Disparities in Climate-Induced Health Outcomes in the Greater Toronto Area.*

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The growing impact of climate change in Canada demonstrates a clear and current threat to human health. These threats are becoming revealed in Canada as the country continues to face the consequences of warming almost at twice the global rate. The focus for this paper is on tempreture increases, lower air quality and more pollution and a decline in health for Toronto. Once the data for this research was collected, the data cleaning process begun which entailed of using packages in R like tidyverse, janitor, dplyr, …. Duplicate and irrelevant observations were removed, as well as unwanted outliers. The process was complete once the data was correct, consistent and usable.

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*Code and data are available at: https://github.com/sarahmansoorr/SUDS2022

Introduction

As climate change worsens, the danger it presents to human health worsens as well. The health impacts due to climate change are already being demonstrated in parts of Canada. Canada is warming at almost twice the global rate and if this continues, emissions will exceed 2 degrees Celsius worldwide.

The Paris Agreement within the United Nations Framework Convention on Climate Change includes 175 countries that have agreed to limit the average global temperature rise to below 2 degress Celcius. Canada had signed to the Paris Agreement as well and committed to cutting emission 30% below the 2005 levels by 2030. However, Canada's emission increased in 2016 compared to 1990. As a response to this increase, the Government of Canada developed a national climate change plan called *The Pan-Canadian Framework on Clean Growth and Climate Change*. This framework notes that human activities are driving severe changes to the Earth's climate which poses substantial risks to human health.

Data

Data Collection

Temperature data was collected from the Government of Canada's website on Weather, Climate and Hazard's page containing past weather and climate data for the station "Toronto City". This data was collected from January 2002 to May 2022. The original data contains daily data on maximum temperature, minimum temperature, mean temperature, heat degree days, cool degree days, total rain (mm), total snow (cm), total precipitation (mm), snow on ground (cm), direction of maximum gust, and speed of maximum gust (km/h). For this research, I will focus on only maximum temperature, minimum temperature, and mean temperature.

Pollution data was collected from the Government of Canada's National Air Pollution Surveillance (NAPS) Program website. This website contains pollution data from 2002 to 2020. Each year contains a file with continuous data and integrated data. I will be using continuous data for each year. The continuous data contains annual summaries and hourly data as well. I will be looking at the means for each year in the annual summaries data. These summaries include the city (which is Toronto in our case), the pollutant (these include: NO, NO2, NOX, O3, CO, PM2.5, and SO2), as well as the levels of each pollutant for each month of the year.

Variables of Interest

Temperature variables of interest:

- Date
- Maximum temperature

- Minimum temperature
- Mean temperature.

Pollution variables of interest:

- Pollutant
- Month
- Year
- Average
- StdDeviation

Data Processing

Population, Frame or Sample

The Data

Table 1: Extracting rows from the Temperature data from 2002 - 2022

Year	Month	Day	Max Temp	Min Temp	Mean Temp
2002	11	18	4.4	-0.5	2.0
2003	7	27	28.6	18.8	23.7
2004	7	13	26.0	20.5	23.3
2006	2	6	-0.8	-4.4	-2.6
2007	6	24	28.4	15.3	21.9
2008	4	19	24.2	12.8	18.5
2011	5	11	17.9	11.5	14.7
2014	2	18	0.7	-4.2	-1.8
2017	1	30	-4.0	-10.1	-7.1
2020	3	23	3.9	0.4	2.2

Table 2: Extracting rows from the Pollution data from 2011 - 2020

Year	Pollutant	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011	NO2	21.0	20.0	14.0	14.0	12.0	11.0	12.0	14.0	13.0	16.0	18.0	18.0
2012	NO2	16.0	17.0	16.0	11.0	13.0	10.0	10.0	12.0	12.0	13.0	17.0	15.0
2013	NOX	21.0	20.0	16.0	14.0	15.0	12.0	12.0	14.0	14.0	17.0	17.0	22.0
2014	PM2.5	10.0	13.0	10.0	8.0	9.0	9.0	8.0	9.0	9.0	8.0	9.0	9.0
2015	O3	23.0	24.0	29.0	32.0	37.0	29.0	34.0	27.0	26.0	16.0	17.0	15.0
2016	NO	11.0	6.0	9.0	7.0	7.0	6.0	4.0	5.0	8.0	9.0	19.0	6.0
2017	NOX	19.0	18.0	17.0	13.0	13.0	13.0	13.0	13.0	17.0	15.0	16.0	22.0
2018	NO	7.0	8.0	3.0	5.0	5.0	4.0	3.0	3.0	4.0	7.0	6.0	9.0
2019	PM2.5	8.0	8.0	9.0	6.0	6.0	7.0	9.0	6.0	6.0	6.0	8.0	8.0
2020	SO2	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.1	0.2	0.1	0.3	0.1

