FIRST YEAR PROJECT - BSFIYEP1KU

COVID-19 AND THE WEATHER

SUBTITLE

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Group K
Andreas Magnus Benggaard - andbe@itu.dk
Michal Rynowiecki - miry@itu.dk
Nicolai Jacob Kofod-Jensen - nkof@itu.dk
Sam Younes isyo@itu.dk
Sree Keerthi Desu - srde@itu.dk

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1 INTRODUCTION

In 2020 the world was hit by an, in recent times, unprecedented pandemic. Given the novelty of both this outbreak and the methods we have for measuring both the number of cases, severity of cases and other variables at any given time, this has opened an opportunity for research into the spread of COVID-19 and related diseases.

The present study investigates the impact environmental factors, specifically the amount of precipitation in a given period, have on facilitating or restraining the spread of COVID-19 in the Netherlands **based on how they affect the number of hospitalized additions per region. We will often be referring to our dependent variable as cases per region for simplicity.**

We use the weather variables by cleaning the data and merging it together with the official statistics provided by the state's government regarding covid-19 so that we can calculate coefficients describing the relationship between environmental factors and covid-19 outbreaks.

2 DATA

The data in the present investigation are from the following sources:

COVID-19 Data	"Novel Coronavirus (COVID-19) Cases in The Netherlands", De Bruin et el. [1]
Population data	Statline, table 70072NED
Weather data	Provided by the course (BSFIYEP1KU at the IT University of Copenhagen)

2.1 Data Cleaning

2.1.1 Initial Cleaning

The data cleaning process can be described iteratively, since for both datasets used in the project the same process was used.

1. Load the data into a dataframe
2. Sanity checks
    - Check the dimensions of the data set
    - Check for missing values
        - If present - Remove rows with missing values
    - Check if each variable has been loaded in as the correct datatype
        - If not - Correct this

3. Calculate basic values
    - Mean
    - Median
    - Quartiles

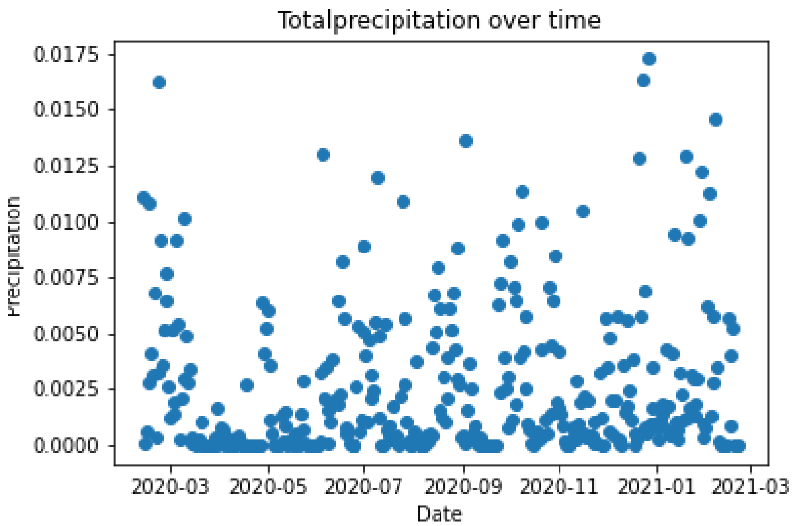
2.1.2 Merging

In order to actually investigate any potential correlations between the two datasets, we had to identify variables upon which to perform an outer join. In this case both datasets had a 'date'-column which, after the data cleaning, were in the same format. But given that for each day both data sets reported both national and regional numbers for the Netherlands, we also had to use this for the join, in order to get an accurate representation of any potential correlations.

3 RESULTS

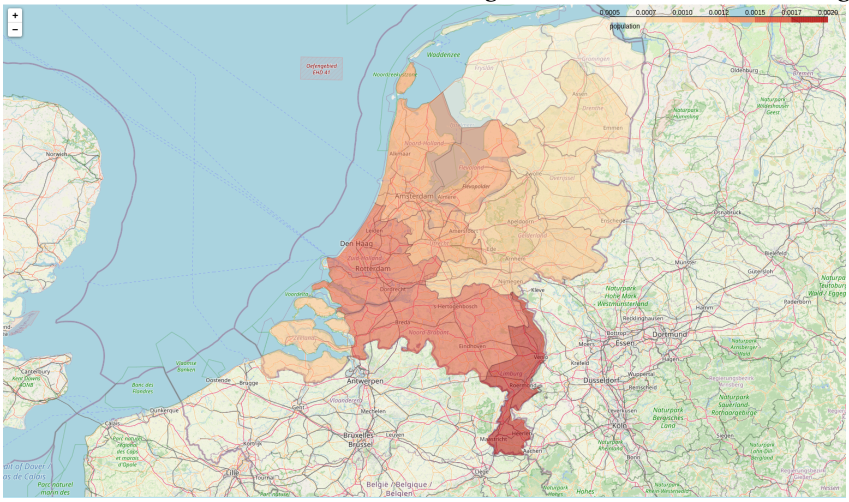
3.1 Weather data analysis

We loaded the weather and corona data and limited it to the regions in the Netherlands. Then we considered the temperature above ground and total precipitation variables and plotted them against the dates in-between the time period 13-02-2020 to 21-02-2021. Along with the plots, we also merged the weather and corona data frames, which caused some of the entries to be lost in the process due to a lack of mutual coverage. The figure attached below is a plot of the total precipitations against the dates.



