Studying the correlation between the population density of the Cities as a function of the Green House Gas Emissions

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Objective:

As the population of the people living across the cities increases around the world, the pollution and the emission of greenhouse gases tend to follow the similar trend. The objective of this study is to analyze the patterns of the Green House gases emissions across the major Metropolitan Statistical Areas in the United States. We will try to derive the relationship between the population size and density to the Green House Gas Emissions. Based on the relationship between them we will try to derive an ideal city with the optimum size and density that can maximize the efficiency of all the infrastructure and utility systems to better increase the quality of life of the citizens.

Keywords: GHG-Green House Gases, MSA-Metropolitan Statistical Areas

Literature Review:

Several studies have been carried out to bring the relationship between the GHG Emissions and the population spread across the cities. There has not been a constant trend that has been observed as multiple parameters such as the local regulatory authorities, Public Transportation, Utilities, citizen awareness etc. play a major role in the GHG emission trends. The findings from the analysis carried out by United Nations Population Fund (UNFPA) shows that in highly dense urban areas there is a highly efficient use of land and other resources that make the per capita GHG emissions much lesser than remote areas. Another study carried out by Boston University also shows that the emissions per capita in the city are much lesser than that of the rural areas as the public transportation facility is very well developed in the city and this plays a major role in reducing the emissions.

Data Source & Methodology:

For this analysis, the data from Vulcan project carried out by Arizona State University was utilized. This data contains the overall GHG emissions and the per capita GHG emissions across all the counties in the USA. This also contains the sub classification of the GHG emissions across the Commercial, Industrial, Residential, On-road Transportation, Aircraft & Non-road Transport. The

counties were grouped into Metropolitan Statistical Areas (MSA is a geographical region with a relatively high population density at its core and close economic ties throughout the area) based on their geographic locations and the sum of population and the overall GHG Emissions in the region were calculated.

The shape file for 2010 Cartographic Boundary File, State-County for United States, provided by U.S. Department of Commerce, U.S. Census Bureau, Geography Division was used as the base layer and the data base. Also, the census bureau data was utilized to sectorize the counties as MSA's and this data was merged with the data of the Pollution levels obtained from Vulcan Data.

To Achieve this, ARCGIS tool was utilized. The data from Vulcan was classified based on the counties and this data was joined with the MSA data obtained from US Census Bureau Website. The ArcMap tool was used to merge both the data from the Vulcan and US Bureau Census, based on the county names. Then the GHG Emissions data of the counties was summed up to obtain the GHG Emission data of the MSA. Then the final joined output table was subject to regression analysis using the Tableau software.

