Advisory group meeting 1

24 July 2024

1pm – 5pm

Advisory group member attendees:

Gary Fuller (Chair) – Imperial College London, UK (GF)

Elizabeth Fu – AirParif, France (EF)

David Carslaw – University of York, UK (DC)

Ludo Vandenthoren – Mutualités Libres, Belgium (LV)

Martin Lutz – Formerly head of air quality management at Berlin City Government, Berlin (ML)

Anna Font – IMT Nord Europe, France (AF)

Transport for London (TfL)

Greater London Authority (GLA)

Actions:

DC: Provide briefing note with further information on Defra/national data available

DC: Provide information/ reports on an alternative for LOESS smoothing

AF: Send over advice on statistical techniques

DC: Information/reports on advanced “leave-out cross-validation” methods

LV: Link to report/ slides for the health impacts study in Belgium

EF: Provide Paris LEZ assessment methodology links

GLA: Send the published London-wide ULEZ Six Month Report

ALL: Send any relevant reports/research links

Notes:

Introductions

- Introductions from all members, including brief summary of their experience of air pollution and low emission zone assessments.

Terms of Reference

- Discussion about purpose of the advisory group.
- Opportunity for questions on the terms of reference.
- Confirmation that all members of the group agree with the terms of reference.

Overview

- Overview of GLA and TfL people and processes.
- Overview of ULEZ policy – what it is, phased expansions, reporting schedules.
- Overview of past methodology (Inner London) and current methodology (Outer London expansion).

Method Discussion – selection of ULEZ border area

- Consider that current method may be understating the impact of the scheme.
- Discussed reasoning for 40 km zone as a control / counterfactual to the ULEZ intervention area (avoiding coastal areas/thinking about weather etc, no Clean Air Zones (CAZ) in this area).

Method Discussion – nation-wide data for other cities

- Group wondered if ANPR data is available from other cities.
- ULEZ cameras give more accurate picture for London than the data from Defra/estimated fleets.

Method Discussion –fleet composition

- Historical fleet data is available over multiple years from the ULEZ monitoring system. Method uses evidence from central and inner London and includes natural churn when estimating the “No-ULEZ scenario” for emissions.

- Discussion of cross-border effect of fleet turnover due to the ULEZ (i.e. vehicles registered outside London driving into London) however only ULEZ camera network is used in analysis.

Method Discussion – NO_x concentrations

- Discussion of benefits of considering NO_x concentrations and linking these with emissions. I.e. how have emissions changed and how has measured NO_x changed?
- Agreement this would be useful although public understanding of NO_x less clear whilst focus for NO_2 is important in relation heath impacts.
- Discussed that providing NO_x concentrations would support the methodology/process and provide internal sensitivity checks for method, although less useful for reporting.
- Potential to use emissions impacts and infer attribution to concentration impacts.

Method Discussion – Isolating the ULEZ impacts

- Agreement that having control sites is a major benefit to the method. Isolating the ULEZ is good, but general agreement that presenting overall changes/trends in concentrations is more straightforward and simpler statistical analysis.
- Noted that general trends already included but that these do not represent an impact and the report should continue to make this clear.
- Discussion of the road increment calculation - the TfL methodology of using “outside background” rather than “inside London” background is a good idea.
- Discuss about potential use of modelled concentration data similar to LAEI could be useful to use to help assess success?
- Discussion that air pollution measurement data is more understandable and accepted when communicating with the public. LAEI inventory has regular update cycle with next one for baseline of 2022 due soon.
- Counterfactual method discussed with reference to detailed method available in the ULEZ six month report.

Method discussion – trend analysis

- Discussed it could be useful to consider additional advanced method called seasonal trend decomposition using LOESS in order to help deal with seasonal cycles and sensitivity to LOESS span parameter.

- Also discussed using moving average rather than LOESS which may be more understandable to general public. However sensitive to end dates of analysis and better for assessment undertaken when a longer time series is available.

- Discussion that the starting point of impacts could be defined statistically with a change - detection - point algorithm. Consider the Buishand Range Test for change-point detection is available.

