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HOW CITY SPACES AFFORD OPPORTUNITIES FOR RIOTS

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Abstract

An analysis is presented of the spatial and temporal distribution of offences during the 2011 London riots, responding to prior studies of the same that have found notable correlations with socioeconomic factors such as deprivation. We focus particularly on the character of street configuration of where incidents occurred, and find that normalized choice measures may be more relevant factors. While agreeing with the data in prior studies, this suggests a different interpretation of how riots occur. Three main proposals are discussed: (a) riots are not opportunistic within a local neighbourhood; (b) spatial configuration may be a more relevant factor than deprivation measures; and (c) rioter movement is determined not by being drawn toward attractors such as retail, but by natural movement through the street network.

Keywords: *riots, crime, proximity*

Theme: *Urban Space and Social, Economic and Cultural Phenomena*

Introduction

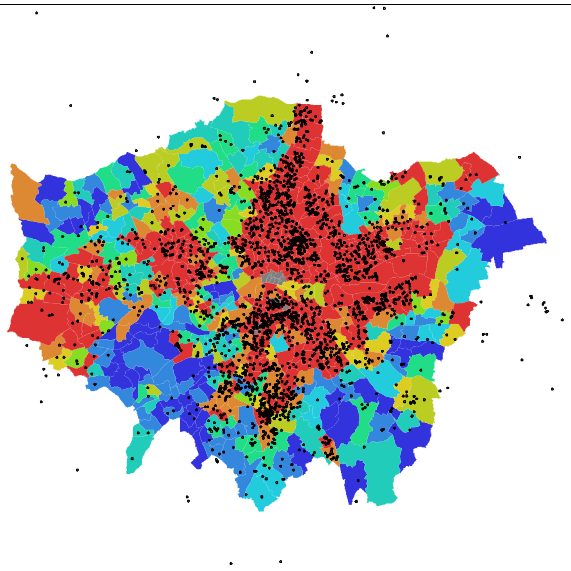
The 2011 London riots have attracted much attention and research into the causal factors of such incidents. This is no surprise seeing that police data record over 5000 incidents across Greater London within only 5 days of the riots. Different perspectives on the incidents were conveyed in an attempt to understand how the riots erupted, mainly focusing on the socioeconomic context and the affordances of social media. Above and beyond that, light was shed on the physical elements that gave an opportunity for these incidents to arise, in particular the design of social housing estates was argued to be an important factor that contributed to this phenomenon.

Recent research into the spatial distribution of both the residences of participants in the London and Manchester riots, and of the riot locations, has indicated clear relationships between measures of deprivation and addresses of offenders (e.g. Davies et al 2012; Williams and Cohen 2012), but do not yet give a complete picture of the location of incidents, travel to incident locations, etc. We present research from an ongoing study of the built environment in relation to security and crime, concerning the link between the structure of the London street network and data on all arrests made in conjunction with rioting activity on the London Riots of 2011, which demonstrates correlations between aspects of the finer scale configuration of London neighbourhoods and the likelihood of riot incidents.

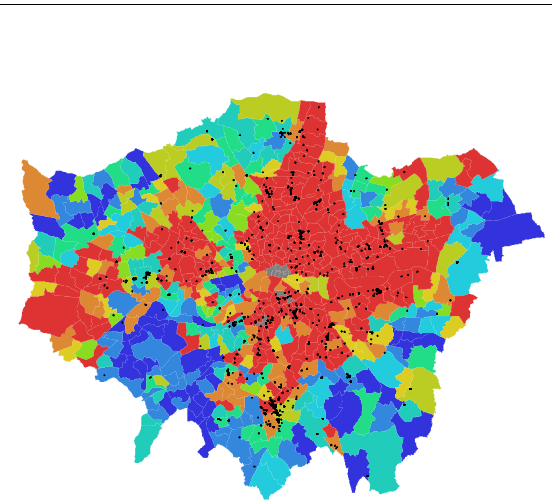
Initial results of Space Syntax research suggest that rioting occurred where urban spaces characteristic of a particular residential morphology are immediately adjacent to urban spaces of a particular commercial type, apparently suggesting a pattern of local, opportunistic behaviour. Police arrest data on distance travelled to the incident reveals a pattern of much longer travel times that indicate this is not always the case, however, and that the factors contributing to the link between spatial characteristics and riot incidents are more complex. We present research that examines the quantifiable spatial characteristics of the various relevant neighbourhoods across London, as they pertain to the spatial distribution of riot incidents. This appears to contradict several important aspects of the current interpretation of how the riots occur, as implied by recent research.

