XXI Semana de la Facultad de Arquitectura e Ingeniería

¡BIENVENIDOS!

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Alcaldía de Medellín
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Evaluation of the influence of precipitation and solar radiation on the ozone concentration in the metropolitan area of Aburrá Valley.

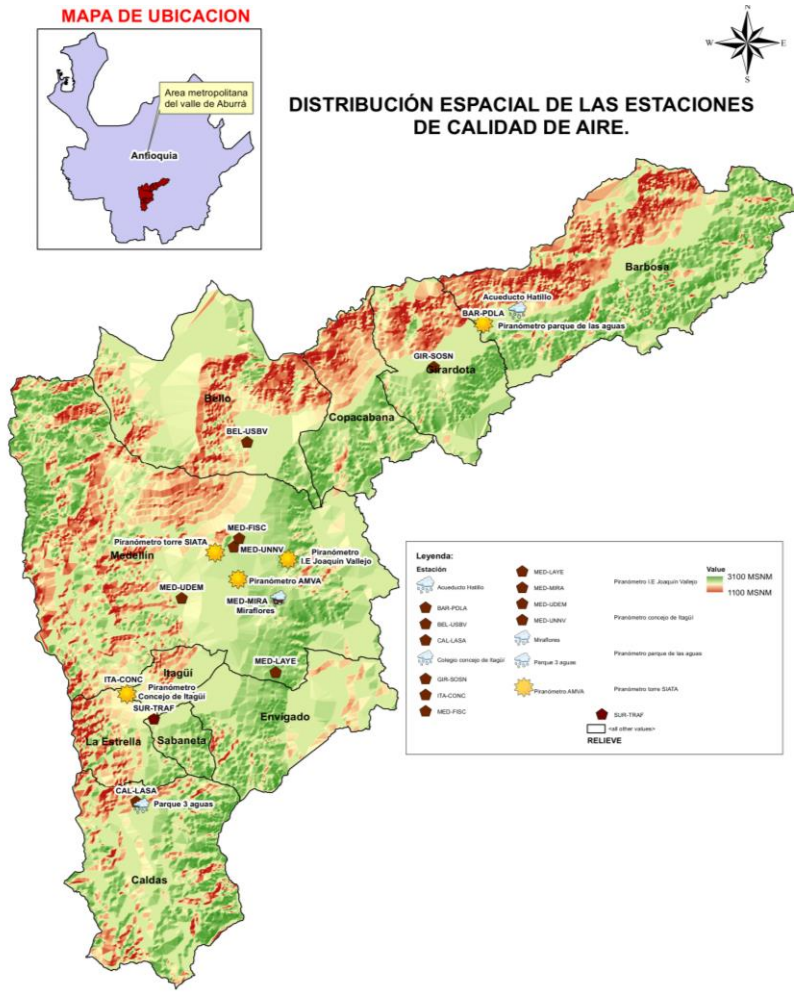
Objectives

General

- Evaluate the influence of precipitation and solar radiation on ozone concentrations in the Aburrá Valley.

Specifics

- Characterize through descriptive statistics the behavior of ozone in the Aburrá Valley.
- Analyze the annual and diurnal variability of precipitation and solar radiation in the Aburrá Valley.
- Verify through descriptive statistics and graphic analysis the relationship between O3 concentrations and aerosols from biomass burning.
- Identify the possible relationships between precipitation and solar radiation and ozone concentrations in the Aburrá Valley.



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Theoretical framework:

At a global level, air pollution and its influence on living beings and ecosystems have been studied for decades [1]; in general, the most studied pollutant and the one that has been given the greatest relevance is particulate matter. Zheng [9] highlights how precipitation is one of the main mechanisms for the removal of aerosol particles in the atmosphere, in this study, he analyzed the effect of precipitation on the reduction of particles (PM) the results show that there are obvious differences in the removal of PM by precipitation processes of different intensity. Regarding ozone, recently European countries and the United States, among others, have suffered serious ozone pollution with a rapid increase in its concentration level, ozone is the only one of the six environmental indicators (PM2.5, PM10 , NO2, SO2, CO and O3) that seems to exhibit a trend of increasing variation in concentration from 2018.

Specifically, the excessive ozone pollution ratio for 338 cities in China is up to 8.3%. This occurs mainly in the developed urban agglomerations of China [10], it was evidenced that temperature was the main factor that affected ozone with a significant positive correlation, precipitation also exhibited a positive correlation with ozone [10]. At the local level, the phenomenon of the net effect of precipitation on the concentration of particulate matter has also been studied, for example, Roldan [11] demonstrated how precipitation modulates the concentration of pollutants in the atmosphere directly and indirectly through different mechanisms such as wet deposition, cloud sweep, and cloud sweep. As for ozone, there is little information regarding the effect caused by precipitation on concentrations at different space-time scales.

Taken from: https://ecologistasenaccion.org/155606/la-contaminacion-por-ozono-cae-un-41-en-espana-en-2020%25e2%2580%25a6

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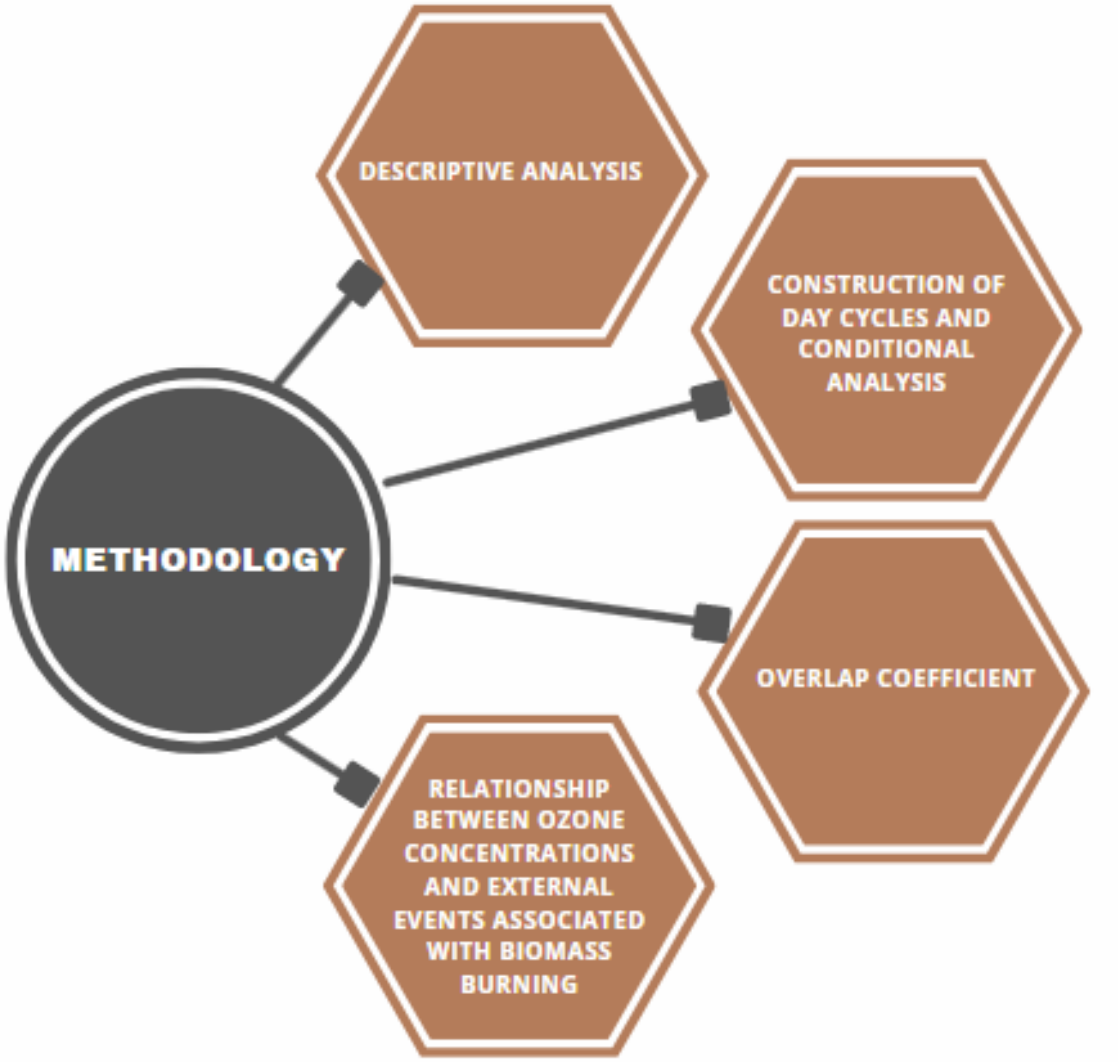

descriptive analysis:
Initially, a characterization of the ozone, precipitation and solar radiation data was carried out, using descriptive statistics (25th and 75th percentile, mean, standard deviation, maximum, minimum and median).

Construction of day cycles and conditional analysis:
Hourly resolution data sets were used, separating the entire record into different categories (48 in total): for each hour of the day and for dry (precipitation ≤ 2 mm) and wet (precipitation ≥ 2 mm) conditions (24 X 2). We repeated the analysis using different precipitation thresholds to separate dry and wet cases (from 0 to 3 mm). The wet case analysis considers pollutant concentrations one hour after the precipitation event to assess the immediate net effect of precipitation.

overlap coefficient:
Negative values of the SOCC index correspond to a decrease in pollutant concentrations associated with rainfall, and positive values are associated with an increase in pollutant concentrations.

Relationship between ozone concentrations and external events associated with biomass burning:
To identify external events associated with biomass burning that may have affected air quality in the Aburrá Valley, indicators such as retro-trajectories, aerosol optical thickness (AOD), the percentage of black-carbon associated with burning of biomass and graphic analysis.

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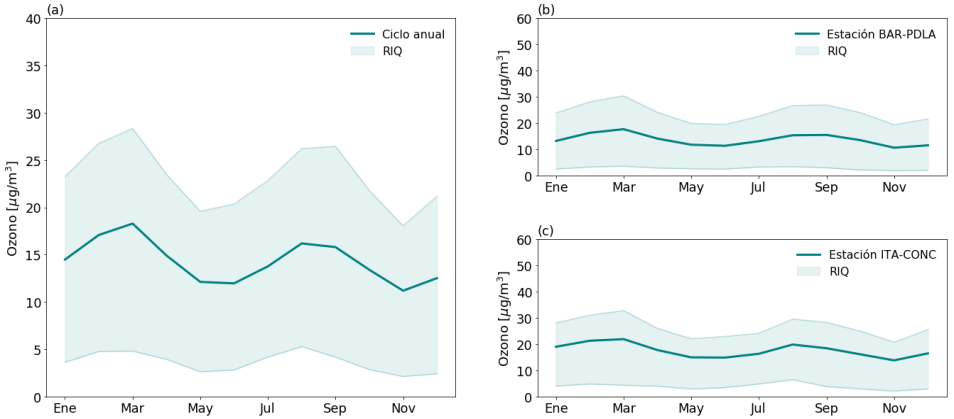
Results and analysis



(a) Annual ozone cycle, (b) Annual ozone cycle BAR-PDLA station, (c) Annual ozone cycle ITA-CONC station.

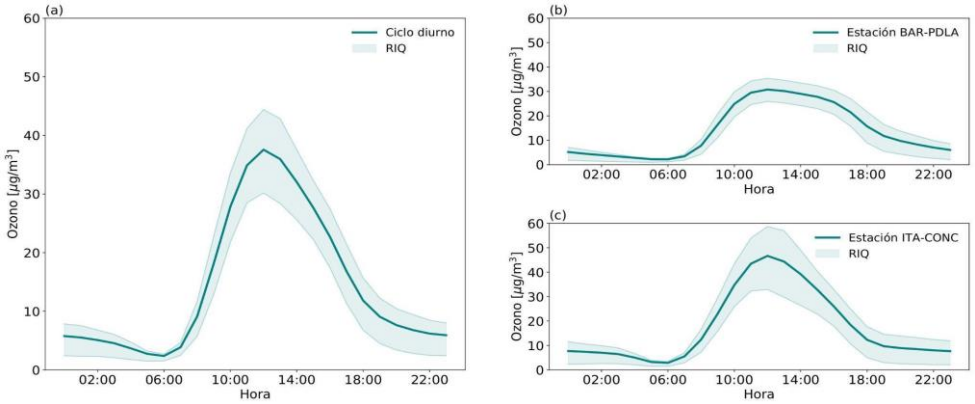
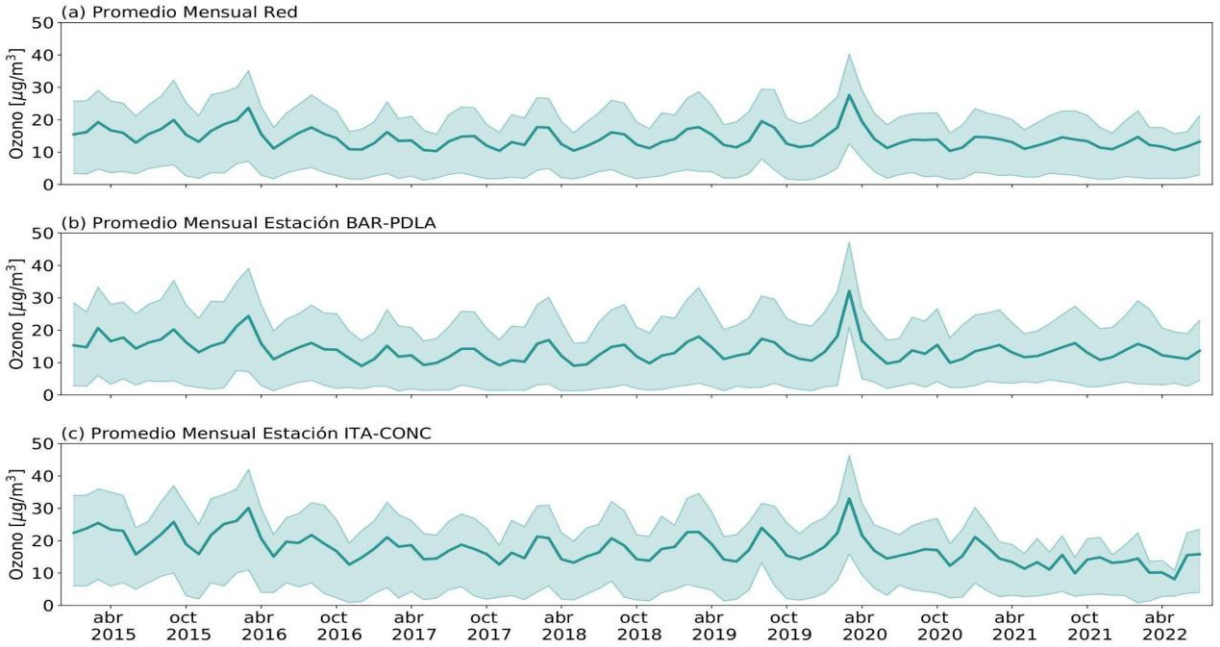


Figure 4. (a) Ozone daytime cycle, (b) Ozone daytime cycle BAR-PDLA station, (c) Ozone daytime cycle ITA-CONC station.



(a) Monthly average ozone Network, (b) Monthly average ozone station BAR-PDLA, (c) Monthly average ozone station ITA-CONC.

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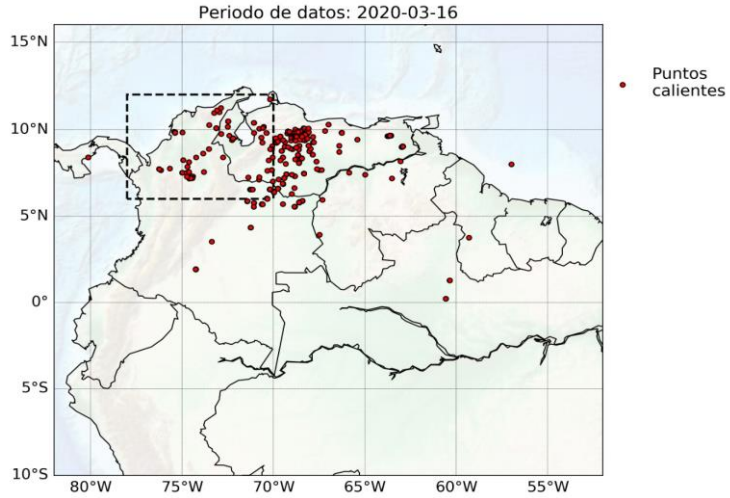
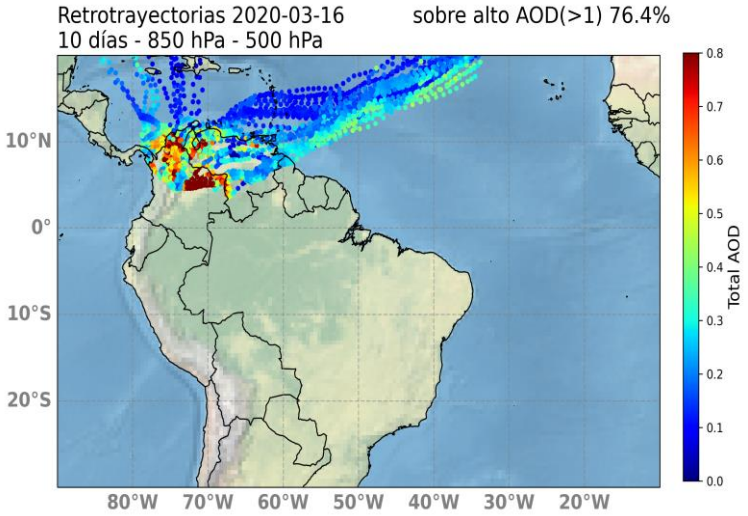
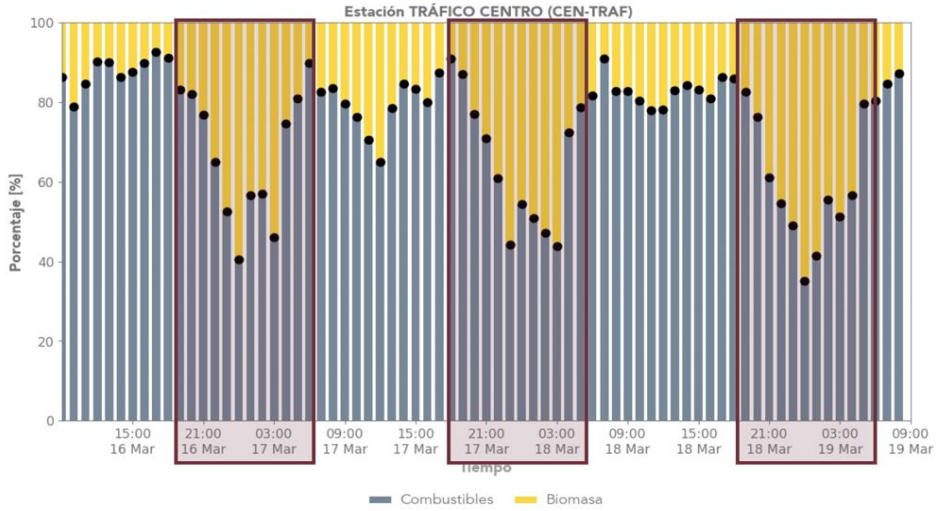


Analysis of back-trajectory and aerosol optical thickness (AOD).



Hot spots associated with biomass burning.



Concentration of the Black-Carbon pollutant in percentage contributed by the burning of fossil fuels and the burning of biomass, March 17, 18 and 19, 2020).

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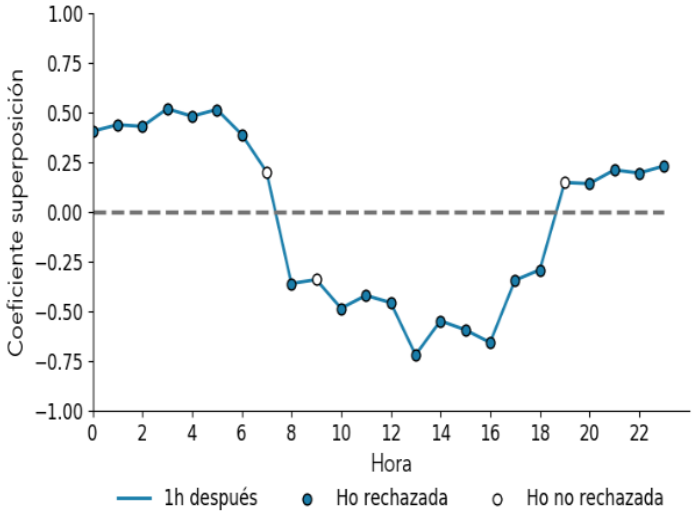
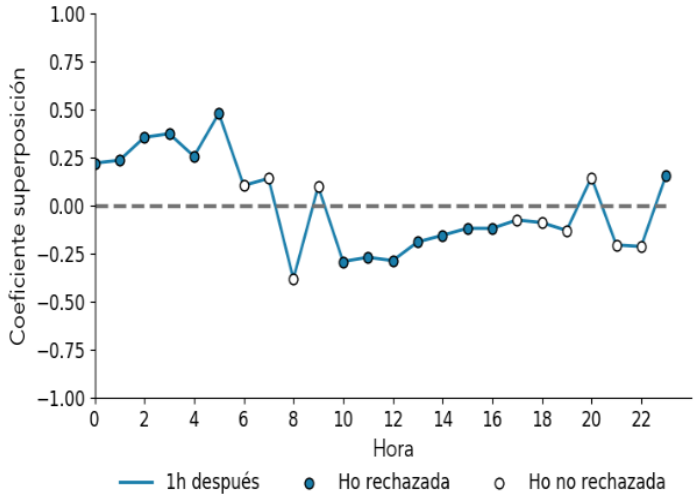
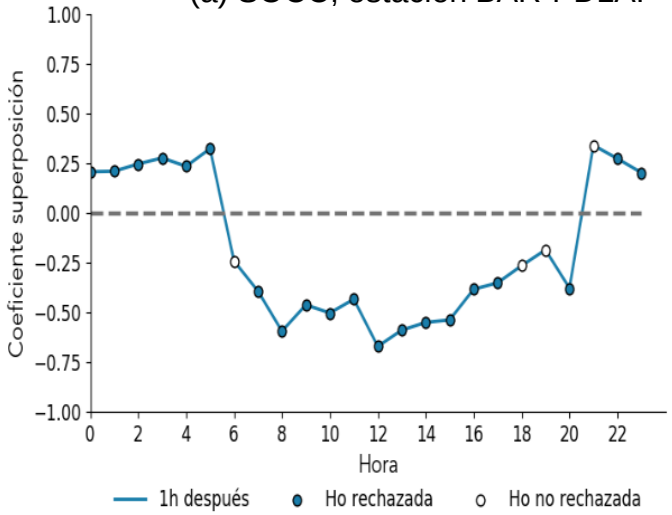


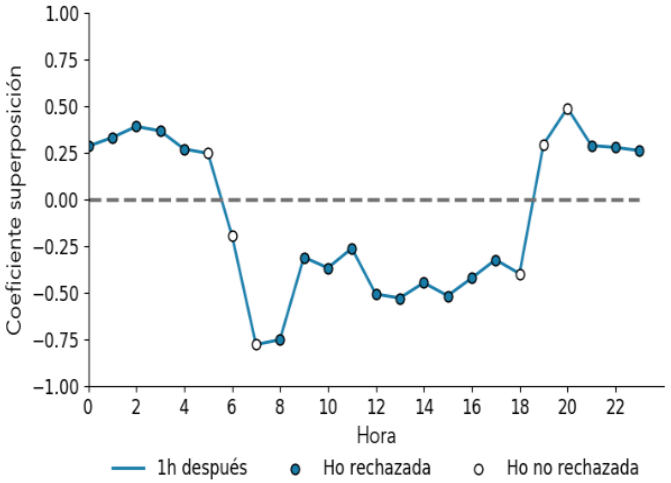
(a) SOCC, estación BAR-PDLA.



(b) SOCC, estación GIR-SOSN.



(c) SOCC, estación ITA-CONC.



d) SOCC, estación MED-MIRA.

the results obtained for the overlap coefficients are presented, where negative values indicate the net removal of aerosols induced by precipitation, and positive values suggest that precipitation leads to pollution accumulation. The circles summarize the results of the Wilcoxon-Mann-Whitney test. The null hypothesis states that the PDFs of pollutants in wet and dry conditions are identical. Filled blue circles correspond to cases where the null value can be rejected; conversely, open circles correspond to times when the null hypothesis cannot be rejected.

