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Matthew Chan

May 6, 2022 4 min read

**The World is on Fire…**

Visualizing a climate crisis.



Image provided by Marcus Millo from iStock

This global warming and climate change crisis is very much an imminent threat to every living being on earth. By taking on this topic as my final project, I wanted to help the intended audience make data-driven decisions with these three research questions that I addressed through my visualizations. They are:

1. How has the increase of CO2 emissions affected the temperature in the countries around the world?
2. How has global warming and climate change affected the glaciers and the ocean levels?
3. What impact has global warming and climate change had on the economy, renewable energy, and public belief?

Before we dive into my visualizations, I think it is best if we define what global warming and climate change are. You might already know or have an idea as to what they mean, but just in case, according to NASA, global warming is "the long-term heating of Earth’s climate system observed since the pre-industrial period (between 1850 and 1900) due to human activities, primarily fossil fuel burning, which increases heat-trapping greenhouse gas levels in Earth’s atmosphere" (NASA, p. 2). So how does this definition compare to climate change? Climate change, according to NASA, refers to "a long-term change in the average weather patterns that have come to define Earth’s local, regional, and global climates" (NASA, p. 3). Global warming and climate change can be used interchangeably, just that climate change also used to describe both human and natural warming effects.

Now that we know what global warming and climate change are, we can now go into my first analysis on world CO2 emission levels by region and country.

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In Figure 1 shown above, there are three graphs to illustrate the world CO2 levels. The left graph displays the total CO2 emissions in a bar graph from 1960 to 2015, with the North American region totaling at least 266 million kilotons of CO2, then East Asia & Pacific region with the second highest total at 238 million kilotons, and Europe & Central Asia region right behind at third highest totaling 226 million kilotons. I chose a bar graph to represent the total CO2 levels because this was the best way to show comparisons between regions by total.

The middle graph displays a time series of the CO2 per capita, with the United States holding the top spot with the most from the 1960s all the way to 2009, before being overtaken by Saudi Arabia. As there are 195 countries, it would be difficult to display every country on this time series graph as all the lines will become jumbled in this small presented view. Therefore, I decided to choose at least two major or recognizable countries from each region from the left graph. A time series graph was selected to best represent CO2 per capita by region or country because this shows the change of total CO2 per capita of each region or country over the years.

And the right graph shows a steady median increase through a gradual darker shade of blue by value in the CO2 per capita as the years go by. I chose this time series line chart colored by value because I thought this was an interesting graph to represent not only the increase in CO2 per capita per year but also by color gradient. To summarize, the global total of CO2 emissions continues to increase as the years go by.

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In Figure 2 shown above, my second analysis is on the global surface temperature from 1880 to 2015. With an increase in CO2 emissions in our atmosphere, the greenhouse effect traps more of the heat from the sun, thereby increasing the global surface temperature. As we look at the left graph, we see an increase of about 3 degrees in Fahrenheit from 1960 to 2015. Although the temperature stops at 54.4 degrees Fahrenheit in 2015, with this forecast (the dotted lines), we can predict that the average global surface temperature will only continue to increase unless we do something to lessen this. I chose to represent this data with a time series line chart because this best showed the change of global surface temperature over the years. The red and orange lines represent the different organizations that recorded the data of each year.

On the right graph, we see the global average temperature in degrees Celsius from September 1880 to September 2013, and the highest average temperature would be in countries like Brazil, most of Africa, India, and Indonesia because these countries are along the equator. Representing the global surface temperature with a map plot allows us to see this represented data easier from a top-down view and location based instead of just with lines and text.

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So, what happens now that the global surface temperature increases? Well for my third analysis, in Figure 3 as shown above, we see that total mean cumulative mass of glaciers from 1940 to 2014 has continued to decrease, especially more rapidly starting around the early 2000s. The dotted lines again show the prediction of the time series line, which shows that the trend line will continue to decrease. This will result in there being less glaciers or ice for the wildlife that depend on them, like polar bears, seals, and penguins. I chose time series line chart again because this best represents data change over time in years.

Graphical user interface, chart, line chart

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Looking at our Figure 4 as shown above, my fourth analysis is on the global sea levels. Now that all the water from the glaciers have been melting into the oceans and seas, according to the CSIRO and NOAA data on the left graph from 1993 to 2013, the sea levels have increased by 2.6 inches overall. The top right graph shows this 67-millimeter increase, and the bottom right graph shows a reconstruction of how much sea level we had, dating all the way back to 1880 from 2013, and we have gained at least 8 inches from then. I also added this little pop-up legend of acronyms for GMSL, CSIRO, and NOAA. GMSL stands for global mean sea level, CSIRO stands for the Commonwealth Scientific and Industrial Research Organization, and NOAA stands for the National Oceanic and Atmospheric Administration. I chose time series line chart for these three graphs because change in data over time is best represented with this.