- All recognised covid represents a major disrupter and make it difficult to identify a statistical starting point. Up until now, have used Mayoral announcement of scheme as starting point due to impact on pre-compliance/behaviour change.

Method discussion – local assessments

TFL asked the group for advice on how to conduct a more local impact analysis, e.g. borough-level, or if not feasible then could we use background to show the impacts for the wider population.

- Agreed that analysis of impacts at specific hotspots would be valuable but it would be difficult to do a “No-ULEZ” scenario here. Maybe additional benefit of summarising the individual site changes in concentrations though not necessarily an impact.

- Discussion of the London network of continuous monitoring sites. Other CAZs rely on diffusion tubes, which are much less accurate/granular. Option to use advanced method called “leave-out cross-validation”, which gives a level of strength of analysis.

- For control sites- consider using the median to protect from sensitivity of outliers in data?

- TfL asked if still appropriate to use aggregated “No ULEZ” scenario to compare with individual sites. It was agreed that given the number of sites it is still suitable but could underestimate the impacts of ULEZ and some sensitivity to local conditions represented in monitoring data.

Method discussion – de-weathering approaches

There a general discussion about the de-weathering approaches, and would this be suitable or a valuable addition to the ULEZ analysis?

- It was agreed that the current method, i.e. looking at the sites around London as the control / counterfactual, is a more robust and suitable approach given the detailed datasets available. De-weathering approaches are useful in other settings but, for the key ULEZ analysis the current TfL method is better.

Summary of how Paris LEZ was assessed

- EF explained how the Paris LEZ was assessed.
- LEZ began with Paris as first phase, then expanded to the Greater Paris metropolis. The impacts evaluation considers the Greater Paris metropolis with no distinction between phasing.
- First step- estimates in pollutant trends. Based on the "Tale of Two Cities approach" (Font et al. 2019). Trends estimates were based on hourly concentrations for urban background and roadside to give estimates of how pollutant trends varied for different periods of the LEZ implementation.
- To assess singular impact for LEZ, (Berlin evaluation method) looked at differences in fleet composition and did not use concentrations directly. Impact of Paris/Berlin LEZ was based on the difference in fleet composition and use calculated emissions calculated using simple model, then for each pollutant do the ratio of emissions between scenarios. Ratio (%) could potentially also be applied to pollutant trend.

Contextualising AQ impacts to population exposure.

- Discussed Belgian analysis - applies to annual average population information so it is difficult to do comparison.
- Discussed potential to look at who lives along 30 m /roadside locations of major roads and apply a specific roadside location to an area.
- TFL - we could look at population and possibly deprivation/BAME to describe number of people in these groups with benefits based on impacts at roadside using the method in the report.
- Would be useful if we see if this can help demonstrate benefits in hotspots.

- Belgium: study showing that people with lower socio-economic background live in more polluted areas.

Wrap-up and Summary of Actions – GLA

- Actions will be summarised and sent via email.
- Notes of meeting will be written up and circulated.
- Next meeting will be set up later in the year when TfL analysis is underway.

Advisory group meeting 2

20 November 2024

9:30am – 1:00pm

Advisory group member attendees:

Gary Fuller (Chair) – Imperial College London, UK (GF)

Elizabeth Fu – AirParif, France (EF)

Ludo Vandenthoren – Mutualités Libres, Belgium (LV)

Martin Lutz – Formerly head of air quality management at Berlin City Government, Berlin (ML)

Anna Font – IMT Nord Europe, France (AF)

Transport for London (TfL)

Greater London Authority (GLA)

Apologies:

David Carslaw – University of York, UK (DC)

Actions:

ML: send graph of trends of NO_2 and NO to show the impacts of different EURO classes.

TfL: Try plotting a ratio of NO_x and NO_2, or on road increment ratio.

TfL: Plot the median rather than the mean as a separate test for monitoring trends, it could lessen the impact of outliers.

TfL: Compare the STL and LOESS trendlines: plot both time series for the two lines and plot an xy correlation to allow comparison.

AF: Send over further advice on the STL methodology and confirm what the recommended period and frequency should be.

GF: Send any papers that use the leave-out-cross-validation and have narrative around how to explain the method.

