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Social sustainability and urban form: evidence from five British cities

Glen Bramley
School of the Built Environment, Heriot-Watt University, Edinburgh EH14 4AS, Scotland; e-mail: g.bramley@sbe.hw.ac.uk

Nicola Dempsey
Oxford Institute for Sustainable Development, Oxford Brookes University, Oxford OX3 0BP, England; e-mail: ndempsey@brookes.ac.uk

Sinead Power
Communities Analytical Services, Scottish Government, Edinburgh, Scotland; e-mail: sinead.power@scotland.gsi.gov.uk

Caroline Brown, David Watkins
School of the Built Environment, Heriot-Watt University, Edinburgh EH14 4AS, Scotland; e-mail: c.j.brown@hw.ac.uk, d.s.watkins@sbe.hw.ac.uk
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Abstract. Planning and urban policies emphasise 'sustainability', but claims that 'compact cities' are more socially sustainable and acceptable have been controversial and subject to limited empirical testing. After a brief review of the concepts and debate, we set out new empirical evidence based on household surveys linked to neighbourhood physical, map-based, and sociodemographic data for five British cities. Statistical models are developed to account for systematic variations in the main social sustainability outcomes. The results are considered both in terms of the role of particular urban form and locational measures, but also in terms of the broader patterns of effects of packages of measures. Outcomes relating to residential satisfaction, stability, neighbourhood environment, and safety are all shown to be lower in higher density/central places, but it is also shown that a good deal of this apparent effect is due to social and demographic factors. Interaction with neighbours and participation in groups is better at medium densities, controlling for other factors, while use of local services is, as expected, greater in denser, more central locations. These findings indicate that compact cities are not 'win – win' on all dimensions of sustainability but, rather, that reductions in transport emissions will have to be weighed against social criteria. In addition, urban form has different aspects, which have differing social effects, and this knowledge could inform the future design of 'smarter' urban environments.

1 Introduction

There has been much debate about how to shape urban development in order to achieve greater sustainability. Many claims have been made for the greater 'sustainability' of compact cities, although these have been particularly controversial in relation to the social functioning and acceptability of urban communities (Jenks et al, 1996, page 11). Urban forms cannot be considered sustainable if they are not acceptable to people as places in which to live, work, and interact, or if their communities are unstable and dysfunctional. Recognition of this has become a significant feature of recent British urban and planning policy (HM Government, 2005; ODPM, 2003). However, the 'compact city versus urban sprawl' debate of the 1990s and early 2000s has relied a good deal on assertion and assumption with regard to the social impacts of different urban forms, with limited reference to systematic contemporary empirical evidence (Jenks et al, 1996).

The main aim of this paper is to provide a comprehensive analysis of the impact of differing urban forms on social sustainability, in relation to medium-sized existing

British cities, drawing on recent research. The specific objectives are (a) to translate the concepts of social sustainability into operational outcome measures; (b) to measure their incidence for a representative set of areas in our sample cities; (c) to relate these patterns to neighbourhood and wider scale urban form measures, while allowing for the influence of demographic and socioeconomic factors; and (d) to relate these findings to the wider literature on urban form and sustainability, drawing out pointers both for planning policy and for future research.

The paper begins (in section 2) with a brief review of the existing literature and debates about urban form and social sustainability, highlighting some expected relationships and some areas of dispute and uncertainty. Section 3 describes the way in which we carried out the research: linking a household survey to neighbourhood physical, map-based, and sociodemographic data; and developing regression models to account for systematic variations in the main social sustainability outcomes. The results are presented in section 4. This highlights both the role of particular urban form and locational measures and the broader patterns of effects of packages of measures. Section 5 discusses the findings and some of their possible implications for policy.

Some limitations to the work should be noted at this point. The scope of the empirical research reported here is limited to five medium-sized existing British cities, suggesting that some care might be needed in extrapolating conclusions to conditions found, at one extreme, in Inner London, or at the other extreme in rural and village settlements. However, in a companion piece Bramley and Power (2009) use national secondary data to analyse some of the same relationships across the whole of England, including these extremes. In this paper we do not attempt to enlarge, either, on the conceptual debate around the definition and significance of 'social sustainability', although again this has been explored in related work (Dempsey et al, forthcoming). We take the range of interpretations derived there as given, merely noting their importance in contemporary policy rhetoric, and asserting that they provide a reasonable representation of the range of social issues raised in the literature.

