



CARBON ABSORPTION BY THE VEGETATION OF THE MOISEÍSTA ECOSYSTEM AND ITS CONTRIBUTION TO ADAPTATION TO CLIMATE CHANGE

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Abstract

The objective of this project is to determine carbon absorption by vegetation in the Moiseist ecosystem and its contribution to climate change adaptation. The project is being carried out at the Moisés Cabeza Junco Technical Industrial Educational Institution in Villanueva, Bolívar (Colombia). The research problem is related to climate change, specifically to rising temperatures, which are linked to the excessive production of greenhouse gases, including carbon dioxide (CO₂) and carbon monoxide (CO). In Villanueva, gasoline combustion by vehicles, waste burning, and land burning for planting are significant sources of CO₂. To achieve the proposed objective and answer the research question, we began by analyzing temperature behavior in relation to carbon monoxide, using data recorded by the air quality sensor installed at the institution. This was followed by the selection and configuration of the sampling site, followed by data collection and the calculation of carbon absorption by the shrubs and saplings at the selected sampling site. The research determined that the 151 individuals that make up the green tunnel of the Moiseist ecosystem are perennial, angiosperm, dicotyledonous species, representing a biomass of 16380,7 g/m² and storing 8190,3 gC/m². With this, we have understood how part of our Moiseist ecosystem cycles and stores carbon, contributing to adaptation to climate change.

Research Question and Hypothesis

How can we determine carbon absorption by vegetation in the Moiseist ecosystem and its contribution to climate change adaptation?

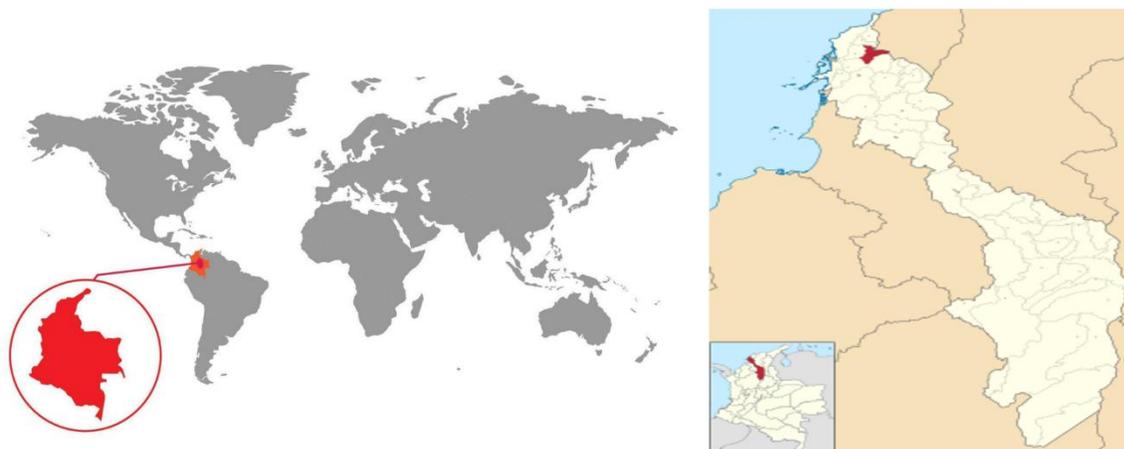
Our hypothesis is that the vegetation in the Moiseist ecosystem absorbs a significant amount of carbon and helps maintain a pleasant temperature in the school.

Research Problem

The project was developed at the Moisés Cabeza Junco Industrial Technical Educational Institution in Villanueva.

Villanueva is a municipality located in the north of the department of Bolívar (Colombia), 35 km from the city of Cartagena, with a population of approximately 26,130. It is 150 m above sea level, its latitude is 10.444167 and its longitude is -75.274722, with an urban area of 1.8 km².