EF: Check internally if anyone has experience using the “leave out cross validation” method, and check internally about localised sites.

ML: Send link to paper showing how LEZ can impact how people feel about quality of life.

Notes:

Minutes from previous session

- All members happy that the minutes accurately captured the feedback from the previous session

Terms of Reference

- Confirmation that there are no changes to the Terms of Reference and all members of the group continue to agree.
- Opportunity for questions on the terms of reference.

Overview of progress on analysis

- TfL – based on feedback from the last session, in general we have kept the core methodology and have applied additional recommended analysis in order to add confidence and increase robustness.
- TfL presented early results of the air quality impacts analysis to the group.

Method Discussion – emission factors:

- Emission factors using 5.6 COPERT rather than 5.8 due to time constraints and continuity with previous work.
    - Agreement from attendees that this approach is acceptable given the parameters within which we are working.

Method Discussion – traffic data:

- Traffic flow data is available for 2024 but without vehicle splits. Next publication from DfT is due June 2025 so TfL are using camera detection data from 2023 and 2024 alongside previous DfT traffic data to obtain proportions for 2024.
    - Agreement from attendees that as the proportion of vehicles remains stable across years, TfL should be confident in applying 2023 proportions to 2024 traffic flow data which will feed into the emissions calculations

Method Discussion – site selection:

There is a general fluctuation in sites opening/closing at all times across London. TfL have six months more data therefore have additional sites to include in the analysis.

- Central London in 2024 quite a few long term sites had closed, therefore only two sites were available to estimate averages over the past 6 months. This was not considered representative of the whole area, particularly as one of these sites was heavily affected by route diversion, increasing traffic and therefore NO_x and NO_2 measurements during the last 3 months. TfL considered adding in sites that opened in the last three years to improve the reliability of the results.

    - General agreement that it is important to be adaptive to sites changing, particularly as the window of analysis changes with each report. Changing the criteria to increase the number of sites so that it remains representative is recommended

    - If changing the rule for site inclusion, it is important to apply this to the rest of the analysis as well, so this additional criterion will be applied across all areas including outside London.

    - Discussion around if these additional sites had been included earlier, whether this could have had an impact on the rest of the analysis. Therefore recommendation for TfL to look at the trend-line and potentially look at comparing with modelled data at these locations to ascertain whether the additional sites are in line with previous trends.

    - Proposal to consider adding another axis on the trend graphs (Fig 6 in Six Month Report) to show the number of sites taken into account for each monthly average. As this would make the graph harder to read, option to add a separate graph in appendix showing how the number of sites fluctuates over time (rather than total number which is in the report already).

    - Could try plotting the median rather than the mean, as it could lessen the impact of major outliers. This was not recommended for the final report but rather a standalone test.

    - Berlin analysis applied corrections of measurement data based on traffic changes (e.g. if there was a reduction of traffic by 5-10%, raised concentration data as a correction). Agreement that this would not help with understandability and transparency of the data.

Method Discussion – NO_x

TfL – based on the previous discussion TfL analysed NOx concentrations (in addition to NO_2) as a separate test, as NO_x is likely to provide a clearer signal in relation to changes to road traffic contribution. TfL showed current results.

- Discussed how there is an opportunity to unify the narratives and quantification between the emissions inventory calculations and the measured concentrations.

- TfL have monthly traffic estimates and monthly fleet composition so can compare changes in emissions estimates to the NO_x road contribution estimates.

- Agreement that the trend in NO_x deviation reflects separate analysis undertaken by ML, demonstrating the impact of different EURO classes over the years.

    - TfL could try plotting a ratio of NO_x and NO_2, or on road increment ratio.

<u>Method Discussion – Contextualising AQ impacts to population exposure.</u>

As per first session, TfL have been doing additional analysis to contextualise air quality impacts to population exposure. TfL presented the progress and results so far. TfL are aiming to overlay population, deprivation and BAME to describe number of people in these groups with benefits based on impacts at roadside using the impacts reported in the report. TfL are cutting a buffer zone around the TLRN road network and investigating if it possible to apply the impact to these zones. TfL posed the question- is applying an average impact to a very specific local location accurate?

