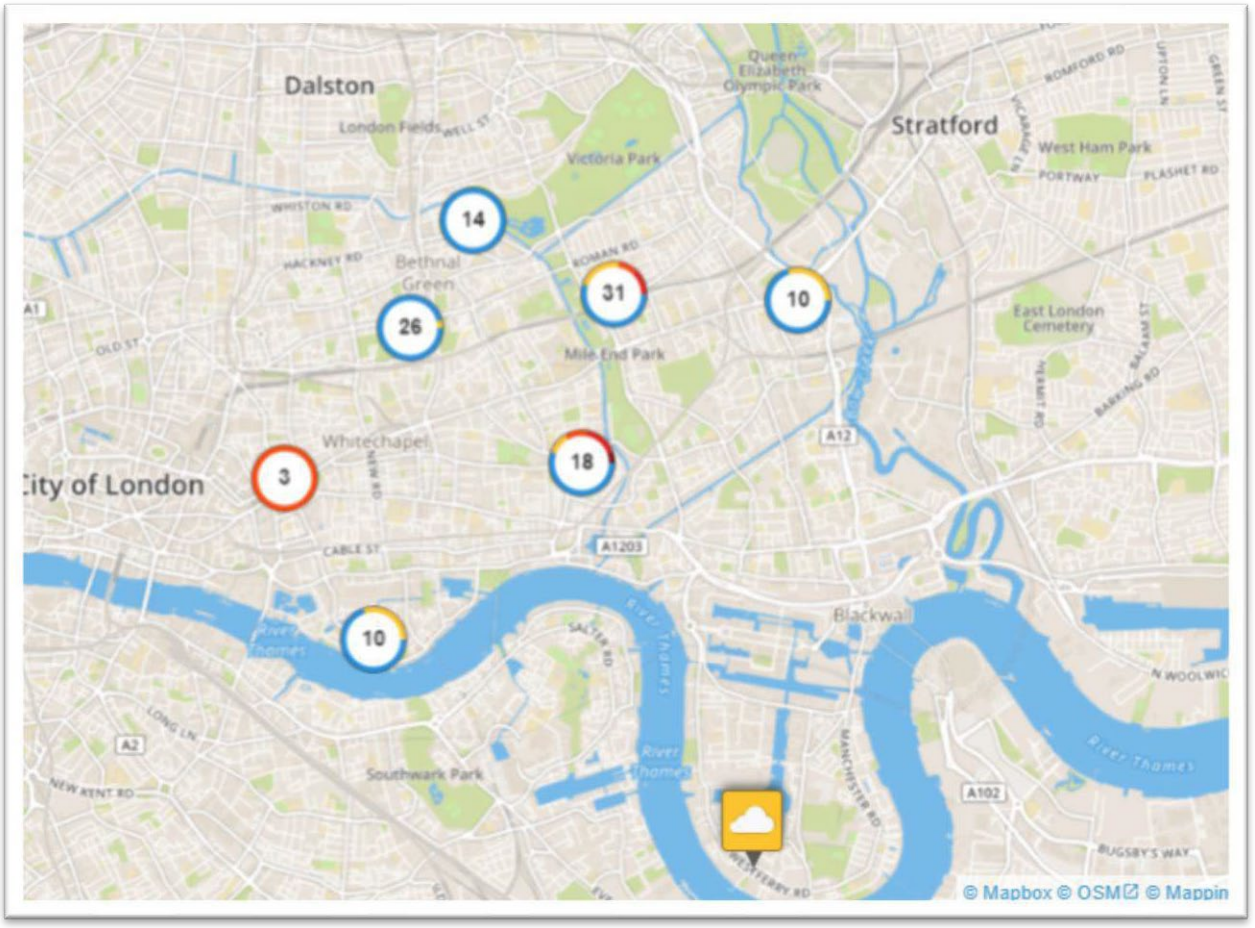
Monitoring Air Quality

in Tower Hamlets 2018



Final Project Report

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This final report has been produced by Mapping for Change for the London Borough of Tower Hamlets. It has been developed as part of a six-month project led by Mapping for Change to engage local residents in Tower Hamlets with the view to increase public understanding about air pollution, its causes and effects, and how concentrations vary both spatially and from day to day. Copies of this report can be obtained from the Mapping for Change website (www.mappingforchange.org.uk).

"A revolution doesn't happen when a society adopts new tools. It happens when society adopts new behaviours and most of that change I think is still in the future."

Clay Shirky

Acknowledgements

We would like to thank all the community members who participated in this project, and whose work is used as examples here to help others learn how they can use a citizen science approach to monitor and map local air quality in their own community. We would like to acknowledge the staff at the Idea Stores whose support in coordinating the monthly diffusion tube changeovers made the project possible.

Contents

Summary

Breathe Clean Air Quality Monitoring was initiated with the aim to increase public understanding about air pollution, its causes and effects, amongst local residents, and how concentrations of different pollutants vary over space and time.

The project focused on one of the major ambient air pollutants, nitrogen dioxide (NO_2), which is considered harmful to health. This report describes the process with which residents in Tower Hamlets carried out an in-depth air quality monitoring survey using diffusion tubes and then goes on to outline the preliminary findings. In addition, due to the emphasis on co-design and the bottom-up approach that Mapping for Change embraces, particulate ($PM_{2.5}$) pollution monitoring was incorporated. Despite this not being an original aim of the project, several residents expressed concerns about particulate pollution at the initial community meetings and so this was pursued.

In summary, the results found that there were higher levels of pollution near the main roads, namely Commercial Road and Grove Road. Away from the main roads, all but one of the sites recorded NO_2 levels below the UK National Air Quality objectives, which are derived from EU limit values (40µg/m^3 as annual mean). The average monthly results show that 23 of the 29 locations were within the UK National Air Quality objectives.

The average NO_2 levels across all the sites showed relatively little variation across the months. In contrast, the results show a wide range of average NO_2 levels between the monitoring sites. This variation between locations is likely to be due to the proximity to busy roads in the borough and the presence of greenspace.

Steps to reduce pollution in the borough could include reducing motorised traffic and increasing active travel. In addition, raising awareness of the effects of burning solid fuel in homes would reduce the particulate pollution. Residents can reduce their personal exposure to NO_2 pollution when walking or cycling by taking quieter routes and using greenspaces, such as parks, to exercise or travel through.

Introduction to air pollution

Air pollution is a concern for everyone and is something that affects us all. It is estimated that across London around 9,400 people each year have their lives cut short by being exposed to London's air. We are all contributors to the problem and can all take steps to improve the air we breathe and to reduce our personal exposure to poor air quality.

A number of studies have been carried out into the health effects of air pollution across all stages of life – from conception to old age; on specific pollutants; and on different health endpoints, such as mortality and cardiovascular disease. Mounting evidence suggests that air pollution contributes to the global burden of respiratory and allergic diseases, including asthma, chronic obstructive pulmonary disease, pneumonia, and possibly tuberculosis (Laumbach and Kipen, 2012). As an irritant gas, NO_2 can damage cell membranes and proteins. High concentrations can produce airway inflammation (experienced as a cough, chest tightness and difficulty breathing) and may lead to narrowing of lung airways, particularly among people with pre-existing asthma. More recent studies have also found a link between air quality and dementia. Jung et al., 2015 found that the risk of Alzheimer's disease increased with long-term exposure to higher levels of $PM_{2.5}$. Possibly even more concerning for many is the health impacts that air pollution is having on new and future generations. These include adverse birth outcomes, impairment of cognitive and behavioural development, respiratory illness, and potentially childhood cancer (Perera et al., 2018).

Nitrogen dioxide (NO_2) is one of the major air pollutants found in our cities and is largely attributed to the burning of fossil fuels (coal, natural gas and oil) and vehicle emissions. Industry and road transport are primary sources of these emissions across the UK. Particulates constitute another significant contributor to poor air quality. In urban areas the primary sources include diesel emissions, domestic solid fuel burning, construction activities and non-exhaust traffic emissions such as brake and tyre-wear. Home wood burning has increased in recent years and in 2016 a government survey found that this could be responsible for 25 to 31% of London's particulate pollution. Despite it being illegal in the capital, many Londoners are burning wood in open fires. Open fires cause much more

particulate pollution than other solid fuel burners and considering that even 'eco' wood burners emit six times more particulate pollution than a modern heavy goods vehicle, this is a concern (https://www.londonair.org.uk/LondonAir/guide/WoodBurning.aspx).

