XXIII SEMANA DE LA FACULTAD

ARQUITECTURA E INGENIERÍA

Del 6 al 10 de mayo

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EVALUATION OF THE COMPRESSIVE STRENGTH OF A CEB ADDED WITH NATURAL FIBERS

María Fernanda Pineda Landazury
Manuela Cabrera Angee
Yasmin Eliana Henao Henao

Research project course
Environmental engineering

Advisors: Joan Amir Arroyave and Jesús Zuluaga de los Ríos
Methodological advisor: Alejandro Builes

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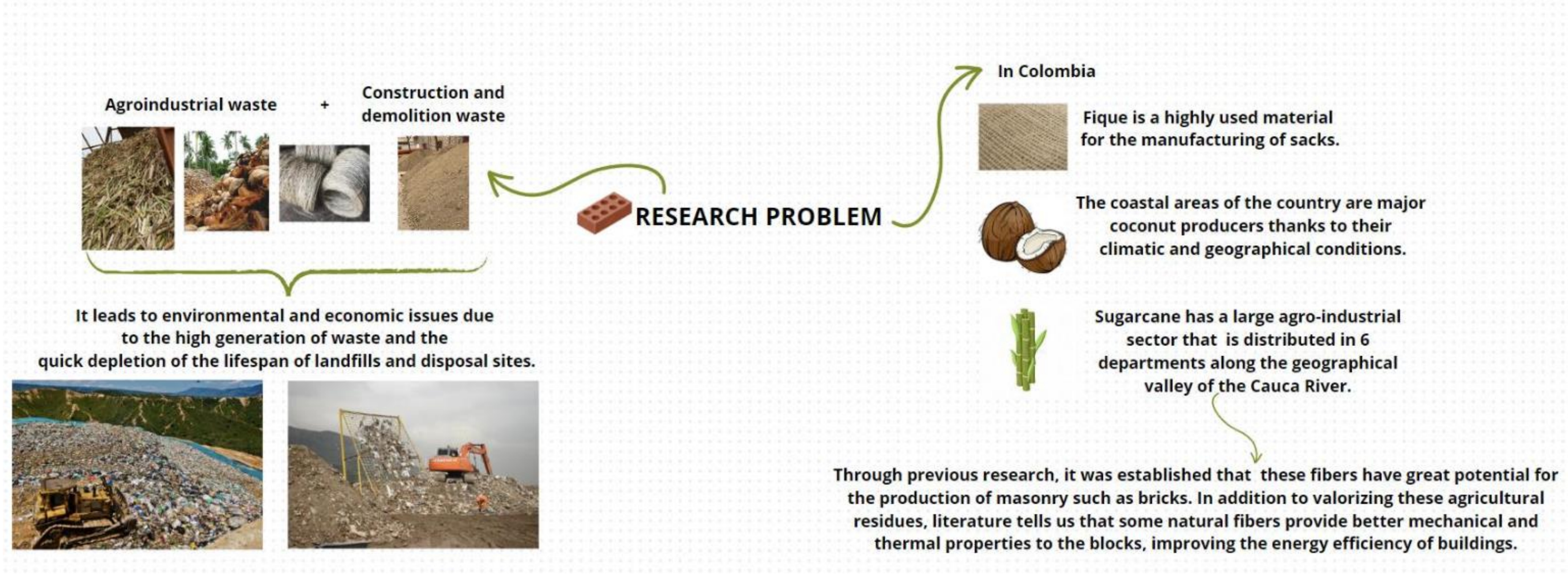
Research problem



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Theoretical Framework

Raw material

Compressed Earth Blocks

Importance of incorporating fibers (coconut, fique and sugar cane)

- Abundant resources.
- Their energy consumption is low.
- Their production is low cost.

Contributes to

Contributing to the sustainability of the SDGs

Circular economy

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Objectives

General

Evaluate the compressive strength of Compressed Earth Blocks (CEB) reinforced with natural fibers.

Specific

1. Characterize the physical properties of the materials used for the manufacture of BTC.

2. Design the mix and manufacture BTC with different types and dosages of fibers.

3. Evaluate the effects of the fibers on the strength of the different manufactured BTCs.

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Methodology

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Methodology

Cured

Tests

1. Compressive strength
2. Density of CEB + fiber additions

Analysis

1. CEB + fiber additions vs conventional CEB
2. CEB + fiber additions vs normativity

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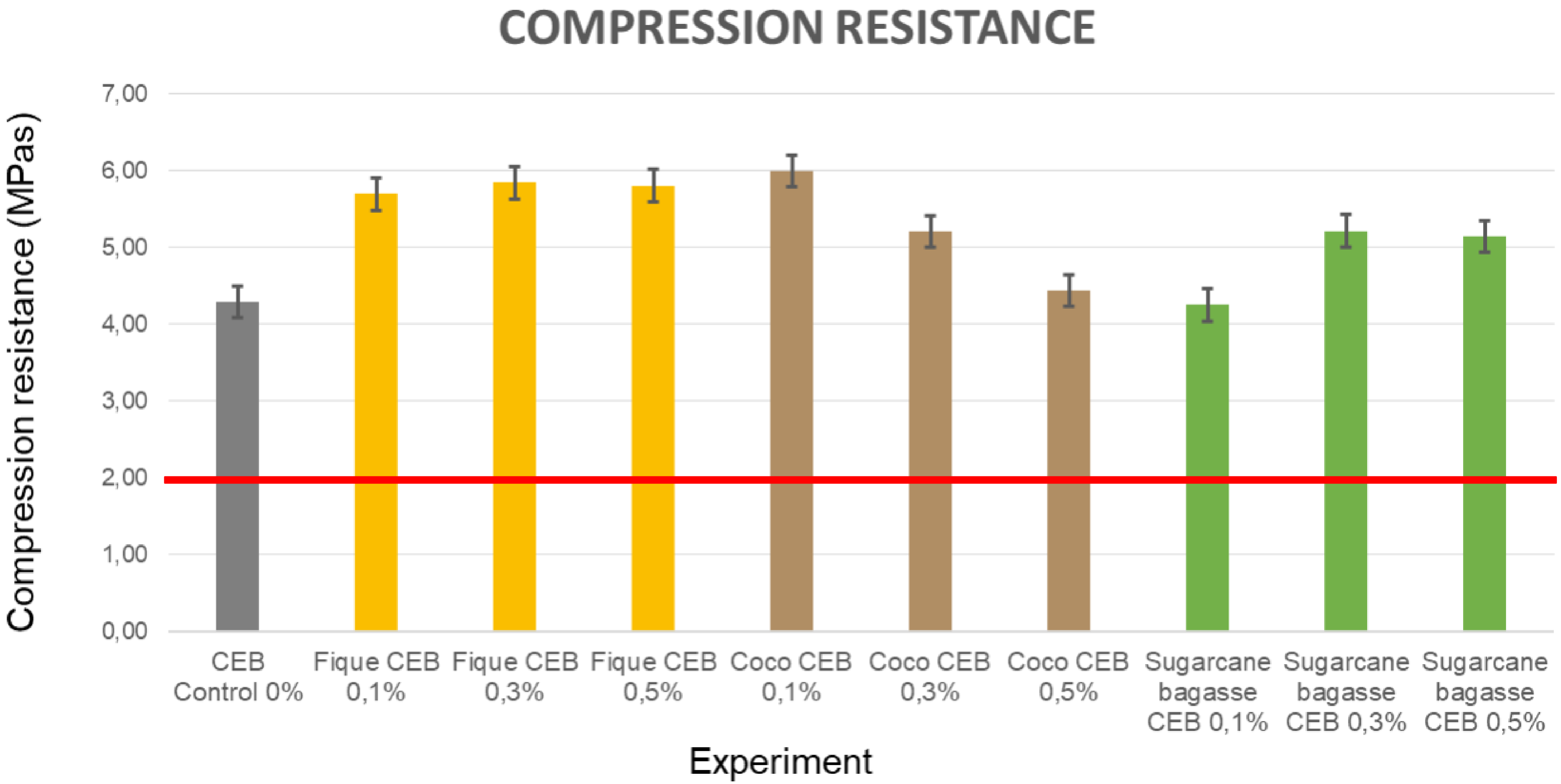
Results and Analysis



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Results and Analysis

Analysis of variance for compression strength.

Source	sum of squares	Gl	half square	Reason- F	Value-P
main effects					
A: fiber concentration	8.59817	3	2.86606	91.17	0
B: fiber type	72.7221	3	4.24069	134.89	0
Interactions					
AB	12.1416	9	1.34906	42.91	0
waste	2.01204	64	0.0314381		
TOTAL	35.4739	79			

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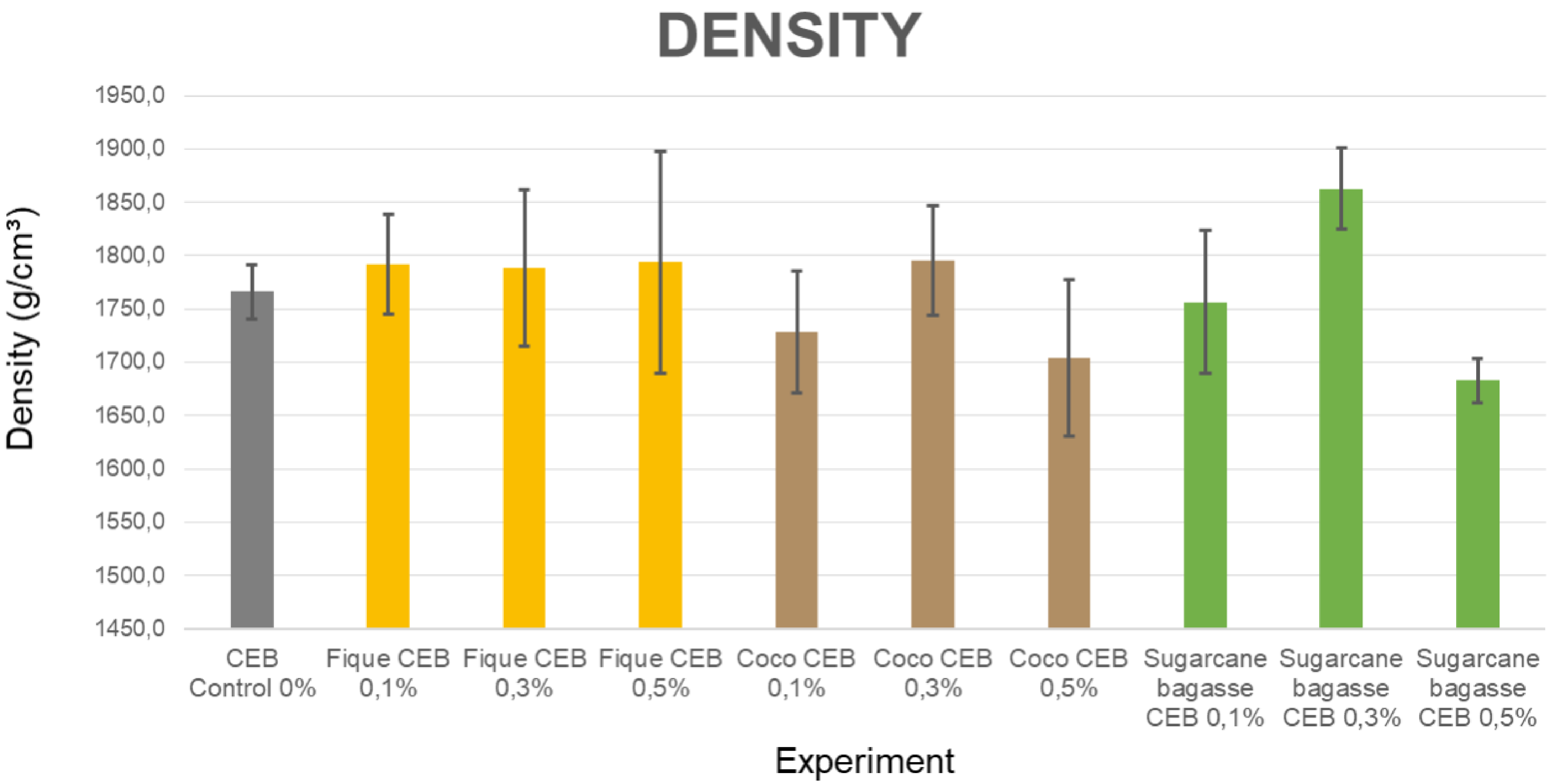
Results and Analysis



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Conclusions

- The resistance of the blocks increases with the addition of fibers (fique fiber being the one that showed the best results).

- The valorization of agro-industrial waste (fique, coconut and cane) and C&D waste (soil) from the manufacture of CEB added with fibers represents a promising strategy for environmental sustainability and the circular economy in the construction sector.

- The selection of the best fiber option will depend on the requirements of the person who wishes to apply the methodology.

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Referencias bibliográficas

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Del 6 al 10 de mayo

Presentado por: Diana María Muñoz Mesa

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Research Problem

- Oil and hydrocarbons derived from it have catapulted its use as one of the greatest drivers of progress, however, it has also been one of the main catalysts of pollution at a global level. From their extraction to their consumption, hydrocarbons generate a chain of environmental impacts, with soil contamination from spills and spills being one of the most pressing concerns.

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Theoretical Framework

- The main concepts and theories that support this research are developed below:

Hydrocarbons and Petroleum: Hydrocarbons are organic compounds formed by carbon and hydrogen, basic in organic chemistry and main constituents of petroleum.

Petroleum is a complex mixture of hydrocarbons, accompanied by sulfur, oxygen and nitrogen in different proportions, and is a primary source of industrial materials.

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Soil Pollution by Hydrocarbons

- Soil contamination by hydrocarbons can occur during oil exploitation, extraction and transportation operations, generating adverse effects on the structure and content of the soil, as well as on the health of plants.
- Environmental legislation regulates the exploitation and use of oil, establishing measures to prevent and remedy soil contamination.

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Bioremediation

- Bioremediation is a process that uses microorganisms to restore or recover contaminated natural environments, such as soil, accelerating the degradation of toxic compounds.
- There are various bioremediation methods, both in situ and ex situ, that are applied depending on the characteristics of the soil and the contaminant.

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Factors Affecting Bioremediation

- Biotic factors such as soil microbiota and nutrient availability influence the effectiveness of bioremediation.

- Abiotic factors such as pH, humidity and temperature also affect the activity of microorganisms and therefore the efficiency of bioremediation.

Sustainable development

- Sustainable development seeks to meet current needs without compromising the ability of future generations to meet their needs, balancing economic growth, social well-being and environmental protection.

Bioremediation is presented as a tool that can contribute to sustainable development by offering an environmentally friendly solution for the restoration of contaminated soils.

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GOALS

- Identify bioremediation systems for soils contaminated with petroleum hydrocarbons and their contribution to sustainable development.

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METHODOLOGY

- The methodology involves an exhaustive bibliographic review to identify objectives, analyze background information and develop the discussion on petroleum hydrocarbons, soil contamination, bioremediation systems and their relationship with sustainable development.

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RESULTS

- **Classification of Hydrocarbons Derived from Petroleum**

The different types of hydrocarbons present in petroleum are detailed, including alkanes, aromatics, resins and asphaltenes.

- **Sustainable Development and Environmental Management:**

The concept of sustainable development and its relationship with environmental management is explained, highlighting the importance of balancing human progress with the preservation of the environment.

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Bioremediation:

- Bioremediation is introduced as a process that uses microorganisms to restore contaminated soils. Different types of bioremediation are mentioned, such as enzymatic degradation, microbial remediation, and phytoremediation.

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- **Biotic and Abiotic Factors that Condition Bioremediation:**

Factors that influence the effectiveness of bioremediation, such as soil pH, moisture, temperature, and nutrient availability, are discussed.

- **Soil Bioremediation Methods:**

In situ and ex situ bioremediation methods, as well as phytoremediation, are described, highlighting their applications and advantages.

- **Bioremediation by Application of Surfactants:**

It is mentioned how surfactants can improve or inhibit the degradation of hydrocarbons in the soil, depending on their composition and concentration.

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ANALYSIS

- The ability of bioremediation to degrade soil contaminants efficiently, using microorganisms and natural methods, is highlighted.

- The ability of microorganisms, such as Pseudomonas, to adapt to adverse soil conditions and degrade hydrocarbons is highlighted.

- The importance of environmental management in the context of sustainable development is highlighted, emphasizing the need to address soil contamination effectively.

- Practical considerations, such as selecting appropriate bioremediation methods and monitoring environmental factors, are discussed to ensure the success of bioremediation projects.

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CONCLUSIONS

- Petroleum and its derivatives, despite being a natural mineral and being used by the entire world population on a daily basis, are also one of the main existing pollutants, mainly in soils as a consequence of their exploitation, handling and transportation.

- Biotechnology proposes, through bioremediation, to address this contamination, in an assertive, functional and effective way through natural techniques that do not cause major alterations.

- Bioremediation is an important tool that allows for the natural recovery of soils contaminated with hydrocarbons derived from petroleum. These have contributed to the development and evolution of the human being, but their manipulation, transformation and use have caused serious damage to the planet, among which is soil contamination, biotechnology can contribute to maintaining soils that are receiving said contamination in the future. , in addition to recovering those already damaged, and this is today the greatest challenge for the future of humanity, which makes bioremediation a necessary mechanism for sustainable development

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Evaluation of the method of solar disinfection for water (SODIS) in the village of Juntas in the municipality of Sopetrán.

Researchers:
Sebastián Velásquez Restrepo
Juliana Garces Velásquez
Mateo Carmona Gil
Marilaysha Jiménez

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Research Problem

The village of Veredas Juntas in Sopetran lacks access to drinking water. Residents consume water contaminated with pathogens, putting their health at risk. It is critical to implement an aqueduct and water treatment systems to ensure safe water and preserve the well-being of the community.

Ubicación

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Theoretical framework

SODIS, consists of exposing water inside transparent plastic bottles to solar radiation, the bottles used are PET, or as they are known soda bottles that can be reused to implement the method, these bottles contain additives such as UV stabilizers to protect the containers and protect the contents from oxidation and UV radiation (R. Meierhofer et al., 2002).

For the method, an exposure time of between 4 and 6 hours is required depending on the solar radiation of the place where the method will be implemented, this time is just enough to completely remove (up to five logarithmic units) the fecal coliforms present in the water (M. B. Keogh et al., 2015).

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Objectives

General

Determine the effectiveness of the SODIS method in reducing pathogenic microorganisms in the water of the Juntas village of the municipality of Sopetrán.

Specific

- ✓ Identify the types of microorganisms present in the water of the Juntas sidewalk.
- ✓ Measure the reduction in the concentration of microorganisms after applying the SODIS method.
- ✓ Compare the effectiveness of the SODIS method with other disinfection methods used in the Juntas sidewalk.
- ✓ Socialize the results obtained on the sidewalk

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Methodology

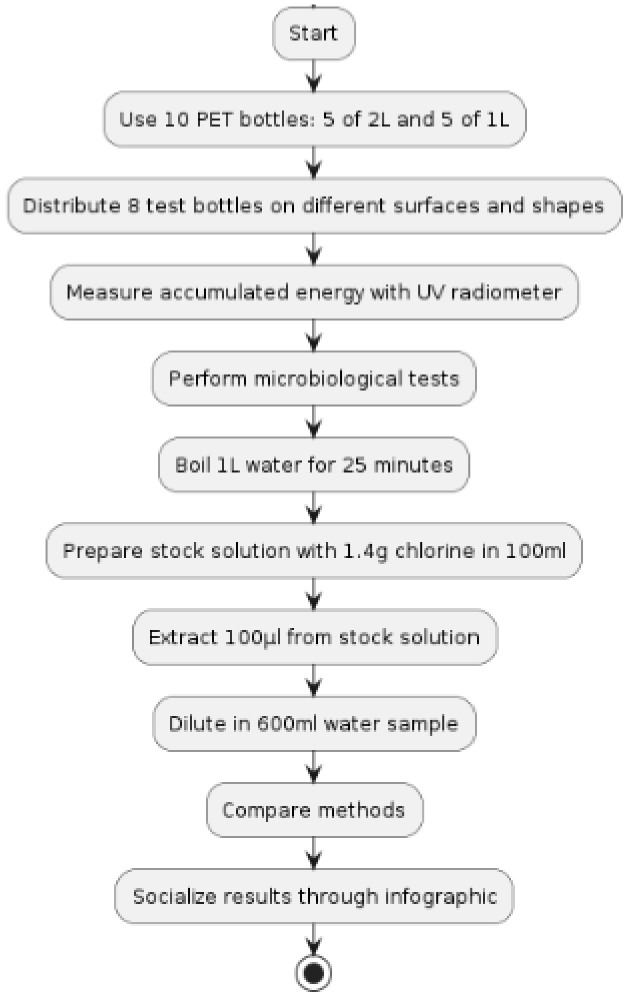
Controllable factors:
1. Use of surfaces
2. PET bottle size(1L,2L)
3. radiant material(Aluminium, black base)

Time : 6 hours
Start time :
9:00 a.m

SODIS application in neighborhoods of the municipality of Sopetrán

Output factor:
% disinfection

Uncontrollable factors:
1. Temperature
2. Radiation received
3. Cloudiness
4. Rains



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Methodology

Experiment	Bottle size (L)	Surface shape	Radiating material
1	1	Flat	Aluminium
2	2	Flat	Aluminium
3	1	Flat	Black
4	2	Flat	Black
5	1	Curved	Aluminium
6	2	Curved	Aluminium
7	1	Curved	Black
8	2	Curved	Black
Control 1	1	Flat	N/A
Control 2	2	Flat	N/A

Table 1. Experimental design, showing how the different variables such as the size of the bottle, the shape of the surface and the irradiating material will be taken. It is noted that there are two types of controls, each with a different bottle size and a flat surface, but without irradiating material. The experiments are divided into different combinations of bottle size, surface shape and irradiating material.

