Can we Measure the Impact of the Coronavirus Lockdown on Air Quality and is there a Link Between Poor Air Quality and increased Covid-19 Mortality Rates?

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1 INTRODUCTION

Subsequent to the initial devastation caused by the recent coronavirus pandemic, many countries worldwide have enforced a mandatory lockdown in a bid to contain the spread of the disease. [2] Whilst this has inevitably invited a myriad of far reaching negative implications, the reduction in vehicle usage along with the temporary closure of many businesses/institutes has seemingly had a positive impact on our environment and air quality. Air quality in this instance refers to the levels of ambient air pollution including pollutants such as [1] nitrogen dioxide (NO2), sulphur dioxide (SO2), volatile organic compounds (VOCs) etc. with a particular focus on course and fine particulate pollution (PM10 and PM2.5 respectively). Released as a result of road traffic emissions (especially from diesel fueled vehicles), industrial combustion plants, processes such as quarrying and natural sources such as volcanoes, particulates consist of a complex mixture of miniscule particles and liquid droplets which are highly prevalent in urban areas. The presence of particulate pollution in high levels in any given area has extensive negative ramifications as PM10 and PM2.5 are not only proven contributors to global warming and acid rain, but they have also been linked to the deterioration of respiratory health. [3] Due to the inhalation and deposition of the particulates into the alveoli of the lungs, they have been associated with chronic pulmonary diseases, e.g. mortality rates along with the risks of acute exacerbation in patients suffering with COPD (chronic obstructive pulmonary disease) are both increased when exposed to high levels of PM. In recent times, there has been progressively increasing amounts of speculation regarding the possibility of particulate matter advancing the spread of the coronavirus and potentially increasing the covid-19 related death rates. This has arisen from a pre identified link between particulate matter and various other airborne diseases such as measles, in addition to the results of recent studies carried out supporting the notion of geographical distribution of particulate matter having an impact on covid-19 mortality.

1.1 Scope

The focus of this study is to research the impacts of the coronavirus lockdown on air quality and investigate the effects of particulate pollution on covid-19 - this is to be achieved through the application and evaluation of data collected from air quality monitors in addition to the analysis of secondary, qualitative data regarding the subject. Live air quality monitors have been set up worldwide by the Luftdaten project providing constant and valid measurements that have been utilised during the development of this research study.
Whilst there is an overall focus on general global air quality, we have assigned a more comprehensive focal point to the north-western italian region of Lombardy. Having been ranked as one of the most polluted areas in Europe and given its air quality trends in association to covid related deaths, Lombardy served as a compelling source of insight and an appropriate sample location.
Additionally, in order to fulfill a personal contribution to the improvement of air quality, this project has involved me building an air quality monitor to provide data from my local area. This can later be used to raise awareness of the importance of clean air on respiratory health and encourage more sustainable activities and behaviours on a smaller scale in and around my areas of education and residence.

1.2 Abstract

This research study endeavours to explore the effects of the coronavirus lockdown on ambient air quality and determine whether higher covid 19 mortality rates can be associated with increased levels of particulate matter in the air. The analysis of both qualitative and quantitative pre-existing data has contributed to the formation of the conclusions of this study as we have ventured into identifying trends in the behaviour of PM levels over the past year and comparing the statistics to the levels measured this year in two major regions impacted by covid 19, Wuhan and Lombardy. Numerous sources have been utilised during the progression of this research including scholarly articles, newspaper extracts and live air quality monitor readings in order draw relevant and knowledgeable conclusions.The results of this have successfully verified a significant correlation between the covid 19 mortality rates and increased particulate pollution, however, this remains a correlation and lacks any official causation - thus rendering this portion of the research question inconclusive until further research can be conducted. The impacts of the worldwide lockdown on air quality has also remained inconclusive as of this moment in time as we are unable to successfully determine

whether any recent improvements in air quality can be attributed to the lockdown measures, or rather other confounding variables such as seasonal variation and wind speed/direction.