2 Existing literature on social sustainability and urban form

2.1 Social sustainability

Following reviews of the issue, based on both academic and policy literature (Bramley and Power, 2009; Bramley et al, 2006; Dempsey et al, 2009), we propose that 'social sustainability' should be seen as comprising two main dimensions.

- *Social equity*, with particular reference (in the context of urban form) to access to services and opportunities
  - essential local services such as shops, schools, health centres;
  - recreational opportunities, open space;
  - public transport;
  - job opportunities;
  - affordable housing.
- *sustainability of community*, comprising a number of subdimensions including:
  - pride in and attachment to neighbourhood;
  - social interaction within the neighbourhood;
  - safety/security (vs risk of crime, antisocial behaviour);
  - perceived quality of local environment;
  - satisfaction with the home;
  - stability (vs residential turnover);
  - participation in collective group/civic activities.

It is clear that, while each of these may be regarded as conceptually distinct, there will often be reinforcing relationships between them. For example, where neighbourhoods

are safe people may be more likely to interact with neighbours and this may lead to more participation in collective activities.

While we consider these aspects of people's experiences under the umbrella term 'social sustainability', it must be recognised that other umbrella terms are used in relation to some of the same or overlapping phenomena. For example, 'social exclusion' may entail lack of access to services, among other things (Pantazis et al, 2006; Pierson, 2002); the concept of 'social capital' generally entails social interaction, trust (underpinned by safety), and civic participation, and is widely argued to be encouraged by stability (Forrest and Kearns, 2001; Putnam, 1993); 'social cohesion' also entails social interaction, civic/collective participation, 'social order' (again related to safety), and place attachment (Forrest and Kearns, 1999). Some writers and official documents refer to the grouping of factors we have labelled 'sustainability of community' as 'quality of life'.

Some commentators would regard health and well-being as an important component of social sustainability or the quality of life. We would agree that health and well-being are important, but believe that many of the ways in which urban form affects these outcomes will be through the factors which we have identified above. Social interaction, safety, local environmental quality, and access to services are likely to affect well-being directly as well as indirectly: for example, through opportunities for exercise in daily life. Negative outcomes on these factors are likely to be implicated in a higher incidence of mental ill-health. However, this study was not designed to provide direct or detailed measures of health and well-being.

In this paper we examine measures of all of the above subdimensions of sustainability of community, while concentrating on summary measures of access to/usage of local services. Both access to jobs and access to affordable housing raise issues about wider 'market areas' within which people may search for and obtain such resources and, as such, require a somewhat different scale of analysis from the essentially neighbourhood focus of this article. It is broader scale aspects of urban structure which are likely to be more important here as, for example, in the well-known 'mismatch' thesis about urban labour markets (Arnott, 1998; Houston, 2005; Ihlanfeldt and Sjoquist, 1998). Some measures of public transport quality feature in the analysis here, but a fuller analysis of transport networks and accessibility again goes beyond the scope of this paper (for parallel work on this, see Ferguson and Woods, 2009).

2.2 The effects of urban form

It is clear from the literature that there are competing claims about the extent to which urban form influences social sustainability: claims and debates which have, to date, rarely been supported by empirical evidence (Jenks et al, 1996). Of the elements of urban form which might be considered, *density* is the one that has received the most attention with regard to its social impact. Much of this focus has been upon the policy question of whether we should contain urban development by developing at higher densities, or allow urban expansion and building at lower densities—the 'compact city' versus 'sprawl' debate (Barton, 2000; Breheny, 1992a; 1992b; DETR, 1999a; Ewing, 1997) and the related 'new urbanism' literature (Calthorpe, 1993; CNU, 2004; Katz, 1994).