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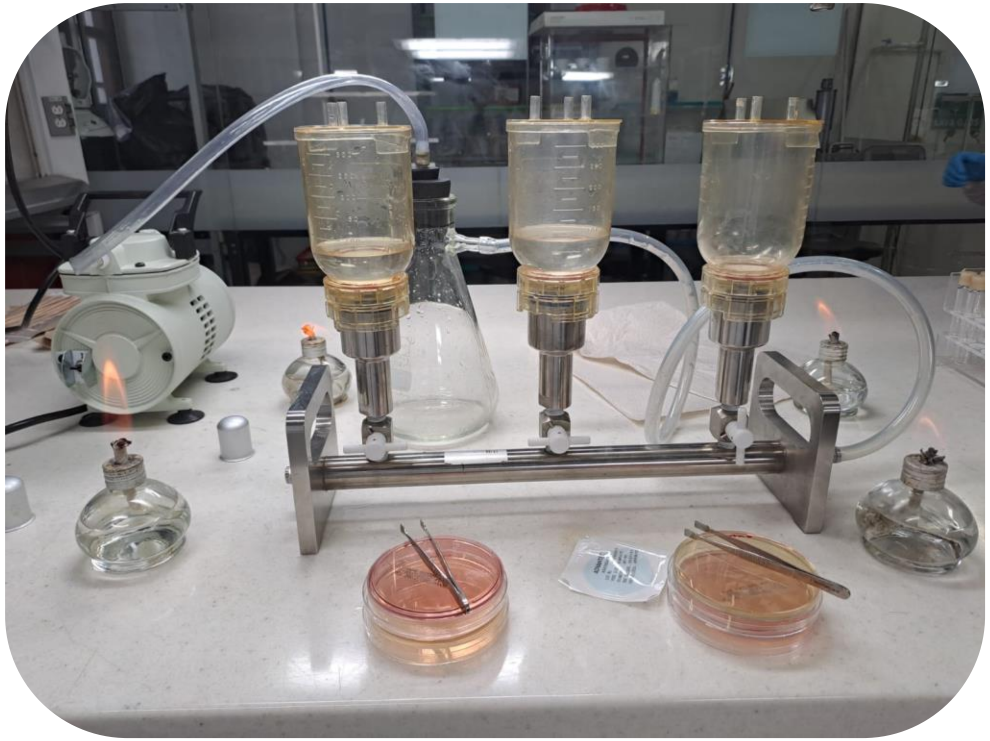
Methodology



Microbiology	Culture media: 48 of chromocult.
Heat treatment	Volumen of water: 1 liter. Time: 25 minutes.
Chlorination	Mother solution:1,4 g/100ml of chlorine chlorinated water: 100 µL/600ml

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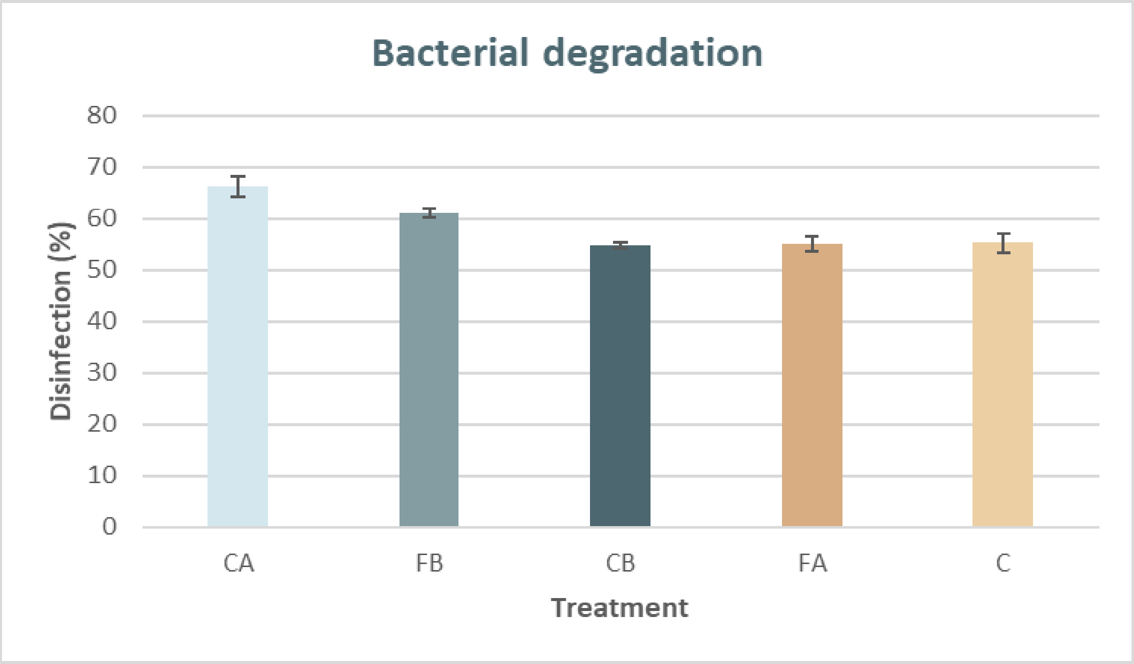
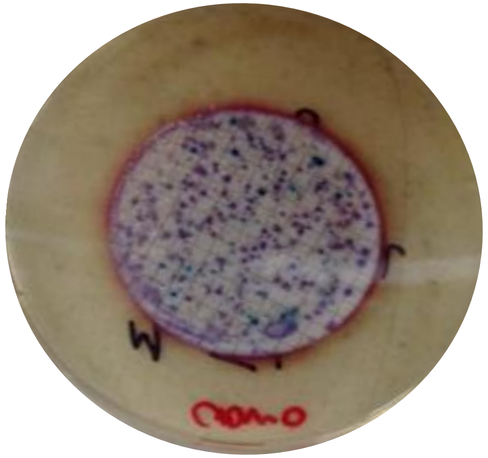
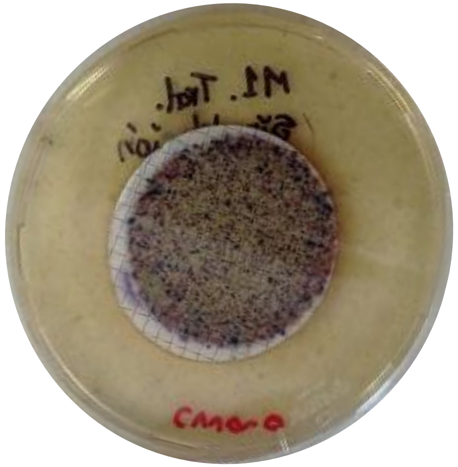
Result and analysis



Graph 1. SODIS degradation percentages, we can observe the percentage of bacterial degradation after applying the method on different surfaces, CA (Curved with aluminum surface), FB (Flat with black surface), CB (Curved with black surface), FA (Flat with aluminum surface), C (Control).

Initial sample





Sample with SODIS

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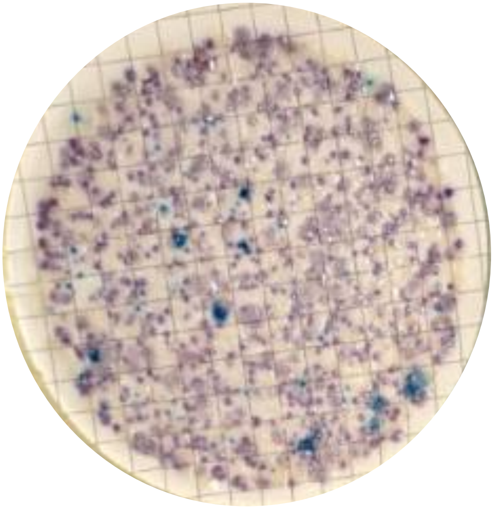
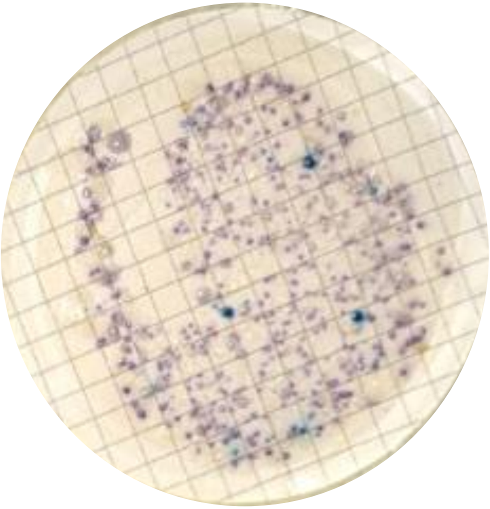
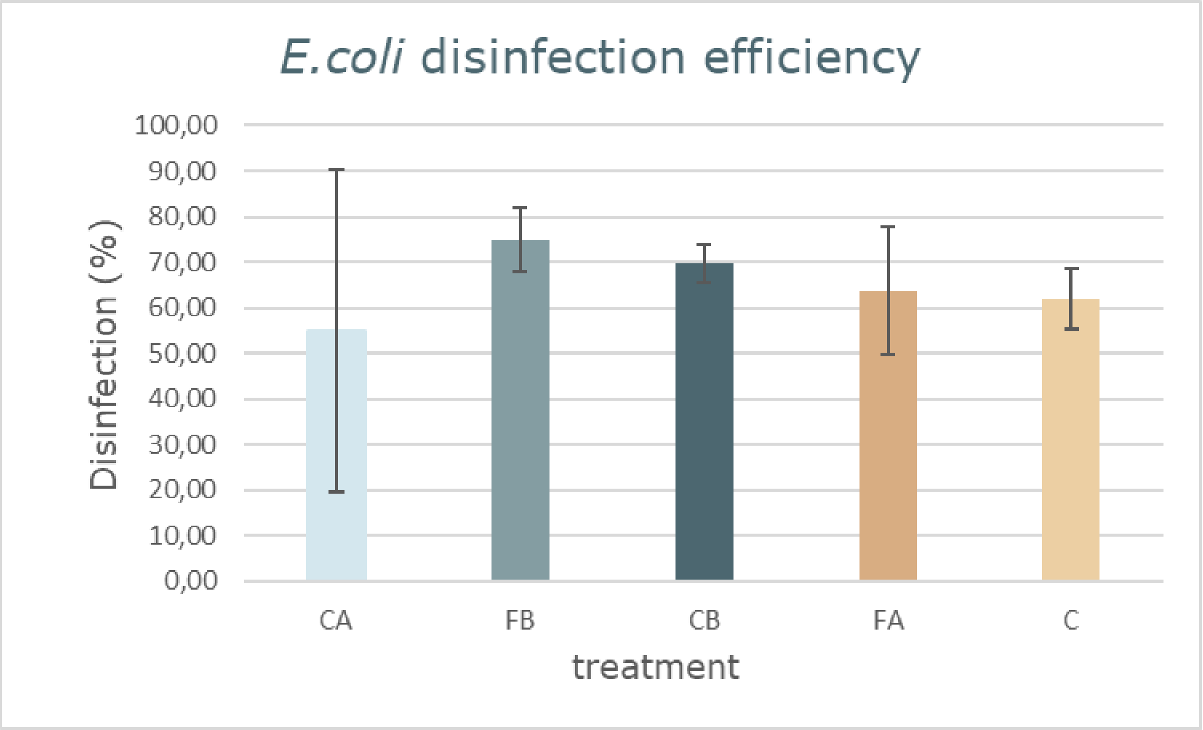
Result and analysis



Initial sample

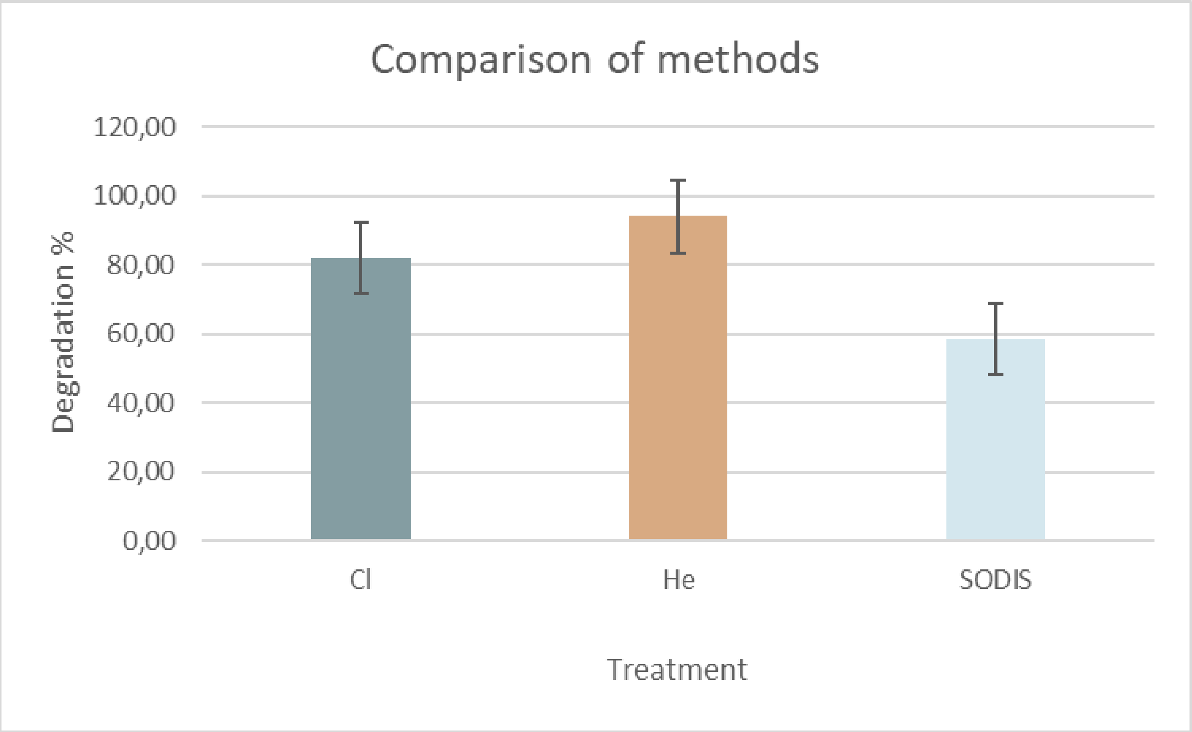
Sample with SODIS





Graph 2. E. coli disinfection efficiency, through the SODIS method we can observe the percentage of E. coli disinfection efficiency on the different surfaces used, CA (Curved with aluminum surface), PN (Flat with black surface), CN (Curved with black surface), PA (Flat with aluminum surface), C (Control).

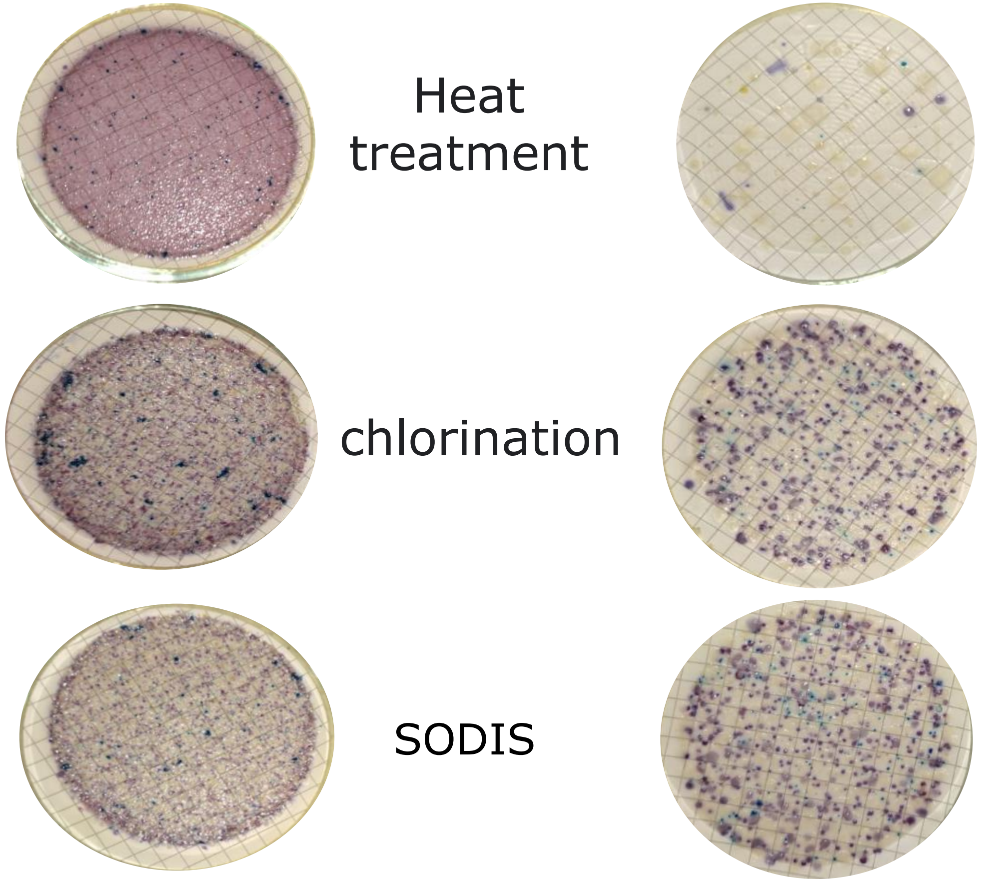
Result and analysis



Graph 3. Comparison of methods, the methods used to compare the degradation of microorganisms were chlorination (Cl), boiling water (He), and SODIS. In the graph, we can observe the percentage of degradation of each method.

Initial sample

Sample with treatment



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Result and analysis

Socializing with the community

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Conclusions

- ✓ A high presence of total coliforms was confirmed in the water used by the inhabitants of the village of Las Juntas. This was supported by the results obtained by culturing the samples on chromocult agar, revealing a substantial amount of colony-forming units (CFUs).
- ✓ The total dose of UV radiation measured was 677.38 KJ/m^2, lower than the recommended energy load of 950 KJ/m^2 for total bacterial inactivation according to Laurie and Mills. This inadequacy may explain the lack of complete success in disinfection.
- ✓ All methods used (boiling, chlorination and thermal disinfection) are effective in disinfecting water, but have limitations. Boiling kills microorganisms on the spot, but does not protect against recontamination. Chlorination can protect continuously if the proper concentration of chlorine is maintained, but in this case it was insufficient. Thermal disinfection achieved 94% efficiency due to the heat resistance of some microorganisms. It is important to properly adjust the doses or concentrations of disinfectants and consider the limitations of each method for optimal and long-lasting disinfection
- ✓ Despite efforts to raise awareness about the risks of consuming untreated water, it was found that 7 out of 10 households consume water without disinfection. Even those who received the information stated that they were aware of the risks, but their bodies were accustomed to it. A high proportion of the population remains at risk due to the consumption of unsafe water, requiring more effective strategies to promote behavioral changes and ensure access to safe drinking water.

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Bioremediation of Zinc contaminated soils using *Zea mays* and *Eisenia foetida* in symbiosis with *Pseudomonas putida*

Members:

María Camila Álvarez Durango, Leidy Tatiana Gañan Marín, Deisy Paola Avendaño Munera

Methodological Advisor:

Alejandro Builes Jaramillo

Thematic Advisor:

Laura Osorno Bedoya

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Research Problem

Soil contamination by zinc is a serious problem not only for plants but also for human health, which derives from various sources such as industry, mining and agriculture. Zinc toxicity is evident at concentrations above 200 mg/kg zinc [2], causing neurological, hepatic and cardiovascular disorders in mammals, including humans, and in plants it can cause stunted growth, chlorosis and interference with the absorption of other nutrients [2], [10]. Therefore, it is necessary to develop remediation techniques for its treatment.

Reference source: https://www.significados.com/causas-y-consecuencias-de-la-contaminacion-ambiental/

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Theoretical Framework

Bioremediation is a technique that uses the capacity of living organisms to absorb, transform and/or degrade contaminants [13], [18].

Zea Mays is a plant with the ability to accumulate and tolerate in its root tissue and transfer heavy metals to its aerial part [5],[8].

Reference source: https://sciencephotogallery.com/featured/maize-zea-mays-bruno-petrigliascience-photo-library.html

Eisenia foetida known as earthworm by its digging, digestion and excretion activity decreases the bioavailable fractions of heavy metals [6], [21].

Reference source: https://sciencephotogallery.com/featured/3-brandling-worms-daniel-sambrausscience-photo-library.html

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Theoretical Framework

Pseudomonas putida helps to promote the bioremediation process and enhances the enzymatic activity of the soil contributing to its regulation and quality [16], [19].

Reference source: https://sciencephotogallery.com/featured/2-pseudomonas-putida-dennis-kunkel-microscopyscience-photo-library.html

The combination of the factors described above is known as integrated bioremediation systems (IBS), in which bacteria, fungi, other organisms and plants are combined in order to bioaccumulate, biostimulant and bioattenuate heavy metal contamination [14].

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Objectives

General

Evaluate the bioremediation of zinc contaminated soil using *Zea mays* and *Eisenia foetida* in symbiosis with *Pseudomonas putida*.

Specific

- Characterize physicochemically the contaminated soil before the bioremediation process.
- Evaluate the growth and development of *Zea mays* in soils contaminated with zinc and in treatment with *Eisenia foetida* and *Pseudomonas putida*.
- Determine the removal efficiency of zinc in contaminated soil with *Zea mays* and *Eisenia foetida* plants in symbiosis with *Pseudomonas putida*.

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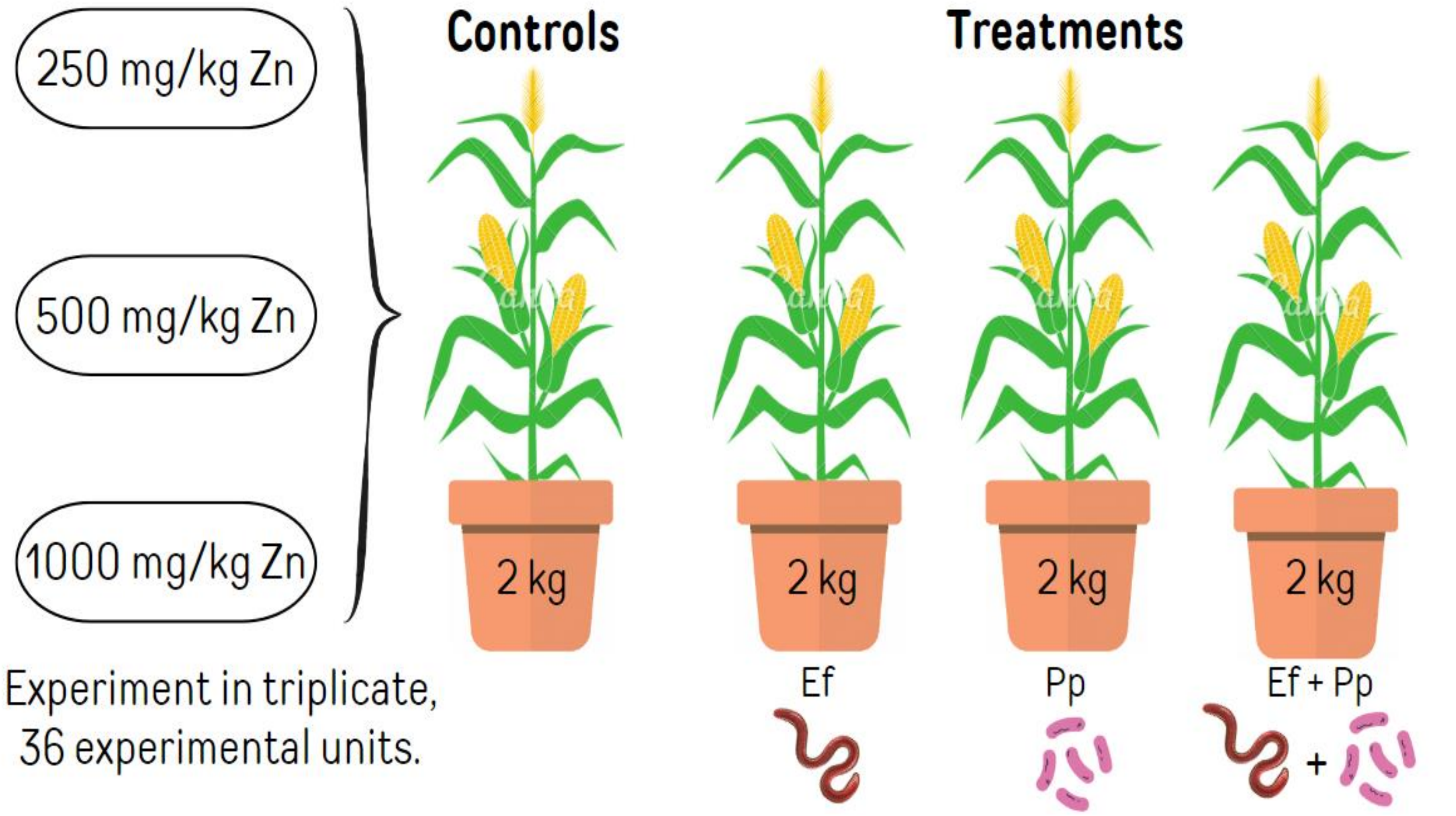
Methodology



Treatments

Ef: *Eisenia foetida*, Pp: *Pseudomonas putida*, Ef+Pp: *Eisenia foetida* plus *Pseudomonas putida*

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Results and Analysis

Soil physicochemical characterization

Table 1. Physicochemical characterization of contaminated soil before the bioremediation process.

PHYSICAL-CHEMICAL ANALYSIS					
**INTERPRETATION: B: Low (deficient); M: Medium (sufficient); A: High (excessive); ND: not detectable; NA: Not analyzed.					
Parameter	**Result**	**Unit***	**Normal**	**Interpretation****	**Method**
pH	5,3	-	5,5-6,0	B	1:1, water, pH meter
CE	0,34	ds/m	1-2	B	Saturated paste
Zn	2,3	mg/kg	3-5	B	Olsen-EDTA

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Results and Analysis

Eisenia foetida

Reference source: authors.