In response to the negative effects that air pollution has on human health, vegetation and ecosystems, the European Commission has set reduction targets for key pollutants for all its Member States and the UK has incorporated these into the UK National Air Quality Objectives. This includes an annual mean limit value for NO_2 of 40µg/m^3 which was to be met by 2010 and for $PM_{2.5}$, 25µg/m^3 by 2015 and 20µg/m^3 by 2020. The World Health Organisation (WHO) however, recommends a 10µg/m^3 annual average concentration for $PM_{2.5}$.

Local authorities around the UK monitor air quality to assess compliance with air quality objectives and to measure the effectiveness of plans and programmes to reduce levels of air pollution. However, the collection and analysis of data is a costly process. As such, the majority of monitoring undertaken by local authorities is limited to collecting data from a few static sites within their jurisdiction. These data are then extrapolated using complex models to infer what pollution levels are in areas where there are no data. Whilst this offers an indication of local air quality, it is unable to create an accurate picture at a scale which the public may relate to or find useful on a day-to-day basis, particularly if they are seeking to reduce their exposure to poor air quality. Models produced during 2013 showing the annual mean NO_2 and $PM_{2.5}$ air pollution for Tower Hamlets can be seen in the Appendices at the end of the report.

Introduction to the project

The London Borough of Tower Hamlets commissioned Breathe Clean Air Quality Monitoring, a six-month project running from May 2018 to November 2018, led by Mapping for Change. The objectives were to increase community awareness about air quality issues and establish the variability of air quality at a smaller scale.

We began by holding community meetings to introduce the problem of air pollution, its causes and effects, and open a discussion around the issues concerning the residents. A citizen science approach was adopted which enabled residents, many of whom have not been involved in a project of this kind before, to carry out grassroots data collection.

Participating residents were given diffusion tubes to measure nitrogen dioxide in a location of their choice over the course of six months. Monthly data were collected, digitised, visualised on an online map and shared amongst the residents to show potential pollution 'hotspots' and highlight the variability of air pollution over time and space.

The image below in Figure 1 show snapshots from Community Maps, Mapping for Change's platform for participatory mapping. The maps posted here show air quality monitoring across London. Data from the monitoring sites across Tower Hamlets were entered each month onto the Community Air Quality Map for participants of the project to see and share with the wider community.

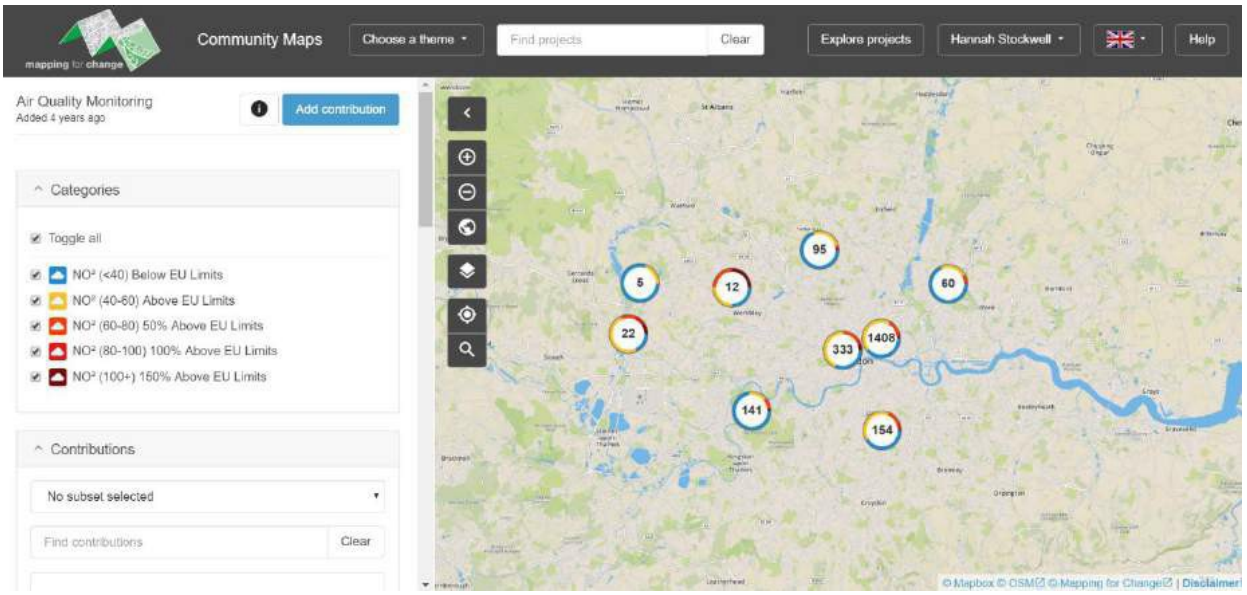

Figure 1. Community Air Quality Map to display NO_2 levels

Methodology

Diffusion tubes (Figure 2) are one of the most common, simplest and well-proven methods for measuring NO_2. They are very useful for identifying areas of high NO_2 concentration, particularly when dealing with sources such as traffic and vehicle emissions. The measurements collected using this method are also comparable with local council data and can be used for indicative comparison with the UK Air Quality Strategy Objectives based on the annual mean.

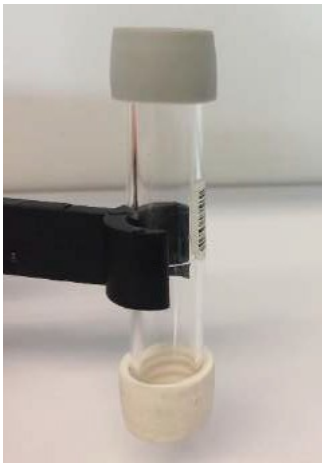

Figure 2: Diffusion tube used to measure NO_2

The diffusion tubes are made from clear plastic, with a rubber stopper at each end. A steel mesh coated with a chemical called Triethanolamine is located at one end of the tube. This absorbs nitrogen from the air when the stopper at the other end of the tube is removed, allowing air in. Laboratory analysis provides the average concentration of the pollutant in the air over the period that the tube was exposed.

To gain an overall insight into air quality across the borough, diffusion tubes were installed at 29 sites (Table 1 and Figure 3). Volunteer residents were recruited (through online and offline methods) to select and manage these sites and training was provided at the two initial workshops held in April.

Each resident selected a suitable monitoring location and installed their tube, positioned vertically using a bracket and tie to fix it in place, with the open end facing down (Figure 4). The start time and date were recorded along with the specific location and any details about the site that might provide additional context. The tube was left exposed for four weeks before being removed, re-capped and replaced with a new tube. The end time and date were recorded so that the exposure time could be calculated. The tubes were collected and sent to the laboratory for analysis. This was repeated each month between May and October 2018. All results for nitrogen dioxide monitoring were digitised using the interactive Community Air Quality Map and shared via email with the residents involved.