- A similar method of applying population information was also used when assessing the Paris LEZ

- TfL also proposed that one method could be to apply modelled 2019 LAEI concentration in the area and potentially project this using the impacts from the report.

- General agreement that population exposure analysis an understandable metric for communicating the effectiveness of the scheme.

<u>Method Discussion – Statistical start date of the “No ULEZ / No Londonwide-ULEZ" estimated trendlines</u>

As per first session, TfL have been doing additional analysis to provide confidence in the choice of start dates for analysis of impacts. TfL presented the progress and results so far using the Pettitt test, a change-point detection method, to detect a point in a time series where a shift can be identified (which could be attributed to the point in time when the ULEZ started to impact the air quality monitoring data).

- As discussed in the first session, Covid is a disrupter in the time period (as the hypothesis of the method is that there is only one change point) and the Pettitt

test is only valuable to detect the influence of a single event, to provide confidence for the first start date (ULEZ in central London), TfL removed data after February 2020.

    - This approach was deemed appropriate by the group

- The tests were run using NO_x rather than NO_2, as this is less influenced by other uncontrollable factors (e.g. atmospheric chemistry)

    - This approach was deemed appropriate by the group

- Discussed that the method does not account for seasonality and cyclic variation – but the Seasonal and Trend decomposition using Loess (STL) method does.

- Agreement across the group that results are very consistent with the assumption dates previously applied in the Six Month Report. Therefore there would be no need to change the start date previously used in the 6-month report, as the test is sufficiently robust, and supports TfL's original assumption.

<u>Method Discussion – Seasonal trends</u>

As per first session, TfL have been doing additional analysis using the STL method. TfL presented the progress and results so far.

- TfL – De-seasonalised data is probably less understood by the wider public.

- Discussion around the input variables to use for period and frequency in the STL function. AF to advise in follow-up.

- Group recommended to plot the LOESS trend and the de-seasonalised STL trend as this will allow comparison between the two – therefore considered a sensitivity test. This could potentially validate use of the LOESS smoothing method.

- Discussion on statistical significance testing.

    - Group outlined that significance tests don't take into account uncertainty in the input data (i.e. air pollutant monitored data). The STL method proposed here is meant to be more understandable. To undertake a significance test would require a new method and require a high level of statistical expertise, whilst likely not being understandable to the public.

<u>Method Discussion – Leave-One-Out Cross Validation (LOOCV)</u>

- As per first session, TfL have been testing the additional advanced analysis using the LOOCV method. TfL presented the progress and results so far.

- Discussion around whether the fleet composition is stable between zones, as it may not be necessary to do this advanced analysis.

Method discussion: other methods for presenting localised impacts

- General agreement that ULEZ impacts at individual site locations cannot be averaged and extrapolated to be representative of average borough level due to the small number of monitoring sites by borough, and local influences and differences between site areas.

- Alternative to monitored concentrations is to provide emissions per borough which TfL are investigating.

- Discussion around the potential to create forest plots, noting that this would be a time-consuming and complex activity given the number of sites in the analysis.

Wrap-up and Summary of Actions – GLA

- Actions will be summarised and sent via email.

- Notes of meeting will be written up and circulated.

- Confirmation of timelines and when the report appendices would be made available for review by the group.

- Next meeting date.

Supplementary Advisory Group meetings

22 November 2024 1:00pm – 2:00pm

26 November 2024 2:30pm – 3:30pm

Two separate meetings were held to discuss methods for calculating confidence intervals.

Advisory group member attendees:

Gary Fuller (Chair) – Imperial College London, UK (GF). *Apologies sent for the meeting on 26 November.*

David Carslaw – University of York, UK (DC)

Transport for London (TfL)

Greater London Authority (GLA)

Actions:

DC: Share an R code that can assist TfL team with undertaking a bootstrapping approach.

TfL: undertake a bootstrapping exercise on the main zonal areas.

Notes:

Minutes from previous session

- DC confirmed that the minutes accurately captured the feedback from the previous session.