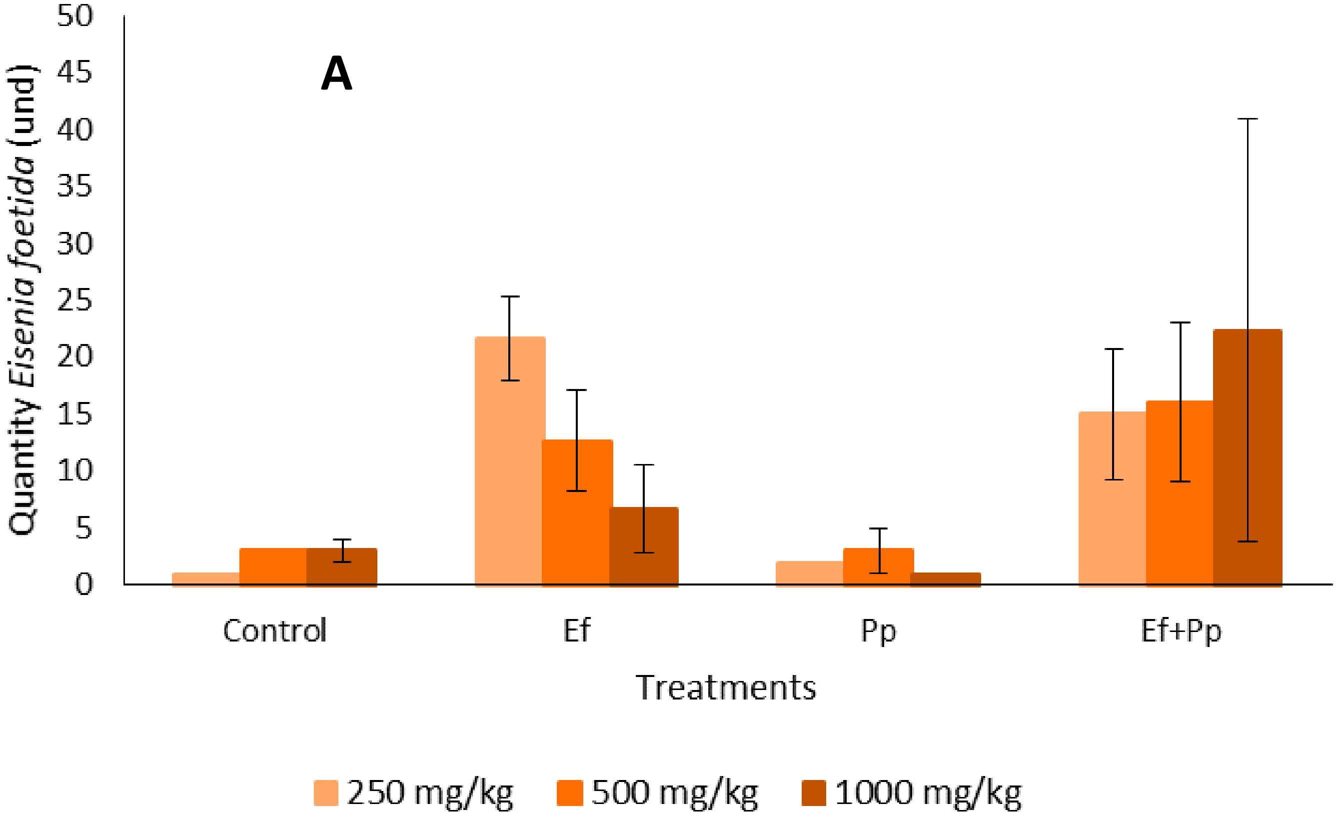

Figure A. Survival of Eisenia foetida after 57 days of exposure to different zinc concentrations.

Note: Ef indicates treatments with *Eisenia foetida*, Pp indicates treatments with *Pseudomonas putida*, Ef+Pp indicates treatments with *Eisenia foetida* plus *Pseudomonas putida*.

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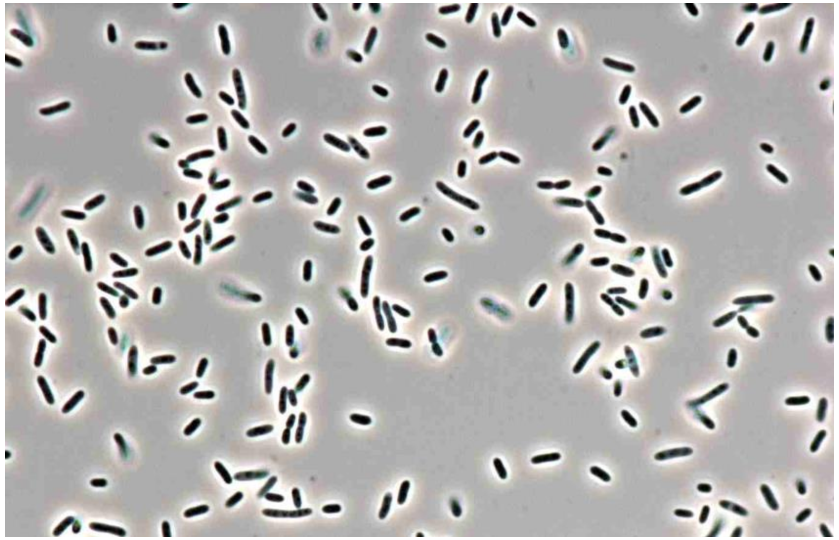
Results and Analysis

Pseudomonas putida



Reference source:
https://www.europeana.eu/es/item/11637/PROKARYAXDSMZXGERMANYXDSMX26234

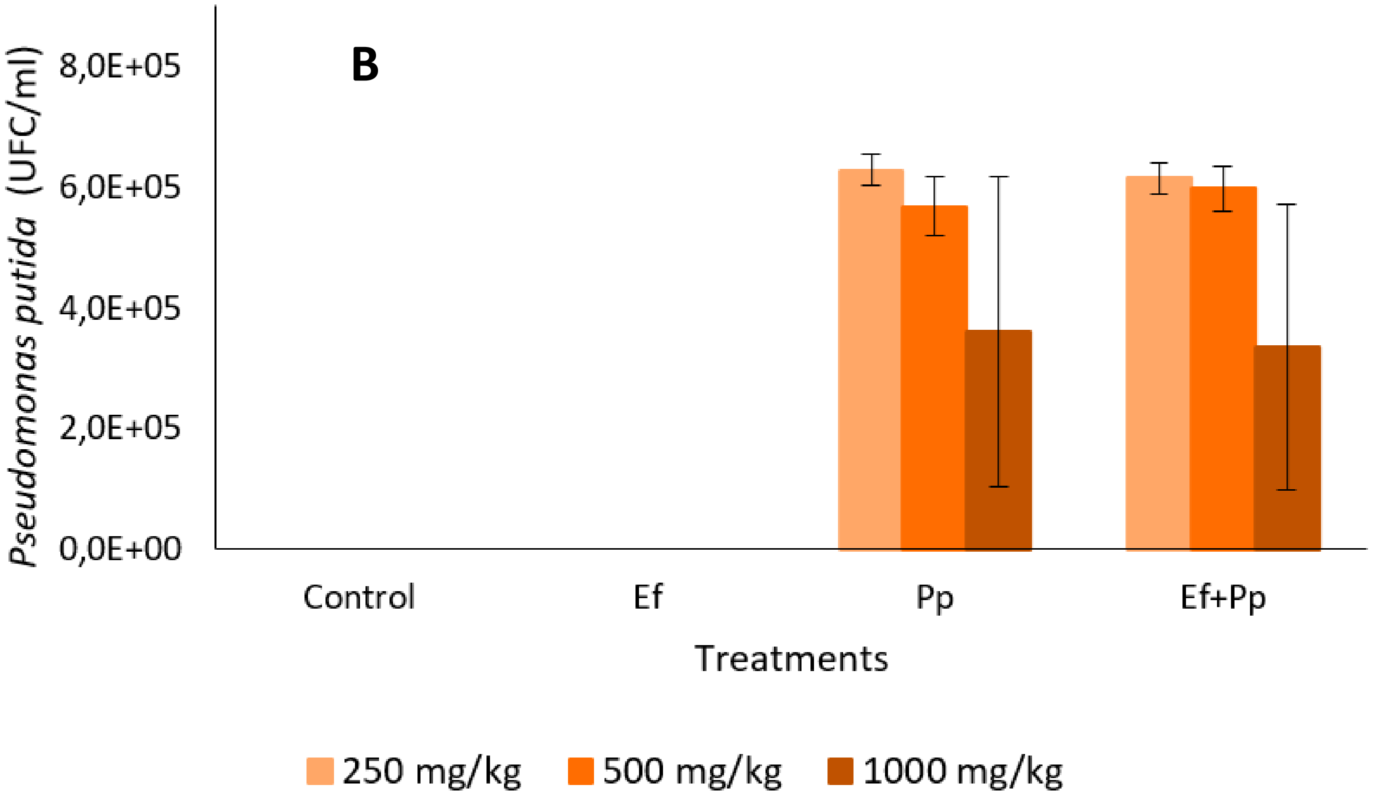


Figure B. Number of *Pseudomonas putida* colonies.

Note: Ef indicates treatments with *Eisenia foetida*, Pp indicates treatments with *Pseudomonas putida*, Ef+Pp indicates treatments with *Eisenia foetida* plus *Pseudomonas putida*.

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Results and Analysis

Aerial and root biomass

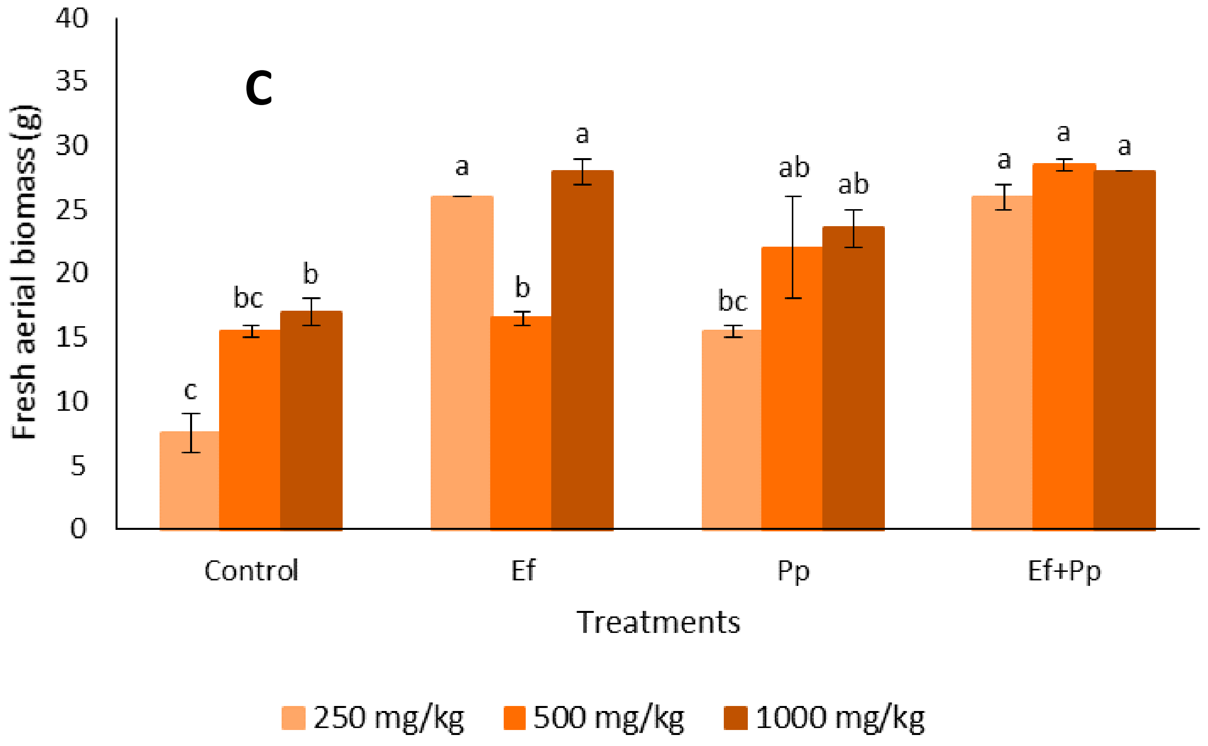

Figure C. Effect of *Eisenia foetida* and *Pseudomonas putida* on the growth of *Zea mays* plants exposed to different zinc concentrations and different treatments.

Note: Ef indicates treatments with *Eisenia foetida*, Pp indicates treatments with *Pseudomonas putida*, Ef+Pp indicates treatments with *Eisenia foetida* plus *Pseudomonas putida*.

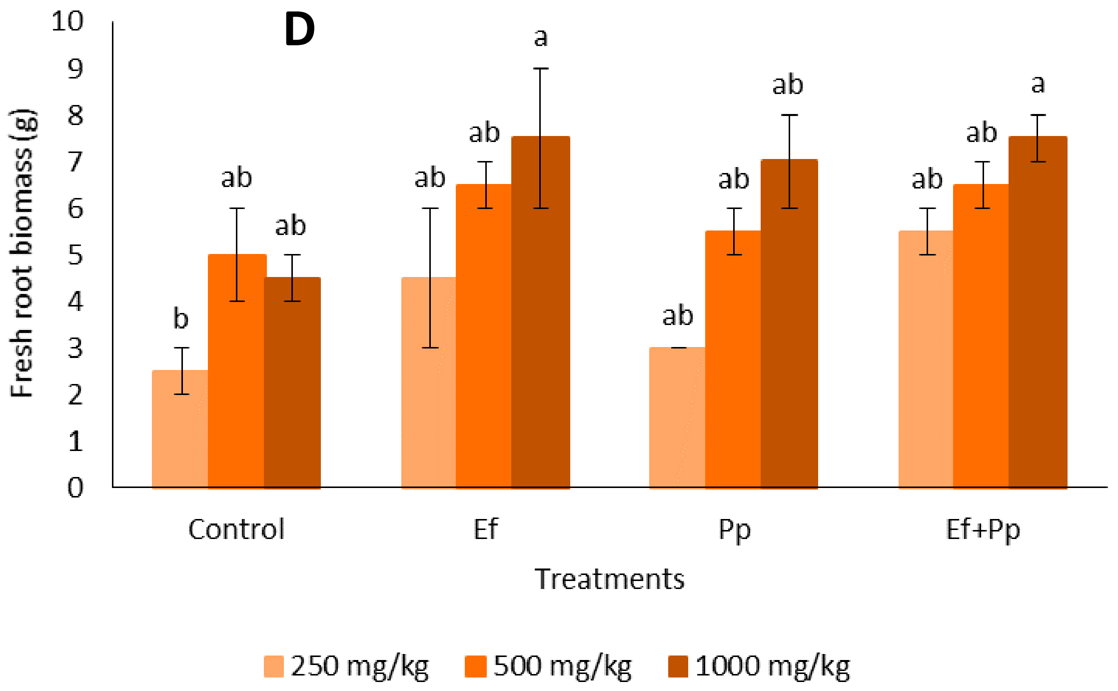

Figure D. Effect of *Eisenia foetida* and *Pseudomonas putida* on root development of *Zea mays* plants exposed to different zinc concentrations.

Note: Ef indicates treatments with *Eisenia foetida*, Pp indicates treatments with *Pseudomonas putida*, Ef+Pp indicates treatments with *Eisenia foetida* plus *Pseudomonas putida*.

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Results and Analysis

Foliar and edaphic zinc concentrations

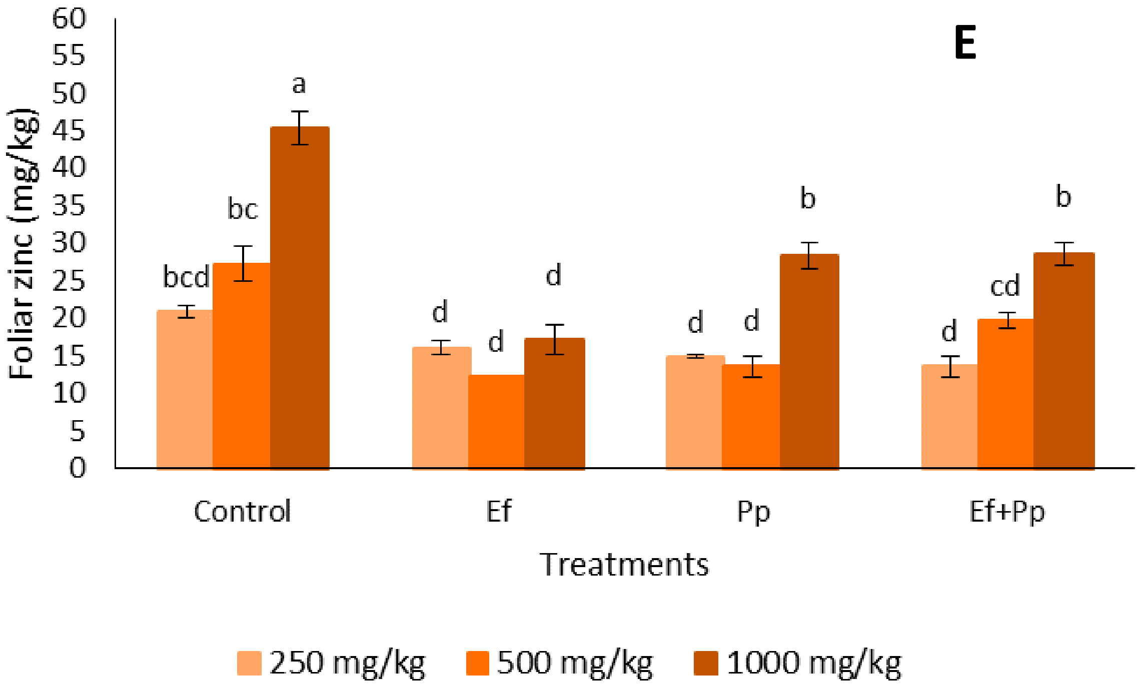

Figure E. Final foliar zinc concentration in treatments with Eisenia foetida, Pseudomonas putida and the combination of both.

Note: Ef indicates treatments with *Eisenia foetida*, Pp indicates treatments with *Pseudomonas putida*, Ef+Pp indicates treatments with *Eisenia foetida* plus *Pseudomonas putida*.

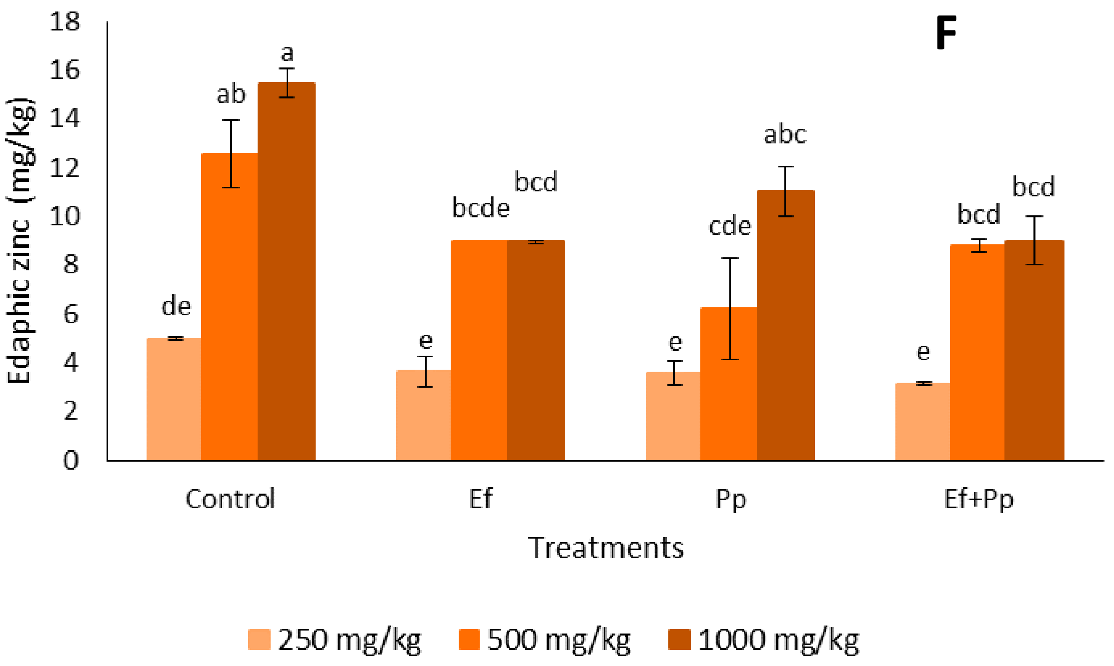

Figure F. Final edaphic zinc concentration in treatments with Eisenia foetida, Pseudomonas putida and the combination of both.

Note: Ef indicates treatments with *Eisenia foetida*, Pp indicates treatments with *Pseudomonas putida*, Ef+Pp indicates treatments with *Eisenia foetida* plus *Pseudomonas putida*.

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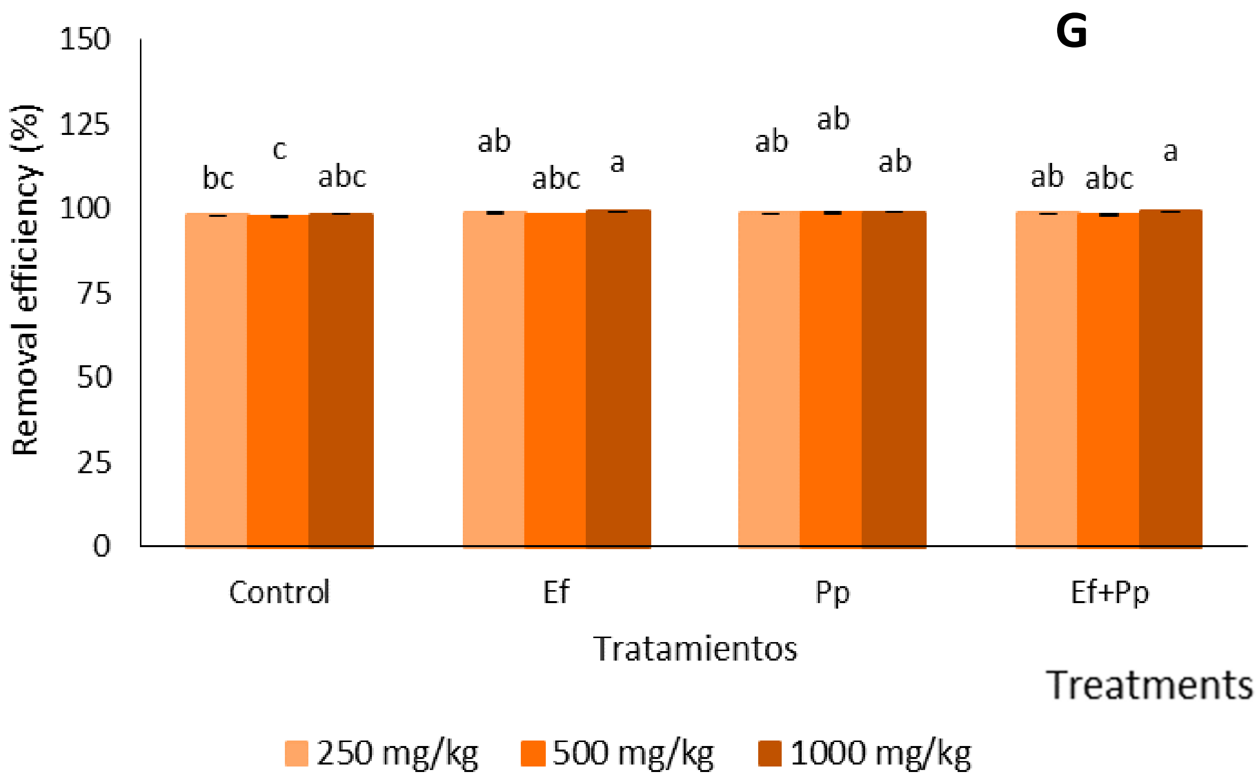
Results and Analysis

Zinc Removal Efficiency



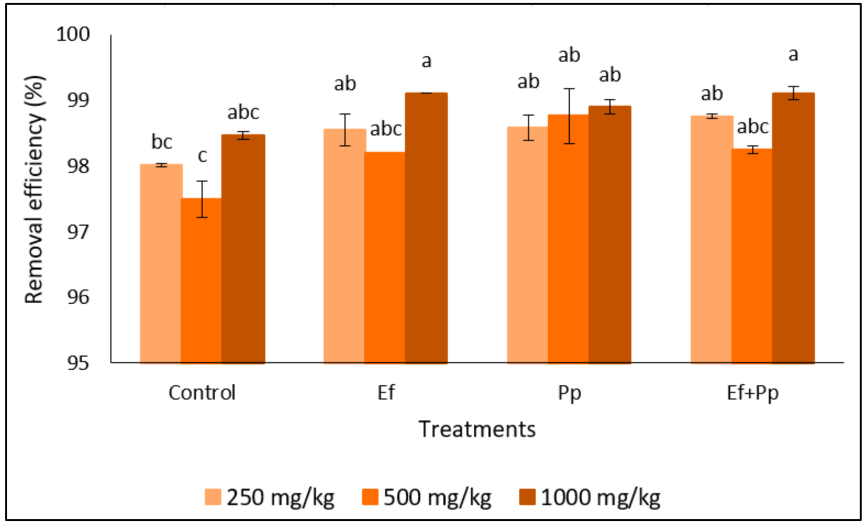


Figure G. Zinc removal efficiency in contaminated soils after the bioremediation process.

Note: Ef indicates treatments with *Eisenia foetida*, Pp indicates treatments with *Pseudomonas putida*, Ef+Pp indicates treatments with *Eisenia foetida* plus *Pseudomonas putida*.

