Emissions Report

Executive Summary

In this project, I explored how much carbon dioxide (CO_2) emissions are generated from cars and trucks in different neighborhoods of Atlanta and Savannah, Georgia. Rather than looking at citywide averages, I focused on each census tract to understand how emissions vary across smaller parts of the city. To do this, I combined U.S. Census population data with estimated vehicle usage and standard emissions rates. I then used Python to create interactive and static maps that clearly show which areas have higher or lower emissions per person.

My goal is to make it easier for communities, policymakers, and city planners to see where transportation emissions are most concentrated and why. What I found is that emissions per person tend to be lower in denser, walkable neighborhoods and higher in areas that depend more on driving. These maps can help identify which neighborhoods might benefit the most from transit upgrades, clean vehicle programs, or emissions reduction efforts.

Background and Context

I began this project with a key question in mind: How fairly are transportation-related emissions and the potential for electric vehicle (EV) solutions distributed across different neighborhoods? As we shift toward cleaner mobility, equity must be a central focus. That means making sure all communities not just wealthy or central ones have access to cleaner transportation, cleaner air, and the benefits that come with reduced emissions. Atlanta and Savannah were ideal places to study this because they reflect two different types of urban forms in Georgia: one is sprawling and car-centric, the other is more compact and coastal.

Transportation is the largest source of greenhouse gas emissions in many cities, but that burden isn't felt equally. Some communities are heavily car-dependent with long commutes and little access to public transit, while others may already have walkable streets or more sustainable infrastructure. At the same time, these differences often align with historical patterns of income, race, and investment. I wanted to understand: Where are the highest emissions per person happening, and are those same areas being included in the EV transition?

By calculating per capita CO_2 emissions at the census tract level, I aimed to spotlight the communities that might need more support whether that's in the form of EV incentives, charging infrastructure, or improved transit options. This analysis lays the groundwork for smarter, more targeted climate policy where the goal isn't just to cut emissions overall, but to do it in a way that's just and inclusive for every neighborhood.

Data Collection Methodology

To understand emissions patterns fairly and accurately, I needed to gather data from trusted public sources and combine them with smart modeling techniques. I started with population and vehicle access data from the American Community Survey (ACS) 5-Year Estimates, accessed through the U.S. Census

Bureau's public API. This dataset gave me information at the census tract level, including the number of households, how many vehicles those households typically have, and overall population estimates. I chose tract-level data specifically because it offers the level of detail necessary to uncover local inequities not just citywide averages.

Next, I used those household vehicle estimates to calculate an approximate number of vehicles per tract. From there, I modeled how many miles those vehicles would likely travel per year using national averages for daily trips and average trip length. I then applied standard CO_2 emission factors from the Environmental Protection Agency (EPA) 0.271 kg CO_2 per mile for passenger vehicles and 0.611 kg CO_2 per mile for trucks to estimate the annual transportation-related emissions for each tract. These emissions were then divided by the tract population to get a per capita value, which helps compare areas of different sizes fairly.

I also processed this data using Python, especially tools like pandas, geopandas, and folium. These tools allowed me to merge demographic and geographic data, run calculations, and create visualizations. Finally, I normalized the emissions data to make it easier to compare across tracts and mapped it interactively, so patterns could be clearly seen by anyone, not just data experts.

This approach made it possible to visualize and analyze how emissions and the opportunity for clean mobility solutions like EVs are distributed across neighborhoods. It sets the stage for identifying areas that are being left behind in the clean transportation transition and could benefit the most from targeted policy or infrastructure investment.

Initial Findings and Insights

After creating and reviewing the emissions maps for Atlanta and Savannah, I observed clear and meaningful patterns in how transportation-related CO_2 emissions are spread out across both cities. These patterns tell us not only where emissions are highest, but also give important clues about who may be affected most and where action is most needed.

In both cities, neighborhoods located closer to the downtown or city center generally showed lower emissions per person. These areas are usually more walkable, with higher population density, shorter travel distances, and better access to public transportation. People living in these central neighborhoods often have more choices for how to get around such as taking the bus, walking, biking, or even working nearby. Because of this, they tend to drive less, which leads to fewer emissions per person.