Table 1: Description of monitoring site locations

Site number	Location in Tower Hamlets
1	Brady Street
2	St Johns CE Primary School
3	Hermitage Primary School
4	Canal bank by Sewardstone Road
5	Harbinger School
6	Canon Barnett School / Commercial Street
7	Sewardstone Road
8	Sewardstone Road/Waterloo Gardens Corner
9	Wilmott Street, off Bethnal Green Road
10	Grove Road (no 42)
11	Grove Road (no 10)
12	Grove Road (outside Pizza Room)
13	Outside Ye Olde Corner Shoppe, Morgan street
14	Opposite Wapping Overground station
15	Olga School
16	St Stephens Green
17	Commercial Rd (between railway bridge and pedestrian crossing)
18	Baldock St (entrance to Grove Hall Park)
19	Mile End Park
20	Shandy Park
21	Pundersons Gardens
22	Wellington School
23	Derbyshire Street
24	Harford Street/Bohn Road
25	Harford Street (Bus stop S)
26	St. Leonards' Priory (by the gate)
27	St. Leonards' Priory (inside the park)
28	St. Leonards' Priory (on the outside fence)
29	St. Leonards' Priory (just outside the park)

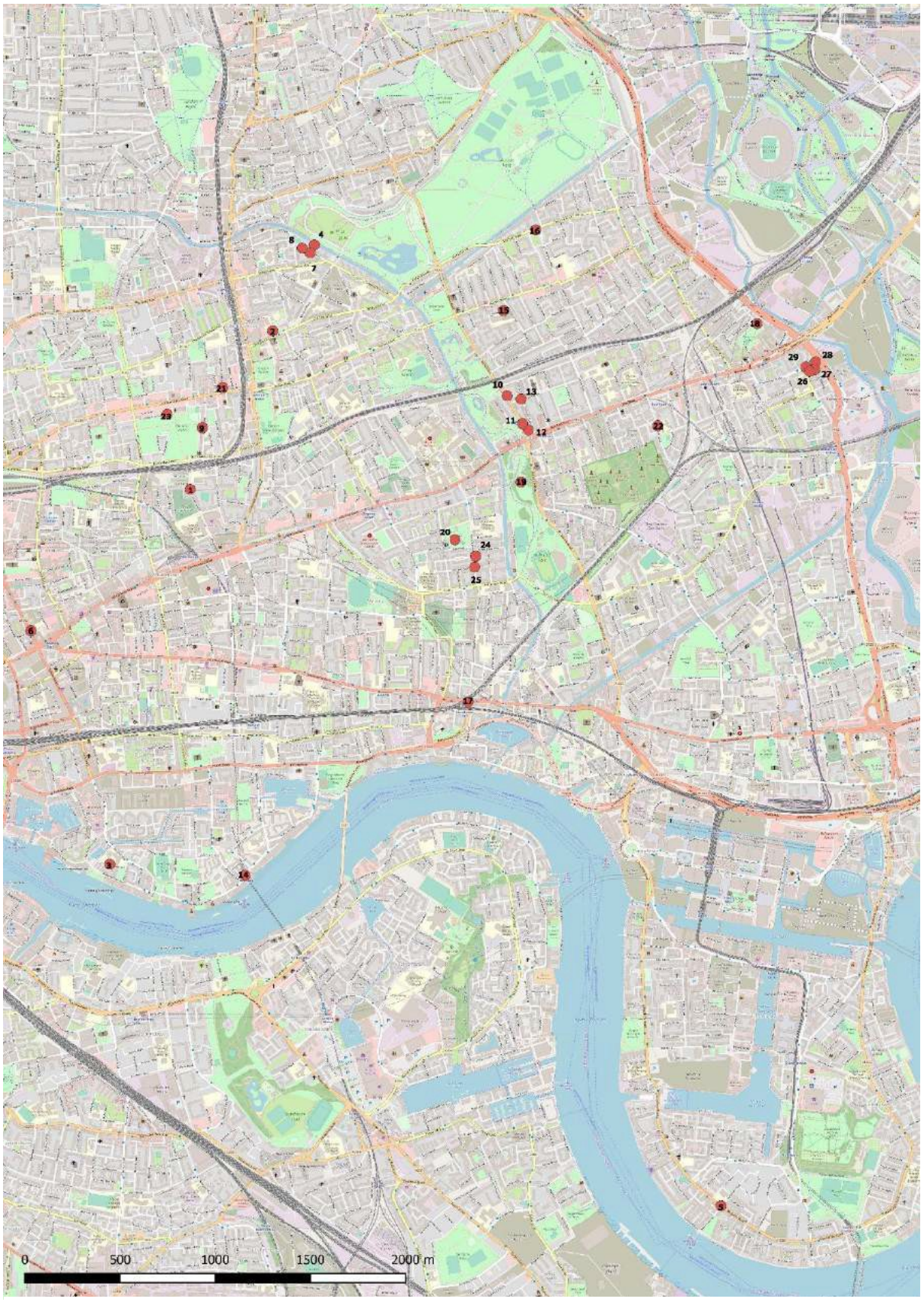

Figure 3. Map of monitoring sites

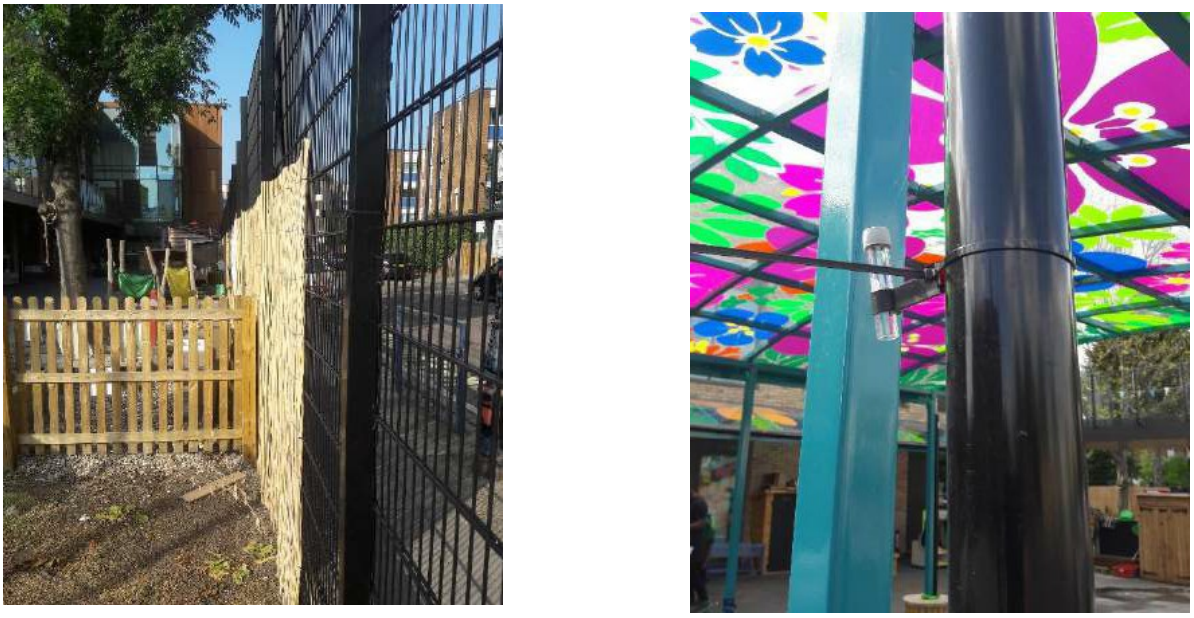

Figure 4. Monitoring sites hosting diffusion tubes to monitor nitrogen dioxide

To measure particulate pollution ($PM_{2.5}$) three residents and one primary school class were trained to use the SidePak Aerosol Monitor in conjunction with a Garmin GPS device. The SidePak Aerosol Monitor uses a small motor to draw air in through an inlet pipe and out through the exhaust (Figure 5). The monitor was set to record the number of airborne particles 2.5 micrometres in diameter and smaller, at a sampling rate five seconds. The Garmin GPS uses several satellites to establish and record its location every 10 seconds, allowing a journey to be plotted.

Figure 5: Sidepak Aerosol Monitor to measure personal exposure to particulates

The participants took turns to use the equipment to monitor their personal exposure to $PM_{2.5}$ for up to a week in May and June. The routes and monitoring periods were selected by the resident so as to be more representative of their daily routines. These included their daily commute, walks nearby the school (Figure 6) and a walk along Hertford Union Canal. The GPS data was synchronised with the SidePak data using Time as the constant to match the two datasets. Journeys and $PM_{2.5}$ readings were mapped and shared with the resident surveyor.