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Conclusions

- Bioremediation of zinc contaminated soils using Zea mays and Eisenia foetida in symbiosis with Pseudomonas putida is an efficient removal method, regardless of the zinc concentration level. All the treatments evaluated were able to reduce the concentration of zinc in the soil, with a range of removal efficiency between 97% and 99%.

- The presence of Pseudomonas putida does not seem to have a significant impact on the treatments, as those including only Eisenia foetida show statistically similar results to those including only Pseudomonas putida. This suggests that the presence of Eisenia foetida contributes positively to the restoration of contaminated soil health, demonstrating its remarkable adaptability and potential to improve soil conditions.

- Although there was little statistical difference between treatments in relation to percent removal, all proved to be effective in reducing contamination and improving soil quality.

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XXIII SEMANA DE LA FACULTAD

ARQUITECTURA E INGENIERÍA

Del 6 al 10 de mayo

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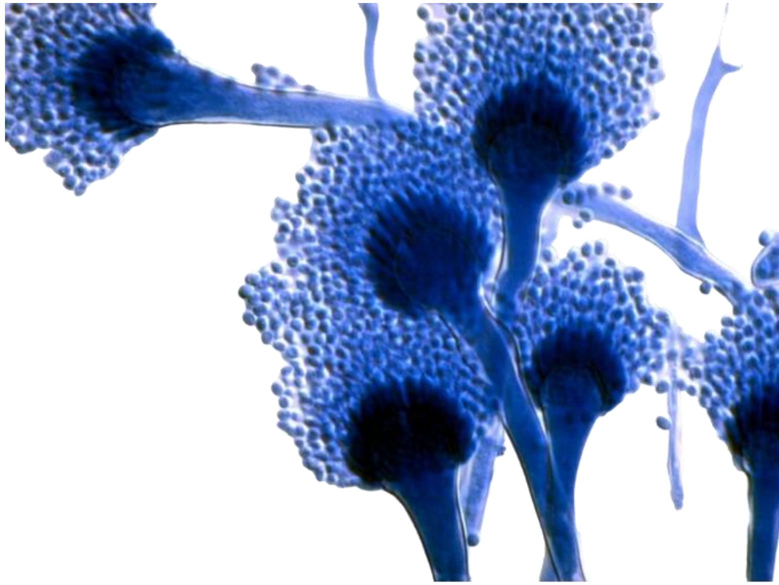
Biodegradation of expanded polystyrene in soil with fungi of the genus *Aspergillus* Spp.

Andrea María Cardona García
María José López Marín
Susana Uribe Gómez
Environmental Engineering Students

Laura Osorno Bedoya
Carlos Fidel Granda Ramírez
Thematical Adviser

Gina Hncapié Mejía
Methodological Adviser

Facultad de Arquitectura e ingeniería
Institución Universitaria Colegio Mayor de Antioquia
2024



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Polystyrene in ecosystems

Fuente:https://www.enter.co/wp-content/uploads/2016/05/3409801088_283866f35b_o.jpg

Fuente :https://www.enter.co/wp-content/uploads/2016/05/A_squirrel_and_his_styrofoam_cups1.jpg

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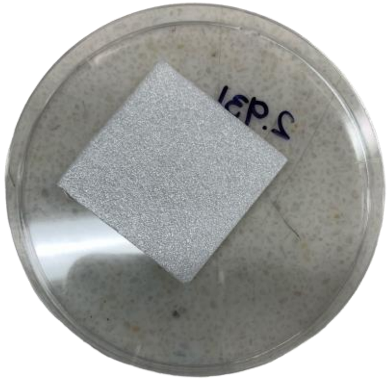

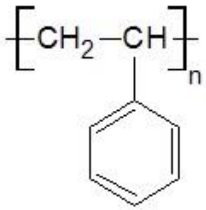

Fuente:http://www.textoscientificos.com/imagenes/polimeros/poliestireno.gif

The unique structure of Polystirene (PS), with its main linear carbon chain and alternating atoms attached to phenyl residues, makes its biodegradation very difficult

Fuente:https://www.poliestireno-reciclado.es/pics/cajas-de-icopor-reciclables-210812.jpg

Recovery and recycling of PS is not always economically feasible due to unstable market price of virgin plastic

Research Problem

Fuente:https://imagenes.noticiasrcn.com/ImgNoticias/reciclajedeicopor.jpg

The monthly amount of waste of PS waste is about 2000 m^3 and only 500 tons are recycled

Their persistence makes a serious threat to both wildlife and human health.

Fuente:https://tse2.mm.bing.net/th?id=OIP.1QKXPf-kHEa9oof4Sj4T2wHaCe&pid=Api

Fuente:https://lanotapositiva.com/wp-content/uploads/2019/07/icopor-home750.jpg

Fuente:https://www.enter.co/wp-content/uploads/2016/05/2518338934_19ab41b241_o.jpg

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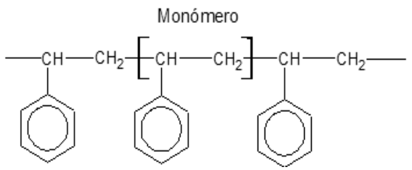
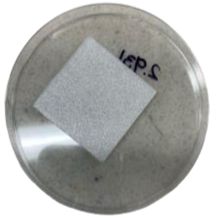
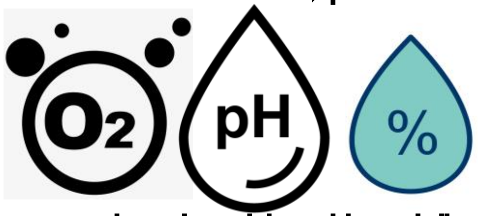
Theoretical Framework

Factors affecting PS aging: PS characteristics and environmental factors



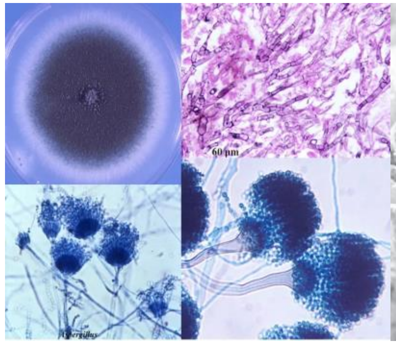


molecular structure, particle size



oxygen levels, pH and humidity conditions

The degradation of plastics is an intramolecular reaction occurs through a sequence of stages:



https://microbeonline.com/wp-content/uploads/2019/04/Aspergillus-characteristics.png

http://www.pantallazosnoticias.com.co/wp-content/uploads/2021/11/ICOPOR-.-copia.jpg

Colonization

https://prensamedica.org/assets/uploads/2018/04/alergias-a-los-alimentos-750x500-c-default.gif

Bio fragmentation

Bio assimilation

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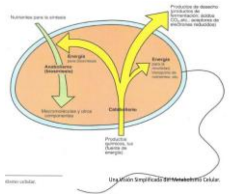
Biomineralization



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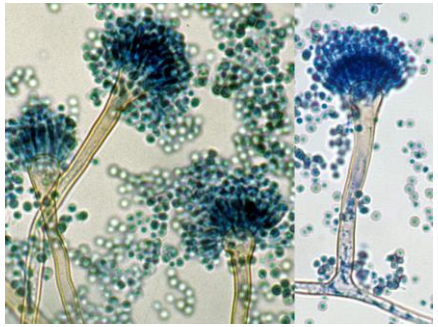
Theoretical Framework

Fungi of the genus *Aspergillus* Spp are filamentous fungi known for their adaptability

Aspergillus flavus (Af) fungus is famous in agriculture for producing white wood rot

The fungus *Aspergillus niger* (An) is the main producer of citric acid have large heads, dark brown



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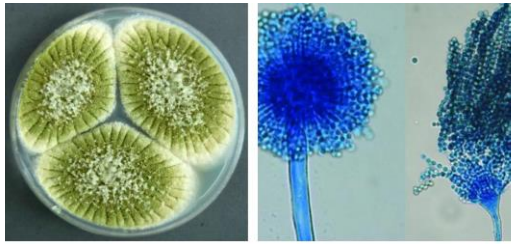

Aspergillus flavus

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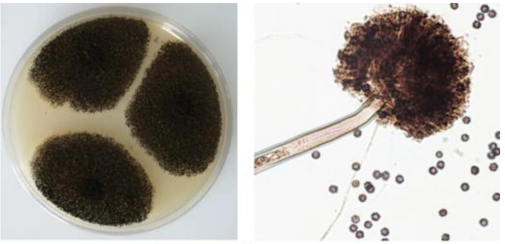

Aspergillus niger

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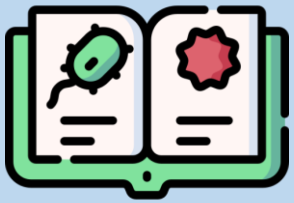
Objectives



General

- Evaluate the performance of fungi of the genus *Aspergillus* Spp as degradation agents of PS in the soil.

Specifics

- Adapt the PS for its subsequent degradation with fungi of the genus *Aspergillus* Spp.
- Obtain the inoculum from the strains of *Aspergillus niger* and *Aspergillus flavus* in the Sabouraud agar culture medium.
- Determine the degradation efficiency of PS with *Aspergillus* Spp.

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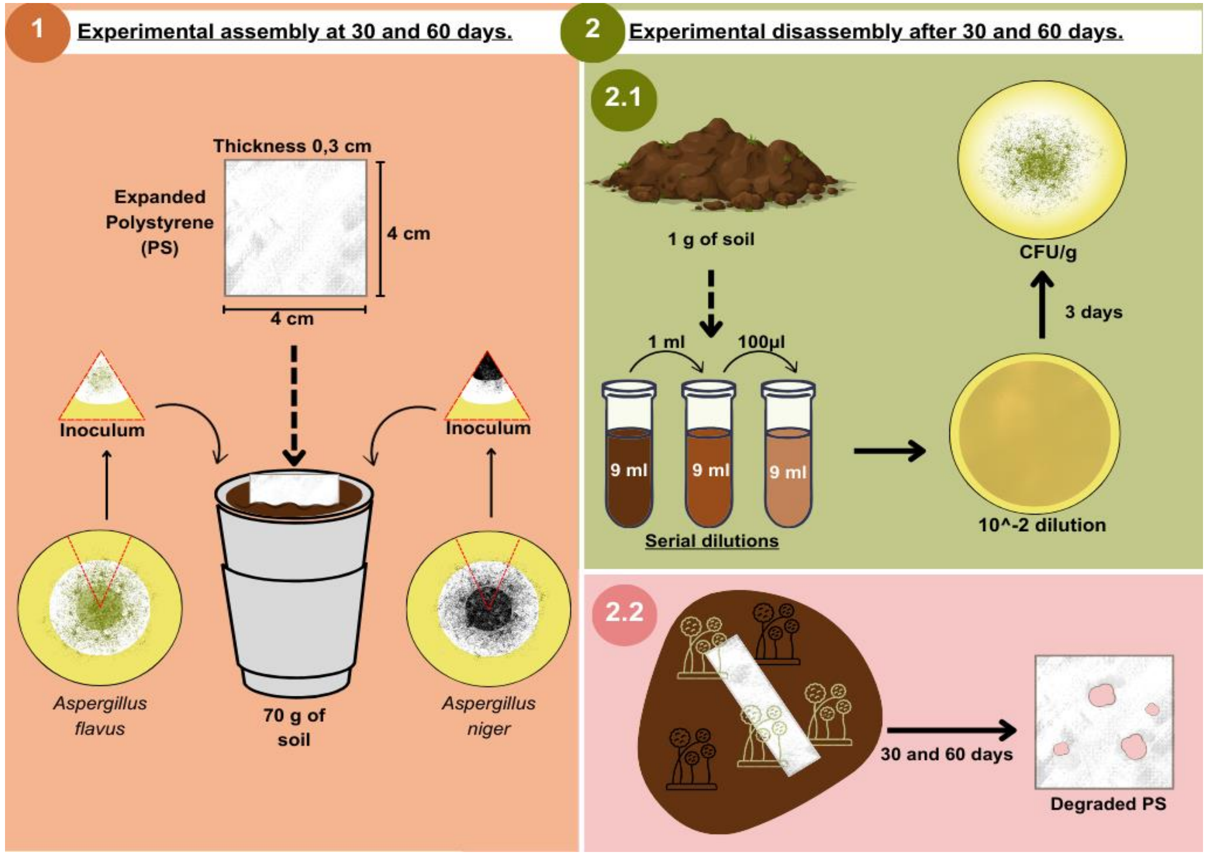
Methodology



Experimental Design

Experiment	Strain	Time (Days)	Radiation (254 nm)
1	AN	30	yes
2	AF	30	yes
3	AN+AF	30	yes
4	Inoculated	30	No
5	AN	60	yes
6	AF	60	yes
7	AN+AF	60	yes
8	Inoculated	60	No
C1	Control	30	No
C2	Control	60	No

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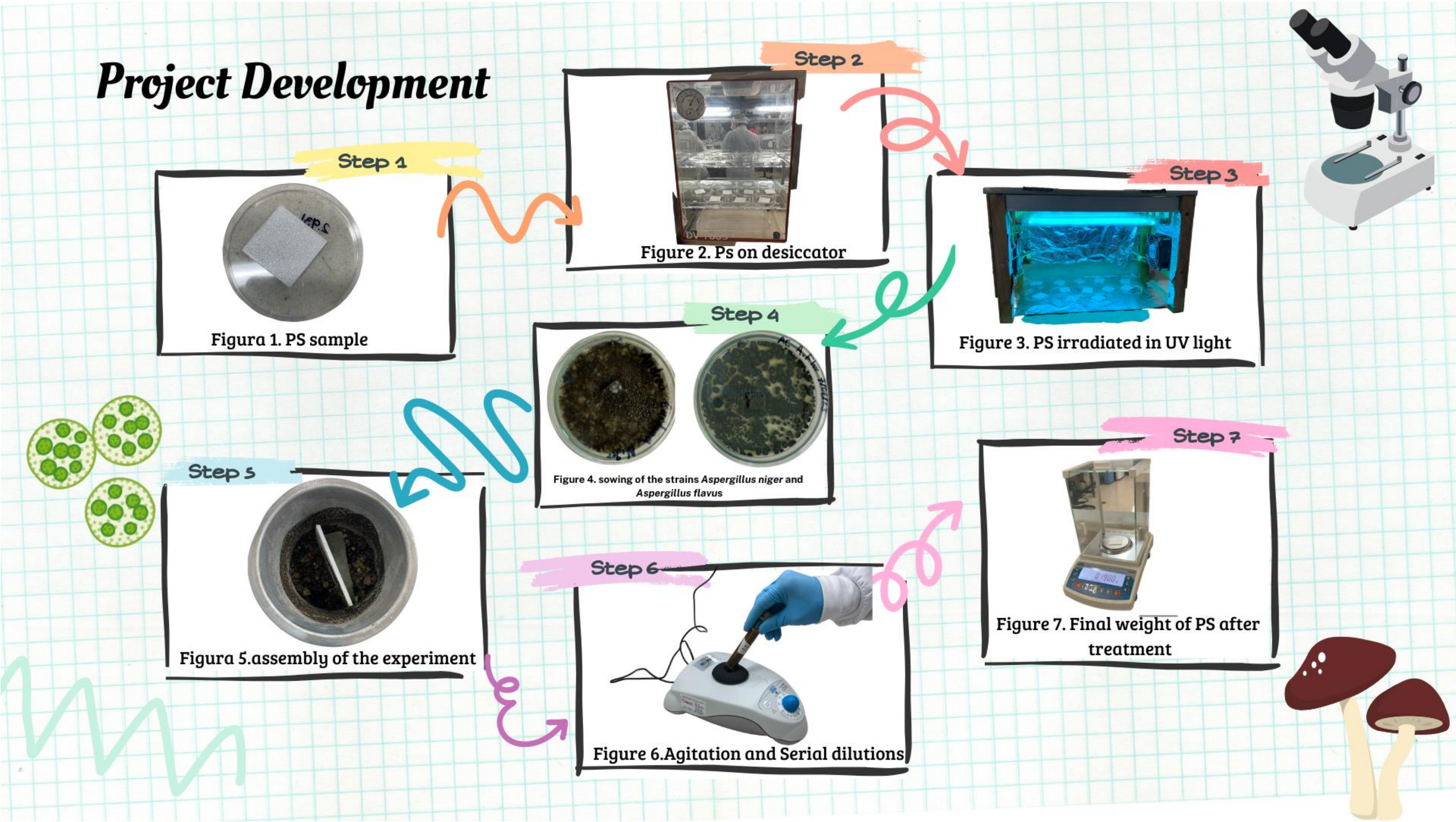

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Results and analysis

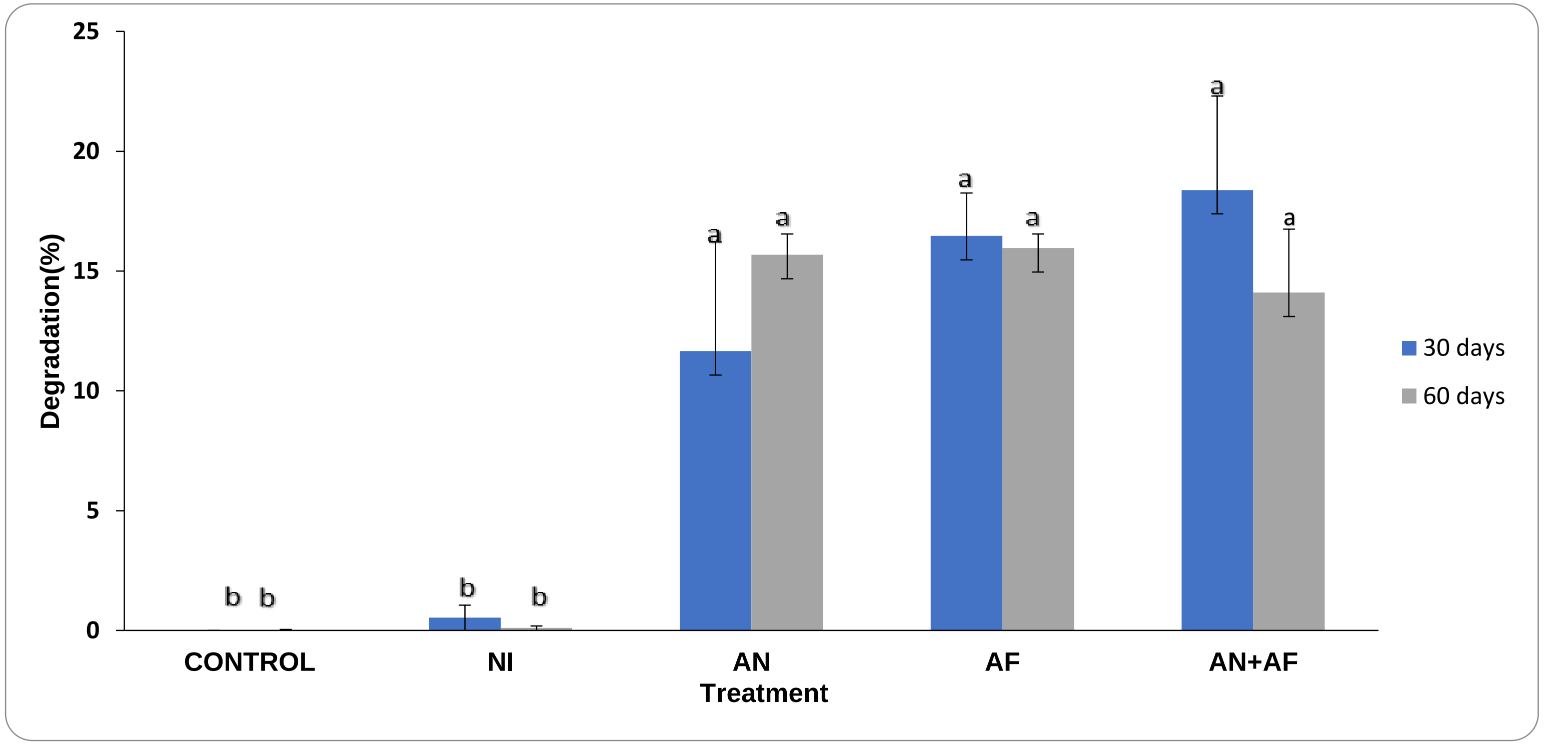

Figure 1. Percentage of biodegradation of the non-inoculated and inoculated expanded polystyrene with microorganism individually and in consortium in 30 and 60 days.

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Results and analysis

Table 1. fungal growth over time per gram of soil per 10^4

Strain	Repetition	30 days	60 days	desv 30	desv 60
NI	1	0	0	0	0
	2				
	3				
	1				
AN	2	38.30	48.70	11.90	12.47
	3				
	1				
AF	2	46.70	48.00	6.60	12.68
	3				
	1				
AN+AF	2	47.00	20.70	6.53	5.91
	3				

Fig 3. *Aspergillus flavus*

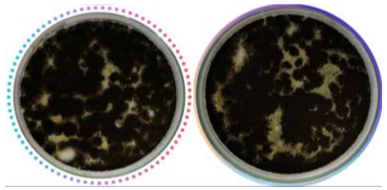

Fig 4. *Aspergillus niger*

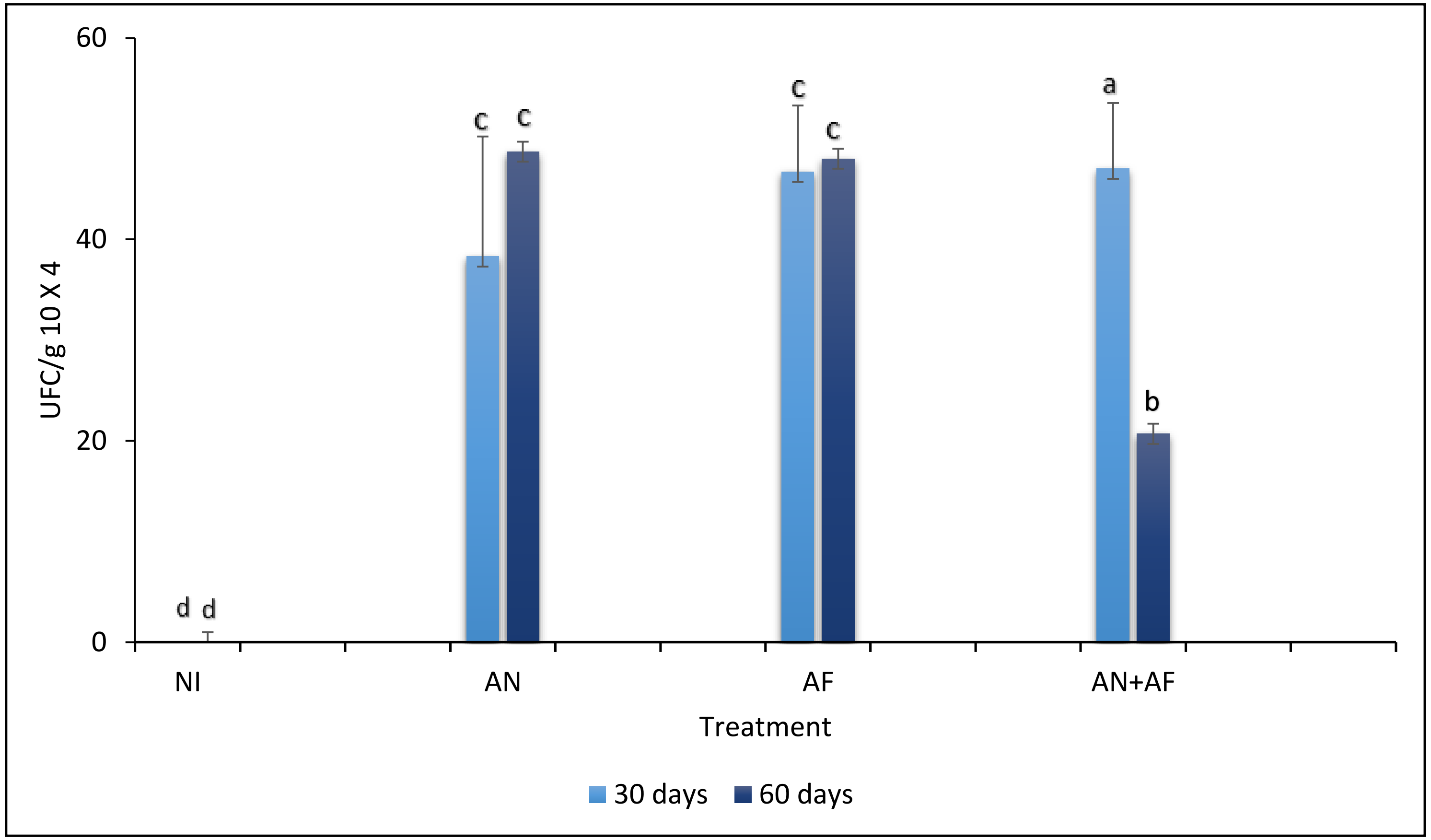

Figure 2. Growth of Colony Forming Units (CFUs) per gram of soil per 10^4.

