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**Article:**

Green, M.A. (2012) Mapping Inequality in London: A Different Approach. *Cartographic Journal, The*, 49 (3). 247 - 255. ISSN 0008-7041

<https://doi.org/10.1179/1743277412Y.0000000018>

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# **Mapping Inequality in London: A Different Approach**

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## **Abstract**

Maps provide an effective means of distributing ideas simply, creating a format which spatial data can be easily understood. However a lot of people are not aware where administrative boundaries lie, limiting their appeal for educating the public on important issues such as poverty and inequality. This paper seeks to utilise a well-known cartographic map design, the London Underground map, to aid data dissemination of the complex issues surrounding inequality and deprivation in London. A discussion of the relevance of this approach to researching inequality in London, as well as how this fits in with previous approaches to mapping London is provided. An example using the recent release of the Indices of Multiple Deprivation 2010 shows the usefulness of this design.

## **Keywords**

Cartography, London Underground, Deprivation.

## **Introduction**

London is a city divided both physically by its famous river and socially in terms of wealth. Yet whilst the river poses more of an inconvenience nowadays, the social divide appears to shut out half the city, damaging the life chances of those on the wrong side of it (Dorling, 2011). This social division has built up over many generations, each future one reinforcing its previous. The gap of those 'with' and those 'without' has continued to grow in recent times, to the point that it is now as wide as during the Victorian era. The Hills Report (2010) notes that the wealth of the top ten percent richest is 273 times greater than that of the bottom ten percent in London. This level of inequality is much higher than elsewhere in England.

The patterns and processes which have resulted in an unequal city present a complex picture. However this picture can still be painted, through maps. Mapping turns numbers into pictures, pictures into ideas and ideas into understanding. Though not always applied when examining spatial data (especially outside geography), they present us with an effective means of communicating ideas. A picture can be worth a thousand words and hence mapping can provide us with a useful means of analysis. Maps allow us to see how inequality has manifested itself in the environment, improving our understanding and helping to tackle it.

This paper presents a new way of exploring the themes of inequality within London. Through recreating a well known map design, it is proposed that the issues brought up in most maps of inequality can be better conveyed to the public. It is proposed that by using familiar map concepts, the issues surrounding inequality can be more accessible to the public. The next section shall examine how inequality and deprivation has been mapped in the past, before focusing on what has been achieved in London. Then the paper will briefly discuss the relevance of this design to researching inequalities in London, before presenting an example of its use.

## **Lies, Damn Lies and Maps**

Deprivation and Cartography

The first people to map deprivation were Charles Booth and Seebohm Rowntree around the turn of the 20<sup>th</sup> Century. Both of these showed poverty to be more widespread than thought

in their respective locations (London and York), as well as it being geographically determined. Since these landmark studies, maps have been used in public policy research. This has been seen in their use for examining the relationship between poverty and environmental risks (Holton, 2004), health (for example Noble et al., 2012) or just simply the spatial patterning of deprivation in major reports (for example CPAG, 2012). The visual nature of maps means that they are good at raising public awareness due to the improvement in data presentation when compared to other dissemination approaches. They provide a resource to open dialogue on poverty, starting a forum for people to discuss these issues. Bedi et al. (2007) used the example of Morocco to highlight this, as poverty mapping helped create a national discussion on the issue which led to King Mohammed VI changing his policies to tackle the patterns.

Some researchers have moved beyond choropleth mapping to improve the visual design of maps. Thomas and Dorling (2004) display data through standardising areas by population size so that no one area dominates a map. Dorling has helped build upon this work through the Worldmapper project (Dorling, 2007). This creates cartograms of the World and increases or decreases the size of each country in relation to its performance within a variable. Size emphasises the divisions and inequalities across the globe, with the results being visually effective. Despite this, the uptake of these approaches has not been widespread (Martin, 2011). Orford (2005) also discusses the future importance of animation, web-cartography and virtual reality in making maps more engaging.

