Air Quality
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Covid-19, Air Quality and Mobility Policies:
Potential Rebound Effects

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Experts in air quality
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Report Prepared By:	Tim Williamson & Dr Ben Marner

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Air Quality Consultants Ltd
23 Coldharbour Road, Bristol BS6 7JT Tel: 0117 974 1086
119 Marylebone Road, London NW1 5PU Tel: 020 3873 4780
aqc@aqconsultants.co.uk

Registered Office: 23 Coldharbour Road, Bristol BS6 7JT
Companies House Registration No: 2814570

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1 Introduction

Purpose and aims of the study

1.1 Poor air quality remains one of the leading, current risks to human health and the environment in Europe. While great strides have been made in reducing air pollution, with some pollutants reduced to barely measurable levels, there remain significant challenges and, with them, significant health impacts for the European population.

1.2 Interventions to control the Covid-19 pandemic have massively disrupted social and economic activity across Europe and have drastically reduced road traffic volumes. This is likely to have reduced emissions of traffic-related air pollution, as illustrated in the EEA's Covid-19 impacts tracker[1] and numerous independent studies[2]. There has been widespread media coverage, both of the air quality improvements caused by the pandemic, and also of potential relationships between exposure to air pollution and the severity of health responses to the virus[3]. The benefits of cleaner urban air have received renewed public interest and there is, therefore, an opportunity to examine in greater detail, the interrelationships between mobility policies, air quality, and health.

1.3 As countries and cities emerge from the more stringent stages of their 'lockdowns', there is an opportunity to reimagine urban transport. This is partly in response to the potential for transmission of the virus within enclosed public transport spaces, but also capitalises on the renewed public and political interest in improved air quality, climate, and health. As economic and social activity increases post-Covid-19 pandemic, there is a danger that the public avoids public transport in favour of private cars (which is currently being promulgated by some governments), and that pressure to relax, or at least delay the introduction of, "restrictions", such as Low Emission Zones, increases. Likewise, there is a unique opportunity to demonstrate the impact that action on polluting forms of transport can have, and the health benefits that such action brings, in order to stimulate a demand that such outcomes can be achieved and maintained through more radical transport and mobility policies. A separate upcoming study, *Covid-19, Air Quality and Mobility Policies: Seven European Cities* has been undertaken to support the latter and help inform long-term solutions in the context of a more virus-conscious world.

1.4 This report builds on the analysis undertaken for *Covid-19, Air Quality and Mobility Policies: Seven European Cities* to analyse the impact on emissions of NOx and $PM_{2.5}$ which would result if traffic levels increase following lockdown. This could be as a result of lifting lockdown restrictions such that

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1 https://www.eea.europa.eu/themes/air/air-quality-and-covid19/monitoring-covid-19-impacts-on

2 Including AQC's own: https://www.aqconsultants.co.uk/CMSPages/GetFile.aspx?guid=1222ff30-3c9f-4189-b353-2f2ee50edab1

3 For example: https://www.bbc.co.uk/news/health-52351290

the people return to their pre-lockdown travel, but avoid the use of public transport. There is some evidence that this is, indeed, happening in some areas[4].

1.5 The seven cities analysed are the same as in *Covid-19, Air Quality and Mobility Policies: Seven European Cities*, i.e. Berlin, Brussels, Budapest, London, Madrid, Milan and Paris, and the same datasets are used. Details of the methodology for the analysis are set out in that report. However, in this study, the scenarios investigated are based on an increase in car vehicle-kilometres of **10%, 25% and 50%** over pre-lockdown levels, with other vehicle classes remaining at pre-lockdown levels.

[4] https://europe.edf.org/news/2020/15/09/traffic-congestion-increasing-london-above-2019-levels-outside-city-centre

2 Analysis methodology

2.1 This section summarises the methodology used in this study; a more detailed description is set out in *Covid-19, Air Quality and Mobility Policies: Seven European Cities*. The methodology consists of 3 stages, described below.