Conclusions

- The biodegradation process was applied with the fungi of *Aspergillus niger* and *Aspergillus flavus* applied in soil for the reduction of expanded polystyrene (PS), evaluating its effect individually and in consortium, for periods of 30 and 60 days.
- Control and non-inoculated samples did not show significant results in the reduction of PS, while in those inoculated with fungi of the genus *Aspergillus niger*, *Aspergillus flavus* and in consortium, degradation was reached between 14% and 18%, without showing statistically significant differences in periods of 30 or 60 days.
- It was analyzed that during the 60 days the samples in consortium presented a decrease in the CFU due to the lack of the nutrient solution and the low percentage of humidity.

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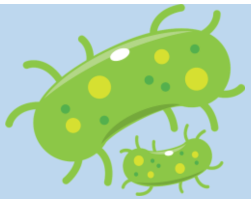
Acknowledgment



- To the Universidad Colegio Mayor de Antioquía
- To the soil laboratory Biofertilizar, for the support of some statistical analyses; and to the teaching advisers, for the accompaniment to the students in the presentation of the proposal and preliminary results, which was instrumental in successfully conducting the research.

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Influence of Dominant Tree Species in the Urban Forest of Colegio Mayor de Antioquia University Institution on Precipitation Regulation and Redistribution.

Karina Andrea Lazcarro Jaramillo, Brenda Michell Guzmán Rojas, Ana María Agudelo Caro, Miriam Alejandra Moreno Muñoz

Thematic Advisor: Santiago Vásquez Sogamoso
Methodological advisor: Carlos Fidel Granda, Gina Hincapié Mejía
Research Group: Environment, Habitat, and Sustainability.
Research Seedbed: Environmental Sciences Research Seedbed SICA.

SICA SEMILLERO DE INVESTIGACIÓN EN CIENCIAS AMBIENTALES

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INTRODUCTION

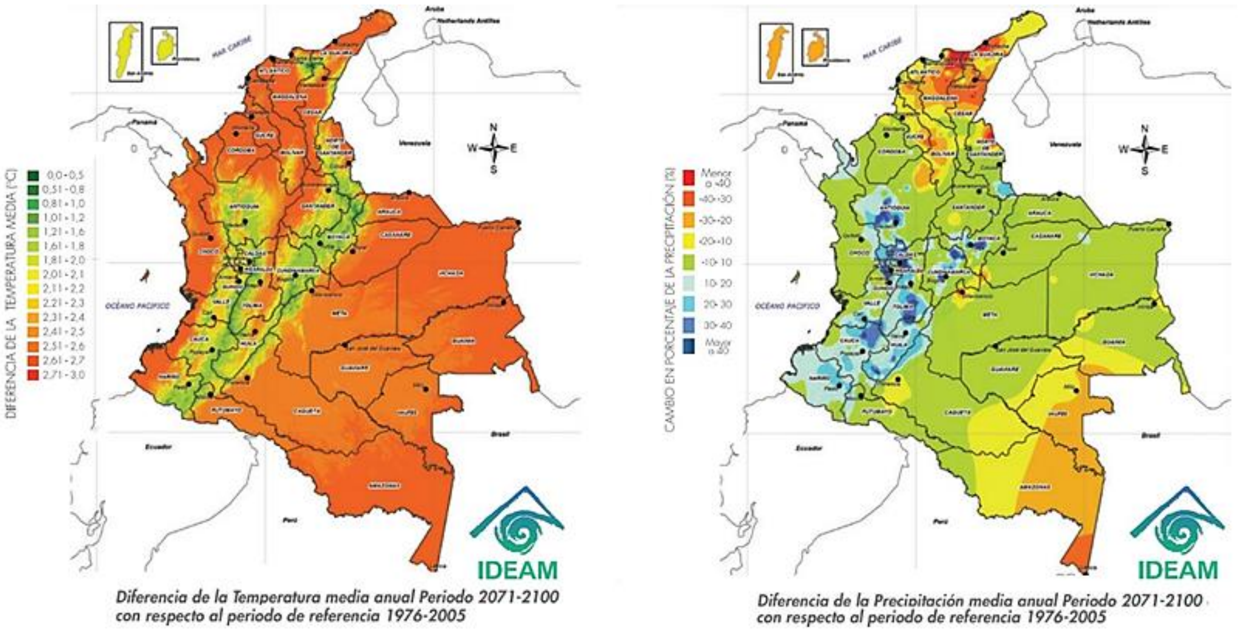

Figure 1. Estimated annual mean difference in temperature and precipitation in Colombia for the period 2071-2100. Retrieved from (Dinámicas Del Clima Andino Colombiano, 2020).

Figure 2. Morphology of the Aburrá Valley. Retrieved from (Área Metropolitana, 2019).

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THEORETICAL FRAMEWORK

Multiple studies examine the **interaction between climate and vegetation** and its impact on soil water availability, emphasizing the importance **of functional traits** of vegetation, such as morphology and physiology, in ecosystem services like **hydrological regulation**. The diversity of tree species can contribute to climate change management in urban areas.

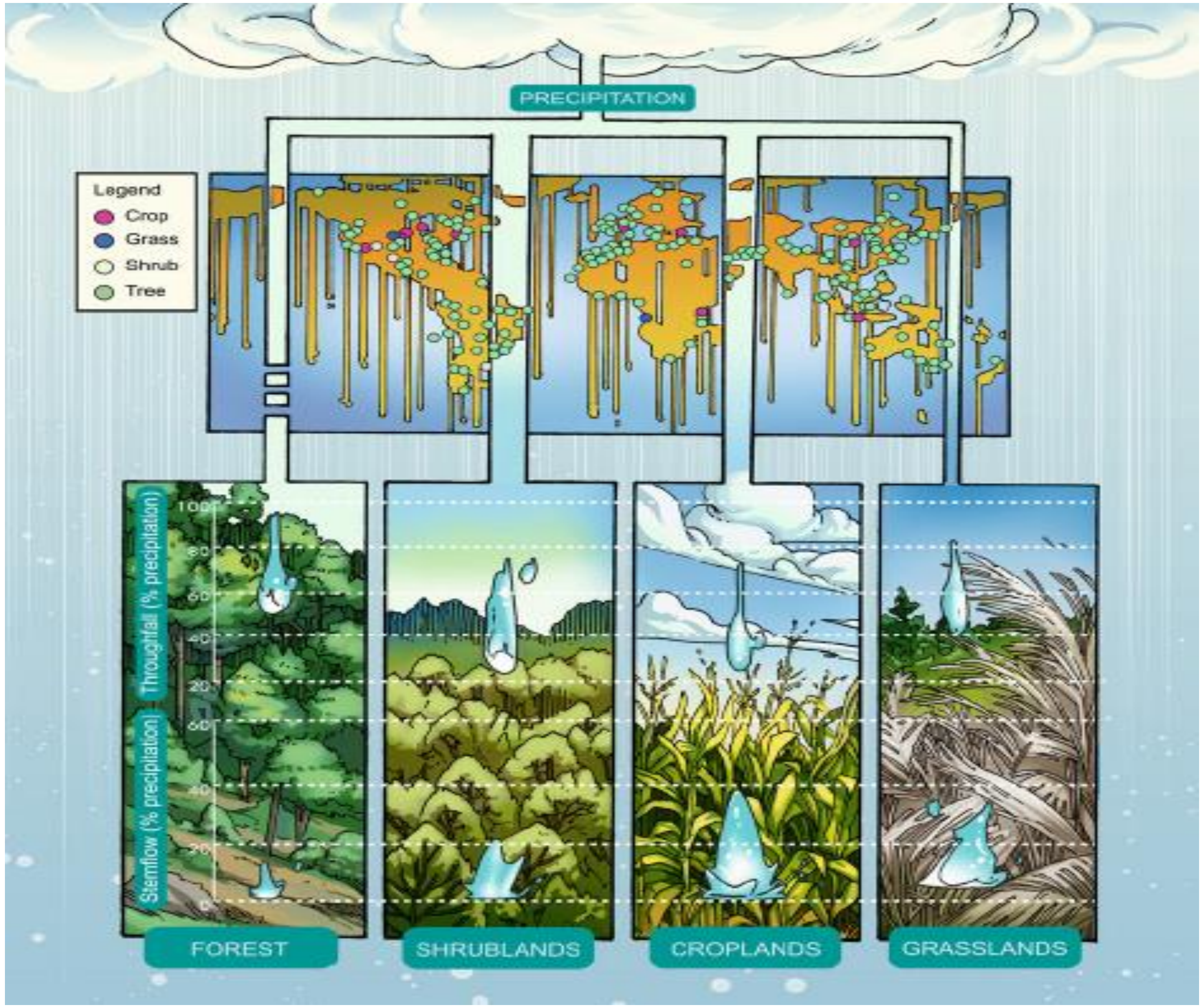

Figure 3. Precipitation. Retrieved from (Precipitation Partitioning By Vegetation, 2021)

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Figure 4. Partitioning of precipitation fluxes in urban trees. Retrieved from (Reyes, 2016).

Figure 5.a. Stemflow. **Figure 5.b.** Throughfall.
Retrieved from (Precipitation Partitioning By Vegetation, 2021)

GENERAL OBJECTIVE

Assessing the influence of dominant tree species in the urban forest of Colegio Mayor de Antioquia University on precipitation partitioning and hydrological regulation.

Figure 6. panoramic view of the university campus**.** Retrieved from *(Institución Universitaria Colegio Mayor de Antioquia, 2021)*

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SPECIFIC OBJECTIVES

1. Identify the dominant species and measure the functional traits of each dominant tree individual, which are related to water interception.

2. Identify the dominant tree species that have the greatest influence on the regulation and redistribution of precipitation in the urban forest.

3. Assess the relationship between hydrological flows and the functional traits of each individual.

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METHODOLOGY

Figure 7. Study Methodology Study of the Influence of Tree Species on Precipitation Partitioning Fluxes. Self Created.

RESULTS AND ANALYSIS

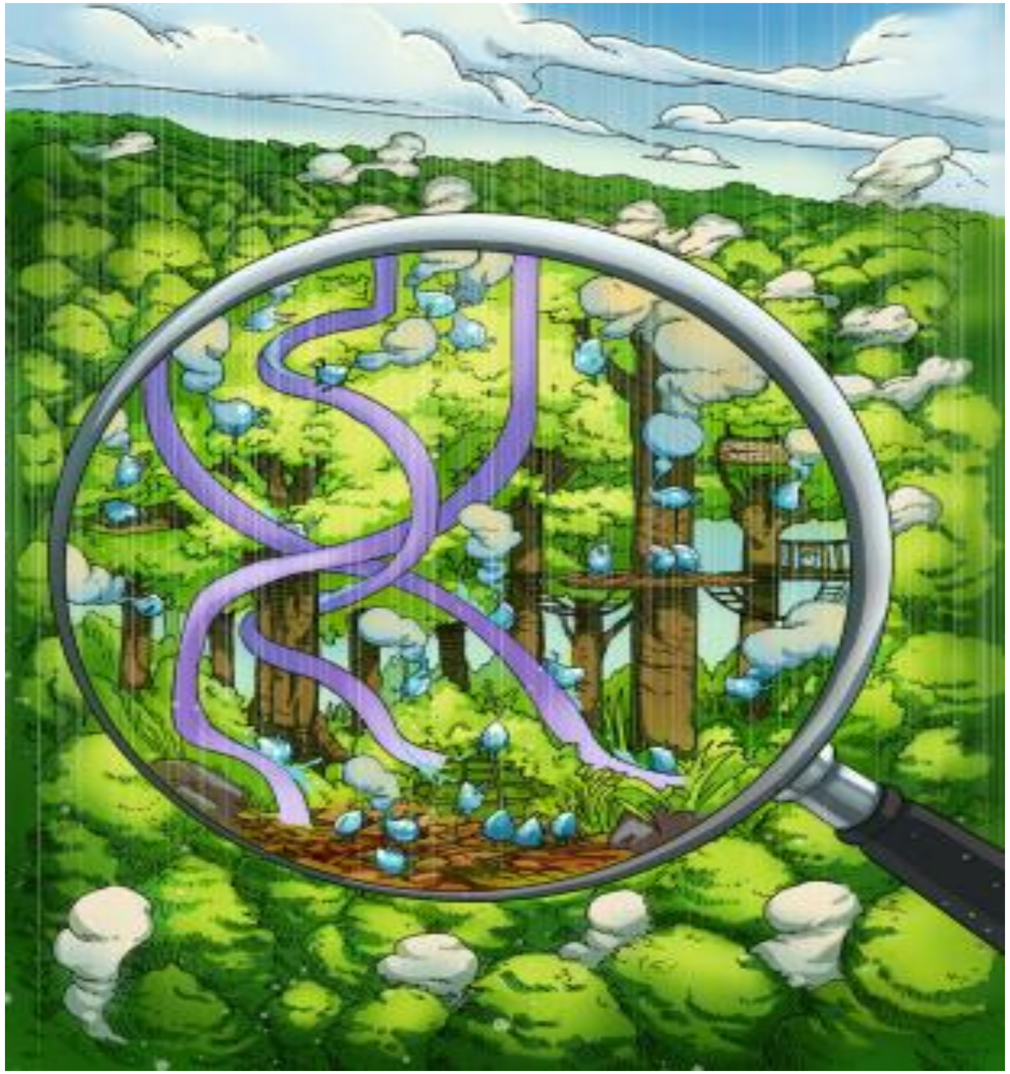

Figure 8. Results and analysis. Retrieved from (Precipitation Partitioning By Vegetation, 2021).

PRECIPITATION PARTITIONING

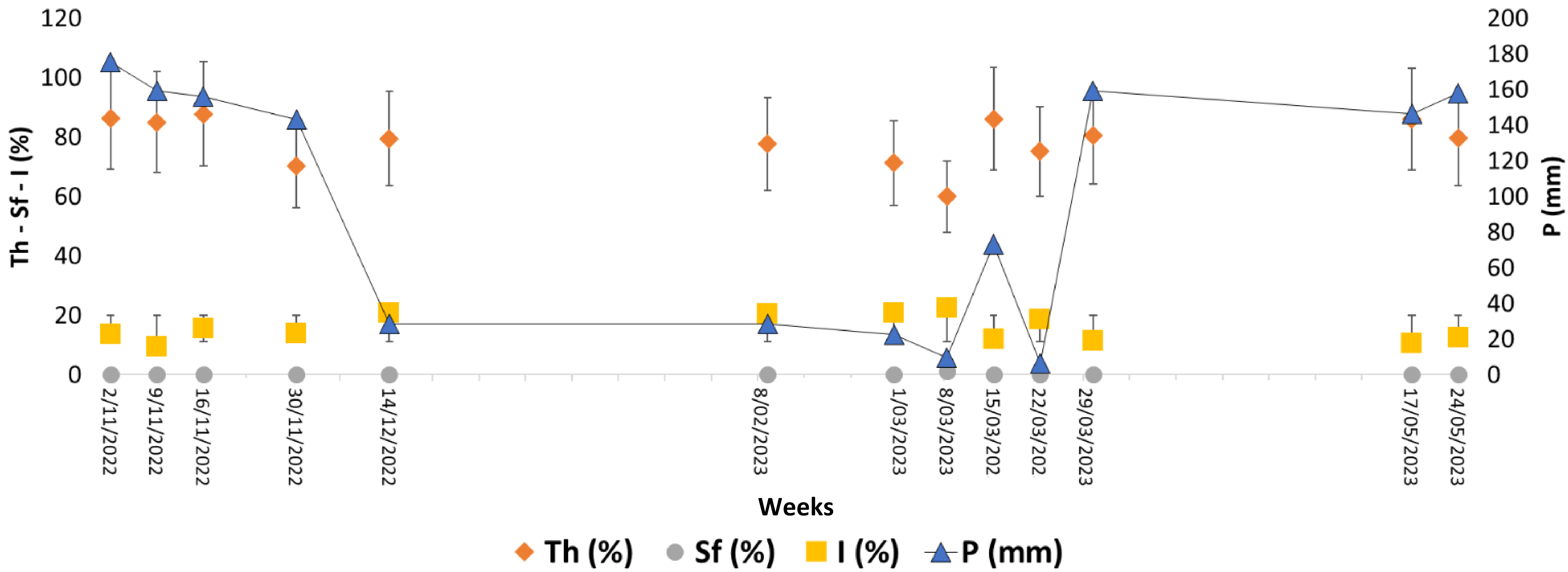

Figure 9. Precipitation partitioning. Self Created.

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STEMFLOW

Figure 10. a. Stemflow. Self Created

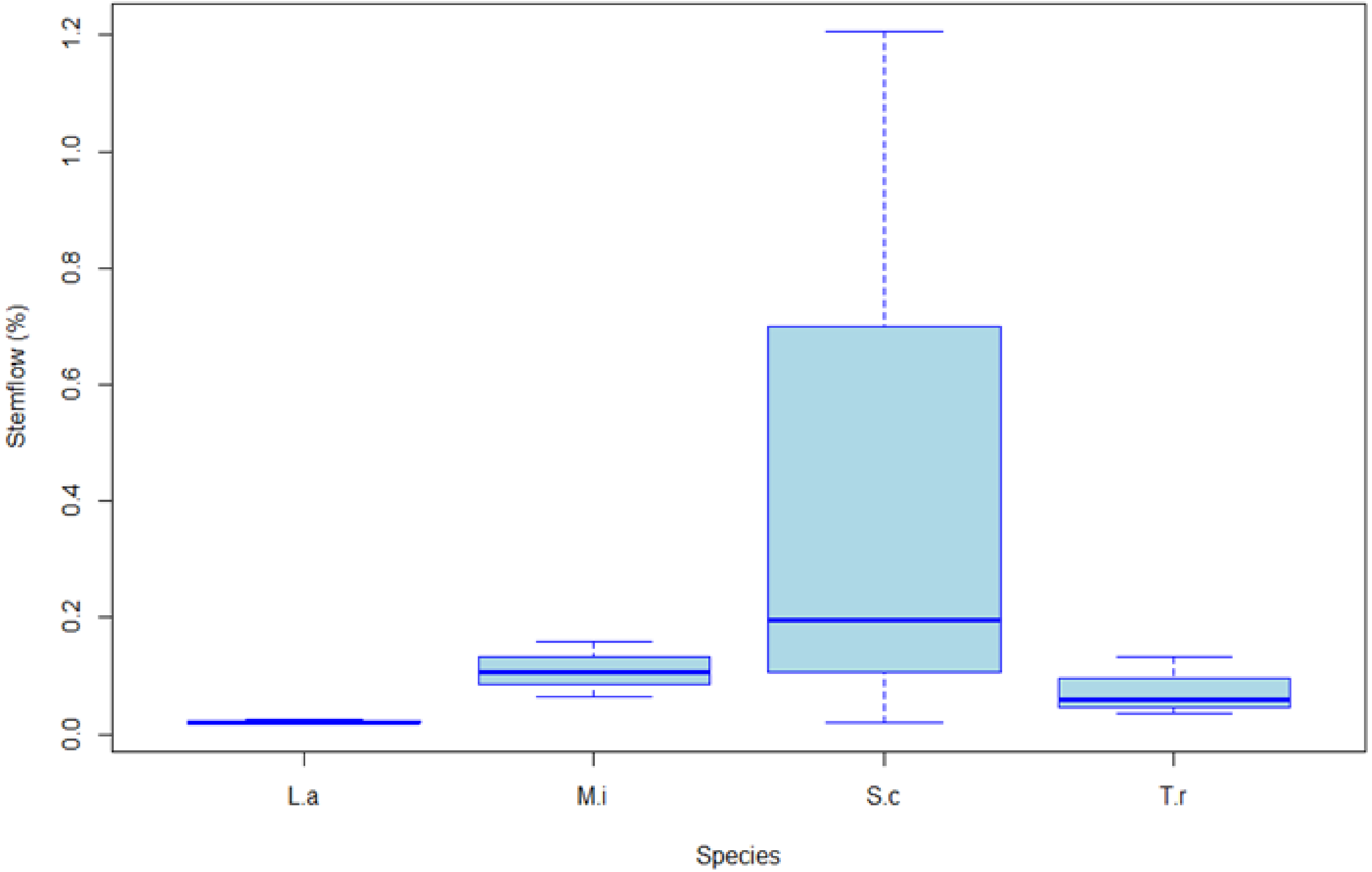

Figure 10. b. Stemflow percentage. Self Created

THROUGHFALL

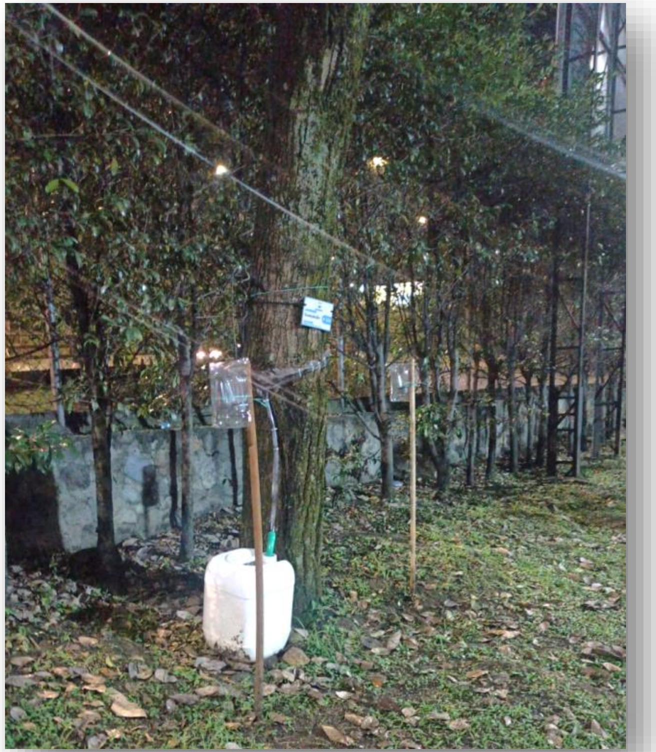

Figure 11.a. Throughfall. Self Created.

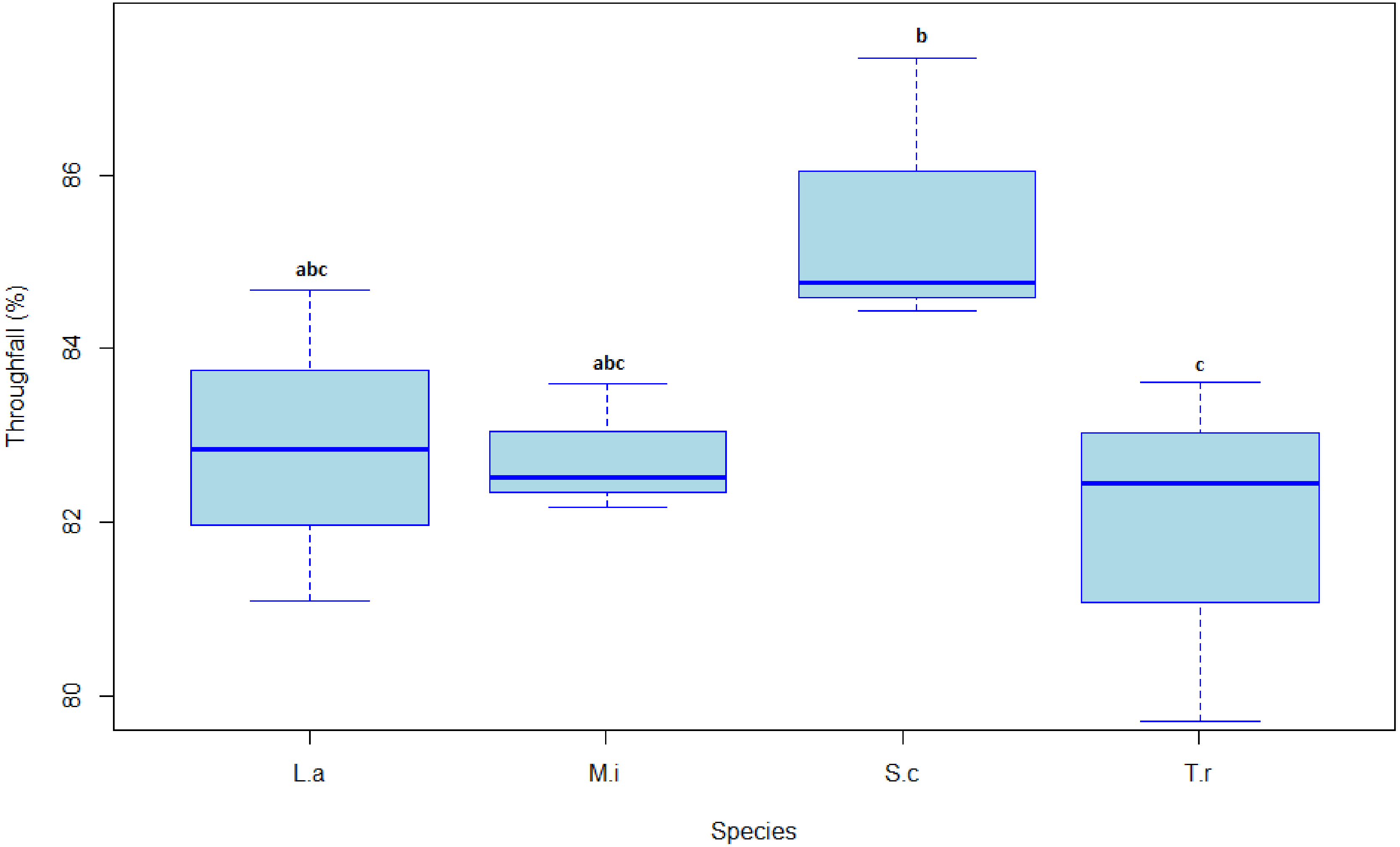

Figure 11.b. Throughfall percentage. Self Created.