Figure 1
Geographic location map of Villanueva



Note. Adapted from *Close-up of Colombia map* [Image], by Vecteezy, 2025, <https://es.vecteezy.com/artes-vectorial/7491044-colombia-mapa-enfoque-aislado-mundo-mapa-aislado-sobre-fondo-blanco-vector-ilustracion>.

The economy of this town is based on agriculture and livestock farming; cassava and corn are staple crops, which are produced on a large scale. Due to human activity, the natural ecosystem of Villanueva was transformed into a constructed ecosystem through the transformation of its flora and the impact of this action on the fauna. The native flora corresponded to that of a tropical deciduous dry forest consisting of a mosaic of tropical forest and savanna vegetation, which was transformed by human activity into grasslands with or without stubble for extensive livestock farming. The biodiversity of the native forest was remarkable, but the number of specimens and species declined as the habitat was transformed by logging and burning for agriculture, hunting, and livestock farming. Deforestation and land use change have reduced wildlife habitat and destroyed many species. The use and abuse of agricultural machinery or agrochemicals without adequate knowledge has destroyed or contaminated habitats, killing thousands of specimens and bringing species to the brink of extinction (Municipal Mayor's Office of Villanueva - Bolívar, 2025).

The research problem is related to climate change, specifically to rising temperatures, which are linked to the excessive production of greenhouse gases, including carbon dioxide.

As we can see in Figure 2, there is an increase in temperature over time.

Figure 2
Temperature behavior over time

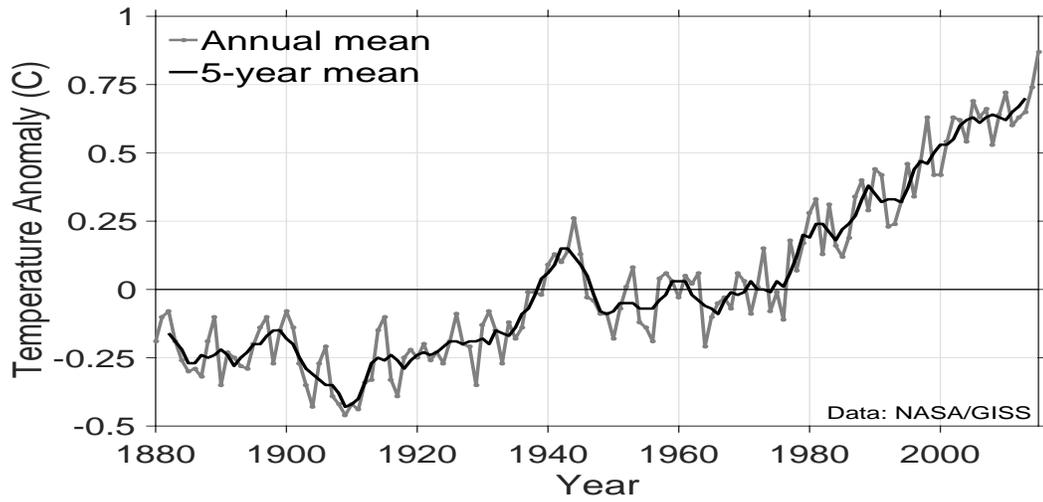


Image: The GLOBE Program, 2025

Figure 3 shows the increase in CO₂ over the years.