Beyond these few examples, however, cartography has not really developed many new ways of visualising poverty and inequality. Thomas and Dorling (2004) argue that innovation within this field is stalling. Although this was eight years ago and some progress has been made, there is still much room for improvement in map design. Maps can be powerful devices to communicate ideas; however their designs are mainly centered on its creator. Many maps are made with respect to what the creator believes is best (MacEachren, 1995; Wood, 1992). Instead we need to re-focus designs towards the users. The brilliance of a map lies not in its geographical accuracy (though it should not lie in what it shows!), but its appeal to others; how it captures the imagination of its users and hence its dissemination of patterns and processes. Visualising data may gain people's attention, but the map needs to be truly engaging if it is to have any value.

### Mapping Inequality in London

No summary of mapping poverty and inequality in London would not begin without mentioning Charles Booth. His landmark work 'Life and Labour of the People of London' (Booth, 1889) was the culmination of nearly 20 years of research into the characteristics of the people who lived in Inner London. Part of this contained a map which classified each individual house into groups based loosely on social class. The map showed a city with severe problems of deprivation, with 30 percent of residents classified as living in poverty. What makes this figure more remarkable is that the study bore out of Booth's desire to prove the then Socialist Party leader Henry Hyndman's claim that 25 percent of Londoners lived in extreme poverty was a mere exaggeration (Orford et al., 2002). The findings proved a decisive factor in encouraging the government to tackle this injustice, as well as how poverty was measured and researched in the future.

Over a 100 years later, Booth's influence is still present. Orford et al. (2002) digitised Booth's map to allow a comparison with a modern London. Data was collected from the 1991 census using the Registrar General's social class groupings for an equivalent

comparison. The corresponding maps showed little change in the patterns of poverty over the course of the 100 year period (a poorer East and more affluent West). Despite all the advances and societal changes that had occurred, Inner London's social environment remained stable. Although the 'East End's' spatial concentration dispersed slightly, there still remained a distinct East-West divide. A correlation of the two poverty measures gave a highly significant relationship of 0.73. Similar findings were shown in Noble et al. (2012).

Choropleth mapping provides a simple yet effective means of displaying inequality across the city. This is easily interpretable, as areas with high levels of poverty can be visually seen. However an issue with this is that since administrative boundaries are arbitrarily used to display the data; people may not necessarily know exactly where these boundaries lie. Gibin et al. (2008) proposed a solution to improve accessibility of use through the creation of the 'London Profiler' website. This combined spatial data with 'Google Maps' to create a tool which would allow users to overlay data over maps which they could better locate themselves on. The recently created 'London datastore' website has also applied this idea to improve data dissemination as well. Improving people's engagement with maps through improving how recognisable they are appears useful

These examples all present the same problem that was identified earlier. Booth's map highlights how little poverty mapping has changed in over 100 years. These maps are still valuable to research, but they lack innovation. Choropleth mapping is the most common form of mapping but is becoming somewhat tiresome. Furthermore as Martin (2011) argues, rather than just focusing on complex models for urban and socioeconomic processes, we need to also develop new novel ways of exploring place and space. There is more data available than ever and we need to begin to explore how is best to display it. Though maps are not strictly analytical, the 'representations' they can create is something which can be exploited further.

### **Going Underground**

The London Underground first opened in 1863, allowing a short journey between Paddington and Farringdon Street, forming part of the Metropolitan line. Despite the few stations available, it proved incredibly successful, with 26,500 passengers using the service in the first six months (Day, 1974). It was introduced as a means of alleviating congestion in the city, allowed through the advances in the railway. It also allowed families to move from the squalors of central London to the suburbs, whilst still able to access employment (Hadlow, 2003). The underground system continued to expand, fuelled by competing companies building their own lines. This competition ended in 1948 with the nationalisation of the whole system. Since then the underground has continued to grow and currently has 356 stations on 12 lines, with the inclusion of the 'Docklands Light Railways' (DLR) and 'London Overground'. It is one of the busiest transports systems in the world, for example in 2007 one billion passengers used the service for the financial year, with an average of three million a day (TFL, 2007).

The London Underground is a place where an interaction between people of all social classes can occur. There are no boundaries, physical or social. People board at random, onto a carriage that has no prejudice. The carriage provides an environment which facilitates the mixing of different types of people. The poor sit next to the rich, the old next to the young, the healthy next to the sick. Passengers may not talk to each other and frequently journeys remain silent. Yet something as simple as a carriage provides a container for social mixing, even if most do not think of it like this. With most of the tube system existing beneath the

ground, people can quite easily pass through areas without having any idea of what that place is like. Each stop on the line may only be a short distance from the previous, however the tube system makes each place seem separate or unconnected. Those that use the system may never know the diversity they pass through each day.