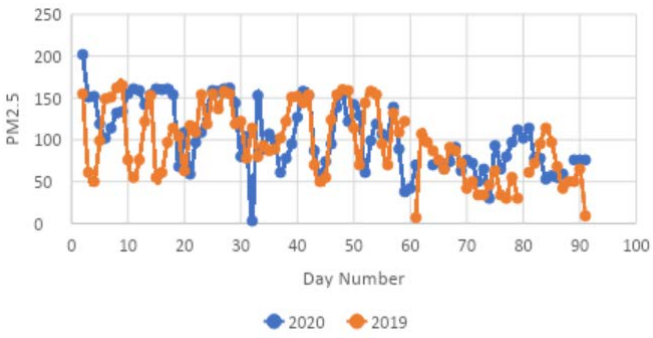
2 METHODOLOGY

The aim of the project was to research the public information related to changes in air quality that have potentially been instigated by the enforcement of the coronavirus lockdown. In addition to this, exploration of the possibility of the spread of covid-19 being spurred on by particulate matter in the air has also been included. This project initially involved the accumulation and analysis of information gathered from a variety of public sources including numerous journal articles, websites and newspapers. This formed a foundation from which we then proceeded to obtain quantitative data. Through the utilisation of live air quality monitors across the world, current and reliable figures have been acquired and compared to identify trends in air pollution levels and any potential disparities based on confounding variables such as wind, climate, location or season. Particulate levels in the air have been analysed from both 2019 and 2020 in order to identify regular air pollution patterns and emphasise any notable changes that have occurred since early this year when the working from home was first encouraged and the closing of the majority of public places was introduced. As a supplementary feature of this project, I have also built an air quality monitor in order to assess particulate levels in my local area, which has therefore enabled me to develop a more personal and extensive comprehension of the topic in question. The project has then been concluded by the composition of a report presenting the research and a poster exhibiting the findings.

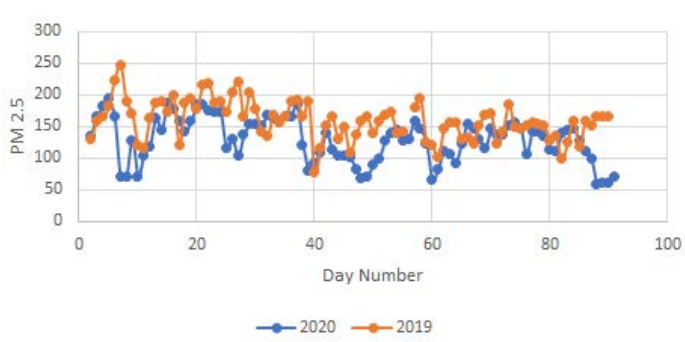
2.1 General effects of lockdown on air quality

The concept of a worldwide lockdown is not synonymous with our typical way of life and is not what the general population is accustomed to, infact, it is likely to have previously been perceived by most people as entirely unfathomable. It is due to this lack of familiarity with the ongoing phenomenon that the topic of the effects of lockdown on our environment has accumulated such high levels of controversy in a relatively short period of time.
With new information and observations surfacing daily, the true effects of the lockdown on our environment are becoming increasingly ambiguous, however, owing to comprehensive statistical analysis, [5] it can be concluded that whilst the PM10 and PM2.5 levels have decreased globally, air quality overall varies subject to factors including location, climate, wind speed/direction etc.

PM 2.5 data from Milan from jan-march 2019-2020.



PM 2.5 data from Wuhan from Jan-March 2019-2020.



We are not yet able to determine the long term effects of the lock down as of this moment in time due to the relatively short lived nature of the current circumstances, however, the short term observable effects can be employed as predictors in forecasting the coming months.
In alignment with the graphs above[6], it can be seen that the period during which lockdown measures were in the process of being enforced, there is a progressive reduction in PM2.5 levels in both Milan - a city located in the italian region of Lombardy - and the epicentre of the pandemic itself, the chinese city of Wuhan. Whilst it is viable that this is a direct result of the reduction in industry and travel, it can also be interpreted from both graphs that particulate levels have expressed a similar pattern throughout the previous year, with levels peaking in early january and depreciating to over half of their concentration by March. This strongly suggests that particulate levels may fluctuate due to seasonal changes.
Venturing further into this proposal, [7]meteorological studies conducted in the middle east monitoring PM10 and PM2.5 concentrations (particularly in schools) expressed an outcome in support of the premise of seasonal variations impacting levels of particulates in the air. Measurements obtained from 12 different locations indicated that PM2.5 levels were found to be three times higher in winter than in spring/autumn which, if generalised to all climates, provides an explanation as to why the data above conveys the presence of PM2.5 in such a way.

2.2 Particulate pollution impact on covid-19

Exposure to coarse and fine PM has frequently been linked to the deterioration of pulmonary and cardiovascular health. [9] Numerous scientific studies have established the role of particulates in a multitude of health conditions such as heart attacks, arrhythmia, asthma, COPD(chronic obstructive pulmonary disease) and increased mortality rates in sufferers of preexisting pulmonary and cardiovascular diseases. In addition to this, particulates have also previously been linked to aiding the airborne spread of numerous different diseases such as bird flu and measles, the most recent of which is covid-19(SARS-COV-2). [10] Preliminary research has been conducted by the italian institute of the University of Bologna to ascertain whether coronavirus particles can in fact be carried across large distances by PM in the air, thus resulting in the widespread contraction of the disease though the ingestion/inhalation of these particulates.
[8] Through the statistical analysis of the number of coronavirus cases alongside the prevalence of particulate matter in the air, a strong correlation has been determined between the geographical distribution of PM10 and the spreading of covid 19 in 110 italian provinces. This was discovered following the findings of the Paules et al study that provided evidence to suggest that the airborne spread of covid 19 is likely to have occurred largely through particulates.
Not only has particulate pollution been linked to the spread of the coronavirus, it has also been regarded as a factor that increases the mortality rates of patients with the disease. Supported by a study administered in Harvard that concluded there to be a significantly higher mortality rate in areas with increased levels of particulate pollution, it has been speculated that the chances of survival from the disease can often be reduced as a result of diminished lung function and the contraction of various other opportunistic diseases such as pneumonia.