The density of urban development has the potential to impact upon all of the dimensions of social sustainability. For example, higher densities may make access to services and facilities both easier and more economically viable (Bunker, 1985; Burton, 2000a; 2000b; Collie, 1990; Haughton and Hunter, 1994; ODPM, 2003; Williams, 2000). Higher densities may also mean that people are more likely to meet each other on the street than they are in lower density areas (Duany and Plater-Zyberk, 2001; Talen, 1999).

In contrast, lower densities reduce the potential for spontaneous interaction and lead to an orientation towards car travel (TCRP, 1998). Glynn (1981) and Nasar and Julian (1995) found 'sense of community' to be higher in neighbourhoods which facilitated face-to-face interaction. There are, however, alternative arguments that in higher density settings people may withdraw from social contact. Wirth (1938) argued that high-density living, along with the anonymity of city life, leads to an increase in stress and the severing of traditional ties resulting in a decline in community or social ties. Bridge (2002, page 4) refers to Simmel's (1995) discussion of the 'psychic overstimulation of the city'. Hence, higher densities may lead to weaker social ties, at least beyond a certain level (Freeman, 2001).

It is argued that in a compact city with high-density and mixed uses, communities are likely to be more mixed and, as a result, have a lower level of social segregation. Suburban sprawl in particular has come to be associated with high levels of segregation and inner-city decay (Bramley and Morgan, 2003; Burton, 2000a; CEC, 1990). However, it is not axiomatic that social mix correlates with density or use mix, and other factors such as housing type and tenure may be more significant than density (Burton, 2000a).

As well as affecting social interaction, density may affect the appearance and aesthetics of places and hence people's attachment to and pride in their neighbourhood. The Transit Cooperative Research Program (TCRP) review (1998) found little evidence to suggest that Americans find sprawl less attractive than more compact forms of development, although they do cite work by Nelessen (1994), Shore (1995), and Diamond and Noonan (1996) which argues that lower density development is less aesthetically pleasing [Audirac and Zifou (1989), on the other hand, argue the opposite]. Gordon and Richardson (1997) claim that, given the choice, people prefer low-density suburban living to high-density urban living, noting that many consumer-preference surveys have shown such a preference (findings which are echoed, in some senses, in our own empirical findings). However, it is appropriate to 'unpack' these suburban and dense/urban living scenarios and identify which elements contribute to this general pattern, whilst recognising that some individuals and groups may have different preferences.

Feelings of safety (from crime or antisocial behaviour) arguably enhance trust and reciprocity between residents and contribute to the sense of community and sense of place in a neighbourhood (Nash and Christie, 2003, page 15; Shaftoe, 2000, page 231). Some of the claimed associations between safety and the built environment include the cited benefits of natural surveillance, for example, windows directly overlooking streets (after Alexander et al, 1977; Jacobs, 1961), which is a function of detailed urban design rather than of density per se. Poor condition and maintenance of the built environment are also claimed to have detrimental psychological effects on people's sense of safety (DETR, 1999b; Woolley, 2002; Worpole, 2003). The idea of "nobody car[ing]" is closely linked to the concept of the "broken window syndrome", where even "cosmetic damage can invite more serious anti-social or even criminal behaviour" (Wilson, 1985, page 78; Nash and Christie, 2003, page 47). Current government policy emphasises the importance of considering crime prevention as part of the urban design process (ACPO, undated; ODPM/Home Office, 2004).

This brief review of the literature reveals that the relationship between density and social sustainability appears to be rather complex, with at times contradictory hypotheses or findings. There are reasons to expect access to services to be better in denser urban forms, while quality of neighbourhood environment, community, and safety may be less good in denser areas. The relationships for social interaction or participation are less clear-cut in the literature. Interactions between urban form and social composition factors, including those associated with housing tenure, may be significant.

For example, certain inner city higher density areas may specialise in housing groups such as students or young professionals who display high mobility and fewer neighbourhood-based social networks (Bailey and Livingstone, 2007; Bramley and Morgan, 2003).