Terms of Reference

- Confirmation that there are no changes to the Terms of Reference and DC continues to agree.
- Opportunity for questions on the terms of reference.

Summary of outcomes and discussion from Advisory Group Meeting 2

- NO_x
- Statistical start date
- De-seasonalising the data
- DC noted that the methodological approach taken for analysing air quality impacts in the Six Month Report was appropriate.

Method Discussion – Leave-One-Out Cross Validation and Bootstrapping

- As per first session, TfL have been testing the additional advanced analysis using the LOOCV method. TfL presented the progress and results so far.
- Discussed the motivation for suggesting LOOCV: to supplement the strength of the current method and provide an estimate of uncertainty.
- Other methods were also discussed which would achieve the same outcome but are simpler to undertake. A good alternative to LOOCV would be a bootstrapping re-sampling technique.

- Agreement that trying a bootstrapping method seems most appropriate, and will allow TfL to test iteratively across all of London.

Agreement that analysing NO_x rather than NO_2 allows connection with emissions estimates.

Method discussion: other methods for presenting localised impacts

- Confirmation that if looking at individual monitoring sites, contextualising local monitoring sites to borough-level is not going to be accurate. TfL will look at emission-level borough data.

Wrap-up and Summary of Actions – GLA

- GLA to set up follow-up meeting with DC and TfL for more detailed method discussion on bootstrapping.

Advisory group meeting 3

04 December 2024

1:00pm – 5:00pm

Advisory group member attendees:

Gary Fuller (Chair) – Imperial College London, UK (GF)

Elizabeth Fu – AirParif, France (EF)

Ludo Vandenthoren – Mutualités Libres, Belgium (LV)

Martin Lutz – Formerly head of air quality management at Berlin City Government, Berlin (ML)

Anna Font – IMT Nord Europe, France (AF)

Transport for London (TfL)

Greater London Authority (GLA)

Apologies:

David Carslaw – University of York, UK (DC)

Actions:

ML: Send graph of trends of NO_2 and NO to show the impacts of different Euro classes.

TfL: Try plotting a ratio of NO_x and NO_2, or on road increment ratio.

TfL: Plot the median as a separate sensitivity test for monitoring trends, it could lessen the impact of outliers.

TfL: Plot an xy correlation for STL and LOESS to allow comparison.

TfL: Generate a table of OAs not intersecting TLRN for comparison

TfL: Look at schools and hospitals in the output areas, noting that there may not be many in these areas.

LV: Send text/paper about attributing census/population data to air quality data.

EF: Check internally if anyone has experience using the “leave out cross validation” method, and check internally about localised sites.

ML: Send link to paper showing how LEZ can impact how people feel about quality of life.

Notes:

Minutes from previous session

- All members happy that the minutes accurately captured the feedback from the previous session.
- Summary of separate session with DC on bootstrapping method.

Terms of Reference

- Confirmation that there are no changes to the Terms of Reference and all members of the group continue to agree.
- Opportunity for questions on the terms of reference.

Request for bios and quotes from members

- GLA request to Advisory Group members to provide bios for the webpage, and optional quotes to summarise the experience of participation in the panel.

Health impacts

- LV has sent links to research articles looking at LEZs in other cities.
- Suggestion to add a sentence into the report to clarify that health impacts it is scoped out of the report.

Overview of progress on analysis

- TfL – undertaken additional analysis based on feedback from the last session, TfL presented updated results of air quality impacts analysis to the group.

Concentration Impact Analysis

- Query to the group- 2024 data is missing three months due to data cut-off period for the report, is this deemed acceptable.
    - This approach was considered acceptable by the group. Noted to make it clear that we have included data up to end of September.

Method Discussion – statistical start date:

- As per previous session, TfL have been doing additional analysis to provide confidence in the choice of start dates for analysis of impacts. TfL presented the progress and results so far using the Pettitt test, a change-point detection method, to detect a point in a time series where a shift can be identified (which could be attributed to the point in time when the ULEZ expansion to outer London started to impact the air quality monitoring data).

