Space and Exclusion: Does urban morphology play a part in social deprivation?

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Abstract

There is currently a growing interest in the spatial causes of poverty, particularly its persistence. This paper presents methodological innovations that have been developed for investigating the relationship between physical segregation and economic marginalisation in the urban environment. Using GIS to layer historical poverty data, contemporary deprivation indexes and space syntax measures of spatial segregation, a multivariate system has been created to enable the understanding of the spatial process involved in the creation and stagnation of poverty areas as well as to analyse the street segment scale of configuration.

Key words: space syntax, GIS, poverty data, street-scale, configuration, urban

Introduction

The study of poverty has a long history, and can be traced back to the work of Charles Booth, whose massive survey of economic conditions across London during the last decades of the 19th century, and their depiction on a series maps of social deprivation has been noted as the first modern social survey (O'Day and Englander 1993), although a concern with surveying and recording poverty can be dated from much earlier in the 19th century, with Engel's 'The Condition of the Working Class in England' (1844) and Mayhew's 'London Labour and the London Poor' (1861). A concern with poverty and deprivation continues amongst researchers, social reformers and policy makers today (DTLR 2001). This paper presents the theory and methods which have been developed for an EPSRC study: 'Space and Exclusion'. The paper opens with a review of current research into the geography of deprivation and goes on to detail some key studies in the area. The following sections explain the use of space syntax theories and methods for microscale spatial analysis and their development for the Space and Exclusion study. The paper ends with some initial findings, suggesting that urban form in its own right can be a significant factor influencing the spatial distribution of poverty.

Background to the Study

Previous research into geographic patterns of income deprivation indicates that despite changes in rates of deprivation, certain urban districts have persistent clusters of social exclusion (DTLR 2001). Previous research into this persistence has tended to concentrate on the social causes of poverty (e.g. Byrne 1998, Rosenbaum 1995), rather than its morphological influences. This paper uses space syntax methods to quantify integration and segregation of the street network in order to study the relationship between urban form and the geography of poverty, using Booth's maps of poverty 1889 and 1899 as a source for precise, street level data on economic situation.

The distance of time allows the longer-term economic/spatial/social evolution of cities to be studied and enables the unpacking of the various contributory factors of urban change to be analysed. This stage of the research focuses on the East End of London during a time of rapid urban change due to slum clearance and immigration flows in the area.

Studies of segregation and their spatial scales

Within the analysis of spatial configuration of deprivation, the detailed analysis of local variations is crucial. This, in turn, requires highly detailed and localised information about the socio-economic condition of the population under consideration. This is clearly the case with the Booth maps, where the 7 classes provide information at the building block level.

During the 1990s, the increased computational capacity of GIS (Geographical Information Systems) and the proliferation of detailed datasets enabled researchers to look at the human-geography at a finer resolution (Martin 1991, Bracken and Martin 1995). The use of statistics that are based on local, neighbourhood scale geographies are now common (Boyle and Dorling 2004, Martin 2004, Webber and Longley 2003). As computing capabilities and methodologies have improved, studies of this type have produced output statistics for increasingly smaller areal units. For example, the UK census in 1991 was published for 113,465 enumeration districts whilst there were 175,434 output areas in the 2001 census, representing 123.47 households on average (Martin 2004). Many applications of detailed geography rely on the postcode unit, which matches about 15 households (Lloyd et al 2003).

However, this rich information falls short of the needs of our study. The census output areas are too large as they contain several street segments and lump together busy and quiet streets, residential and shopping streets. This is diametrically different from the individual building block detail which is used in Booth map, or the type of data which has been used in other studies (Hillier 1998).

Although reports from geographers that have been granted access to household level statistics exist (Benenson and Omer 2003), and in some locales (USA for example) detailed information is available to the public freely (Thurstain-Goodwin 2003), in most cases these data are unavailable due to disclosure and privacy concerns, and even in areal outputs, data are adjusted to ensure confidentiality (Boyle and Dorling 2004). In the UK it is only in the case of historical data (e.g. census data over 100 years old), that information on individuals and households is

available. Although the main sources of historical social data for this study are the Booth maps, it also uses census data as a reference for information on immigration in the East End area.