With millions of people using the tube each day, it provides an opportunity to improve public understanding of the themes of inequality and poverty. This could be achieved through mapping. The London Underground map is instantly recognisable, being incredibly popular for its simple but effective presentation and stylish design. The map was originally created by Harry Beck in 1931, although it was not introduced until 1933 under fears the public would not understand it (Day, 1974)! Beck's inspiration was to bring clarity to previous designs by concentrating on how the lines were connected together rather than geography or distance (Hadlaw, 2003). This different way of representing space could be seen as an example of cartography, although it is more geometric in design. The familiarity of design, along with its popularity makes an adaptation of the map ideal for improving data dissemination towards the public. Its application to improve how we can visualise information has been highlighted elsewhere (Nesbitt, 2004 provides some abstract examples like for displaying a business plan).

Whilst maps are already good visual aids for improving data dissemination, designing the map around a popular cultural icon is even more powerful as a form of representation. Maps present ideas beyond what we experience in our daily lives (Wood, 1992). Beck's map is not just symbolic for transportation but also the personal experiences that take place during its use (Eco, 1985). Applying the map to incorporate deprivation information allows us to prompt these representations. This allows us to better 'grasp' the concept of the spatial variation of poverty in London. It presents a reality which is not visible (Wood, 1992). Connecting with users helps them imbue their own meanings and personalise their experience with the map, making it easier to derive information from it (Pinker, 1998). Representations are what make cartography interactive, helping people to engage more effectively with the themes of inequality, poverty and heterogeneity of the types of areas over space (MacEachren, 1995). Though this approach may be less useful for policy or for explaining patterns (I am not trying to suggest that tube stations are causing poverty!), its focus is upon the design. It presents a city as fluid and connected, with people of varying backgrounds constantly passing through it (Gilbert, 2002).

The use of the London Underground map appears only to have been applied once to aid researching inequality. The London Health Observatory produced a map of a small section of the Jubilee line (LHO, 2007). Focusing on life expectancy (2001-2005), the diagram showed that by starting at the Westminster station, each stop on the line travelling east represented a fall of almost a year for males up to Canning Town, where it was 6.1 years less. Whilst not entirely accurate, as data was gathered from electoral ward data which cover larger areas than just each individual stop, the presentation is effective in highlighting the wide inequalities in life expectancy that exist within a short distance. Similar to the application of the London Underground map later, this paper aims to use the map to improve our interpretation of deprivation patterns across the city.

## **Data and Methods**

The London Underground map was drawn in ESRI's ArcMap 9.3 through creating a series of points to represent each station based on the latest version of the map found on Transport for London's (TfL) website. As shown by comparing Figures 1 and 2 below, the end result is

relatively similar and hence recognisable. One difference between the two is that each station in this project's map contains its own circle. TFL's map differs since not every station is as distinctly marked, with many identified by a notch at a right angle to track line. This change was necessary to improve the visual impact of mapping data.

Each station was geo-referenced to its real world position using postcode data found on TFL's website, to allow them to be assigned data based upon their location. The 'Indices of Deprivation 2010' variable was then collected and stations were assigned the scores of their respective Lower Super Output Area (LSOA). This variable was chosen since it provides a more accurate indicator of poverty than other measures through including seven different domains to fully capture the various factors affect deprivation. Also using a variable at a low geography allows the map to highlight the intricacies throughout London. Data was also collected for the two previous indices of deprivation variables also (2004 and 2007 variants) to allow temporal comparisons.