According to the results obtained, the precipitation does play a fundamental role in the removal of the aerosol, it is evident how for all the stations under study negative values are obtained in a diurnal ozone cycle that, as previously described, lead to an elimination of the aerosol. It is important to take into account that, regardless of whether there is high or low precipitation, this variable does not fully define high or low ozone concentrations, that is, precipitation is not necessarily the only variable that determines aerosol concentrations, but it is one of them. the variables that can modulate its behavior.

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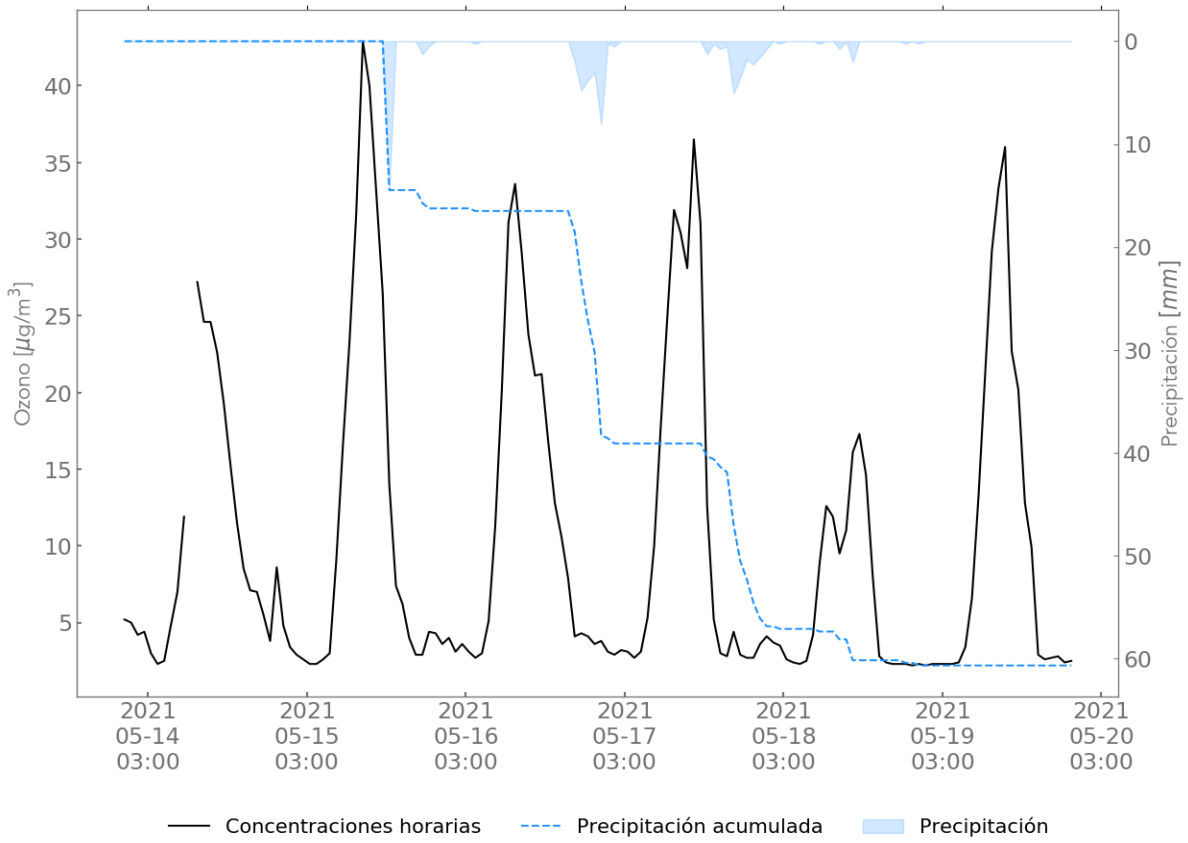

a significant precipitation event is graphically evidenced (2021-05-14 to 2021-05-20), where values are taken two days prior to the event, three days during the events, and two days after; the ozone concentration and precipitation data are contrasted for the period of time described above, as a result of this it can be shown that the precipitation had a positive effect on the reduction of the ozone concentration since the beginning of the event, as the event occurred. accumulated precipitation in the evaluated period, the concentration had a proportional reduction, once the event ends, the ozone concentrations return to their usual average values.

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Conclusions:

In this study, the method was implemented with a conditional analysis, in addition to the estimated FDPs of ozone, which made it possible to examine in a probabilistic sense the net effect of precipitation on ozone concentrations, with which it was possible to show that precipitation in a diurnal cycle it leads to the stabilization of the atmosphere near the surface, for which the dispersion of aerosols and pollutants is affected. The results of the study indicate that the effect of precipitation on ozone is highly influenced by the stability of the atmosphere, the method that uses the complement of the coefficient of superposition with sign, allows to show how this interaction between the variables occurs at different times. of the day

Precipitation events in a night cycle lead to accumulation of the pollutant, while rainfall events in a daytime cycle lead to wet deposition of the pollutant. The accumulated precipitation affects the reduction effect on the concentrations that with time is increasingly positive.

On the other hand, it was possible to conclude that external events associated with biomass burning do have an impact on ozone concentrations in the metropolitan area of the Aburra Valley.

Bibliography:

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Determination of the optimal dose of Moringa Oleifera biocoagulant for the removal of turbidity from a raw water sample, comparing its efficiency with a conventional coagulant (aluminum sulfate).

Sebastián Restrepo Guerra.
Juan Diego Betancur Mestra.
Juan Carlos González Garces.

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Research problem

BANCO MUNDIAL
BIRF • AIF

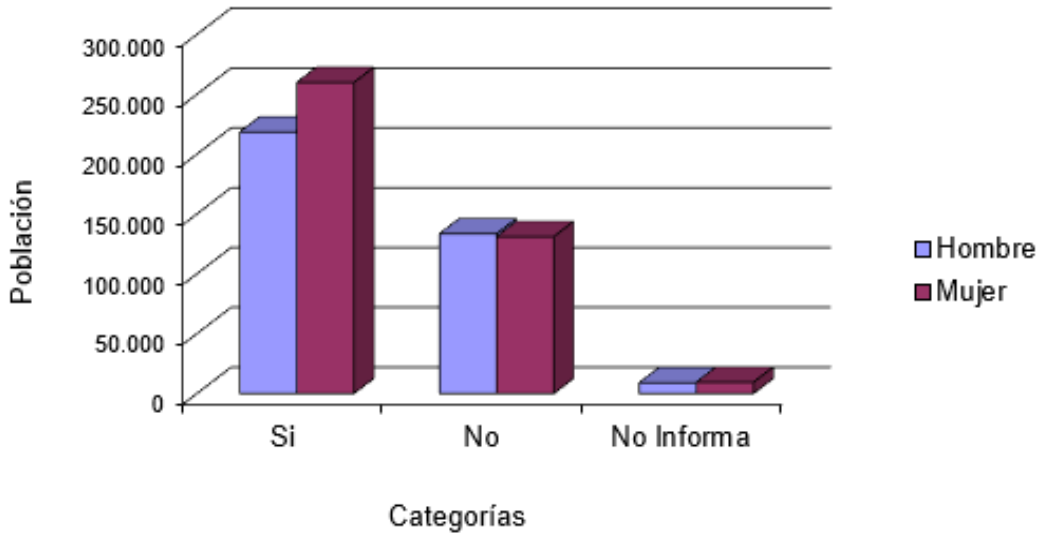
El saneamiento inadecuado y la falta de acceso a agua limpia afectan a millones de personas en todo el mundo

LR LA REPÚBLICA

Cabe resaltar que en Colombia, 12 millones de personas tienen acceso inadecuado al servicio de agua potable, esto representa 25 % de la población del país. **Así mismo, 3,2 millones de personas no tienen acceso a agua potable, problemática que se incrementa en el sector rural.**

viernes, 24 de marzo de 2023

MINISTERIO DE VIVIENDA, CIUDAD Y TERRITORIO



DANE 70 AÑOS
INFORMACIÓN PARA TODOS

Wastewater treatment using a natural coagulant (*Moringa oleifera* seeds): optimization through response surface methodology

Wendesen Mekonin Desta*, Million Ebba Bote

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Theoretical framework

MINISTERIO DE LA PROTECCIÓN SOCIAL
MINISTERIO DE AMBIENTE, VIVIENDA Y DESARROLLO TERRITORIAL

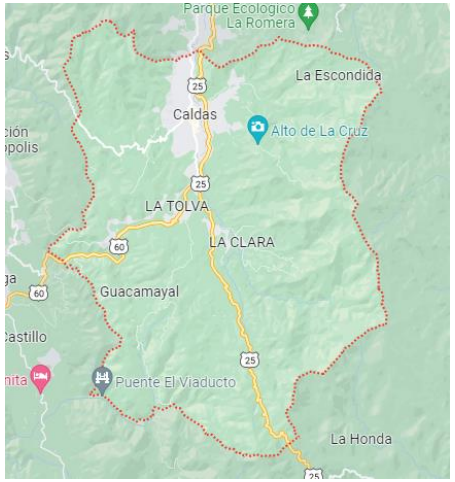
RESOLUCIÓN NÚMERO 2115

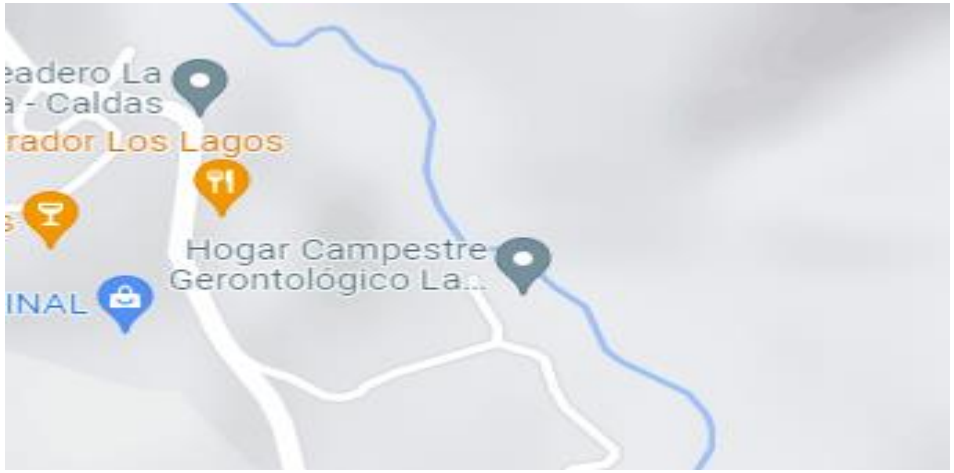
(22 JUN 2007)

Informe Nacional de Calidad del Agua para Consumo Humano

INCA 2020

El futuro es de todos | Gobierno de Colombia





2	Antioquia	Caldas	Junta de Acción Comunal Vereda Salada Parte Baja	80,5	Inviable sanitariamente

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Objectives

General

To evaluate the efficiency of a coagulant based on M. Oleifera in the removal of turbidity in a sample of problem water declared as unsanitary by the IRCA.

Specific

- Obtain the coagulant from M. Oleifera guided by the methodology found in the bibliography.
- Determine the problem influent by characterizing the water, verifying that it complies with the turbidity conditions (> 20 NTU), and based on documented studies in the area.
- Define the optimal coagulant dosage through experimental design.
- Evaluate the turbidity removal efficiency of the coagulant by making a comparison between initial and final conditions of the problem water sample.
- Experimentally compare the percentage of turbidity removal between the moringa-based coagulant and a conventional one, in this case aluminum sulfate.

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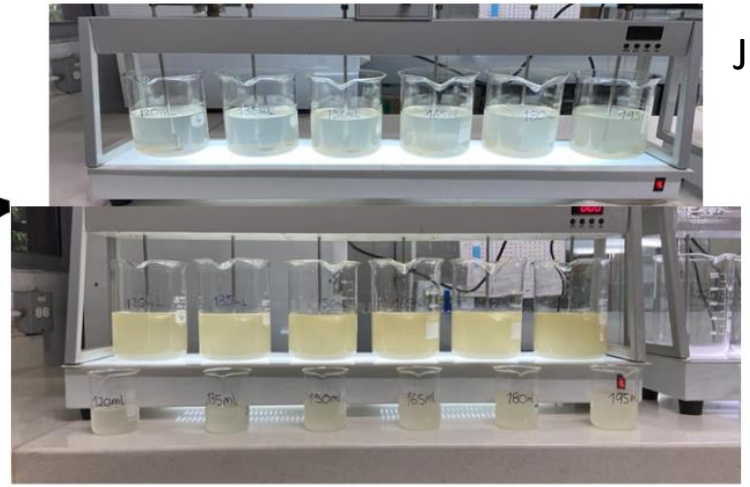
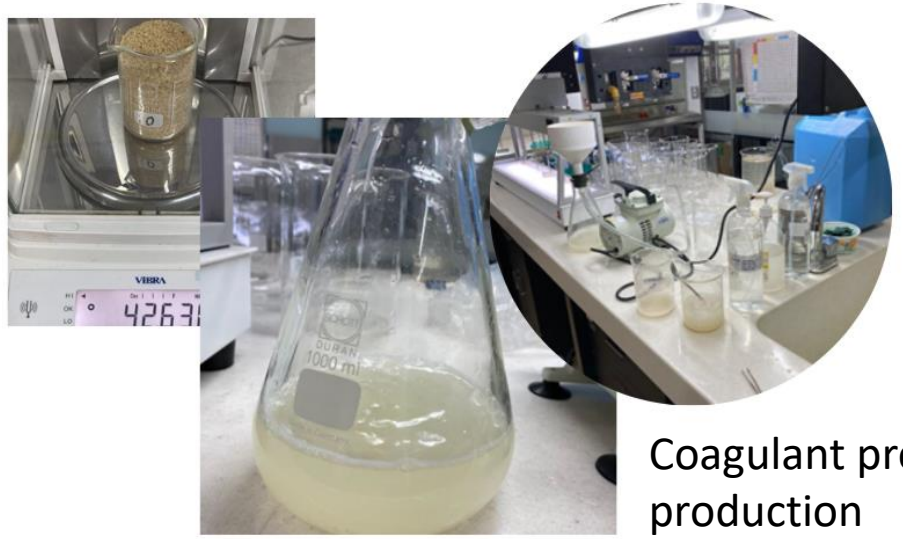
Methodology

Source selection

Sample collection

Jar test





Coagulant preparation and production

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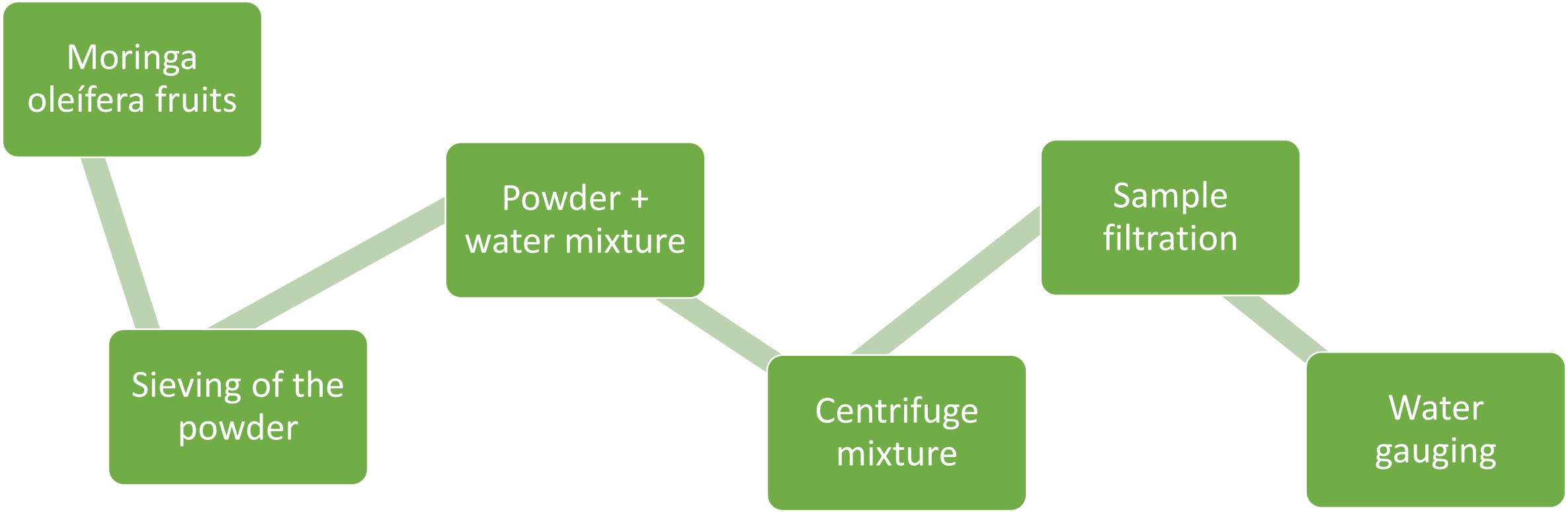
Methodology

obtaining the coagulant from *Moringa Oleifera*. (C. T. VELA AREVALO,2016)(H. Lilliehöök, 2005)(F. A. Turriago & G. R. Melo, 2012)



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Methodology

Experimental design *Moringa Oleifera*

Series	Coagulant	Doses (ml)						Total Repetitions
1	M. Oleífera	120	135	150	165	180	195	6
2	M. Oleífera	120	135	150	165	180	195	6
							Total	12

Experimental design aluminum sulfate

Series	Coagulant	Doses (mg)						Total Repetitions
1	Aluminum sulfate	20	26	32	38	44	50	6
2	Aluminion sulfate	20	26	32	38	44	50	6
							Total	12

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Results and Analysis

Coagulant jar test - *Moringa Oleifera*

Coagulant dose (mL)	Initial turbidity (NTU)	Final turbidity (NTU)		Removal efficiency (%)	
		Test 1	Test 2	Test 1	Test 2
120	103	40,93	37,7	60,26%	63,40%
135	103	27,72	25,64	73,09%	75,11%
150	103	29,97	28,54	70,90%	72,29%
165	103	33,99	28,6	67,00%	72,23%
180	103	37,86	31,26	63,24%	69,65%
195	103	42,67	39,55	58,57%	61,60%

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Results and Analysis

Coagulant Jar Test - Aluminum Sulfate

Coagulant dose (g)	Initial turbidity (NTU)	Final turbidity (NTU)		Removal efficiency (%)	
		Test 1	Test 2	Test 1	Test 2
20	103	10,38	12,28	89,92%	88,08%
26	103	14,27	16,43	86,15%	84,05%
32	103	17,12	20,41	83,38%	80,18%
38	103	19,4	23,52	81,17%	77,17%
44	103	17,76	21,06	82,76%	79,55%
50	103	15,53	18,35	84,92%	82,18%

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Conclusions

- An object of further study could be to design a Moringa oleifera coagulant with another organic compound so that it does not lose its characteristics of bio coagulant, which has the capacity to enhance efficiency and is projected as a feasible alternative to replace conventional coagulants such as aluminum sulfate.
- For the specific case of the problem water sample, the doses obtained show a variability in the results in terms of turbidity removal, however, the range between 120ml and 150ml would be the maximum and minimum permissible limits in which the coagulant could have a higher efficiency.
- Another important factor for future case studies is the influence of temperature on the behavior of the coagulant, since it could act as an inhibitor causing denaturation of the proteins present in Moringa, which are involved in the coagulation process.
- In the case of the turbidity of the Moringa coagulant, color is a disturbing factor, so if a colorless coagulant were achieved in its entirety, it could present a possibly positive change in terms of turbidity removal.
- A possible experimentation would be the evaluation of the removal efficiency of the coagulant at different nephelometric turbidity units, in order to determine the maximum and minimum limits, and to be able to make a comparison with water quality reports already elaborated.
- Moringa-based coagulant

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EFFECT ON THE RESISTANCE AND CAPILLARITY OF A DRYWALL SHEET COMPOSED OF GUADUA AND BANANA STEM, AS A SUSTAINABLE CONSTRUCTION ALTERNATIVE.

Juliana Zapata Benítez
Edwin Arturo Blandón Hernández
Valentina López Arango
Alejandra Marín Orozco
Yarys Silvana Espinosa Rivas

INTRODUCTION

The implementation of organic material such as banana fibers, guadua, flax, among others, are increasingly common as a good option for sustainable construction, which leads to studies in different parts of the world that demonstrate the efficiency Of these, as an example of this, there are countries such as India, where a study was carried out on banana fibers as an alternative to improve resistance in different materials.

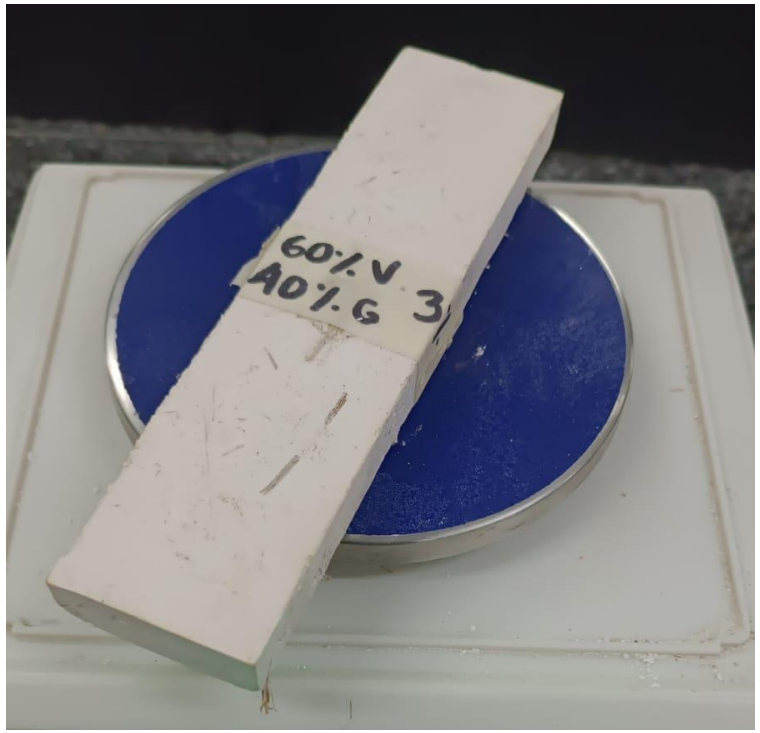

Figure 1: Drywall panel made in the project.

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INTRODUCTION

- On the other hand, there is Switzerland, where Arab, Farrokhzad and Habert, identified the benefits of green drywall as a sustainable material, comparing it with a traditional gypsum panel, observing an improvement in thermal insulation and a reduction in diffusion. of heat through the walls.

- With what has been described above, it could be inferred that with these materials (guadua fiber and banana stem) in the construction, it could contribute to the mitigation of the environmental impacts generated by traditional drywall in some manufacturing processes and in its final disposal as waste biodegradable.

Figure 2: Banana stem fibers.

Figure 3: Guadua fibers.

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METHODOLOGY

01 PRE-TREATMENT OF BIODEGRADABLE MATERIALS

They were separated into pieces and left for 24 hours at 50°C, then the fibers were extracted and cut to 1 cm in length. Subsequently, a mineralization process was carried out and finally they were dried in the kiln.

02 CONSTRUCTION OF DRYWALL SHEETS

Molds were used, measuring 16 x 4 x 1.5 cm. Subsequently, the mixing was carried out by making sheets with 100%, 60%, 50% and 40%, with a ratio of 1:10 (by volume).

03 STRENGTH OF DRYWALL SHEETS

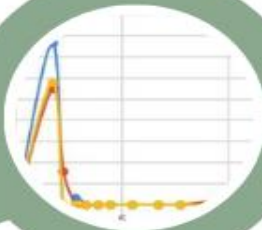
They are left to dry naturally for a week in order to demold them and then take them to a press to measure the pressure that the plates can withstand.

04 CAPILLARITY OF DRYWALL SHEETS

The sheets were also left to dry for one week, and then each one was immersed in water for approximately nine hours to perform the weight difference test to establish its capillarity capacity.

05 DATA ANALYSIS

An analysis is performed using statistical methods, entering all the data obtained in the resistance and capillarity tests, following the established protocol.



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RESULTS

Drywall sheets: The manufacturing of 90 Drywall sheets with natural fibers was sought, starting with 45, which were tested for flexibility resistance, the amounts of fiber per sheet were established according to their weight as shown in Table 1, in order to know the best proportion of mixture and fiber to achieve a similarity with the traditional Drywall.