Figure 3
Behavior of carbon dioxide over time

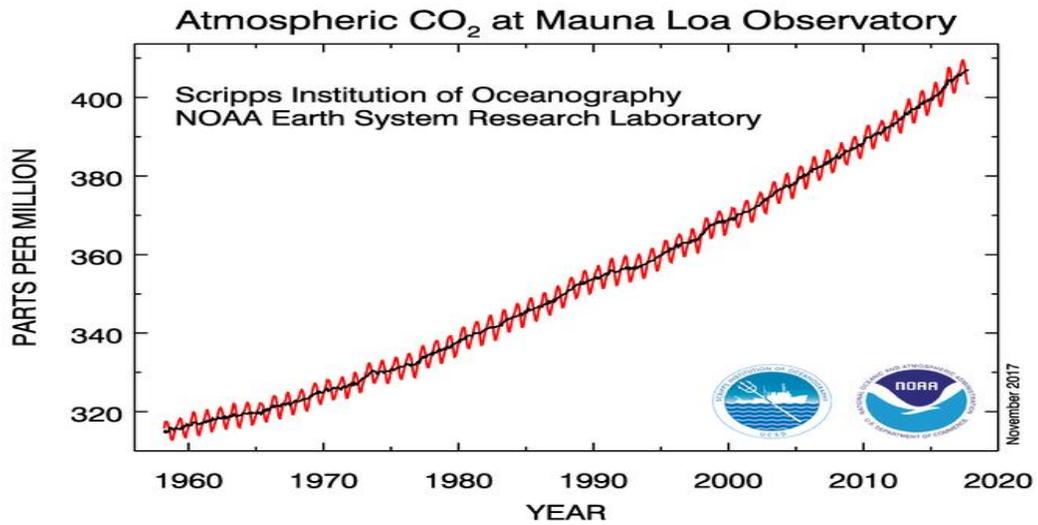


Image: The GLOBE Program, 2025

Increases in atmospheric CO₂ have contributed to a rise in Earth's temperature. From ice cores, we know atmospheric CO₂ is higher today than it has been in the past 800,000 years.

Figure 3

Temperature and CO₂ from Antarctic ice cores over the past 800,000 years

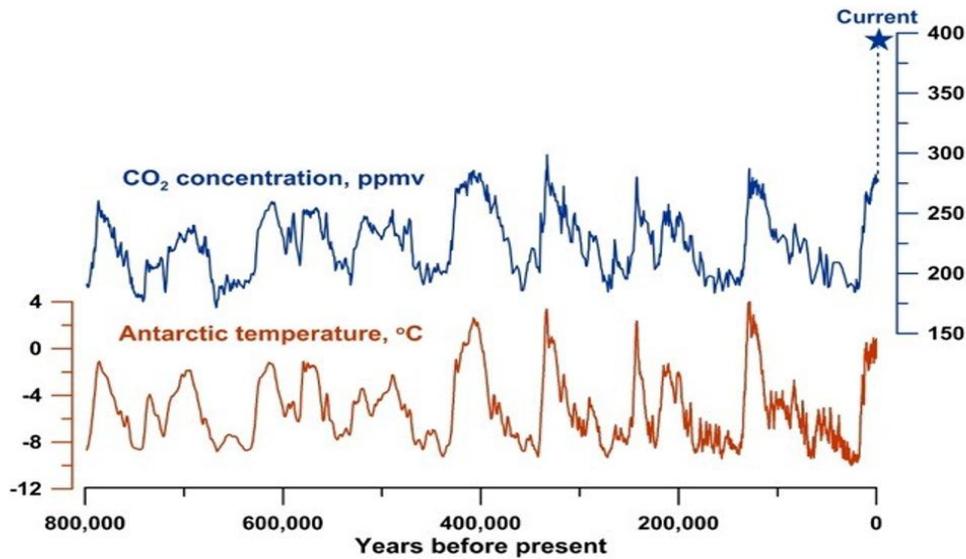


Image: The GLOBE Program, 2025

In Villanueva, gasoline combustion by vehicles, waste burning, and land burning for planting are significant sources of CO₂. As with the combustion of any fossil fuel (oil, gas, or coal), the formation of this gas contributes negatively to the climate and promotes overheating and climate change. The increase in carbon dioxide is the main contributor to climate change, contributing to the rise in global temperatures. This is because CO₂ is a greenhouse gas that traps heat in the atmosphere and warms the Earth (The GLOBE Program, 2025).

Why is it important to address this problem and contribute to its solution?