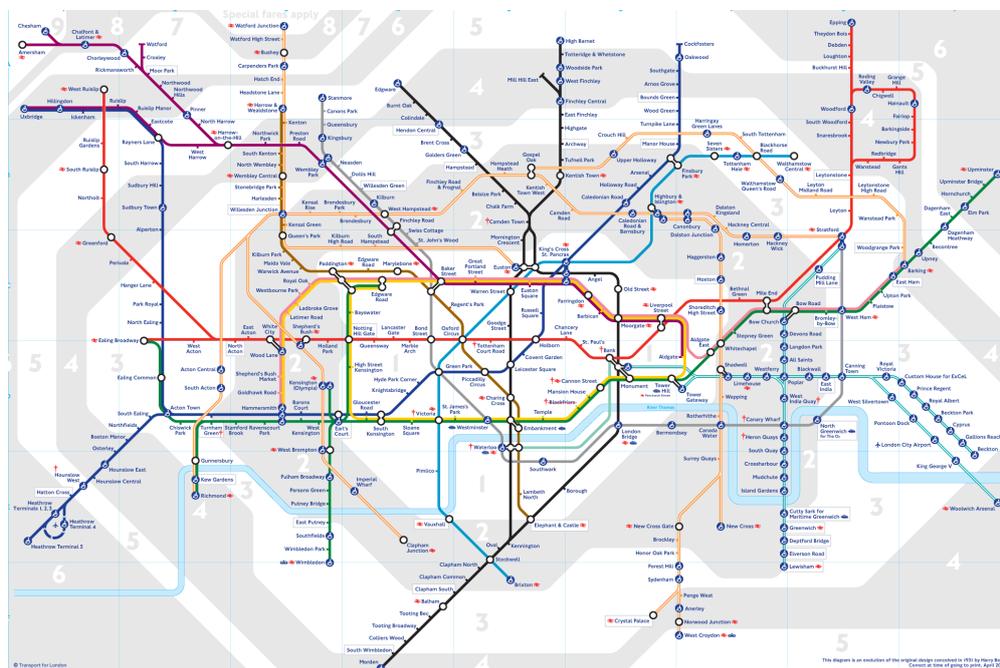


Figure 1: TFL's London Underground map

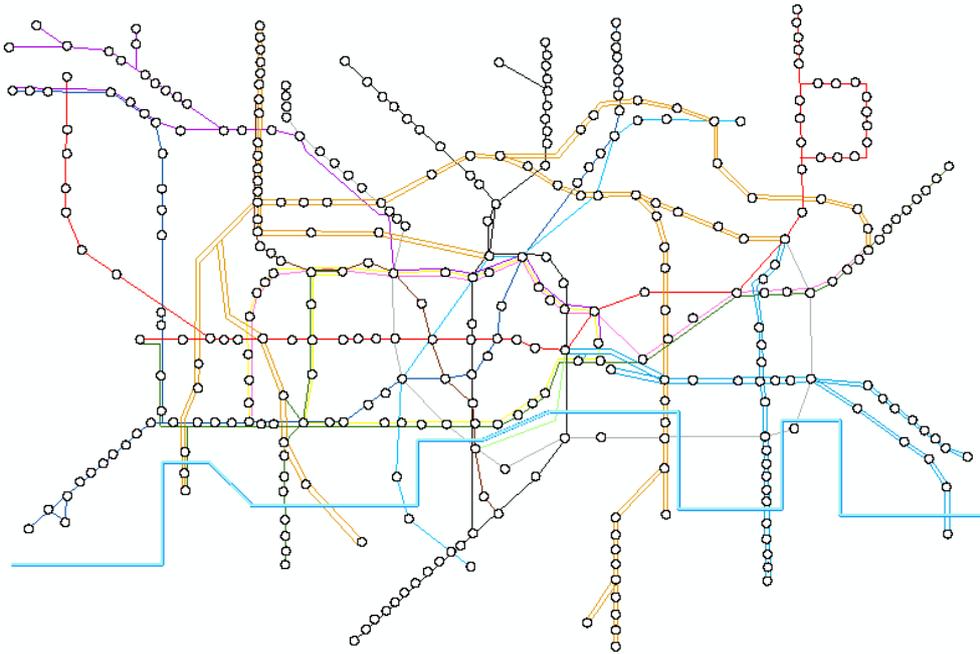


Figure 2: The London Underground map recreated in ArcMap.