Table 1. *Fiber weight used in each plate*

Porcentaje del peso total de la placa	Peso vástago 100% (g)	Peso 50% vástago + 50% guadua (g)	Peso guadua 100% (g)	Peso 40% vástago + 60% guadua (g)	Peso 60% vástago + 40% guadua (g)
1%	0,75	0,38+0,38	0,75	0,45+0,3	0,3+0,45
3%	2,25	1,13+1,13	2,25	1,35+0,9	0,9+1,35

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RESULTS

- To carry out the construction of the sheets, molds were used as shown in Figure 4, which can be disassembled for greater convenience at the time of disassembly, measuring 16 x 4 x 1.5 cm and made of copper.

Figure 4: *Mixing gypsum with natural fibers in mold for drying*

For the first test, which is the flexural strength test, the plates were weighed before performing this test, since the plates have been losing moisture over time, therefore, we measured their dry weight, as shown in Table 2.

Table 2. *Fiber weight used in each plate*

Porcentaje del peso total de la placa	Peso Vástago (100%)	Peso 50% vástago + 50% Guadua	Peso Guadua (100%)	Peso 60% Vástago + 40% Guadua	Peso 40% Vástago + 60% Guadua
1%	79,66 g	79,58 g	81,23 g	75,83 g	77,85 g
	76,82 g	74,29 g	79,46 g	79,74 g	78,29 g
	78,23 g	81,15 g	77,20 g	79,76 g	78,66 g
3%	82,65 g	83,61 g	79,58 g	82,37 g	80,13 g
	80,30 g	83,71 g	83, 94 g	83,77 g	81,02 g
	82,30 g	84 g	80, 02 g	84,36 g	83,73 g

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RESULTS: FLEXURAL STRENGTH

- Bending is the type of resistance that the plate has. To determine the loading of the plates, a press was used to determine the Humboldt bending resistance as shown in Figure 5.

Figure 5: *Flexural strength testing of Drywall boards.*

- The results provided by the press are in load (KN), which must be expressed in stress, which was done using the following formula.

$$\text{Esfuerzo} = \frac{3PmL}{2bh^2}$$

Where each of the variables are:

Pm: fracture load (N) **L:** Plate length (mm)

b**:** Base of the plate (mm) **h:** Plate height (mm)

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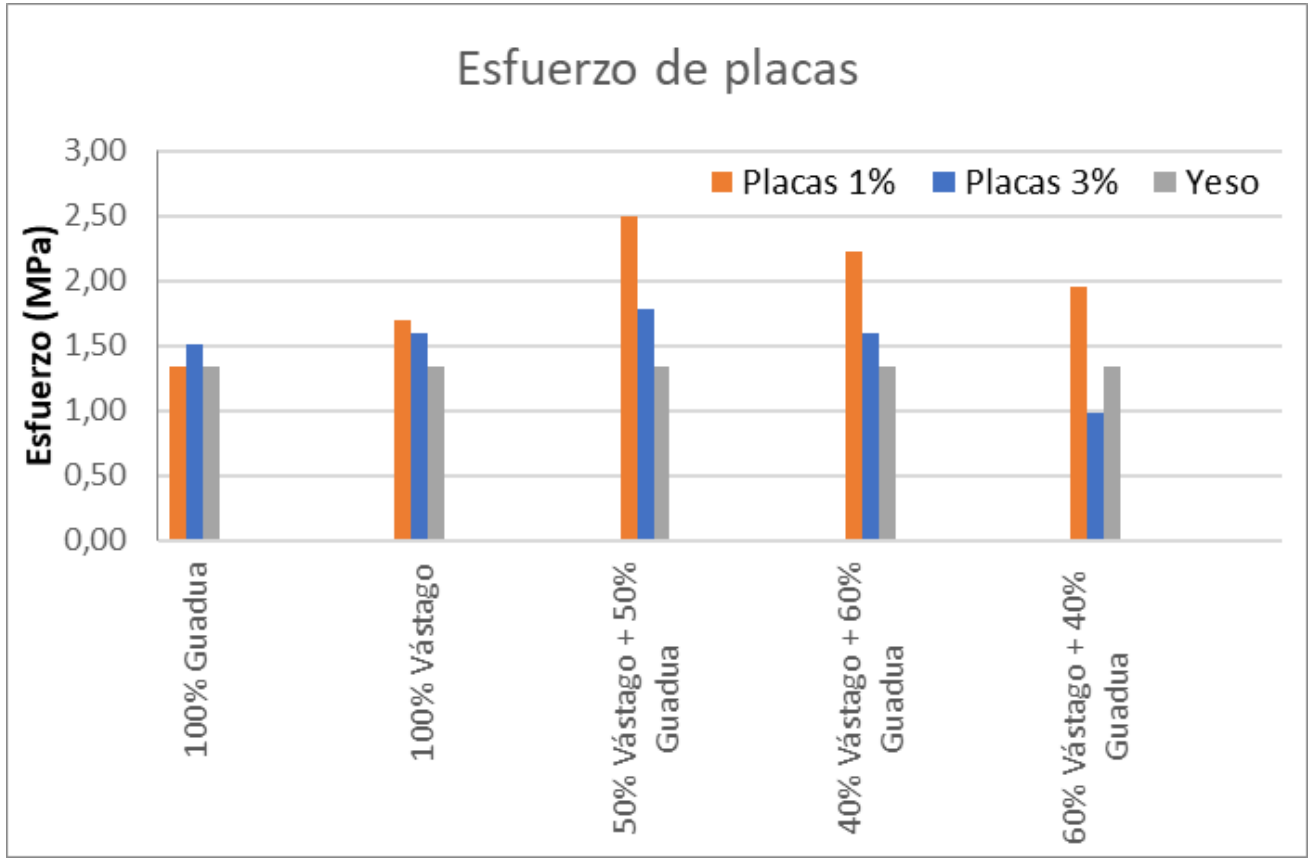
ANALYSIS OF RESULTS

With the results shown in graph 1, it is evident that the Drywall boards containing 3% guadua are more resistant to bending, compared to the 1% and the gypsum boards used as blank.

On the other hand, it can be observed that the Drywall boards containing 1% stem are more resistant than those containing 100% Guadua; however, there is no notable difference between 1% and 3% stem.

In general, all the boards have a good result with respect to resistance, except 60% stem and 40% Guadua at 3%, since it gives a lower value than that of the gypsum without fiber, therefore, the fibers are not performing their function.

Finally, it can be inferred that the plates composed of 50% Stem and 50% Guadua with 1% fiber have the best results.



Graph 1. *Stress results of the plates in all their fiber percentages.*

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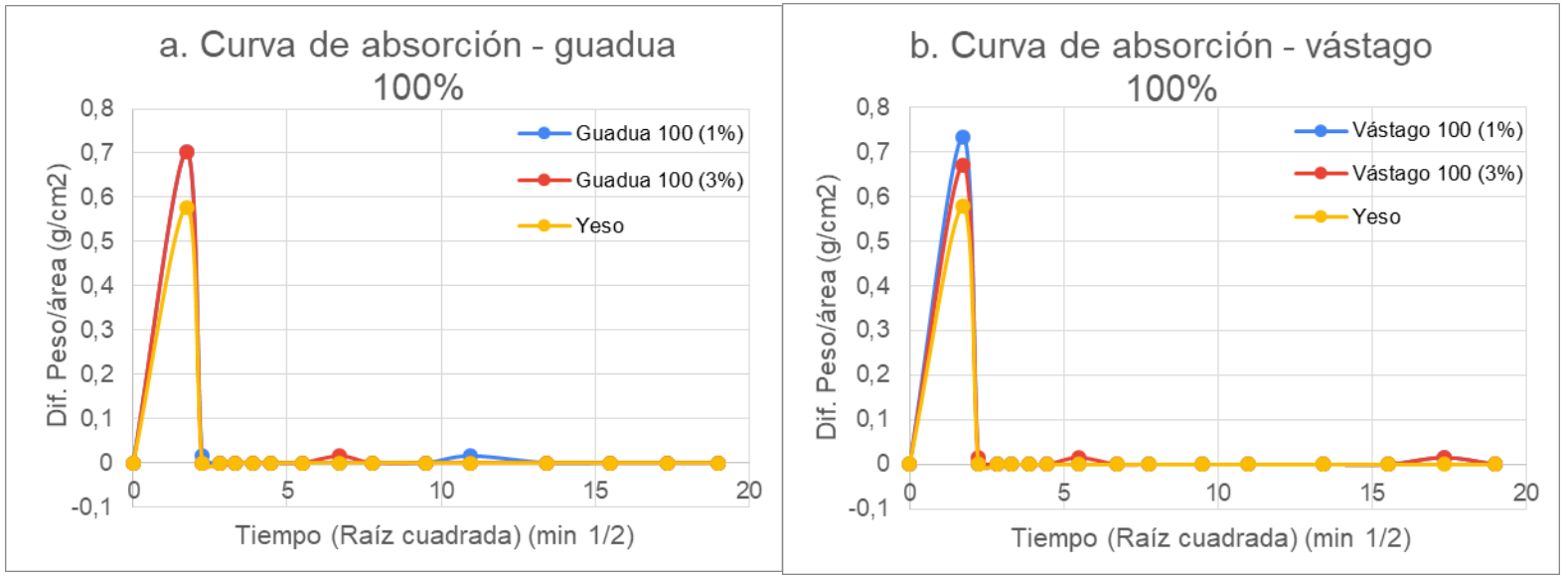
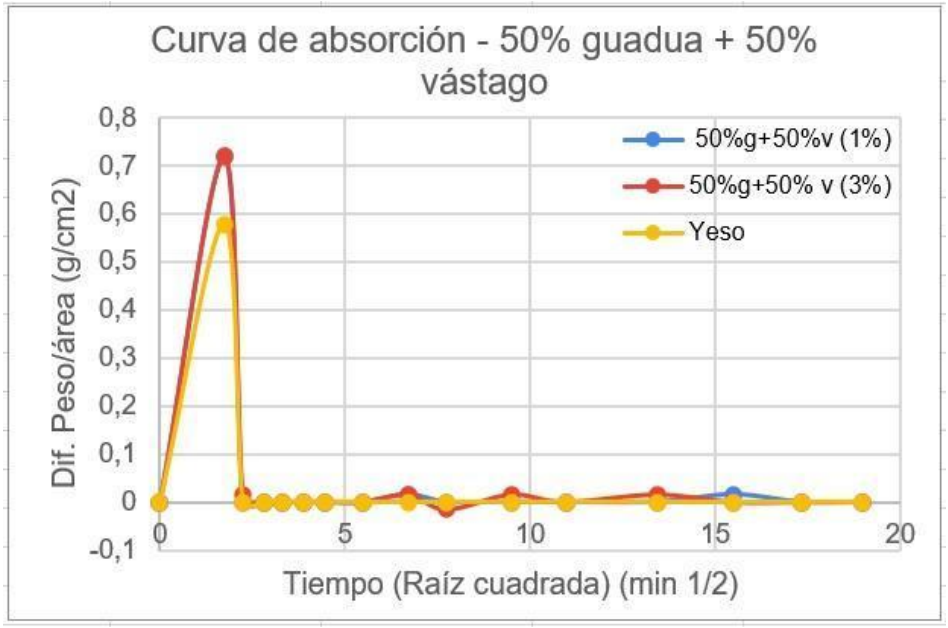
RESULTS: CAPILLARITY



Graph 2. *Results of absorption in plates at 1%, 3% and blank, in a) results with 100% guadua, in b) results with 100% stem.*



Graph 3. *Absorption results in 1%, 3% and blank plates with 50% guadua + 50% stem.*

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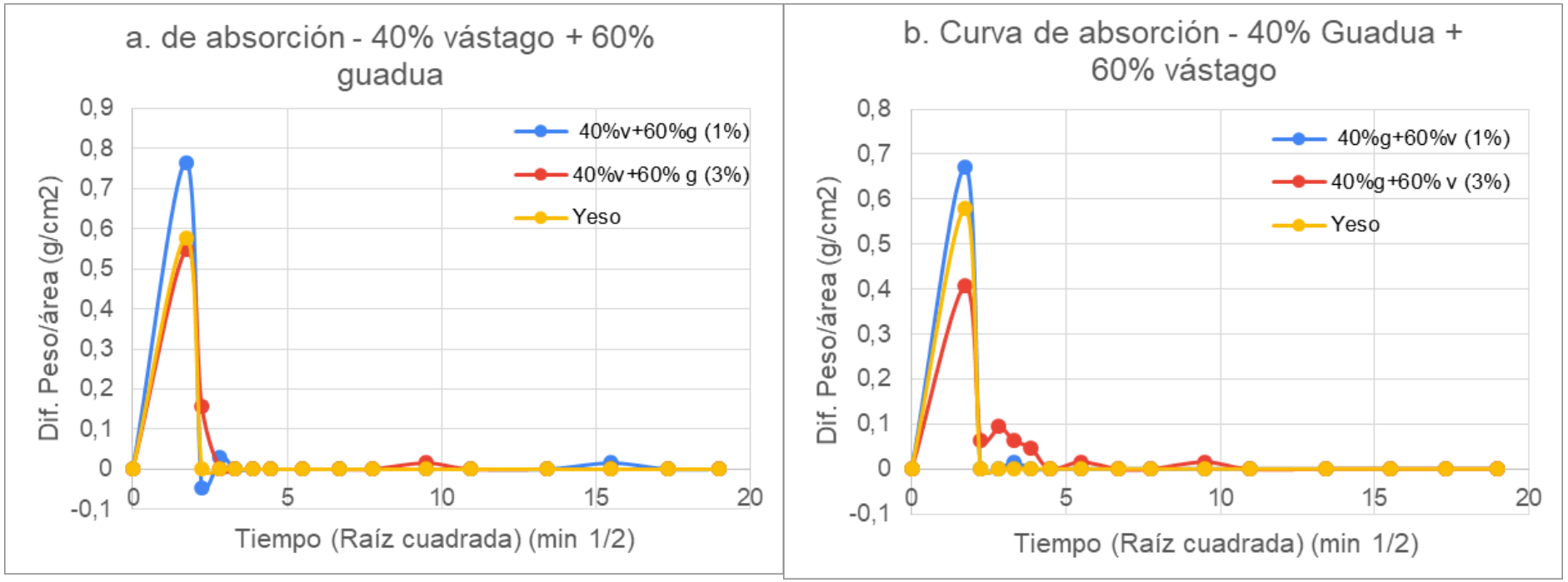

Graph 4. *Absorption results in 1%, 3% and blank plates, in a) with 40% stem + 60% guadua and in b) with 40% guadua + 60% stem.*

ANALYSIS OF RESULTS Taking into account the analysis of the previous results, it can be inferred that the combination of fibers with gypsum to make the plates has a direct effect on the resistance and capillarity of these, showing more convenient results for the cases where they are interwoven, and at the same time the 1% of fiber with respect to the weight of the plate with a homogeneous confluence of 50% for each component, presents better standards than the other alternatives observed. In contrast to what happens with the original board composed only of gypsum, since it does not comply with the protocols of resistance and/or capillarity.

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CONCLUSIONS

1. The higher the percentage of fiber in the drywall sheets, it does not mean that the flexural and capillary strength results will be more effective. Better results were obtained on the 1% fiber replacement drywall sheets.

2. In the flexural tests, the best result was obtained with 50% guadua and 50% stem with 1% of the total weight of the plate, therefore, the mixture of both natural fibers is more efficient than using only one of them.

3. In the capillarity test, the plates containing stem fiber in higher proportion had a higher water absorption than the gypsum plates in the first minutes, also the plates with 1% of fiber with respect to the total weight of the plate always showed a high tendency of capillarity, while those with 3% showed better results with respect to the water absorption capacity since it was lower.

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Stabilization of the effluent from the multi-stage anaerobic treatment system of the Organic Fraction of Municipal Solid Waste (FORSU) for agricultural application

Facultad de Arquitectura e Ingeniería - Ingeniería Ambiental

Proyecto de Investigación

Daniel Andrés Barrera Diaz

Luísa Fernanda Preciado

Laura Gaviria Dàvila

Medellín, Antioquia
26/Abril/2023

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THEORETICAL FRAMEWORK

Inadequate management is one of the main environmental problems and brings with it a great impact of pollution on natural resources, which has been caused by population growth, consumerism and lack of environmental education

By 2019 it reached approximately 26.46 million tons worldwide (Caicedo, 2022)

It is essential to find alternatives to chemical fertilization, such as biofertilizers

Among the biological processes is anaerobic digestion, which is mediated by a union of microorganisms that takes place in the absence of oxygen; the organic matter is broken down into simpler compounds that are transformed into VFA, transforming it into biogas, consisting mainly of CH_4 y CO_2

Additionally, an effluent called Biol is generated, which can be used as a liquid organic fertilizer, ecologically and economically profitable

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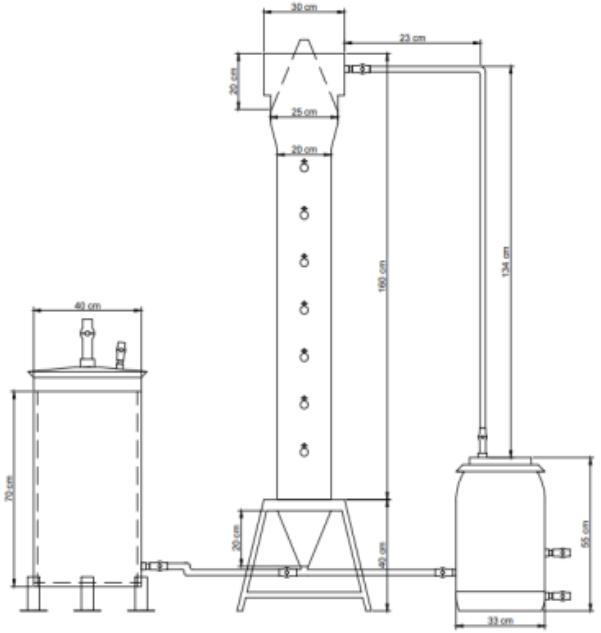
RESEARCH PROBLEM

The use of the organic fraction of solid waste by means of anaerobic digestion is a strategy that has been applied for the treatment of solid waste

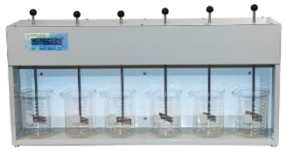
This generates an effluent or Biol, which has increased interest due to its potential as an organic fertilizer → Although it is rich in plant nutrients, it requires a stabilization process

The objective is to stabilize the effluent through the separation of suspended solids using organic coagulants, for the reduction of pathogens and organic load, and to evaluate its fertilizer potential in the germination of radish seeds



Circulation 30 days

4 Liters



Grafica 1. Esquema de la Planta (Elaboración Propia)

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OBJECTIVES

General

To evaluate the stabilization of the Biol from the multi-stage anaerobic treatment system of the Organic Fraction of Municipal Solid Waste (FORSU) for agricultural use

Specific

1. Identify the operational parameters of the UASB reactor for the production of Biol
2. Characterize the Biol physicochemically and microbiologically
3. To evaluate the effect of nopal cactus mucilage as a coagulant of Biol
4. To evaluate the phytotoxic effect of Biol on seed germination

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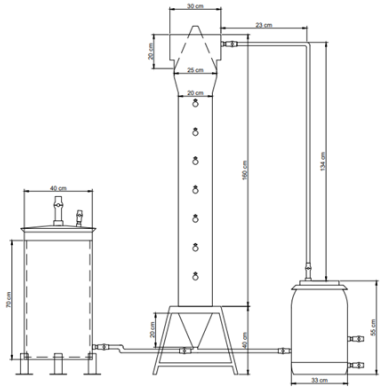
METHODOLOGY

Obtaining the Digestate

The digestate is obtained from the multi-stage anaerobic treatment system. This is composed of a Hydrolytic Reactor - Acidogenic Drained Bed Acidifier (HRADBA), an Upflow Anaerobic Reactor (UASB) and a tank where the effluent (Biol) arrives. The system is fed with food waste in the Hydrolytic Reactor and this passes to the UASB Reactor together with a granular sludge from a treatment plant.



Physicochemical and microbiological characterization of the Biol

When the digestate was obtained, COD, pH, conductivity, turbidity and microbiological analysis of Total Coliforms in Chromocult Agar were measured. An external laboratory analysis will also be performed to measure Total Kjeldahl Nitrogen, Phosphorus and Potassium

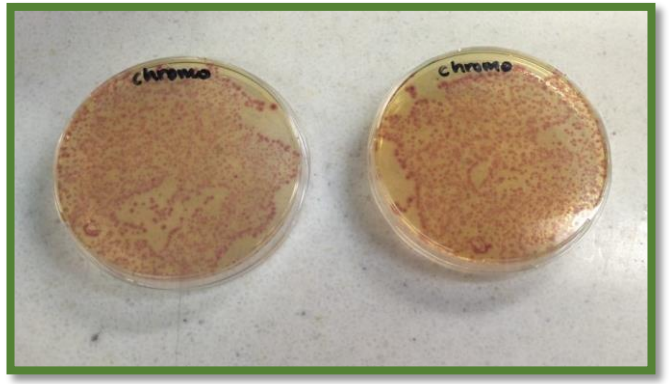


Imagen 1. Análisis Microbiológico

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Obtaining the Coagulant

Following Contreras et al. (2015),

- Taking 2 stalks, crushing them with distilled water in a 1:2 ratio (w/v); this mixture was placed in an oven at 50°C for 1 hour for heat treatment.
- Then, the suspension was centrifuged at 3500 rpm for 10 minutes and a supernatant was left, to which 96% (v/v) ethanol was added in a 1:4 (v/v) ratio, and allowed to settle to precipitate the mucilage.
- It was separated by filtration and dried in an oven at 70°C until it had 10% humidity. The final product can be pulverized for use.

Imagen 2. Process for obtaining the Nopal coagulant

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Separation Test

According to Beggio et al., (2021)

- In a Flocculator equipment for Jar Test, 1 L of Biol obtained was taken and arranged in beakers.
- The digestate was mixed in the equipment to homogenize the sample for 10 seconds at 300 rpm.
- The coagulant was added in doses of 25, 30, 35 and 40 mg/, in a period of 60 seconds at a speed of 300 rpm.
- After this time it is adjusted to a slow agitation of 50 rpm for approximately 10 minutes and it is observed which one has removed more solids

Imagen 3. Jar Test

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Seed Phytotoxicity

According to the protocol described by Sobrero and Ronco (2004)

- Dilutions of the sample are made with toxicity values between 100 and 0%, thus obtaining doses of 100, 50, 25, 12 and 6% toxicity, with a negative control of distilled water.
- The seeds are placed in Petri dishes that previously have filter paper and about 2 mL of the dilution, avoiding the formation of air pockets.
- Put the lid on and inside a black plastic bag to maintain humidity.
- Place in a place at room temperature for 48 hours. A photographic record will be made at 24 h to observe the amount of germinated seeds.

