

THE EFFECTS OF ROUTE CHOICE ON PERSONAL EXPOSURE TO BLACK CARBON – A CASE STUDY IN LONDON

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1. INTRODUCTION

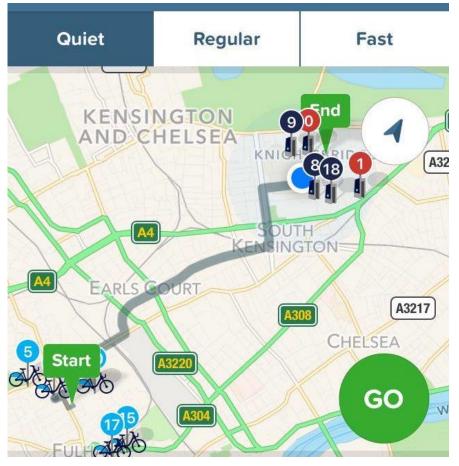
Black carbon (BC) is a component of the particulate matter emitted by the incomplete combustion of carbonaceous fuels, unrelated to noncombustion sources (Cheng et al., 2014). BC has been associated with respiratory symptoms in children (Kim et al., 2004), cardiovascular health effects (Peters et al., 2000) and with increased ST-segment depression in elderly (Gold et al., 2005). The aim of this study was to see if an individual could reduce their black carbon exposure by changing the route they take to work for example.

2. METHODOLOGY

The study conducted entailed two independent fieldworks. The collection of BC data was carried out using two Micro-Aethalometers (Model AE51, AethLabs, United States). The instruments were carried in the top pocket of a small backpack. The cycle routes for the two field works were chosen using the mobile app, Citymapper (2016). An additional set of data was taken with GPS recordings by the mobile app Strava (2016). The data collected was analysed using MATLAB (The MathWorks, Inc., United States).

3. FIELD STUDY I: FIXED ROUTE

The first field study was conducted between Fulham and South Kensington, using Santander cycles. The trip was bordered by the stations Halford Road (West Kensington) and Queens Gate (Central). Samples were collected on weekdays, between 8am and 10pm. For differentiation between on and off peak times, the differentiation outline by Tfl, as adapted for the oyster fare paid on the underground lines, was used; 6.30-9.30 Morning Peak and 16.00-19.00 Evening Peak (Transport for London, 2016).



	Mean BC On Peak [µg/m³]	Mean BC Off Peak [µg/m³]
Instrument 1	3.39 ± 0.73	2.64 ± 0.48
Instrument 2	3.64 ± 0.69	2.90 ± 0.55
Average	3.52 ± 0.69	2.77 ± 0.50

Figure 1: Fixed route between Fulham and SK Table 1: On-peak and off BC concentrations and 95%

confidence intervals

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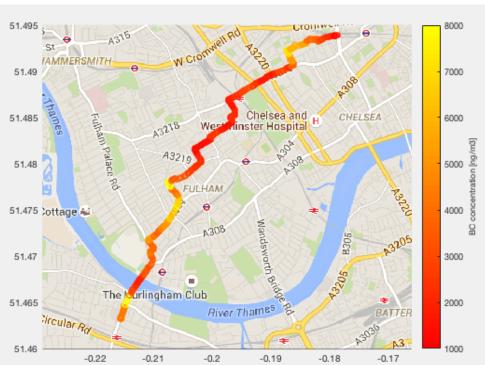
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4. FIELD STUDY II: ROUTE COMPARISON

Three route types between South-Kensington and Putney Highstreet were compared. These were a quiet route and a fast route cycled using the Santander cycle stations Queens Gate (Central) and Montserrat Road Putney, and a public transport route, using busses 14, 430 and 74.



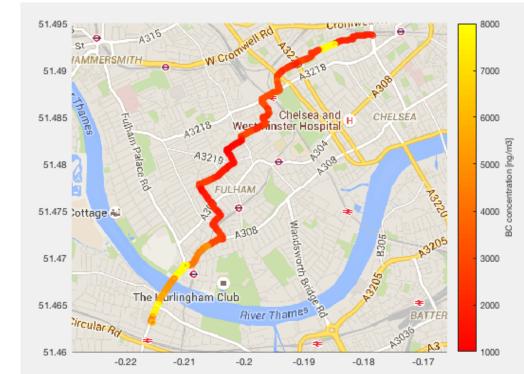
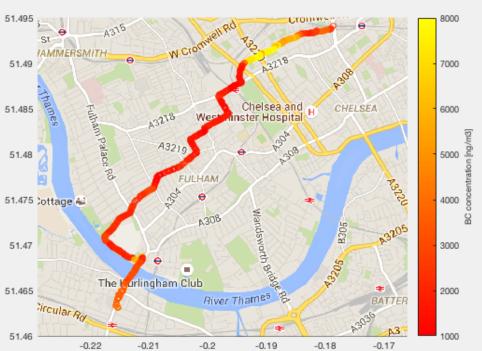


Figure 2: Fast Route from Putney to SK

Figure 3: Fast Route from SK to Putney



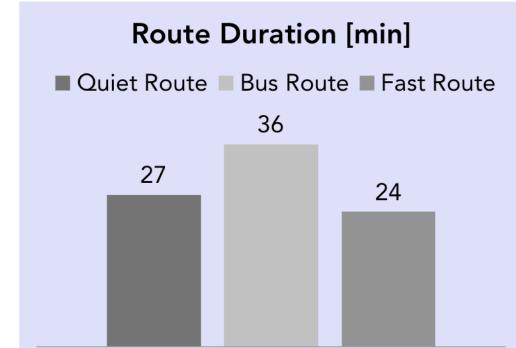


Figure 4: Quiet Route between SK and Putney

Figure 5: Route durations

	Mean BC Quiet Route [µg/m³]	Mean BC Bus Route [μg/m³]	Mean BC Fast Route [μg/m³]
Instrument 1	3.15 ± 0.43	6.92 ± 1.48	3.80 ± 0.49
Instrument 2	2.98 ± 0.43	6.96 ± 1.49	3.61 ± 0.45
Average	3.06 ± 0.30	6.94 ± 1.03	3.71 ± 0.33

Table 2: Mean BC concentrations on quiet, bus and fast routes with 95% confidence intervals

5. INCREASED INHALATION RATES ON ACTIVE TRANSORT MODES

Using breathing rates and the concentrations measured, BC dosages along the three routes were calculated and compared. As an outcome, the bus route became the lowest exposure route, followed by the quiet and fast routes. These results however, proved to depend largely on the adopted inhalation rates.

	Mean BC Dose Quiet Route [10 ⁻¹² μg/kg]	Mean BC Dose Bus Route [10 ⁻¹² μg/kg]	Mean BC Dose Fast Route [10 ⁻¹² μg/kg]
Instrument 1	1.69 ± 0.21	1.46 ± 0.31	2.04 ± 0.26
Instrument 2	1.60 ± 0.23	1.47 ± 0.32	1.94 ± 0.24
Average	1.65 ± 0.16	1.47 ± 0.22	1.99 ± 0.18

Table 3: Mean BC dose on quiet, bus and fast routes with 95% confidence intervals

6. CONCLUSIONS

- > Exposure to BC could be reduced by up to 56% by changing route.
- > Incorporating inhalation rates, resulted in the bus route becoming the lowest exposure route.
- > Dosage calculations were found to be highly dependent on inhalation rates.
- > Examining GPS linked BC data, it was found traffic density and high BC concentrations were found to be linked. This was also recorded in the fixed route study, where concentrations on peak were 27% higher than off peak.