### Discussion

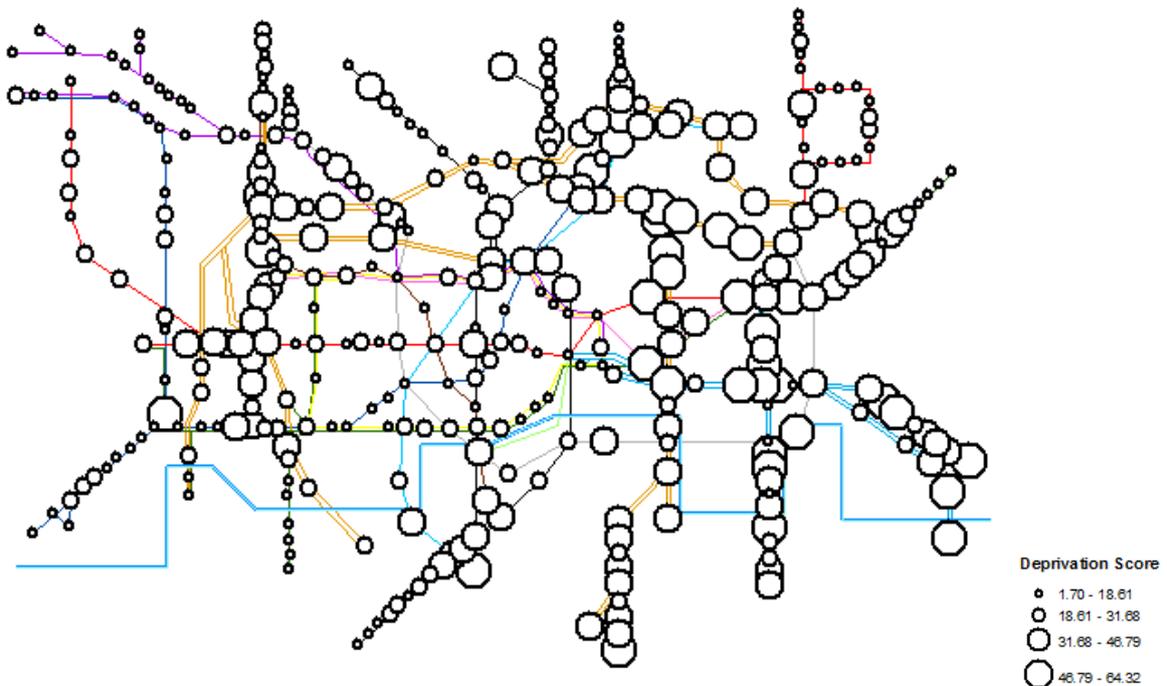


Figure 3: The spatial distribution of deprivation across London.

Figure 3 maps the indices of deprivation (2010) variable across the tube stations, with larger values representing areas of higher deprivation. Graduated symbols were used to improve the visual impact of the map, akin to what makes the ‘Worldmapper’ project impressive. The map generally exhibits the social heterogeneity of the city, with varying levels of deprivation

over small spaces. It presents a picture of a divided city, with large areas of both affluence and deprivation. The map captures the high levels of poverty found in the East of London, showing that the map presents somewhat accurate geographies. This does not however mean that the ‘West End’ is mostly low scores. Interestingly there appears to be a straight line of higher scores running down from the North Wembley Station on the Bakerloo line towards Hammersmith at the end of the Circle and Hammersmith and City lines. Not only is this an anomaly within an area of low deprivation, but it is also an intriguing pattern warranting further investigation.

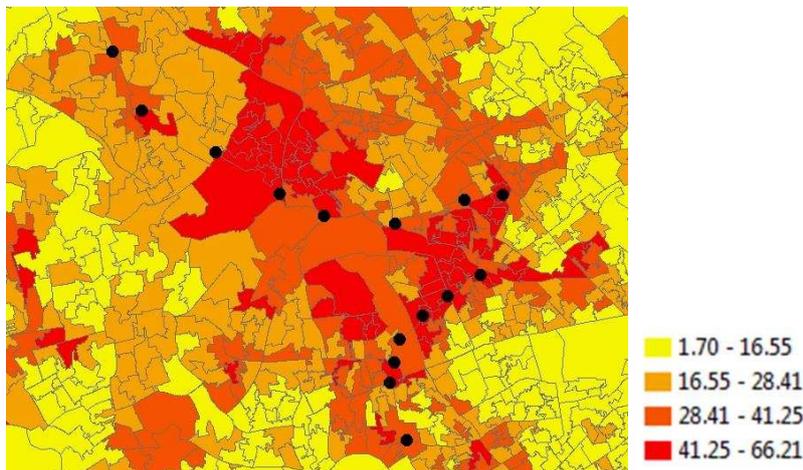


Figure 4: The location of stations plotted on the Indices of Deprivation (2010) for London.