2.2 **Stage 1: Data collection**. Air quality monitoring and traffic data were collected for each of the cities. There was a strong preference for local traffic data and requests were made of the city authorities. However, within the time constraints of the project, local data were only available for Berlin and London. For the other cities, data were obtained from Emisia, under their COPERT programme. This was specific for each of the cities but derived from national datasets and undifferentiated between, for example, central and outer city areas.

2.3 **Stage 2: attribution of emissions to vehicle classes**. Using available traffic data (local data for Berlin and London, COPERT data for the remaining cities) and standard emission factors (from Berlin and London emission inventories, or COPERT factors where local data were not available), the calculated traffic contribution was assigned to different vehicle types and classes: petrol/diesel, cars, LGVs, HGVs, buses and other (including motorcyles).

2.4 **Stage 3: scenario analysis**. Varying the proportion of traffic or individual vehicle classes to show the impact of mobility scenarios. This stage also allows the calculation of changes to $PM_{2.5}$ emissions, using standard emission factors. For the purposes of this study, the proportions of passenger cars were increased above pre-lockdown levels to simulate the effect of people returning to pre-lockdown travel patterns, but avoiding public transport.

3 Scenario Analysis Outputs

3.1 Increasing passenger car journeys above typical pre-lockdown levels will clearly have a significant adverse impact on air quality. Table 1 and Figure 1 andFigure 2 show the impact on traffic emissions of NOx and $PM_{2.5}$, associated with increases of 10, 25 and 50% in passenger car kilometres. As a broad indicator, road traffic currently makes up around 50% of total NOx emissions for most European cities, although this varies by location and country.

Table 1: Increase in traffic emissions of NOx and $PM_{2.5}$ associated with different levels of traffic increase compared to pre-lockdown levels

	% increase in car vehicle-km	% Increase in transport emissions						
		Berlin	Brussels	Budapest	London	Madrid	Milan	Paris
Increases in traffic NOx	10%	5%	5%	3%	5%	5%	4%	5%
	25%	13%	12%	8%	13%	14%	11%	12%
	50%	27%	24%	17%	26%	27%	21%	24%
increases in traffic $PM_{2.5}$	10%	6%	6%	4%	6%	7%	5%	6%
	25%	16%	15%	11%	16%	16%	13%	15%
	50%	32%	31%	21%	31%	33%	26%	30%

Figure 1: Increase in traffic emissions of NOx associated with different levels of traffic increase compared to pre-lockdown levels