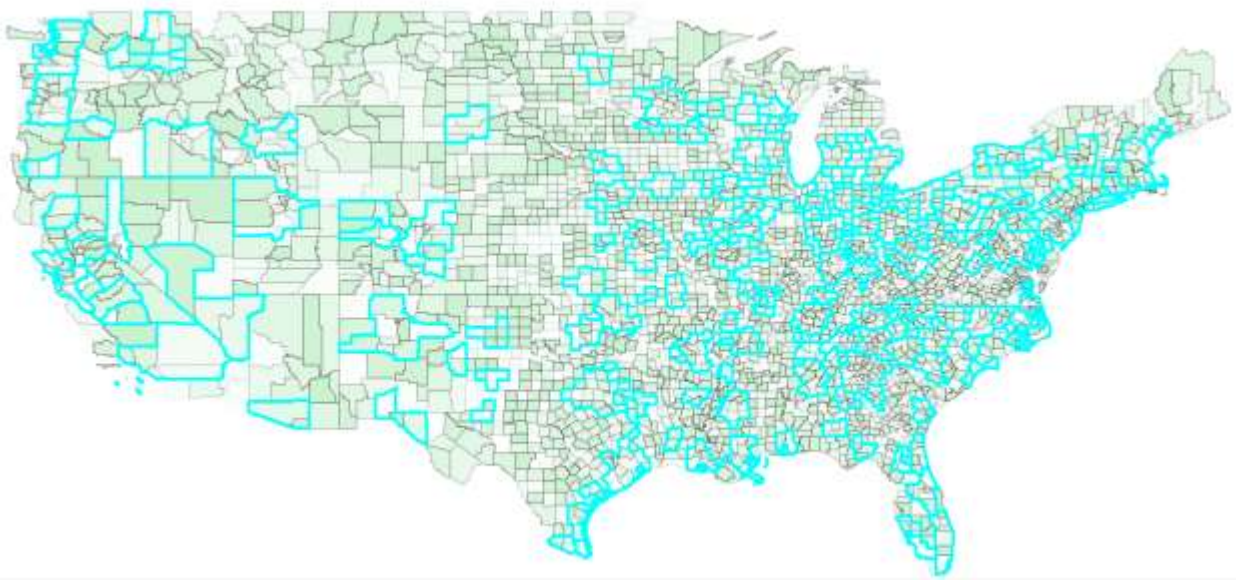

Figure 1 Segregation of Counties based on MSA

Results:

The analysis performed shows that there is a a positive correlation between the per capita Pollution data and the City Density and between Per Capita Pollution and Population. However the R^2 value of the correlation is not so significant, so it is not possible to derive any correlation between the population density and the pollution levels.

