Impact of COVID19-induced Lockdown on Air Quality in Ireland

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Introduction

• Analyze the impact of COVID19-induced lockdown on the air quality of the atmosphere.
• In this paper, we focus our case study for the city of Dublin in Ireland.
• We analyze the average concentration of a common gaseous pollutant majorly responsible for industrial and vehicular pollution, viz. nitrogen dioxide (NO2).
• Concentrations are obtained from the tropospheric column of the atmosphere collected by Sentinel-5P, an European Space Agency earth observation satellite.
• Comparison is done on the average concentration of NO2 with that of the previous year data for the month of March and April to quantify the improvement in the air quality.
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The data product used for this study - nitrogendioxide_tropospheric_column product of the file which gives the total atmospheric NO$_2$ column between the surface and the top of the troposphere, which stands for tropospheric vertical column of nitrogen dioxide

Level-2A products used in the study.

Plots for Ireland for initial days of Lockdown, i.e 24-March-20 till 29-March-20.

Dublin subset from the global data set, latitude range from 53.24$^\circ$ to 53.41$^\circ$ and longitude range from -6.11$^\circ$ to -6.45$^\circ$ was fixed and the concentration data points are selected.
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Pre-processing

- Combining each NetCDF files into a single file along time dimension.
- Set up the latitude and longitude extension as per the area of study.
- Below steps to obtain daily average concentration for entire period of study
  - Replace NaN values of the data grid to 0.
  - Calculate the sum of all measurement values in the grid.
  - Divide resultant sum by number of non-zero values to have daily average for region.
  - Repeat this for all the dates of interest for comparative analysis.
- Average fifteen-days concentration average for month of March and April for comparative analysis.
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Pollutant Analysis of Ireland

We observe that the concentration of NO$_2$ dropped significantly on 24-March-2020 (day of the lockdown) for Ireland, subsequently all ‘non-essential’ travel were banned after 3 days. We noticed a shape drop again on 28-March-2020 and we observe a clear reduction in NO$_2$ concentration (*cf.* e, f submaps).
Pollutant Analysis of Dublin

Plot of average daily concentration of nitrogen dioxide obtained from Sentinel-5P for the years (a) 2019, and (b) 2020. We observe that the lockdown significantly reduced the concentration of nitrogen dioxide for the corresponding months of the two years. We show the lockdown period in green color.
Results

- Dublin Daily Analysis
  - March
    - Last 10 days of March 2019 recorded the average NO$_2$ concentration of 5.489 µmol/m$^2$.
    - Last 10 days of Mar-2020 recorded the average concentration of 3.044 µmol/m$^2$, a drop of about 44.54%.
  - April
    - The calculated average concentration of NO$_2$ for Apr-2019 was 7.075 µmol/m$^2$
    - For Apr-2020 it was 3.831 µmol/m$^2$, recording a significant drop of 45.8%.
Pollutant Analysis of Dublin

The fifteen-days average nitrogen dioxide concentration for the months of March and April. We can observe from the bar plot that there is a reduced NO$_2$ concentration from second half of March 2020 and beyond.
Results

• Comparative Analysis
  • Dublin noticed an increasing trend of $\text{NO}_2$ concentration for Mar-Apr 2019, trend for 2020 was very much different due to lockdown.
  • Second half of Mar-2020 recorded a 31.17% drop as compared to same period last year.
  • A complete lockdown further improved the $\text{NO}_2$ concentration for the first half of Apr-2020 by 46.35% as compared to the first half of Apr-2019
Conclusion & Future Work

- Lockdown provided a great opportunity for researchers to analyze the effect of vehicular pollutants on air quality.
- This work will influence the policy-makers to implement stricter environmental laws.
- Our future work includes the short-term forecasting of pollutant data from historical data.
- In future, we would like to:
  - use the popular LSTM-based models to learn the underlying pattern of such time-series pollutant data and propose relevant recommendations to city planners and environmental agencies.
  - use a multi-sensor framework involving ground-based sky cameras and monitoring stations, in addition to the satellite measurements.
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Thank you for your attention!¹

¹https://github.com/dkaloni/LockdownAnalysis_Ireland.