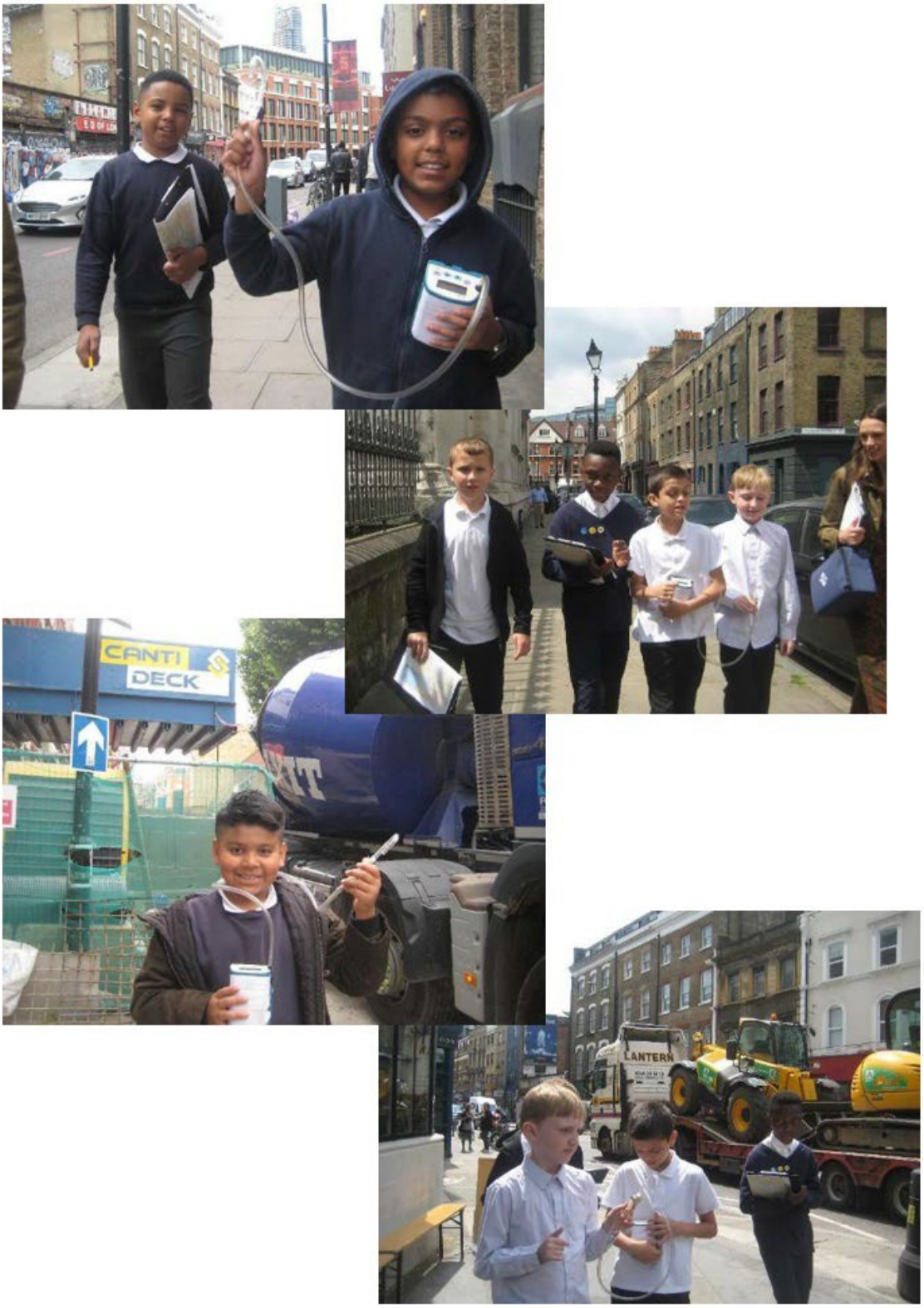

Figure 6: Pupils monitoring particulate pollution near their primary school

Results

Residents' perceptions

Residents of Tower Hamlets were asked to complete a brief online questionnaire at the start of the project to help frame the issue of air pollution and concerns around this subject.

A total of 75 people responded to the questionnaire, answering some or all of the questions. The residents were asked an open question: 'Do you have any specific concerns about air quality in your area?'. The responses were varied and included both the causes and effects of air pollution. The pie chart below (Figure 7) shows a summary of the perceived sources of air pollution, with traffic being seen as the biggest contributor, sited by 35 residents. In addition, in response to the same question, 20 people also raised the issue of health concerns, with 18 individuals expressing that they were specifically concerned about the effect of poor air quality on children's health. This concern was also raised during the introductory workshops where a number of parents chose to monitor nitrogen dioxide at locations near primary schools and parks across the borough.

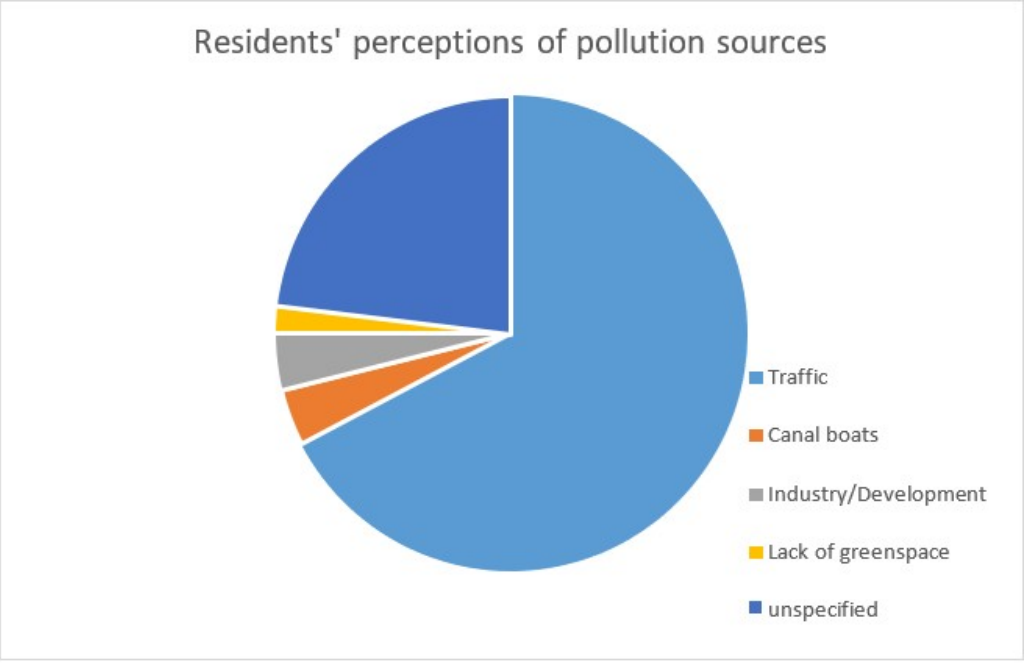

Figure 7: Residents perceptions of the source of air pollution in Tower Hamlets

A total of 20 residents went on to take part in the citizen science air quality monitoring. We asked this group to complete a more detailed questionnaire before the monitoring started, to which nine individuals responded. The majority of this group agreed that traffic was the most likely cause of air pollution, in particular lorries and private cars. This was closely followed by demolition and construction. All of the respondents felt that the air quality in the borough was always, often or sometimes poor with none saying it was 'good' or 'not a problem'.

Nitrogen Dioxide

Of the initial 29 nitrogen dioxide (NO_2) monitoring sites originally set up, complete data for the six-month monitoring period was only received from 13 sites due to tubes being removed and residents no longer being available to take part in the project.

All the data used in these results have been bias adjusted (by a factor of 0.87). Figure 8 shows the average reading across all the sites per month. The UK limit of 40µg/m^3 illustrated by the dotted line was not breached in any month during the project. September and October had slightly higher levels of NO_2 although there was little variation between the months.