The global carbon cycle is a key regulator of the Earth's climate system and is essential for the functioning of ecosystems; this cycle is no longer in balance due to human activities, particularly the burning of fossil fuels and land use change. Increased CO₂ is the main factor contributing to climate change, with concentrations in the atmosphere more than 40% higher than their natural range over the last 800,000 years. Understanding how ecosystems recycle and store carbon is key to understanding solutions to climate change (The GLOBE Program, 2025).

This project is aligned with the thematic mission “Sustainable Territories (adaptation to climate change with a territorial approach)” defined by the Ministry of National Education in coordination with the Science, Technology, and Innovation Missions (CTel) of Minciencias, the central axis of the Colombian government's science policy (CONPES

4036 of 2023). It is also aligned with Sustainable Development Goals 11 (sustainable cities and communities), 13 (climate action), and 15 (life on land).

Introduction and Review of Literature

There are two options for addressing climate change: mitigation and adaptation. Mitigation involves reducing greenhouse gas emissions into the atmosphere, while adaptation means being prepared to deal with the effects and damage caused by climate change. Both measures are necessary: mitigation to prevent extreme climate changes from increasing, and adaptation because it is necessary and urgent to adjust to this new reality. For mitigation, it is recommended to care for and maintain forests, reduce the use of fossil fuels such as oil, gas, and coal, improve agricultural and livestock practices, and use clean energy sources such as the sun, wind, and water. For adaptation, it is recommended not to build houses on the banks of rivers and seas, to store water for times of drought, to protect crops in rainy or dry seasons, and to keep our homes and communities clean (PNUD ECUADOR, 2025).

The last time in Earth's history CO₂ levels were this high was over 3 million years ago, during the mid-Pliocene Warm Period. The increase in atmospheric CO₂ occurred over thousands of years. Sea level was 5-20 m higher, global air temperatures were 4°C warmer, and global sea surface temperatures were 2°C warmer. Today, we are increasing atmospheric CO₂ at a rate faster than we've ever seen in the geologic record. Scientists collect carbon cycle data to understand how terrestrial ecosystems will respond to warmer temperatures and higher CO₂ (The GLOBE Program, 2025).

Research Methods and Materials

To answer the research question, the team proposed the following methodology. Figure 4 shows the step-by-step process followed in conducting the research.

Figure 4
Data collection plan

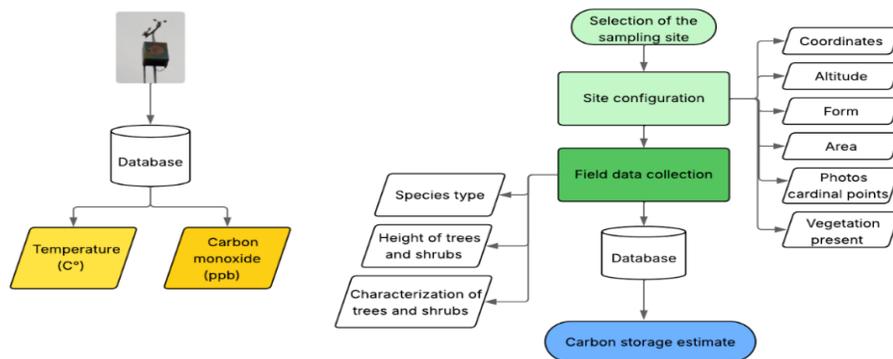


Image: Own elaboration based on *Non-Standard Site Carbon Cycle Protocolos*, 2025

The first part consisted of analyzing temperature behavior in relation to carbon monoxide, using data provided by an air quality sensor installed in the school by the Regional Autonomous Corporation of the Canal del Dique (CARDIQUE). Unfortunately, the installed equipment does not measure carbon dioxide. The data analyzed corresponds to the years 2023 and 2024.

Figure 5

Evidence from the first part of the research development



Image: Student Research Incubator, 2025

For the second part of the project, the GLOBE protocols followed were: Site Selection, Non-Standard Site Carbon Field Protocols, Shrub/Sapling Protocol.

