Analyzing the Effect of Population Growth on Temperature Changes

1. Introduction

1.1 Motivation for Analyzing Population Growth and Temperature Changes

In recent decades, global warming and climate change have emerged as significant challenges affecting ecosystems, human health, and economies worldwide. The rising concern over increasing global temperatures necessitates understanding the various contributing factors. Among these factors, population growth is often debated for its potential impact on climate change through increased carbon emissions, deforestation, and urbanization. This project aims to explore the relationship between population growth and temperature changes on a global scale, providing insights that can help in formulating effective climate policies.

1.2 Main Research Question

The central question this project seeks to answer is:

"Is population growth related to temperature changes on a global scale?"

2. Used Data

For this project, we have identified two primary datasets, World Population Growth and Temperature Change, to analyse the relationship between population growth and temperature changes:

2.1 World Population Growth

The World Population Growth Dataset provides detailed data on global population trends from 1951 to 2023. Key attributes include total population count, annual growth rate, population density (individuals per square kilometer), and yearly population increases. This data set are fed to the python script named as “pipeline.py”. The output of the script is calculation of the population for each decade on a global scale, and the average growth rate. To Match these output data with second dataset, the output data is narrowed from 1970 to 2020 and after cleaning data we only have Decade, Population and growth rate column for every decade.

2.2 Temperature Change

The FAOSTAT Temperature Change dataset gives yearly updates on average surface temperature variations by country from 1961 to 2019. This data covers monthly and seasonal temperature changes and is sourced from NASA's GISTEMP. It also includes the standard deviation of temperature changes relative to this baseline. For our project, we calculated the temperature change for each decade from 1970 to 2020. Ultimately, we only require the decade and its corresponding temperature change rate for analysis.

3. Analysis

3.1 Data Collection and Preparation

The data collection and preparation process begins by downloading datasets from Kaggle using provided APIs, followed by extraction and preprocessing, aggregation, and loading. Figure 1 illustrates the pipeline structure in a flowchart format. Preprocessing plays a crucial role as it ensures data compatibility for analysis. This involves cleaning the data and handling missing values to achieve consistent formatting across datasets. During the aggregation and merging step, temperature data is aggregated from monthly to decade intervals and then merged with the population dataset. Finally, in the loading step, the results are stored in an SQLite database for further use and analysis.

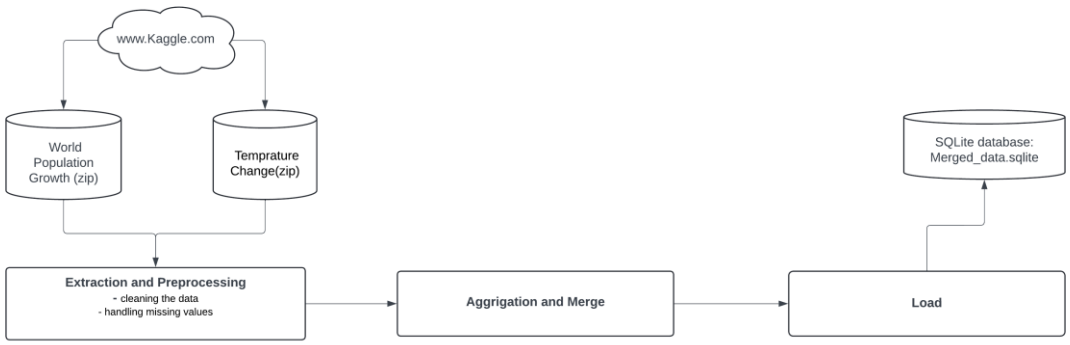

Figure 1: Data Pipeline Structure

To align the "Temperature Change" dataset with the population dataset, average global temperature changes, as presented in Table 1 along with their respective standard deviations, were calculated for each decade. In this table, the "Temperature change mean" represents the average temperature change observed over the decades. Additionally, the "Population Growth rate" in the population dataset is computed based on the last decade's data. This alignment enabled a direct comparison between temperature and population data. Subsequently, both datasets were integrated into a unified database to streamline data visualization and analysis.

Table 1: Average and Standard Deviation of the Temperature Change

#	Decade	Temperature change mean	Standard Deviation
1	1970	0.335612	0.714372
2	1980	0.446705	0.715942
3	1990	0.587427	0.763206
4	2000	0.768479	0.783268
5	2010	0.939156	0.836255
6	2020	0.945272	0.831200

3.2 Analysis

Based on the final dataset containing average temperature change, population, and population growth rate, we can create visualizations. Figure 2 displays the average

temperature change as a bar diagram and population as a scatter diagram. The color of each point in the scatter diagram corresponds to the population growth rate value.