The current understanding

The current understanding of the London riots draws on a number of sources. While much research has been done on the social and psychological aspects of the phenomenon (Gross 2011), we are primarily interested here in their spatial dynamics, as revealed in research including crime data, mathematical modeling, and mapping of incidents in time and space. To put this background in context, we note here that at least two distinct methodological approaches have been taken, as exemplified by two distinct studies: a mathematical model of agent decisions located in time and space (Davies et al 2013), and an analysis of the network configuration of streets (Space Syntax Network 2011). Although these represent different approaches, they agree on several of the important factors that form the basis of the current understand of the riots and serve to outine the points most relevant to this discussion.

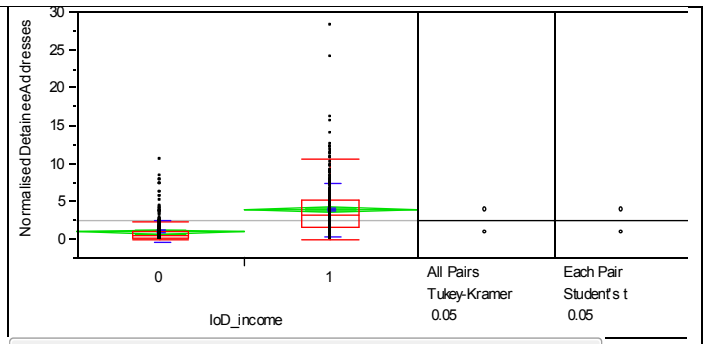


Correspondence between IMD and offender's addresses



Correspondence between IMD and Incidents

Higher IMD _ income based_ 2007 census



Quantiles

Level	Minimum	10%	25%	Median	75%	90%	Maximum
0	0	0	0.107807	0.416667	1.033215	2.258333	10.33333
1	0	0.398887	1.5	3.190909	5.2	8.425926	28.125

Oneway Anova

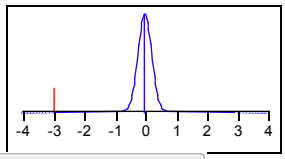
Summary of Fit

Rsquare	0.227649
Adj Rsquare	0.226403
Root Mean Square Error	2.712416
Mean of Response	2.4385
Observations (or Sum Wgts)	622

t Test

0-1
Assuming equal variances

Difference	-2.9406	t Ratio	-13.5183
Std Err Dif	0.2175	DF	620
Upper CL Dif	-2.5134	Prob > |t|	0.0000
Lower CL Dif	-3.3678	Prob > t	1.0000
Confidence	0.95	Prob < t	0.0000



Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
IoD_income	1	1344.4844	1344.48	182.7440	<.0001
Error	620	4561.4645	7.36		
C. Total	621	5905.9488			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
0	308	0.95403	0.15455	0.6505	1.2575
1	314	3.89461	0.15307	3.5940	4.1952

Std Error uses a pooled estimate of error variance

Means and Std Deviations

Level	Number	Mean	Std Dev	Std Err Mean	Lower 95%	Upper 95%
0	308	0.95403	1.51247	0.08618	0.7844	1.1236
1	314	3.89461	3.51136	0.19816	3.5047	4.2845

One way analysis of number of offender addresses (normalized by ward area) by IMD aggregated by ward

Figure 1 correspondence between indices of deprivation (IMD)[1] aggregated by ward against number of incidents or offenders' addresses normalized by ward area

The first is the role of socioeconomics. It has been emphasized in the literature that offenders come from disproportionately deprived areas. Davies et al. (2013) explicitly note that approximately 50% of riot offences occurred within the 20% most deprived areas as determined by UK's Index of Multiple Deprivation (IMD). Space Syntax (2011) do not directly refer to such poverty measures, but implicate proximity of post-war housing estates, generally associated with deprivation, as factors contributing to the likelihood of riot incidents nearby, then go on to note that court records indicate the majority of offenders live on such estates. They conclude by suggesting that further analyses including the IMD are crucial next steps.

1 Source of socioeconomic variables: Licence detail: UK Crown Copyright with data.gov.uk rights

Our evidence suggests that the socioeconomic factor is indeed highly relevant, and corroborate the suggestions above by noting the effect of deprivation on increasing potentials for crime activity. We look for correspondence between highly deprived urban neighbourhoods and number of incidents or number of offender addresses per ward. Indices of deprivation (IMD) are recorded according to the Income Scale, which is the number of people who are Income deprived. The scores are aggregated by ward. The number of incidents and the number of offenders' addresses are normalised by ward area. Data of IMD was split into two halves at a threshold of 80 to compare the means of the addresses count between the category of wards that are highly deprived and those that are less deprived. When rendering this relationship visually (figure 1), a clear correspondence can be seen between rioting origin/activity and IMD scores. The correspondence is confirmed by the one way ANOVA analysis shows a clear difference in the mean value supported by the statistical tests, thus confirming previous findings.

