,5	38	1,05	0,64	0,12	0,1	0,23	0,04	0,24	14,1
Susceptible Kaolin	46,3	37,5	1,16	0,57	0,06	0,12	0,25	0,04	0,12	13,9
Non-Susceptible Kaolin	46,6	37	1,38	0,62	0,1	0,15	0,24	0,04	0,15	13,7

Table No. 2. Determination of iron by A.A. spectroscopy

Sample	Parameter	Result	Unit
Bleached	Fe	0,02	%
Susceptible	Fe	0,208	%

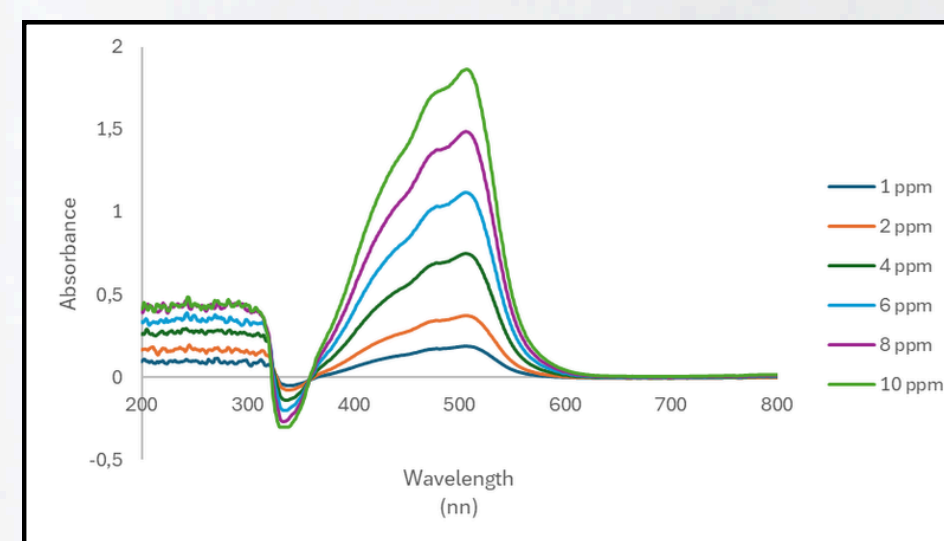


Figure N°2 Absorbance vs. Wavelength Graph

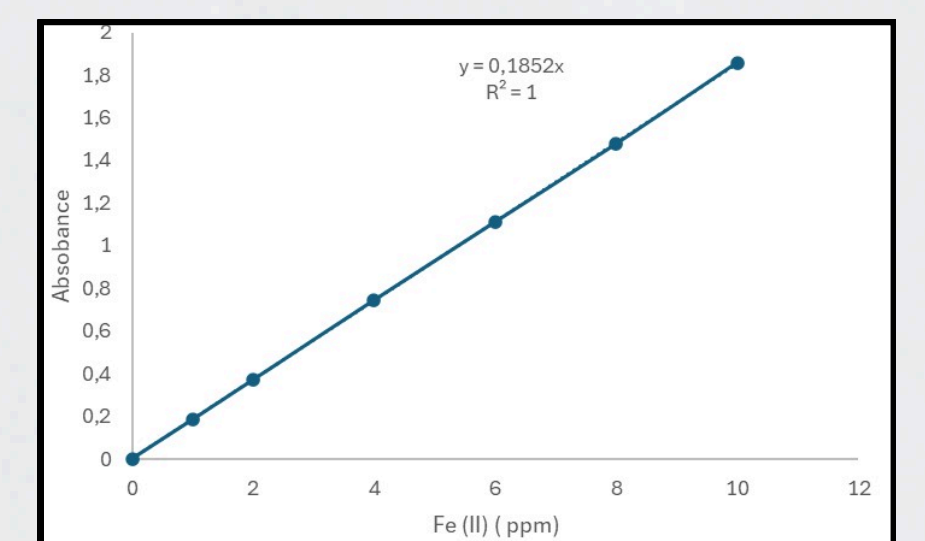
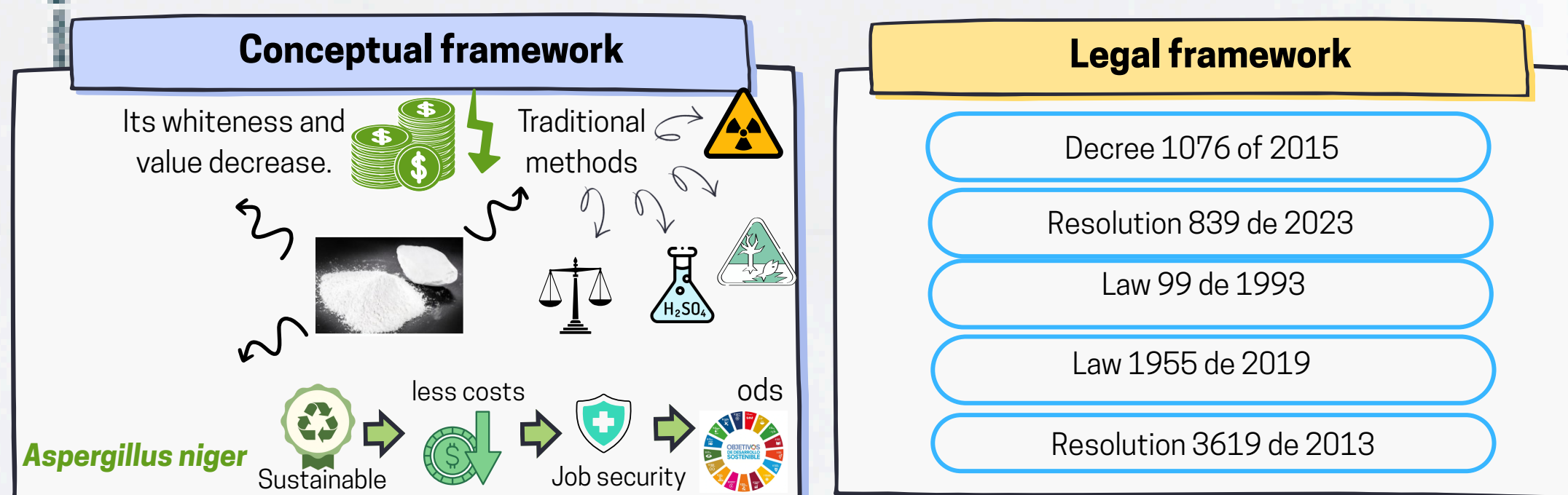


Figure N°3. Calibration curve: absorbance vs concentration

Theoretical framework



State of the art

Izabela Musial, et al
It has been shown that *Aspergillus niger* can generate organic acids

Kaigiang Li, et al
Clostridium pasteurianum
With a whiteness index of 60.8 to 90.4%

Filip Polák, et al
Aspergillus niger
45% iron bioextraction in 19 days

Qiu-xiang Hea, et al
Bacillus cereus, Bacillus sphaericus, Bacillus mycoides
They enhance iron leaching up to 3.76 mg Fe. g-1

Objectives

General objective

To determine the efficiency of the bioleaching process using *Aspergillus niger* for iron removal from kaolin, as a sustainable alternative to traditional physicochemical bleaching

Specific objective 1

Characterize physically and chemically kaolins susceptible or not to bleaching for the iron bioleaching process.