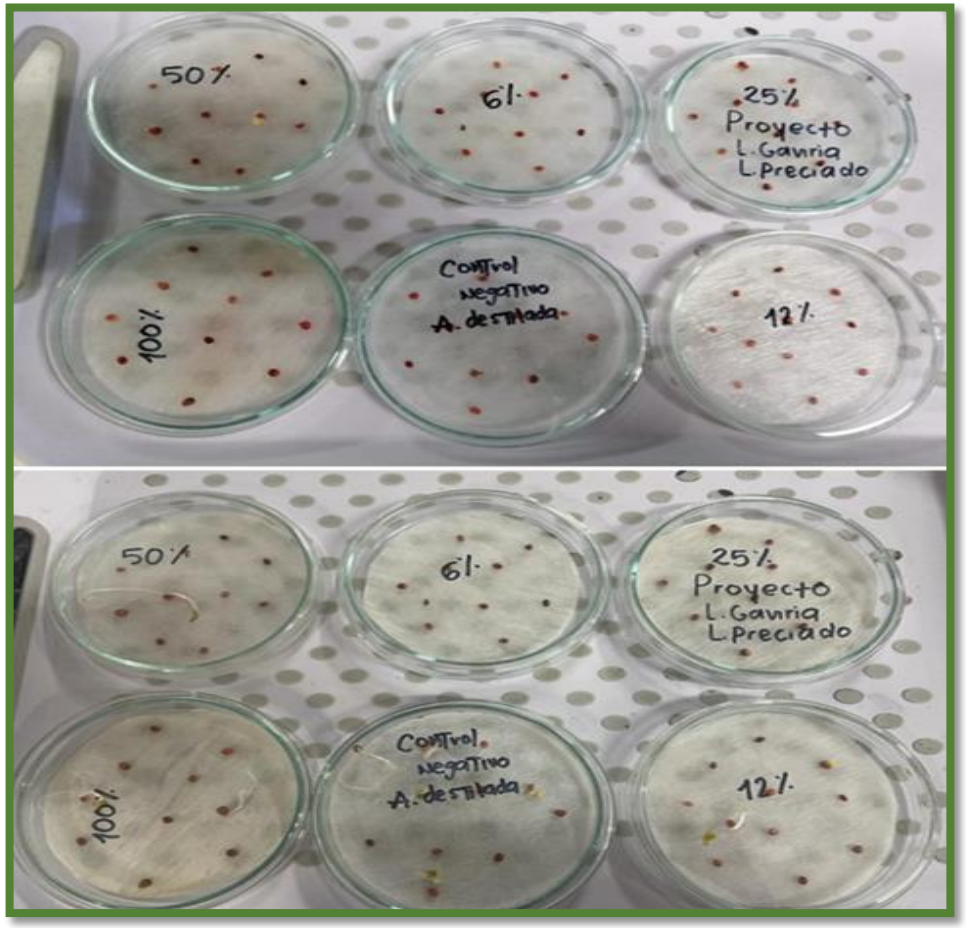

Imagen 4. Seed phytotoxicity

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RESULTS AND ANALYSIS

Table 1. UASB reactor start-up operational characteristics

Flujo másico (Kg DQO/d)	3,90
TRH (d)	2,23
TRH (min)	3210,53
Caudal (mL/min)	19
Caudal (m3/d)	0,027
Vel. de flujo en la campana (m/s)	0,145
OLR (Kg DQO/m3 d)	0,64

Table 2. Physicochemical, Microbiological and Nutrient Analysis Characterization

Elementos Analizados (%)		Método Analítico
Nitrógeno Total	2.04	Kjeldahl
Fósforo	1.62	Colorimetría
Potasio	0.81	Absorción atómica

Parámetro	Resultado
DQO (mg/L)	8,967
pH	7,9
Conductividad (dS/cm)	0,009
Turbiedad inicial (NTU)	33,59
Coliformes Totales (UFC)	<500

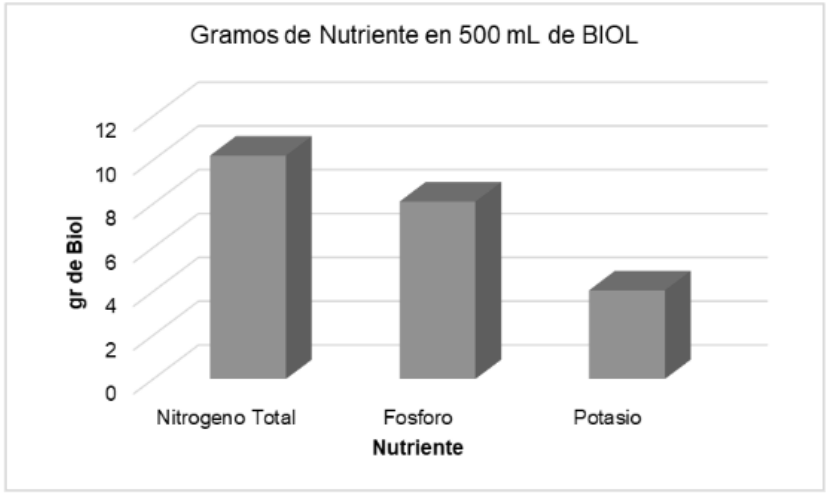

Figure 1. Grams of available nutrients in 500 mL of Digestate.

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RESULTS AND ANALYSIS

Table 3. Grams of Nitrogen, Phosphorus and Potassium in Biol in 500 mL of Digestate

Nutriente	g/500 mL	g/L (NTC 5167)
Nitrógeno Total	10,2	15
Fósforo	8,1	15
Potasio	4,05	15
Total	22,35	-

Table 4. Coagulant doses applied and parameters after separation test

Dosis	pH	Turbiedad
25 mg/L	8,1	9,37
30 mg/L	8,2	26,57
35 mg/L	8,1	14,31
40 mg/L	8,1	15,58

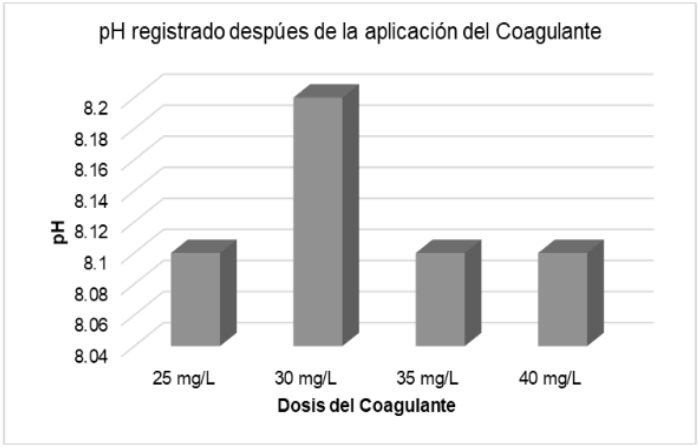

Figure 2. pH recorded after coagulant application.

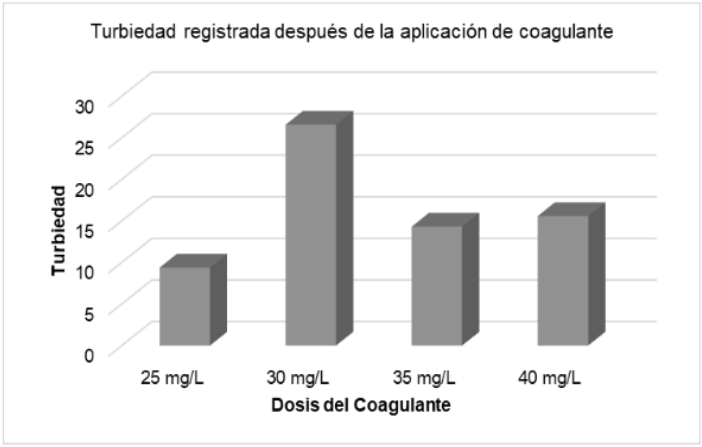

Figure 3. Turbidity recorded after coagulant application

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RESULTS AND ANALYSIS

Table 5. Percentage of solids removal in Biol after separation tests

Dosis	Remoción (%)
25 mg/L	72,10
30 mg/L	20,89
35 mg/L	57,39
40 mg/L	53,62

Table 6. Seed Germination

Dosis	Semillas Germinadas
0 (Control)	6
100	3
50	1
25	0
12	2
6	0

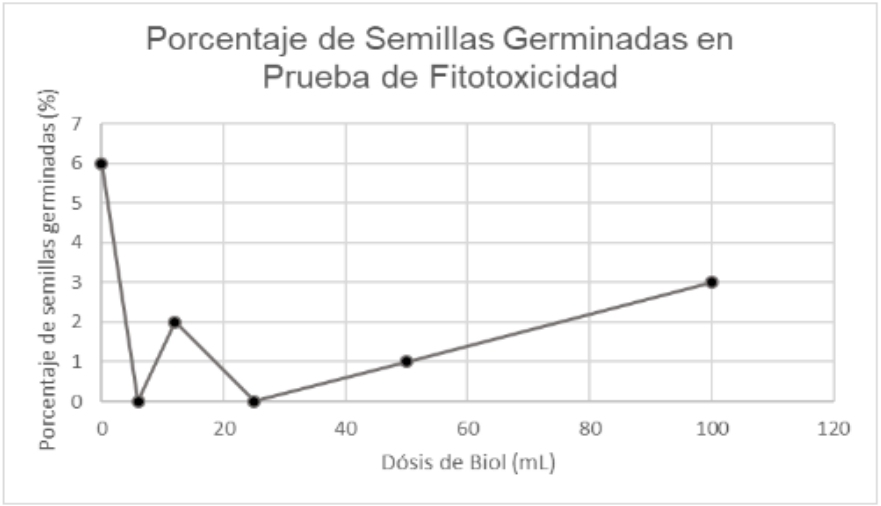

Figure 5. Percentage of germinated seeds

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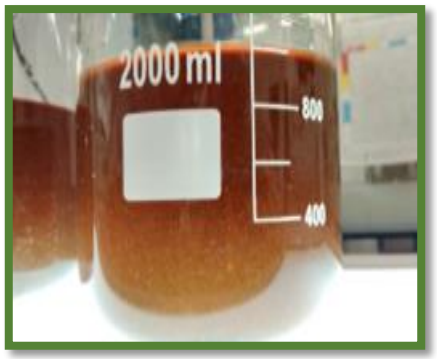
ANALYSIS OF RESULTS

For pH, there was no noticeable variation in the coagulant doses applied, all had a similar result except for the third dose (35 mg/L) which had a change of ± 0.1 with respect to the other concentrations. According to Contreras (2015), the natural coagulant does not significantly alter the pH. But if there is a difference compared to Biol before its solid separation ± 0.3

Imagen 3. Jar Test



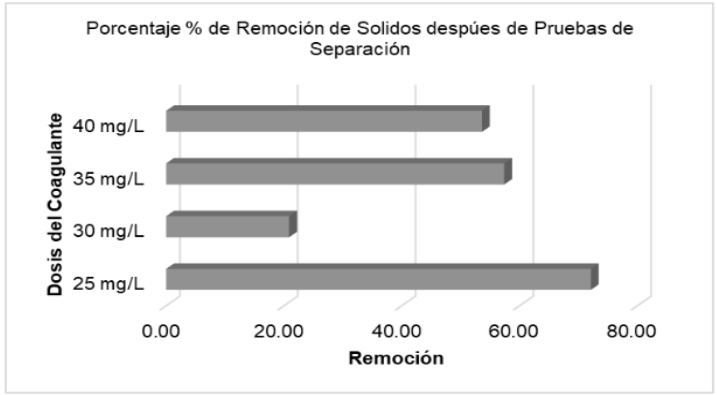


Figure 4. Removal recorded in % after separation tests

A clarification of the color was generated together with a dispersion of flocs and colloids in the different containers, a greater abundance was obtained in the lower dose of the coagulant, decreasing 72% of turbidity in this.

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ANALYSIS OF RESULTS

- The measured COD was 8967 mg/L, this has a high organic load that can be beneficial in soils and crops, confirming the availability of nutrients

- According to Beggio et al. (2021), the separation test can remove the greatest amount of solids in the effluent being treated, and although a large part of the organic load is also concentrated in the solids, it is mainly removed, which can produce phytotoxicity since in these it can be more aluminum or other heavy metals

- The toxicity test was effective in certain doses of Biol applied, even so, the negative control had the highest number of germinated seeds and the 100% dose of Biol had germination and growth in 3 of the 10 seeds, therefore it is ruled out that be external factors or adverse conditions that did not allow growth.

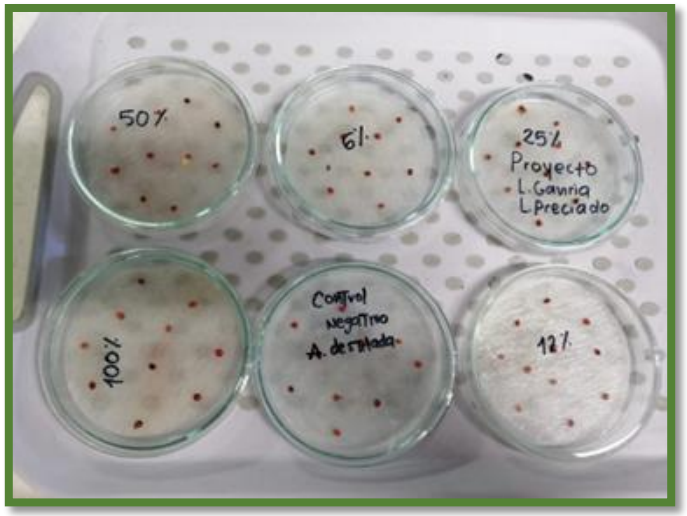

Imagen 4. Seed phytotoxicity

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CONCLUSIONS

- The separation test was effective and waste could be reduced with the lowest dose of coagulant. It must be taken into account that there could be a margin of error since at the time of processing the sample it was cold and not at room temperatura

- The coagulant showed an effectiveness in the clarification and removal of solids in Biol, achieving a removal of up to 72.10%, for which reason it can be considered appropriate to use it in low doses for the removal of solids

- An external laboratory analysis is required to evaluate if the Biol processed with the lowest dose still contains the necessary nutrients for its application, and it is also required to do the toxicity test to rule out that the growth of the seeds has indeed been due to the Biol toxicity and not by other external factors

- It is recommended in the future to carry out tests on plants or crops in a controlled environment without the risk that the pathogenic load may affect growth or promote diseases in them.

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Effect of the macrophyte Eichhornia crassipes on phytoremediation of water contaminated with Chromium

- María Camila Holguín Zuluaga, Juan David Cartagena Demoya
- **Advisors**: Laura Osorno Bedoya, Carlos Fidel Granda Ramírez.

RESEARCH PROBLEM

Chromium

- Heavy metal
- Silvery White color
- Hard and Breakable
- It is found on the geochemical moon with 0.47% Cr_2O_3 and 3-20 times larger tan the terrestrial specimen.
- Toxic Material to health and the environment.
- Cr (lll) residual element necessary for good health.
- Cr (Vl) Frecuently used in the industrial sector.

THEORETICAL FRAMEWORK

WASTEWATER TREATMENT

PROCESS:
- Physical
- Chemical
- Biological

→ Quick and expensive treatments.

→ Environmentally friendly and economical treatment

Eichhornia crassipes

Taken from: https://www.cal-ipc.org/plants/profile/eichhornia-crassipes-profile/

- Natural self-purification.
- Remediation time: 20 – 31 days
- Removal of Cr 70% - 95,5%
- Initial concentrations: 2, 4, 6, 612 y 1400 mg/L Cr

(Hadad 2011; Carreño and Granada 2016, and Tabinda 2020)

Objective´s

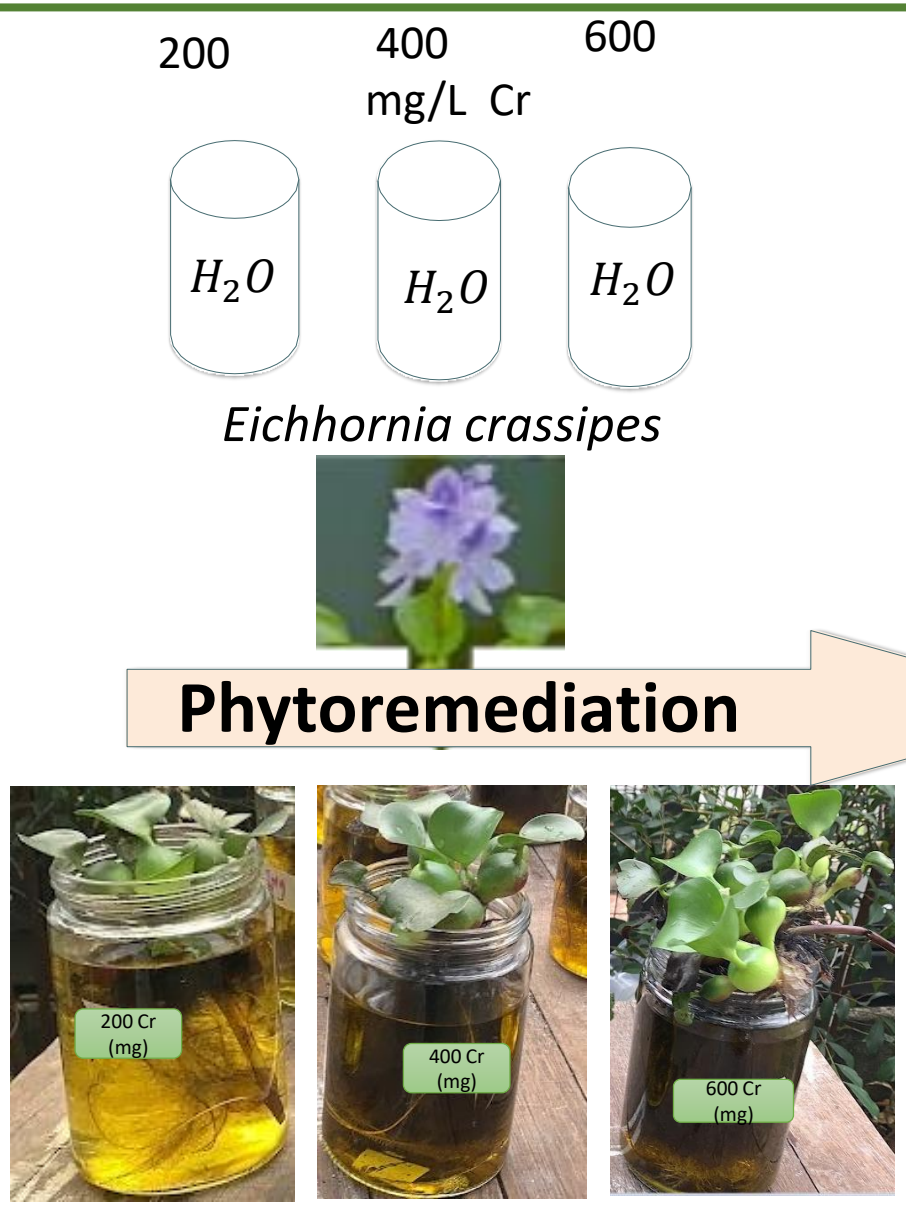
General:

Evaluate the chromium phytoremediation effect in water by usingthe plant Eichhornia crassipes.

Specific:

- *Evaluate the growth and development of plants Eichhornia crassipes in contaminated water* Cr.
- *Measure the percentage of Eichhornia crassipes remediation in contaminated water with Cr in certain concentrations.*

Methodology



VARIABLES

- Concentration of Cr (mg/L)
- pH
- Dry weight of macrophyte (g)
- Removal Cr (%)

- Statistics: Completely randomized desing with 3 concentrations and 3 repetitions
  Anova with $P<0.05$ with Statgrahpics

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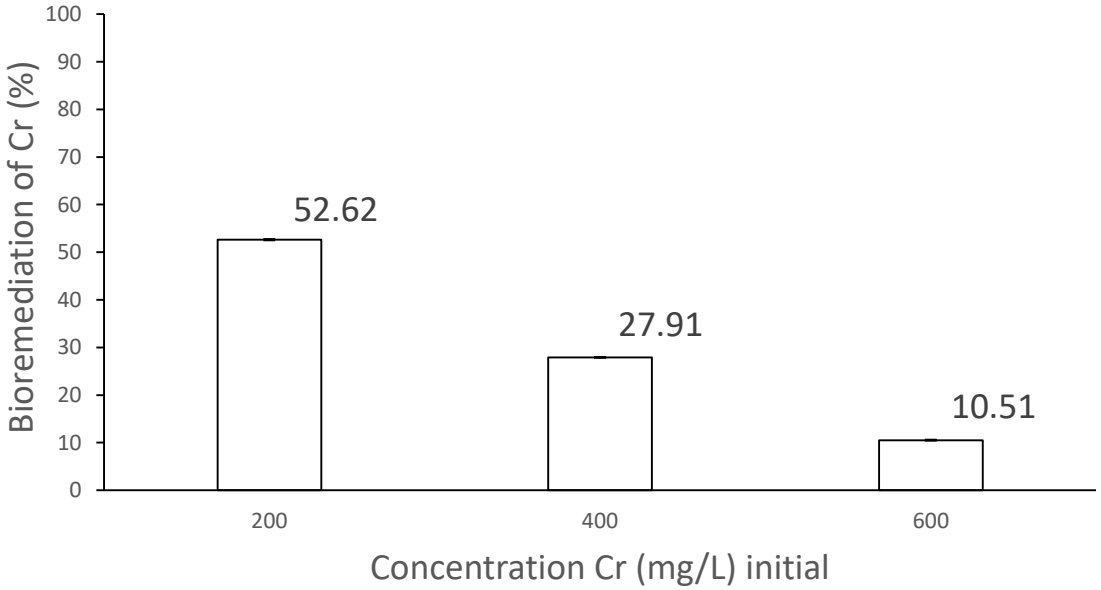
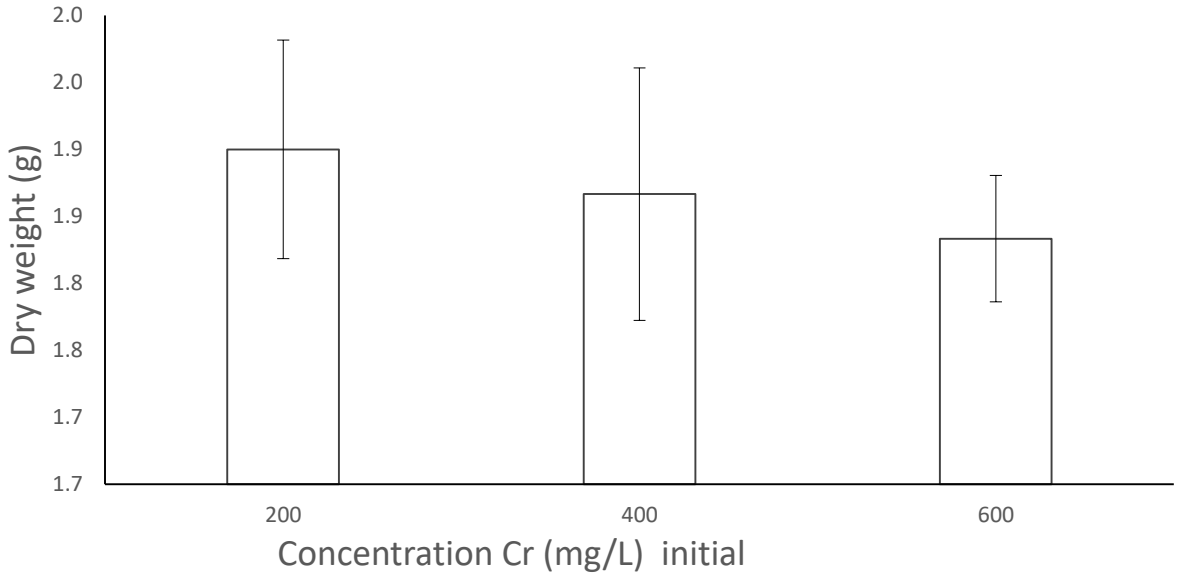
RESULTS AND ANALYSIS





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CONCLUSIONS

- The Eichhornia crassipes obtaintment in Colombia is relatively simple, this is given for climatic reasons and nutritional richness that we find in many aquifers of this country, in addition of the invasive features of the macrophyte *Eichhornia crassipes*

- The macrophyte is tolerable to the heavy metal Chromium, if these are subjected to very high concentrations greater than or equal to 400 mg/L $K_2Cr_2O_7$ this will present a process of chlorosis, which will spread progressively and trigger necrosis which will prevent the process of effective phytoremediation.

- The phytoremediation process performed with macrophyte *Eichhorina crassipes,* revealed the ability to remove high amounts of chromium reducing concentrations of 200 mg/L $K_2Cr_2O_7$, 400 mg/L $K_2Cr_2O_7$ y 600 mg/L $K_2Cr_2O_7$ in a 53%, 28% and 11% respectively with a period time of 15 days of treatment, the research showed that the use of the *Eichhornia crassipes* as an adsorbent of the heavy metal chromium is an effective and economical way to remove water contaminated with heavy metals

RECOMMENDATIONS AND OBSERVATIONS

- *Assing nutrient solution as Hoagland and Snyder to the phytoremediation process , this will help to improve the growth and development of Eichhornia crassipes.*

- Analyze the amount of heavy metal adsorbed by the plant.

- Continuous exposures to 0.045 nanograms per cubic meter (ng/m3) of Cr6 from all sources combined for 30 years could increase cancer risk to 25 in a million; Non-carcinigenic health effects associated with Cr_6 include irritation or nasal allergies. The chornic REL for Cr_6 is 200 ng/m3 in air (0.2 µg/m3).

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ANALYSIS OF SOCIAL VULNERABILITY IN THE CONTEXT OF FLOODS: A LAND USE PLANNING

Students

Erica Vargas

Laura Camila Moreno Rivera

Maria Elena Restrepo Molina

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Research problem:
How is the territory affected by the flooding of the San José River in the San Fernando neighborhood of Apartadó?

Objectives
General

- Make a diagnosis of the territory affected by the flooding of the San José river in the San Fernando neighborhood of the municipality of Apartadó

Specifics

- Contextualize the social situation presented by the inhabitants in the San Fernando neighborhood by the San José de Apartadó river.

- Verify in the current regulations of the municipality that territorial planning tools exist in relation to flooding.

- Provide input from environmental engineering in the management of land management for the proposed area.

Urban area of Apartadó municipality. Taken from IGAC (Agustin Codazzi Geographic Institute) Geoportal.