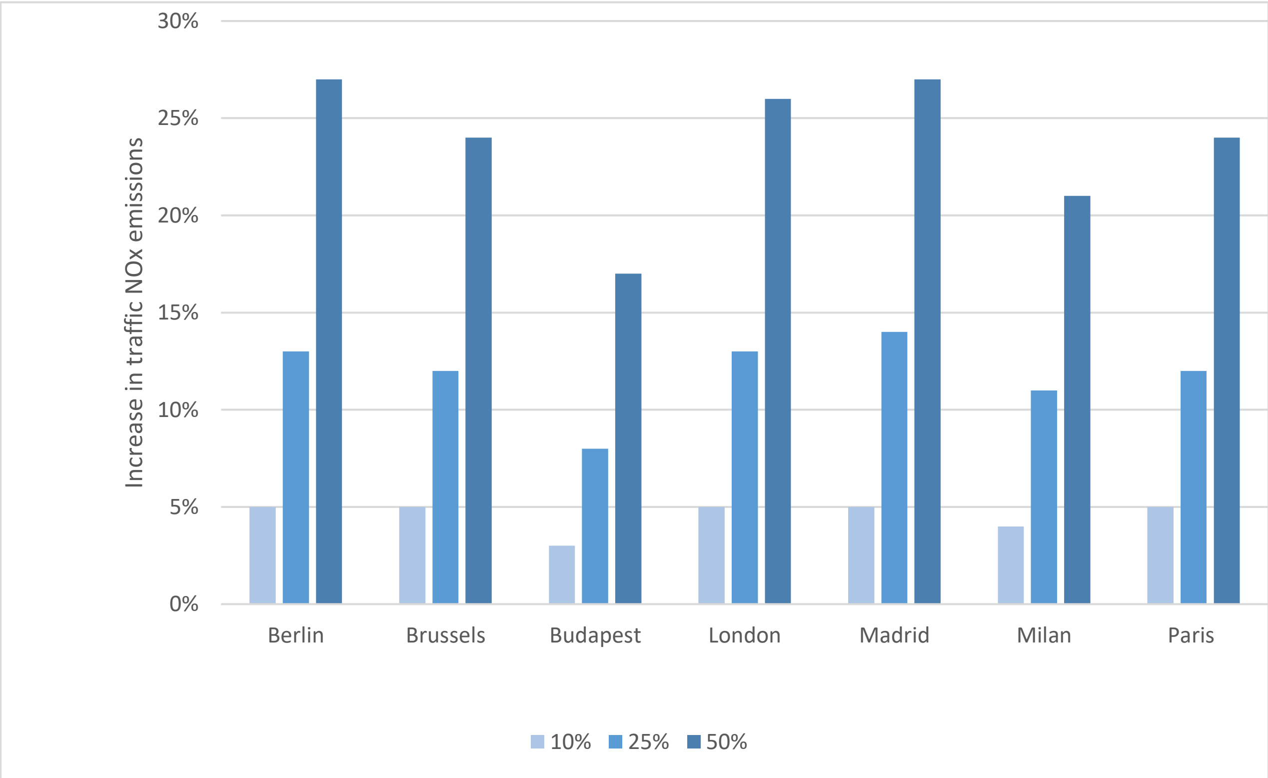
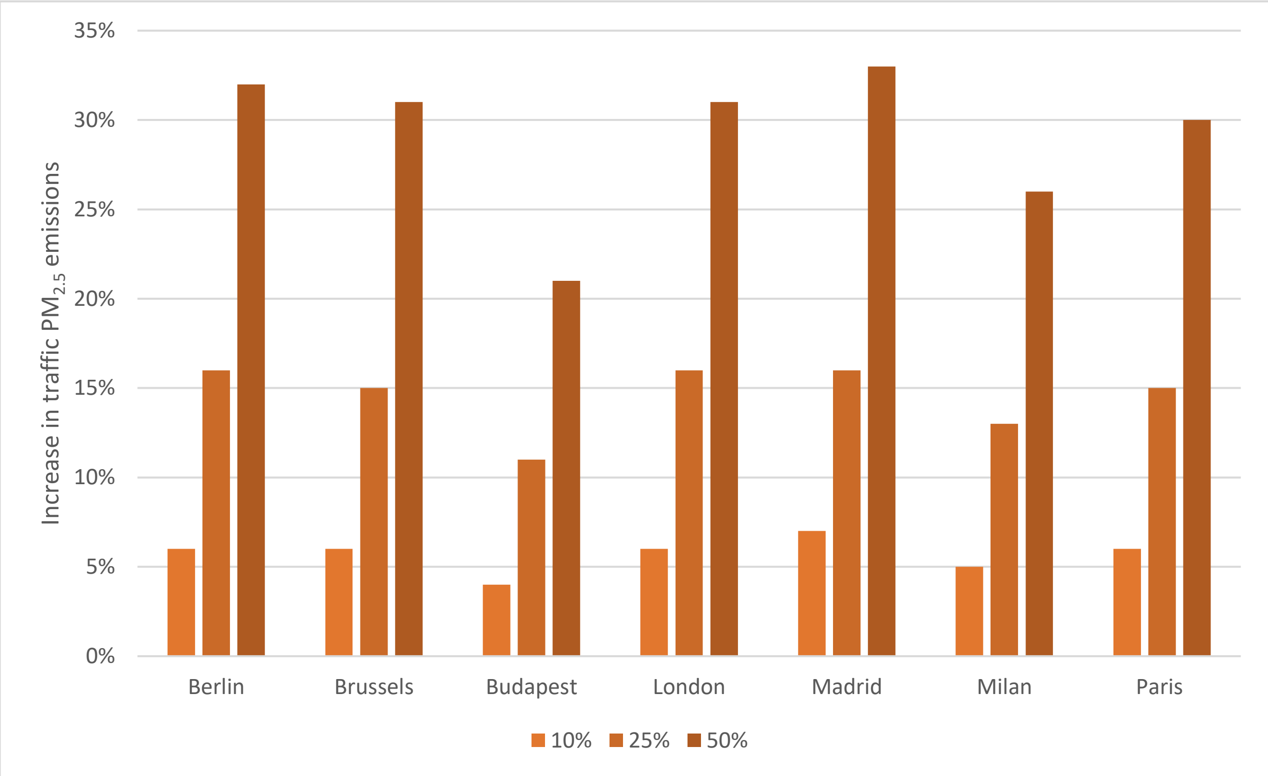