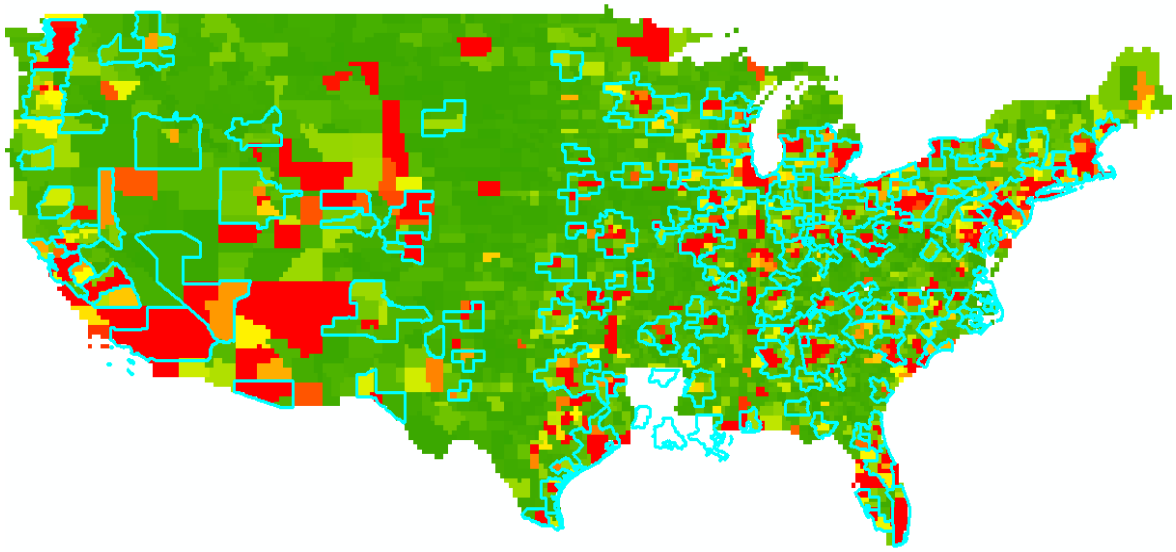

Figure 2 Population Levels at MSA

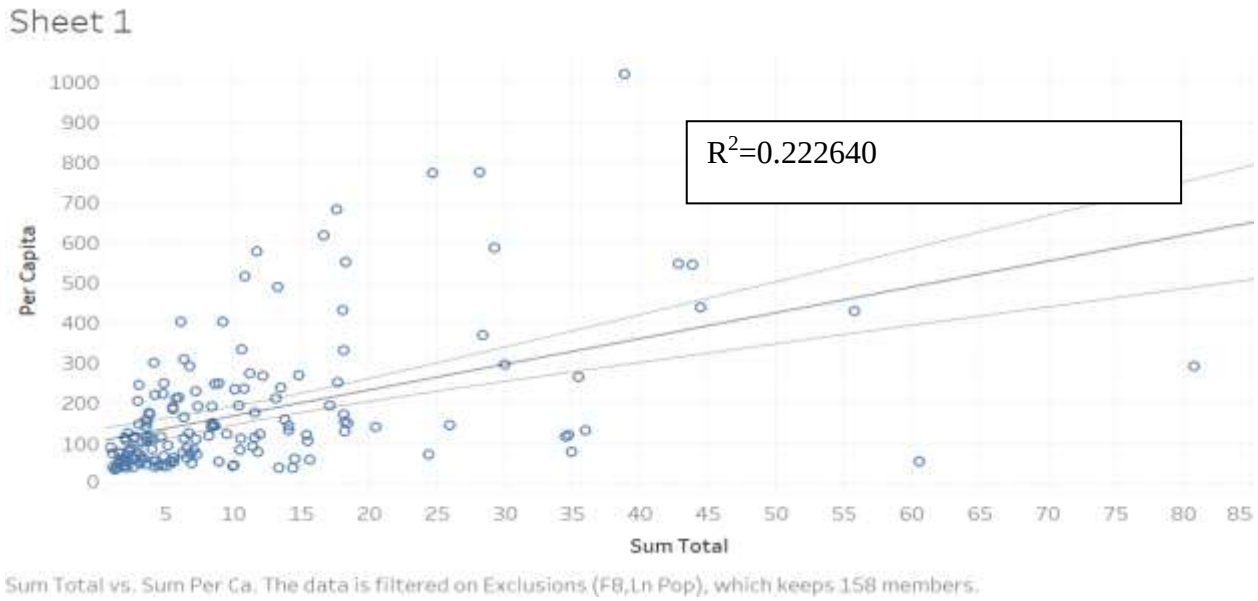

Figure 3 Relation Between Total Area Compared to Per Capita Pollution

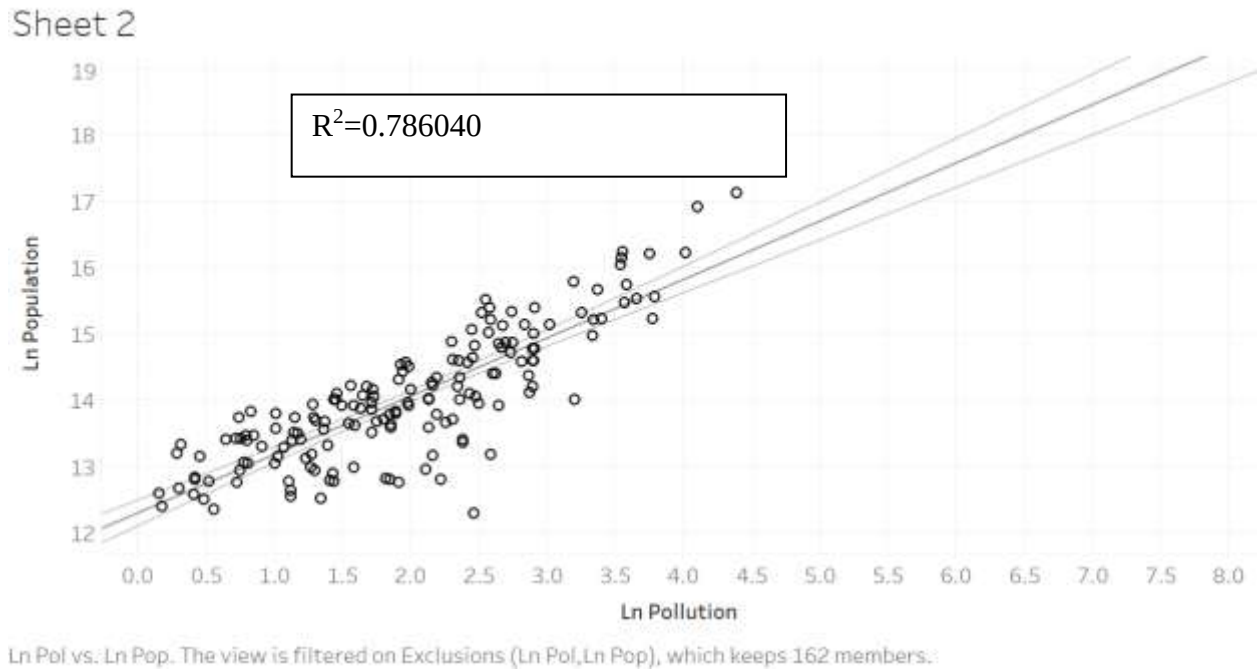

Figure 4 Relationship between the Log of Population to the Log of Pollution

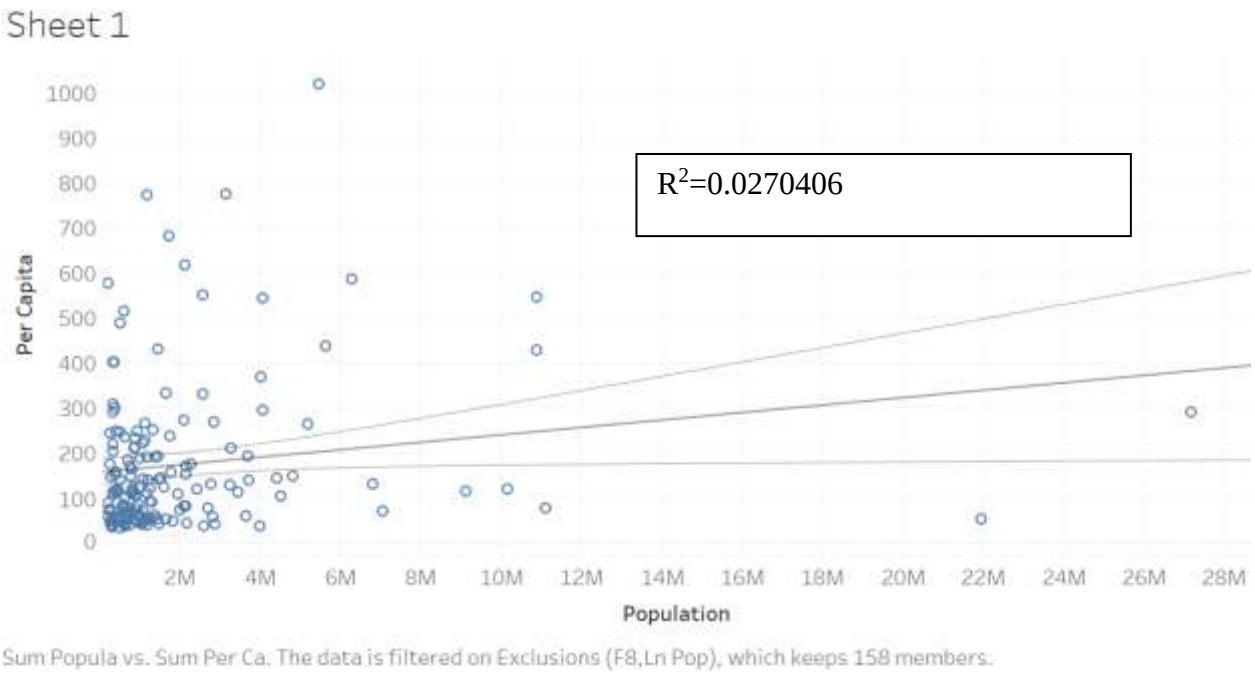

Figure 5 Relationship between Population and Per Capita Pollution Level

Rank	NAME	Average Per Capita
1	Steamboat Springs-Craig, CO	52.33423636
2	Morgantown-Fairmont, WV	40.66354167
3	Parkersburg-Marietta-Vienna, WV-OH	28.66366429
4	Salt Lake City-Provo-Orem, UT	26.76793913
5	Brownsville-Harlingen-Raymondville, TX	26.555575
6	Charleston-Huntington-Ashland, WV-OH-KY	25.68535
7	Manhattan-Junction City, KS	25.6822
8	Macon-Warner Robins, GA	23.32557273
9	Amarillo-Borger, TX	22.23369444
10	Cincinnati-Wilmington-Maysville, OH-KY-IN	22.09480857