Previous analysis of the spatial aspects of deprivation and poverty has been based on censuses (Leclerc and Nelson 1999, Noble et al 2000, Ballas 2004), and usually provide information at neighbourhood scale level. Some recent studies (Harper 2002) have used the finer scale of postcode geography to inform local policies.

Various methodologies are employed in spatial inequality, deprivation or poverty measurement studies. Spatial deprivation can be measured with a limited use of GIS, and be analysed with statistical tools and methods, using geographical names as proxies for locations and by aggregating data to a larger area approximating a 'neighbourhood'. This is the case with the influential study of Noble and his colleagues (2000), which developed an Index of Multiple Deprivation for the UK government. The proliferation of GIS in Census studies and the availability of census data in GIS-friendly formats mean that increasingly more studies are using census information as the basis for their measurement of deprivation. This is the case in a recent study of the relationship between crime and deprivation (Bowers and Hirschfield 1999). In that study, data was used at Enumeration District level – the smallest census unit that was available at the time.

The space syntax approach

Previous research by Vaughan (1994, 1999) has used Space Syntax methods to analyse the spatial configuration of cities to understand the spatial form of immigrant quarters. This research has shown that there is a distinctive relationship between the pattern of distribution of immigrant groups according to their length of time in the country, economic status and family structure. Vaughan has also suggested that the organisation of immigrants as a community is spatially related. One of the main findings of Vaughan's research was a relationship between social deprivation and distance of residence from sources of employment at the perimeter of the settlement area. Analysis of the relationship between economic segregation and spatial segregation found that immigrant quarters had spatial attributes which made them more prone to poverty, and that poverty persisted over time.

Other research has found distinctive patterns in the geography of poverty and that "forms of deprivation are patterned spatially by a series of urban processes, which lead to greater concentrations of problems in particular places" (Spicker 2003, 1). Our study is investigating such effects of fine scale changes in urban form by using Space Syntax methods of modelling and analysing space, which have been developed over the past 20 years at the Bartlett, UCL, in order to provide an objective method of measuring the built environment as a physical entity and the complexity of urban form to be described and analysed and the social logic of its structure to be understood. Measures of space considered as a network, geometry and other metric properties of space can be considered alongside social and economic measures. These methods, first developed by Hillier and Hanson (1984) have been found to throw light on a wide range of factors associated with settlement formation and human activity (Hillier et al 1993, Hillier 1996). The importance of these methods for analysing poverty patterns is that they allow us to consider the network of streets in a local neighbourhood through which the population moves in its every day activities and that the analysis considers local to global relationships. Space syntax has been applied to numerous research projects into the relationship between urban form and society and the research outcomes have influenced policy in the UK and abroad (e.g. Ballintyne et al on crime prevention, 2000).

Methods
Data Sources

Academic research into the industrialist and philanthropist Charles Booth's work in recording statistics of poverty in late 19th century London is extensive (e.g. Glennerster et al 1999), of which the relatively recent Englander & O'Day review (2003) provides an overview of approaches to and criticisms of Booth's work[1].

Surprisingly enough, Booth's published maps of 'descriptive poverty', showing vast coverage of block-by-block variation in poverty classes across central London and its environs, have rarely been used in geographical studies. One exception to this is a study into mortality from diseases associated with childhood poverty (Dorling et al 2000,

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[1] See Shepherd (2000) http://mubs.mdx.ac.uk/Staff/Personal_pages/Ifan1/Booth.

Orford et al 2002), whilst previous studies of the maps have mainly highlighted its importance as a dataset (O'Day and Englander 1993, Czapski 1989).

