## Methods

### Documents

Two CID reference documents, the CID Asset Information Guide (TFL, n.d. a) and the database schema (TFL, n.d. b) were obtained and assimilated to develop a description of the CID.

### Datasets

R version 4.0.3 was used for data importation and analysis (R Core Team, 2020). The CID data was accessed via the TFL cycling open data portal (TFL, 2017). As the data was available in a JSON file, the function read\_sf from the package sf was used to access and download the data into R as a simple features (sf) tibble (Pebesma, 2018). This function converts longitude and latitude into geometry. To simplify accessing and downloading the CID, an R package was created named CycleInfLnd (Tait and Lovelace, 2019).

Geographical boundaries (full extent of the realm), areas (ONS, 2020a) and estimated population for mid 2019 (ONS, 2020b) for London Boroughs were obtained from the Office of National Statistics. Boundary data was imported as an sf data frame using st\_read (package sf).

Full extent – used for ?

Clipped to coastline was used for boundaries for chloropleth and to obtain geographical area of the Boroughs (km2) lon\_LAD\_boundaries\_May\_2020\_BFC.Rds

Full extent of realm used to divide infrastructure that crosses Thames eg cycle lanes on bridges

Road lengths

Number of crossings

### Data manipulation

All spatial data was transformed into the British National Grid (ONS, 2020c) The tidyverse package was used for data cleaning, transformation and manipulation (Wickham et al., 2019). Each data item was examined to see if it was in the correct data format.

The CID variables were examined for completeness.

To ensure that all assets were correctly assigned to a London Borough, all assets were spatially cross-referenced with Borough boundaries. Where there was a mismatch or the CID Borough was NA, these were corrected as follows. Two ASL were assigned to the Borough location where the relevant ASL Traffic signal was located (1 NA, 1 reassigned). 29 Crossings were corrected (28 were NA, 1 reassigned) and a further one Crossing converted into two observations as the Borough Boundary intersected the Road and the Crossing equally. As Cycle lanes and Tracks can cross multiple Borough boundaries as well as cross into Local Authorities outside London, each Cycle Lane and Track was segmented by Borough boundaries and new assets created for each segment. For Cycle Lanes and Tracks, 72 observations were segmented and reassigned the correct Boroughs whilst a further 354 assets with no Borough assigned were segmented and then created into 621 assets. For Signals, there were no Nas, 2 observations were identified as being incorrectly labelled so were relabelled. Traffic calmning – no NAS for Borough, 138 reassigned.

Missing values were reviewed and managed appropriately. Where different datasets were to be joined, relabelling of the variables in common and their values was performed to enable successful joins. For example, consistency in London Borough names as either ‘Kensington and Chelsea’ or ‘Kensington & Chelsea’.

**PCT data**

Route network data and its associated estimated number of commuter cyclists using the network was exttacted from the Propnesity to Cycle Tool for the Greater London region (n = 69872). It was spatially cropped to the boundaries of the London Boroughs which gave 71494 route segments. 3233 of these segments crossed one or more Borough boundaries (1 boundary was crossed by 1600 and 2 boundaries crossed by 11). The length of each segment was calculated in metres. The number of metres cycled for commuting was calculate by multiplying the length of the segment by the number of cyclists using that segment.

**Cycle lanes and tracks data – degree of separation**

On road cycle lanes only were included in the analysis. Cross tabulations were generated for the various degrees of separation (segregated, stepped, part-segregation, mandatory and advisory cycle lanes) to establish whether a single asset could have more than one type of separation. For example of the 1371 segregated cycle lanes, 89 of them were also stepped. It was decidmmmmmmm7 ed to assign each asset to the ‘highest level of segregation’ according to the DfT Design guidance. This was achieved by creating multiple columns each representing a numeric value for degree of segregation (10000 for full segregation, 1000 for stepped etc down to 1 for advisory). These columns were summed. If the sum was > 10000 then the asset was assigned to full segregation if between 1000 and 10000 then assigned to stepped etc etc. The cycle lanes were split by whether they were shared with buses or contraflow lanes as opposed to general cycle lanes.

Spatial visualisations were generated to demonstrate the degree of separation.

Order of Protection from motor traffic on highways (DFT guidance pg 33)

# Fully kerbed > stepped > light segregation > Mandatory/Advisory

# FK/S/LS suitable for most people at 20/30 mph only FK suitable for 40mph+

# M/A only suitable for most poepl on 20mph roads with motor vehicle flow of <5000

# Correspnd in CID to:

# CLT\_SEGREG > CLT\_STEPP > CLT\_PARSEG > CLT\_MANDAT > CLT\_ADVIS

# NB seems to be little difference in CID between SEGREG and STEPP - majority of

# stepped are also labelled as segreg and only 5 are labelled as just stepped and they

# look very similar to those that are segreg in the photos

Lengths - ?

