The Effects of Human Population Growth on Climate Change in South American Countries.

Climate change is described as a change in the Earth's average conditions, at present, one of the world's greatest threat to ecology and biodiversity (Begum et al., 2015). The study applied correlation analysis using the data software Python to investigate the relationship between human population growth and CO_2 emissions as a primary driver of climate change were obtained from the World Bank (World Bank, 2020).

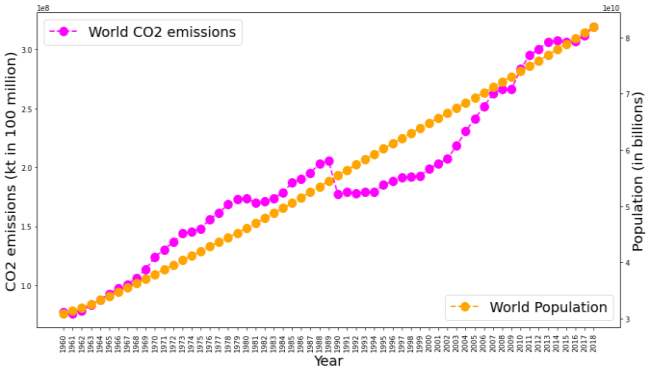

Figure 1 – Line chart showing the world CO_2 emissions and population from 1960 until 2018.

As illustrated in Figure 1, overtime both the world population and CO_2 emissions have increased from 3.1 billion and 77039800 kt to 8.1 billion and 319193504 kt, respectively. This claim is further enhanced because the Pearson Correlation Coefficient (PCC); r=0.961 signifies an almost positive linear correlation. Additionally, as shown in Figure 2, this relationship is confirmed with respect to South American (SA) countries with every country's population and CO_2 emissions increasing from 1960 to 2018.