Shepherd (2000)[2] explains in detail that there were in fact three maps of poverty. The first map published in 1889, showing the actual poverty situation of the East End of London, was the result of a house-to-house survey conducted by Charles Booth and his team. Later editions in 1889[3] and 1899[4] were maps of social condition, more than poverty. They represented a combination of factors such as regularity of income, work status and industrial occupation (because some occupations were seasonal and thus irregular).

Our study will eventually digitise key areas in both the latter maps, each of which covers a significant area of London, including prosperous and poor areas. We aim to compare and analyse change over the 10 years separating the two surveys and also to compare with the situation represented in the most recent census. The following is a description of the first stage of our project, in which we have sought to contend with the theoretical and methodological challenges involved with analysing the relationship between spatial and social factors in the Booth maps.

Booth defined 7 'classes', ranging from streets coloured gold (upper middle and upper classes), through red (middle class) through to black (lowest class). See **Figure 1** below, adapted from the 1889 map.
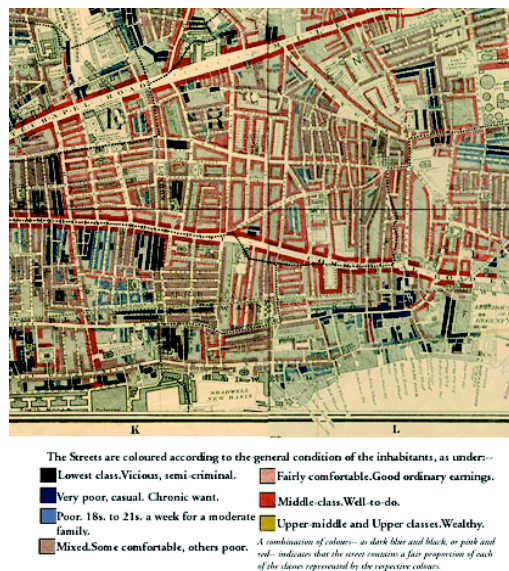

Figure 1 Section of Charles Booth's 1889 Map of London Poverty. Source: London Topographical Society

Digitising the Booth data

After undertaking a process of georeferencing the 1889 map[5] to contemporary landmarks, in order to enable later comparison with contemporary data, Booth data was matched to the space syntax spatial model of the entire extents of the London map. This was done by creating a model of the open space structure, representing the pattern of space as a set of the fewest and longest set of 'axial lines'. Axial line models allow for the local space unit ('convex' space, one from which all other points are visible) to be fully represented, by ensuring that all axial lines pass through all the convex spaces in the system. The axial map is a simplified representation of the street network, but one which, when analysed syntactically, has been shown in most circumstances to give robust approximations of the effect of street network on movement rates along the various alignments of the network (Hillier et al 1993). The completed network is analysed by examining topological interrelationships, using graph theory (Hillier 1998). Figure 2 illustrates the process of drawing axial lines on the Booth's maps.

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[2] See images at http://www.bartlett.ucl.ac.uk/research/space/space_and_exclusion-overview.htm.
[3] See images at http://www.bartlett.ucl.ac.uk/research/space/space_and_exclusion-overview.htm.
[4] See searchable maps at http://booth.lse.ac.uk.
[5] See images at http://www.umich.edu/~risotto/imagemap.html.