Figure 4 shows the real world geographic location of the stations that comprise this ‘line’ of deprivation. These are plotted on top of the indices of deprivation (2010) values for LSOAs, divided by quartiles. Despite the wider area being relatively well off, these stations are located in a large area of contrasting make up. Most of the stations on the top line (Bakerloo and London Overground) lie in Brent which is relatively deprived. However two stations (Latimer Road and Ladbroke Road) are both located on the edge of the ‘Kensington and Chelsea’ London Borough, which contrasts with the wider area which is better off.

There may also exist inequalities between and within each line. Returning to the idea discussed earlier regarding a social mixing process, a Gini coefficient was calculated for each line using the indices of deprivation (2010) values of each station (see Table 1 below). This was chosen to highlight those lines which are running through a range of different neighbourhoods, since a higher value shows diversity of values. The Gini coefficient gives the variation in the observed data compared against if there was an even spread of data. It ranges from 0 to 1, with a value of 0 representing perfect equality, with 1 being the most extreme inequality.

Those lines which have low Gini’s (i.e. the stations they pass through have similar values) are the newer lines (the DLR and London Overground). Examining the map shows these lines mostly pass through more deprived areas, with the Gini coefficient suggesting less variation in these types of areas. Although there is no suggestion that people of lower socio-economic status are using the services, it does suggest that the expansion of the transport network has mostly benefited poorer areas, providing them with greater accessibility. This relationship can be seen through correlating both average deprivation score and the Gini coefficient, producing a strong negative relationship (-0.823,  $p=0.001$ ). But with 12 points this result should be taken cautiously. Although the lowest Gini value is for the Victoria line, the small

number of stations may account for this.

Line	N	Mean Deprivation Score	Gini Coefficient
Bakerloo	24	27.4	0.22
Central	49	21.5	0.26
Circle	35	21.6	0.25
District	60	22.8	0.30
Hammersmith & City	29	33.0	0.20
Jubilee	27	26.5	0.21
Metropolitan	34	14.1	0.31
Northern	49	22.5	0.22
Piccadilly	56	21.7	0.28
Victoria	16	34.4	0.10
DLR	41	36.5	0.20
London Overground	77	32.0	0.19
All Stations	356	25.9	0.29

Table 1: Comparison of the diversity of deprivation scores along the lines of the London Underground.

NB. Values for the ‘Waterloo and City’ line were not calculated due to the small dataset.

The temporal aspect of inequality can also be compared by looking at the changes between 2004 and 2010. Other than the district line, the most unequal lines all witnessed falls, becoming more equal. The more equal lines have generally become slightly more unequal or remained about the same. This would suggest that the levels of inequality have become more similar across the city. All the lines witnessed falls in the average deprivation score. Overall there appears to be improvement in the social problems found in London.

Correlating the relationships between the change in inequality and change in average deprivation score for the 2004 and 2010 data produced insignificant results. However examining the change between 2007 and 2010 values gave a negative correlation, suggesting that those areas witnessing the greatest fall in deprivation were lines which became more unequal. This finding could be interesting, with London not just becoming less deprived but also more unequal. This could just be due to one area becoming better off, which in turn would make an area more unequal. Or the bottom end of London is staying at similar levels, whilst the top end is continuing to increase its share of wealth, further stretching the distribution (and making areas less deprived). This is picked up by the recent TUC report which sees the growth in real wages for those in low income jobs stagnate, with huge growth at the top end (Lansley, 2011). Nevertheless with only 12 lines (and the fact that it was insignificant between 2004 and 2010), a deeper study is required, something which is outside the aim of this paper.

#### Limitations

It could be argued that there lies bias within the map design. As Figure 5 shows, the real geographical distribution of stations throughout London does not completely cover London. The South (especially the South-East) is under-represented and this may miss out important spaces of inequality, which remain invisible. Also in those areas on the outskirts and the

North, the railway is more important for public transport. This will also make the inequality along the lines and the notion of the social mixing caused by the London Underground less representative. The poor may also buses instead, as they are cheaper for transport, adding to this issue. A wider study which incorporates the whole of London, for example within London Boroughs, would more be useful for researching spatial patterns of inequality.