Also notable from previous research is the finding that riot locations occur primarily in areas of commercial activity. Davies et al. (2013) note that 51% of offences occurred against commercial premises. Space Sytntax Network (2011) use areas identified as 'established town centres' as part of a filter to identify between 84% and 96% of offence locations. Although many of these latter may be offences against non-commercial premises or property, these town centre areas are also those with the highest concentration of retail and commercial land use, and so strongly imply proximity. A plausible explanation for this is simply the affordances offered by retail premises for acquisitive offences; Davies et al. (2013) note this explicitly in suggesting that it is exactly this factor that makes such locations 'crime attractors'. The implication in both cases is that retail zones offer opportunities and therefore act as attractors to the rioters.

There is a further implication that rioting activity is opportunistic in the sense that individuals will tend to take advantage of a local outbreak of activity in deciding to riot. The primary finding in Space Syntax (2011) is one of local influence. Riot locations appear to occur where a post-war housing estate is in close proximity (400m or about five minutes' walk) to a local town centre, generally consisting of the retail zones mentioned above. The contributing factor of these estates is theorized to be their effect on socialization of their residents, as it is primarily residents of such estates that have been observed to participate. Although not explicitly stated, the assumption implicit here is that it is a portion of these residents who travel to the local high street within five minutes of their home, and take advantage of this opportunity to engage in rioting in a familiar and convenient location.

While our observations generally agree statistical findings of the studies mentioned, we present evidence that contradicts the story currently implied. In particular, the observations presented here suggest three revised interpretations:

1. Riots are not opportunistic in the sense suggested above.

2. Spatial configuration may be more relevant than deprivation measures.

3. Rioter movement is determined not by being drawn toward attractors such as retail, but by natural movement through the street network.

Each of these is addressed in turn in the following sections.

Method

Prior spatial studies of the riots have quantified the role of space primarily as measures of physical distance, either between an offender and a riot location (Davies et al. 2013) or between housing and commercial land uses (Space Syntax 2011). In addition to this, our primary concern in this paper is network distance. More particularly we are interested in the type of network distance that measures angular depth in the system, proven in Space Syntax as a powerful measure for capturing vehicular and pedestrian movement as well as active economic centres. Space Syntax is a branch of urban sciences that deals with network representations of spaces. Here space is defined as street space. It is represented by a line segment. These lines are represented as nodes in a topological network. The representation adapts the mathematics of network science to fit with planar networks, where nodes are spatially distributed and links are associated with a cost of turning from one street to the other. The cost of turning in segment analysis was defined by the degree of angular turn from one street segment to another; which was a specific syntactic measure of angular weighted graphs (Turner, 2000). The reason for angular weighting is cognitive (Hillier, Iida, 2005) as people tend to minimise angular turns as they walk through street spaces. Angular measures were proven to be more efficient than metric measures in predicting movement behaviour on a regional scale while being closer to population density on a localised metric scale (Turner, 2009).

In segment analysis, structural attributes are usually calculated by measuring geometric depth in the street network. Mainly choice -uniquely termed by Space Syntax- can be used to capture the angular geometric properties of centrality in a segment network representation of streets. Choice represents an angular weighted betweenness. It might be calculated for different neighbourhoods[2]. The neighbourhood might either be limited to a predefined metric radius or might cover the whole network (radius *n*). Angular choice was only normalised very recently (Hillier *et. al.*, 2012), and is still under testing. The normalised angular choice NACH captures one of the defining geometric characteristics of a street network. The normalisation regarded the dual relationship between total depth and choice as a cost-benefit relationship; where the cost of systems enlargement is countered by the benefit of shortening journeys across the system to reach to all segregated areas. Another important measure is node count calculating segment density within a predefined neighbourhood. NACH and node count define different characteristics of the network structure. Their mutual presence defined as over-permeability is thought to allow for better predictions for where riot incidents might be, especially when coupled with the presence of a post-war council estate (Space Syntax Network, 2011). It is important to mention that data used for Space Syntax Network findings was limited to one Borough of London (Haringey). In this paper we will generalise the results over the area of Greater London, for which street data of riots incidents and offenders' addresses was made available by the department of security and crime sciences, UCL. Due to lack of data on post-war estates, we relied mostly on the spatial measures to test the findings presented by the Space Syntax network. We looked at over-permeability defined as a relationship between NACH radius 10000metric and node count within a radius of 100metres. The values of NACH R10000metric are found to be highly correspondent with commercial and retail activity in Greater London (Space Syntax Network 2011). We also looked separately at NACH values for different radii.