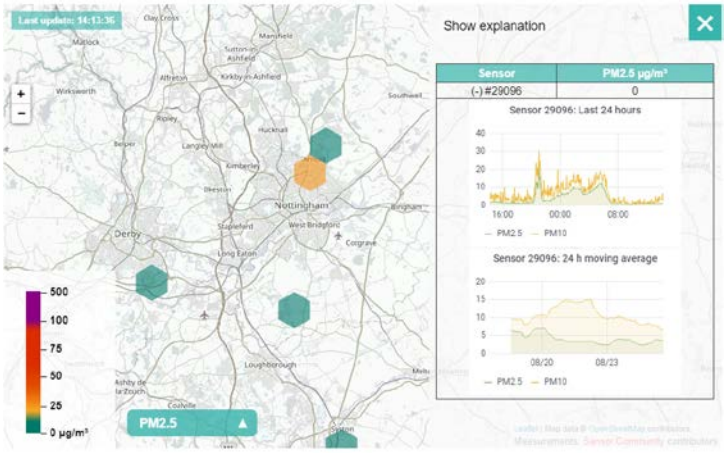
2.3 Measuring particulates

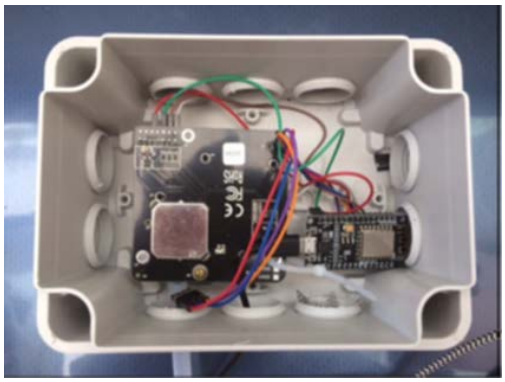
During this research project, the particulate measurements used have been derived from online sources of secondary data made available to the public. This provides current data that we were able to analyse in order to draw relevant conclusions. [11]The most common instrument used worldwide to measure particulates is a TEOM (tapered element oscillating microbalance) analyser. This operates by drawing in ambient air through a filter at a constant flow rate, which is regulated by a tapered tube, and consistently weighing the filter in order to determine the mass concentrations of PM present. Vast volumes of these monitors have been

activated and placed globally, and with free and easy access to them via the internet, the data obtained is available to the general public. This can be employed as a major asset in spreading awareness of the importance of reducing particulate pollution by providing real-time measurements that can be compared to other areas and identifying when actions to reduce particulate emissions are imperative.

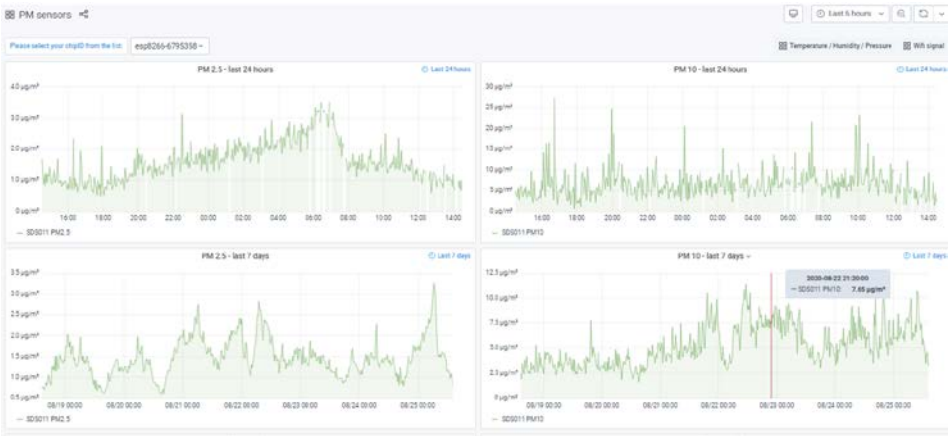
2.4 Building a sensor

As an accessory to this project, I have assembled an air quality monitor from its components (provided by the Luftdaten project) using an instruction leaflet to guide me. In doing this, I feel that I have developed a more extensive understanding of the functionality of the monitors whilst also contributing to spreading awareness on the topic. I have arranged for the monitor to be fitted in a local primary school where the students and teachers will be given a presentation on the monitor itself as well as the particulates it measures in order to express how detrimental it is to reduce the emissions of these particulates. Once fitted into its correct location, the sensor can be registered onto the Luftdaten website with a location so that it can display continuous monitoring on the luftdaten map showing all the sensors across the world. It will appear on the map as shown below where the data it records can be accessed and observed, this can then be utilised to track particulate levels over a long period of time and eventually determine potential trends or the general behaviour of the levels of PM10 and PM2.5 in the surrounding area.