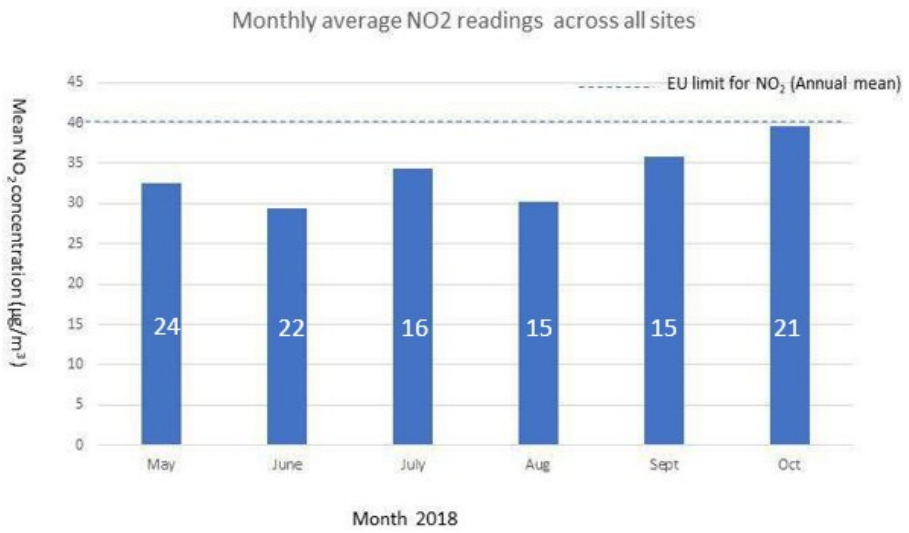

Figure 8: Monthly average NO_2 readings of all sites combined. The number on each bar shows how many locations data were received for.

Figure 9 below shows the results of NO_2 monitoring across all sites over the six months for comparison. The dotted line represents the UK limit of NO_2 (annual mean). Results show that the highest NO_2 concentration was recorded at site 17 (Commercial Road) in July measuring 89.35µg/m^3. This was followed by September (80.69µg/m^3) at the same site, then June and May at sites 12 and 11 respectively (77.52µg/m^3 and 76.41µg/m^3), both of which were located on Grove Road. The lowest levels of NO_2 (11.79µg/m^3) was recorded in August at site 3 located at Hermitage Wall.

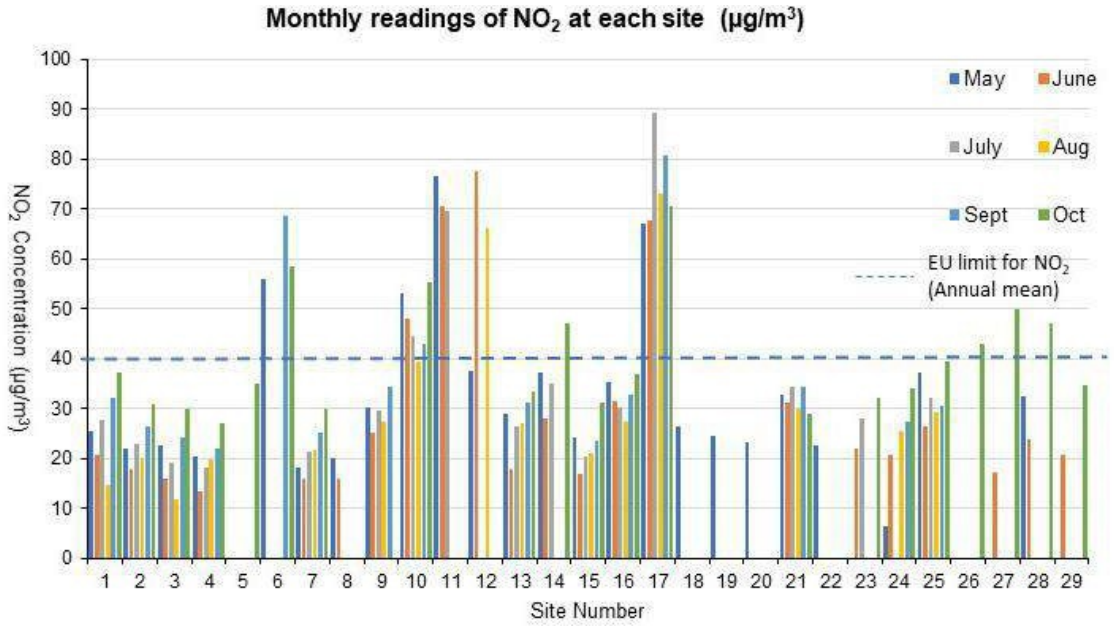

Figure 9: Bar chart showing NO_2 readings at all sites each month. The dotted line represents EU limit of NO_2 (annual mean)

Figure 10 below shows the average level of NO_2 over the six-month period at each site. The dotted line represents the UK limit of NO_2 (annual mean). The graph shows that the air quality varies greatly across the locations with the six-month average ranging from the highest of 74.71µg/m^3 at site 17 to the lowest of 17.96µg/m^3 at site 8. The UK limit for NO_2 was breached at 6 out of the 29 sites and was almost double the limit of 40µg/m^3 annual mean at two sites, 11 and 17.

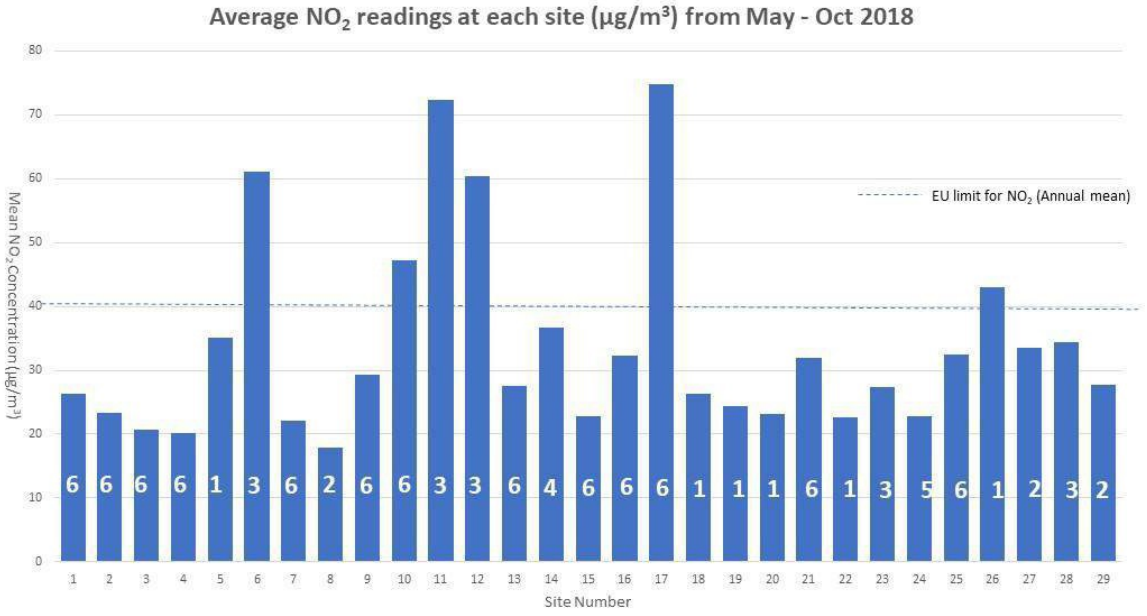

Figure 10. Graph showing the average level of NO_2 per site from May 2018 – October 2018, the dotted line represents EU limit of NO_2 (annual mean). The number on each bar shows how many months' data were received.

Air quality can be affected by several factors, including meteorological conditions and traffic levels. As the pollution didn't vary greatly over the six months (Figure 8), the weather is unlikely to have had a great impact. However, figures 9 and 10 show a great deal of variability over space rather than time. The graph (Figure 11) below, shows each site colour coded to segment the different types of locations. Red bars represent those monitoring locations near a main road, yellow in residential areas or near schools and green represents urban greenspace. The graph clearly shows that the highest readings are taken near main roads (red). Sites 26-29, although within a greenspace – at St Leonards Priory – are also very close to the A12 and A13 and show higher readings than the other greenspaces.