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Theoretical Framework

Floods are natural events that occur when water covers land areas that are normally dry. These events can be caused by various factors, such as heavy rains, river floods, and storms. Floods are common in many parts of the world and can have serious effects on the environment and people living in the affected areas.

Taken from Caracol Radio, article from October 28, 2019.

Taken from El Tiempo newspaper, article from May 10th, 2022.

The causes of floods can be varied and complex. The geography of the area, the climate, the topography, urbanization, deforestation, and the construction of infrastructure can all contribute to the occurrence of floods. In the specific case of San Fernando neighborhood in Apartadó, the construction of housing and urbanization in risk areas, deforestation and the loss of natural vegetation, as well as the lack of maintenance and cleaning of bodies of water, are factors that increase the vulnerability of the territory to floods.

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Methodology

Find information in local and departmental newspapers about flooding in the Apartadó neighborhood of San Fernando.

Interviews will be conducted the community leaders in the San Fernando neighborhood of Apartadó

Timeline of floods in the San Fernando neighborhood in the last 10 years

The information contained in the POT, POMCA, and PDM will be reviewed to identify how flood issues are documented

The aim of gathering the information is to create zoning maps and overlay them with the maps found in the territorial planning instruments

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Results and analysis

- *Historical review for flood events in the San Fernando neighborhood of Apartadó:*

These events occur mainly during the rainy months, which include the periods from April to May and October to December. It is evident that since the construction of the bridge in 2008, floods have become more frequent and sometimes more intense. Over the years, several flooding events have occurred in the area, which have significantly affected the community.

Community visit:

- During the flood investigation in the San Fernando neighborhood of Apartadó, a community visit was conducted and neighborhood leaders were consulted to conduct a survey of 24 people. An approximation was made to the variables of exposure to floods, taking into account the occupancy of household members and if they could cope with the costs involved in a flood, such as evacuation, replenishment of lost assets and purchase of food to be supplied during the flood

Photograph of a meeting with the communities - Own elaboration.

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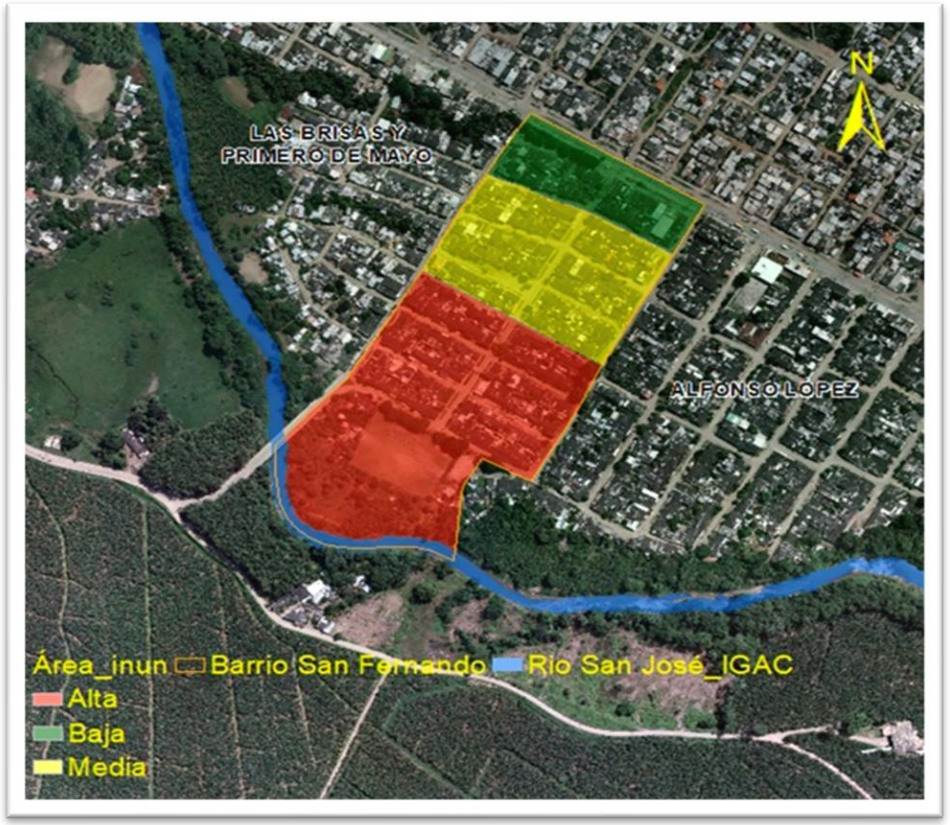

San Fernando neighborhood - Apartadó, with areas of threat based on the level of overflow of the San José de Apartadó river. Taken from the Geoportal of the Catastro Management of Antioquia. (Figure 1.)

Polygon with flood levels.
From the socialization with the leaders of the neighborhood, and taking as a route the information provided by them according to the level of flooding that occurs in the neighborhood during the most critical flood events, were established areas of threat, demarcating medium and low flood levels.

Review of public documents related to risk management and spatial planning plans.
Development plan for the municipality of Apartadó 2020-2023, the Management and Management Plan for the León River Basin.
In the current POT for the municipality of Apartadó 2011-2023, Agreement 003 of June 23, 2011, articles 22- 27- 31 and 80, are related to flood problems including the San Fernando neighborhood

Compare POT maps vs map drawn according to information from community leaders.
Map land use vs map raised according to documentation of the leaders, is an area of 53,336 m2 of protection, of which 46,789 m2 correspond to the high flood zone indicated by the leaders of the neighborhood, Whereas according to article 51, the protection zones have restriction for constructions of buildings, it has a total of 149 lands.

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Land use map

Map of areas at recoverable or mitigable risk of flooding.

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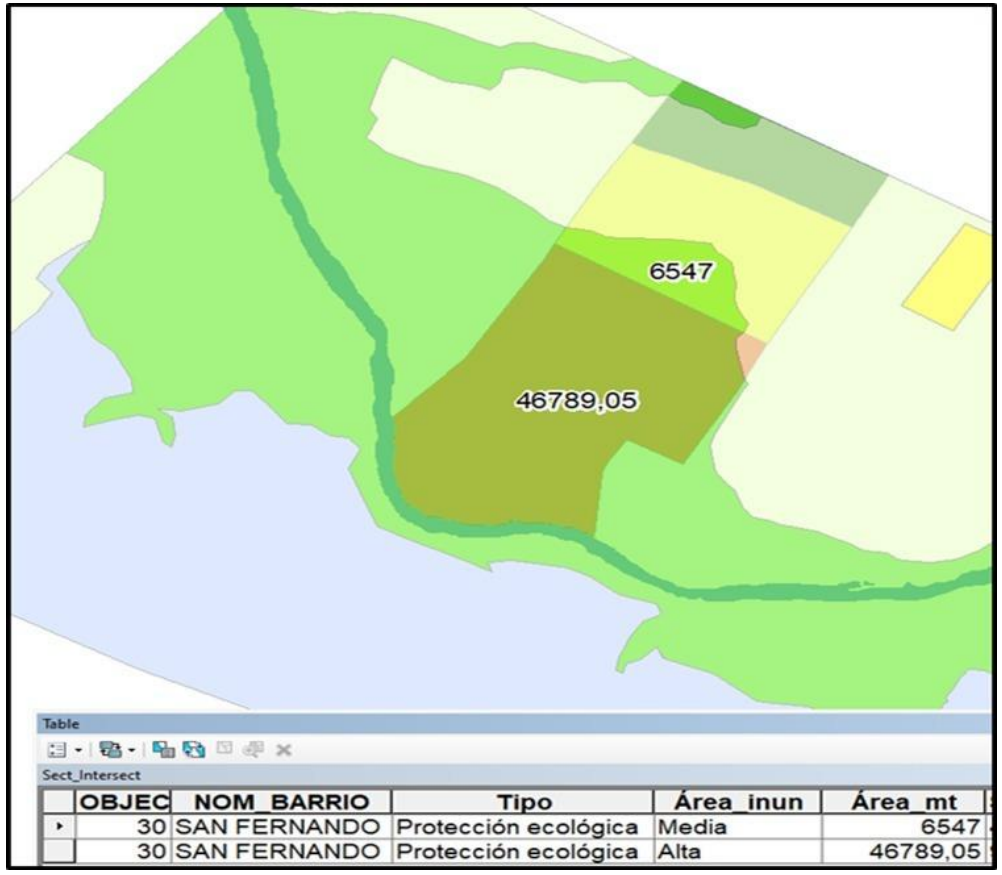
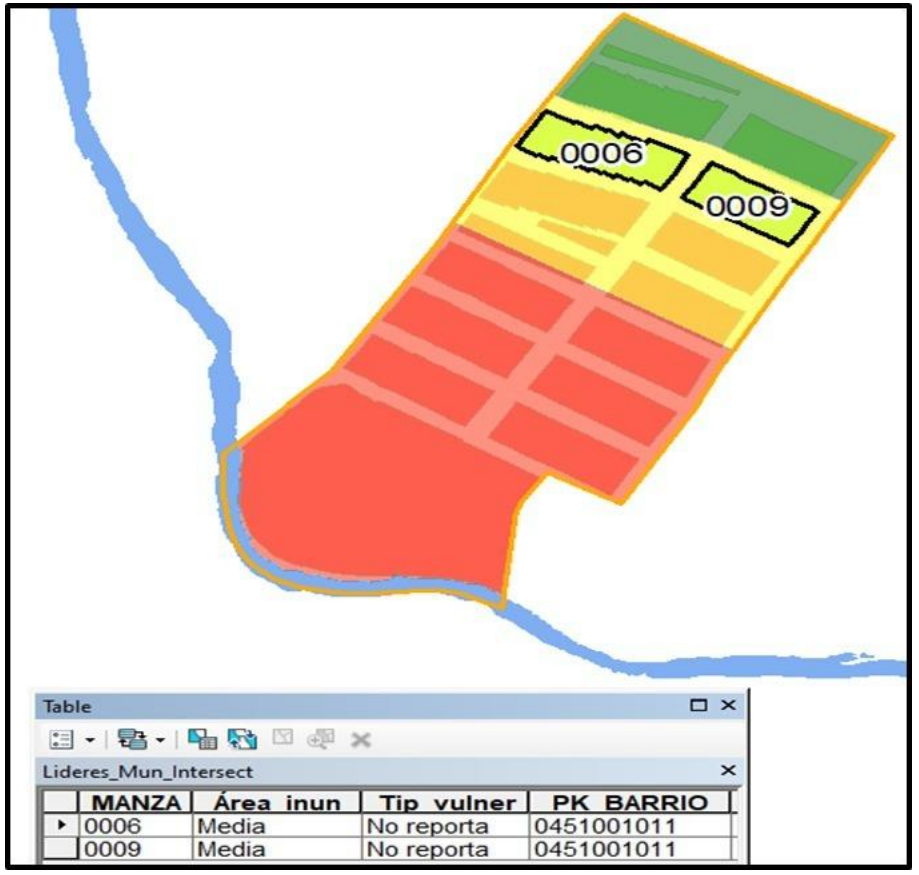


Overlay of land use map vs Figure 1 map.



Overlay of flood vulnerability map onto Figure 1 map

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Conclutions

- Flooding in the study area is becoming more frequent and intense, which has generated concern and distrust in the community regarding the measures taken by local authorities to reduce flood risks.
- Taking into account that the San Fernando neighborhood has been the most affected in multiple flood events, it is necessary not only to include it in articles related to flood risk in the POT but also to include it in improvement or relocation plans for affected families in programs such as the river master plan.
- Finally, it is concluded that the territory of Barrio San Fernando has been affected in several ways. Firstly, physically, in the deterioration of public spaces such as roads and housing, and in the increase of erosion problems in the riverbanks. Secondly, economically, it has contributed to the depreciation of housing. And thirdly, socially, it has created inequalities among people who have to continue living near the river due to lack of resources to change housing, in addition to the loss of credibility in government entities regarding programs for river recovery and assistance to people affected during emergencies.

Recomendations

- It would be appropriate for the municipal administration to review how construction licenses and permits for the constitution of RPH are issued in places with restrictions on land use, as protection zones and in case these permits have been given before the current POT, a legal way should be found to modify them, since these areas are not suitable for living.
- There are strategies for amphibious mode construction types, which have been widely used in countries such as the Netherlands with climatic conditions similar to those of Apartadó in flood events and which, in universities such as the EAFIT, have already been studied and modelled on sites such as the Guatapé dam.

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Physicochemical stabilization of a biosolids from a wastewater treatment plant using lime to reduce the emission of H_2S and CH_4

Authors: Daniela Cuartas Piedrahita

Lizza Fernanda Brid González

Ana Belén González Lozano

Teacher: Alejandro Builes Jaramillo

Adviser: Julián Esteban López Correa

Research project

Environmental Engineering

Institución Universitaria Colegio Mayor de Antioquia

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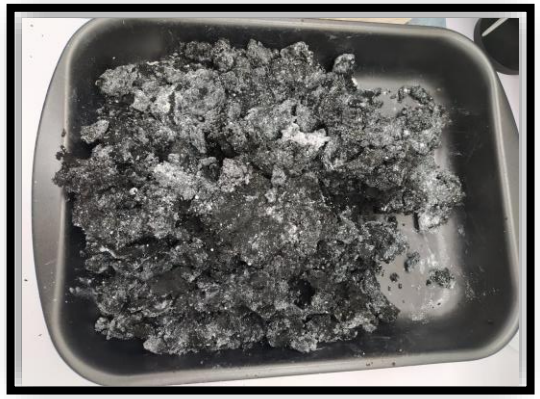
Introducción

Biosolids are donated to farms and used as soil amendments

The offensive odors emitted have generated a rejection and usually contain potentially toxic elements

Lime, a widely marketed liming material, its main use is the correction of acidity in soils



Reduces the emission of substances that generate annoying odors and also the risk due to the presence of potentially toxic elements

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Objectives

To evaluate the use of quicklime as a treatment for the reduction of emissions of compounds (H_2S and CH_4) associated with nuisance odours from biosolids from a WWTP.

- ✓ Determine pH, EC (electrical conductivity), moisture, redox potential, H_2S and CH_4 of the biosolid generated at a WWTP.
- ✓ To evaluate the effect of the application of quicklime (CaO) at different doses on the physicochemical characteristics and the emission of compounds such as H_2S and CH_4 from the biosolid.
- ✓ To determine the presence of potentially toxic elements in untreated and treated biosolids using the TCLP test (toxicity characteristic leaching procedure).

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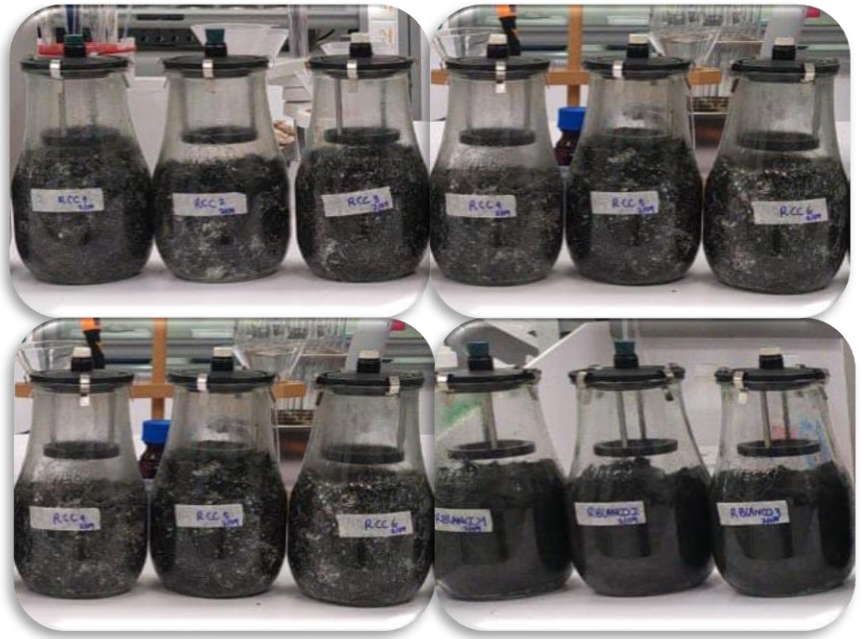
Methodology

1. **Biosolid collection**

2. **Reading initial parameters**

3. **Assembly of biosolid with lime and whites**



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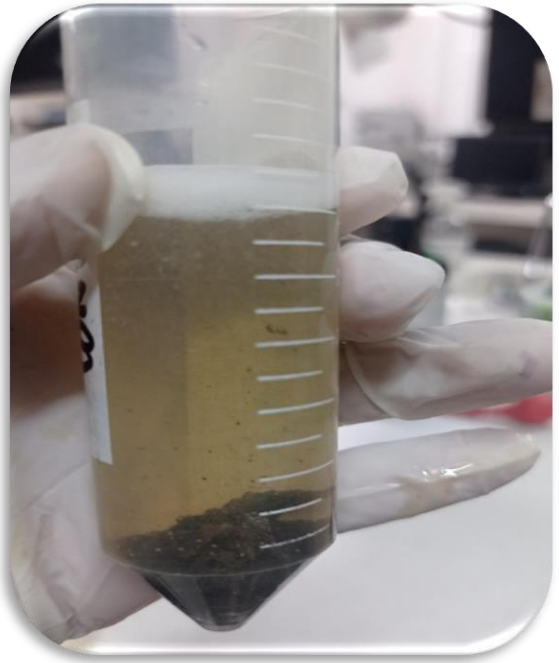
Methodology

4. Evaluation of final parameters

5. TCLP test of lime-free biosolid

6. TCLP Reading Test 4 (32 days)



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Results and Discussion

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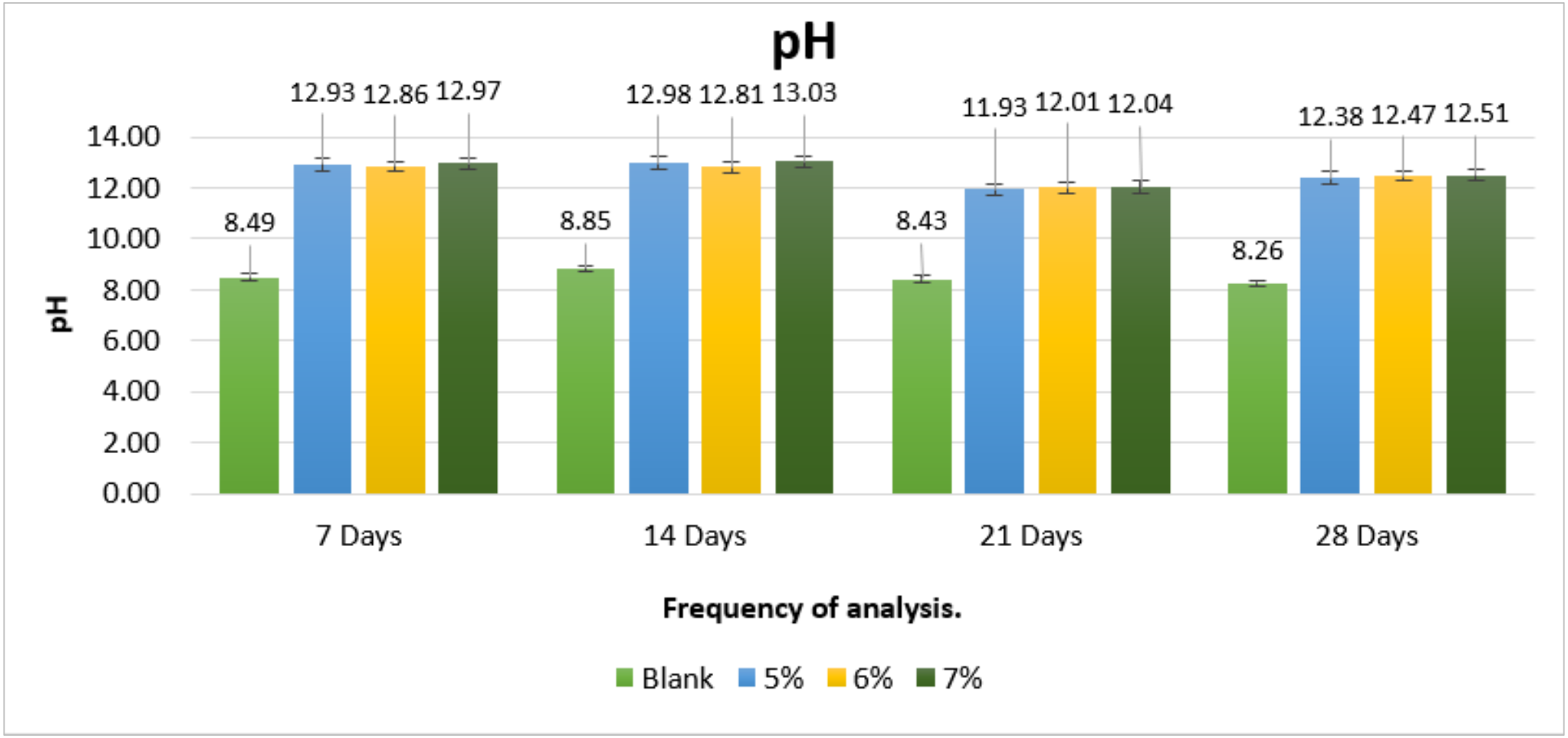

Figure 1. pH Results

pH increased with respect to white approximately 4.5 units. It is evident that there was no significant oscillation between the percentages of lime and the exposure times.

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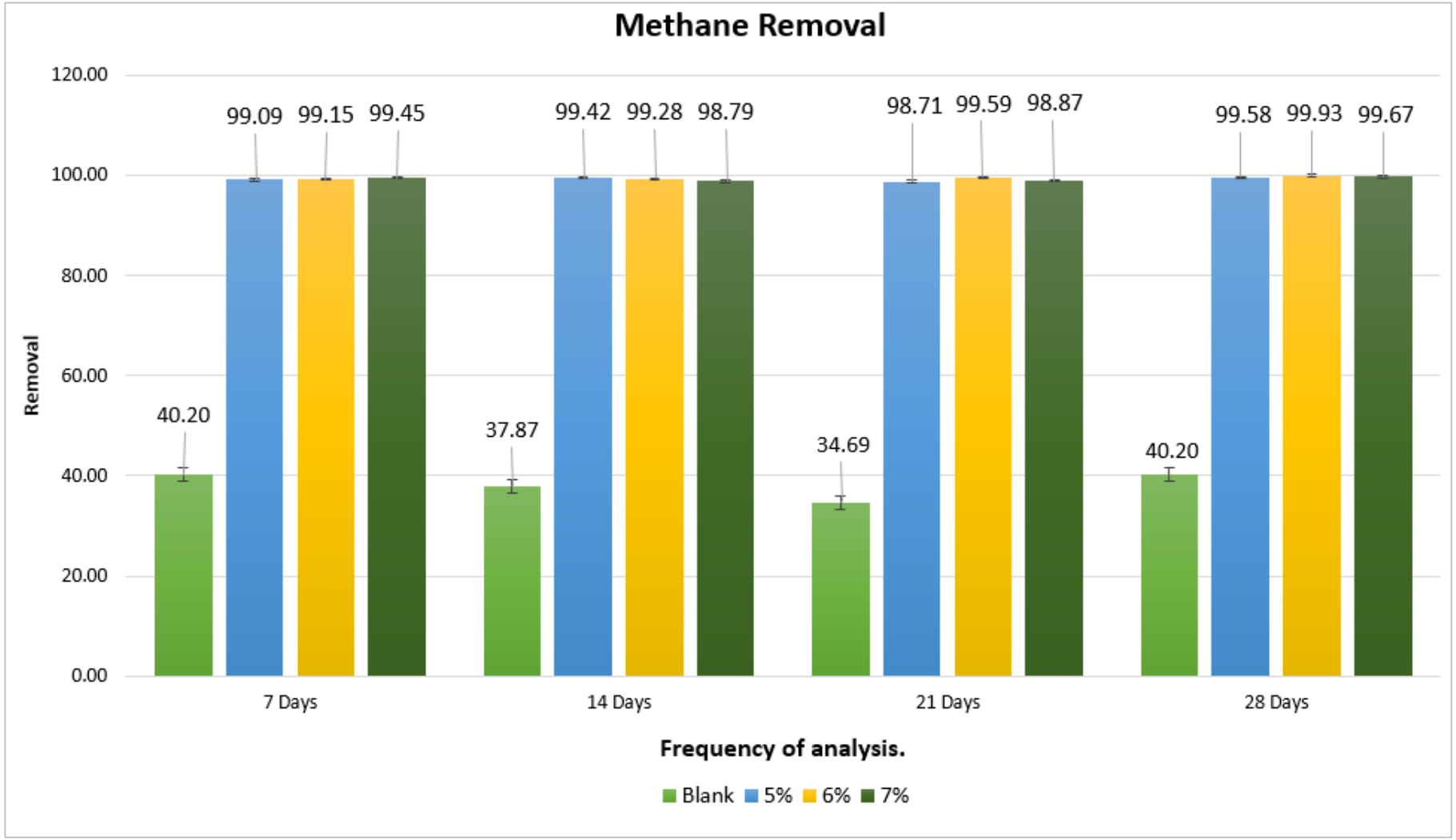

Figure 2. Methane results

Removal above 90% is evident for all three concentrations in the four readings that were taken.