2. the number of segments in the neighbourhood

Riots are not locally opportunistic

The first hypothesis implied by existing research is that riots are predominantly a local phenomenon, with individuals taking advantage of nearby activity. We address this first by examining travel distances. Under the existing hypothesis, we would expect median travel distances between home and offences to be within the same range as the 400m (or five minute walk) proximity used to explain the relationship between housing and high street.

The physical distance between origins and incidents can be seen to follow an exponential trend, as the CDF plots indicate (see figure 2). Most journeys are below a radius of 2000 metres, while less than 20% rise up to 5000metres and above. In fact this is approximately an order of magnitude further. Metropolitan police arrest data records rioters travelling a mean distance of 3.3 km between home and their point of arrest (in Harringay, the zone with the largest number of data points), or approximately eight times farther than the local neighbourhood considered as the zone of spatial effect, with some travelling as much as 4.6 km.

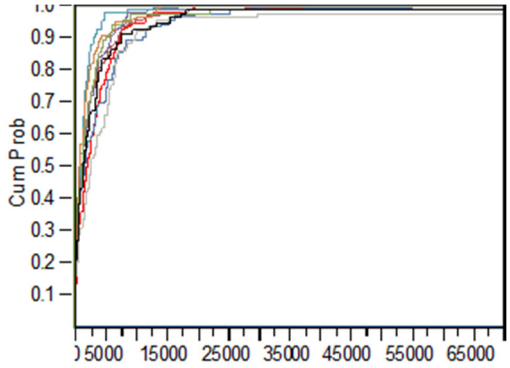


Figure 2 CDF plots representing data on distance between incidents and offenders' addresses taken for clusters of incidents in the following boroughs; Croydon, Peckham, Greenwich, Hackney, Brixton, East Ham, Clapham, Ealing, Camden Town

The temporality that associates the distance of travel shows an interesting pattern in the diagrams and histograms in figure 3. Events seem to start increasing quickly to reach a high peak, after which they start decreasing gradually at a lower rate. It is clear that, when events intensify, they tend to be associated with longer distances of travel signifying -may be- the role of social media and other means of communication that invite action from remote locations. Incidents that follow the high peak appear to be local, perhaps benefiting from the chaos that followed the rioting activity. This pattern seems to apply to most London boroughs.

To reveal the effect of social media, we plot the Google trend factors for each geographic location against the distances of rioting activity that took place in these localities (figure 4). We find that in cases where there is a high count of incidents associated with long distances of travel there is high media attention communicated through the web. This is clearly the case with Croydon, Tottenham, Hackney, Ealing and Enfield. This seems to support the assumption that long distances of travel to rioting locations might be triggered by media. This finding is yet in need for further verification; by probably looking for evidence in Twitter feedback and by distinguishing the directionality of travel whether inwards or outwards.