In contrast, the outer areas or outskirts of both cities had higher emissions per person. These neighborhoods are typically less dense and more spread out. People living here often have to travel longer distances to get to work, school, or other daily needs. Public transportation options are usually limited or not available at all. As a result, residents in these areas rely heavily on personal vehicles, and they end up emitting more CO_2 from daily driving.

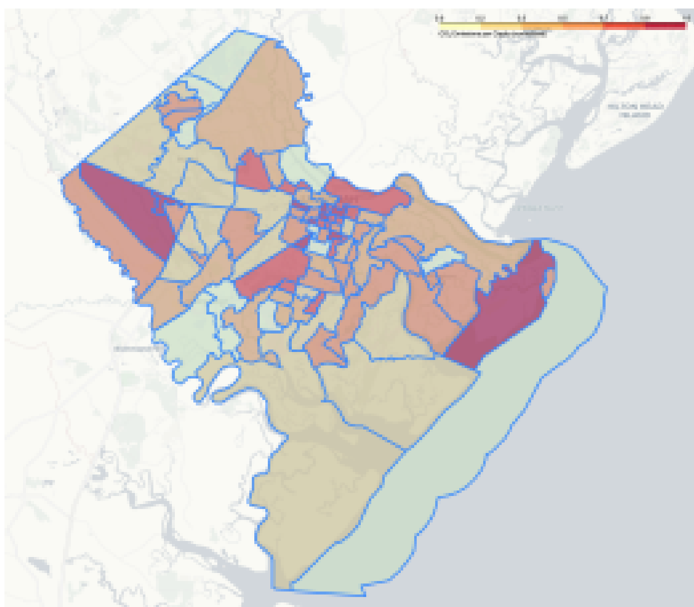
A unique pattern appeared in Savannah: some of the tracts with the highest emissions were located near the Port of Savannah, which is a major hub for freight and shipping. While my emissions model focused mainly on personal vehicle use, it is likely that truck traffic and commercial vehicle activity near the port are increasing emissions in those areas as well. This mix of residential and freight-related pollution raises concerns about air quality and environmental stress in nearby communities.

One important insight is that emissions are not always linked to income in a direct way. Some high-emission areas are not wealthy, and some low-emission areas are not poor. What matters more is how the neighborhood is designed and what transportation options people have. If someone lives in an area where everything is far away and there's no bus or train, they have to drive even if they can't afford it or don't want to. This shows that emissions are often shaped by access and infrastructure, not just individual choices.

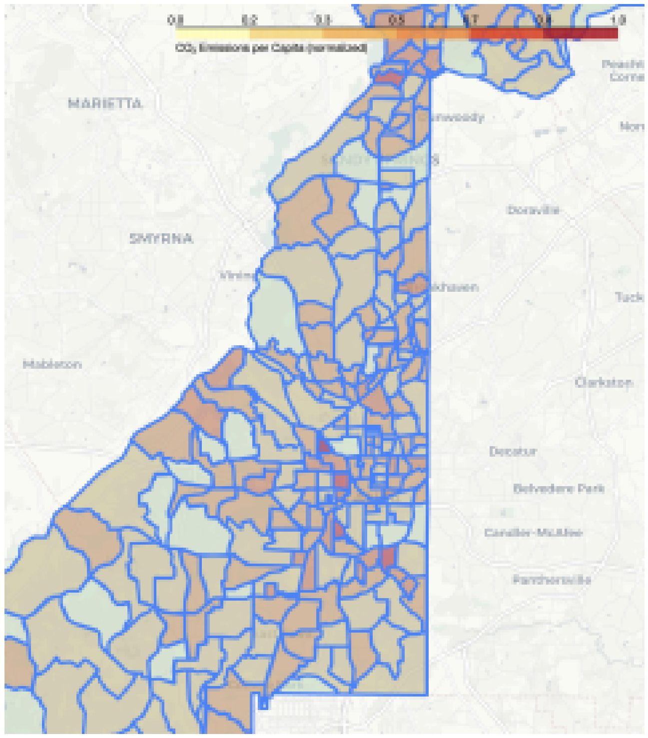
These findings highlight the importance of transportation equity. The places with the highest emissions per person are often the ones with the fewest resources to reduce them. These areas may not have EV chargers, reliable public transportation, or programs that help people switch to cleaner vehicles. If we don't include these neighborhoods in clean mobility efforts, we risk leaving them behind in the climate transition.