Specific objective 2

Determine the kinetics of iron bioleaching in kaolins using the fungus *Aspergillus niger*.

Specific objective 3

Evaluate the efficiency of iron bioleaching in the bleaching of kaolins using the fungus *Aspergillus niger*.

Conclusion

The results obtained through physicochemical characterization made it possible to establish the initial conditions of the kaolin samples, revealing differences in chemical composition and in the content of iron-rich compounds among the materials analyzed. These results highlight the need to implement material purification processes, which supports the use of bioleaching with *Aspergillus niger*

The results obtained from the calibration curve showed a good linear relationship between iron (II) concentration and absorbance in the range of 0 to 10 ppm, confirming compliance with Lambert-Beer's law under the experimental conditions evaluated. The high correlation coefficient obtained confirmed the accuracy and reliability of the method.



The Influence of Kelvin Waves and the Madden-Julian Oscillation (MJO) on Aerosol Transport to the Aburrá Valley from Fires in Northern South America

Author: Mariangel Avendaño López

Thematic advisor: Alejandro Builes Jaramillo

Methodological advisor: Fidel Granda-Ramirez - Andrea Tamayo Londoño

Research Problem

The Aburrá Valley experiences an air quality crisis (Feb–Mar) due to its topography and the transport of aerosols from regional wildfires (Fig. 1). This study analyzes how the MJO and Kelvin waves generate atmospheric conditions that facilitate this influx (Fig. 2). The findings enable the anticipation of critical episodes, strengthening public health prevention and regional climate action management[1].

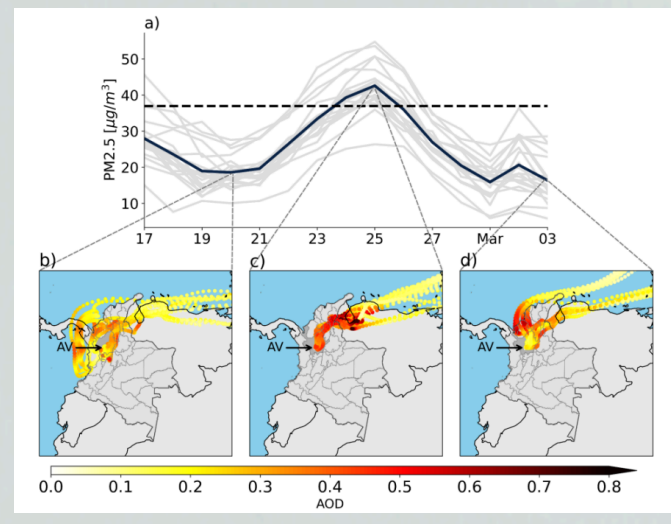


Fig. 1: Regional aerosol transport and vertical mixing in the Aburrá Valley [1].

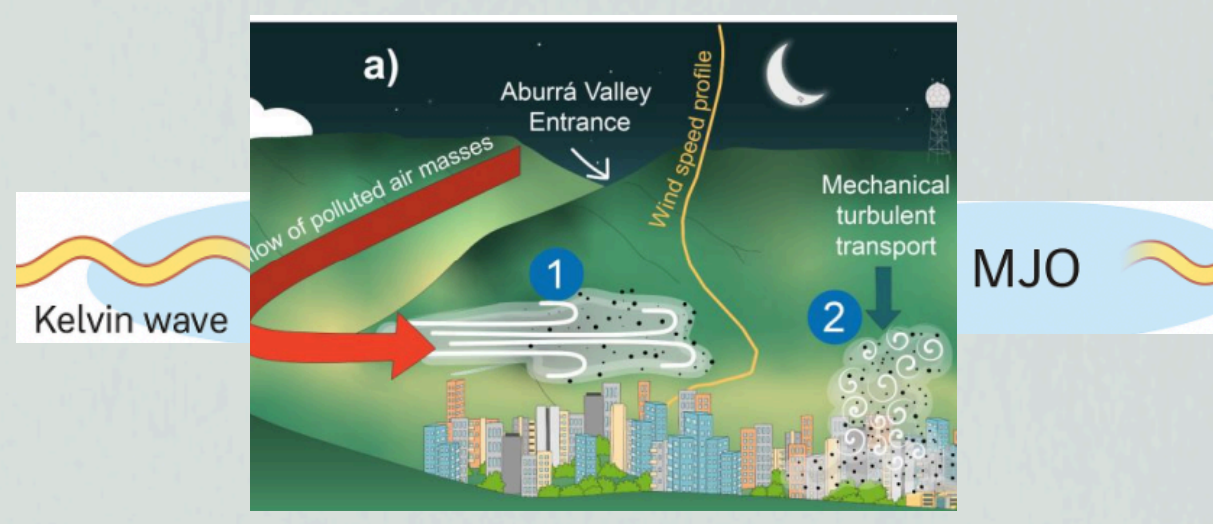


Fig. 2: Schematic model of the meteorological variables that influence dispersion. Adapted from [1].

