How Does Infrastructure, Environment, and Daily Behaviors Collectively Influence the Carbon Footprint of a School?

Rochester School

What is the project about?

Subject: The Rochester School's carbon footprint evaluation
Certification: LEED Platinum certified educational institution
Methodology:
- Mathematical calculations
- Energy consumption analysis
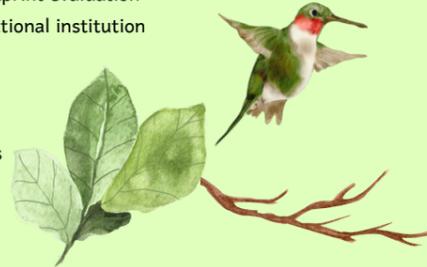- Consideration of anthropogenic factors

Tools Used:
- GLOBE application
- iTree Eco
- Arc Skoru

Objective: Assessing the effectiveness of the school's sustainability initiatives and global climate change.

Results:
- School's carbon footprint significantly lower than the Colombian national average
- Success attributed to: Renewable energy sources, energy-efficient infrastructure and native tree planting efforts on campus.
- Outcome: Highlighting positive environmental impacts of the institution's commitment to sustainability.

Background

Global warming, primarily caused by human activities like fossil fuel burning, has been observed since the pre-industrial era. Modern daily activities such as driving and electronic device usage exacerbate this phenomenon. This increase in Earth's temperature, due to rising greenhouse gas levels, leads to severe consequences like natural disasters, air pollution, and ocean acidification, threatening global ecosystems. While Colombia, a developing nation, may not be a major greenhouse gas emitter, deforestation contributes significantly to climate change. Human activity disrupts the carbon cycle, necessitating the creation of the carbon footprint measurement to mitigate emissions. Immediate action is crucial, as predictions suggest a potential 2°C temperature increase by 2050. Reducing carbon footprints can prevent catastrophic environmental impacts. Sustainable institutions like Rochester School, with platinum LEED certification, prioritize understanding their carbon footprint to evaluate the effectiveness of sustainable practices, including plant fixation, anthropogenic impact, and campus design.
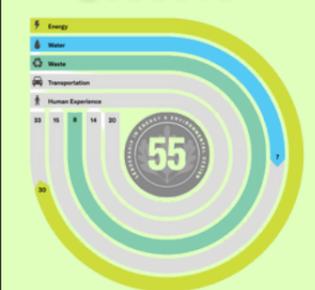
Collected data

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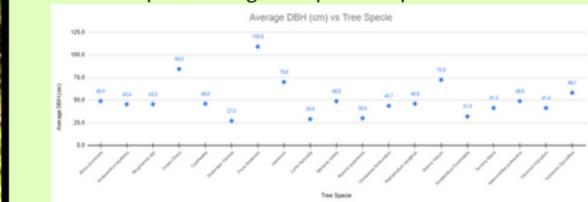## Methodology

Tools used for data collection:
- ARC Skoru platform
- iTree Eco Tool
- GLOBE Observer app
- GLOBE protocols.

Data collected includes:
- Fixed carbon in grass and trees
- Gas emissions
- Transportation
- Energy consumption
- Photovoltaic panels compensation.

Carbon fixation methods:
- GLOBE Protocol on Graminoid Biomass for herbaceous carbon fixation.
- GLOBE Observer app used to measure and register 132 trees on campus.

Process for tree carbon fixation:
- Measurement and registration via GLOBE Observer app.
- Tree height estimation using angle measurement and step count.
- Optional steps include photo capture and circumference measurement.

iTree tool analysis:
- Identifying trees with common name and genus/species for data input.
- iTree determines per tree and per year: fixed carbon, oxygen production, CO_2 capture, carbon sequestration value, pollution elimination value.