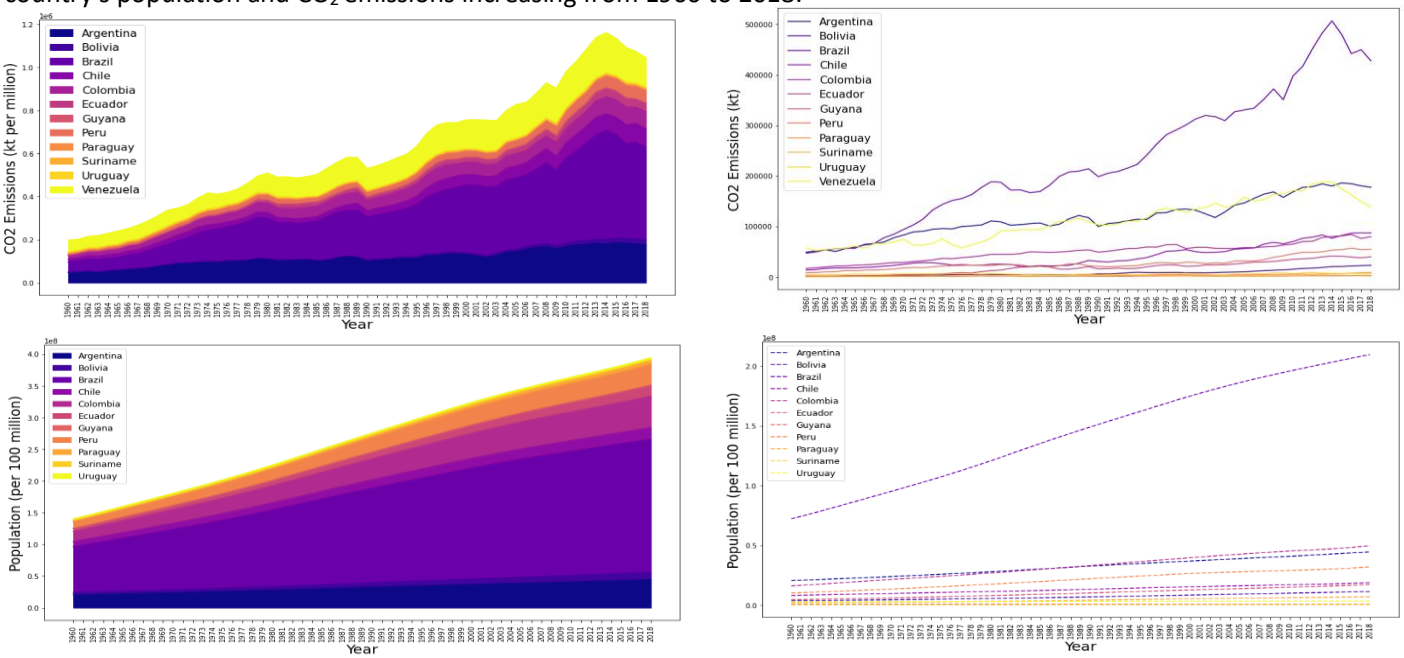

*Figure 2 –Graphs of South American CO_2 emissions: **A** Stacked area plot and **B** Line plot and Population: **C** Stacked area plot and **D** Line plot*

Table 1 – Shows the Pearson correlation coefficient and P-Values.

Country	r	P-Value
Argentina	0.959	< 0.0001
Bolivia	0.939	< 0.0001
Brazil	0.968	< 0.0001
Chile	0.933	< 0.0001
Colombia	0.963	< 0.0001
Ecuador	0.973	< 0.0001
Guyana	0.703	< 0.0001
Paraguay	0.954	< 0.0001
Peru	0.870	< 0.0001
Suriname	0.491	< 0.0001
Uruguay	0.433	0.0061
Venezuela	0.975	< 0.0001

A PCC was performed using the data in Figure 2. The statistical analysis in Table 1 revealed the results have shown to reject the null hypothesis; with statistically significant results were found in 12 out of 12 SA Countries. The results show an almost perfect positive linear correlation between population and CO_2 emissions. Although, Suriname and Uruguay have a slightly positive linear correlation; r=0.491 and 0.433, respectively. However, the null hypothesis cannot be accepted because the P-values remain to be <0.05.

Also, the study observed the CO_2 emissions overtime in SA, as observed in Figure 3. A PCC was performed on the CO_2 emissions in 1980 and 2018 with r=0.975 (P-value <0.0001) indicating an almost perfect positive linear correlation. It can also be observed visually that the most developed countries; Venezuela, Argentina, and Brazil, released the most CO_2. This is owing to the developed countries engaging in melting of iron(III) oxide, with the reduction reaction producing carbon dioxide (Hou et al., 2018).

In summary, human population is positively correlated with the amount of CO_2 emissions released in both SA countries and globally. However, the direction of causality cannot be inferred. Therefore, future research aiming to explore this relationship, could incorporate the amount of CO_2 emissions produced per person. The incorporation of this variable will offer an innovative insight to reduce the impact of climate change.

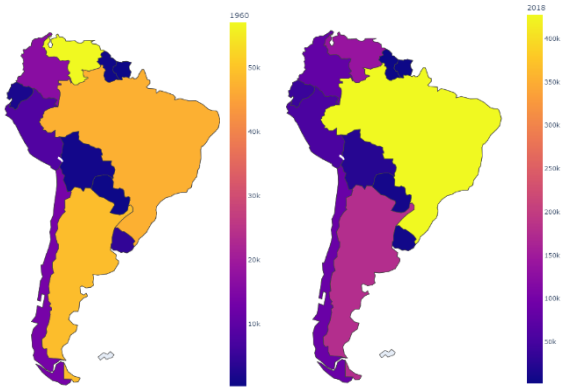

*Figure 3 – Map of South American CO_2 emissions in **A** 1960 and **B** 2018.*

Begum, R.A., Sohag, K., Abdullah, S.M.S. and Jaafar, M., 2015. CO2 emissions, energy consumption, economic and population growth in Malaysia. Renewable and Sustainable Energy Reviews, 41, *pp.594-601.*

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Hou, T., Charlier, B., Holtz, F., Veksler, I., Zhang, Z., Thomas, R. and Namur, O., 2018. Immiscible hydrous Fe–Ca–P melt and the origin of iron oxide-apatite ore deposits. *Nature communications*, *9*(1), pp.1-8.