3.2 Folium maps

Furthermore, we created choropleths of hospitalized addition, population, and cases per capita based on the regions of the Netherlands. The figure below is a choropleth of cases per capita of the regions which illustrates that Rotterdam and the Hague were the most affected regions.



3.3 Pearson, spearman, and log-log pearson correlation

Moreover, we applied Pearson correlation to find the quantitative representations of the correlations between the corona data and weather variables, specifically the cases per region and total precipitation respectively. From our results, we were able to gather that the temperature above ground variable has the most statistical significance in regards to the p-value and also has the highest absolute value amongst the coefficients of all the weather variables used in the Pearson correlation test. On the other hand, total precipitation does not appear to have a significant correlation with corona outbreaks as shown by the Pearson correlation coefficient. All weather variables, except for solar radiation and wind speed, show a p-value of less than 0.05 which indicates that they are significant to the research.

Likewise, the Spearman correlation test showed us similar results, i.e., temperature above ground has the highest absolute value of coefficient along with the lowest p-value indicating high statistical significance once again. In fact, the p-value is 0.0 which is exceptionally good, indicating that the null hypothesis is entirely rejected, which could either be a coincidence or a computational mistake. The coefficient has also increased relatively indicating a stronger correlation between the variables. The absolute value of Spearman's correlation coefficient of the total precipitation decreased to 0.073 compared to Pearson's correlation coefficient of 0.077, whereas the p-value increased indicating a decrease in statistical significance. The negative coefficient indicates a decreasing monotonic trend between corona cases per region and total precipitation.

The results highlighted that both Bonferroni and Holm-Bonferroni corrections returned true for total precipitation which implies that the p values are below the threshold of 0.005 further indicating that total precipitation is statistically significant with regards to the corona outbreak intensity.

3.4 OLS regression results

In addition, we also looked at Ordinary Least Squares (OLS) regression. We used cases per region as our dependent variable and the weather variables as our independent variables. The result showed us that total precipitation had the highest coefficient of 0.0001 and a relatively low p-value. Moreover, we also looked at the logged OLS regression and found exactly the same results for the same variables.

3.5 OLS regression of dataframe merged with stringency index data

For the OLS merged with the stringency index, the total precipitation has a coefficient of 1.907e-06 which is relatively high compared to the other weather factors. However, it also has a quite high standard error of 3e-05. The lowest coefficient is -7.163e-17 for the “International Support” factor. The highest coefficient is international travel controls with the value 7.047e-06.

4 DISCUSSION

The results for the different weather factors were somewhat contradictory.

The results of the Pearson correlation showed that the temperature above ground is the most statistically significant according to the Pearson correlation which does not support our hypothesis.

Whereas the OLS regression models including the regression merged with stringency index data show that total precipitation has the strongest correlation with total precipitation from the weather variables. The Bonferroni and Holm-Bonferroni returned "True" for total precipitation showcasing that it is indeed statistically significant with respect to cases per region.

According to the analysis that we carried out on the provided data sets, total precipitation has a strong correlation **with the variable describing the intensity of corona outbreaks.**

A research paper [2] that researched temperature and precipitation **associated** with covid-19, based in Oslo, Norway. The paper aimed at analyzing the correlation between weather and corona data. The results of their research showed that temperature and precipitation are associated with daily corona cases. This reflects our hypothesis. Temperature was positively associated with corona whereas precipitation is negatively related.

A hypothesis for the correlation of total precipitation to corona is when precipitation is high, people tend to stay inside due to the rain, snow, or other environmental factors while still going to work, school, or holding social gatherings indoors. By doing so, they tend to be close together with friends and family where air circulation is undesirable, meaning the spread of corona could be intensified.

Another hypothesis is that low precipitation enables people to spend more time outside allowing people to break restrictions and be exposed to the virus.

Both of the above hypotheses do not actually prove direct causation between the temperature, precipitation, or other environmental factors and the spread of the virus. It can be noted that the environmental factors changing human behavior to that of them to having more social interactions carry an increased risk of virus transmission, but it does not actually create a biologically beneficial environment for the spread of the virus.