This second part began with the selection of the green tunnel of the Moiseist ecosystem as the location for the project.

Figure 6 shows a satellite image of the Moiseist ecosystem in which the school is located, accompanied by a photo of the green tunnel that is the sampling site.

Figure 6

Images of the sampling site



Moiseist ecosystem

Green tunnel

Note. Adapted from *Environmental Monitoring*, URBAGIS, 2025, <https://cardique.urbagis.com/>.

Image: Student Research Incubator, 2025

Once the site was selected, its configuration was carried out. For the sampling site configuration, the non-standard field carbon protocol was implemented. The shape of the site, the area, the vegetation present, the coordinates, and the altitude were determined, and photos of the cardinal points were taken. All this information was recorded on the data sheet and shared in the GLOBE scientific database.

Figure 7

Evidence of the sampling site configuration



Image: Student Research Incubator, 2025

After setting up the sampling site, data collection was carried out using the protocol for shrubs and sapling. The height of each shrub in the green tunnel was measured, the species was classified as perennial or non-perennial, and the length of the longest and shortest sides of the shrub was measured. All this information was recorded on the data sheet and shared in the GLOBE scientific database.

Figure 8

Evidence of data collection from shrubs and sapling in the green tunnel



Image: Student Research Incubator, 2025

Finally, when the data was sent through GLOBE, the calculations to convert the raw data into biomass and carbon storage values were automatically completed.

Figure 9
Carbon calculation

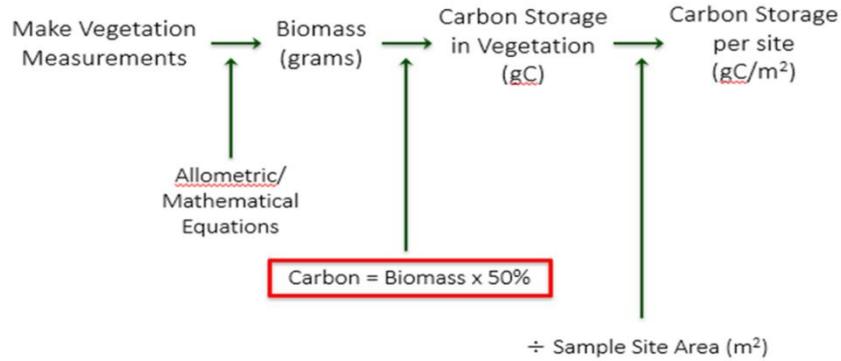


Image: The GLOBE Program, 2025

Figure 10
Carbon storage estimate



Image: Student Research Incubator, 2025

Results and analysis

The results obtained in the first part of the research are presented below.

Figure 11
Temperature behavior in relation to carbon monoxide daily at 1:00 pm.