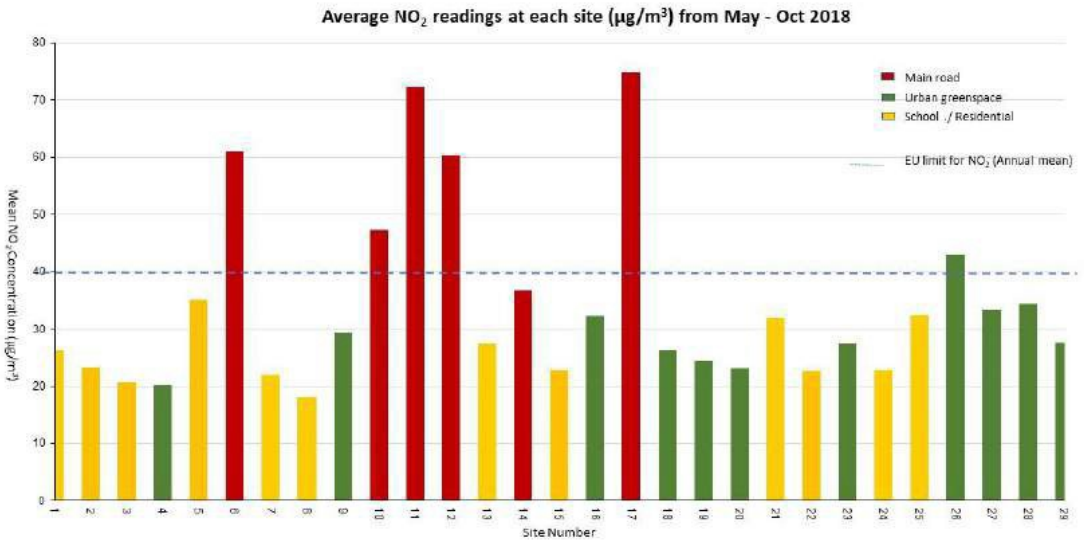

Figure 11. Graph showing the average level of NO_2 per site from May 2018 – October 2018 with site type categorised.

Particulates

Monitoring for particulates took place between the months of May and June, 2018. Due to the methodology it is difficult to compare the data directly as variables include both location and time. Maps of the journeys taken are shown in figures 12 to 16. Where the points are bright red, $PM_{2.5}$ is measured at 200µg/m^3 or over. Any point represented by one of the three shades of green indicates that the readings were less than 25µg/m^3 (the EU annual average limit). Points with a colour ranging from white to red show readings over 25µg/m^3. Although data cannot be directly compared with EU standards, it is indicative and can be used to compare spatial and temporal variability over the monitoring period.

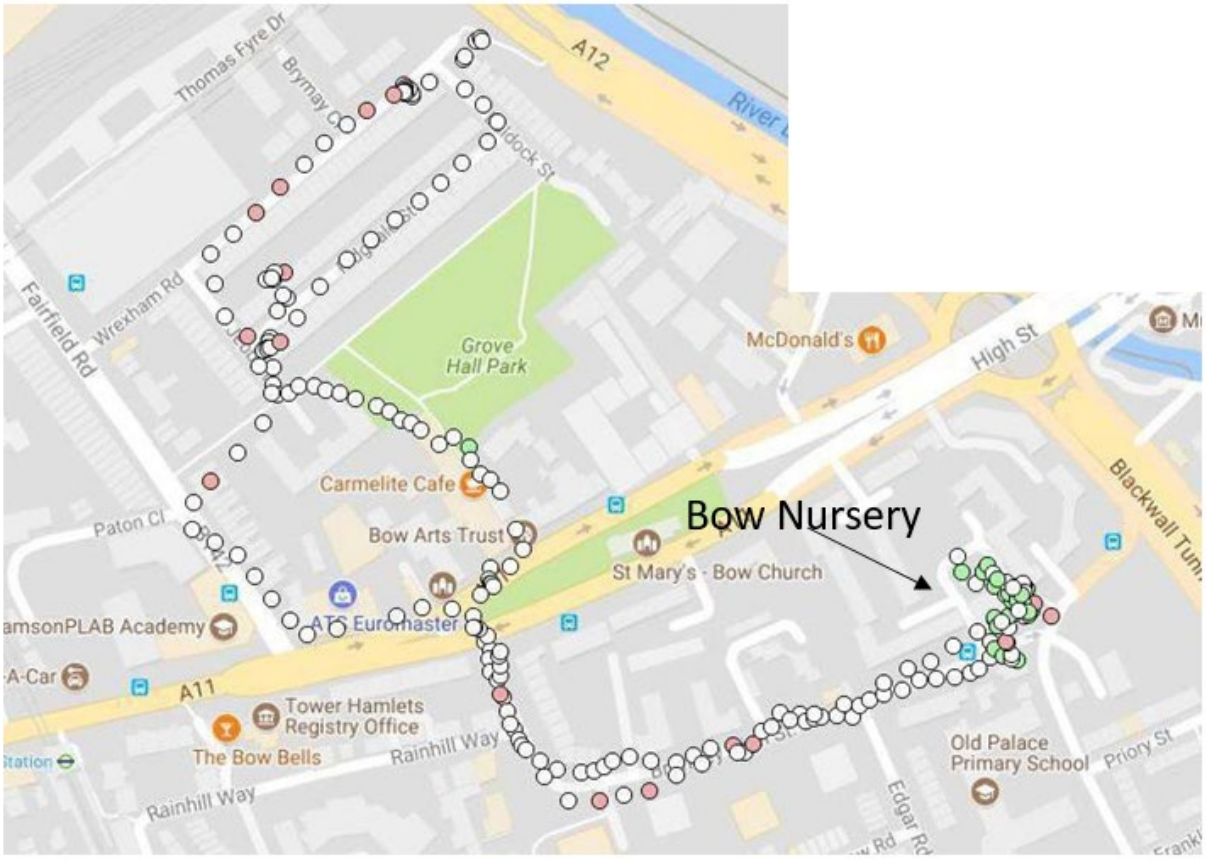

Figure 12. Route taken around Bow at morning rush hour whilst measuring particulates.

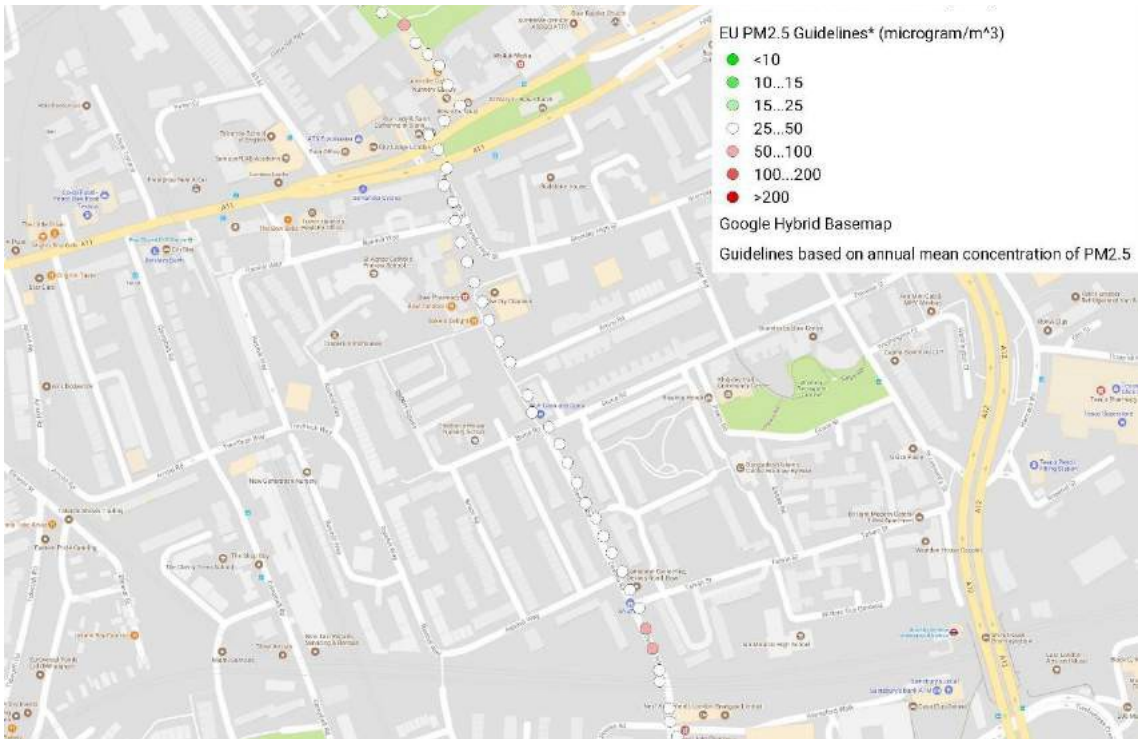

Figure 13. Linear route taken around Bow whilst measuring particulates.