- For central London ULEZ the signal is clearest for the start date given that this was the area that was impacted. output suggesting March 2017 as change detection point in central, for inner it was February 2017, for outer February 2015. January 2017 was decided to use, therefore analysis supports this date and no evidence that we should change our start point. NO_2 was also analysed

- Agreed that NO_x should be shown and worth showing central, inner, outer and London-wide graphs for transparency.

- Test shows that as there was not a clear signal in outer London from the first central London ULEZ, there were faster rates of improvement in central and inner London, demonstrating the need for additional measures in outer London to reduce concentrations.

- Much higher p value for outer London and therefore higher p value explains that there is less confidence associated with the outer London date.

- Start date for outer London expansion of December 2022 is generally supported by the Pettitt test which was showing early 2023, additionally it allows a complete year for analysis, and captures almost a full seasonal cycle. Could be worth adding to the appendix that if we had a change point of April, this would make approximately xx% change.

- Concluded that the previously assumed start dates are therefore supported by this analysis, and we now have statistical confidence in this decision.

<u>Method Discussion – Seasonal trends</u>

- As per previous session, TfL have been doing additional analysis using the STL method. TfL presented the progress and results so far.

- STL method is sensitive to the period and frequency parameters

- LOESS smoothing method the span parameter chosen was 0.375

- The default window parameters for the STL function is applied, is this acceptable?

    - Yes, add into the appendix for transparency

- The LOESS and STL graphs look very similar, no need to present these in the report due to complexity however can plot the xy regression plot and put in an appendix to support original choice of method (i.e. using the LOESS with span of 0.375).

Method Discussion – Contextualising AQ impacts to population exposure.

As per first session, TfL have been doing additional analysis to contextualise air quality impacts to population exposure. TfL presented the progress and results so far. TfL are aiming to overlay population with deprivation indices to describe number of people in these groups with benefits based on impacts at roadside using the impacts reported in the report. TfL are cutting a buffer zone around the TLRN road network and investigating if it possible to apply the impact to these zones. TfL posed the question- is applying an average impact to a very specific local location accurate?

- TfL have output area data (from the census)
- Transport for London Road Network (TLRN)- took the geographical information of the TLRN and selected all of the output areas that intersect the TLRN.
- Average concentration at 4m alongside each road.
- Looked at the average concentration alongside each TLRN.
- Gathered together population- overlayed index of multiple deprivation (LSOA). Assume that the proportion in the larger area is the same as the output area.
- What is the impact from 2019 – 2023 (or 2024 if acceptable). If we project those concentrations from 2019 to 2023/2024, that gives us an idea of populations that have benefitted the most from the ULEZ.
    - LV- also similar to what was done in Belgium- can share more text about this.
- In the smaller output areas, apply the demographics from the wider LSOA areas.
- ML- similar work undertaken for Berlin. Used a grid of 500 m x 500 m and that was used rather than averaging roadside clusters, there is a bias in the data.
    - TfL – the data available in LAEI is 20 m x 20 m so slightly more granular data.
- 2019 data from LAEI, then applying impact analysis gives a no-ULEZ and ULEZ line. Taking the difference between 2019 and apply the impact. Therefore applied these impacts as a reduction and so can indicate the level of different change in benefits.

- Overlay with deprivation to see what the split of deprivation indexes (IMD 1 – IMD 10) in these areas that are particularly high concentration.
- Sensitivity test could also look at the areas that do not have a TLRN.
- Berlin used spatial units called LOS, but did not use the roadside data, rather the background data.
- TfL can cut this to borough-level. Using the TLRN, as the core road network in London is the best way to fairly apply the roadside concentration.
- Could overlay with school and hospital data. Focus on primary schools as more likely to walk to school.

Emissions Impacts

- TfL showed analysis of vehicle-type (diesel, petrol, electric) for central, inner and outer London. This data will be used for emissions calculations.

Wrap-up and Summary of Actions – GLA

- Actions will be summarised and sent via email.
- Notes of meeting will be written up and circulated.
- Next steps- separate meetings will be set up as needed.

Supplementary advisory group meeting

17 December 2024

3:30pm – 4:30pm

A separate meeting was held to discuss methods for calculating confidence intervals.