One of the problems with trying to relate urban form to social phenomena is the difficulty of separating causal effects from selection effects, where selection effects are the result of different individuals and groups living in different places. For example, people with mobile careers or lifestyles may tend to live in certain areas because of their housing tenure, access to central amenities, and their affinity to similar people. They may display low place attachment, community engagement, or local social interaction, and high mobility, but this is not causally related to housing types or neighbourhood density. It is much more likely to be related to their individual characteristics, some of which may be measurable (age, occupation, household type) but some of which may not. It is difficult to separate these factors fully in cross-sectional analysis, although we can go some way by controlling for known demographic and socioeconomic characteristics.

3 Developing measures of social sustainability and urban form at linked neighbourhood level

Our empirical investigation of social sustainability is focused on fifteen case-study areas within five medium-sized British cities. These areas (typically containing some 2000 households) were chosen to reflect a diversity of typical British urban forms, with varying ages, types, and tenures of housing and sociodemographic profiles. In each city one area was chosen close to the city centre, one towards the suburban periphery of the main built-up area, and one in between. In each of these locational bands, tenure and housing type varied considerably.

3.1 Household survey

In our view the principal source of evidence concerning the social acceptability of different urban forms should be people themselves, particularly those living in the areas in question. With this in mind, we designed a household-survey questionnaire to collect data on social issues and other sustainability themes (for example, travel behaviour). After consideration of different options (postal, drop-and-collect, telephone) we opted for a self-completion postal method (with two reminders) and managed to achieve a respectable 37% response rate (4381 responses). The survey responses reported below have been reweighted using the 2001 Census to reflect the underlying demographic profile of the population of each area, so countering possible differences in response rates between demographic groups.

In designing the questionnaire we looked at a number of national and local surveys covering similar topic areas and utilised or adapted some of the questions they contained. This not only takes account of whether questions have been shown to work, but also enables the wider benchmarking of our results. In general, we do not rely on a single question to provide evidence about a given aspect of social sustainability but, rather, draw on responses to a cluster of questions. In grouping responses together for the composite social outcome measures we consider both their logical/linguistic interpretation ('face validity') (Bryman, 2004) and patterns of correlations between the responses across our sample.

3.2 Composite social outcome measures

We use the survey to generate ten composite measures which capture the different aspects of social sustainability defined in section 2 above. Seven of the measures relate to the sustainability of community, while three relate to access to and use of local services.

These composite outcome measures are expressed in an index form which is easy to understand. For example, the 'social interaction' measure is based on responses to thirteen questions including whether respondents have friends in the neighbourhood, know neighbours by name, look out for each other, chat, borrow things, and so forth[(1)]. For each question, negative responses reduce the score from a neutral value, whereas positive responses increase it (with neutral responses being possible in all cases). Neutral responses across all the thirteen questions would result in a score of 100 on the interaction index; all positive responses would score 200; and if all responses were negative, the score would be zero. The resulting index scores are numbers in the range 0 – 200, but typically around or just above 100, for individuals. These are effectively continuous variables and we can therefore compare mean values and variations between and within groups, areas, or area types.

3.3 Measuring urban form

To establish relationships between these outcomes and urban form, we link the location of sample households (addresses) to information about those locations, in particular information about the small areas within which people live. It should be noted at this point that the emphasis here is on the urban form of the *residential neighbourhood* rather than, for example, the places where people work, shop, or spend their free time.

We have a choice about the spatial *level* at which urban form characteristics might be attributed to individuals. This could be at any of the following levels: address of individual house/property; street block; subarea; case-study neighbourhood; and city, or even city – region.

For the analyses reported in this paper we rely mainly on linkage at the level of the 'subarea'. These subareas were defined using maps and local knowledge to identify natural subdivisions via major boundary features. Each subarea is relatively homogenous in terms of urban form, and there are six or seven in each case-study neighbourhood. This gives a total of ninety-eight subareas, most of which have a population of around 400 – 500 households (a small number of subareas are mainly nonresidential and contain very few households). Census and other neighbourhood data were apportioned to the subareas from source units, census output areas, or other geographies. In addition to a wide range of sociodemographic data, the census yields certain measures of urban form (gross density, dwelling type, storey height).