Figure 14. Late morning route taken around Bow whilst measuring particulates.

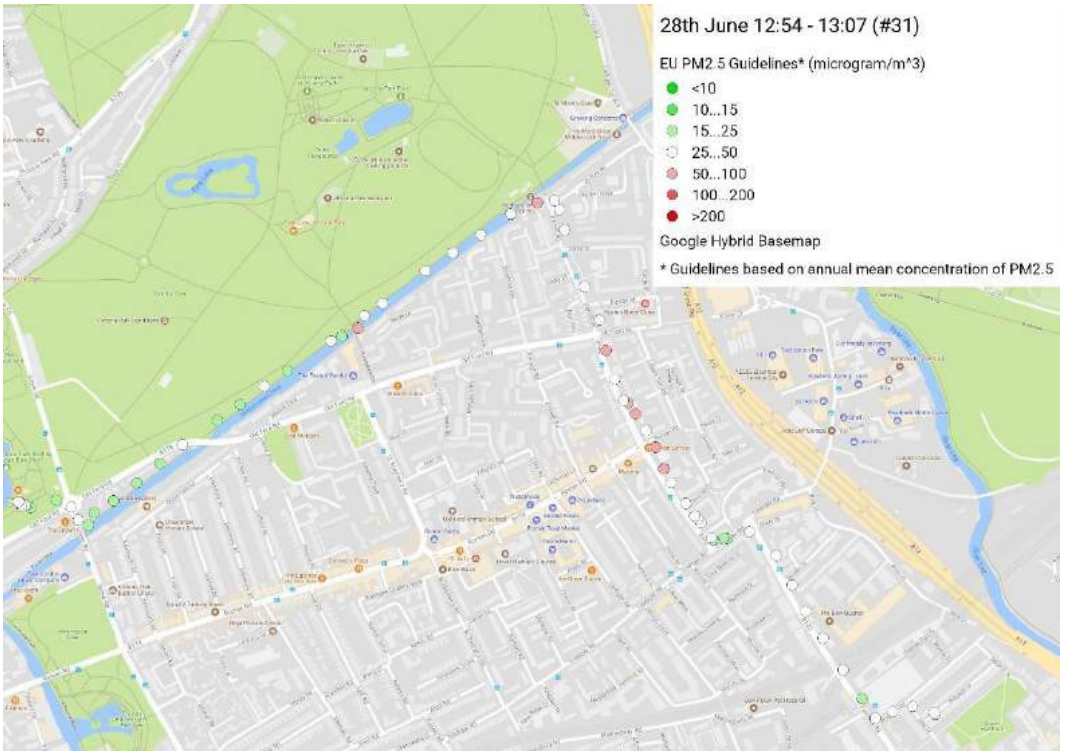

Figure 15. Lunchtime walk along the canal whilst measuring particulates.

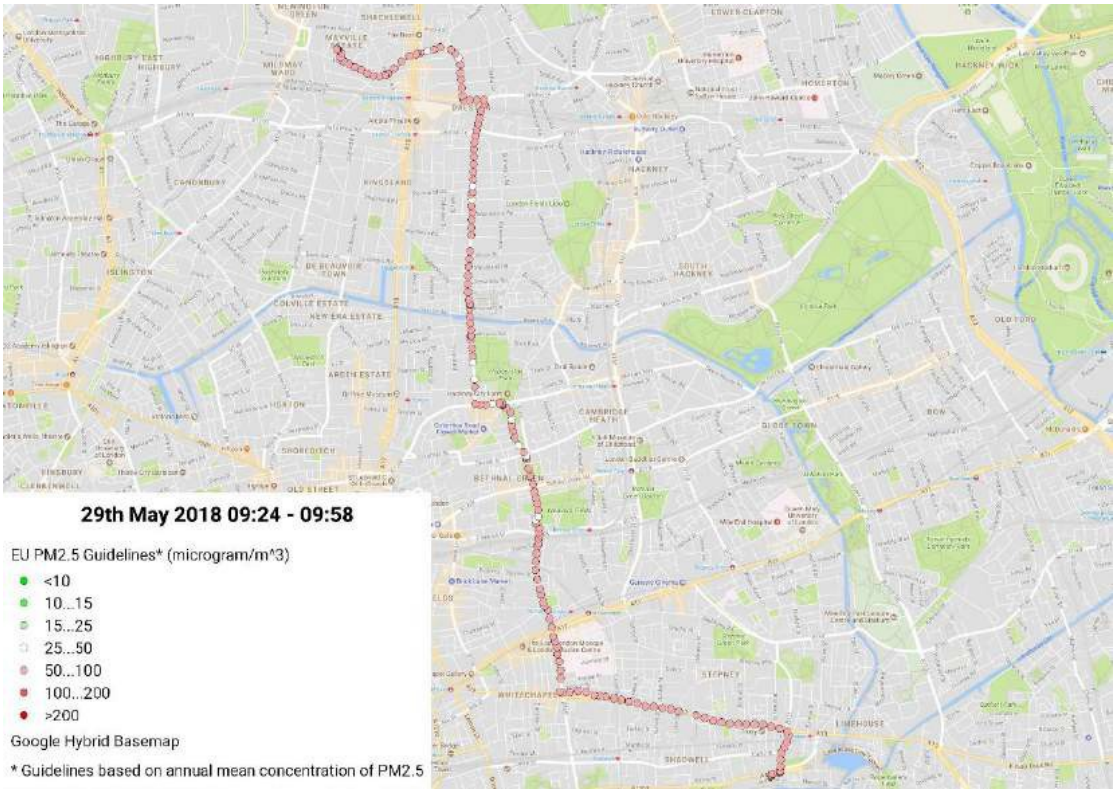

Figure 16. Daily cycle commute from Limehouse to Dalston measuring particulates.

Conclusion

Community Participation and Awareness

One of the primary aims of the Breathe Clean project was to increase public understanding about air pollution, its causes and effects, and how concentrations vary both spatially and from day to day. This was done by adopting a bottom-up citizen science approach to monitoring air quality, using simple methods and tools, to enable local residents to participate.

The level of participation and commitment of residents to conduct this study over six months is testament to their genuine concern about air quality within Tower Hamlets and willingness to engage in the wider discourse.

The data gathered by the community provides a valuable insight into the temporal and spatial variability of air quality across the area. Where many residents initially felt the local air quality was either always, often or sometimes poor, the data gathered demonstrated that this is not always the case and the situation is not uniform across the area.

Monitoring results

Monitoring nitrogen dioxide over the course of the six months shows that the UK target of 40µg/m^3 is not currently being met in every part of the borough. Although there were variations between across monitoring sites, with two having almost double the UK limit for NO_2 concentrations, the combined annual average for the area as a whole (33.62µg/m^3) is below the UK legal limit, which is very encouraging news. This variability highlights the importance of understanding air pollution at a hyper-local level, especially when encouraging behaviour change such as being active outdoors or walking to school. The route taken for a cycle, run or commute can make all the difference to an individual's exposure to pollution, and ultimately their health. For example, site 10 was located at a bus stop on Grove Road where the average NO_2 levels exceeded the EU limit (47.23µg/m^3). Considering that people can regularly wait for several minutes at a bus stop, this could be significant but also relatively easy to avoid. By using a smartphone application to inform when the bus is due, or by waiting on the side street (Morgan Street where average NO_2 levels at site 13 were 27.52µg/m^3) until the bus is in sight, individuals could reduce their personal exposure. Bearing in mind that individuals waiting at a bus stop periodically will be exposed to short intervals of pollution it is worth also considering the 1-hour exceedence objective which states that hourly NO_2 levels should not

exceed 200µg/m^3 more than 18 times per year. This project did not collect real-time data, however, a study by the AEA Group found that a kerbside location in the South East with an annual average over 50µg/m^3 (60µg/m^3 for other parts of the UK) is likely to exceed the 1-hour objective. Site 10 falls just below this threshold.