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INTERCEPTATION

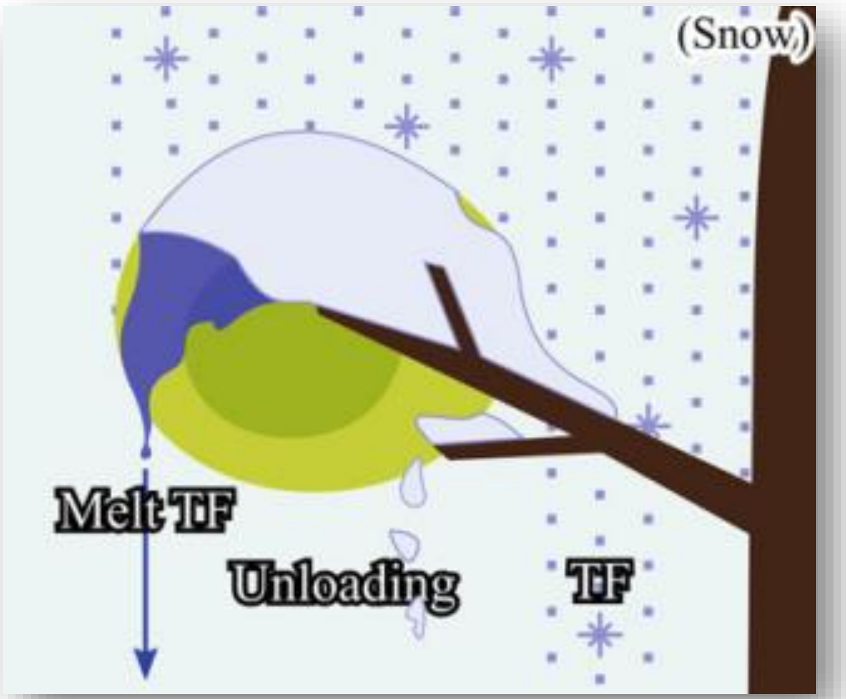

Figure 12.a. Interceptation. Retrieved from (Precipitation Partitioning By Vegetation, 2021)

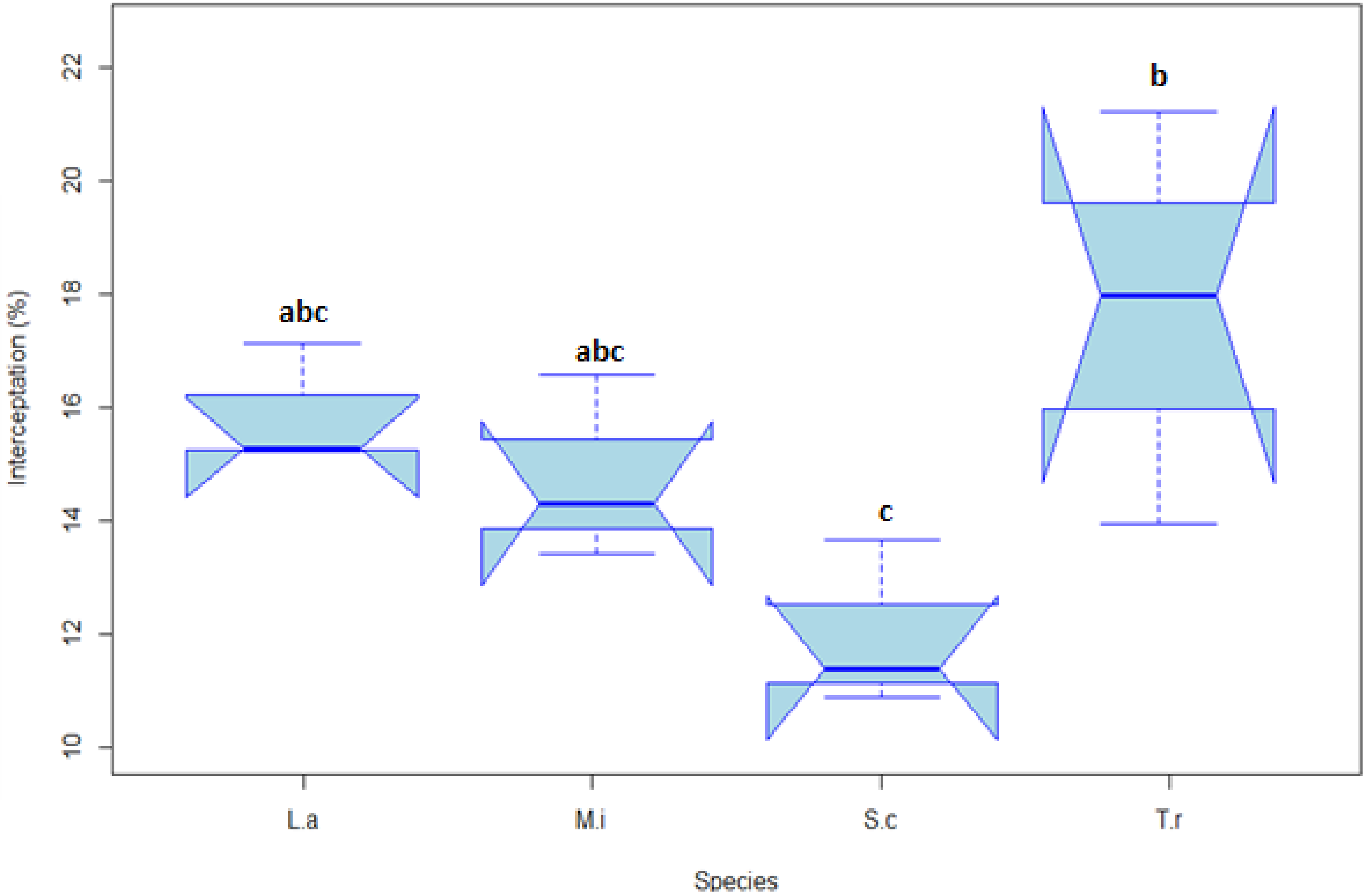

Figure 12.b. Interceptation. percentage. Self Created.

CORRELATIONS BETWEEN FUNCTIONAL TRAITS AND PRECIPITATION PARTICIPATION FLUXES

Figure 13. Correlations between functional traits and precipitation participation fluxes. Self Created.

CONCLUSIONS

Urban trees play a significant role in the regulation and redistribution of precipitation within urban environments. This study observed that during periods of intense rainfall, trees are capable of reducing surface runoff by enhancing internal precipitation, whereas during light rainfall events, they facilitate water retention, thus decreasing surface runoff. Additionally, the study emphasizes the importance of integrating the structural and functional characteristics of trees into urban green infrastructure management to enhance hydrological regulation and effectively address the challenges posed by climate change.

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PHYTOREMEDIATION WITH *Eichornia crassipes* IN SYMBIOSIS WITH *Bacillus subtilis* IN CHROMIUM CONTAMINATED WATERS

Yessica Yulieth Pedroza Vargas
Luis Alberto Acosta Martínez
María José Navarro Uparela

Methodological advisor: Gina Hincapie Mejia
Thematic advisor: Laura Osorno Bedoya

Institución Universitaria Colegio Mayor de Antioquia
Faculty of Architecture and Engineering
2024-1

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RESEARCH PROBLEM

The presence of heavy metals in aquatic ecosystems due to the activity industrial and the lack of adequate treatment of contaminated effluents is a problem environmental impact of great magnitude.

Photograph obtained from: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcR18MxbVfcc_V-Y_2tNUfxmkZqHCkLDOmm9iCyegZ2otA&s

The accumulation of these metals in aquatic organisms, as well as their transfer through the food chain, poses significant risks to human health and the ecological balance of the aquatic ecosystems

.

Photograph obtained from: https://encrypted-tbn0.gstatic.com/images?q=tbn:ANd9GcTxcv9iF7fOO5Zu7_WgTqCMOHZuwWL4JvICY-aqAQfywg&s

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THEORETICAL FRAMEWORK

Eichornia crassipes

Rooted macrophyte that grows in water contaminated and has great potential for the accumulation of heavy metals.

Absorbs chromium ions through roots and translate them to other parts of the plant, such as stems and leaves .

E crassipes under conditions of Neutral pH and exposure media of 90 mg/L of Cr, accumulated amounts significant amounts of metal, with a removal percentage of 75%.

Photograph obtained from: https://www.quora.com/unanswered/What-do-you-know-about-the-efforts-in-Kerala-to-make-use-of-water-hyacinths

Photograph obtained from: https://sklenicemk.live/product_details/51697294.html

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THEORETICAL FRAMEWORK

Bacillus subtilis

Bacteria that has developed tolerance to heavy metals such as chromium, survives in environments with concentrations without suffer significant damage.

It has the ability to absorb ions Cr on their cell surface, they can reduce it to its least toxic form, the Cr(III).

Bacillus sp. with other isolated microorganisms is not as efficient as using only Bacillus sp. since they were obtained removal results of 100%, while overall only 85% was obtained.

Photograph obtained from: https://www.bionity.com/es/noticias/1179022/microbio-del-ano-2023-bacillus-subtilis-para-la-salud-y-la-tecnologia.html

Photograph obtained from:https://twitter.com/mICROBIOsh/status/1501543424218091525

OBJECTIVES

General

To evaluate the effect of bioremediation of chromium in water using Eichornia crassipes in symbiosis with Bacillus subtilis.

Specific

- Establish the quantification model of Cr^{6+} in the water matrix in the presence of Eichornia crassipes.
- Evaluate the growth and development of Eichornia crassipes in water contaminated with chromium.
- Calculate the efficiency of chromium bioremediation in waters with Eichornia crassipes in symbiosis with Bacillus subtilis.

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METHODOLOGY

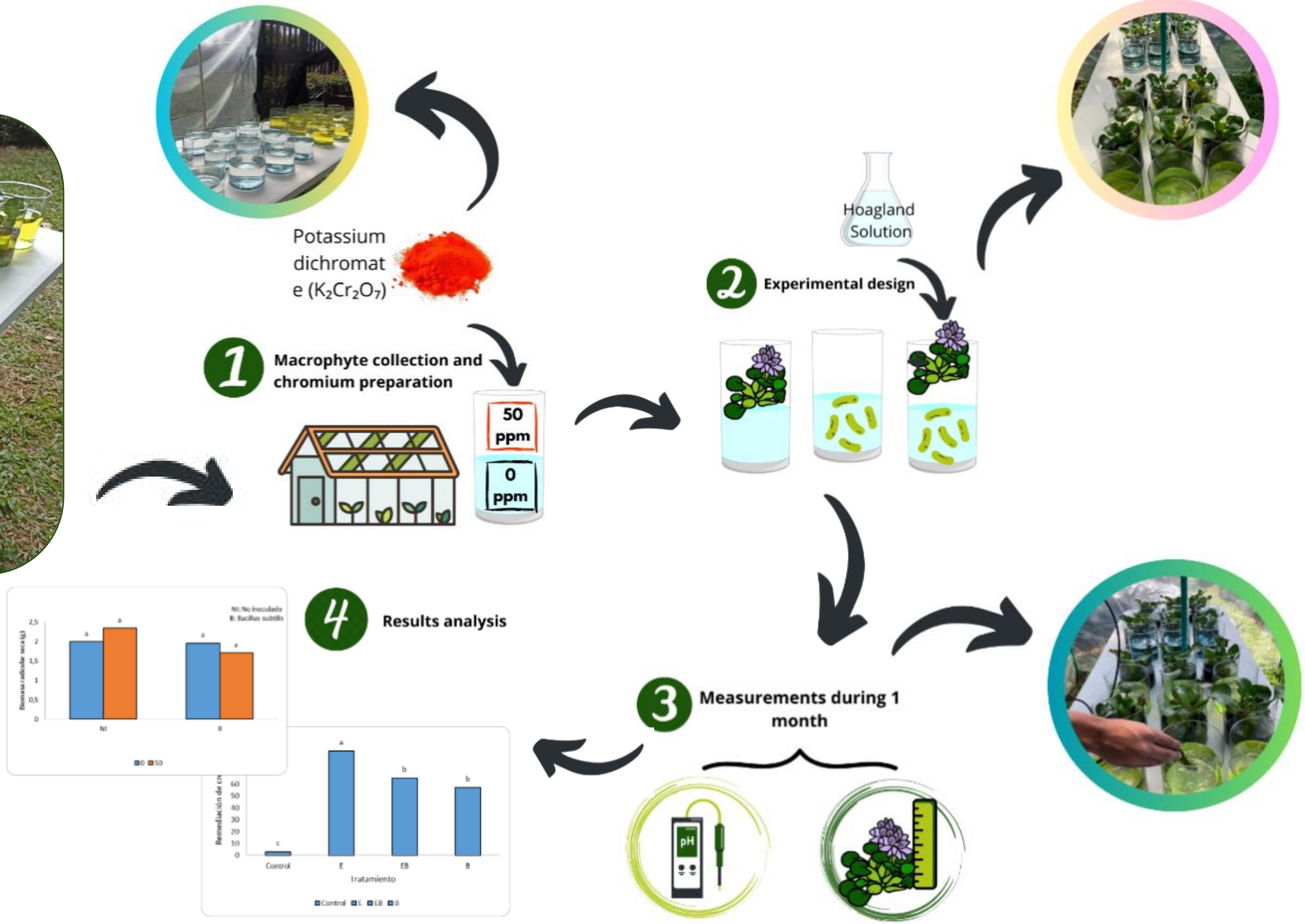

Figure 1. Project methodology.
Source: Authors.

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RESULTS AND ANALYSIS

Image 1. Disassembly on day 32

Source: authors.

Image 2. *Eichhornia crassipes* in symbiosis with *Bacillus subtilis*, without chromium - with chromium.

Source: authors.

Image 3. *Eichhornia crassipes,* without chromium - with chromium.

Source: authors.

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RESULTS AND ANALYSIS

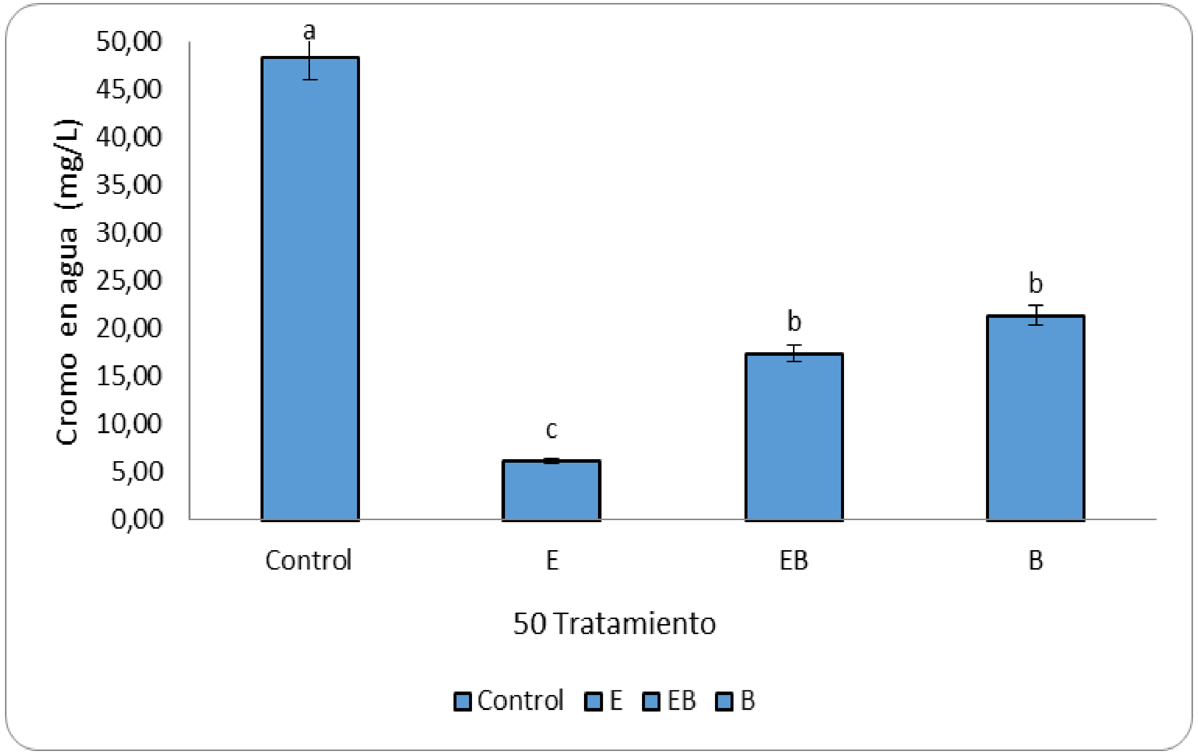

Figure 2. Chromium concentration in water (mg/L).
Source: authors.

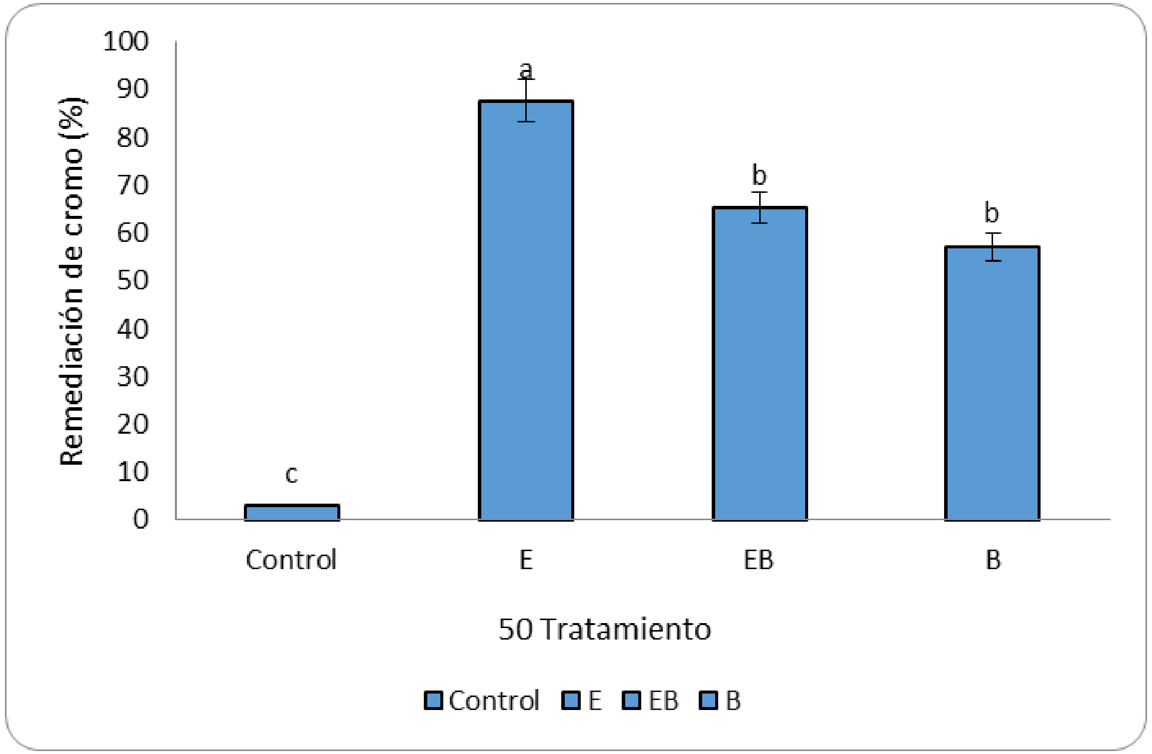

Figure 3. Chromium remediation percentage.
Source: authors.

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CONCLUSIONS

- Based on the observed results, it is concluded that Eichornia crassipes has the ability to adapt to bodies of water contaminated with heavy metals such as chromium, since its growth in leaves and roots was not significantly affected by the conditions in which it was found.

- Bacillus subtilis also demonstrated to be tolerant to high concentrations of Chromium, however, a greater presence of the bacteria was observed in treatments where there was symbiosis with the plant, evidencing the possibility that the bacteria is more efficient in remediating the contaminant in environments where has been related for the longest time to Eichornia crassipes.

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CONCLUSIONS

- Although the presence of Bacillus subtilis was significantly greater in the symbiosis relationship with the plant, the results show that for Eichornia crassipes the symbiosis with the bacteria under contaminated conditions did not have a positive effect on its development and growth. This is attributed to the formation of a biofilm by Bacillus subtilis, which, although it protects the plant from stress caused by pollution, can also limit its growth due to possible competition for nutrients.

- Although these two microorganisms do not have a symbiotic association established in the scientific literature, with the results obtained in terms of remediation and the amount of chromium in water after treatment, it is concluded that this association does have the capacity to remediate waters contaminated with chromium not in high percentages as if Eichornia crassipes did it on its own as mentioned in the results.

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XXIII SEMANA DE LA FACULTAD
ARQUITECTURA E INGENIERÍA

Del 6 al 10 de mayo

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Determination of the risks associated with the contamination of the El Hato stream in the town of San Félix in the municipality of Bello-Antioquia

Luis Mateo Giraldo Guzmán
Mateo Bedoya Miranda
Verónica Granada Sánchez

SICA
Semillero de Investigación
Institución Universitaria Colegio Mayor de Antioquia

Course teacher
Gina Hincapié

Adviser
Lila Cortez
Juan David Correa

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Research Problem

- Water pollution due to human settlements is a significant global environmental issue, impacting both quality of life and aquatic ecosystems.
- Human activities in urban and rural areas generate waste that ends up in nearby rivers, streams, and lakes, leading to toxic substance accumulation and habitat degradation.
- This pollution has severe consequences for public health, biodiversity, water quality, and ecosystems, necessitating measures to reduce water pollution and protect aquatic resources.

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Theoretical Framework

- Activities in rural areas, particularly agriculture and livestock farming, contribute to water pollution due to waste from these processes.
- Various factors such as changes in the environment, land use, geomorphology, and precipitation intensity affect water quality and quantity.
- Water quality assessment involves using indices like the Water Quality Index (WQI) to simplify evaluation and determine vulnerability to threats.

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Objectives

General:

Determine the risks associated with El Hato stream contamination in San Felix, Bello, through comprehensive water diagnostics.

Specific:

- Diagnose El Hato stream water quality using WQI and microbiological analysis considering community economic activities and consumption dynamics.
- Correlate potential risks to the community based on contaminant loads and concentrations found.
- Socialize the results with the community.