The other key source of urban form measures is Ordnance Survey Mastermap, which may be analysed using GIS to determine the proportion of land area attributable to different elements (for example, residential buildings, gardens, greenspace, roads) and associated ratios (eg percentage of greenspace, net dwelling density, average garden size). Other urban form and quality measures derived from a site-inspection survey were also incorporated (for example, building height, rundown areas, mixed use), along with simple measures of access distance to city centres. A group of more sophisticated network connectivity measures were derived from the Mastermap layers for roads and pathways, utilising the technique of multiple centrality analysis (MCA), a development of the space syntax concept (Cardillo et al, 2005)[(2)]. Other socioeconomic data attached includes components from the indices of multiple deprivation (IMD), particularly overall deprivation, low income, and geographical barriers to accessing selected facilities (effectively a proxy for more rural locations).

[(1)] Full details of the these composites are provided in table A1 on the journal website at http://dx.doi.org/10.1068/a4184

[(2)] The subset of MCA measures used in this analysis is presented in table A2 on the journal website at http://dx.doi.org/10.1068/a4184

In addition to the array of neighbourhood (mainly subarea) urban form attributes, we also include in our analysis certain indicators at the individual household/address level, particularly housing type, floor (storey) height, and access to a garden.

A key issue in interpreting evidence on the association between social outcomes and urban form is that of untangling 'real' and potentially 'causal' associations from what may be apparent, fortuitous, or ambiguous relationships, given the complexities of urban life and the different kinds of relationships which may be at work. Simply showing that, in a two-way table or correlation, there is an apparent (negative) relationship between, say, density and neighbourhood satisfaction, does not establish that there really is such a relationship, let alone that it is causal. It is essential to take account of (control for) the influence of other relevant variables, that is, other physical, social, economic, or demographic factors which may also influence neighbourhood satisfaction. For example, older people may tend to answer satisfaction surveys in more positive ways than do younger people, and at the same time older people may be more likely to live in low-density suburbs. To take another example, neighbourhoods with concentrations of poor people tend to exhibit a greater incidence of certain social problems which affect neighbourhood satisfaction; such neighbourhoods are also often higher density areas.

3.4 Modelling outcomes

Although we use simple descriptive tables to show the patterns between different forms, our main analysis and conclusions rely more on statistical modelling. Multiple regression analysis provides the standard tool for establishing the direction and strength of relationships while simultaneously taking account of the relationships with other variables. Initial exploratory analyses were undertaken using ordinary least squares (OLS) regression in the SPSS package to arrive at a provisional model for each outcome. For the final models, however, we took account of the multilevel structure of the data, recognizing that, while some variables were at the individual level, others were at the higher subarea level, with the whole dataset effectively clustered by subarea (Snijders and Bosker, 1999). The models were reestimated in more parsimonious forms using a generalised linear model with random effects, implemented using the Stata package (xtreg command). This approach has three main advantages: (a) robust standard errors and significance levels are generated for the explanatory variables, allowing for the lesser degrees of freedom at subarea level, leading to more reliable inferences about individual relationships; (b) as a byproduct, a number of variables of marginal (nonrobust) significance could be dropped, yielding simpler, more parsimonious models; (c) the intercept (constant) in the model is allowed to vary between subareas, reflecting random variations in outcome (not fully captured by explanatory variables) at this level. It should also be added that using multilevel data helps to overcome the problem of potentially misleading ecological correlations in traditional cross-sectional regressions using grouped area-level data.

Although this approach goes beyond ordinary linear regression, it still represents a relatively conservative modelling strategy. We do not systematically explore nonlinear and interaction terms between variables, nor the possibility of 'random slopes' (that is, different sensitivities to particular variables in different subareas), although one or two individual nonlinear versions of variables are tested (density, and distance from the central business district. Such exploration could feature in future research. However, it is important to note that, because of the range of different urban form indicators used in the models, the overall 'urban form effect' generally turns out to be nonlinear when plotted against particular measures like density, as shown below.

4 Empirical results

4.1 Descriptive profiles

Table 1 presents data on the urban form and access characteristics of the sample neighbourhoods, breaking these down by location (inner, middle, and outer) and gross residential density bands. It should be emphasised here that density measures in the first two columns are the sample-weighted means of subarea-level figures (the average of the localised densities at which people actually live), which are systematically higher than conventional averages calculated over larger areas[3]. The third column shows the simple gross density calculated at the larger case-study neighbourhood level; these figures are typically much lower (half or less) than the sample-weighted (or population-weighted) figures.