Figure 2 Axial lines drawn over the Booth map

Figure 3 shows the results of axial analysis in which 'integration' radius 3 is displayed graphically. 'Integration' is a normalised measure of the shortest topological distance from one axial line to all others and it is also expressed pictorially in a range of colours from red for the most integrated to blue for the least integrated. 'Radius 3' integration measures the integration only up to three lines away from each line in every direction, also termed 'local integration'. 'Local integration' has been found to correlate strongly with the distribution of pedestrian densities and thus is the best predictor of economic and social activity at the street level (Hillier 2002)[6]. Integration can be calculated at a range of scales from 3 (local) to n (equalling the total number of lines in the model, also termed 'global').
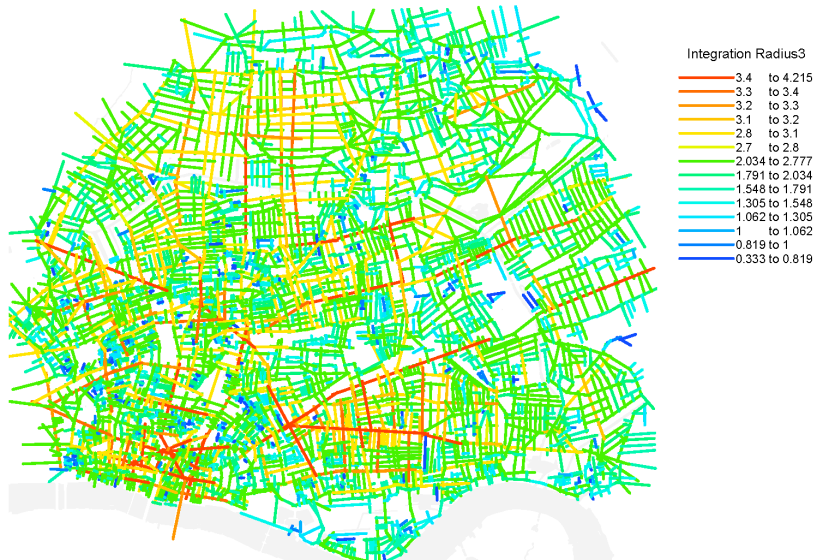

Figure 3 Axial map of London 1889 showing radius 3 integration

At the next stage a segment model was created, in which axial lines are broken at each intersection; and analysed mathematically to take account of angle of incidence between streets segments.

One of the challenges of the Booth data was how to retain data on the incidence of class variation within a block and along a street alignment. A variety of ideas were tested in order to see the best method of automating the linking of Booth data to the axial lines. The final method chosen was to create a buffer around each axial line to capture points

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[6] For a recent review of space syntax methods and limitations, see Steadman (2004).

representing Booth's classifications along the street in a given block. This way, the line segment contains information about the street blocks to which it relates.

The process is demonstrated in **Figure 4**, in which 'block A' is associated with Axial line 30 and 'block B' is associated with both line 30 and 31 because it relates to both lines. The advantage of this approach is that the spatial structure provided by the axial line analysis is itself considered as a factor and is matched directly to the social data.

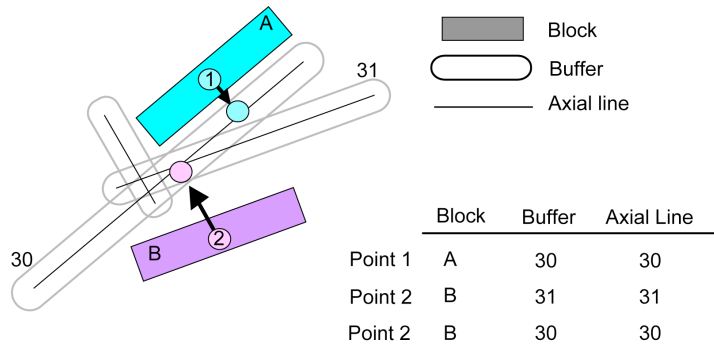|	Block	Buffer	Axial Line
Point 1	A	30	30
Point 2	B	31	31
Point 2	B	30	30

Figure 4 Booth classification points assigned to axial lines using buffered areas

The initial study area chosen was the East End of London. This area has for the past 200 years been continuously inhabited by poor and immigrant populations. The boundaries for the study area were: to the north, Hackney Road, Bishop's Road; to the south, the River Thames; to the west, Shoreditch High Street, Kingsland Road; to the east, Regent's Canal. The boundaries of the axial line map exceed the study area with a buffer of 2 km, created in order to analyse the area within its wider geographic context.