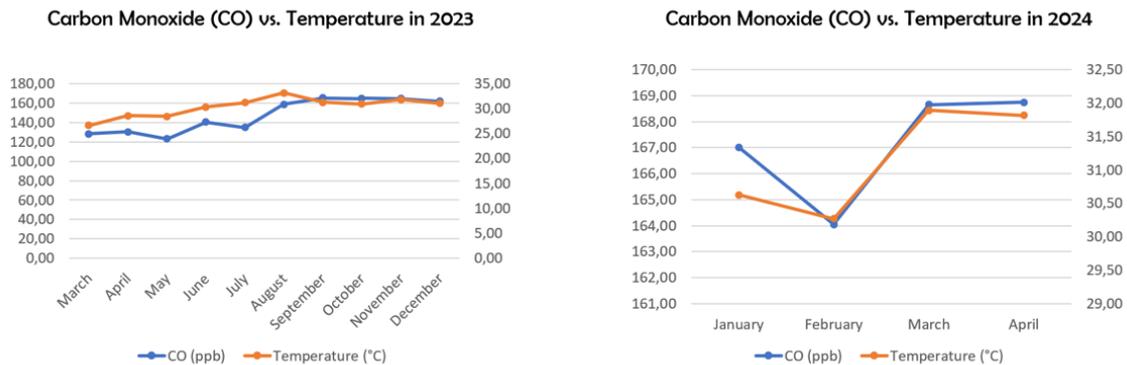


Image: Student Research Incubator, 2025

Figure 11 shows the carbon monoxide and temperature data measured every day at 1:00 p.m. from March 2023, when the sensor installed in the school began operating, until April 2024 (thereafter, the data was reported at 9:00 a.m. and 9:00 p.m.). Both graphs show a directly proportional relationship between these two variables, i.e., as carbon monoxide increases, the temperature increases, and as carbon monoxide decreases, the temperature decreases.

Figure 12

Temperature behavior in relation to carbon monoxide daily at 9:00 a.m. and 9:00 p.m.

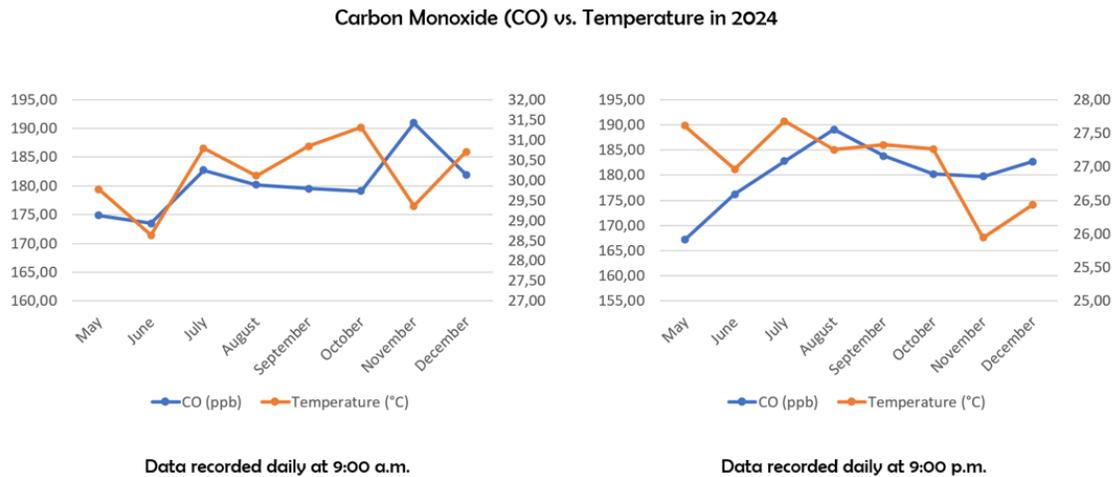


Image: Student Research Incubator, 2025

Figure 12 shows the carbon monoxide and temperature data measured every day at 9:00 a.m. and 9:00 p.m. Both graphs show that the relationship between the two measured variables is not the same as at 1 p.m. We infer that this difference is related to vehicular traffic, since the reporting times could coincide with peaks in mobility that influence carbon monoxide concentrations.

The results obtained in the second part of the investigation are as follows:

Table 1

Population and sample size

Population		Sample	
Moiseist ecosystem		Green tunnel	
Area	Dimensions	Area	Dimensions
40000 m ²	100 m x 400 m	498 m ²	6,34 m x 78,5 m

Source: Student Research Incubator, 2025

Table 1 shows the data related to the population and the sample under study. When comparing the area corresponding to each one, we see that the sample area (green tunnel) represents only 1,24% of the total area (moiseísta ecosystem).

Table 2

Sampling site configuration

Site Type	Carbon Cycle	Non-Standard
Shape of Site	Rectangle	
Coordinates	Latitude	Longitude
	10,43854	-75,27772
Elevation	109,6 m	
Sample Shrub/Sapling	151	
Species type	Evergreen (100%)	

Source: Student Research Incubator, 2025

Table 2 shows the data related to the sampling site configuration. The determination of the non-standard site type is due to the fact that the green tunnel is a place with human traffic. All 151 individuals at the site are evergreen.