There is a strong gradient in terms of net dwelling density from inner (265) to outer (96) locations but, rather surprisingly, little gradient in gross density (from 63 to 50).

Table 1. Urban form measures by location and density.

	Net dwelling density nddenssa[a]	Gross dwelling density gddenssa[a]	Gross case-study area density gddenscs	Distance from CBD (km) dist150k	Detached dwelling (%) DwelDetach	Terraced dwelling (%) DwelTerr
Location						
inner	264.8	63.0	29.1	1.0	1.2	12.5
middle	106.0	50.8	27.6	2.5	6.6	36.0
outer	96.2	49.6	16.4	6.7	20.9	17.1
total	158.1	54.7	24.4	3.4	9.4	21.6
Gross density (dwellings per hectare)						
<20	93.3	14.3	20.2	4.0	19.3	11.2
20–40	122.8	27.4	18.2	4.2	14.2	11.6
40–70	150.7	52.6	25.8	2.5	4.1	26.7
>70	255.4	118.1	33.0	3.0	3.6	34.2
total	158.1	54.7	24.4	3.4	9.4	21.6

	Flats (%) DwelFlat	Buildings >4 storeys (%) pov4stor	Average garden size (ha) avgdnsiz	Gardens (% area) presgdn	Green space (%) pgreen	Nonresidential and mixed use (%) pnrmix
Location						
inner	81.1	61.6	0.003	10.5	26.6	16.2
middle	42.0	20.3	0.013	34.6	15.3	4.6
outer	19.4	2.1	0.024	45.6	18.2	1.6
total	48.2	28.7	0.013	29.8	20.2	7.7
Gross density (dwellings per hectare)						
<20	48.5	29.9	0.024	28.8	25.7	8.6
20–40	47.2	27.3	0.016	31.0	23.3	10.4
40–70	50.1	30.5	0.009	28.2	16.8	7.6
>70	46.8	27.3	0.008	31.3	17.2	3.9
total	48.2	28.7	0.013	29.8	20.2	7.7

[a] Gross density (gddenssa) is the sample-weighted mean of subarea-level gross dwelling densities; case-study area density (gddenscs) is the simple ratio of dwellings to the total area of whole case-study areas.

[3] Our net density figures are also higher than some others because the denominator is solely residential building footprint and garden plot areas, without any allowance made for streets or pavements, as this can be more readily calculated from Mastermap.

Gross and net densities do not necessarily move closely in step, because of the varying presence of nonresidential land uses and undeveloped land. Our data indicate that, in these cities, quite a lot of people are living at quite high net densities, even though they may be in 'outer' (suburban) locations, and even though the apparent gross density is quite low, particularly when measured for larger zones (such as our case-study neighbourhoods).

These are relatively compact cities and the average distance to the city centre is still less than 7 km even in the 'outer' areas. Nevertheless, there is a marked transition in house-type mix from 81% flats and only 1% detached in the inner areas to 19% flats and 21% detached in the outer areas. Terraced houses are most prevalent in middle-ring areas and in areas with relatively high gross densities. More than three fifths of buildings in our inner areas are four or more storeys in height, a figure which falls to only 2% in the outer areas. Unsurprisingly, average garden size rises with distance from the centre and as density falls: gardens represent only 10% of the land area in inner areas but 47% of land in the outer areas. Greenspace, however, seems to have a slightly higher share of land in the inner areas than in the outer ones, although the absolute amount is smaller. Nonresidential and mixed uses are mainly found in inner and middle areas.

Table 2. Social sustainability outcomes by location and density.