Analysis

The East End as 'Poor Area'

Analysis of the spatial form of the study area shows that there is an overall clear structure to the area. This is illustrated by examining the local integration map (**Figure 3**). The main streets of the area are well connected streets (the streets coloured red, orange and yellow), which surround pockets of lower integration and lower class streets. However, it is also notable that these main streets are not well connected to other main streets in the system, providing an explanation of how the East End is considered to be a 'Poor Area' overall.

Statistical analysis of the integration measures supports these observations: analysis of the spatial values averaged for each economic class (Table 1) shows significant differences between the poverty classes (class 1, 2 and 3) and the 'comfortable' classes (5 and 6). For example, for 'local integration', all three groups of the poverty streets had significantly lower than average values ($p<.0001$), whilst the top 'middle' class was significantly higher than average ($p<.0001$). These results suggest that the streets classified by Booth as red (middle class) were the most accessible parts of the street network. These findings are explained by previous space syntax research, which shows that streets with high integration values tend to contain the socially and economically lively activities of the city (Hillier 1996); that is not to say that the middle classes preferred to live on busy, noisy streets, but that their occupations – which in this area were predominantly in trade and skilled crafts - meant they were inclined to live on the main streets of the area (see Watson 1914, 1).

Table 1		Spatial values averaged by Booth class		
No	Class	Integration R3	Integration R7	Axial Length
1	Black	1.750	1.543	77.204
2	Dark Blue	2.036	1.543	112.630
3	Light Blue	2.004	1.471	127.650
4	Purple	2.465	1.597	166.362
5	Pink	2.596	1.622	199.113
6	Red	3.337	1.834	289.435
	All streets	**2.534**	**1.619**	**184.275**

It is apparent that the middle class streets provide the overall structure to the area, constituting the main local and global integrating streets. Fishman (1988) confirms how the range of housing conditions in the area reflected the labour situation of their inhabitants: "Labour divisions were reflected in the contrast between the modern two- or three-storied terraced houses built to accommodate the 'respectable' and 'responsible'... and the decaying cottages in squalid streets and courts inhabited by the 'feckless' casuals" (op cit, 36) and shows how the middle-class enclaves and the respectable poor were not a concern for reformers (op cit, 48).

Another pattern that emerges from this analysis is that the higher-class streets are significantly longer, whilst the lowest class streets are significantly shorter than average. **Table 1**, shows how 'axial length' for middle class (no. 6) street segments are on average three times as long as class no. 1. Indeed, all three poverty classes were significantly shorter than average (p<.0001) and the 'comfortable' classes were significantly longer than average (p=.0305, <.0001). This is a very clear indication that poverty classes tended to live in the shorter, back streets of the area.

The Spatial Distribution of Class

One of the important outcomes of Booth's study of the East End of London was to show that it was not a singular morass of poor, criminal streets; but that it contained a variety of classes, with finely differentiated deprivation situations (see **Figures 5** and **6**). For example, from Booth's statistics the lowest class only constituted 1.5% of all streets in the East End and Hackney (Booth 1902, 1, 34-36). Our research supports his contention, since at the higher end of the scale, 13% of street segments were found to be coloured red in the East End study area. The research presented here supports Booth's statistics.
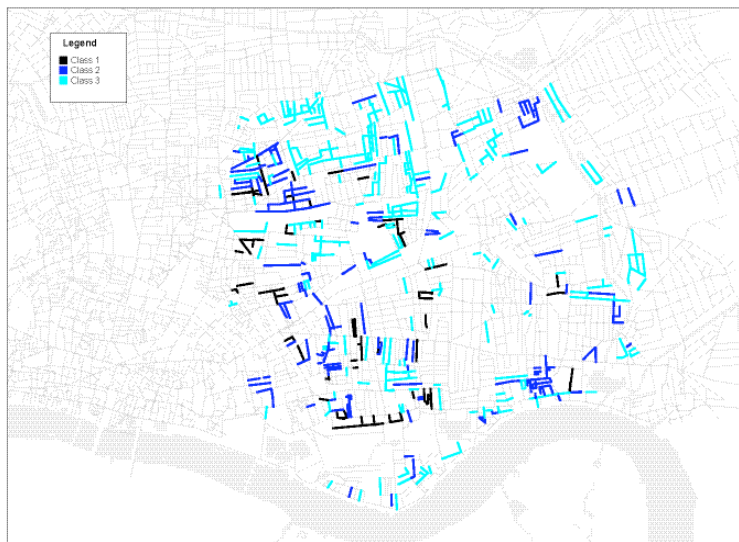