**OSM speed data**

Historical OSM data from ???2019 was downloaded This was read into R using osmextract package. Having transformed the data to the British National Grid, it was spatial limited to within the outer boundary of the 33 London Boroughs using st\_intersection. Observations that had the following values in the OSM category highway were kept( "primary", "residential", "trunk", "trunk\_link", "service", "unclassified", "tertiary", "secondary", "tertiary\_link", "secondary\_link", "primary\_link", "living\_street") whereas others such as motorway, escalator, proposed, bridleway, footway etc were dropped. This should have resuled in all waterways, aerialways and railways being dropped.

The ‘maxspeed’ variable was examine. All observations that had “NA” for maxspeed were dropped as were those labelled as national, signal and variable leaving 71660 observations. The resulting values for maxspeed were wrangled to obtain the speed in numeric miles per hour that was grouped into 10mph increments.

Usual practice in the UK for a highway lane width is 3.65m (Manual for Streets 2, pg 53) but this is dependent on multiple factors such as traffic volume and composition. The absolute minimum for cycle lanes and tracks is between 1.5 and 3 metres depending on direction and cycle flow (LTN 1/20 pg 43).

CID lane is sptially located at the nearside kerb – so CID buffer needs to be 3-6m

highway speed limit lines in general are mapped to centre line of road

so single lane road buffer should be 3.65m, two way road would be 7.3 and then more than one lane would need to be wider.

**IMD data**

**- ons data**

**- used local authority combined average - ? rank ? Average score**

**- assigned each LA to the decile of deprivation**

Spatial joins

London squared – used to enable spatial arranged of barcharts

# source data = "https://github.com/aftertheflood/londonsquared/blob/master/site/data/grid.csv"

### Data analysis

The number of infrastructure assets were calculated including by Borough. Borough was chosen as this is the local administrative unit and because whilst TfL builds a large amount of infrastructure, Borough’s also have their own Cycling Plans where they can build cycling infrastructure. For cycle parking, the number of cycle spaces as well as the number of cycle parking sites were calculated. Spatial lengths for cycle lanes/tracks and restricted routes were calculated using st\_length.

Mapview was used to display CID and ONS boundary data on background maps (e.g. street maps) to facilitate data visualisation (e.g. where the assets were in relation to Borough boundaries) and spatial analysis (Appelhans et al., 2019). Parallel coordinate plots were used to visualise multiple dimensions of the CID data (Inselberg, 1985; Wegman, 1990) using the Ggally extension to ggplot2 (Schloerke et al., 2021). To minimise the impact of the differences in scale in number of assets by Borough, the Borough were ranked.

### **Data quality and managing missing data**

Only one observation out of 233596 had an invalid survey date and only one duplicate observation was identified. The commonest missing data was photograph urls ranging from to 1.1% (Signage) to 6.7% (Restricted points). Five datasets had observations that did not have a Borough listed (see Table 3). Whilst the proportion of observations with missing Boroughs was very small, when the length of the observations from the Cycle lanes and tracks and Restricted routes datasets was calculated, it was seen that the missing proportion by length was much higher and thus needed addressing to enable fair comparison between amount of infrastructure by Borough.

**Table 3: Observations missing Borough data by asset type**

|  |  |  |  |
| --- | --- | --- | --- |
| **Asset** | **Number missing** | **% of total** | **% of length of assets** |
| Advanced stop lines | 1 | 0.03% | - |
| Crossings | 28 | 1.6% | - |
| Cycle lanes and tracks | 354 | 1.4% | 6.8% |
| Restricted routes | 18 | 1.3% | 8.2% |
| Signage | 2 | 0% | - |

### **Asset analysis by Borough**

The Boroughs were ranked according the total count or length of assets with one representing the Borough with the most and 34 representing the least. Although there are only 33 Boroughs in London, there was an additional ‘No Borough stated’ category as these charts were constructed before the approach to managing the missing Borough data was developed. As Boroughs vary by size and population, count and length were standardised to count/length (number or kilometre) per area (square kilometre) and per estimated head of population. Again Boroughs were ranked with 1 representing the highest density of infrastructure count/length by area or population.

Findings

# Highest\_separation rest\_count contra\_count shared\_count

# 1 Segregated 976 393 2

# 2 Stepped 5 0 0

# 3 Part-segregated 273 72 4

# 4 Mandatory cycle lane 1501 165 6

# 5 Advisory cycle lane 6877 283 36

# 6 No separation 53 522 2797