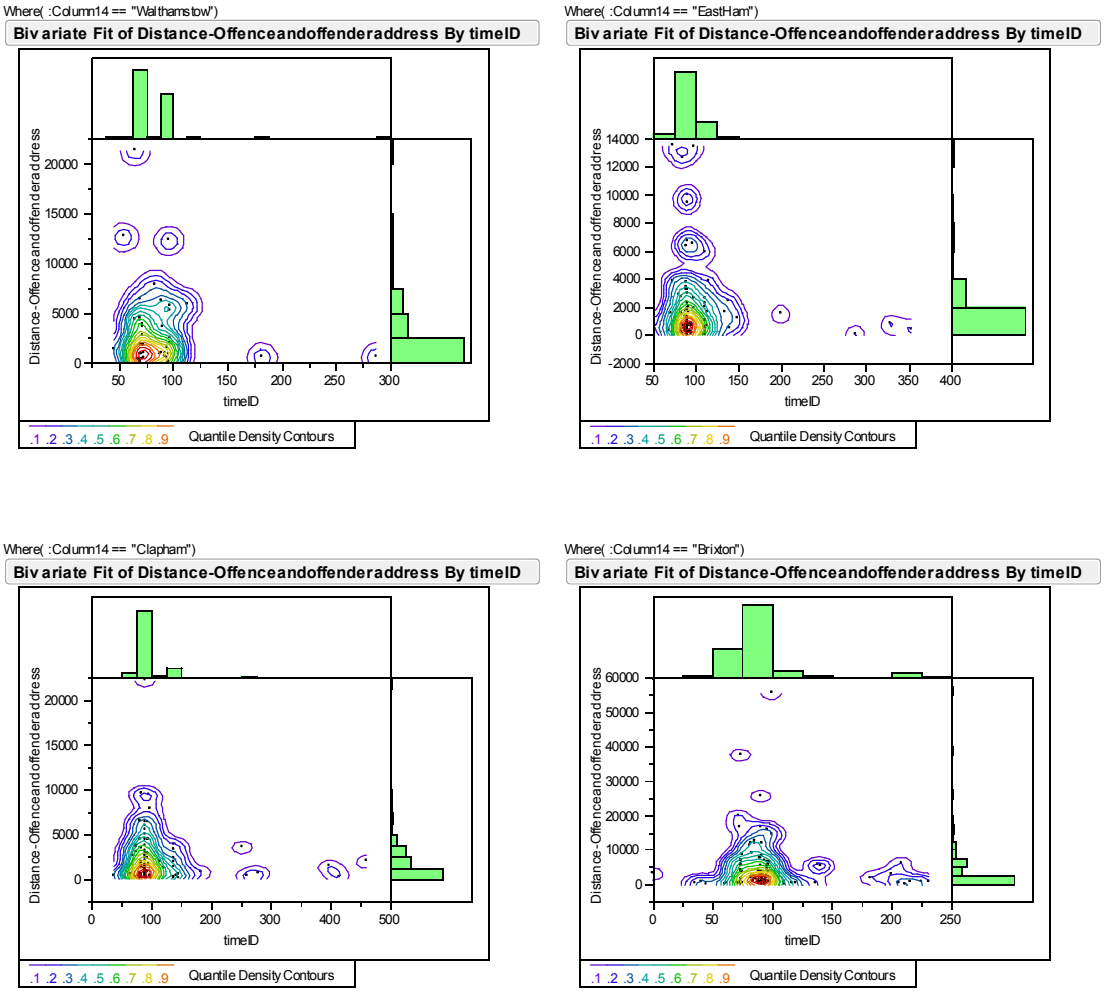


Figure 3 Plots representing distance against time for a selection of London boroughs.