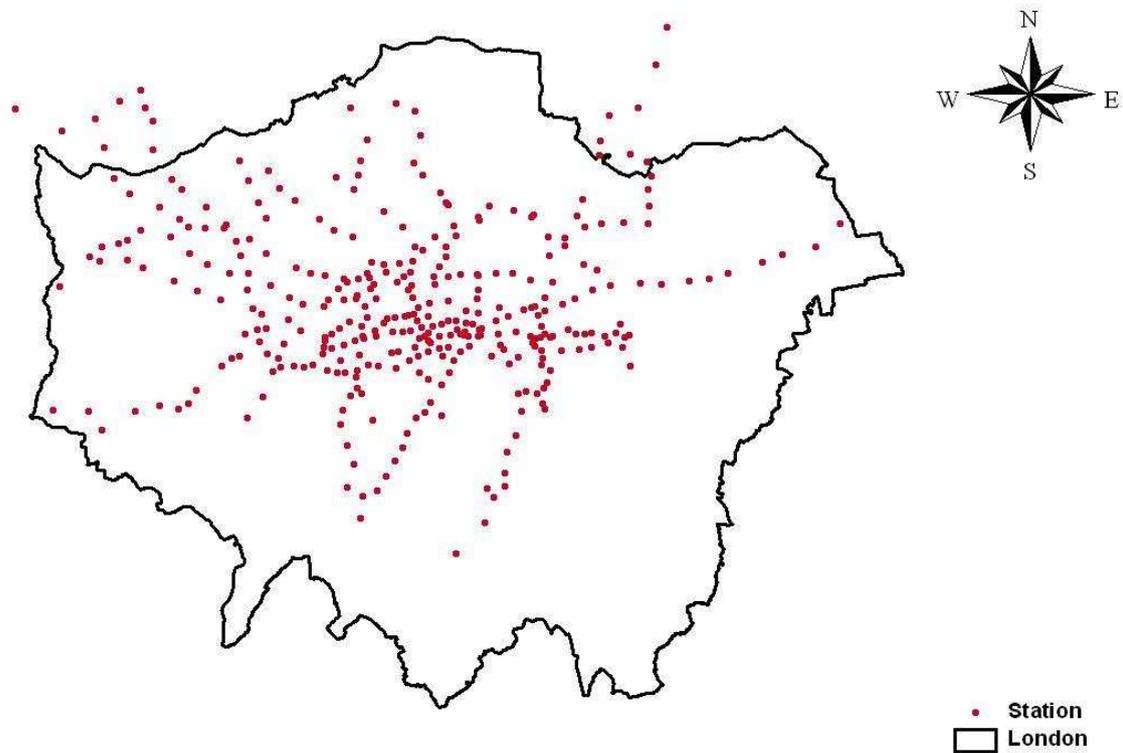


Figure 5: The real world locations of London Underground stations.

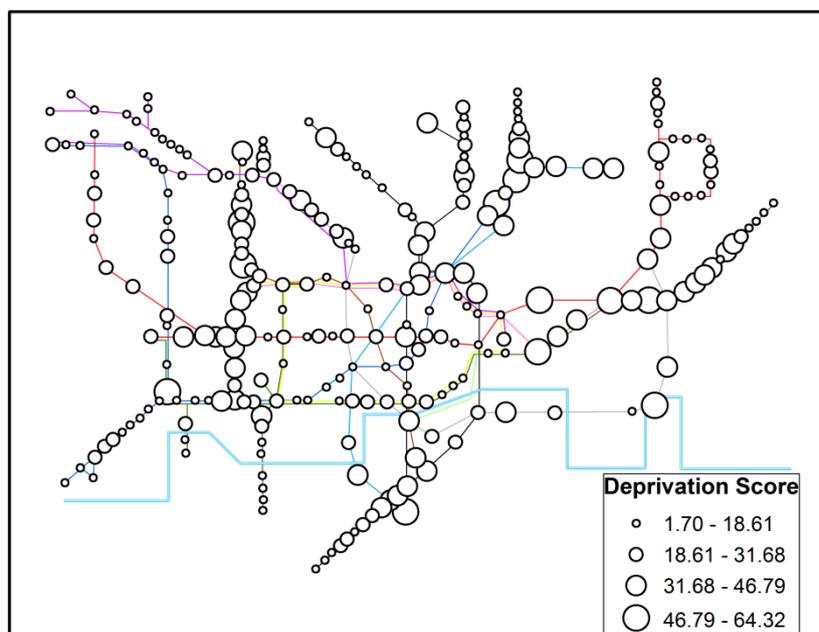


Figure 6: The spatial distribution of just the underground stations.