	Pride, attached nhpride	Social interaction nhinter	Safety nhsafe	Environmental quality nhenvir	Satisfaction with home homesat
Location					
inner	92.5	97.3	123.4	100.4	117.3
middle	115.7	122.5	133.0	120.2	130.9
outer	118.4	129.1	126.9	129.8	139.7
total	108.5	115.9	127.6	116.4	129.0
Gross density (dwellings per hectare)					
<20	116.3	118.4	134.4	120.6	139.0
20–40	112.7	116.4	131.4	121.1	131.3
40–70	109.0	117.3	127.2	113.9	125.7
>70	97.3	111.7	119.1	111.2	123.6
total	108.5	115.9	127.6	116.4	129.0

	Stable versus mobile stable	Participation in groups grppart	Use of neighbourhood facilities/services usenfac	Frequency of use of utility services utilfreq	Frequency of use of leisure services leisfreq
Location					
inner	109.7	94.2	108.5	236.2	103.5
middle	127.6	101.5	103.0	223.3	81.1
outer	147.1	104.6	88.0	188.1	51.2
total	127.7	100.0	100.0	216.3	79.1
Gross density (dwellings per hectare)					
<20	132.4	105.4	102.4	207.4	81.7
20–40	132.1	106.0	98.2	211.0	82.9
40–70	121.0	97.5	105.7	236.7	85.8
>70	128.1	92.5	92.7	202.1	63.5
total	127.7	100.0	99.9	216.2	79.0

Table 2 shows average scores for the ten composite social sustainability performance measures for the same breakdown of sample areas in terms of location and gross density. For all indicators higher scores indicate a more favourable outcome. These descriptive profiles, of course, simply show the raw bivariate relationship with these urban form factors, without any attempt to control for other influences.

For three of the outcomes there is a common pattern of ranking, broadly in line with expectations, whereby outer areas score better than inner areas and less dense areas score better than denser areas—this applies to pride/attachment, social interaction, and satisfaction with the home. The differences generally seem greater between the locational bands than between the gross density bands

For four of the outcomes there is a modified or attenuated version of this pattern. In relation to safety, while inner areas are worst, middle rather than outer areas are best (within our sample of cases).[4] For environmental quality and also for participation in groups, medium density [20–40 dwellings per hectare (DPH) gross] is slightly better than the lowest density bands. For stability versus mobility, both low-density and medium-density areas score similarly and better than average, while medium–high-density areas (40–70 DPH) scores lowest. These patterns suggest possible non-linear relationships with density.

For the remaining three outcomes, those relating to usage of local services, the pattern is different; broadly as expected although with some deviation. For each of these measures, inner areas score better than middle areas which score better than outer areas, as expected on grounds of accessibility and availability of services. Frequency of use of leisure services shows the greatest difference between inner and outer areas of all of the indicators. This perhaps confirms the significance of leisure, entertainment, and cultural amenities to an 'urban way of life'. The relationship with density generally shows a rise with density up to the medium-high band (40–70 DPH), but then a marked falling off in the highest band.

4.2 Modelling results overall

The full regression model details for the ten social outcomes are not shown in the body of this paper to save space but are provided on the journal website at http://dx.doi.org/10.1068/a4184 (table A5). Altogether, fifty-four variables are included as significant for at least one outcome, with about half of these being individual household-level variables and half being subarea attributes. Typically, individual outcome models have fifteen to twenty significant variables, broken down into the following four categories: D—demographic; S—socioeconomic; A—access/location; U—urban form.[5]

The overall model performance (R^2 statistics) can be partitioned into the proportions of variance explained 'between' groups (that is, subareas) and 'within' groups (that is, between individuals within subareas) (Stata, 2005, pages 282–308). The overall proportion of variance explained (between individual observations) is typically around 0.2 to 0.3, not an uncommon figure in microanalyses of social phenomona. However, it is noteworthy that for most of the outcomes the level of explanation between the (92–94) subareas is much higher, at around 0.60–0.85. So, compared with with a simpler, more traditional cross-sectional regression of area-level data, the fit of the models is quite high. In other words, we are explaining most of the variation between different neighbourhoods and, since urban form is essentially an area phenomenon, this is very encouraging.

[4] There are significant peripheral council housing estates in two of our outer areas, which may affect this finding.

[5] Size of dwelling attributes (for example, rooms), are treated as a measure of material living standard, associated with income/wealth, and hence placed in the socioeconomic category rather than the urban form category.