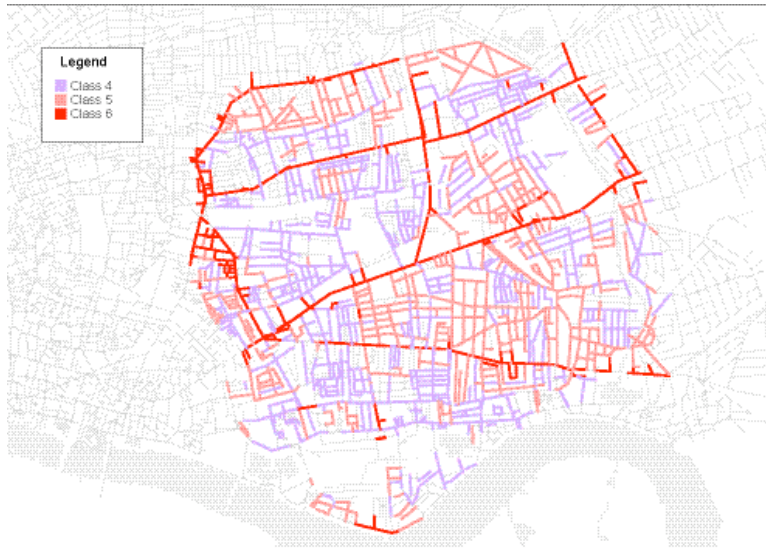Figure 5 Axial map showing street segments coloured by Booth classes, showing three bottom classes only

Figure 6 Axial map showing street segments coloured by Booth classes, showing three higher classes only

The following analysis considers the lowest three classes, ranging from very poor to "poor, 18s to 21s a week for a moderate family", shown above to be located in significantly segregated streets, and considered by Booth to be below a notional line of poverty, and thus together constitute the poverty classes[7]. Segment analysis in which the spatial integration of each street block was analysed at a range of radii, from radius 3 (local), through to radius n (global) considered the most detailed spatial relationships of the East End area. Mean integration values were plotted in a cell chart, and each Booth class shown as a separate point **(Figure 7)** the results showed that the top three classes of the study area (Red, Pink, Purple), followed a consistent pattern with a rise in integration values following the rise in the Booth classes.
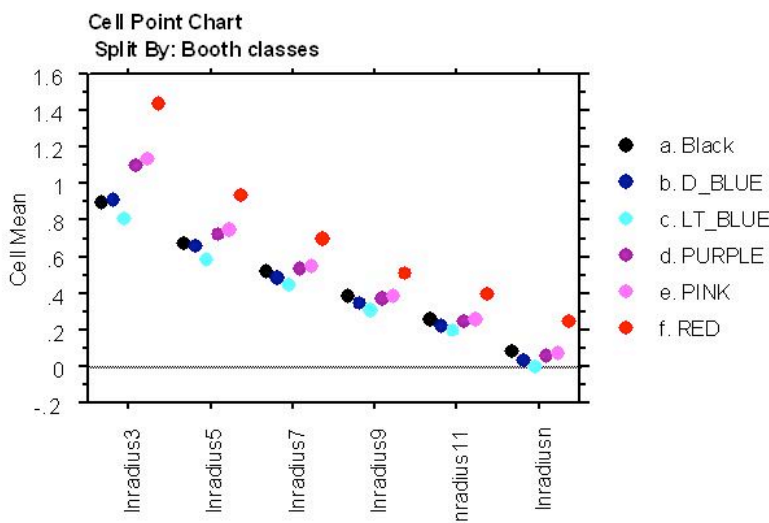
Figure 7 Average Integration at radius 3 ('local'), 5, 7, 9, 11 and n ('global'), split by Booth classes, East End 1889