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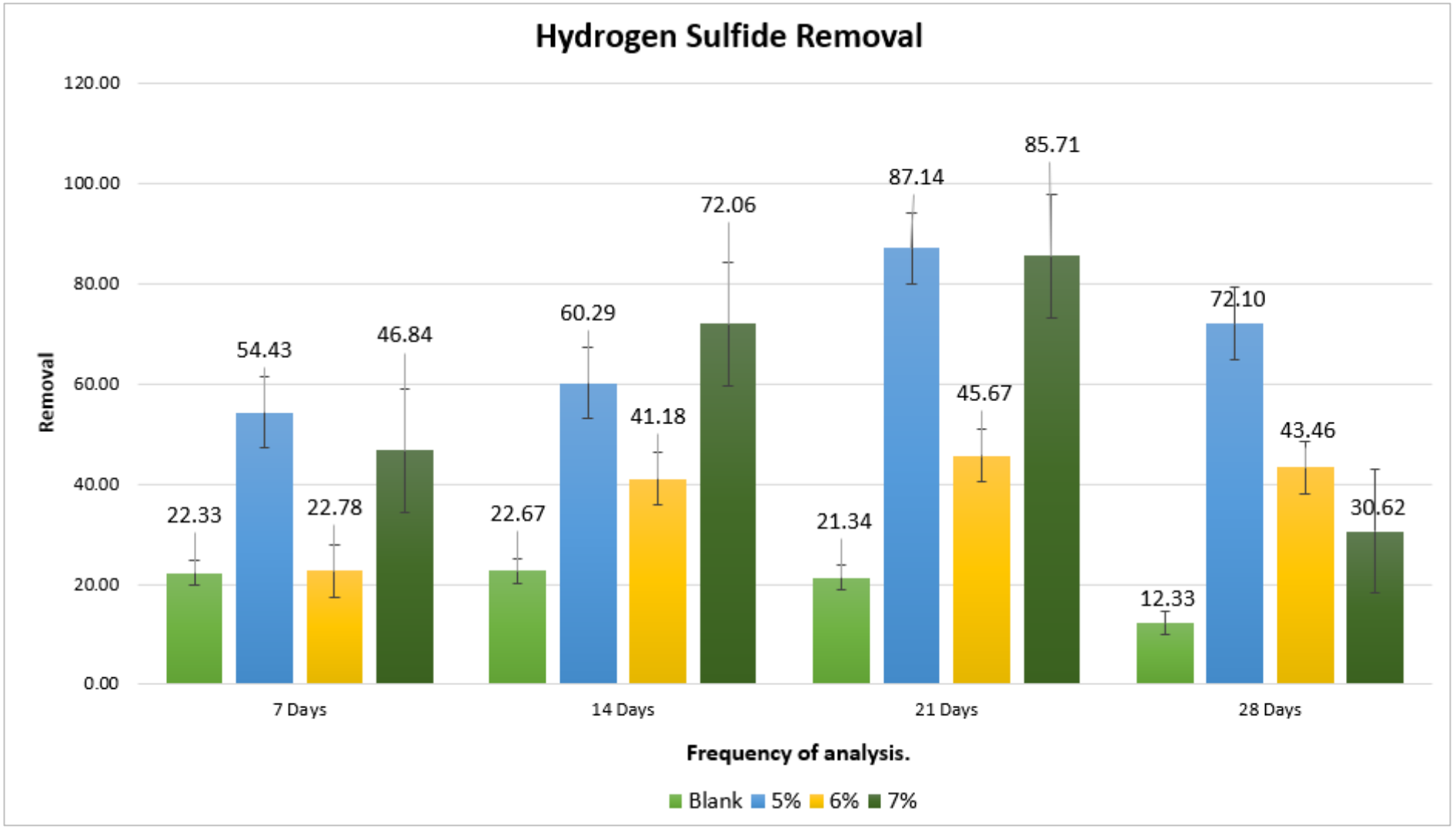

Figure 3. Results Hydrogen Sulfide
Better efficiency at 5% in the third reading is evident.

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TCLP Results

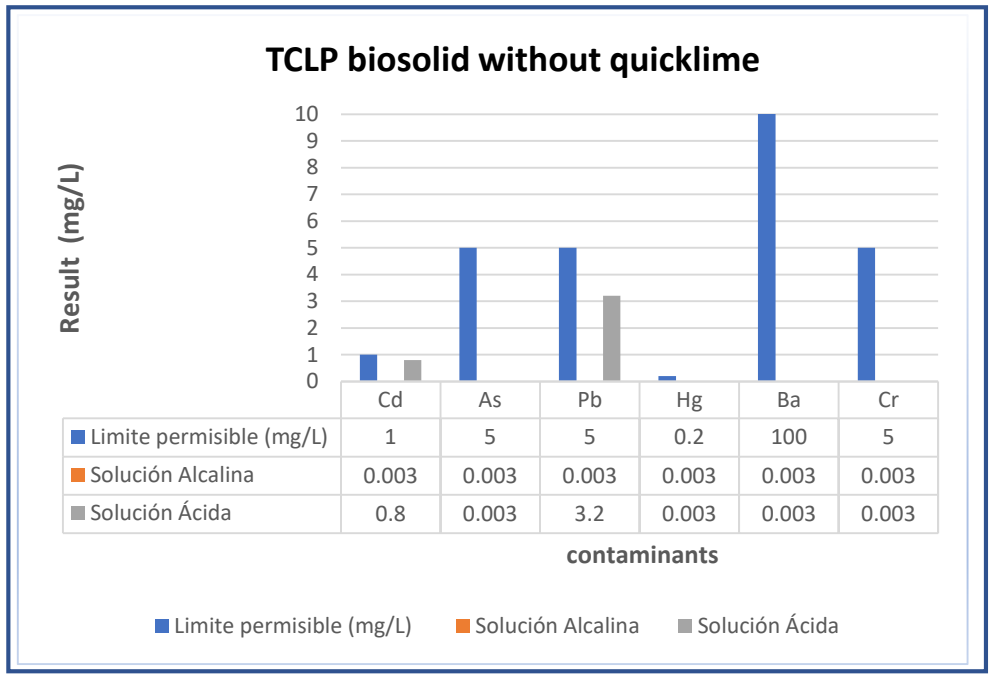

Figure 4. Results of TCLP Biosolid without the application of cal

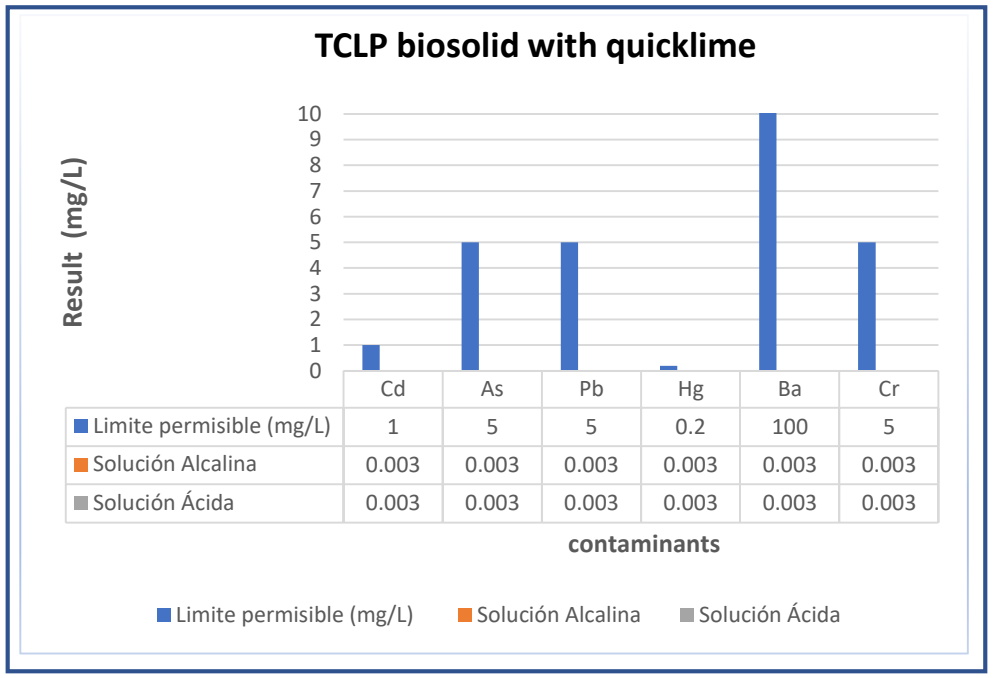

Figure 5. Results of TCLP Biosolid with the application of cal

The TCLP test was performed with lime-free biosolid and with lime at 5% of the fourth reading in which a removal of 99.6% of cadmium and 99.9% for lead was obtained

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Conclusions

- ✓ The application of lime did modify the physical parameters evaluated such as pH, EC (electrical conductivity), moisture, redox potential, H_2S and CH_4 of the biosolid generated in a WWTP. However, pH and odour producing gases were studied in more detail, as these are the relevant ones for the investigation.

- ✓ The pH increased with respect to the blank by approximately 4.5 units.

- ✓ CH_4 was removed above 90% for all four readings with all 3 lime concentrations.
- ✓ H_2S was most efficient at 5% lime at the third reading (21 days).

In general, the alternative proposed in this stabilisation study can be an option for the physical-chemical stabilisation of biosolids from a WWTP, with the aim of reducing emissions of compounds (H_2S and CH_4) associated with nuisance odours and the bioavailability of potentially toxic elements.

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THANK YOU

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Production and characterization of coffee pulp compost enriched with *Trichoderma* spp. and *Bacillus thuringiensis*

Students: Estefani Montoya Osorio - Ana María Céspedes
Course instructor : Alejandro Builes
Thematic teacher advisor: María Isabel Aristizabal - Laura Osorno Bedoya

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General information

Trichoderma spp.

- Fungal genus present in practically all arable soils of the world.
- Accelerates the decomposition of organic matter.
- Biological control agent.

Bacillus thuringiensis

- It is a soil-dwelling bacterium.
- It is commonly used as a biological alternative to pesticides.

Pulp process

It consists of dragging the coffee cherry by passing it between two surfaces, one smooth and the other serrated. The machine separately expels the coffee beans and the pulp that would be the residual product.

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Research problem: Coffee pulp is a by-product of coffee processing, but currently it is not so common to use it because there are alternatives that cannot be implemented due to cost, space or time. This is an environmental problem at a national level, affecting water sources, soil and air.

Figure 1. Coffee bush.

Figure 2. Coffee pulping

Figure 3. Storage of coffee pulp

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Objectives

General:

To produce and characterize coffee pulp compost biologically enriched with *Trichoderma* spp. and *Bacillus thuringiensis.*

Specifics:

- To implement a composting system in an open system (pile) for the treatment of coffee pulp biologically enriched with *Trichoderma* spp. and *Bacillus thuringiensis.*
- Characterize coffee pulp for composting.
- To evaluate the composting process of coffee pulp biologically enriched with *Trichoderma* spp. and *Bacillus thuringiensis.*
- To chemically characterize coffee pulp compost biologically enriched with *Trichoderma* spp. and *Bacillus thuringiensis*.

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Methodology

Mounting

- San Cristóbal
- Guintar - Anzá

Experimental design

- T1 coffee pulp, manure, vegetal material
- T2 coffee pulp, manure, vegetal material and *Trichoderma* spp
- T3 coffee pulp, manure, vegetal material and *Bacillus thuringiensis*

Follow-up

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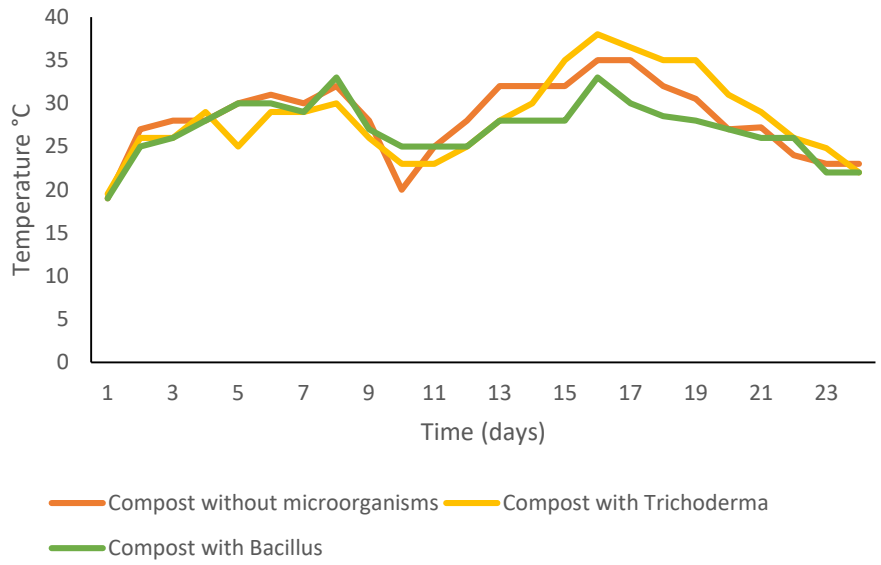
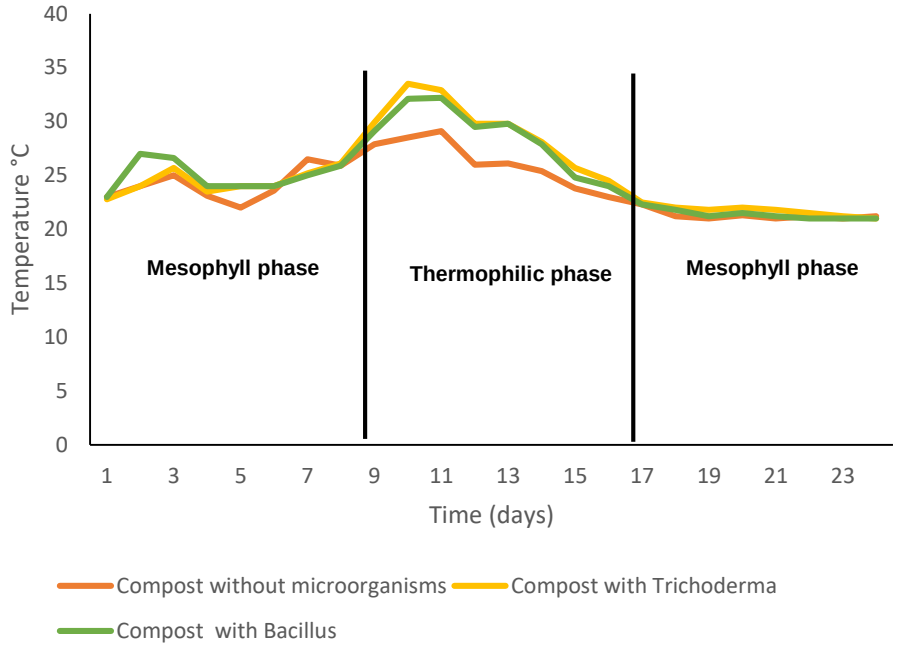
Results and analysis

Temperature monitoring

Mounting 1



Mounting 2



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Initial results

Coffee pulp characterization

Mounting 1

Analysis	Results	Method of analysis
Ashes	17.19 g/100 g	Gravimetric
Moisture and other volatile matter	81.9 g/100 g	Gravimetric
Nitrogen	2.8 g/100g	Volumetric (Kjeldahl)
pH	7.51	Potentiometry

Mounting 2

Analysis	Results	Method of analysis
Total oxidizable organic carbon	38.1 %	Titulometry
Moisture and other volatile matter	9.42 %	Gravimetric
Nitrogen	0.45 %	Kjeldahl
pH (10%)	3.77	Potentiometry
C:N Ratio	84.7	Mathematical calculation

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Final results

Physicochemical characterization of the compost for the different treatments.

Analysis	Results compost with *Bacillus*	Results compost with *Trichoderma*	Result compost without microorganisms
Total oxidizable organic carbon	30.60%	28.80%	29.10%
Moisture and other volatile matter	21.30%	24.20%	25.10%
Nitrogen	2.28%	2.25%	1.08%
pH (10%)	8.43	8.35	8.55
C:N Ratio	13.4	12.8	26.9

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Microbiological analysis results

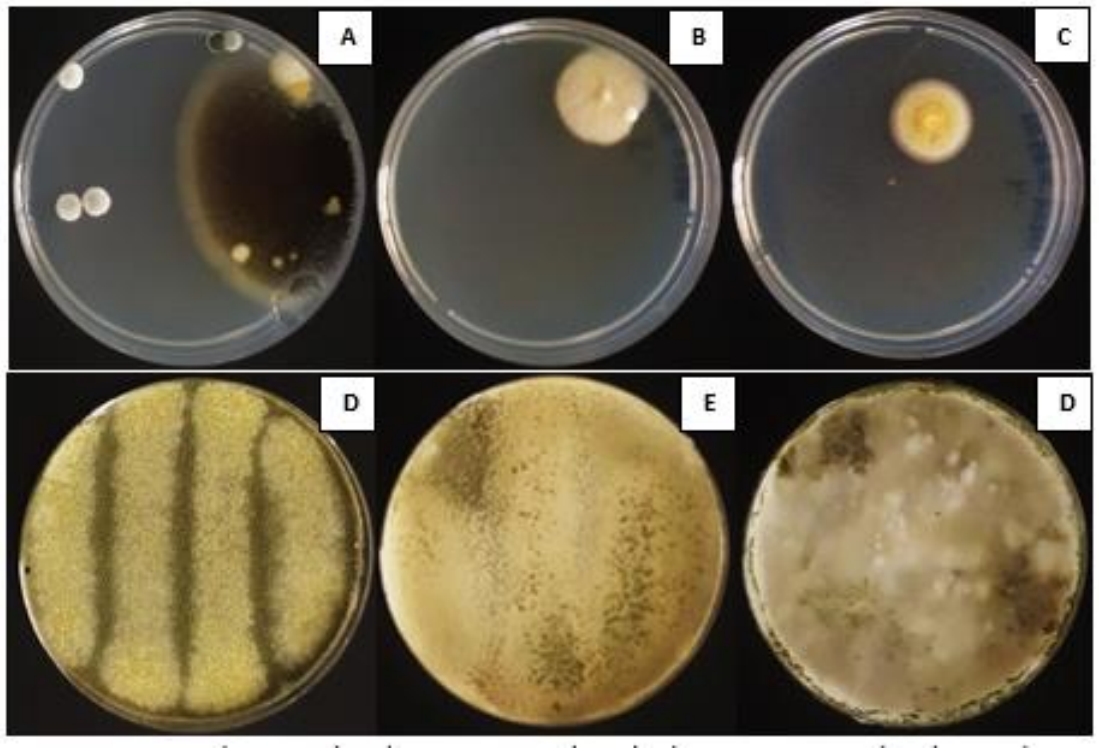

Figure 4. Growth on plate A-C) Serial dilutions of the analyzed sample, D-F) Growth of *Trichoderma* spp. – Strains Biofertilizar.

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Microbiological analysis results

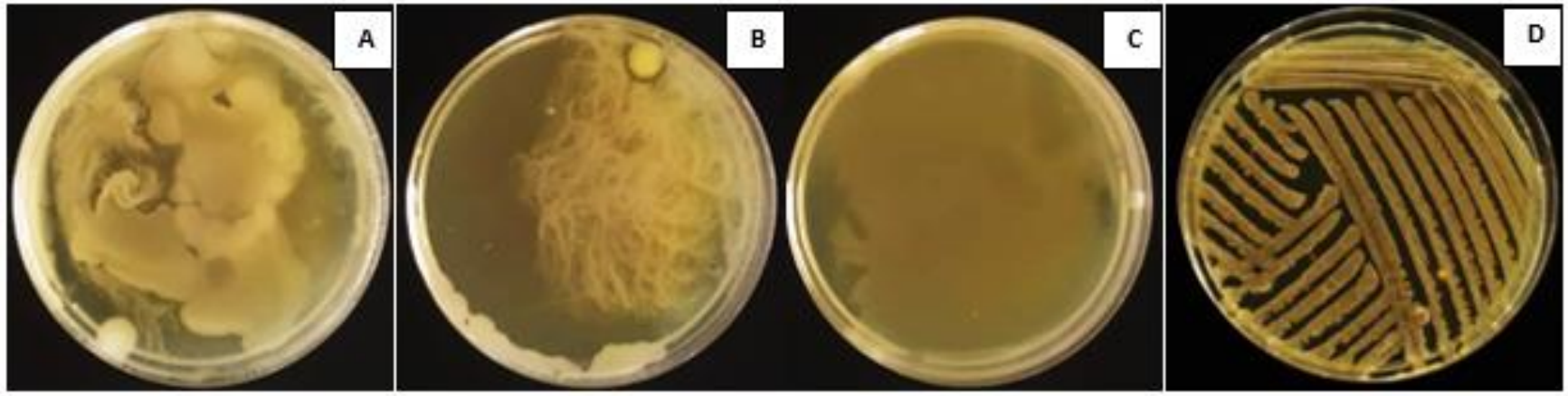

Figure 5. Growth on plate A-C) Serial dilutions of the analyzed sample, D) Growth of *Bacillus thuringiensis*.– Strains Biofertilizar.

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Conclusions

- It is possible to implement composting processes on coffee farms, this does not require further monitoring and can also be carried out in the storage sites already used.

- According to the evaluation of the composting process, it was evidenced how the microorganisms (*Bacillus* and *Trichoderma*) influence the temperature, allowing a thermophilic phase to develop more easily, so that the decomposition process is faster.

- According to the chemical characterization at the end of the composting process, parameters such as the C:N ratio for the treatment without microorganisms were observed within the ideal values for a process like this, which is why it is concluded that the microorganisms do not generate additional value to the compost.

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Future work

- At the end of the composting process the presence of *Bacillus thuringiensis* and *Trichoderma* spp. was evaluated, finding their absence, for this reason it is considered pertinent to carry out the composting process and when it is in the maturation phase to add microorganisms as an added value to the final product.

- To monitor the plants to which the enriched compost is applied in order to evaluate the effect as biopesticides of *Bacillus thuringiensis* and *Trichoderma* spp.

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Distrito de
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COMPOSTING SYSTEM FOR THE USE OF ORGANIC WASTE AT INSTITUCION EDUCATIVA ENTRERRIOS

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Methodological adviser

Faculty of Architecture and Engineering
Institución Universitaria Colegio Mayor de Antioquia
2023

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Research Problem

The management of solid organic waste is a significant challenge worldwide due to industrial growth, urbanization, and accelerated consumerism, leading to an increase in the amount of waste generated.

AMÉRICA LATINA	COLOMBIA	ENTRERRÍOS
Implementing appropriate policies and strategies to mitigate the negative impact of improper waste management.	The treatment of organic waste is usually carried out in sanitary landfills or dumps, which exacerbates health and poverty problems in peripheral communities.	At least 419.18 tons/year of organic waste are generated, which negatively impacts the quality of life and health of the municipality's residents.

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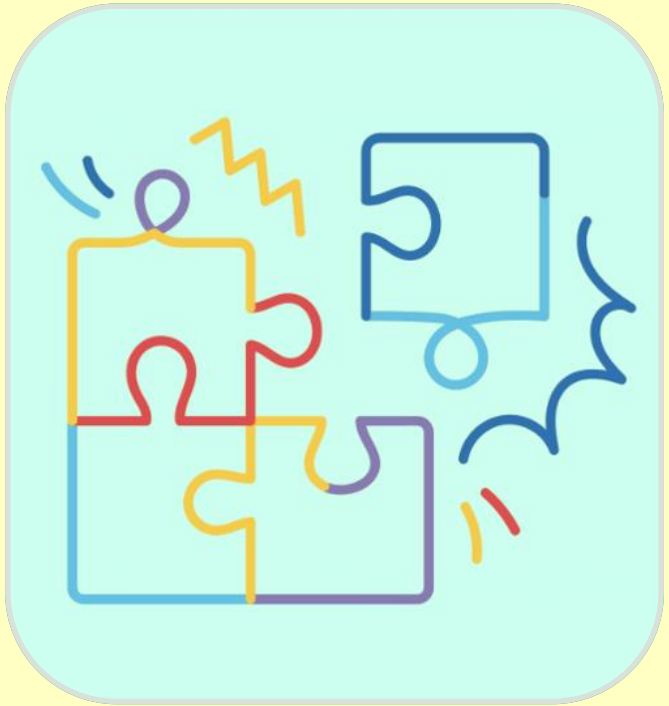
Theoretical Framework



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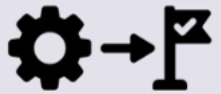


General Objective

Implement a composting system at the Institución Educativa Entrerríos to increase the utilization of organic solid waste generated within it.