By mapping emissions at a neighborhood level, we can better understand where help is needed most. This information can guide future policies such as where to add EV charging stations, where to improve transit access, or where to offer clean vehicle incentives so that everyone has a fair chance to be part of the solution.

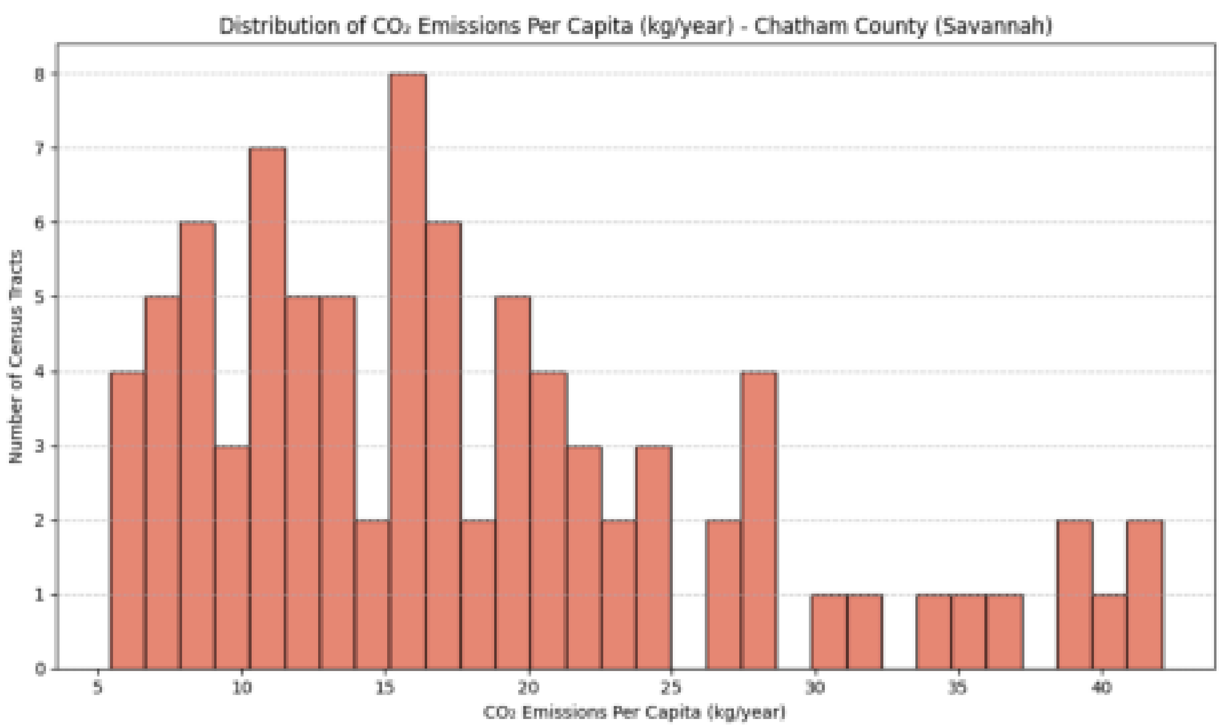
Emissions Charts



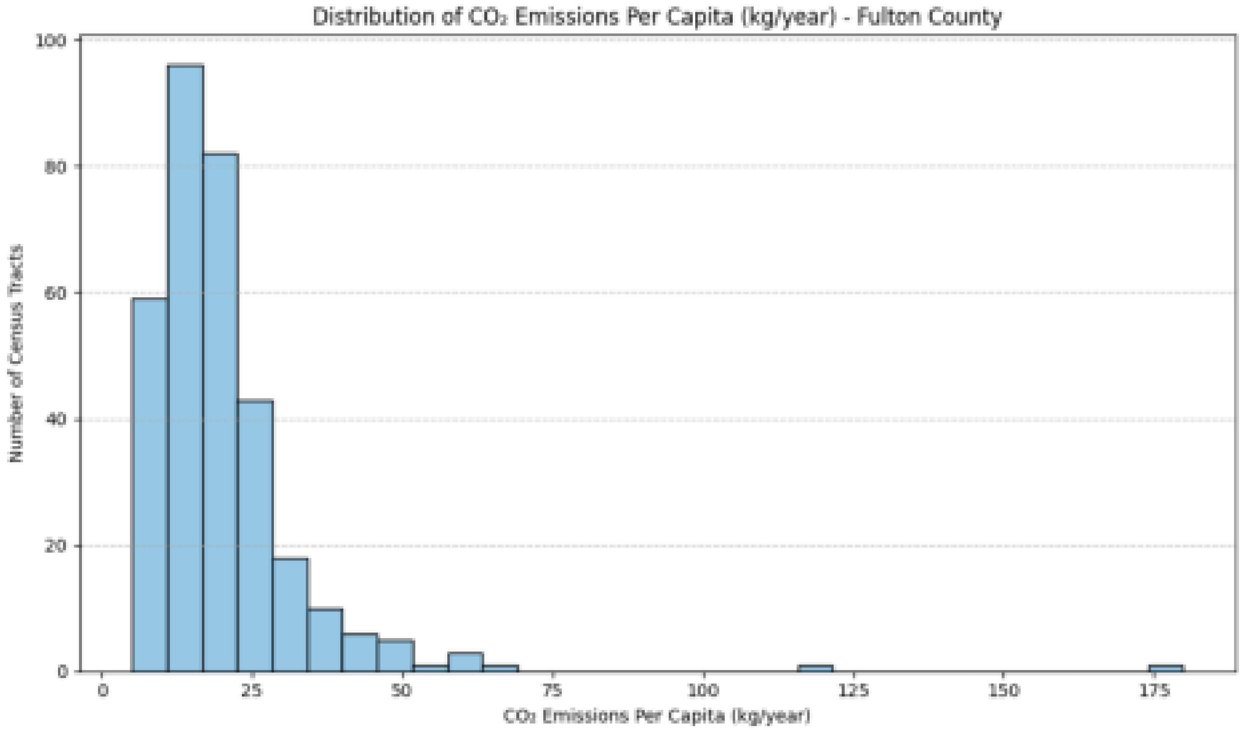
Emission Charts: Savannah



Emission Charts: Atlanta



Emission Distribution: Savannah



Emission Distribution: Atlanta

Next Steps

Now that I have created a baseline map of estimated CO_2 emissions per capita across census tracts in both Atlanta (Fulton County) and Savannah (Chatham County), the next logical step is to dig deeper into the factors influencing these emissions. While this initial model relied on simulated vehicle miles traveled (VMT) and general emission factors for cars and trucks, a more precise analysis could incorporate real VMT data from sources like regional planning commissions or the Federal Highway Administration.

I also plan to enrich this emissions data with additional demographic and socioeconomic layers, such as household income, race/ethnicity, housing density, and commuting behavior. This would help answer key questions about environmental justice, like: *Are the highest emitters also the least able to access clean alternatives like EVs or public transit?*

On the technical side, I aim to improve the mathematical soundness of the model by:

- Using finer vehicle classification (e.g., SUV vs sedan)
- Differentiating emissions based on vehicle fuel types (e.g., gasoline vs diesel)
- Incorporating trip purposes (commute vs non-commute)

Another key investigation will be to overlay EV infrastructure availability such as charging stations or EV rebates to explore gaps between high-emission areas and clean mobility access. This will help prioritize policy actions and investments.

Finally, I would like to validate the model by comparing tract-level estimates with available regional air quality data or transportation emissions inventories, if available. These validations will improve the credibility of the tool for use in policy recommendations or grant proposals.

References

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