Figure 2: Increase in traffic emissions of $PM_{2.5}$ associated with different levels of traffic increase compared to pre-lockdown levels



4 Key Messages

4.1 As lockdown policies ease and people are encouraged to return to pre-lockdown activities, there is a risk of a resultant increase in road traffic associated with a perceived risk in using public transport. There is some evidence that this is happening in some areas, and that the issue is recognised by public authorities. For example, London's congestion charge was reinstated in May (having been suspended in March) and the charge increased in June. However, a report from the Environmental Defence Fund[5] indicates that traffic levels in outer London areas had risen above what was typical pre-lockdown.

4.2 The analysis in this report has shown that such "rebound" effects can have significant impacts on the emissions of key air pollutants and thus on air quality. It is unlikely that these impacts will be spread evenly across cities, with the potential to exacerbate inequalities in air pollution exposure for those in more deprived communities. Significant increases in emissions of either NOx – with exceedances on the NO_2 Limit Values still commonplace in major European cities – or $PM_{2.5}$, where pressure is increasing to adopt more stringent limits to protect public health, should be of major concern to both city authorities and national governments. Therefore, action will be needed to balance the protection of public transport users from Covid-19 and the protection of the wider population from the health effects of air pollution.

[5] https://europe.edf.org/news/2020/15/09/traffic-congestion-increasing-london-above-2019-levels-outside-city-centre

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5.1 The authors of this report would like to thank and acknowledge the following people (and their colleagues) for their assistance in the identification and supply of data:

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Sergio Fernández Balaguer	EMT Madrid
Silvia Monori	Mobility Environment and Territory Agency, Milan
Karine Léger	Airparif, Paris

6 Glossary

AQC	Air Quality Consultants
BRT	Boosted Regression Tree
EU	European Union
EV	Electric Vehicle; for the purposes of this study, this can also include hybrid vehicles operating in fully electric mode
HDV	Heavy Duty Vehicles (> 3.5 tonnes)
HGV	Heavy Goods Vehicle
ICE	Internal Combustion Engine
LDV	Light Duty Vehicles (<3.5 tonnes)
LGV	Light Goods Vehicle
$\mu g/m^3$	Microgrammes per cubic metre
NO	Nitric oxide
NO_2	Nitrogen dioxide
NOx	Nitrogen oxides (taken to be NO_2 + NO)
NRMM	Non-road Mobile Machinery
PM_{10}	Small airborne particles, more specifically particulate matter less than 10 micrometres in aerodynamic diameter
$PM_{2.5}$	Small airborne particles less than 2.5 micrometres in aerodynamic diameter
WHO	World Health Organisation

7 Appendices

A1 Uncertainty and Limitations

A1.1 This study has used the best available information to provide an analysis of the impact on emissions of NOx and PM2.5 which would result if traffic levels increase following lockdown. The analysis is intentionally high-level and thus, while the results can be considered as reasonable best-estimates, they should not be viewed as definitive or precise. The principal sources of uncertainty are outlined below.