Specific Objectives

Characterize organic solid waste to obtain a diagnosis on the possibility of using it in composting processes.

Define an environmental education strategy for the institutional community on the proper separation of organic solid waste used in composting processes.

Initiate the operation of the composting system with organic solid waste from the institution, parallel to environmental education activities.

Project in the long term the percentage of organic waste utilization through a temporal monitoring to project its impact on the reduction of solid waste sent to the landfill.

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Methodology

Study Area

1.Diagnostic

2. Planning

3. Execution

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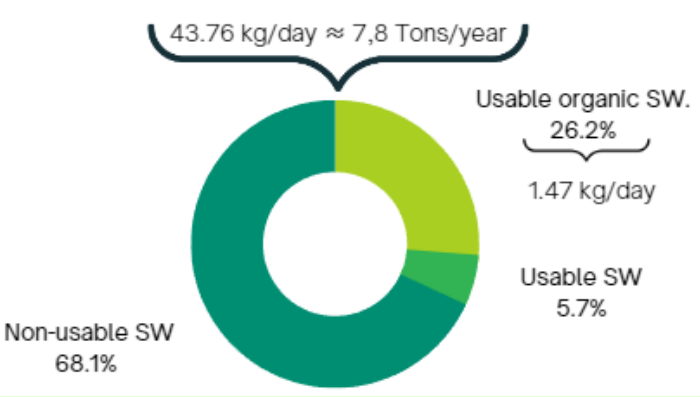
Results and analysis

Initial characterization of solid waste and per capita production

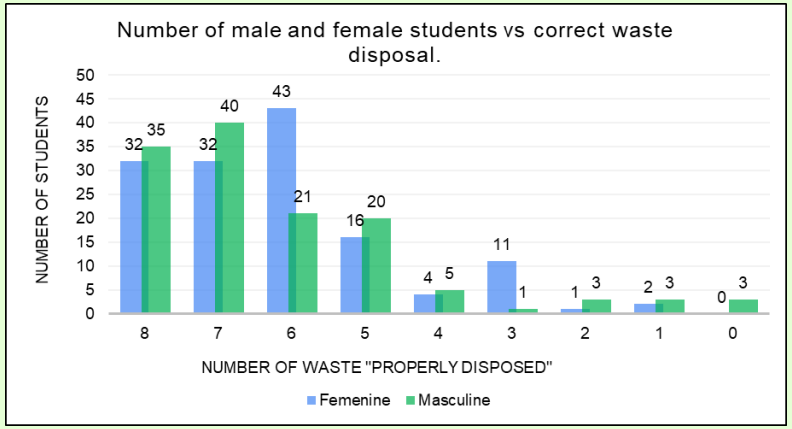


Initial diagnostic of the teaching staff, administrative personnel, food service staff, and general services personnel of the institution

Professors have adequate knowledge on solid waste and composting, but improvements needed in areas like color codes and availability of waste bins

Initial diagnostic of students at the institution.

Number of properly disposed waste based on student population



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Results and analysis

Environmental Education Campaign

Start of composting operation.

pH values are adequate for composting bacteria, and temperature and humidity values are optimal. Maintaining these levels avoids density and aeration issues and prevents water accumulation in the composter.

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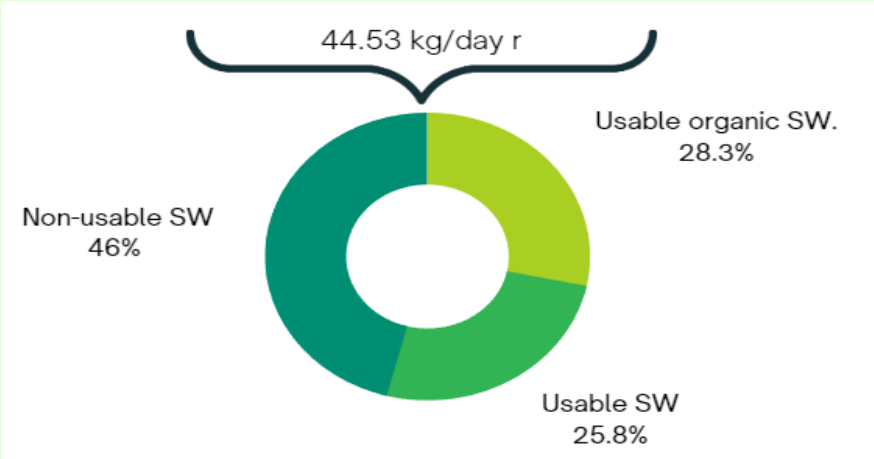
Results and analysis

Final characterization of Solid Waste generated at the Educational Institution after implementing the Environmental Education campaign.



"Future projection of the efficiency of the environmental education campaign and composting implementation in the utilization of organic waste generated in the educational institution."

By implementing the composting system in the educational institution, it is possible to reduce 882 kg of organic solid waste annually and produce 97 kg of compost monthly, using an independent composter with sufficient capacity to process the amount of waste generated daily.

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Conclusions

- The characterization of the solid waste of the Institución Educativa Entrerríos revealed that most of the waste is non-recoverable, but there is a significant percentage of organic waste suitable for the composter. Confusion in the surveyed adult population about waste separation and composting was identified, although students had good knowledge on the subject after a successful environmental education campaign.

- The Institución Educativa Entrerríos could compost around 25% of the organic waste it generates daily, especially those generated by the student restaurant. The results of the environmental education campaign showed a commitment from the students and staff to contribute to proper solid waste management and the promotion of composting.

- The composting process with the organic waste from the Institución Educativa Entrerríos has been successful, producing high-quality compost suitable for use as fertilizer in the institution's plants and for creating vegetable gardens. The composter has functioned properly, maintaining optimal conditions for microbial activity and the decomposition of organic materials.

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Analysis of conductivity behavior in a surface water body using a real-time sensor based on Arduino

Investigation Project

Juan Esteban González
Diego Steven Arias
Juan Pablo Pino Arango

2023

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And what is the problem?

The loss of bodies of water with optimal quality, the increase in emerging pollutants, and the spread of invasive species are clear examples of the problem that decreases in water quality entail.

The importance of maintaining good water quality is to increasing the need for advance technology to help monitor the water condition and maintain the water condition.

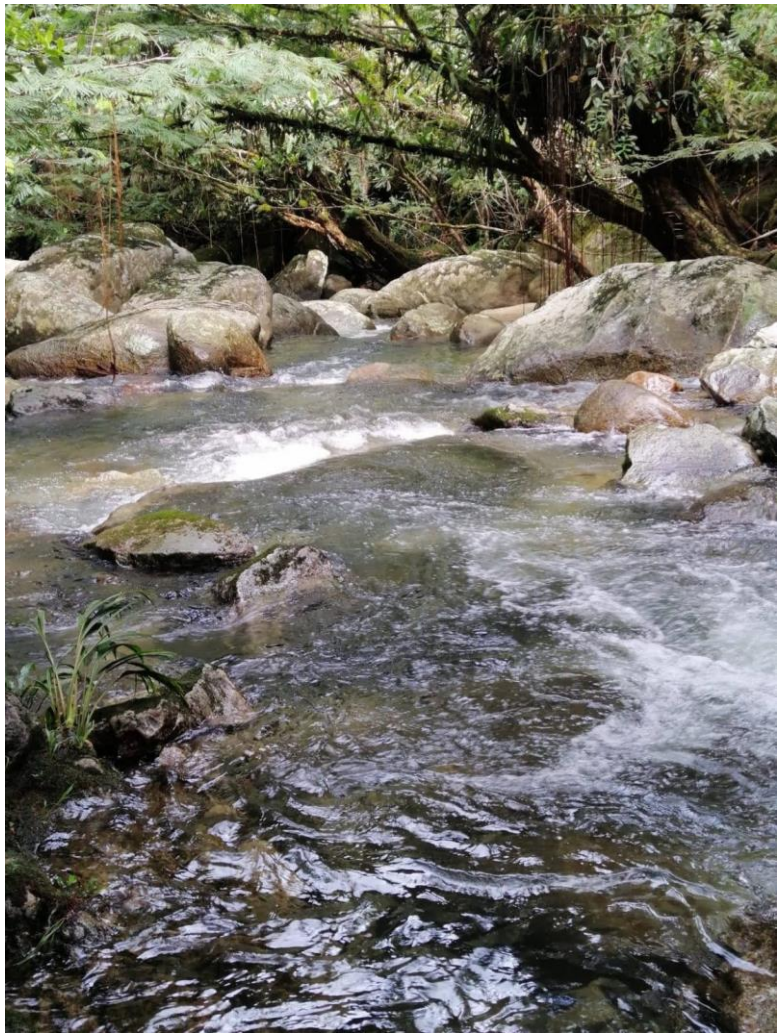

Fig 1. Body of surface water of Zafra, San Rafael.

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Theoretical framework

Fig 2.
Illustration measurement of conductivity

By measuring conductivity trends, you can give an indication of the behavior of the influent.

Conductivity has been selected as a monitoring parameter by various authors, since it is through this that an attempt is made to determine the amount of total dissolved solids in water. (Akram et al., 2022)

According to IDEAM, conductivity is a measure of the property of aqueous solutions to conduct electric current, where the main factor affecting its measurement is the amount of dissolved ions found in the aqueous solution

On the other hand, Total Dissolved Solids represent a wide variety of dissolved inorganic salts in the form of ions (such as sodium (Na+), magnesium (Mg+2), calcium (Ca+2), potassium (K+), chloride (Cl-), sulfate (SO4-2), nitrates (NO-3) and bicarbonates (HCO-3) and dissolved organic matter. Therefore, the relationship conductivity - Total Dissolved Solids is mainly given by the inorganic ions dissolved in the water where the higher the amount of dissolved ions, the higher the recorded conductivity. (Jamei et al., 2020)

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Objectives

General

- Analyze the conductivity behavior of a surface water source for decision making in water resource management through a low-cost conductivity sensor

Specific

- Prototyping a sensor for measuring conductivity behaviour and continuous data acquisition over time.
- Perform the conductivity sensor validation
- Perform the calibration of the conductivity sensor
- Perform tests with surface waters

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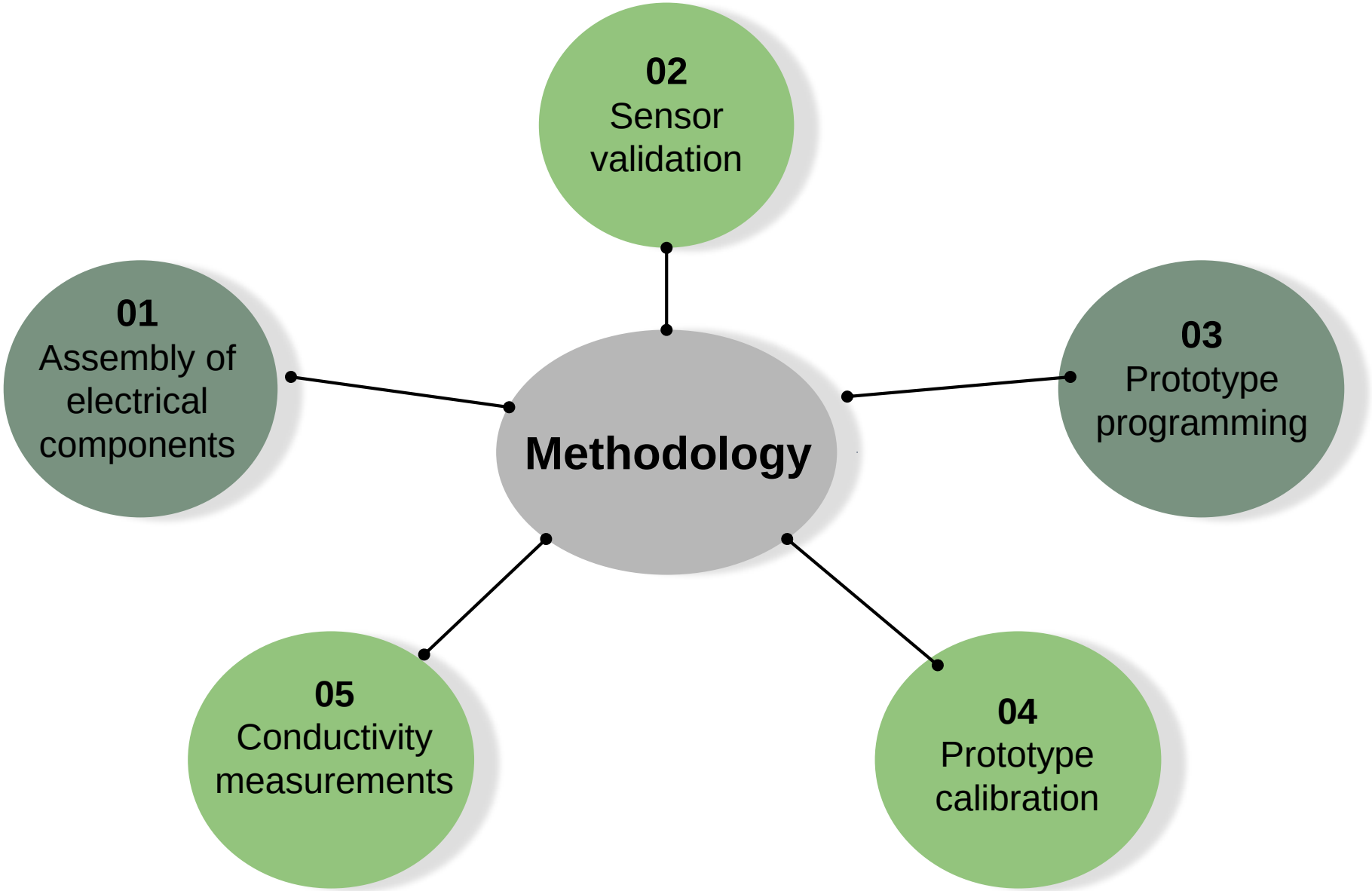

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Assembly of electrical components

Connection diagram and component set (Arduino Uno development board, Data Logger Shield V1.0 board, SD card, RTC, SDT sensor, DS18B20 sensor)

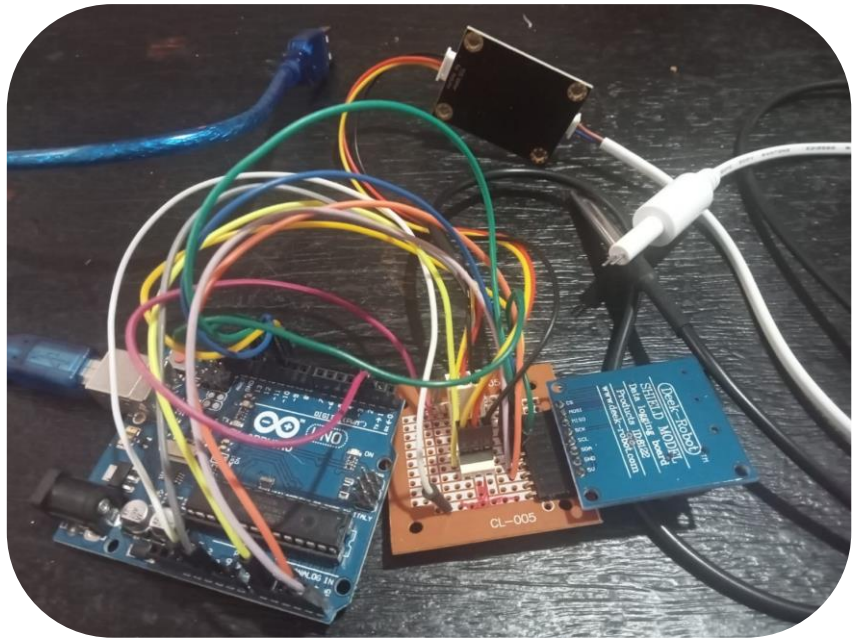

Fig 3. Assembled components.

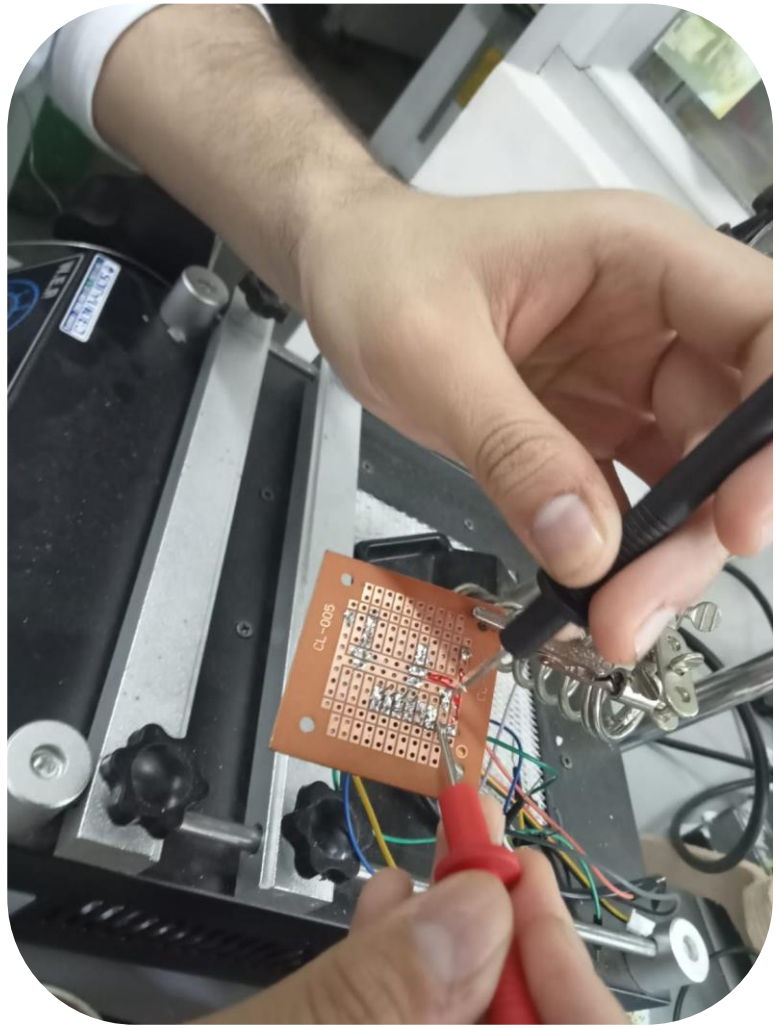

Fig 4. Component soldering.

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Sensitivity test

An initial sensor stability test was conducted to see how the sensor behaved over a long period of time, where around 1,850 data points were taken over a seven-hour period.

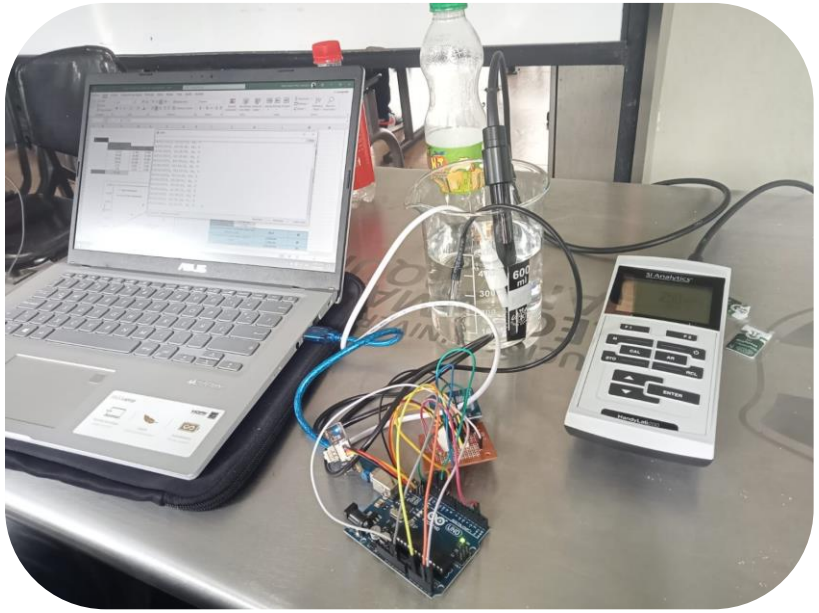

Fig 5. Prolonged measurement

Fig 6.conductivity meter and conductivity sensor.

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Programming

A programming sequence was initially recreated using Arduino Blocks, but due to the limitation of the programming language and problems related to the temperature sensor, the decision was made to carry out the programming in the Arduino software.

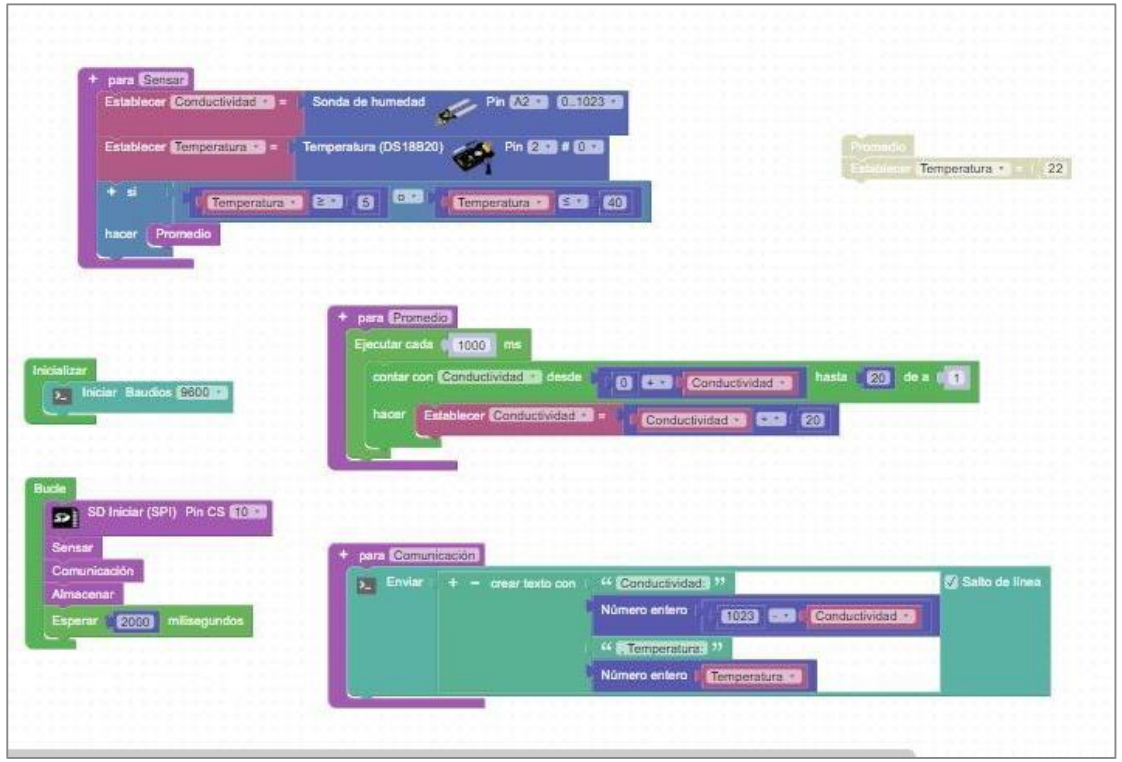

Fig 7. Arduino Blocks programming.

```
#include <OneWire.h> //biblioteca para el sensor de temperatura DS18B20
#include <DallasTemperature.h> //biblioteca para el sensor de temperatura DS18B20
#include <LiquidCrystal.h>
#include <SPI.h> //pasa RTC
#include <SD.h> // para SD
#include "RTClib.h"
#include "MedianFilterLib.h"

MedianFilter<int> filtroCond(7);
MedianFilter<int> filtroTemp(7);


int intentos = 5;
unsigned int CS = 10; // pin para SD
#define pinCond 1//pin analogo donde se conectan los datos del sensor de conductividad
unsigned int pinTemp = 2;//pin digital donde se conectan los datos del DS18B20
int cond, temp;
char fecha[16];
char horario[16];
char horario2[16];
//unsigned long intervaloLecturaComprobar = 10; // Temporizador para comprobar conexiones en minutos
//unsigned long tiempoAnteriorComprobar = 0; // almacena la ultima vez que se lanzo nuestro evento
```

Fig 8. Arduino Programming.

