How dates and locations affect the rainfall.*

The relationship between dates, locations and rainfall

Rui Hu

09/23/2024

Rainfall associates with citizens. The purpose is to analysis the rainfall of Toronto. The data about Rain Gauge Locations and Precipitation from opendatatoronto contains locations and rainfall. It shows that the rainfall associates dates and locations.

1 Introduction

Rainfall is one of most important natural phenomena of the environment. It associates with all humans' activity. For individuals, we need to decide whether we should take an umbrella this day. For restaurants, how much food they should prepare every morning. A rainy day can't attract the same number of customers as a sunny day. For farmers, they need to decide the best time to plant or harvest. City authorities should prepare for the possible heavy rain in the future.

As a result, this paper purposes to understand the rainfall and contribute to the agriculture, environment protection and city planning. We use data from Gelfand (2022) in order to disclose the relationship between precipitation, locations and seasons.

*Code and data are available at: https://open.toronto.ca/

The remainder of this paper is structured as follows.

Section 2 Data

Section 3 Model

Section 3.1 Model set-up

Section 3.1.1 Model justification

Section 4 Results

Section 5 Discussion

?@sec-first-point First point

Section 5.1 Second point

Section 5.2 Third point

Section 5.3 Weaknesses and next steps

Section A Additional data details

Section B Model details

2 Data

Simulated data is of daily precipitation(Figure 1) which considers that rainfall is randomly every day.

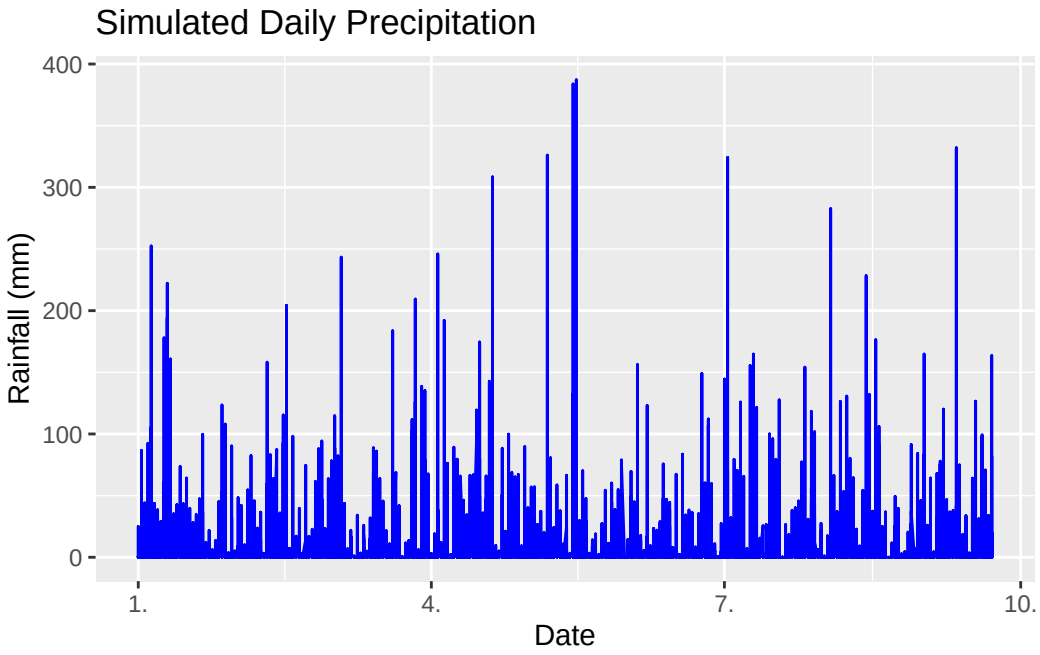

Figure 1: Simulate Precipitation

Some of our data is of daily precipitation (Figure 2), from Gelfand (2022).

In this figure, the location is fixed as (longitude=-79.4781121, latitude=43.6476803). In order to find the rainfall everyday from January to September, daily precipitation shows rainfall in mm.

And also planes (Figure 3). Daily precipitation is not able to find a rule for the rainfall. Monthly precipitation gathers elements in daily precipitation.