Figure 13

Vegetation found in green tunnels

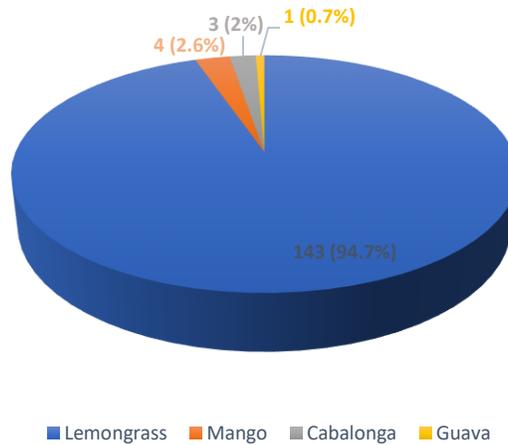


Image: Student Research Incubator, 2025

Figure 13 shows the quantities and percentages of vegetation found in the green tunnel. The dominant vegetation was found to be ornamental lemongrass, with 143 shrubs representing 94.7% of the sample.

Table 3
Characterization of shrubs and sapling

Common name	Lemongrass	Mango	Cabalonga	Guava
Scientific name	<i>Swinglea glutinosa</i>	<i>Mangifera indica</i>	<i>Thevetia peruviana</i>	<i>Psidium guajava</i>
Species	Glutinosa	Indica	Peruviana	Guajava
Gender	Swinglea	Mangifera	Thevetia	Psidium
Family	Rutaceae	Anacardiaceae	Apocynaceae	Myrtaceae
Order	Sapindales	Sapindales	Gentianales	Myrtales
Class	Dicotyledons	Dicotyledons	Dicotyledons	Dicotyledons
Division	Angiosperms	Angiosperms	Angiosperms	Angiosperms
Kingdom	Plant	Plant	Plant	Plant
Domain	Eukaryote	Eukaryote	Eukaryote	Eukaryote

Source: Student Research Incubator, 2025

Table 3 shows the taxonomy of the vegetation that forms part of the green tunnel. It can be seen that all species belong to the same domain, the same kingdom, the same division, and the same class.

Table 4
Biomass and carbon storage of the green tunnel

Total Biomass (g/m ²)	Total Carbon Storage Size (gC/m ²)	Shrub Biomass (g/m ²)	Shrub Carbon Storage (gC/m ²)	Shrub Biomass Evergreen (g/m ²)	Shrub Percent Coverage Evergreen (%)	Shrub Average Height Evergreen (m)
16380,7	8190,3	16380,7	8190,3	16380,7	50,64	4,11

Source: Own calculation based on the calculations from the GLOBE application, 2025

Table 4 shows the data obtained from the calculation performed by the GLOBE Observer application after uploading the observations made in the field. If the total biomass is 16380,7 grams per square meter, then the biomass in the 498 m² of the green tunnel is approximately 8,16 tons (16380,7 x 498 = 8157588,6 grams = 8157,5886 kilograms = 8,1575886 tons).

If the total carbon storage is 8190,3 grams of carbon per square meter, then in the 498 m² of the green tunnel, carbon storage is approximately 4,08 tons (8190,3 x 498 = 4078769,4 grams = 4078,7694 kilograms = 4,0787694 tons). In other words, 50% of 8,16.

Conclusions

The first part of the project concludes that air temperature behaves in the same way with carbon monoxide (CO) as with carbon dioxide (CO₂), i.e., there is a direct relationship between these two gases and temperature; an increase in the concentration of these two greenhouse gases leads to an increase in air temperature.