Theoretical Framework

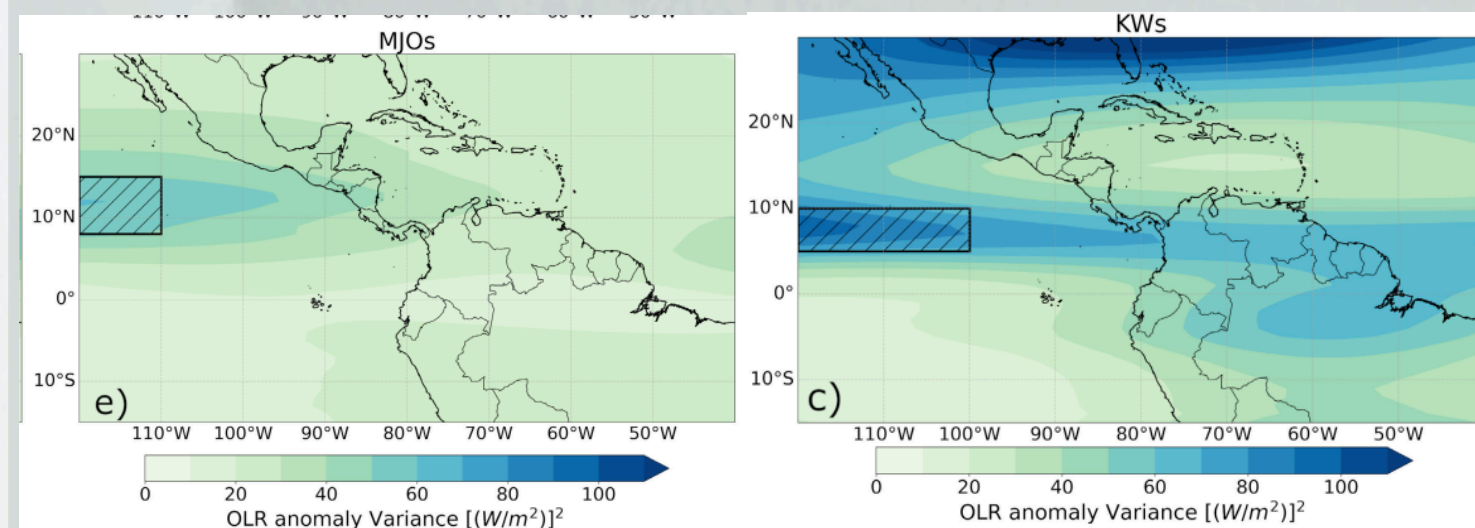


Fig. 3: Maps showing the influence of climate variability (OLR): (a) Madden-Julian Oscillation and (b) Kelvin Waves

These systems regulate the transport of BC and OM, biomass tracers, and components of regional PM2.5 [3], [4]. Using Aerosol Optical Depth (AOD), the influx and distribution of these pollutants into the Aburrá Valley are quantified [5], [6].

Regional variability is modulated by the MJO (30–60 days) and Kelvin waves (2.5–17.5 days), phenomena that affect zonal winds and tropical convection [2].

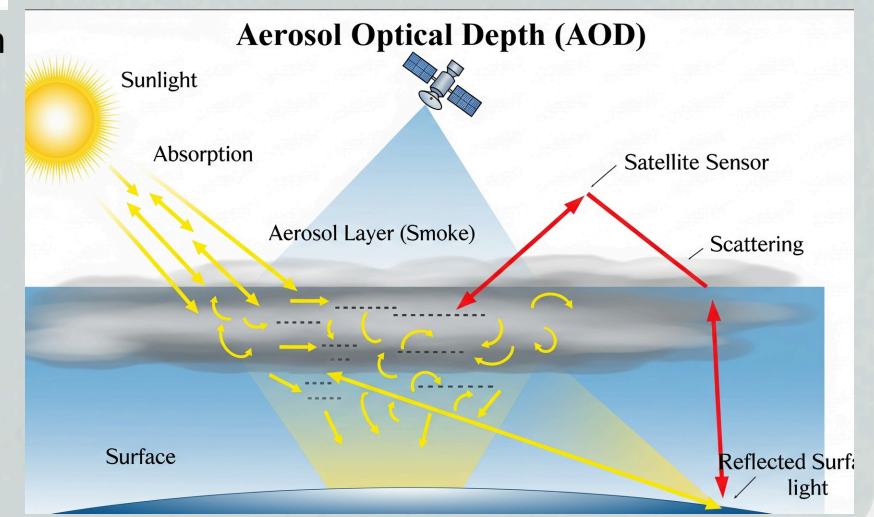


Fig. 4: Principles of Aerosol Optical Depth (AOD) Measurement via Remote Sensing

Objectives

General: To analyze the relationship between Kelvin waves and the Madden-Julian Oscillation (MJO) with the transport of aerosols such as black carbon and organic matter generated by wildfires in northern South America, and their arrival in the Aburrá Valley during the months of February and March over a two-decade period.

Specific Objectives

-To estimate the average behavior and anomalies of total aerosols, organic matter, and black carbon during February and March in the 2003–2022 period in the study area.

-Relate the activity of Kelvin waves and the Madden-Julian Oscillation (MJO) to the average data obtained for total aerosols, black carbon, and organic matter in the study area during the months of February and March.

-Evaluate the statistical relationship between the transport of total aerosols, black carbon, and organic matter, and their impact on air quality in the Aburrá Valley, through the analysis of anomalies and the application of significance tests.

Methodology

Phase 1: Processing CAMS reanalysis data (2003–2022) in Python to establish reference averages and detect peaks in AOD, BC, and OM during the fire season

Phase 2: Identification of days with MJO and Kelvin wave activity to quantify variations in pollutant load compared to days without such waves

Phase 3: Application of Student's t-test to confirm the statistical significance (>95%) of the anomalies and their correlation with the deterioration of air quality in the Valley

Partial Results

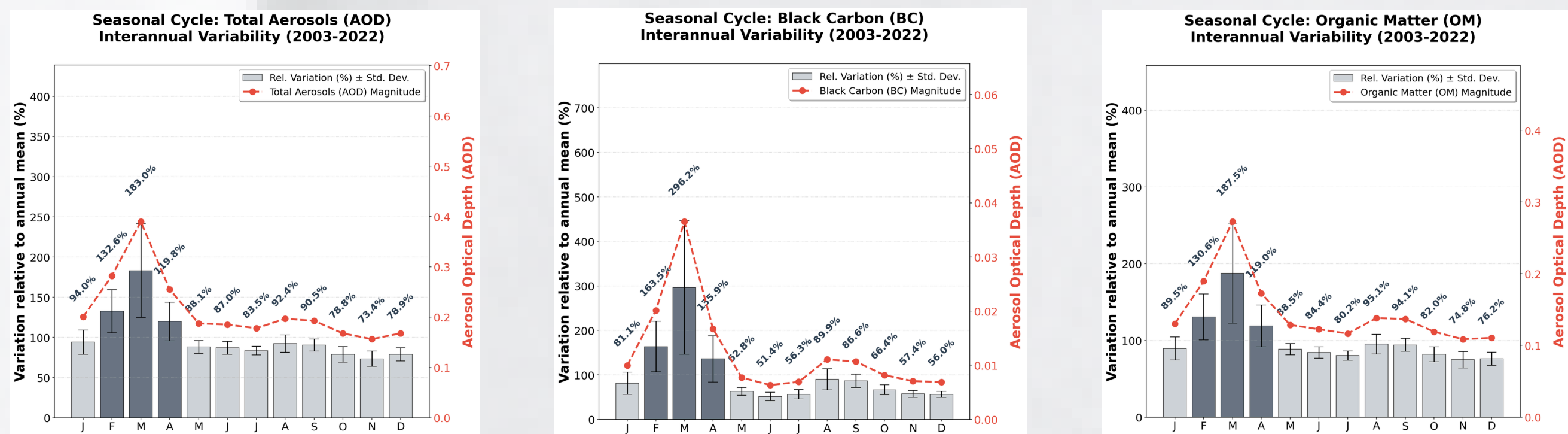


Fig. 5. Seasonal Aerosol Cycle: Relative Variation (%) vs. Aerosol Optical Depth (AOD) for (a) BC, (b) OM, and (c) Total AOD.