Analyses of Ambient Measurements

Measurements

A1.2 The results of the study are underpinned by the ambient concentration measurements made in each of the seven cities. These measurements will be subject to a degree of uncertainty. More importantly, they represent individual sites which are each subject to location-specific influences. The results from these monitoring sites have been used to define changes to air quality across each city as a whole. These city-wide or zone-specific averages will be affected by the distribution of the monitoring sites from which they are derived; meaning that if additional monitoring sites were available for a city, then the overall averages would change. In the case of those cities with fewer monitoring sites, particularly where these show quite different results from each another (as is the case in Budapest), then the calculated city-wide averages are less certain.

Emissions Calculations

Activity Data

A1.3 For Berlin and London, it has been possible to use traffic volumes and fleet compositions, as well as either average link speed, or service categories, taken from the official emissions inventory of the city. These data are considered to be robust but will still be subject to some uncertainty; particularly since, in each case, the data are predictions of activity levels in 2020 (without Covid-19 lockdowns) which were extrapolated from counts and predictions made in earlier years.

A1.4 For the other five cities, it has been necessary to rely on national-level fleet and speed data (for urban settings) held by Emisia. These data are primarily intended for national-level reporting (for example, to the European Commission). While still providing a robust basis for high-level emissions calculations, these activity data are less precise than those available in Berlin and London.

Emissions Factors

A1.5 The emissions factors used for Berlin are derived from HBEFA, while for all other cities the COPERT emissions factors have been used[6]. The different approaches have made the best use of the available information for each city. All road transport emissions factors are subject to uncertainty and, while both COPERT and HBEFA are ultimately derived from the same European Research for Mobile Emission Sources (ERMES) emissions database, each treats the data in different ways and is subject to different uncertainties. Overall, both emissions models provide equally valid results which can be considered as fit for purpose in terms of this study.

Congestion Effects

A1.6 It has been assumed that there is a linear relationship between the total vehicle-kilometres for a particular vehicle type on a given road and the NOx emissions from that vehicle type on that road. In practice, this relationship will be non-linear because altering the total flow of vehicles will affect driving characteristics. Put simply, increasing traffic will often increase congestion and increase emissions from all remaining vehicles. It has not been possible to take account of this effect in the study.

Secondary $PM_{2.5}$

A1.7 The calculations of $PM_{2.5}$ emissions have focused solely on primary particles. The managed transport interventions explored would all affect emissions of NOx and also ammonia from road traffic. This has the potential to reduce the formation of secondary $PM_{2.5}$, but it has not been possible to include this additional benefit within the calculations, and the effects to $PM_{2.5}$ of the different scenarios will have been under-predicted.

Overall Uncertainty

A1.8 It is not possible to quantify the overall uncertainty which is inherent in the results of this study. However, the data sources and assumptions made are fit for the purpose of providing high-level indications of how the air quality improvements experienced during the Covid-19 lockdowns might be affected by changes in transportation policies and behaviours.

[6] For London, COPERT was used by application of the UK EFT, which embeds COPERT emissions factors with London-specific fleet compositions.

A2 Professional Experience

Stephen Moorcroft, BSc (Hons) MSc DIC CEnv MIEnvSc MIAQM

Mr Moorcroft is a Director of Air Quality Consultants, and has worked for the company since 2004. He has over 35 years' postgraduate experience in environmental sciences. Prior to joining Air Quality Consultants, he was the Managing Director of Casella Stanger, with responsibility for a business employing over 100 staff and a turnover of £12 million. He also acted as the Business Director for Air Quality services, with direct responsibility for a number of major Government projects. He has considerable project management experience associated with Environmental Assessments in relation to a variety of development projects, including power stations, incinerators, road developments and airports, with particular experience related to air quality assessment, monitoring and analysis. He has contributed to the development of air quality management in the UK, and has been closely involved with the LAQM process since its inception. He has given expert evidence to numerous public inquiries, and is frequently invited to present to conferences and seminars. He is a Member of the Institute of Air Quality Management.