With regard to the second part, thanks to the implementation of the proposed methodology and following GLOBE protocols, it was possible to select the green tunnel of the Moiseist ecosystem as the sampling site, a site that represents 1,24% of the total area of the school; The green tunnel was configured in such a way that it could be classified as a non-standard site, rectangular in shape, whose coordinates allow it to be located on the globe, as well as determining that it is made up of 151 specimens, including saplings and perennial shrubs such as ornamental lemongrass (the most abundant), mango, cabalonga, and guava. All these plants produce flowers and fruits whose embryo is formed by two cotyledons.

Another conclusion from this second part of the project is that field data was successfully collected using the available tools and, using the GLOBE Observer application, it was determined that the biomass of the green tunnel is 16380,7 g/m², or 8,16 tons in total. Similarly, carbon storage was estimated at 8190,3 gC/m², or 4,08 tons of carbon in total. Upon evaluating the information obtained, we realize how the project contributes to climate change adaptation insofar as it allowed us to understand how the green tunnel cycles and stores carbon, which is key to understanding the solutions to this problem; and, consequently, the research question initially posed by the group has been answered.

Discussion

Ideally, we would have had portable equipment capable of measuring carbon dioxide and temperature at the sampling site. This would have allowed us to compare the data obtained outside and inside the study area and show the impact of the green tunnel on the community in a more meaningful way. For the first part of the project, only the data provided by the air quality sensor installed in the school by CARDIQUE was available, as there was no financial support for the purchase of materials and equipment.

The project will continue by addressing another area of the Moiseist ecosystem until it is 100% complete, as only one of the areas that comprise it has been covered.

Looking at the results obtained from the green tunnel study, we are motivated to find out what data we can obtain from studying our entire Moiseist ecosystem.

Acknowledgments

We would like to thank IETI Moisés Cabeza Junco, led by its rector, for providing us with the physical spaces to plan and develop our project. We would also like to thank CARDIQUE for opening the doors of the Environmental Quality Observatory to us and allowing us to learn how the variables involved in our project are monitored. To GLOBE for providing us with the protocols and applications that were extremely helpful in achieving our results. Thank you all very much.

Bibliography/Citations

Municipal Mayor's Office of Villanueva - Bolívar. (19 de Marzo de 2025). *Our municipality*. Obtained from <https://www.villanueva-bolivar.gov.co/municipio/nuestro-municipio>

PNUD ECUADOR. (2025). *Efecto invernadero y cambio climático*. Obtained from <https://www.youtube.com/watch?v=x29AI0sKQc0>

The GLOBE Program. (2025). *GLOBE PROGRAM*. Obtained from <https://www.globe.gov/>

Badge Descriptions/Justifications



By presenting our research project to the VSS, we have earned this badge.



Our report includes an analysis of temperature and carbon dioxide data downloaded from the GLOBE database, as well as carbon monoxide and temperature data collected by the research team through the air quality sensor installed at the institution and other data collected during field trips. The limitations of these data were discussed, conclusions were drawn about past, present, and future events, and the data were used to answer the research question.



The research problem addressed in the project is related to climate change, specifically rising temperatures, which are linked to excessive greenhouse gas emissions, an environmental problem that affects not only Villanueva but the entire planet. The students understood how the ecosystem studied cycles and stores carbon, and are able to contribute to climate change adaptation.



The project benefited from the collaboration of engineer Delimiro Navarro Arrieta, a member of the GLOBE International STEM Network (GINS) and certified GLOBE trainer, who helped improve the implementation of protocols and supported more sophisticated analysis and interpretation of the results.



The project clearly describes how in Villanueva, gasoline combustion by vehicles, waste burning, and land burning for planting, which are significant sources of CO₂, gave rise to the research question. In addition, connections are made between local and global impacts.



The project clearly describes the interconnection of the terrestrial sphere “Biosphere” in the research question and applies GLOBE protocols for site selection, site setup, carbon cycle for non-standard sites, shrubs, and young trees. The research team explains the processes that influence and depend on each other through the analysis and interpretation of scientific data.