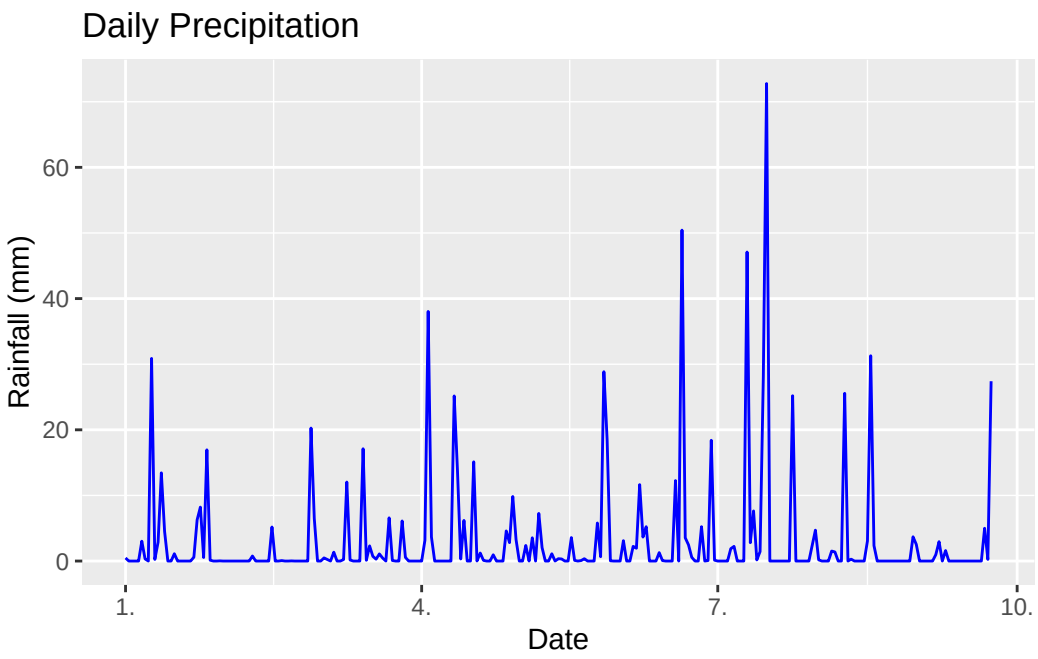

Figure 2: Daily Precipitation

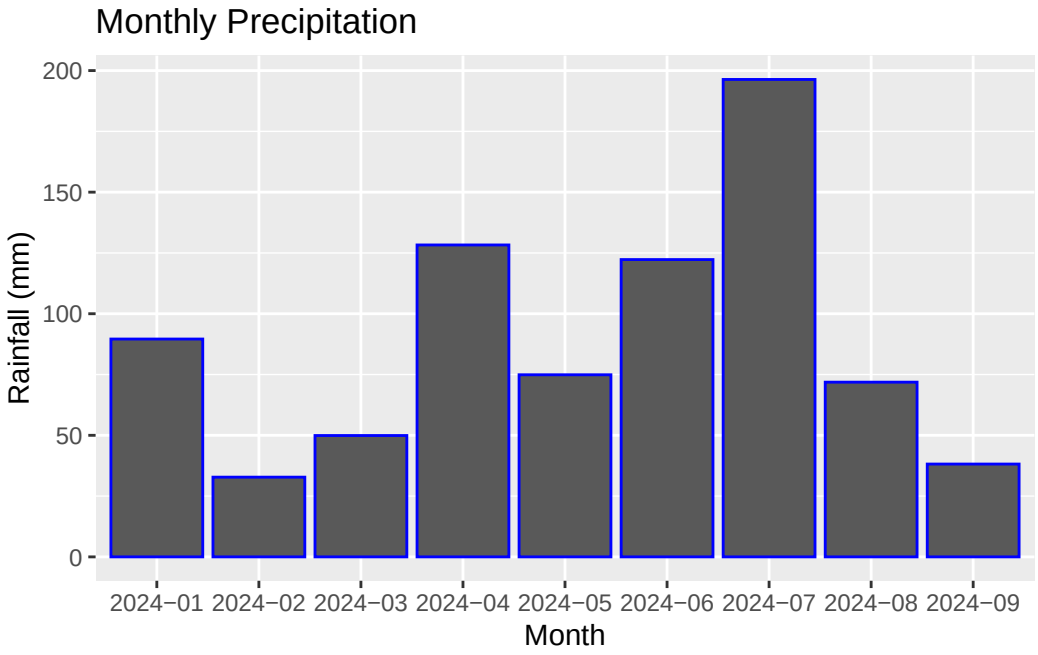

Figure 3: Monthly Precipitation

Variables in two figures are the following: Rainfall: precipitation measured by rain gauge equipment (mm) Date: Every day from January to September. Month: Every month from January to September.

3 Model

The goal of our modelling strategy is twofold. Firstly, it tells the relationship between precipitation and longitude is positive or negative. Secondly, it tells the relationship between precipitation and latitude is positive or negative.

Here we briefly describe the linear regression model used to investigate the effects of longitude and latitude on precipitation.

More information are included in Appendix B.

3.1 Model set-up

Define y as the total rainfall in 2024. Then x_1 is the longitude and x_2 is the latitude.

$$y = ax_1 + bx_2 + e \tag{1}$$

We run the model in R (R Core Team 2023).

3.1.1 Model justification

We expect a positive relationship between the precipitation and coordinates. In particular, increasing longitude or increasing latitude may cause increasing precipitation. y represents precipitation in mm. x_1 represents longitude and x_2 represents latitude. The coefficients a and b are used to represents the change of precipitation by longitude and latitude.

4 Results

$$y = -389.9x_1 + 934.7x_2 - 71080.4 \tag{2}$$

5 Discussion

##First discussion point {#sec-first-point}

When talking about rainfall, one purpose is that the rain is only formed by (). It means that the precipitation every day is totally random just like the data which we simulated in (Figure 1). From our daily life, if today is rainy, the precipitation is greater than not rainy day. The data we simulated shows that, the rainy days are randomly choose. We are not able to find any rules from it. However, in the real data which comes from Gelfand (2022) (Figure 2), it is totally wrong. Although it is same that some days rain and some days sunny, July seems to have more rainy days and also the precipitation is higher than other months. To find more about it, the bar chart in (Figure 3) merges all days into months. So we can see the total precipitation for each month. We can easily see that July is higher than other weeks. Although precipitation seems to be random every day, monthly data shows that the rainfall during summer is higher than other seasons.