The NO_2 monitoring shows that pollution levels are high around the main roads and suggests that pedestrianisation or traffic control would reduce air pollution. This is obviously a complex issue and would require expert analysis and wider consultation so as to not simply displace traffic to the quieter roads but reduce it. However, sites 26 to 29 have lower NO_2 levels than might be expected considering their proximity to two main roads (A12 and A13). These sites are in or close to St Leonards Priory Park, a greenspace currently under development, which could support the idea of using plants as an air filter or barrier against the busy roads. A recent study suggests that the planting of roadside hedges can also reduce air pollution from particulates (Abhijith & Kumar, 2019).

The results from particulate monitoring are difficult to draw conclusions from as the ad-hoc approach was used for raising awareness more than citizen science. However, a particular point of note was the route along the Hertford Union Canal (Figure 15). During the initial meetings, concerns were raised by residents about the burning of solid fuel on the canal boats, which have increased in number over recent years. Burning solid fuel contributes more to particulate pollution than NO_2, hence the desire to measure $PM_{2.5}$. The map of the canal walk clearly shows a number of (green) points below the EU limits to the west. This corresponds with large trees, gardens and greenspace at both edges of the canal. The first white dot, indicating an increase in $PM_{2.5}$, is as the monitor travels underneath a bridge. As the canal edge on the south side becomes more built up, the white dots become more frequent. The two pink dots, a further increase in particulate pollution, correspond with the route going underneath the bridges. The closed pathway may reduce air circulation and therefore trap the particulate pollution, concentrating it. Air circulation and wind can affect particulate levels and the area around Bow Nursery (Figure 12) has very varied levels of $PM_{2.5}$ ranging from below 25µg/m^3 to over 50µg/m^3. This could be due to the protection given by the closed positioning of buildings and the trees offsetting the pollution from the main road, hence it cannot be assumed that enclosed areas are always a negative. Local authorities are not legally obliged to monitor particulate pollution, instead they have access to modelled data provided by GLA. However, more local scale particulate monitoring of the borough would be useful to enable any conclusions to be drawn around the cause and effect of particulates and the benefits of solid and natural barriers.

Final remarks

The project's success was made possible by combining residents' local knowledge and their commitment, with the technical knowledge and experience provided by Mapping for Change. Local insights gave context to the monitoring programme making the data collected more relevant to those involved, adding scientific evidence to the residents' opinions giving strength to the voice of the community. The results of this project offer a valuable resource which can be used as a foundation to effect change and improve the air quality in all areas of Tower Hamlets.

The London Borough of Tower Hamlets are already making great strides to improve air quality in the borough. They are committed to continue monitoring NO_2 at 90 sites across the borough and have recently introduced new powers to issue fixed penalty notices for idling vehicles whist holding anti-idling events at a number of primary schools. The council are also partners of the Zero Emission Network (ZEN) which is working with businesses and residents in London's City Fringe area save money, reduce emissions and improve local air quality.

In 2017, the council published the London Borough of Tower Hamlets Air Quality Action Plan 2017-2022 which sets out plans to improve and monitor air quality over the next five years. The plan includes installing a network of publicly available electric vehicle charge points; working with schools to reduce emissions and exposure; and essentially, ensuring a joined-up approach by working in partnership with TfL and GLA. You can read the full Action Plan at www.towerhamlets.gov.uk/Documents/Planning-and-building-control/Strategic-Planning/Local-Plan/Submission_2018/Air_Quality_Action_Plan_2017.pdf.

In addition, round 2 of the Mayor of Tower Hamlet's Air Quality Fund has opened for applications. This £121,000 fund is available for any local group, school or organisation who has a proposal to improve the air in Tower Hamlets. The first round of funding enabled a number of worthwhile projects to be undertaken, such as installing green screens around a nursery and swapping diesel powered landscaping equipment for battery powered tools.

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Appendices

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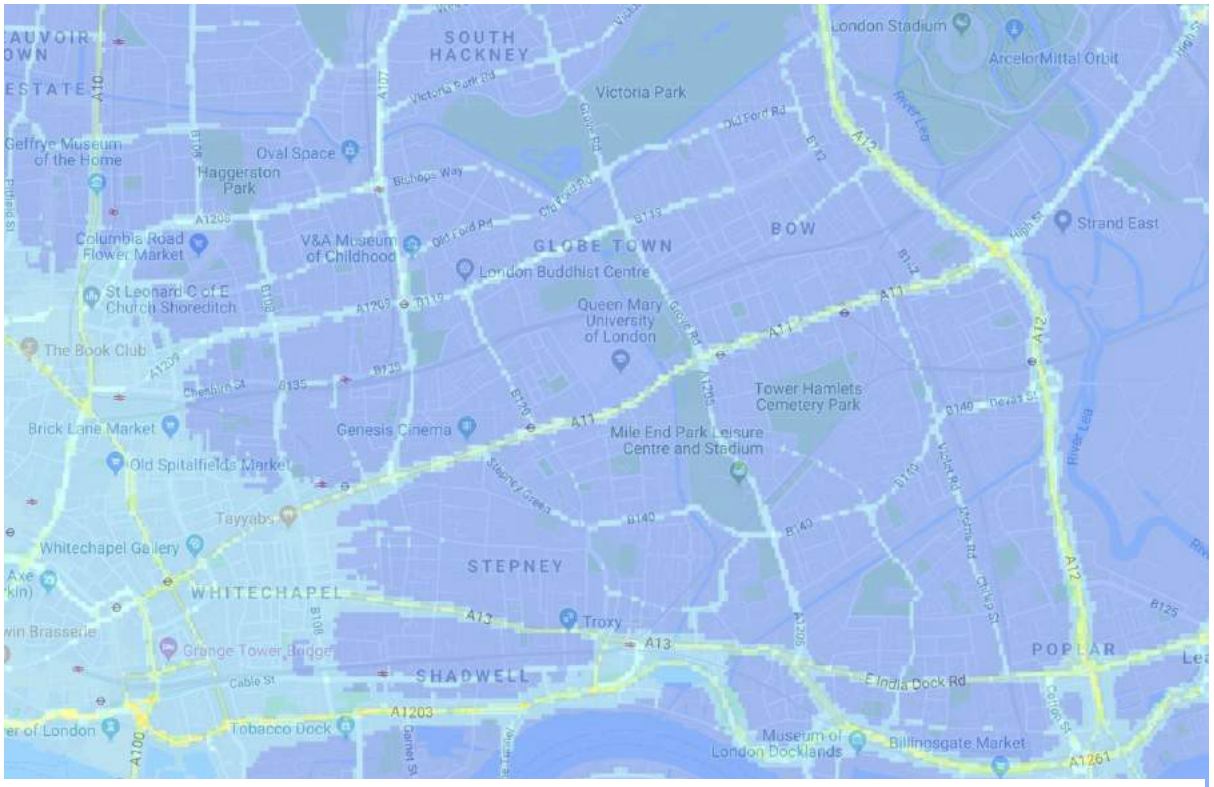
Key: Annual mean NO2 air pollution for 2013, in microgrammes per metre cubed (ug/m3)

<16 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85 88 91 94 >97

Passes annual mean objective | Fails annual mean objective

Appendix 1: Modelled annual mean NO2 concentrations for Tower Hamlets, based on measurements made during 2013



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Key: Annual mean PM2.5 air pollution for 2013, in microgrammes per metre cubed (ug/m3)

<13	13	15	17	19	21	23	25	27	>33

Passes annual mean objective — Fails annual mean objective

Appendix 2: Modelled annual mean PM2.5 concentrations for Tower Hamlets, based on measurements made during 2013