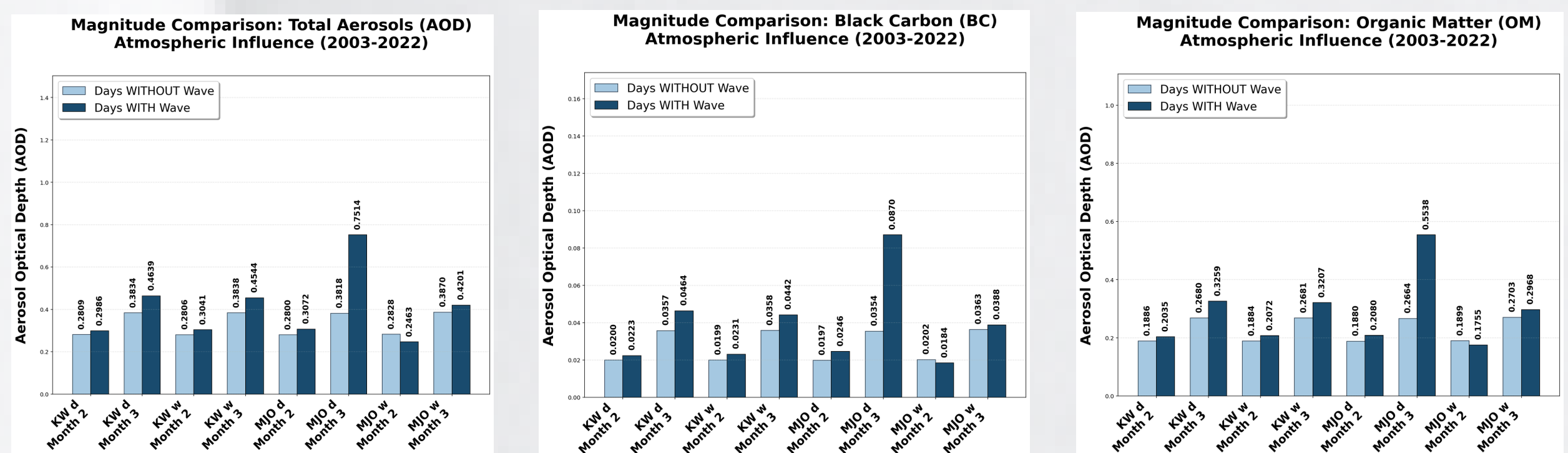


Fig. 6. Comparison of AOD Values: Days with Wave vs. Reference Conditions (2003–2022).

Partial Conclusions

-March is the month with the highest risk from outdoor aerosols; black carbon (BC) levels are 296.2% higher than the annual average.

-El tránsito de las fases secas de la MJO y Ondas Kelvin coincide con aumentos persistentes de aerosoles, generando condiciones atmosféricas que favorecen la densidad de partículas en la columna.

- Los eventos de mayor impacto, como la anomalía del 145.6% de BC en marzo bajo la fase seca de la MJO, cuentan con una validez estadística superior al 95%.

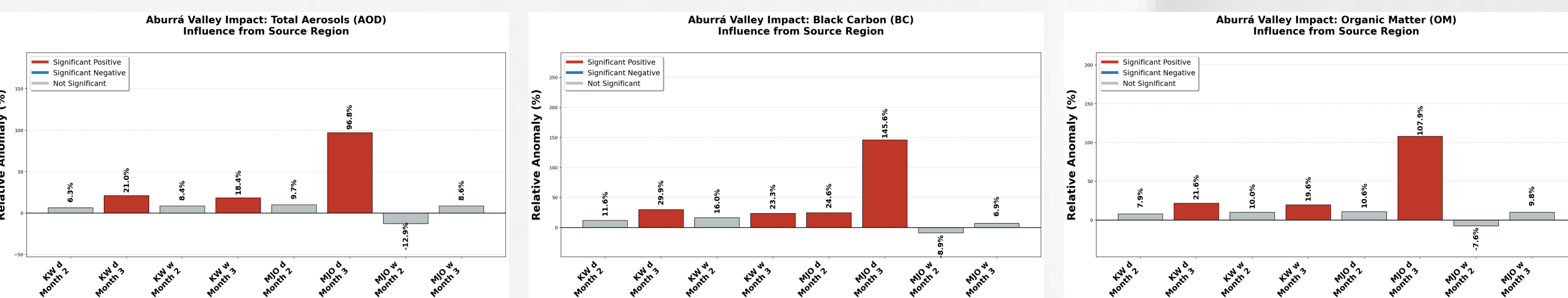


Fig. 7. Spatial Distribution of BC Anomalies and Statistical Significance Under the Influence of Dry Phases of the MJO and Kelvin Waves

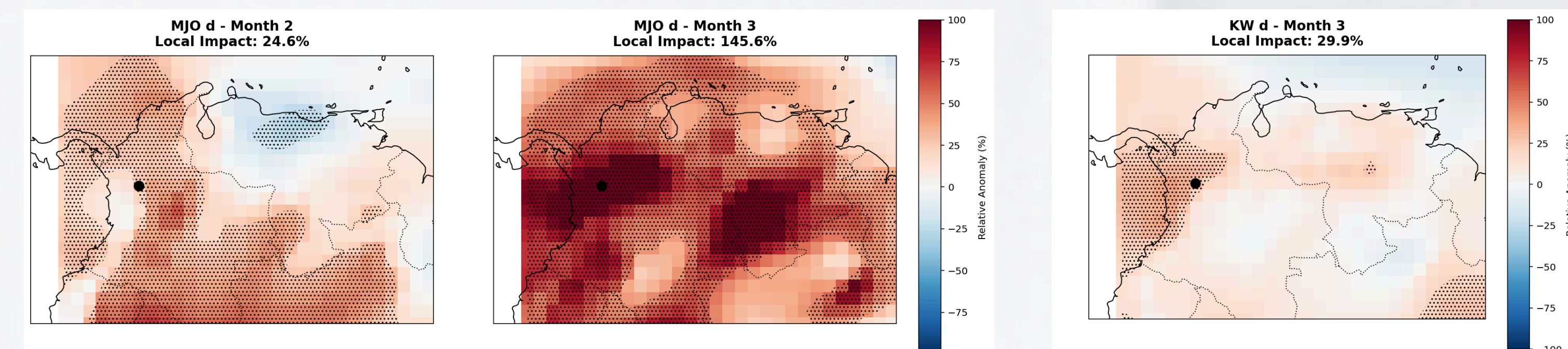


Fig. 8. Percentage variation in (a) AOD, (b) BC, and (c) OM under the influence of atmospheric waves.

References



Assessment of the Influence of the Eastern Tropical Waves on the Orinoquia Savanna Ecosystem Through an NDVI Analysis from 2000 to 2020.

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Methodological Advisor: Andrea Tamayo

Problem

The savannas of the Orinoquia are highly sensitive to water availability and depend largely on their rainfall pattern [1], which is dominated by the southward migration of the Intertropical Convergence Zone [2] however, there are additional regional drivers, such as the Eastern Tropical Waves (TEWs) [3]. There remains a knowledge gap regarding how these waves influence vegetation productivity, particularly in terms of their response in indices such as the Normalized Difference Vegetation Index (NDVI).