Results

Rochester's carbon footprint will be calculated with the following formula: $CFRoch = (A + C) - P$

Where P represents carbon fixated by plants, A represents anthropogenic impact and C represents campus energetic consumption and compensation. The total grams of sequestered carbon by grass at Rochester's campus (multiplying the area by gC/m2) is equal to 164.436,6. All values will be used in tons, which means the amount of fixated carbon by grass is equal to: 16,44 Ton/m2. "The final aspect (C) of Rochester's carbon footprint includes energy, natural gas, and water usage, transportation emissions, waste generation, and mitigation efforts linked to having a LEED Platinum site. The city collects operational carbon emission data through its Sustainability Department, using the ArcSkoru platform for calculating emissions and implementing compensatory actions. As a result, Rochester Carbon footprint is as follows:

$CFRoch = (A + C) - P$
$CFRoch = (204.826 \text{ Ton } CO_2-e/yr + 1,69 \times 108 \text{ Ton } CO_2-e/yr) - 176,14$ Ton C–e/yr
$CFRoch = 169,204,649.86 \text{ Ton } CO_2-e/yr$

The Total Emissions (MtCO2e) in Colombia in one year are 270.31, or 270'310.000 Ton CO_2–e/yr.

This means Rochester School is 101'105.351 tons of CO2-e per year below the national average.

Results

Graph 1. LEED Measurements of the School's Sustainable Behavior

Age Group	CO₂ per Age Groups
3 - 6 years old	85,881,600 ml
6 - 12 years old	227,990,400 ml
12 - 18 years old	113,400,000 ml
18+ years old	57,024,000 ml
3 - 6 years old	85,881,600 ml
Total CO₂	570,177,600 ml
Total metric Tons CO₂/day	561.05
Total metric Tons CO₂/yr	204826

Table 1. Amount of CO2 in age groups

Graph 2. Average DBH per tree species

Discussion

The 132 trees used for this study cost 12 years ago around 132 dollars. Today, according to the iTree Eco tool, the same trees have an approximate value of 24660 UDS. This means Rochester School does not have the need of buying carbon credits.
The trees planted at the school not only contributes to mitigating the carbon footprint, but it has shown evidence to become an ecological corridor for birds and other fauna.

Average DBH vs. Tree Species: Larger, older trees have higher carbon fixation potential, contributing to carbon sequestration.
Possible Sources of Error:
- Sampling bias, identification errors, measurement errors, small sample size, assumptions on growth rate and carbon storage, lack of statistical analysis, observer bias, data entry mistakes.
- Comparison with Similar Studies:
- The UK Sustainable Development Commission's "Schools' Carbon Management Strategy" offers guidance on reducing carbon footprints, aligning with Rochester's goals.

Discussion on Hypothesis:
- Support for hypothesis; ample campus vegetation suggests potential for carbon sequestration.
- Results focus on vegetation aspect; additional evidence needed for full hypothesis validation, especially regarding infrastructure and daily practices optimization.

Conclusions

In order to significantly reduce the carbon footprint of an educational institution like Rochester School, a combination of strategies is necessary, with a sustainable site forming the foundation for additional initiatives. Rochester School has successfully reduced its carbon footprint to 101,105.351 tons of CO2–e per year below the national average through comprehensive strategies implemented by the Sustainable Area. The school has planted 13,400 trees over the past five years, which are not yet mature enough to measure their full impact on carbon sequestration. However, these trees have already created an ecological corridor, increasing bird species from 12 to over 40.
To accurately measure carbon fixation, an updated tool is needed, as some Colombian native tree species are not recognized by current tools like iTree Eco. Further analysis is required to determine the carbon sequestration rates of different native tree species, allowing for informed decisions on future planting. The diversity of trees may contribute to bird diversity, including migratory species. Introducing additional flowering plants can attract pollinator birds like hummingbirds, enhancing the ecological impact of the school's green initiatives. Regular evaluations every 2 to 4 years are crucial to monitor progress and guide future actions towards sustainability.

Fig 1. Aerial image of Rochester School

Fig 2. Globe's Tree Map

Fig 3. Labeled Tree

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