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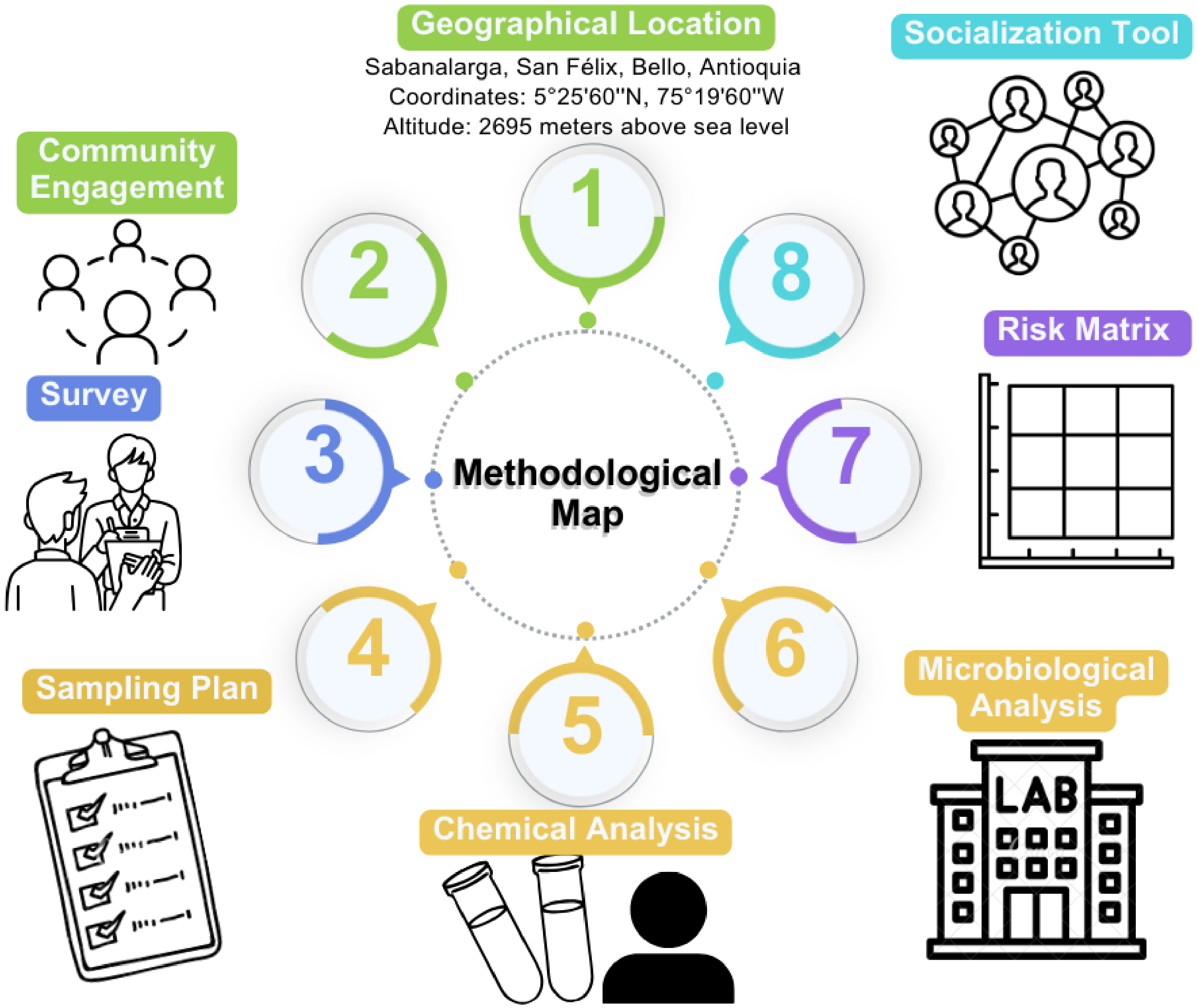

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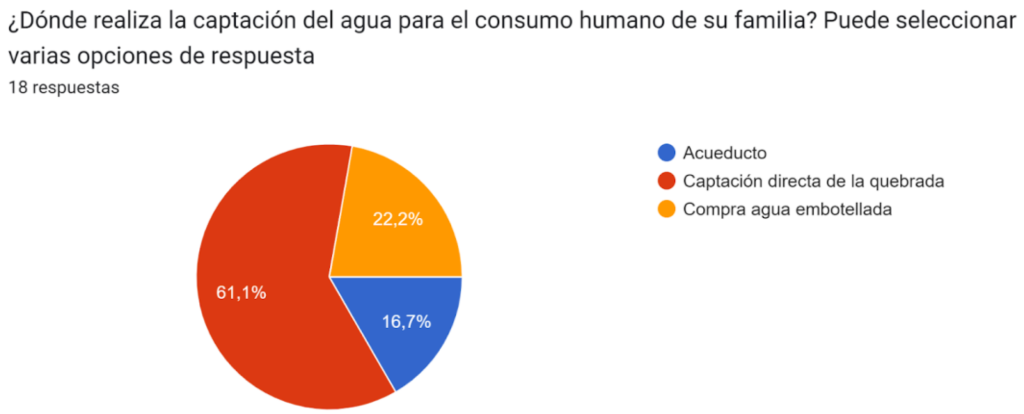
Results and Analysis



Location of water collection for human consumption

Productive activities

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Results and Analysis

Average wet season data

Parameters	Sampling point 1	Sampling point 2
DQO (mg/L)	225.33	282.00
SST(mg/L)	3.33	4.67
pH	6.6	6.8
OD (%)	0.84	0.90
Conductividad (µs/cm)	16.83	46.47

Average dry season data

Parameters	Sampling point 1	Sampling point 2
DQO (mg/L)	208.67	256.43
SST(mg/L)	4.00	5.33
pH	6.60	6.80
OD (%)	0.68	0.65
Conductividad (µs/cm)	21.30	52.63

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Results and Analysis

Microbiological analysis

	Dilución 10-1	
Recuento	M1 Casa	M2 Quebrada
CT	150	160
E. Coli	7	9
	Dilución 10-1	
Recuento+Dilución	M1 Casa	M2 Quebrada
CT	1500	1600
E. Coli	70	90

	M1	M2
CT	1,5x10^3 UFC/100 mL	1,6x10^3 UFC/100 mL
E.Coli	7,0 x10^1 UFC/100 mL	9,0x10^1 UFC/100 mL

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Results and Analysis

ICA, Quebrada el Hato		Risk classification									
		Categories of values that the indicator can take (%)					Risk level				
Rainy season		0,00 - 0,25	0,26 - 0,50	0,51 -0,70	0,71 - 0,90	0,91 - 1,00	Sanitarily unfeasible	High	Half	Low	Risk free
Sampling points	1			X					X		
	2			X					X		
Dry season											
Sampling points	1			X					X		
	2			X					X		

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Results and Analysis

The water quality is at an acceptable level for the intended use, but could present some risks for certain specific uses or for certain sensitive groups. Water with a medium AQI is considered to meet the quality standards established in most environmental regulations and guidelines.

However, it is recommended to maintain continuous surveillance and take preventive measures if significant changes in water quality are observed to avoid possible adverse impacts on human health and aquatic ecosystems. Furthermore, this finding suggests a consistency in water quality regardless of climatic conditions. It is recommended to maintain continuous monitoring of water quality during both seasons to detect possible variations over time.

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Conclusions

Monitoring results in El Hato creek reveal significant changes in the parameters of conductivity and dissolved oxygen at both sampling locations. These changes suggest an increase in the concentration of dissolved salts and ions in the water.

The increased conductivity can be attributed to activities such as livestock farming, agriculture, and fish farming in the area, which involve the use of fertilizers, pesticides, and chemicals that are introduced into the water, thus increasing the concentration of dissolved salts and minerals. On the other hand, the decrease in dissolved oxygen levels is likely related to organic contamination from untreated domestic wastewater. The presence of decomposing organic matter depletes the available oxygen in the water, negatively affecting aquatic ecosystems and water quality.

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Conclusions

The microbiological analysis of samples from El Hato creek and the surrounding area reveals concerning levels of fecal and total coliforms, indicating a significant risk to water quality in the region. The high presence of fecal coliforms suggests contamination from human waste, underscoring the urgent need to address and control water quality to mitigate risks to public health, particularly regarding human consumption. Preventive and corrective measures are imperative to mitigate this risk and safeguard the health of the local community.

In conclusion, the gathered data emphasizes the immediate need for action to address the escalating contamination in El Hato creek. The increase in conductivity and the decrease in dissolved oxygen levels point to human activities as the primary drivers of water quality degradation. The presence of microbiological contaminants, especially fecal coliforms, highlights the urgency of implementing effective management and control measures to protect both the environment and public health in the region.

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¡GRACIAS!

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Production and feasibility analysis of Biochar derived from leaf litter produced in a TLUD.

Yicenia Agudelo Cardona
Laura Marcela Hincapié Miranda
Salome Ramírez Olaya
Maria Camila Silva Rúa
Environmental Engineering Students

Andrea Tamayo Londoño
Julián López Correa
Thematic advisers

Gina Hincapié Mejía
Methodological adviser

Facultad de Arquitectura e Ingeniería
I.U Colegio Mayor de Antioquia
2024

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Problematic

Defficient management of organic wastes.

The leaf litter is not conducive to aerobic processes in productived soil.

Final disposal of leaf litter in sanitary landfills.

Leaf litter accumulation can clog sewer systems.

Source:https://www.flickr.com/photos/medellin_digital/19867467044

Source:https://mariagpearellano.wordpress.com/2012/05/22/alcantarillado-publico/

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Introduction

Proportions:
Leaf litter : 75%
Sawdust: 25%

Biochar: formed by heating biomass in partial absence of oxygen.

Sawdust: large surface area compared to its volume, facilitating increased oxygen contact and combustion efficiency.

From 400 to 600°C, organic material is thermally decomposed without reaching complete combustion.

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Objectives

General

Evaluate the production and possible applications of Biochar, obtained through the pyrolysis of leaf litter from a self-built TLUD (Top-Lit Updraft) device.

Specifics

- Determine the production conditions of Biochar derived from leaf litter using TLUD technology.
- Characterize physicochemically and superficially the Biochar produced.
- Investigate the possible environmental applications of the Biochar produced.

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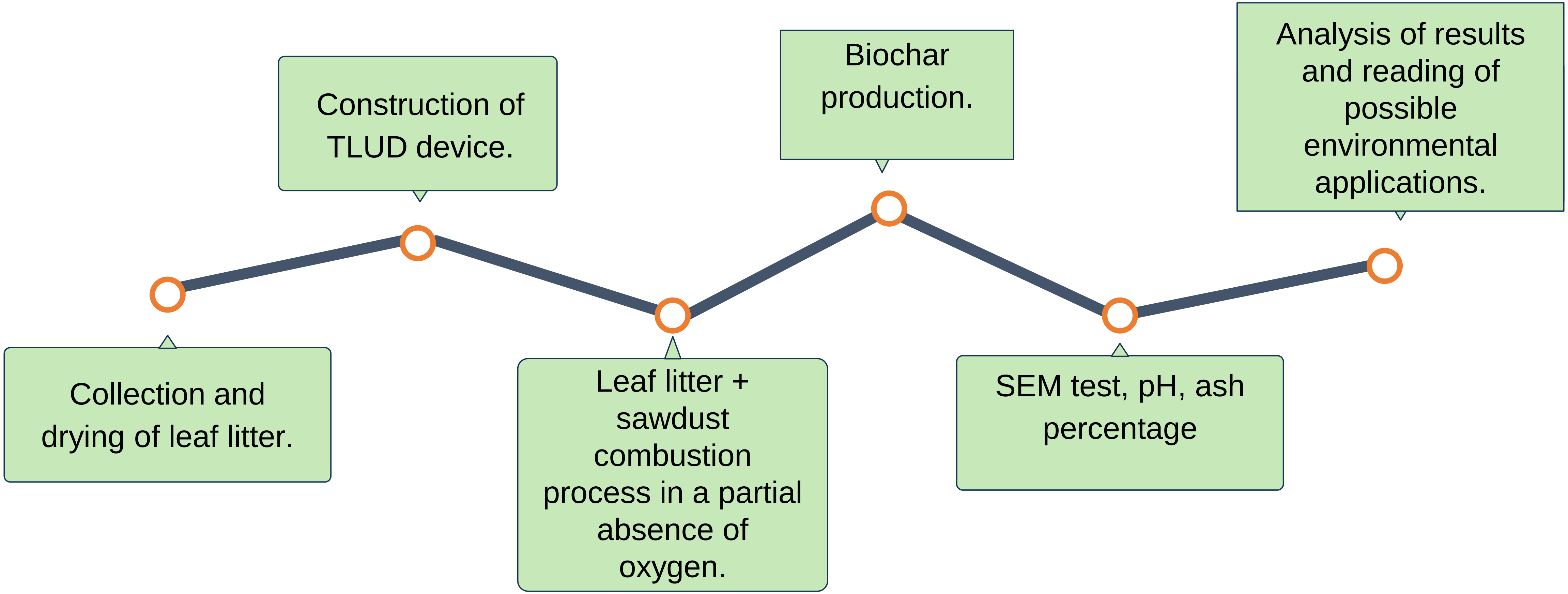
Methodology



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Results

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TLUD in operation.

Thermocouple.

Biochar process

Leaf litter collection.

Biochar produced.

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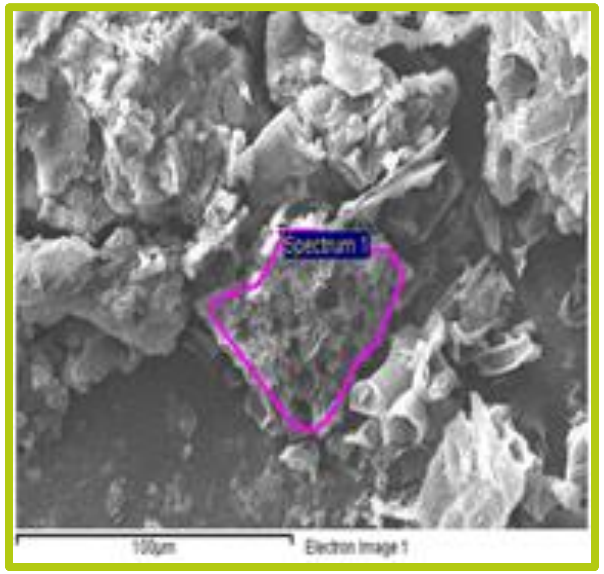
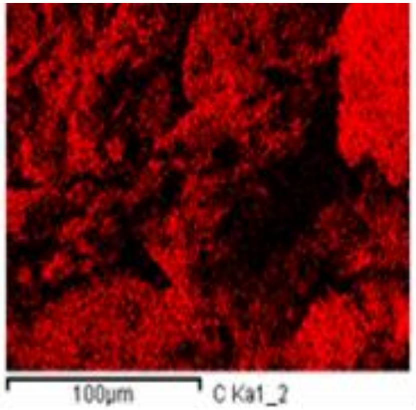
Characterization

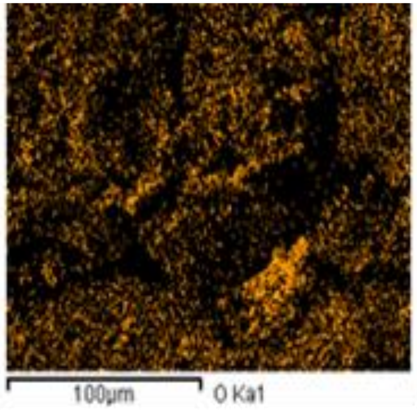
SEM ANALYSIS



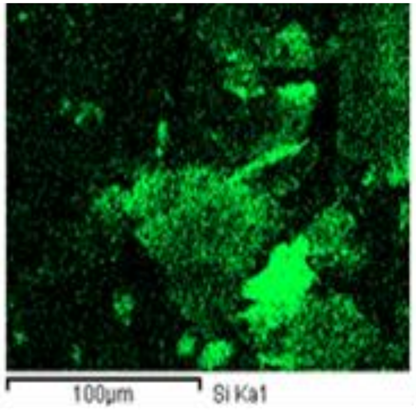
SEM microphotography



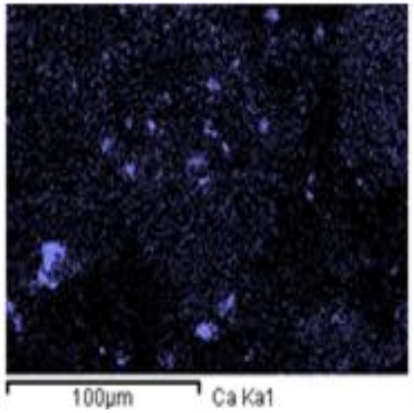
Carbon



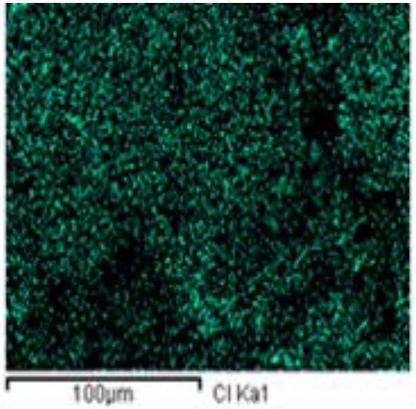
Oxygen



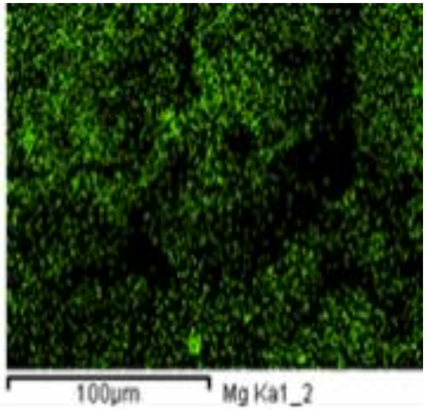
Silicium



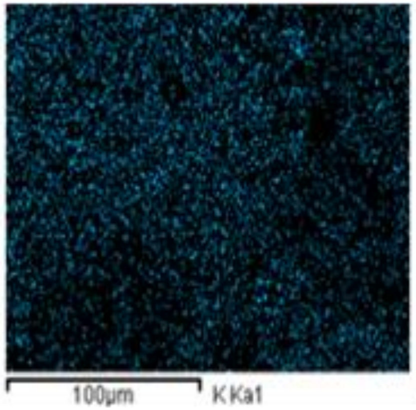
Calcium



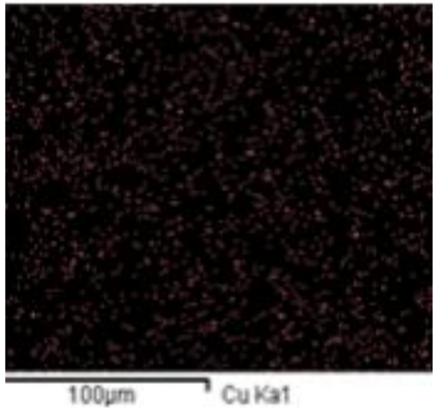
Chlorine



Potassium



Magnesium



Copper

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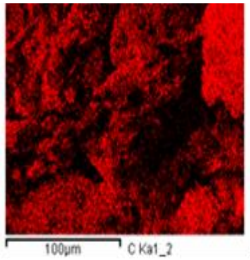
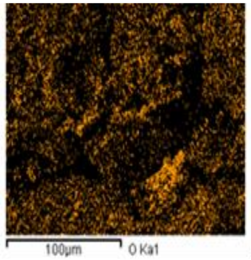
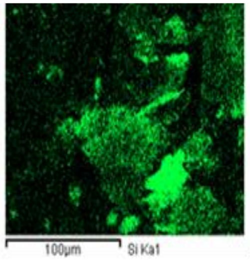
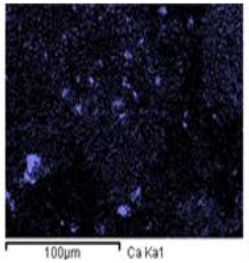
EDS ANALYSIS



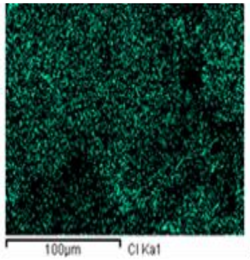


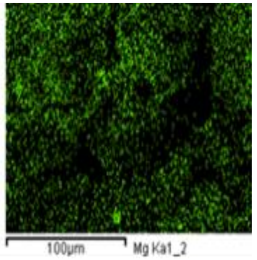


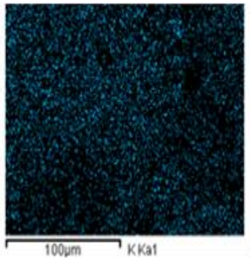


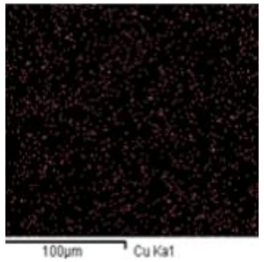
Element	App Conc.	Intensity Corrn.	Weight %
C	115.12	0.7196	73.48
O	8.24	0.3221	11.74
Si	18.21	0.9882	8.46
Ca	6.98	0.9598	3.34
Cl	2.38	0.8059	1.35
K	1.44	1.0310	0.64
Na	1.18	0.9765	0.56
Mg	0.79	0.8668	0.42
TOTAL			**100.00**

Table 1. Elemental Composition by EDS









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Ash percentage

Temperature: 650°C

Time: 16 hours

% Ash =17,7%

82.3% of the sample is converted to Biochar during the combustion process.

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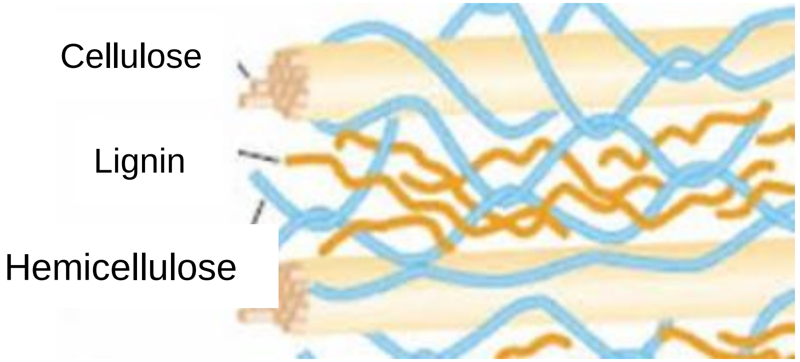
pH measurement

Biochar acid: 5.671

Proportion 1:10

Causes for the production of acid biochar:

1. Lignocellulosic raw materials.
2. pollutants present.



Source: https://www.hosokawa-alpine.es/procesamiento-de-solidos/industrias/quimica/lignina/

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Possible applications of Biochar

Source:https://www.flickr.com/photos/medellin_digital/19867467044

Cattle ranching: minimum doses in food

Alkaline soil amendment

Source:https://mariagpearellano.wordpress.com/2012/05/22/alcantarillado-publico/

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Conclusions

- The combination of sawdust and leaf litter in a specific proportion, monitored with a thermocouple during combustion, made it possible to obtain a biochar.
- The efficacy of Biochar is validated through its remarkable ash content, indicating an efficient pyrolysis process in the transformation of biomass into a carbonaceous product.
- Since Biochar is acidic, its main applications could be in ranching and alkaline soils.
- Litter stored for several days or months contains a higher proportion of lignocellulose, which leads to the resulting biochar containing more organic acids and thus contributes to its acidity.
- The presence of carbon in Biochar can provide numerous soil benefits, such as improving soil structure, increasing water and nutrient retention, and promoting beneficial microbial activity.
- The Biochar yield was 0.666%.

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Review of the most used cutting-edge technologies in the inspection of sewer networks

Author

Jonathan Quintero Henao

Thematic advisor

Luis Fernando Monsalve

Methodological advisor

Luis Alejandro Builes Jaramillo

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PROBLEM

Sewer pipe networks are critical to any city's underground infrastructure, and their uninterrupted functionality is paramount. However, wastewater pipes will gradually suffer from defects over time, such as blockages, cracks, corrosion, roots, etc., which significantly affect their performance. Inspection of sewer systems plays a crucial role in estimating structural condition and preventing defects. Fault detection is often a costly and challenging activity due to the hidden infrastructure of networks. Nowadays, several inspection methods have been implemented that facilitate and speed up this work.

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THEORETICAL FRAMEWORK

- **VISUAL INSPECTION TECHNOLOGIES**

They are the most common tools in evaluating the structural and functional condition of sewer pipes. They provide clear evidence of most defects in wastewater pipe networks.

A camera is placed inside a pipe and the captured images are transmitted to an operator located on the surface who interprets the images and records the location and nature of the defects observed.

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THEORETICAL FRAMEWORK

- **ACOUSTIC INSPECTION**

Active detection requires the presence of a sound source and a receiver to measure the acoustic response of the pipe, and generally analyzes reflected waves that contain information about pipe discontinuities such as blockages. Passive detection is used to identify leaks when the signal generated by high-pressure fluid escapes from a perforated pipe.