Visualizing the Data and the Implications

Visualizing Temperature from 2002-2022

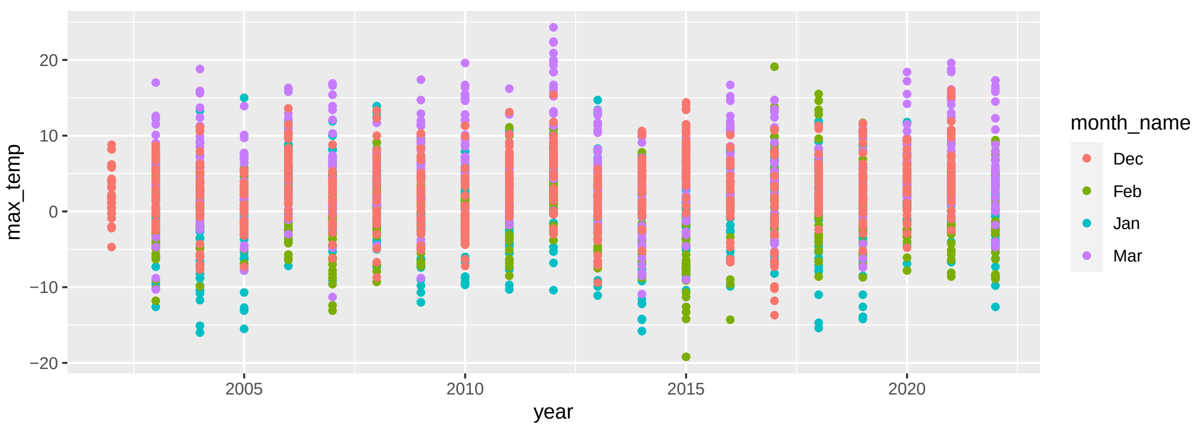

Figure 1: Temperature 2002 to 2022 for December to March

Implications 1

Visual 2

Implications 2

Visuals 3

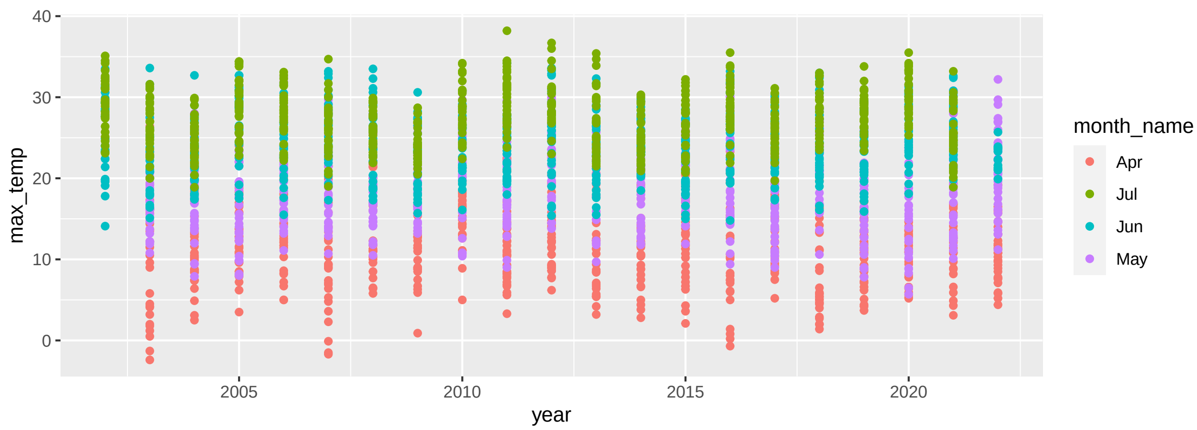

Figure 2: Temperature 2002 to 2022 for April to July

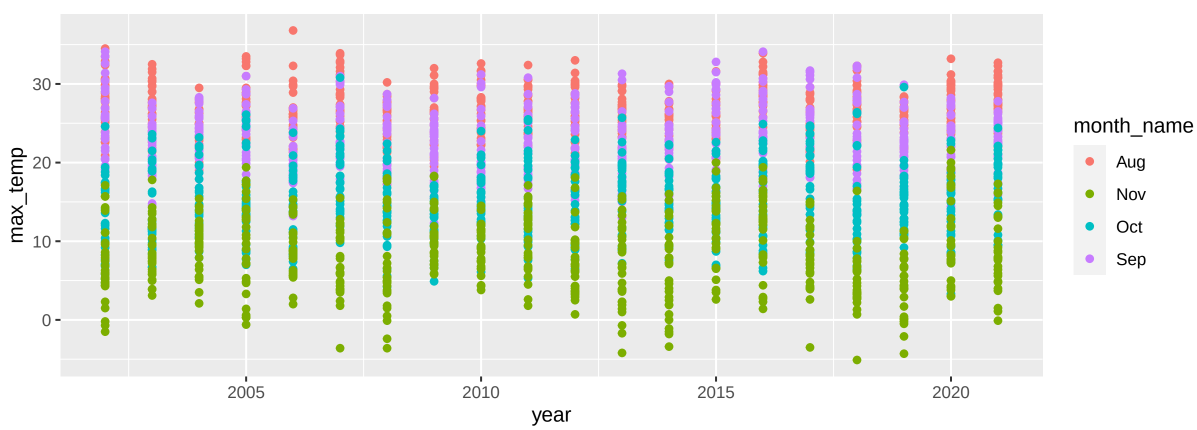

Figure 3: Temperature 2002 to 2022 for August to November

Implications 3

Limitations

Results

Next Steps

Conclusion