Table 1 Highest Per Capita pollution MSA

Rank	NAME	Total Pollution
1	New York-Newark, NY-NJ-CT-PA	80.8663
2	Los Angeles-Long Beach, CA	60.6043
3	Chicago-Naperville, IL-IN-WI	55.8322
4	Houston-The Woodlands, TX	44.4662
5	Pittsburgh-New Castle-Weirton, PA-OH-WV	43.8407
6	Washington-Baltimore-Arlington, DC-MD-VA-WV-PA	42.8446
7	Atlanta--Athens-Clarke County--Sandy Springs, GA	38.8935
8	Detroit-Warren-Ann Arbor, MI	36.0085
9	Cleveland-Akron-Canton, OH	35.4928
10	San Jose-San Francisco-Oakland, CA	34.999

Table 2 Highest pollution rated based on MSA

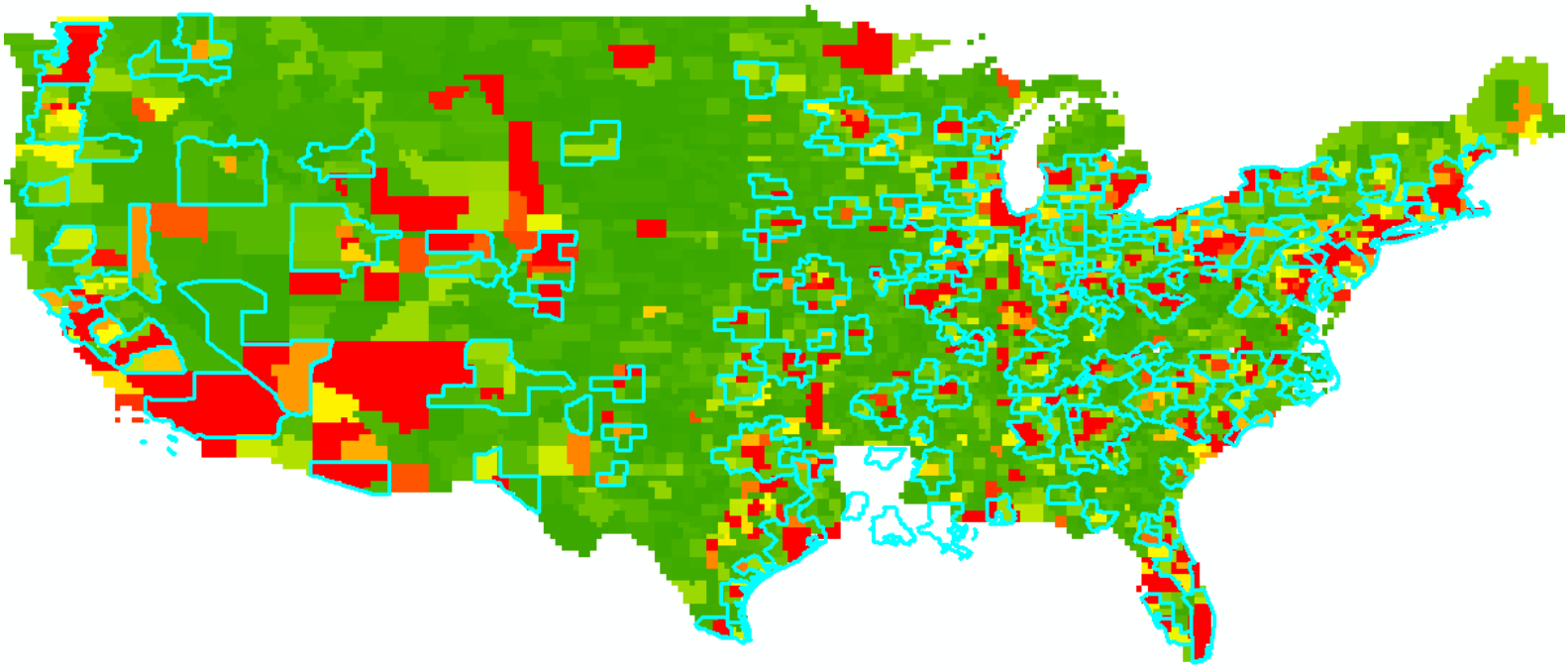

Figure 6 Total Pollution Levels at MSA

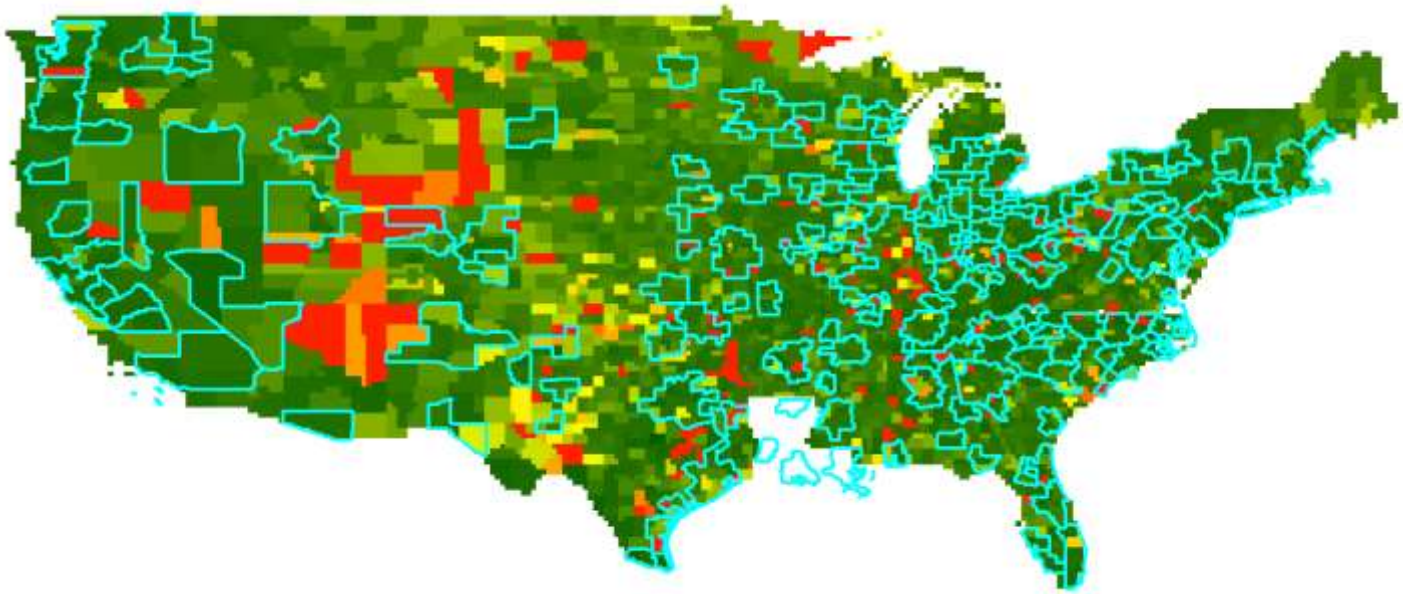

Figure 7 Per Capita Pollution Level

Discussion:

The findings of this study reveals that there is a positive correlation between the population density levels and the Green house gases emissions. But the low R-Value makes it difficult to prove the same. Also, when trying to understand the highest ranked cities it is observed that the overall pollution levels may be higher in the Bigger MSA's like that of New York, Los Angeles and Chicago however th Per Capita Emissions for these regions are much lower and for smaller MSA's like that of Steam Boat Springs & Morgantown it is higher. So when we try to derive on a conclusion of what could be an much sustainable city with reduced GHG emissions, there cannot be a relation drawn based on the population density and we understand that there are several other parameters such as local regulatory authorities, Public Transportation, Utilities, citizen awareness etc. that govern the same.