Theoretical framework

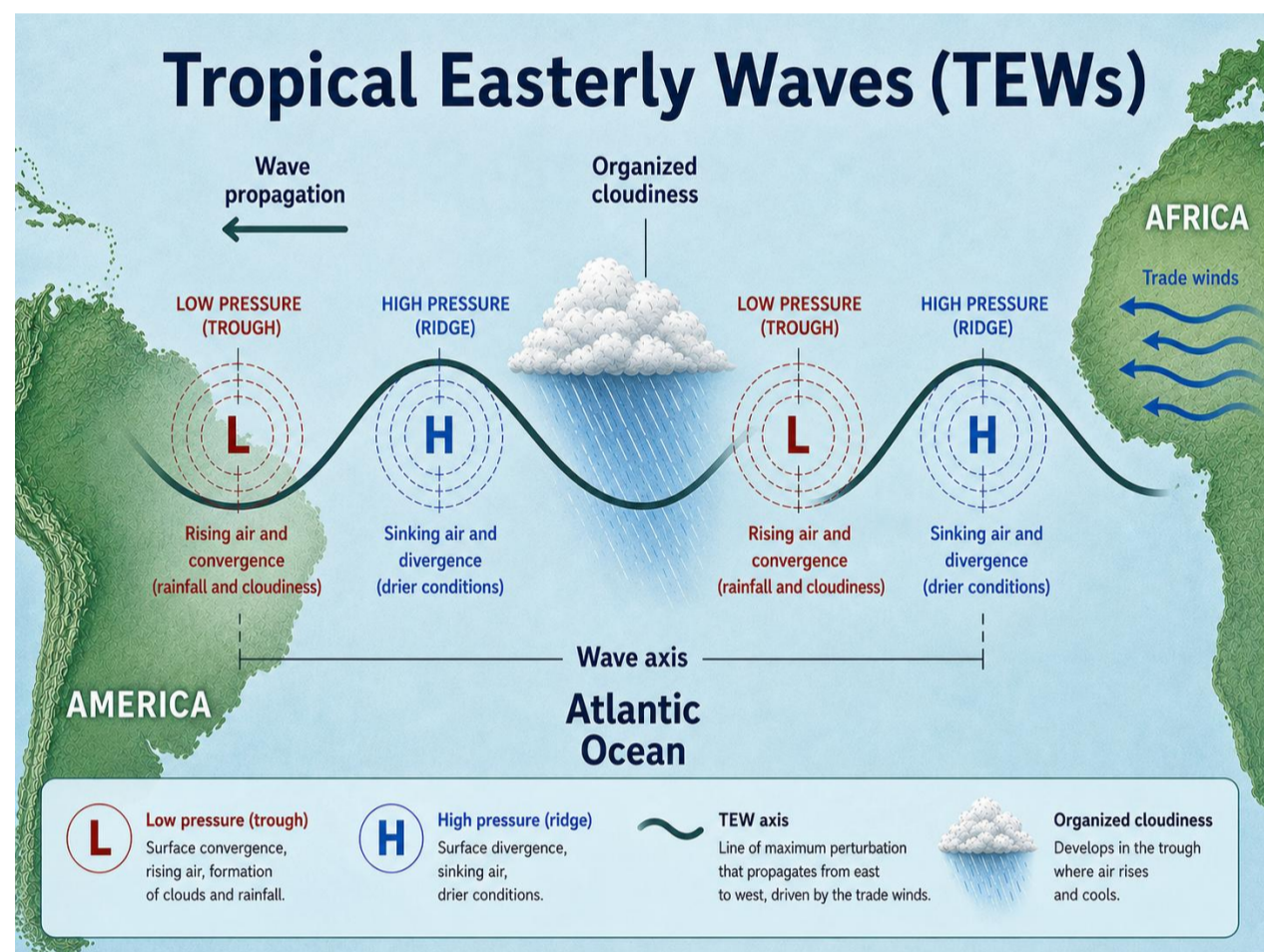


Fig 1. Structure and Propagation of Tropical Easterly Waves.

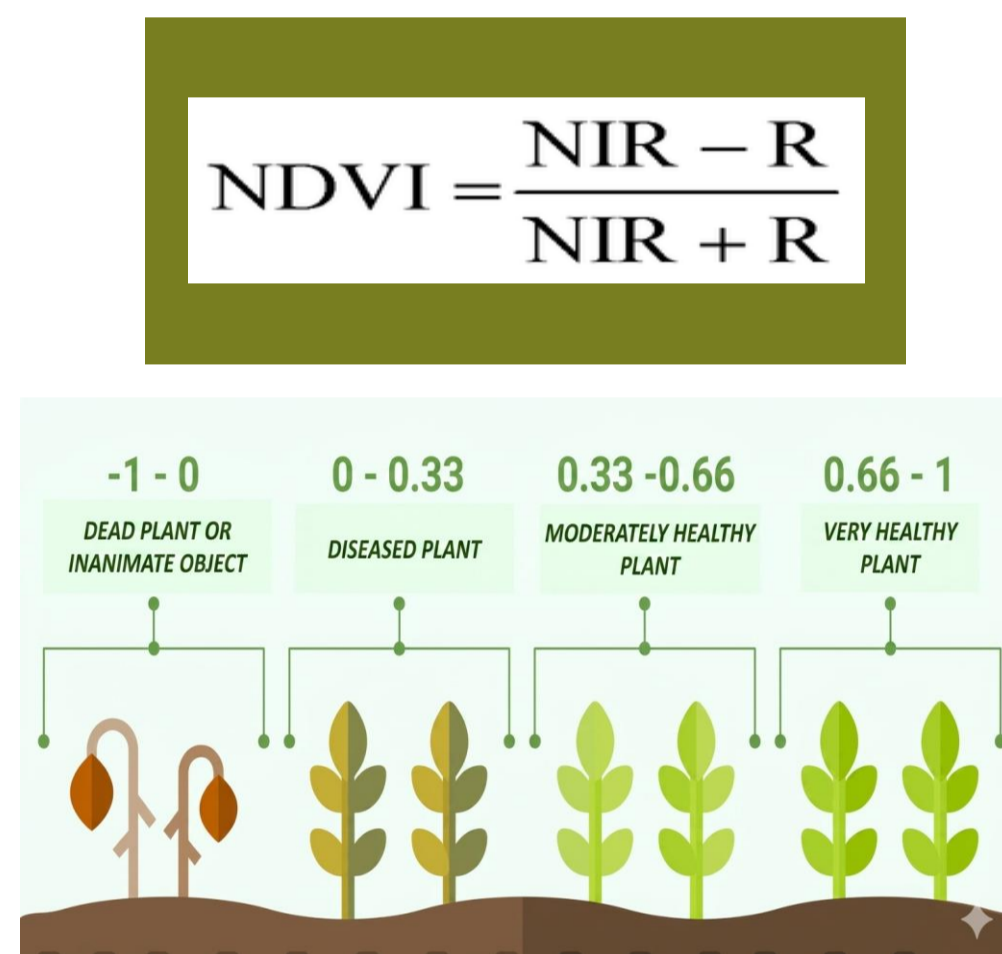


Fig 2. NDVI Formula and Interpretation of Values.