The bottom two classes (Black and Dark Blue) follow a different pattern, with averages slightly higher than those of the class sitting just above them (Light Blue). This result is at first surprising, when the expectation would be that the lowest classes would be those most removed from the integrated structure of the district. However, bearing in mind they comprise the 'Lowest ' and 'Very poor, casual, chronic want' population of the area, it is less surprising

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[7] See Gillie (1996) for more on the poverty line in Booth's work.

that this population, which is least likely to be functioning participants in the economic and social life of the city, would follow the regularities of the spatial structure.

It is at the local scale (radius 3) that the greatest class differentiation takes place and this is particularly the case for the Red (Middle Class) streets. T-tests of mean spatial values for each class suggest a reason for this difference – the three lowest classes are significantly more segregated than average both for Radius 3 integration and for Radius n integration ($p<.0001$). On the other hand, of the three higher classes, only 'Red' ('Middle Class') streets are both globally and locally more integrated than average ($p<.0001$), indicating that the location of this class was at a remove from the surrounding population, and confirming the historical account quoted in Fishman (1988) above.

Summary

This paper has reported on the initial findings of a project investigating the relationship between spatial segregation and poverty. It has shown that space can itself be considered as a factor in the geography of poverty.

Previous research suggests that despite the many attempts to improve housing quality over the past 100 years, these interventions have "failed to substantially alter the geography of poverty" (Orford et al 2002, 34). While they identify the phenomenon of geographical persistence of poverty and indicate that this seems to be linked to "processes associated with London's housing market" unlike this study, they do not identify any underlying factors contributing to this pattern.

Similarly, a recent White Paper on planning cities, (DTLR, 2000) indicates that "many of the areas of East London identified by Charles Booth in the late 19th century still show up today as having the worst social deprivation" (section 2.18). Other contemporary sources highlight the importance of this research, which has shown how the morphology of the streets can have an impact on people's lives. Booth himself was aware of this and scattered through his writing are comments such as "Thus... the 'poverty areas' tended to be literally walled of from the rest of the city by barrier-like boundaries that isolated their inhabitants, minimizing their normal participation in the life of the city about them..." (quoted in Pfautz 1967, 120), yet the importance of space itself in having an impact on people's lives is rarely highlighted in such studies as a fundamental aspect of life in poverty, despite the fact that accessibility to the economic life of the city is clearly of paramount importance today, as it was 100 years ago. An exception to this is Lupton (2003a, 5), who states that "physical characteristics, through their impact on population mix, lead neighbourhoods to 'acquire' certain other characteristics, such as services and facilities, reputation, social order and patterns of social interaction, as people and place interact. *For example, disadvantaged individuals in an isolated area will form one set of social relations, while disadvantaged individuals in a well-connected area may form another*" (our italics). She also highlights the importance of space in her influential book 'Poverty Street' (Lupton 2003b), but again a method for analysing the physical dimension is not suggested.

It is important to emphasise that while space has an explanatory power over the formation and persistency of deprived areas, it is not replacing other explanations. However, studies which deal with socio-economic factors without due consideration of space are possibly missing an important, vital factor. Indeed, this study has demonstrated that analysis at the street scale, considering spatial and social/economic measures as separate variables, enables an understanding of how spatial location plays a part in an individual's potential to take advantage of the spatial economy of the city.

The next stages of the project will be to study the East End 10 years later, after a major influx of immigrant refugees from Eastern Europe and then to consider the impact of this social situation on the social-spatial form of the area. Thereafter a comparison with a west central district of London city will be undertaken.

Acknowledgements

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