Advisory group member attendees:

Gary Fuller (Chair) – Imperial College London, UK (GF)

David Carslaw – University of York, UK (DC)

Transport for London (TfL)

Greater London Authority (GLA)

Actions:

TFL: Run the bootstrapping as advised.

Notes:

Summary of outcomes and discussion from Advisory Group Meeting 3

- Summary of all topics discussed and conclusions
- Request for bios

Bootstrapping methodology

- Does our methodology lend itself well to bootstrapping- yes.
- Observed data is already averaged by site- monthly data by site, apply LOESS function to get trendline. Can apply bootstrapping to the LOESS data. Do we need to go back to the original sites prior to averaging and using LOESS.
    - DC- Resampling needs to be done on the sites that go into the analysis to see how much they differ from the control sites.
- Strong evidence base of many sites with high standards of measurement in London.
- Applying confidence intervals for monitored / “ULEZ scenario” works, however for “No ULEZ scenario”, the observed data is corrected and smoothed based on the control sites. How do we apply bootstrapping method to this scenario?
    - The counterfactual line off-set by start point. From the starting point, don’t bootstrap separately the two scenarios.
    - Could do a t-test to compare the two. But bootstrapping is better for less normally-distributed data.
    - Randomly sample from each of the populations that you are sampling. Key part is with resampling.
    - Query on number of runs, several hundred runs is appropriate (e.g. 500 runs would be more than enough to establish either a mean, median, or 95% confidence interval)

Wrap-up and summary of actions

- Actions will be summarised and sent via email.
- Notes of meeting will be written up and circulated.
- Next steps- separate meeting upcoming where the results will be shared.

Supplementary advisory group meeting

20 December 2024

12:00pm – 1:30pm

Advisory group member attendees:

Anna Font (Chair) – IMT Nord Europe, France (AF)

Elizabeth Fu – AirParif, France (EF)

Martin Lutz – Formerly head of air quality management at Berlin City Government, Berlin (ML)

David Carslaw – University of York, UK (DC)

Transport for London (TfL)

Greater London Authority (GLA)

Actions:

TFL: Sense-check the air quality monitoring sites along the TLRN to see if they align with the predicted concentrations for 2023. Provided sense-check confirms broad alignment, continue with population exposure analysis.

TfL: complete the median analysis

TfL: Finalise the bootstrapping analysis.

<u>Population Exposure</u>

TfL presented the results of the population exposure analysis and deprivation.

- Query from the group- NO_2 concentrations decrease with distance from the road, how is this captured in the analysis?
    - TfL applied OAs which is the smallest output area that we can apply. Important to be careful that the wording is clear when writing this up in the report.
- Query about using the legal limit value, i.e. there are still benefits to reducing NO_2 concentrations that are below the limit value, would it make sense to look at changes in absolute values?

    - This level of more in-depth analysis could be looked at as part of updated modelling i.e. as part of LAEI.
    - Noted that the benefits of the Berlin LEZ were expressed in the same way, using the legal limit value as the benchmark.
    - Looking at the health impacts, legal limits is not the best metric for this, as negative health impacts can still be seen at lower concentrations.
    - TfL to check the monitoring data to ascertain whether these lower concentrations (e.g. below 10 µg/m^3) are observed along the TLRN at available monitoring sites.
        - Noted that using a lower threshold could over-exaggerate the impacts of the ULEZ.
    - Threshold-based analysis has the potential to overstate the impacts of the ULEZ therefore is key to ensure that the health impacts are not linked to this analysis.
- Acceptance from the group on this approach for population exposure analysis, noting that the way that this is discussed in the report needs to be mindful that health impacts are not linked to this.

<u>Bootstrapping</u>

TfL presented the results of the bootstrapping analysis, from applying 500 simulations.

- Query around whether 500 simulations needed for central London given the smaller number of sites.
    - Agreement that number of simulations needs to be the same across zones, and that the random sampling with replacement means that smaller number of sites does not cause an issue.

<u>Wrap-up and summary of actions</u>

- Reminder to send bios for website.
- Notes of meeting will be written up and circulated.
- Because of timings of analysis- some work still to be done.

Next steps, report will be shared with the group for comments.