Hollis et al. [4] characterized the behavior of TEWs at the global and regional scales, including northern South America. Arias et al. [5] analyzed changes in NDVI values linked to ocean surface temperatures in the Orinoco and Amazon basins. However, there is no research linking these two variables in the Orinoquia region.

Objectives

General: To assess the impact of TEWs on the Orinoquia savanna ecosystem using an NDVI analysis covering the period from 2000 to 2020.

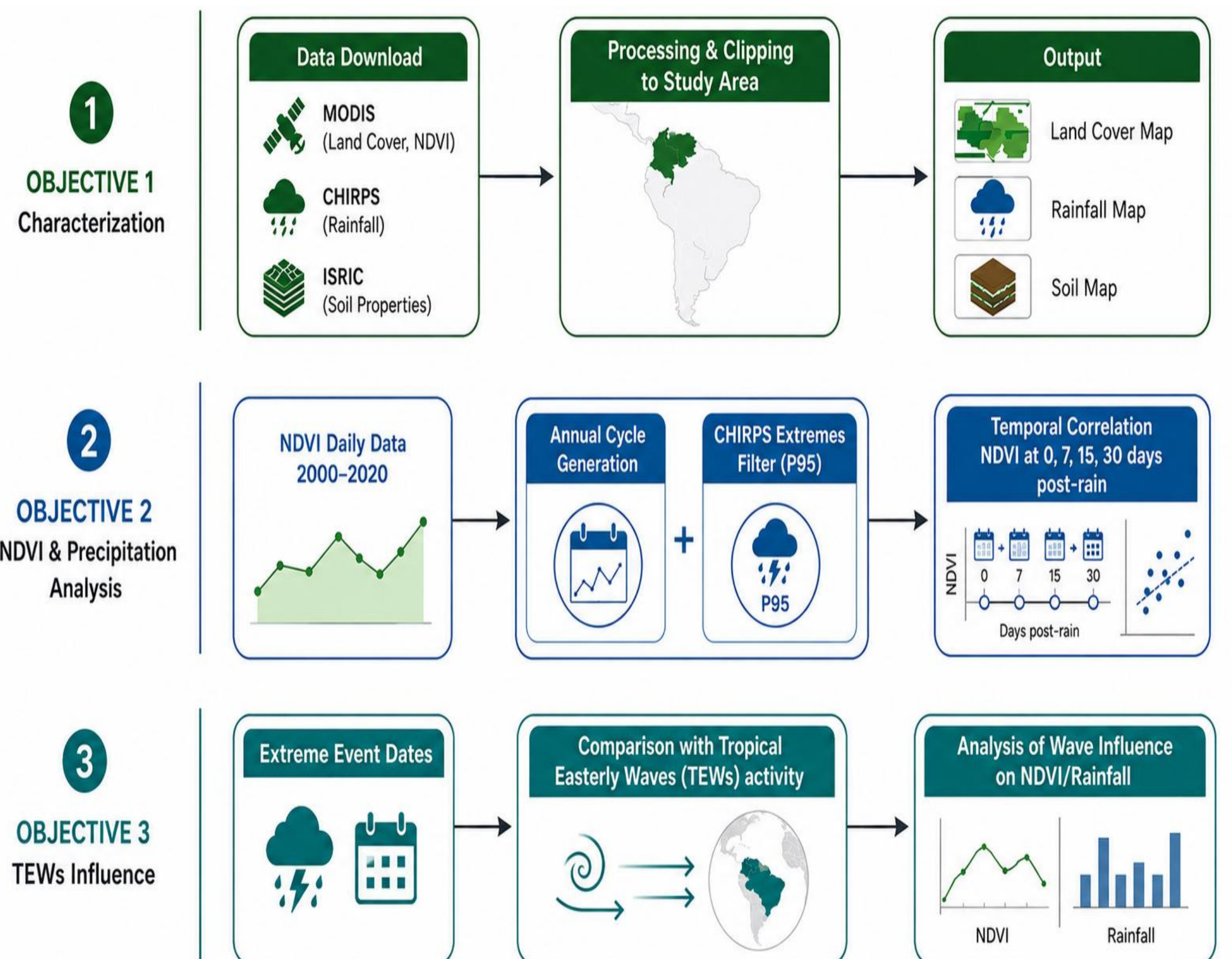
1. Characterize land cover, precipitation patterns, and soil types in the Orinoquia savanna biome.

Specific

2. Analyze the seasonality of the NDVI in the region and its relationship with the Orinoquia savanna ecosystem from 2000 to 2020.