This bias is not just in what is covered by the transport system, but also relates to what was included in the map. Excluding the 'DLR' and 'London Overground' to create a map of just the underground stations presents a different map (Figure 6). This removes a lot of deprived areas from the map, resulting in a less pronounced pattern. There is still an east-west divide, though it is less distinct. The removal also further reduces the coverage of South east London, making the map less representative. However the aim of this paper was to convert the tube map and currently this incorporates both the 'London Overground' and 'DLR' networks. As this is the current point of reference it makes sense to focus on just this, whilst acknowledging the slight bias that exists.

Data is collected at the LSOA level, however this geography is small and may not relate to the wider area. Thus there may be some error involved in the geographical patterns presented here. Another approach would be to set buffers around the stations and take the average score of this instead. However the patterns found seemed to be similar to those found in the past literature (c.f. Orford et al., 2002). Also since one of the main aims of this project is to improve public awareness of these issues, this map may lead to the stigmatisation of areas. People may look at the map and identify some stations as 'no-go areas', choosing instead to get off at a different station instead. However all maps create the problem of profiling. The map presented here has been created to improve interpretation and therefore a trade-off has arisen.

Finally, the issues of data generalisation and ecological fallacies must also be considered with this analysis. Though the data was collected at the LSOA level (a geography which was created to keep areas as socially homogenous as possible), the patterns shown are not causal. Inferences about the population of London should not be made based on these aggregated statistics. The levels of inequality reported across the lines fall into this issue. By dividing up the stations into their respective lines, inequality appears low. However only the 'Metropolitan' and 'District' lines (two out of twelve) are larger than the value for all the stations combined, highlighting the issue. Any inequality comparisons should be made cautiously.

## **Conclusion**

It may be a cliché of geographers to use maps, but this does not mean that we have to rely on just standard topographic maps. What is presented attempts to innovate mapping; through using people's experiences and representations to drive map production. Using a popular and well known design of London will be more effective for people visualising inequalities than a standard map of wards or boroughs (which are less recognisable). It visually stands out compared to other maps of deprivation and inequality. This means the map gets a reaction, as people (mainly those from London) apply it to their own experiences. When the human mind can apply past structure onto the fresh information provide, the map becomes a more effective tool (MacEachren, 1995; Pinker, 1998). Though the ideas surrounding map design are not new, hopefully this paper can help stimulate more discussion on how to design maps, focusing more towards what may be best for capturing an audience.

Just as Harry Beck sought to bring simplicity to complexities of the network of stations, this paper has attempted to bring clarity to the complex patterns and processes of inequality that exist within the city. The maps have shown London in a new light, highlighting the inherent inequalities across the city. The map is no longer just a tool for navigation; an extra layer of information is provided at no cost to the map (albeit the station names have not been included) resulting in new information. There are distinct geographies set across the city,

showing that where you live can have an impact on your life. This could be useful in increasing awareness of these issues. With such a recognisable map, people can easily visualise the changes in any variable plotted from station to station and begin to think about these issues. This approach appears somewhat useful as a public information tool.

### **Acknowledgements**

I am indebted to my Grandad, who without giving me a diary I would have not thought about this idea. I would like to thank Danny Dorling for encouraging me to follow this idea and transform it into a paper. Many thanks to Luke Temple, Robin Lovelace and Bethan Thomas for turning an early draft into something a little more interpretable. I would also like to thank all the helpful comments received from those who attended my presentation at the 'BSA Researching Inequalities Postgraduate Conference' at the Open University (6<sup>th</sup> May 2011). Finally thanks must go out to the anonymous referees for their constructive comments in making this a better paper.

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