Global Climate Change Analysis and Projection

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Business Problem

With a few notable exceptions, including renewable energy startups, sustainable agriculture startups, well-established sustainable forestry, conservation efforts by electric power companies, and electric vehicles, the business community has been largely unresponsive to the global threat of climate change.

Because our economy has no way to price in the very real costs of heating the globe and laissez-faire 21st-century governments have not restricted the emissions of greenhouse gases the way an earlier generation restricted toxic pollutants in the 1970s and '80s, there has been no immediate incentive for most companies to make changes.

It's everybody's problem, so it's nobody's problem.

Many businesses will be affected, some catastrophically. Just how much is hard to tell. The media mostly over-cover the climate change deniers at times and then predict doom without much in the way of specifics.

To get some clarity on the timeline of the problem, particularly for the real estate market along coastlines worldwide, I propose to analyze the data available on the primary cause, the temperature rises we should expect over the next few decades, and one particular impact of global warming: the rise of the oceans and seas.

Datasets

I will employ the following publicly available datasets.

1. Global greenhouse emissions back to 1750 via Our World in Data from various sources.
   I will use monthly annual worldwide emissions from this data source. Will include methane, nitrous oxide, and other gases, but they are generally dwarfed by CO2. Will examine if a CO2-only model explains most of the effect, using PCA and regression.

2. Carbon dioxide levels in the atmosphere since 1958, as measured at the Mauna Loa Observatory by NOAA and the Scripps Institution / UC San Diego via CO2.Earth. I will compare annual emissions versus annual changes in carbon dioxide levels.

3. Average land temperatures back to 1850 from Berkeley Earth. I figure this holds one of the primary effect/target variables, the average temperature across the land portions of the planet.

4. Average ocean temperatures back to 1850 from Met Office Hadley Centre. This holds the other primary effect/target variable, changes in the average temperature across a grid of ocean and sea locations across the globe.

5. Sea ice extent in northern and southern arctic regions back to 1978 from the National Snow and Ice Data Center. This might make a good secondary effect variable(s). The gas emissions raise CO2 levels, which trap the sun's heat, which warms the air and oceans, which melt the ice. Will use it to identify one of the major effects of rising sea temperatures.

6. Mean sea level variations since 1993 from NASA. This effect holds the answer to the trillion-dollar question. Will sea level rise enough to wipe out some of the most valuable real estate in the world?? Namely, ocean-front properties, Venice, New Orleans, the Maldives, Miami, Guangzhou, New York City, Kolkata, Mumbai, Shanghai, Tianjin, Tokyo, Hong Kong, Bangkok, and Amsterdam.

Data Science Approach

I won't be able to determine cause and effect, but I will do time series analysis, correlation, and predictive modeling between widely-attributed causes and effects.

For each cause, I will look at its correlation to accepted effects and develop a regression model of the relationship between them. I will analyze the time series to determine the trend and plot the current trajectory of each variable to 2030, 2050, and beyond when plausible. After developing a good predictive model across the variables, I will use it to predict the effects of meeting Paris/Glasgow reduction targets.

The first cause variables are the greenhouse gas emissions: the billions of tons of Carbon Dioxide (CO2), Methane (CH4), and Nitrous Oxide (N2O) produced worldwide each year over the last 170 years. Couldn't find data on other greenhouse gases.

The first effect is the concentration of each gas in the air. We have good data on CO2 from the Mauna Loa Observatory, but not on the other gases. This is also the primary cause of rising temperatures.

The second effects are the temperature increase on land and sea surfaces. We have good data on their variations, surprisingly covering the entire planet all the way back to 1850. The warmer seas cause increased sea ice melting and the warmer land melts glaciers and ice sheets, which flow into the oceans, driving up mean sea level. They both drive many other effects, some regional and local, which I won't be able to cover.

The third effect I will cover is the extent (in millions of square kilometers) of sea ice near the north and south poles. Sea ice melting increases the warming of the seas because seawater absorbs more heat from the sun than white ice, creating a vicious cycle. Ice also

forms an insulation layer, helping plants and animals beneath weather the cold winter. Because a given mass of ice takes up about 9% more volume than the same mass of water, melting should actually mitigate the rising sea level a bit.

The ultimate effect I will analyze is the mean sea level variation. If it rises about 25 feet (7.5 meters), this will have a devastating effect on world real estate assets, hence the global economy.

The ultimate answers I seek are

1. How much will sea level rise by 2050, given the current conditions?
2. How much will it rise if Paris Accord and Glasgow goals are met?
3. What reductions are needed by what timeframe to keep sea-level rise under 25 feet or other levels?

Deliverables

A. Jupyter notebooks describing analysis and design decisions, Python code, and data visualizations for the Data Wrangling, EDA, Feature Engineering, and Predictive Modeling phases
B. Project final report
C. Presentation slide deck