3. Assess the impact of TEWs on the NDVI of the Orinoquia savanna.

Methodology



Preliminary results

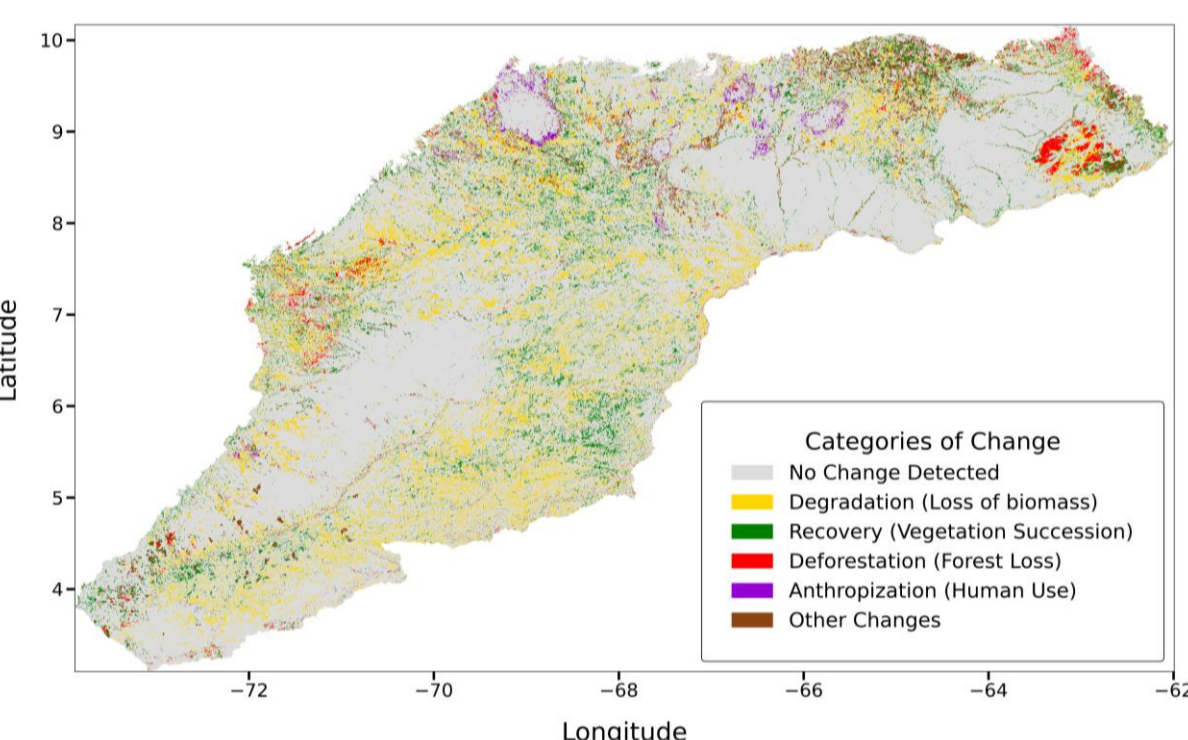


Fig 3. Changes in the coverage of the study area from 2001 to 2020

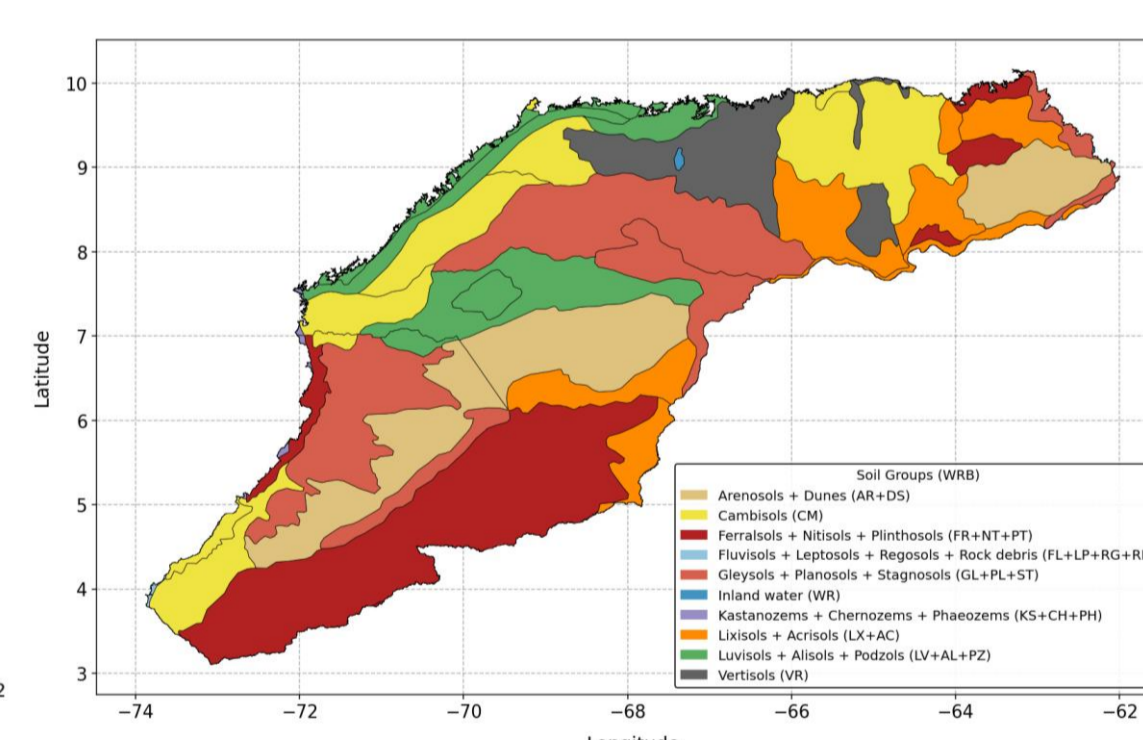


Fig 4. Soil map of de study region

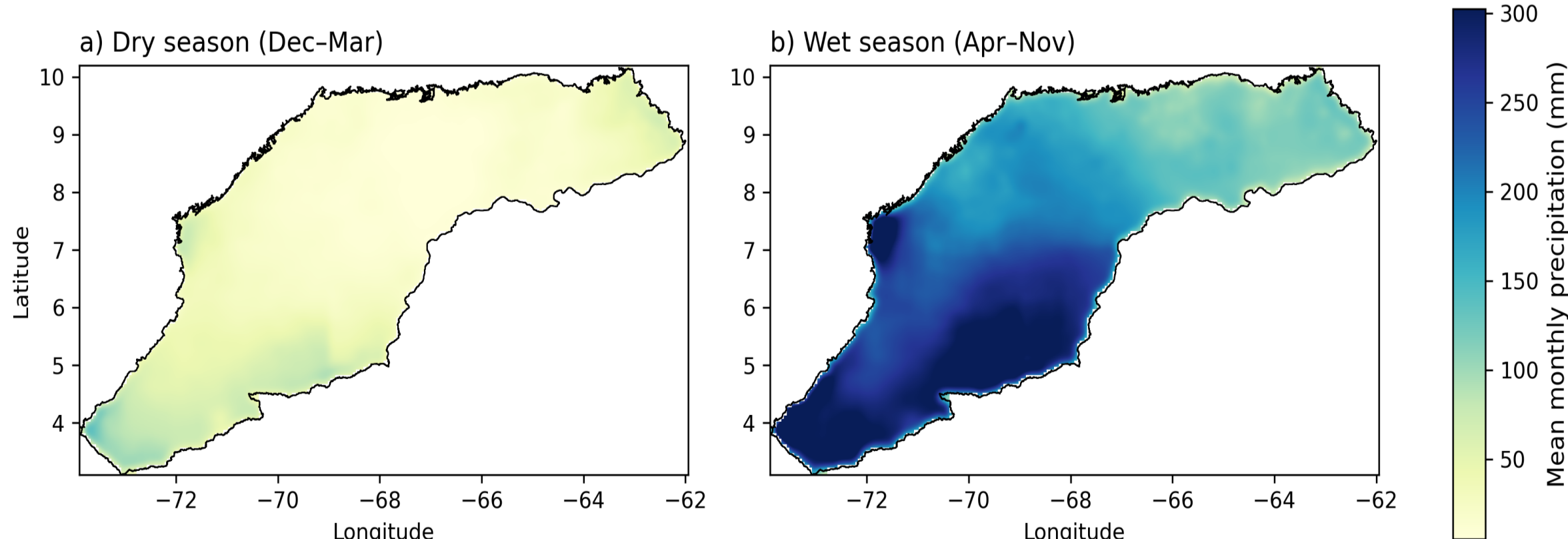


Fig 5. Seasonal average monthly precipitation in the study area

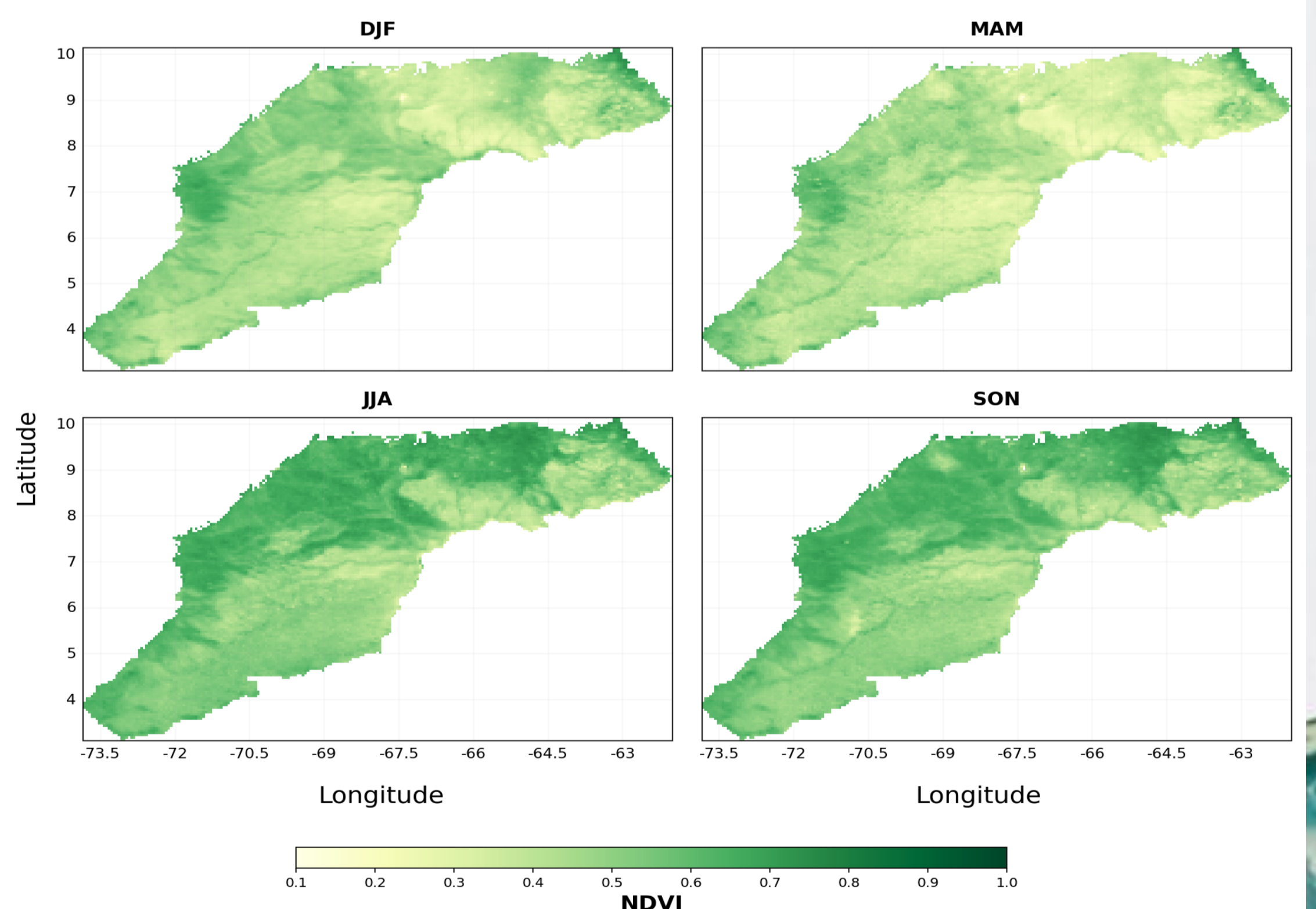


Fig 7. Quarterly NDVI study area 200-2020



References

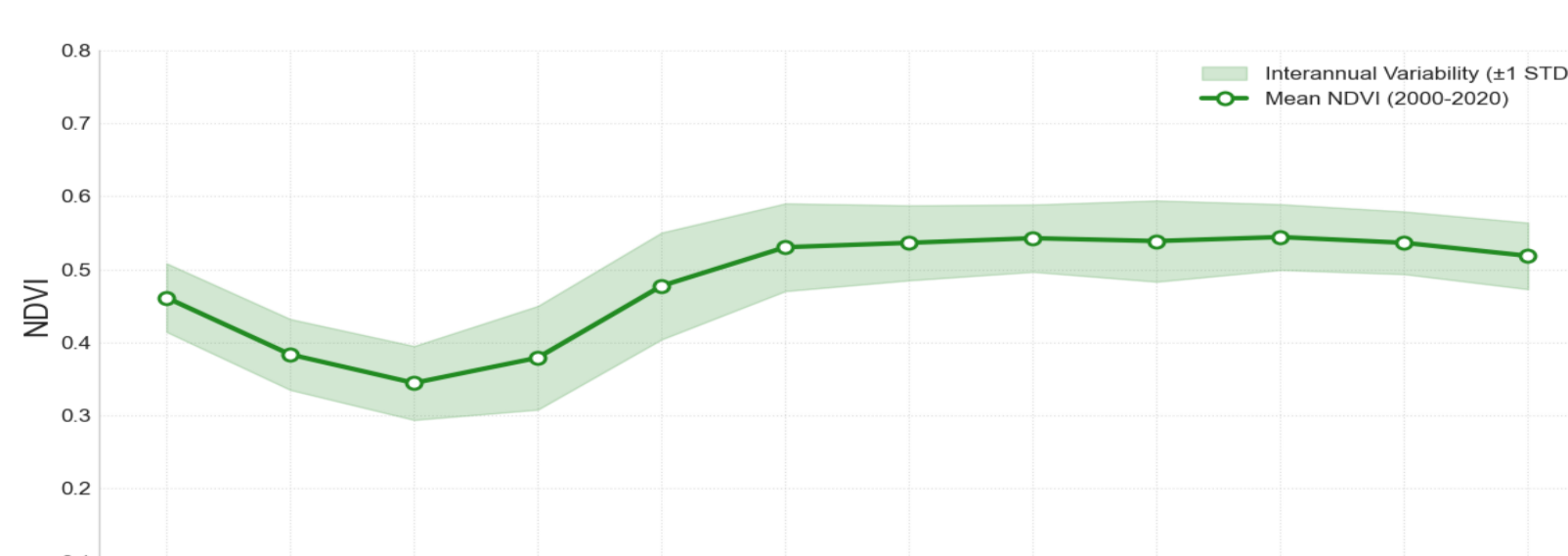


Fig 6. Annual NDVI cycle (2000 – 2020)

Preliminary conclusions

The spatial distribution of the NDVI reflects the interaction between climate, soil, and land cover, forming a system in which multiple factors act simultaneously; the results reveal an efficient yet fragile system whose resilience depends on the stability of the climate regime, which limits productivity with lows during the dry season and recovery during the wet season. However, this response is modulated by soils, which influence water retention, and by changes in land cover, which introduce spatial heterogeneity.