Chart, line chart

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With warmer temperatures and more moisture in the air, this results in more weather activities, notably weather catastrophes. As shown in Figure 5 above for my fifth analysis, in 2010, the total economic loss was $310 billion due to this year being one of the most active seismic years in decades, with quakes at Haiti, Chile, Turkey, China, and Indonesia, the Russian heat wave, and Pakistani flooding. In 2017, the economic loss totaled a whopping $519 billion due to this year being one of the higher-than-average reported storms, with some of the strongest and costliest hurricanes like Hurricane Harvey, Irma, and Maria, costing $95 billion, $80.7 billion, and $69.7 billion respectively. Although this time series shows a slight increase in the global economic loss from weather catastrophe, further research is needed to investigate the significance of this phenomenon. For instance, the challenge I encountered here is that we do not know if every natural disaster and weather catastrophe has been recorded from the data provided, and we also do not know if only a few major disasters have been the main cause of the economic losses. I chose the time series line chart with a trend line because I wanted to show the potential increase of this correlation between the global economic loss and weather catastrophe over time.

Chart

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The costly weather catastrophes worldwide only proved that there needs to be more focus on solutions to lessen CO2 and other greenhouse emissions. In Figure 6 as shown above for analysis six, from 2005 to 2021, many countries are coming together to increase renewable energy investments. On the left graph in 2019, China surprisingly leads in the total investments with $90.1 billion, the United States with $59 billion, and Europe just behind with a total of $58.4 billion. The top right graph shows a decrease in growth rate percentage of global clean energy investments from 2005 to around 2017 but begins to pick back up in 2019. The bottom right graph shows that the worldwide investment in clean energy hasn’t been increasing as much over the years from 2005, and the graph also is missing the data for slightly increased investments in years 2019 to 2021 like in the top right graph. I represented the left graph as a bar chart because this best compared the investments between regions in 2019. The top and bottom right graphs were made as time series line charts because they showed data change over time in years.

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An increase in global interest and investment in renewable energy has also allowed for an increase in renewable energy consumption. Figure 7 shows the seventh analysis on the global renewable energy consumption between 2000 to 2020. Compared to in 2000 when the total renewable energy exajoule consumption was only 2.64 EJ, this total exajoule in 2020 jumped to about 32 EJ. This 32 EJ, however, is still small compared to the other energy types of consumption as the world total energy consumption is 556.63 EJ in 2020. Luckily, this renewable energy consumption will hopefully only continue to increase, as shown in the projected forecast in the right graph. Since I thought having so many bars in the bar graph was a bit distracting, a better use of the data that I utilized was converting this data to be represented in a time series line chart as shown in the right graph.

Chart

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With all these weather phenomena and catastrophes, what does the public think about it? Figure 8, or analysis eight, as shown above, shows Italy and the United Kingdom ranking the highest with 81% of the public believing there to be a global climate emergency. The United States only ranks 22nd in the world with 65% of the public believing there to be a climate emergency worldwide. And Moldova ranks 37th with only 50% or half the public believing in a climate crisis. I highlighted United States because I wanted to highlight the country that I am from, as well as how many other Americans believe in this climate emergency. The graph on the right shows this public belief in map form. I put this data in map form because I was wondering if the region has any correlation with the public belief percentage, but more research is needed to justify this.

**Recommendation**

Now that we understand or know how imminent the dangers of the climate crisis are, what can we do about it? The first thing we can do is to reduce our use of fossil fuels, thereby decarbonizing, to quickly reduce our CO2 and methane emissions. We can do this by increasing the switch to wind and solar energy alternatives now that these alternatives are becoming more economically viable. We can also plant more trees to restore forests and grasslands. Additionally, there is a machine called the carbon capture and storage, and this device captures the CO2 in the air already. However, it runs on fossil fuels, and we do not know enough of the effectiveness of this machine. Another alternative would be doing ocean fertilization, which creates plankton blooms to absorb CO2 in the air at oceans, but the long-term impacts have not been studied enough to know if this is a safe method. A second major thing we can do is to get every, or as many more countries possible, working together to set climate goals and reduce greenhouse emissions. And a third major thing to do is increasing political support to encourage individuals to adopt low carbon-intensive lifestyles, like going vegetarian, food-waste reduction, and renewable energy options.

**Next Steps**

For this project in the future, the logical next steps would be to find up-to-date data. As we saw with some of the visualizations, they are not up to the current year of 2022, preventing us from seeing the much-needed changes in data. This data research would also include finding out if all disasters were recorded for the global economic loss of each year, as well as more research needed in the correlation between increased economic loss and weather catastrophes, as discussed in analysis five. A final future step would be to include the global warming and climate change policies and their impact on the climate crisis.

A group of people holding signs

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**In Conclusion**

So, what are your plans now after learning from my created climate visualizations on the impact global warming and climate change has had on the environment, economy, and us all, in one form or another? Will you be going vegetarian or vegan, how about reducing the amount of food waste, or even switching to solar panels or driving an electric car? I would like to close this blog post by reminding all that there is no Planet B, so it is important that we take immediate action to solve this problem together, whether it be reducing our carbon footprint, or building the next invention to solve this.

Citation:

NASA. (n.d.). Overview: Weather, Global Warming and Climate Change. Nasa: Global Climate Change. Retrieved March 28, 2022, from https://climate.nasa.gov/resources/global-warming-vs-climate-change/