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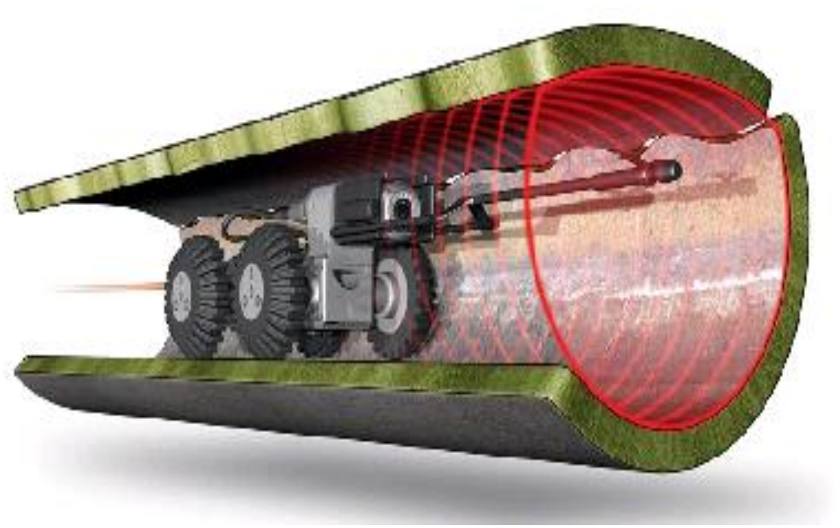
THEORETICAL FRAMEWORK

- **LASER**



The system consists of a laser projector that acts as a source that emits defined light patterns within the pipe, and the light reflected from the walls is captured by the camera sensor to recreate representations of the conditions of sewer pipe networks. .

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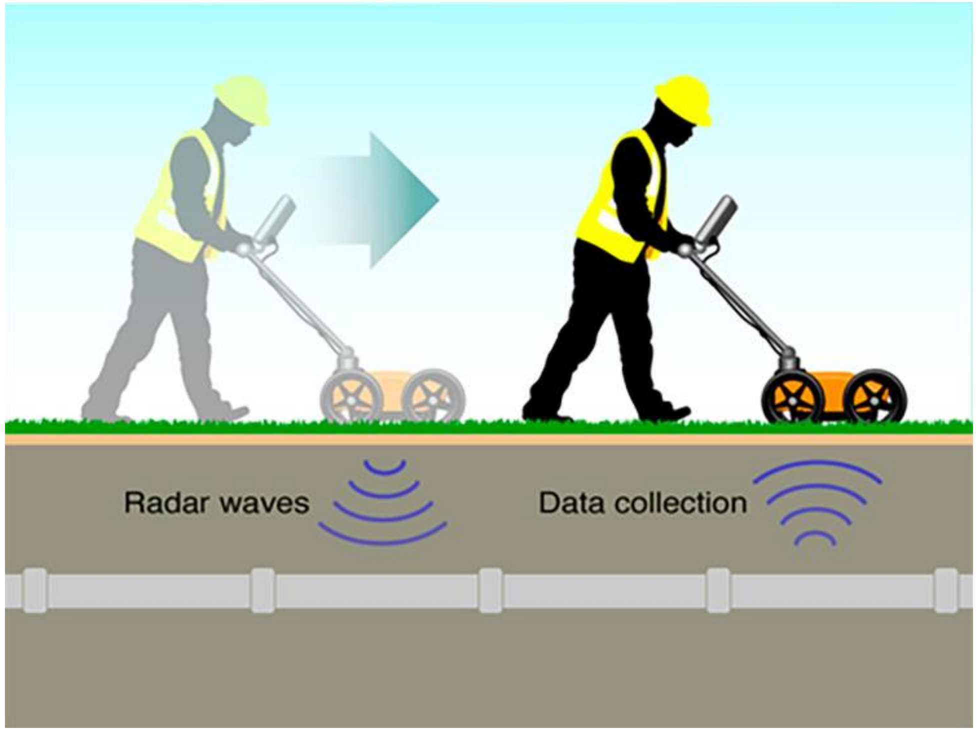
THEORETICAL FRAMEWORK

- **RADAR**

It is a technology that emits pulses of radio waves into the ground or any non-metallic medium, measuring the strength and delay time of the refraction waves to generate images of identified defects in pipes.



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OBJECTIVES

- **General objective**
- Analyze the current technologies used in sewer inspection in order to evaluate their effectiveness, applications, advantages and limitations.
- **Specific objectives**
- Identify the most used sewer inspection technologies according to their application context
- Analyze the effectiveness of each technology in terms of problem detection and accuracy.
- Evaluate the status of these sewer inspection technologies in the city of Medellín.

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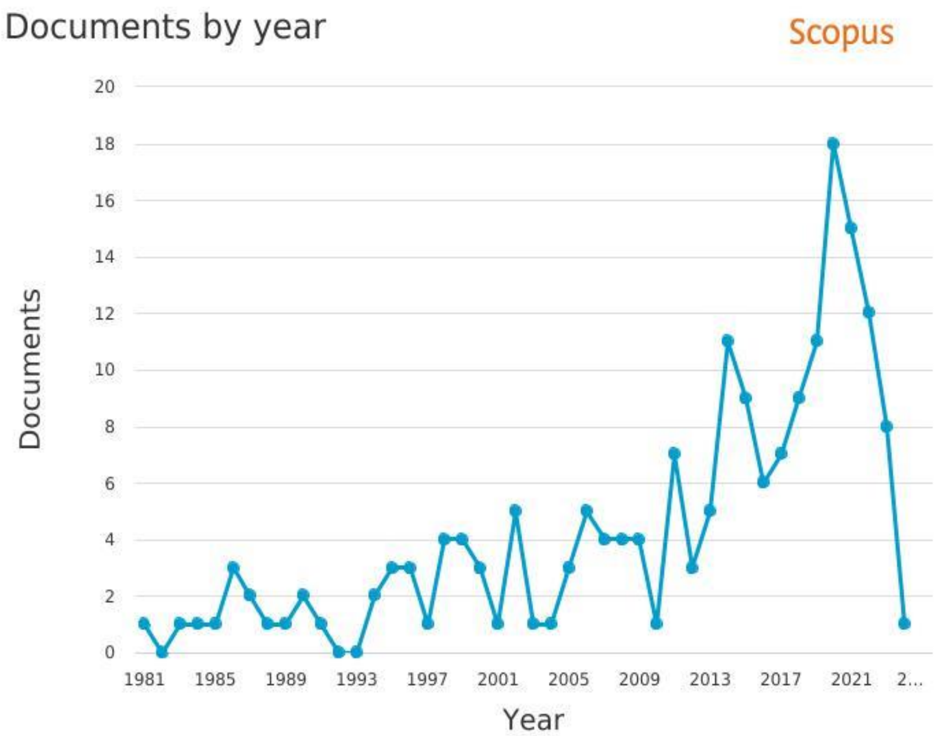
METHODOLOGY

Operator: (sewer AND vision OR cctv OR zoom OR quickview OR acoustic OR ultrasonic OR sonar OR vibe OR laser OR radar OR gpr AND inspection).

Results: 491 documents among 185 journal articles, 279 session papers, 13 review articles, 2 short surveys and 8 conference reviews. For this analysis, the search was limited to the 185 journal articles found.

Featured authors: Su Tung-Ching, Wang Mingzhu, Clemens Francois.



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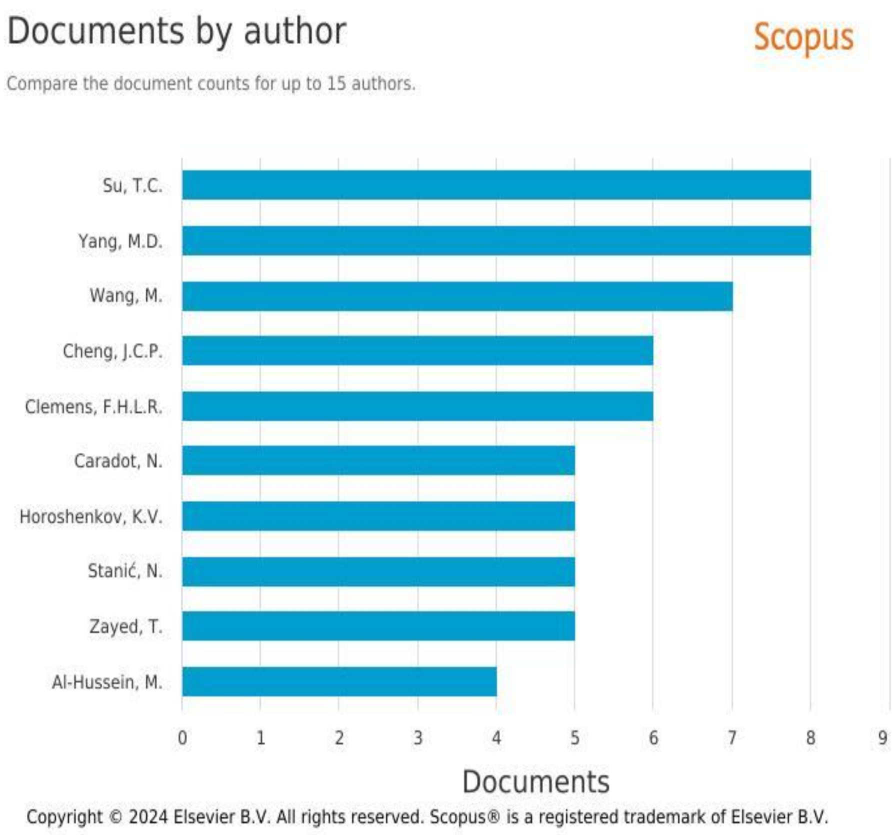
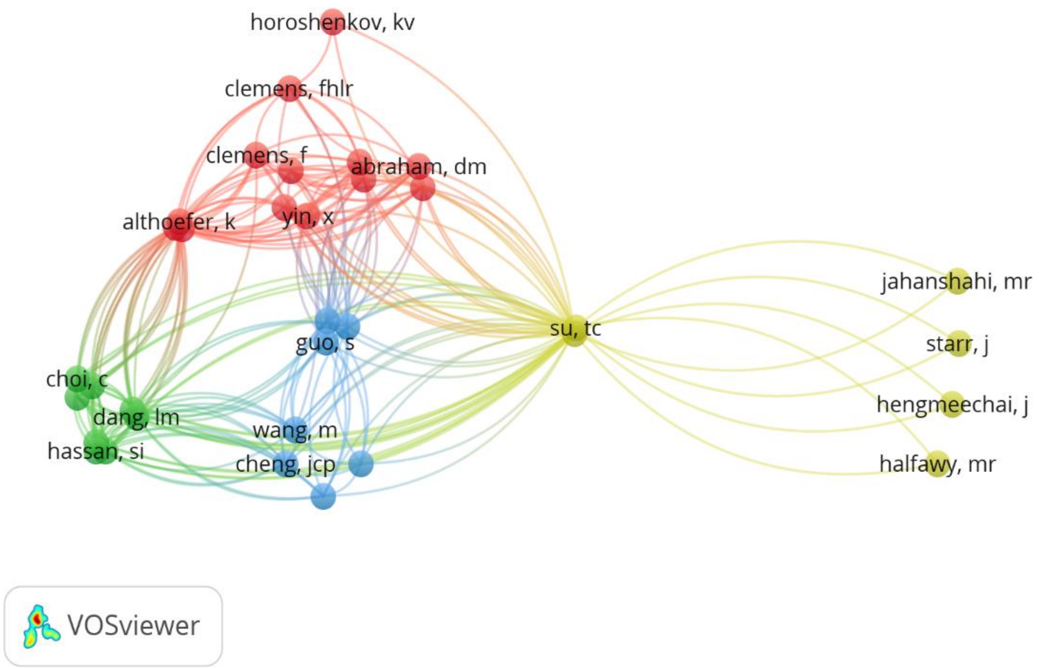
METHODOLOGY





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RESULTS AND ANALYSIS

- **CLOSED CIRCUIT TELEVISIÓN CCTV**

The system consists of a remotely controlled platform or robot, a tracker, a camera, a cable tray, a recorder and a control station.
They are used to study the conditions of sewer pipes by taking images and videos of their internal surface. The acquired data integrates information about defects such as cracks, debris, roots, deflections, etc.

Not applicable when the pipe is full of water.

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RESULTS AND ANALYSIS

- **Camera zoom and quick view QV**

Both technologies are used to perform well inspections using a camera. They consist of a smart display controller, transmission cable and a camera mounted on the end of a telescopic pole or tripod. The main function is the generation of still or video images in a pipe made of any material.

Zoom and QV do not pass through the pipe segment being inspected. The main detectable defects are leaks, cracks and sedimentation.

Not applicable when the pipe is full of water

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RESULTS AND ANALYSIS

Technology	Limitations	Advantages	Precision/Effectiveness
CCTV	Extraction and preliminary cleaning	Favorable in high pressure, toxic and unhealthy environments	Decreases as the pipe diameter increases
	manual interpretation of data	Runs through the entire section of pipe	Decreases the detection of defects covered by biofilm or mud
	difficulty detecting minor defects		Does not offer precision on the intensity of the defect
	Water level in lower pipe 20% diameter		Provides a clear view of the pipe surface condition

Technology	Limitations	Advantages	Precision/Effectiveness
Cámara Zoom y QV	manual interpretation of data	Favorable in high pressure, toxic and unhealthy environments	Decreases as the pipe diameter increases
	difficulty detecting minor defects	No prior cleaning required	Decreases the detection of defects covered by biofilm or mud
	Water level in lower pipe 20% diameter		lacks pan and tilt display
	Its evaluation is limited to inspection pits		Does not offer precision on the intensity of the defect
			Provides a clear view of the pipe surface condition

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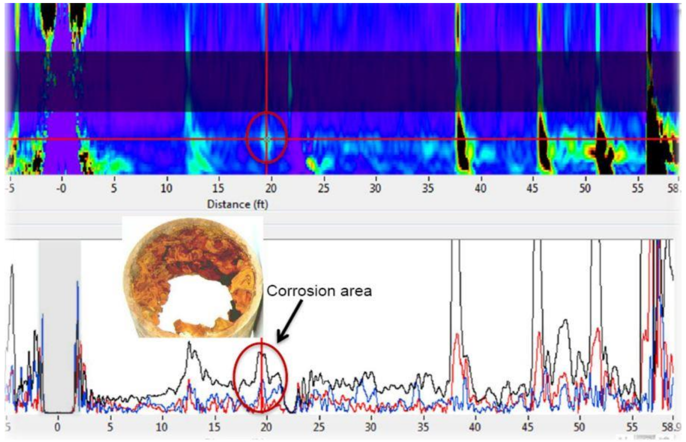
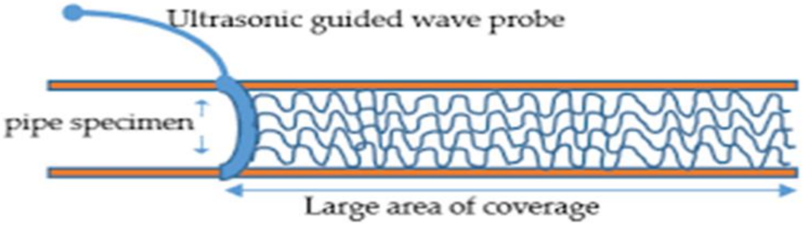
RESULTS AND ANALYSIS

• LONG RANGE ULTRASONIC TEST

This technology uses sound waves that travel through defined structures that function as guides. In the case of sewer inspection, the waves are guided through the pipe network.

Several detectors are placed in a circumferential ring on the external surface of the pipes to detect material loss, corrosion or erosion on their walls. This technology allows inspection in pipes filled with water





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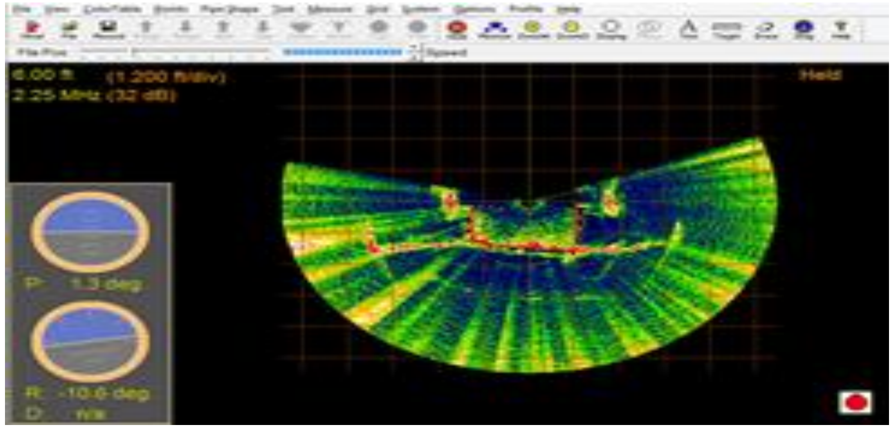
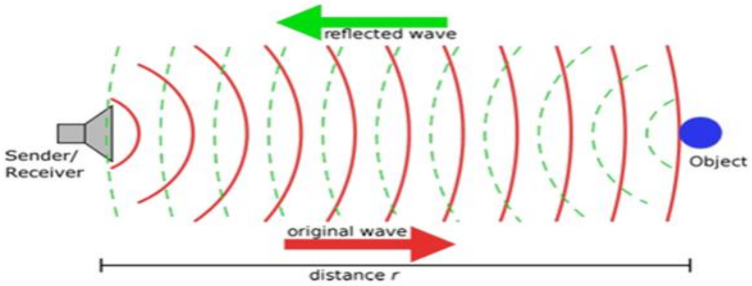
RESULTS AND ANALYSIS

• SONAR TECHNOLOGY

sonar uses the propagation of sound waves in water to detect the submerged target; The amount of energy and the time range it takes for sound waves to travel to the target and return to the source are used to estimate the location of various defects. This system used for the detection of sedimentation and defects of the internal surface of pipelines in operation. requires water in the pipe, the sonar head must be kept submerged in the water throughout the process





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RESULTS AND ANALYSIS

Technology	Limitations	Advantages	Precision/Effectiveness
long range ultrasonic test	This requires excavation.	Favorable in high pressure, toxic and unhealthy environments	Decreases due to attenuation and energy losses in the pipe material and surrounding soil
	Trained personnel for data interpretation	allows inspection of entire pipe sections	effective only on pipes made of homogeneous materials
		This allows inspection in pipes filled with water	

Technology	Limitations	Advantages	Precision/Effectiveness
Sonar	Trained personnel for data interpretation	suitable for pipes with high wastewater densities	Accurate in detecting deformations, collapses, deposits and floating objects
	sonar head may become embedded in mud	This technology allows inspecting sewer networks in operation	
		This system does not require prior cleaning	
		This system does not require excavation	

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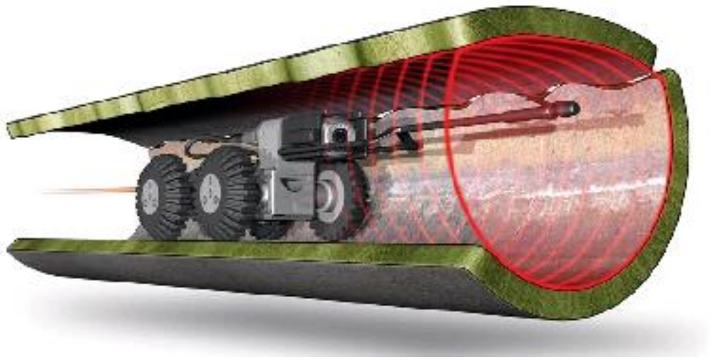
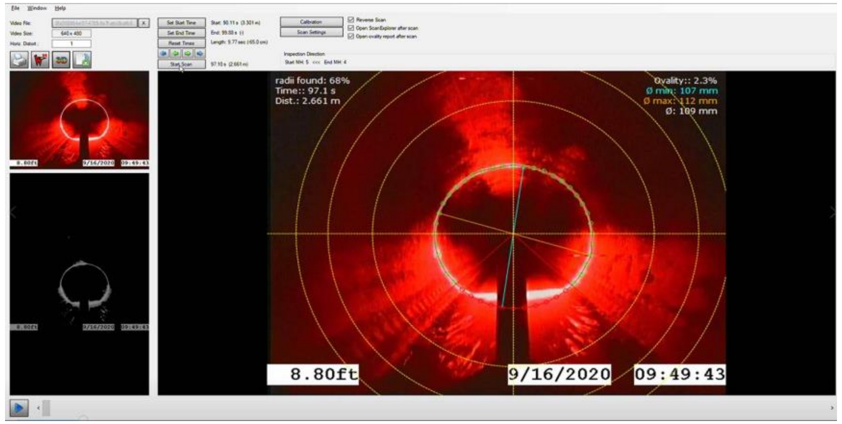
RESULTS AND ANALYSIS

LASER PROFILING

The system consists of a remotely controlled platform or robot, a laser projector that acts as a source that emits light patterns reflected in the shape of a circular ring, the reflected light is processed by the camera sensor to recreate representations of the conditions of the sewer pipes.





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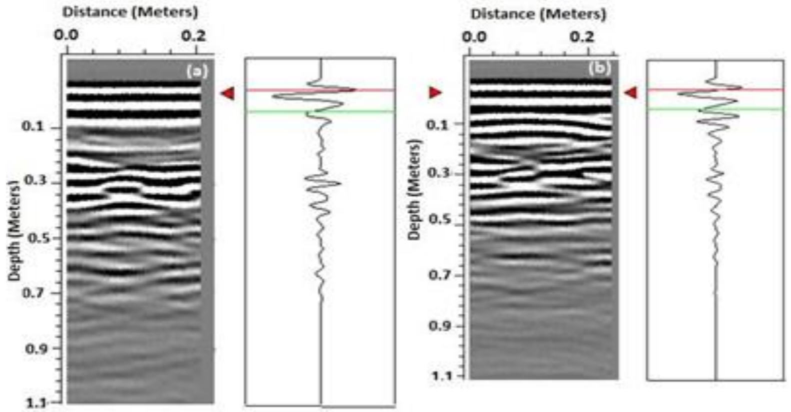
RESULTS AND ANALYSIS

- **GROUND PENETRATING RADAR (GPR)**

GPR is usually used to detect water leaks in sewers, identifying cavities in the ground created by the turbulent flow of escaping water, or to identify pipe segments that appear deeper due to soil saturated by leaking water. Used to locate existing holes surrounding pipe when the surrounding medium allows adequate penetration



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RESULTS AND ANALYSIS

Technology	Limitations	Advantages	Precision/Effectiveness
Laser profile	Trained personnel for data interpretation	Favorable in high pressure, toxic and unhealthy environments	This system offers precise measurements of pipe geometry
	This system requires prior cleaning	This system does not require excavation	

Technology	Limitations	Advantages	Precision/Effectiveness
GPR	Trained personnel for data interpretation	Favorable in high pressure, toxic and unhealthy environments	GPR are affected by the general environment of the pipe, concrete, soil, rock etc.
	sonar head may become embedded in mud	This technology allows inspecting sewer networks in operation	Low frequencies provide better depth, high frequencies provide high definition images
		This system does not require prior cleaning	Conductive materials can attenuate the GPR signal by limiting the depth of penetration
		This system does not require excavation	

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RESULTS AND ANALYSIS

- **INSPECTION TECHNOLOGIES IN THE CITY OF MEDELLÍN**

The technical standard states that inspections of the sewer networks of the city of Medellín are carried out using the following methodologies:

Basic recognition inspection: pole video cameras (zoom or Qv) and push video cameras are used for quick visualization of pipeline conditions.

Conventional visual inspection: carried out with CCTV, provides a complete and effective evaluation of the conditions of each section of pipe.

Inspection under special conditions: Use of equipment with additional features such as multi-sensor inspection technologies, laser profiler, sonar or a combination of them.

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CONCLUSIONS

- Visual inspection technologies, such as CCTV, zoom cameras and (QV), are the most used technologies to evaluate the condition of sewer networks due to portability and few technical requirements. Their joint application allows you to obtain a comprehensive view of the condition of the pipes.
- Sonar and long-range ultrasonic testing offer a comprehensive evaluation of challenging pipelines. Laser-based technology offers precise and detailed quantitative analysis of defects. Their effectiveness in detecting structural and functional defects makes them promising options for assessing the condition of sewers.
- The complementarity of visual inspection technologies with acoustic techniques and laser profiling expands the evaluation capacity of sewer networks and contributes to more effective and proactive management.
- Among the inspection techniques used in the city of Medellín, three methodologies stand out: basic recognition inspection, conventional visual inspection and inspection under special conditions. These techniques vary in complexity and scope, from a quick evaluation of general conditions to the identification of defects and detailed observations.

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