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Validation

Several solutions with different concentrations were made with sodium chloride (NaCl). 6 solutions were prepared with concentrations of 100 (µS/cm), 150 (µS/cm), 200 (µS/cm), 250 (µS/cm), 300 (µS/cm), 350 (µS/cm) each. determined with a calibrated conductivity meter. Subsequently, to each of the previous solutions with their respective determined concentrations, three analogous data were taken from the sensor.

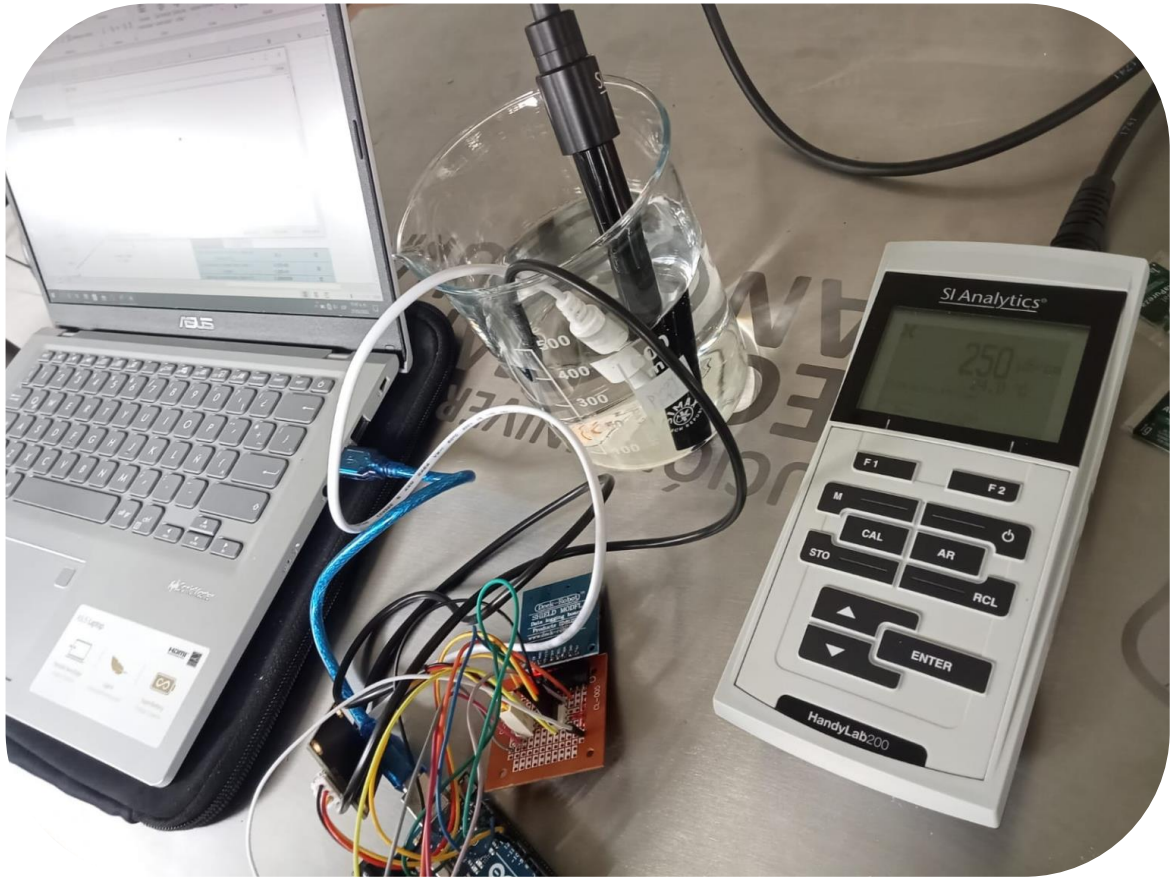

Fig 9. Sample with a point conductivity.

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Results: Assembly of electrical components

1. Sensor prototyping:

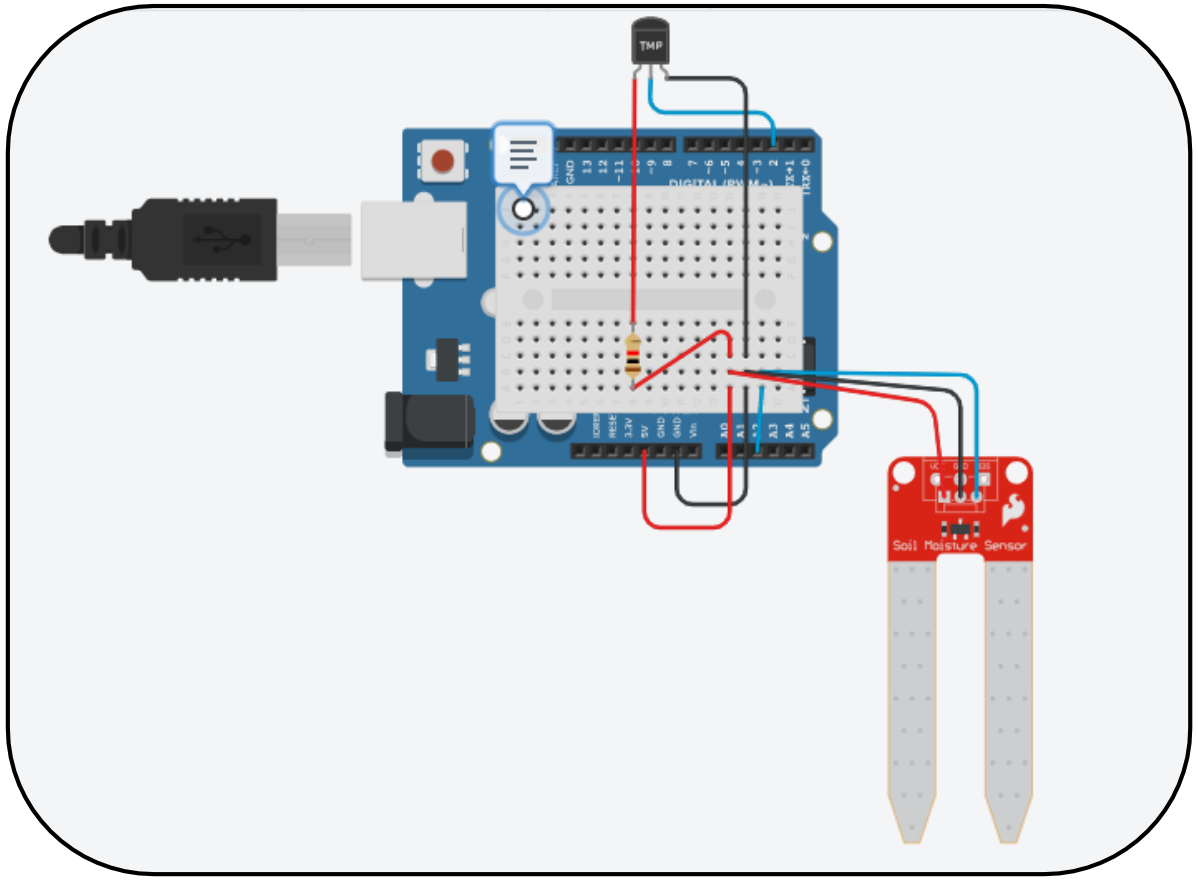

Fig 10. Initial assembly.

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Results: Sensor Validation

2. Sensitivity test:

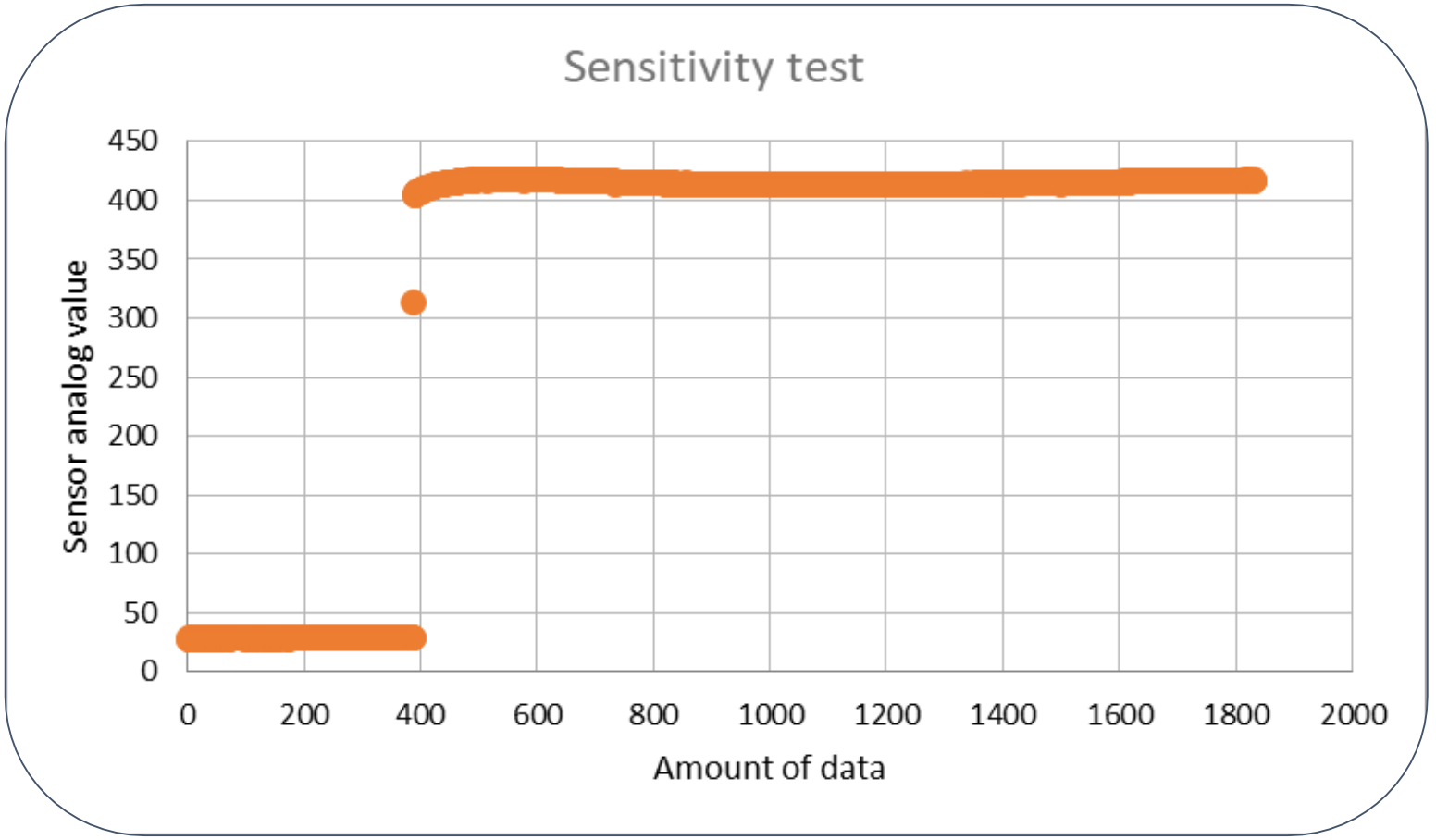

Fig 11. Sensitivity test.

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Results: Sensor Validation

3. Data validation:

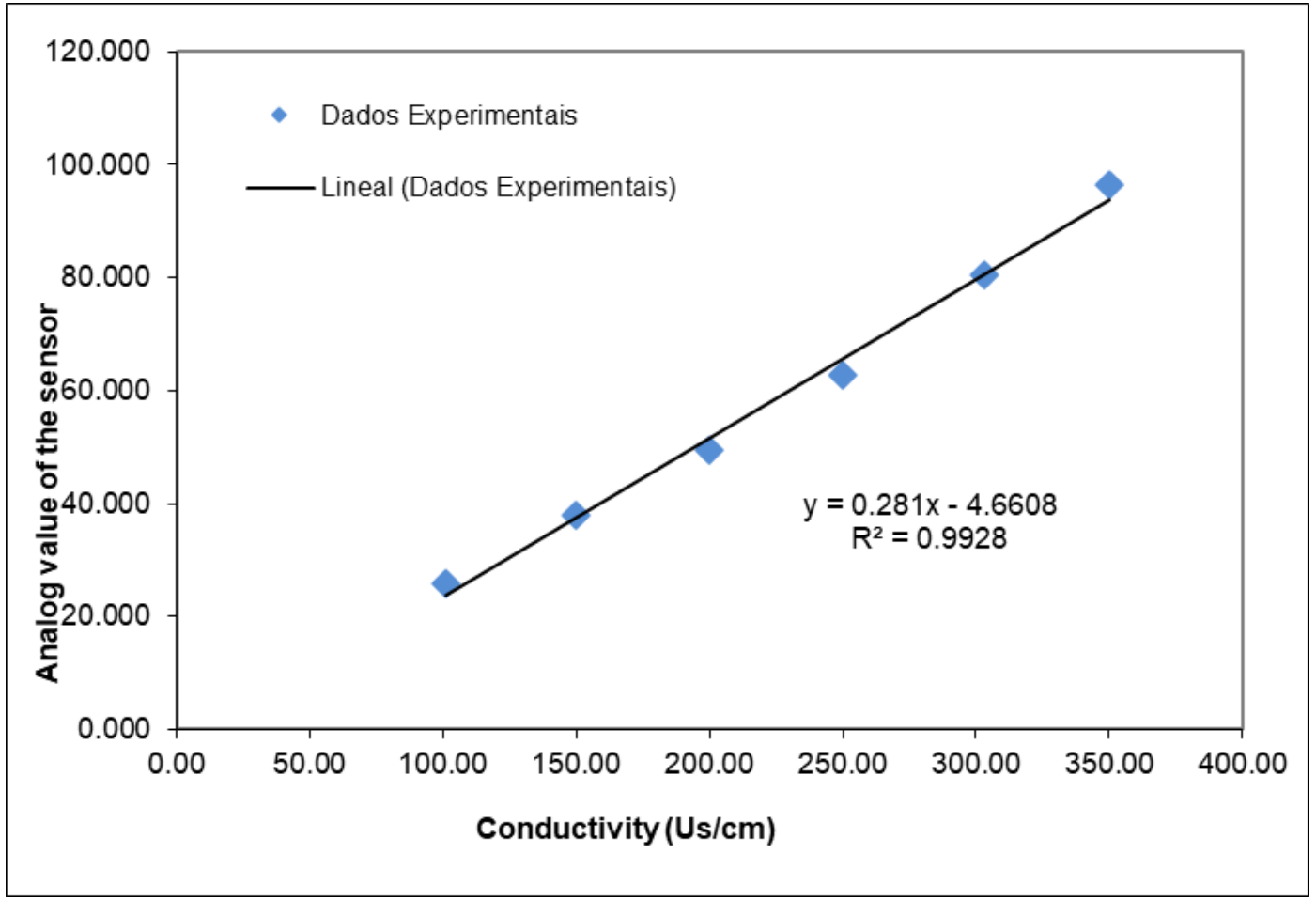

Fig 12. Sensor validation.

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Results: Calibration

4. Experimental design:

- Conducted an experiment design 3^2 factorial

		Levels		
order	variables	-1	0	1
A	Ce	50	300	550
B	Temperature (T)	5	25	45

Table 1. Conductivity and temperature variables

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Results: Calibration

5. Experimental design:

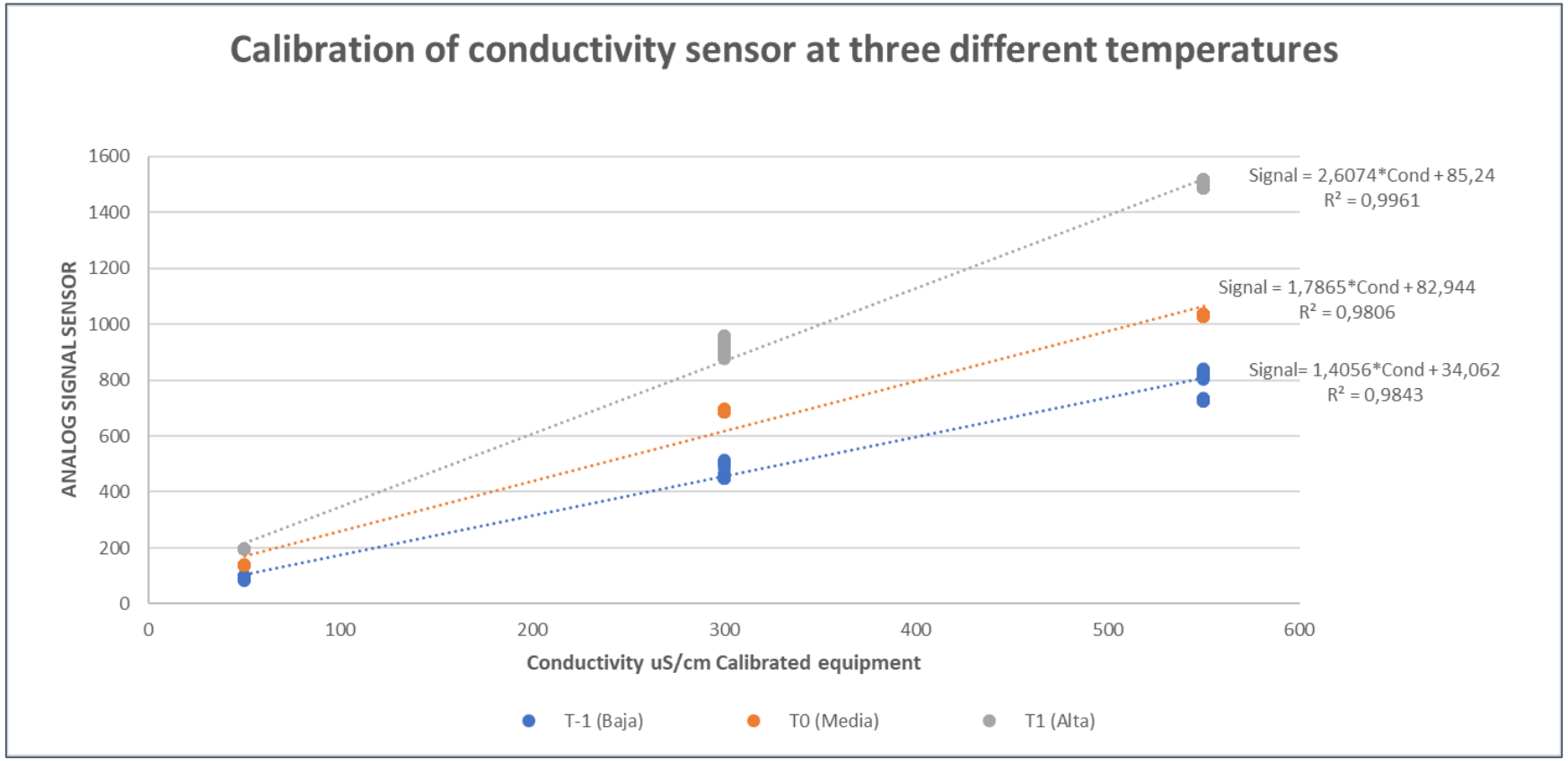

Fig 13. Equations with different temperatures.

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Results: Perform tests with surface waters

6. Measurements:

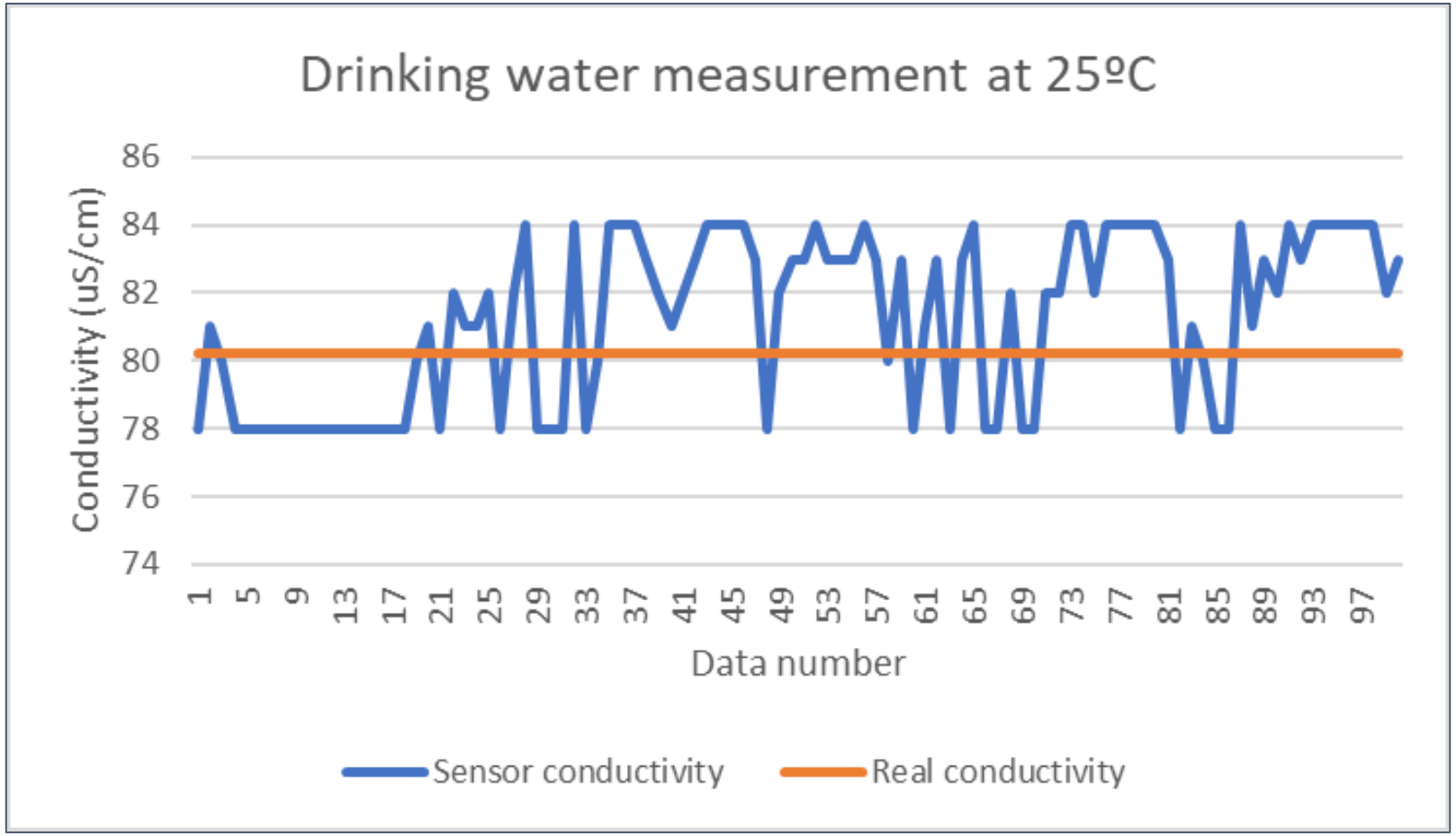

Fig 14. Comparison of real and sensor conductivity.

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Conclusions

- The use of electrical conductivity as an indicator to measure surface water quality is an easily applicable technique in situ, which makes it a valuable tool for monitoring and controlling water quality. The measurement of electrical conductivity can detect anomalies in the natural behaviour of the influent and the concentration of dissolved ions, which can be indirect indicators of contamination. Therefore, measuring electrical conductivity can help in making informed decisions to protect the environment and reduce the environmental impacts of human alterations in surface water bodies.

- The combination of technology and methodology used in this project allows for accurate and continuous data on the conductivity and temperature of water, which is crucial for monitoring and tracking the water resource.

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Conclusions

- In general, we can conclude that the constructed and programmed conductivity sensor is capable of performing precise conductivity measurements in ranges of 50 to 1000 µS/cm conductivity, which makes it suitable for applications in which the conductivity of water in such ranges is required. However, it is necessary to continue working on the design and programming of the sensor to improve its sensitivity and measuring capacity in high conductivity ranges.

- The SDT SEN-0244 sensor assembly together with the DS18B20 temperature sensor, the Data Logger Shield V1.0 card and the Arduino Uno development card proved to be functional for measuring the conductivity and temperature of the water.

- Sensitivity and limit detection tests show that the sensor is capable of measuring conductivity in low to medium conductivity ranges, but has limitations in measuring high conductivities.

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References