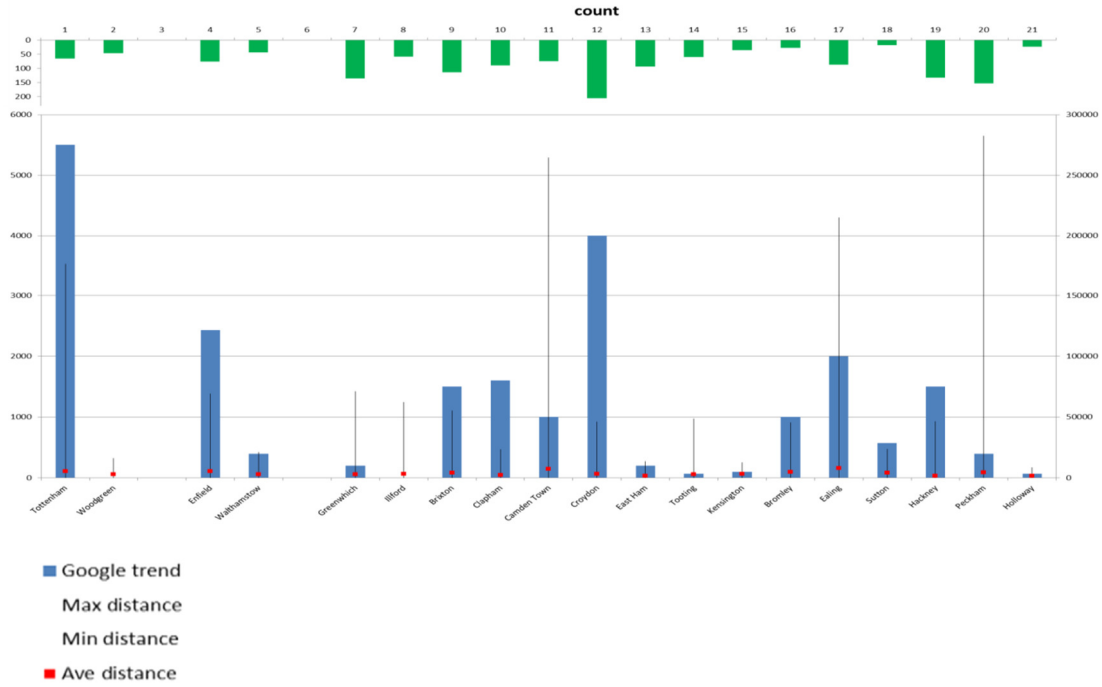


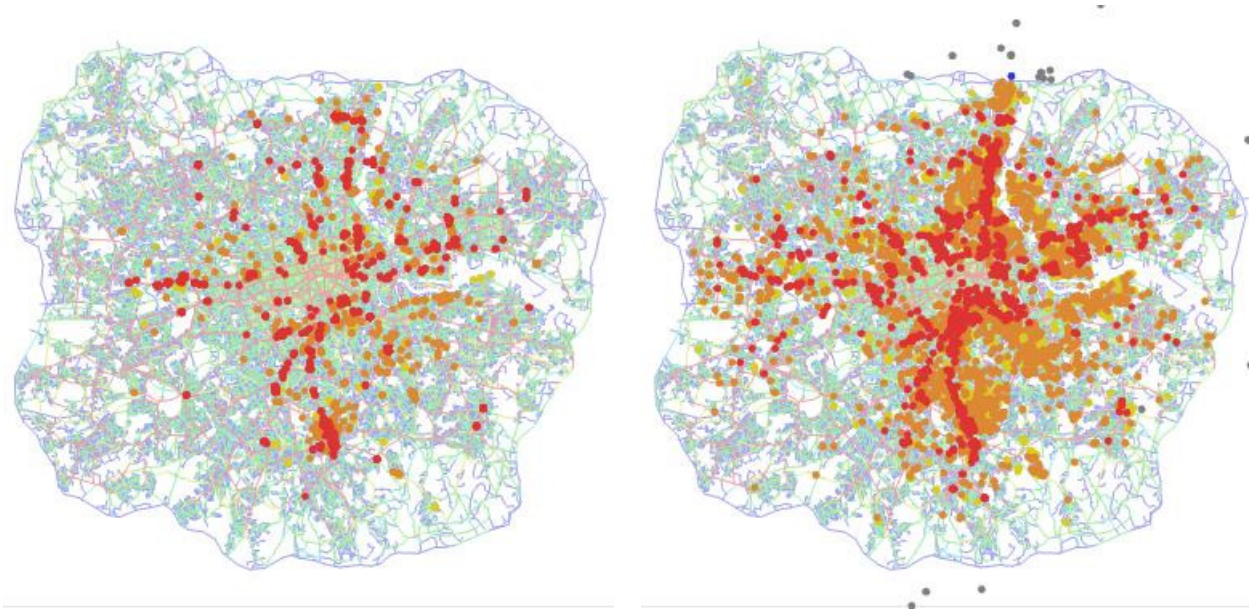
Figure 4 A diagram showing the relationship between distance and factors representing Google trend communication during the riots period for each location.

Space is more significant than poverty

In this section, we test again the hypothesis that riot locations are strongly affected causally by proximity to deprived areas as Davies (2013) Gravity model suggests. The model based on physical distances, suggested that the likelihood for incidents increases with proximity, and IMD. Therefore in absence of other factors such as policing etc. IMD has a strong impact on the riot locations and dissipates evenly based on distance.

Here we argue that Normalised choice is a far better predictor of the location of riot offences than IMD and distance decay functions. Choice is network based, not gravity/distance based. NACH R10000 seems to be most effective at picking up areas with dense incidents and offenders' addresses within a vicinity of 400metres distance (figure 5).

To look for quantitative definition for the spatial and socioeconomic measures that are within a 400metres catchment area of an incident or an offender address, we define a threshold of 75% of the spatial and IMD values (table 1, 2). We look at choice, over-permeability, and IMD separately and combined. We find that choice performs best at forecasting where offenders live and even better at where offenders are likely to commit crimes. When combined with choice, or when used separately, over-permeability appears to be slightly less effective at predicting counts of riots or offenders' addresses. However, the measure is helpful in defining another physical characteristic of the street network; that is of node count. When combining choice with IMD, the predictability of rioting activity appears to be even lower. It is important to emphasise that –unlike spatial street data where maximum values are considered- IMD data is aggregated by ward. Hence, the results need to be confirmed by seeking more consistent data set on poverty that better relate to the spatial data.