Dr Ben Marner, BSc (Hons) PhD CSci MIEnvSc MIAQM

Dr Marner is a Technical Director with AQC and has over 20 years' experience in the field of air quality. He has been responsible for air quality and greenhouse gas assessments of road schemes, rail schemes, airports, power stations, waste incinerators, commercial developments and residential developments in the UK and abroad. He has been an expert witness at several public inquiries, where he has presented evidence on health-related air quality impacts, the impacts of air quality on sensitive ecosystems, and greenhouse gas impacts. He has extensive experience of using detailed dispersion models, as well as contributing to the development of modelling best practices. Dr Marner has arranged and overseen air quality monitoring surveys, as well as contributing to Defra guidance on harmonising monitoring methods. He has been responsible for air quality review and assessments on behalf of numerous local authorities. He has also developed methods to predict nitrogen deposition fluxes on behalf of the Environment Agency, provided support and advice to the UK Government's air quality review and assessment helpdesk, Transport Scotland, Transport for London, and numerous local authorities. He is a Member of the Institute of Air Quality Management and a Chartered Scientist. Dr Marner is a member of Defra's Network of Evidence Experts and is a member of Defra's Air Quality Expert Group.

Tim Williamson, BSc (Hons) MSc MIEnvSci MIAQM

Mr Williamson has 25 years' experience in environmental policy support, development and analysis, mainly in air quality but also covering climate change and resource efficiency. He has broad experience of the field, having held positions in the public and private sectors, and for an environmental NGO, Environmental Protection UK. Tim has worked at the national level, leading multi-disciplinary evidence teams on air quality and, latterly, resource efficiency in Defra for 11 years. He has also worked both for and with local authorities, covering Local Air Quality Management and carbon reduction programmes. Tim has a strong track record in international work, having been involved in EU policy development and on projects supporting both the European Commission and European Environment Agency, and Governments in several parts of the world. He is a Member of the Institute of Air Quality Management and is a Chartered Scientist.

Ricky Gellatly, BSc (Hons) CSci MIEnvSc MIAQM

Mr Gellatly is a Principal Consultant with AQC with over eight years' relevant experience. He has undertaken air quality assessments for a wide range of projects, assessing many different pollution sources using both qualitative and quantitative methodologies, with most assessments having included dispersion modelling (using a variety of models). He has assessed road schemes, airports, energy from waste facilities, anaerobic digesters, poultry farms, urban extensions, rail freight interchanges, energy centres, waste handling sites, sewage works and shopping and sports centres, amongst others. He also has experience in ambient air quality monitoring, the analysis and interpretation of air quality monitoring data, the monitoring and assessment of nuisance odours and the monitoring and assessment of construction dust. He is a Member of the Institute of Air Quality Management and is a Chartered Scientist.

George Chousos, BSc MSc AMIEnvSc AMIAQM

Mr Chousos is an Assistant Consultant with AQC, having joined in May 2019. Prior to joining AQC, he completed an MSc in Air Pollution Management and Control at the University of Birmingham, specialising in air pollution control technologies and management, and data processing using R. He also holds a degree in Environmental Geoscience from the University of Cardiff, where he undertook a year in industry working in the field of photo-catalytic technology. He is now gaining experience in the field of air quality monitoring and assessment.

Tomas Liška, BSc

Mr Liška is an Assistant Consultant with AQC, having joined in September 2020. He holds a BSc in Meteorology and Climate Science from the University of Leeds and is currently finishing his PhD at the University of Edinburgh where he has been investigating population exposure to air pollution and its inequality in the UK. Tomas has a keen interest in modelling and data science. He is now gaining experience in the field of air quality monitoring and assessment.