5 LIMITATIONS

During the research we encountered several obstacles that could be a deterring factor in the validity of our results. Firstly, the analysed data set lacked the number of covid tests carried out. This could potentially make the number of cases irrelevant. However, the number of deaths and hospitalizations remain an objective indicator that is independent of the missing values.

Some of the values were dropped during the merging of data due to technicalities. This could have a negative impact on the scope of data. Specifically, 204 rows of the original data set were dropped.

Another issue we stumbled upon were the missing values in stringency index, which might limit the accuracy of the measurements that we used to correlate the measure of covid cases and the environmental factors.

Finally, we didn't have any information regarding government regulations introduced during the outbreaks of covid, such as lockdowns, which could limit the exposure of people to environmental factors.

6 CONCLUDING REMARKS

The results from the research suggest a possible correlation between the covid outbreaks with the temperature above the ground variable along with a possible correlation with the total precipitation variable, **however if the relation is existent**. Although total precipitation has a significant impact on the cases per region, we observed that the temperature above ground impacted the variable more according to the Pearson correlation. On the contrary, every result pointed to total precipitation as the most correlated variable confirming our hypothesis. However, it is likely that the weather only impacts the social behavior of people in the Netherlands and does not actually provide a better environment for the spread of the virus. It is important to note that our research has many limitations, hence we do not recommend our results to be used for any further research.

Research conducted is not completely flawless, so its findings should be taken into account with careful consideration. The future works in this area can be based on the coefficients describing the relationship between weather as well as inspecting the unconsidered factors such as humidity.

References

[1] J De Bruin, R Voorvaart, V Menger, I Kocken, and T Phil. Novel Coronavirus (COVID-19) Cases in The Netherlands. nov 2020.

[2] Mesay Moges Menebo. Temperature and precipitation associate with Covid-19 new daily cases: A correlation study between weather and Covid-19 pandemic in Oslo, Norway. *Science of The Total Environment*, 737:139659, oct 2020.

A TABLES

A.1 Weather Data metrics

Variable	count	mean	std	min	25%	50%	75%	max
RelativeHumiditySurface	20220.0	7.70e+01	1.31e+01	3.38e+01	6.78e+01	7.93e+01	8.78e+01	9.90e+01
SolarRadiation	20220.0	6.41e+06	6.32e+06	0.00e+00	7.78e+05	4.16e+06	1.11e+07	2.48e+07
Surfacepressure	20220.0	2.39e+06	5.03e+04	2.18e+06	2.36e+06	2.40e+06	2.43e+06	2.49e+06
TemperatureAboveGround	20220.0	2.81e+02	7.58e+00	2.50e+02	2.76e+02	2.82e+02	2.87e+02	3.01e+02
Totalprecipitation	20220.0	2.20e-03	3.39e-03	0.00e+00	7.20e-05	7.20e-04	2.90e-03	4.13e-02
UVIndex	20220.0	1.42e+01	1.39e+01	0.00e+00	3.38e-01	9.75e+00	2.55e+01	5.27e+01
WindSpeed	20220.0	3.72e+00	1.74e+00	6.87e-01	2.44e+00	3.33e+00	4.61e+00	1.37e+01

A.2 Corona Data metrics

	count	mean	std	min	25%	50%	75%	max
region_code	4344.0	25.500000	3.452450	20.0	22.75	25.5	28.25	31.0
deceased_addition	4152.0	3.665703	6.923995	-3.0	0.00	1.0	4.00	77.0
confirmed_addition	4332.0	244.049400	417.929016	-46.0	8.00	68.0	257.00	3179.0
hospitalized_addition	4152.0	5.698940	12.976320	-3.0	0.00	1.0	6.00	270.0
deceased_cumulative	4164.0	605.770653	692.735743	0.0	69.00	314.0	870.25	3653.0
confirmed_cumulative	4344.0	23076.545580	42795.712372	0.0	936.00	6088.0	18962.75	250759.0
hospitalized_cumulative	4164.0	1144.249039	1179.334164	0.0	161.00	619.0	1749.50	6043.0

B Correlations

B.1 Pearson

	Correlation	p-values
RelativeHumiditySurface	3.429129e-16	-0.126307
SolarRadiation	5.628132e-01	0.008996
Surfacepressure	1.971974e-10	0.098688
TemperatureAboveGround	1.496281e-43	-0.212671
Totalprecipitation	1.599316e-05	-0.067000
UVIndex	5.656131e-26	-0.162764
WindSpeed	5.808188e-04	0.053448

B.2 Spearman

	Correlation	p-values
RelativeHumiditySurface	3.268932e-15	0.122051
SolarRadiation	6.749240e-57	-0.243401
Surfacepressure	1.143578e-01	0.024543
TemperatureAboveGround	7.826975e-256	-0.495802
Totalprecipitation	8.558288e-05	-0.061013
UVIndex	1.872523e-210	-0.454739
WindSpeed	1.972349e-10	0.098688