When the sensor is connected to the WiFi the data can be checked on the website https://api-rrd.madavi.de/grafana/d/GUaL5aZMz/pm-sensors?orgId=1&theme=light&var-chipID= using the unique chip number. The sensor records PM2.5, PM10, temperature and humidity. The output from a typical sensor is shown here.



3 RESULTS AND CONCLUSIONS

The aim of this project was to research the impact of the coronavirus lockdown on air quality and whether increased particulate pollution led to an increase in the covid 19 death rates. Whilst the research has been conducted through the employment of the abundant amount of relevant materials accessible to us, the results have ultimately remained inconclusive. Due to the correlational nature of majority of the conclusions drawn, it is difficult to establish a single, congealed verdict regarding this research question, it has in fact brought many other questions to the surface, such as the effects of wind speed/direction on PM, that require further research to reach a viable conclusion.

Throughout this study, based on the secondary data analysed, we have been able to identify a link between increased covid 19 mortality rates and the geographical distribution of particulate matter, however, there are a range of varying factors to consider and this cannot be confirmed as fact. An overall increase in air quality has also been acknowledged in many locations, however, further exploration is also required, with the allowance for a sufficient period of time to have passed, in order to confirm whether the observable changes are due to the decrease in vehicle and industrial emissions throughout the lockdown phase or the effects of seasonal variation.

4 EVALUATION

Although all feasible attempts have been made to maintain validity and reliability in the results of this research study, there have been certain limitations. Consisting purely of the web analysis of existing information, this research project can be regarded as limited due to the lack of primary data obtained. As a consequence of the remote nature and time frame of its conduction and completion, gathering primary data or further researching the confounding variables identified during the process has not been possible therefore hindering the progression of this research to an extent. The relatively short lived nature of the topic of this research (the coronavirus lockdown) has also presented as a limitation of the project. A combination of the unfamiliarity with the current means of life and the vast quantities of new information surfacing daily can potentially give rise to a lack of temporal validity in our findings. Another factor that could be improved upon to increase reliability of the results is aiming to increase sample sizes. While there have been multiple locations studied and included in the report, drawing from a larger sample of varying regions with contrasting climates may assist in providing more clarity in the conclusions.

5 APPENDIX

Detailed below is the instruction guide used to help build the air quality monitor.
[12]https://drive.google.com/open?id=1NuF82S_-lvWhbmwfRaBRpyScPcbOD4ar&authuser=1

6 REFERENCES

{1} introduction

[1] https://uk-air.defra.gov.uk/assets/documents/reports/aqeg/pm-summary.pdf

[2]https://arxiv.org/pdf/2007.00755.pdf

[3]https://www.bmj.com/content/368/bmj.m1103/rr

]Is there a Plausible Role for Particulate Matter in the spreading of COVID-19 in Northern Italy?

{2} Methodology

[5]https://www.frontiersin.org/research-topics/14268/cities-in-lockdown-implications-of-covid-19-for-air-quality-and-urban-environmental-health

[6]https://aqicn.org/data-platform/covid19/

[7]https://www.sciencedirect.com/science/article/abs/pii/S1352231013005980

[8]https://www.bmj.com/content/368/bmj.m1103/rr

[9]https://www.epa.gov/pm-pollution/health-and-environmental-effects-particulate-matter-pm#:~:text=Health%20Effects&text=Exposure%20to%20such%20particles%20can,a%20variety%20of%20problems%2C%20including%3A&text=decreased%20lung%20function,airways%2C%20coughing%20or%20difficulty%20breathing.

[10]https://www.theguardian.com/environment/2020/apr/24/coronavirus-detected-particles-air-pollution

[11]https://www.thermofisher.com/uk/en/home/industrial/environmental/environmental-learning-center/air-quality-analysis-information/teom-technology-particulate-matter-measurement.html

{3} Results and Discussions

{4} Evaluation

{5} Appendix

[12]https://drive.google.com/open?id=1NuF82S_-lvWhbmwfRaBRpyScPcbOD4ar&authuser=1

7 ACKNOWLEDGEMENTS

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