NACH values corresponding to incidents

NACH values corresponding to Offenders' addresses

Higher NACH radius 10000metric

Figure 5 NACH values corresponding to incidents and Offenders' addresses within an area of 400metres = 5minutes walk

Table 1 number of incidents within an area of 400metres = 5minutes walk against different spatial and socioeconomic measures (above 75% threshold)

total	@75% NACH10000&Over-Permeability	@75% NACH10000&IMD	@75% NACH10000	@75% Over-Permeability	@75% IMD
2242	2183	1752	2240	2183	1753
100%	97.37	78.14	99.91	97.37	78.19

Table 2 number of Offenders' addresses within an area of 400metres = 5minutes walk

total	@75% NACH10000&Over-Permeability	@75% NACH10000&IMD	@75% NACH10000	@75% Over-Permeability	@75% IMD
3256	2969	2558	3234	2975	2570
100%	91.19	78.56	99.32	91.37	78.93

Rioters move through the grid, not to the attractor

The final implied hypothesis is that the primary importance of the retail element is as an attractor, affording opportunity for looting etc. to an individual offender. While an offender might be thought to be opportunistic in the sense of acting locally, they act as a "rational agent" (Davies et al 2013) in choosing the specific target. The retail element, and its retail function in particular, is thus conceived as an attractor—a direct motivator of action. There is certainly a demonstrable correlation between riot locations and commercial/retail land use; our data (not shown here) agrees with this.

There is another factor of these locations that may be more relevant, however. Because high values of choice in the street network are associated with more through movement, there is a natural clustering of commercial activity in these areas—the "local town centres" referred to in (Space Syntax Network 2011). Rather than the retail element acting as the attractor, it may be instead the natural movement through, and corresponding famiarity with, these high choice routes that make them likely zones for riot activity.

Unlike the socioeconomic or land use labels used in (Space Syntax Network 2011; Davies et al 2013) , we find that not only is normalised choice a clear indicator of offence locations, but it is particularly relevant at distances of several km. In Figures 6 and 7 indicate the longer range radii are slightly better at predicting incidents and offenders' addresses. The difference is remarkable between the mean of overall NACH values and NACH values recorded within 400 metres of an incident or an offender address. This difference falls slightly at a radius of 5000metres and falls again at a radius of 1200metres. The range of values narrows after a radius of 5000metres to sustain a fixed value for lower radii.

There are two likely mechanisms at play here. The first is that these choice levels are important because they correlate with the placemnt of the retail centres that act as attractors to rioters. This agrees well with previous studies that note such retail attractors, but gives a further explanation based on spatial configuration. The second mechanism is that the rioters themselves are actually drawn to the riot locations by virtue of their likelihood to travel through high choice routes—natural movement (Hillier et al. 1993). The fact that this distance corresponds roughly to the median distance travelled to riot offences suggests not only that the street network is a contributing factor in the selection of location. Natural movement is movement determined by the street network in the absence of other factors, such as attractors. Riot participants can be considered to be participating in the natural movement of the city, not simply drawn to attractors.

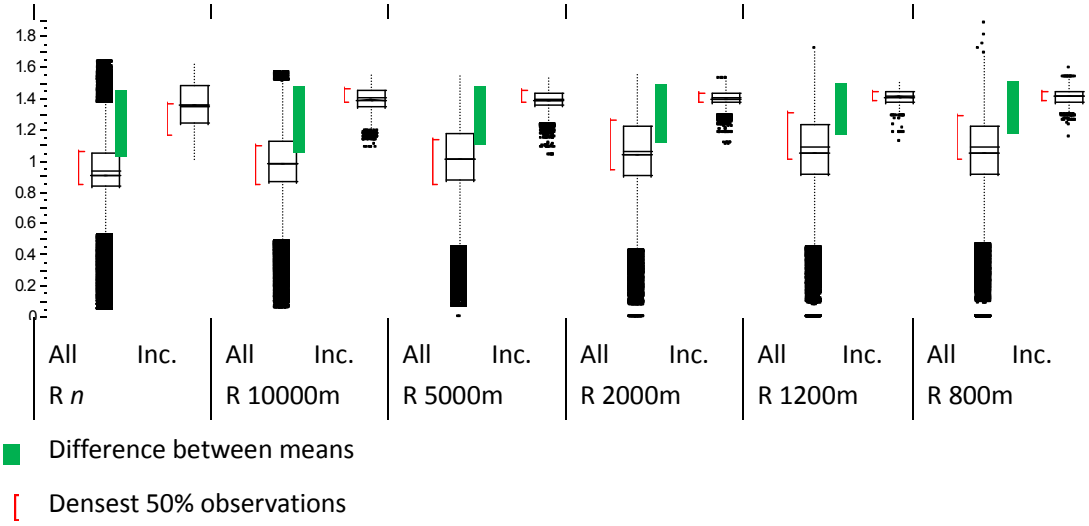


Figure 6 Outlier box plots showing the statistical distribution of NACH values calculated[3] for all segments against NACH values for segments within 400 metres of an incident