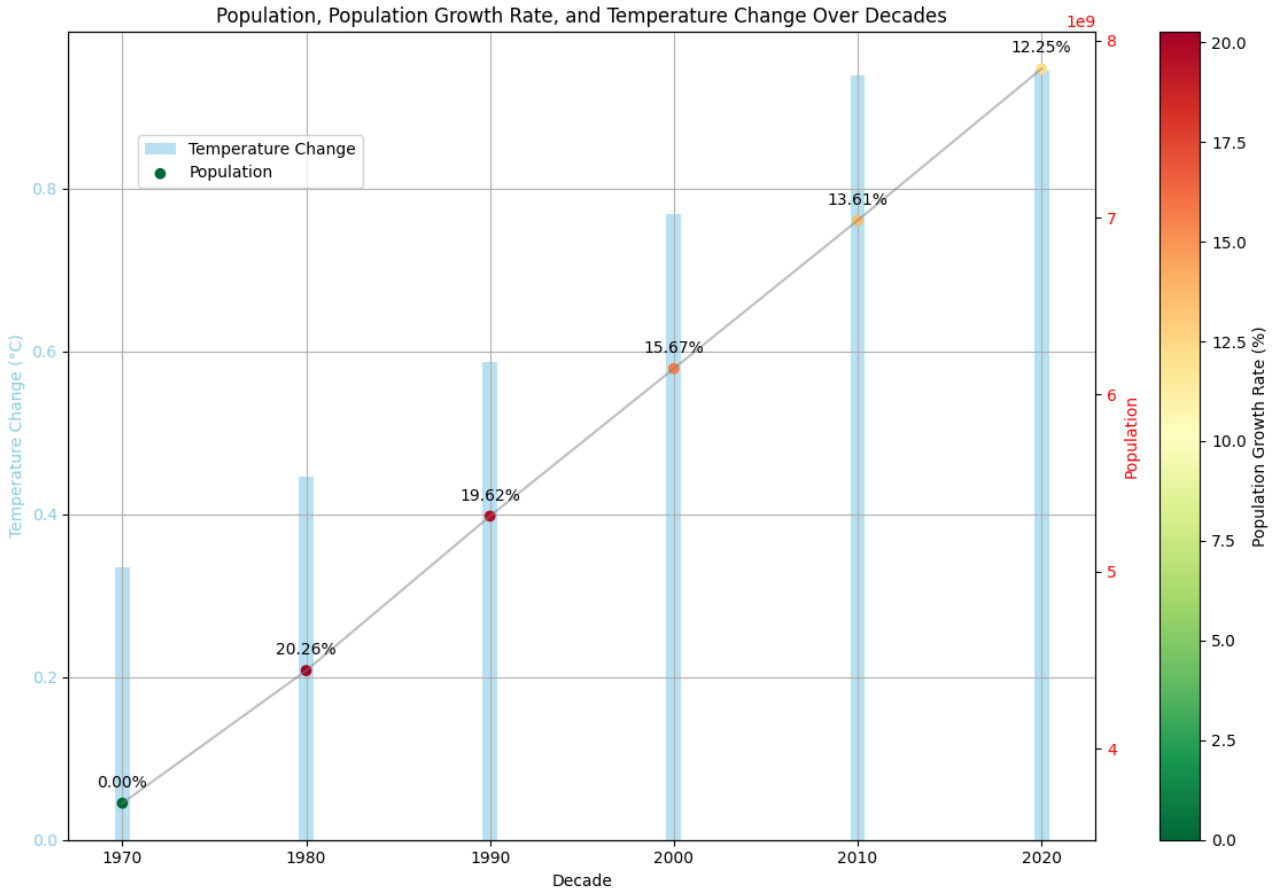

Figure 2: Temprature change Relation with World Population

In Figure 2, it is evident that the global population has experienced a significant increase from 1970 to 2020. Similarly, the average temperature shows a similar trend, with rapid changes observed from 1970 to 2010. However, the temperature increase during the last decade was minimal, rising by only 0.01 degrees Celsius. Additionally, the Population Growth Rate displays a decline over the study period.

3.3 problems

The "Temperature Change" dataset only contains data up to 2019, while the population dataset extends to 2023. To address this discrepancy, I treated the data from 2011 to 2019 as a single decade for comparison with the 2020 population data.

4. Conclusions

Based on the data presented, Figure 2 illustrates in overall same trends in both global population growth and average temperature change over the decades from 1970 to 2020. The population has consistently risen during this period, showing substantial increases from one decade to the next. Similarly, the average temperature exhibited rapid changes up until around 2010, followed by a notably slower increase in the last decade, with a rise of only 0.01 degrees Celsius. This slower recent increase in temperature contrasts with the ongoing significant growth in global population.

To address whether there is a relationship between population growth and temperature changes on a global scale, several factors need consideration. Both population growth and temperature changes are observable phenomena, direct causation between the two requires careful analysis. Population growth influences resource consumption, land use changes, and industrial activities, all of which can contribute to greenhouse gas emissions and affect climate patterns. While over the past decades, the global population has surged significantly, accompanied by notable impacts on environmental dynamics, including temperature trends. The data from 2010 to 2020 show a marked contrast: while population growth continued, the rate of temperature increase slowed considerably. This observation suggests that effective management strategies, such as sustainable development practices, energy efficiency improvements, and technological innovations, can mitigate the environmental impacts associated with population growth.

Based on data spanning from 1970 to 2010, one can conclude that population growth may contribute to an increase in global temperature. However, recent data from the last decade, coupled with advancements in technology and regulatory measures, highlight the influence of other significant factors on global temperatures. This complexity makes it challenging to establish a straightforward correlation between population growth and higher global temperatures or global warming. Therefore, further analysis incorporating all relevant factors or parameters is essential to reach a comprehensive conclusion.