5.1 Second discussion point

The regression model (Section 4) shows that there are positive correlation between precipitation and longitude. Also,there are positive correlation between precipitation and latitude. This finding means that the north-eastern part of Toronto has a higher precipitation. By analzeing this finding, the rainfall in the Toronto can be well known. It helps city workers with there work.

5.2 Third discussion point

In the first part, the monthly data (Figure 3) convinces that precipitation in the Toronto is not random every day. The highly precipitation in July concludes that summer may cause heavier rainfall than other seasons. This may cause by higher temperature in summer. In the second part, the linear regression model proves that North Eastern part of Toronto is more likely to have more precipitation. This may cause by the distance away from Ontario lake.

5.3 Weaknesses and next steps

Our data from Gelfand (2022) only represent the rainfall data from January 2024 to September 2024. As a result, the change of climate by global warning may cause a change on our analysis. Also, the location is only focused on Toronto. As a result, it may not suitable for all the areas around the world. Next step, the data from past years and different area can be gathered which can support or generalize our assumptions.

Appendix

A Additional data details

Data source: Rain Gauge Locations and Precipitation from Gelfand (2022).

Data variables:

date: date of the data (e.g. 2024-1-1)

longitude:longitude of the rainfall

latitude:latitude of the rainfall

Total_Rainfall: Total rainfall that day

B Model details

y: precipitation in mm

x_1: longitude

x_2: latitude

References

Gelfand, Sharla. 2022. *Opendatatoronto: Access the City of Toronto Open Data Portal*. https://CRAN.R-project.org/package=opendatatoronto.

R Core Team. 2023. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.