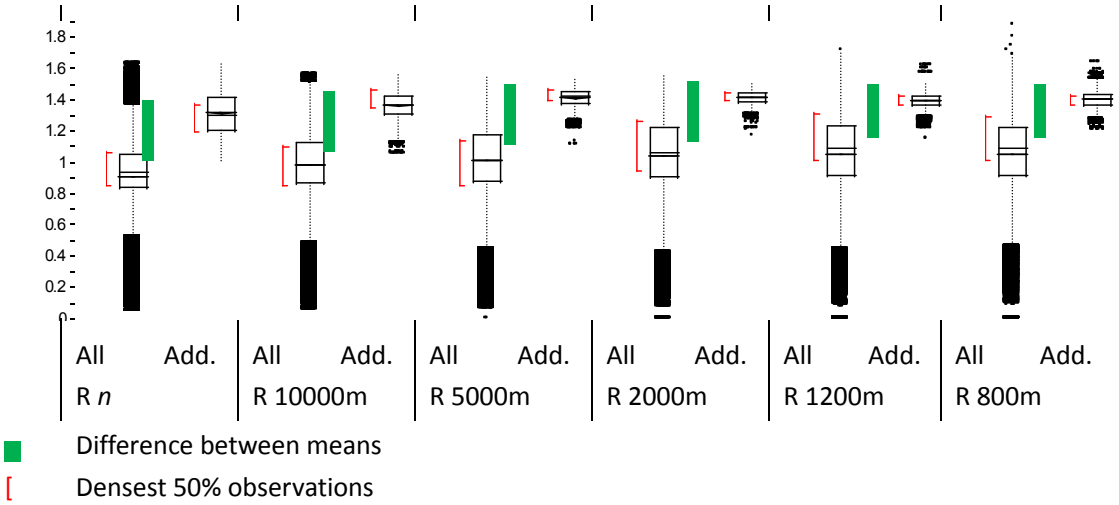


Figure 7 Outlier box plots showing the statistical distribution of NACH values calculated for all segments against NACH values for segments within 400 metres of an offender home address

Conclusion

Several prior studies of the 2011 London riots have noted significant patterns in their spatial dynamics, notably in terms of distances and correlation with population geography, land use and street configuration. These sketch a picture of riot behavior that is at first driven by socioeconomic factors, but then motivated spatially by factors of proximity and immediate opportunity. The observations noted here agree in statistical facts with previous work, but suggest an interpretation that is different and somewhat more complex.

3 NACH is calculated using UCL Depthmap (Turner, 2010).

The primary contribution has been the analysis of the larger scale configuration of streets, beyond the neighbourhood of the immediate five minute walk. We observed that rioters travel significant distances to riot locations, suggesting some longer range planning than simple local opportunism, but that their choice of movement to riot is determined more by the configuration of streets than by targeted attractors. Where the prior interpretation suggests opportunism in timing of events but intentionality in targets, a more accurate description might be the reverse.

The riots represent a unique phenomenon of study due to the concentration of offences in time and space, and the amount of data available. Several aspects of the interpretation of these data, however, particularly the relationship of incidents to the configuration of urban streets, may well generalize to other riot occurrences, or more generally to other types of crime and crowd behavior. The interpretations presented here are based on analyses that are still ongoing, and may be dependent on several questions still to be resolved. In particular, we have asserted the importance of the street network as a determining factor while still acknowledging the relevance of particular land uses—retail or housing estates. Determining the separate effects of space, use, and policy is still an open question, but one the answers to which may well be significant to planning, policy and policing strategies. These may be determined empirically and warrant further research in this area.

Acknowledgements

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References

Davies, T. P., H. M. Fry, A. G. Wilson, and S. R. Bishop. 2013. “A mathematical model of the London riots and their policing.” *Sci. Rep*. 3, 1303; DOI:10.1038/srep01303.

Gross, M. 2011. “Why do people riot?” *Current Biology* 21:673–676.

Hillier, B., A. Penn, J. Hanson, T. Grajewski, and J. Xu. 1993. “Natural movement: or configuration and attraction in urban pedestrian movement.” *Environment and Planning B: Planning and Design* 20:29-66.

Hillier, B. 2012. “Credible mechanisms or spatial determinism.” *Cities*. doi:10.1016/j.cities.2012.05.013.

Space Syntax Network. 2011. *First Findings 2011 London Riots location analysis: Proximity to town centres and large post-war housing estates*.

Till, J. 2012. “The broken middle: The space of the London riots.” *Cities*. doi:10.1016/j.cities.2012.01.004.

Williams, N., and N. Cowen. 2012. “Manchester riots of 2011 and the Index of Multiple Deprivation.” *Radical Statistics* 106.