4.3 Specific relationships

In commenting on each outcome in turn, we focus primarily on access and urban form effects, but also highlight noteworthy effects among the demographic and socioeconomic control variables.

'Neighbourhood pride and attachment' is clearly related to having a (larger) garden, to lower gross density, and to being in a more rural location. There is a marginal negative effect from the MCA 'betweenness' score as well. These results are in line with the predominant picture in the literature, and apply after controlling for a range of demographic effects (particularly age) and socioeconomic effects (tenure, working, poverty, and smaller dwellings—the last two being negative).

'Social interaction' (including 'friendliness') is similar in some ways to 'neighbourhood pride and attachment', but different in others. Families and longer residence are associated with more social interaction, with younger and single-person households being less engaged. There is still clearly a relationship with having a garden and, in addition, living above the ground floor shows up as negative. There is no apparent relationship with either of the density measures. However, for this outcome, living further out from the city centre (log distance) is negative and the MCA accessibility measure is positive. Two further noteworthy associations are that terraced housing areas score positively and that there is also a positive association with neighbourhood greenspace. We believe these findings are consistent with some of the literature, and with common sense. Gardens are conducive to interaction, both as a locus for social activity but also as a relatively safe, 'semiprivate' outdoor space which provides opportunities to interact with neighbours and passers-by. High overall densities have the problems of anonymity and psychic overstimulation, and higher storey flats provide fewer opportunities for comfortable meeting on the street or near the entrance to the home. Terraced housing is the best for this, because the houses are close enough for people to bump into each other or to talk across the wall or fence; in low density detached suburbia, people are more likely to go from their house door to their car and then drive away. In addition, in areas of higher general accessibility it is easier for people to meet up, and more interaction can be created indirectly through use of local services or public transport.

The 'safety' outcome has a negative association with gross density and with one MCA accessibility measure, and a positive association with the proportion of residential garden area. These associations are in line with what we would expect from the literature, suggesting that 'suburbs' are safer (or are perceived to be safer). However, safety actually falls with distance from the central business district (CBD) in this sample, when other effects are controlled for; there is also a negative association with the MCA variable msteff, which indicates that areas which have a more elemental network (with less redundancy, that is, cul de sacs versus grids) are, or feel, less safe. Safety is generally greater for males, younger people, private renters, the better off, and people living in less poor areas.

'Neighbourhood environmental quality' has a negative association with net residential density, terraced housing, higher buildings, and being on through routes, while being positively associated with more rural locations. Social renting, poverty, and lower income are clearly associated with worse environments, whereas the relationships with age and length of residence are more complex. These findings are consistent with some previous literature, but we would suggest that experience of environmental quality is not just a function of physical design features but also of the care and maintenance services in place. 'Poor' and 'inner' areas may need more of these services to bring standards up to a decent level (Fisher and Bramley, 2006; Hastings et al, 2005).

'Satisfaction with the home' shows strong relationships with (mainly) individual-level housing type and associated urban form attributes, as expected. Satisfaction is clearly associated with having a garden, with bungalows and detached houses, and with being in areas with larger gardens, while it is negatively associated with terraced houses. Satisfaction is clearly greater for households with more rooms, and less for social renters (who tend to have less choice). Older people are more satisfied; younger, larger, lone-parent, and nonwhite households are less satisfied.

'Residential stability' is seen in some literature as a key to neighbourhood social capital, but it is clearly strongly related to lifestage demography (age, family status, and family size) and tenure (private renting). Lack of a garden is again negative for this outcome. Net residential density has a negative effect on stability, but this is nonlinear (the quadratic term means that this negative effect declines to a minimum around 250 DPH). Nonresidential and mixed uses are also negative for stability; this may reflect the environmental disturbance effect of these other nearby uses, but it may also partly reflect any lifestage selection effects not fully controlled for by the demographic and socioeconomic variables.

'Participation in groups' is also seen in some literature as a key proxy for social capital. However, in this study we have found that it is the outcome for which we have the poorest predictive power in the models—even at the area level (the 'between' subareas R^2 is only 0.234). This may be partly because we chose to use a combination of participation in activities at neighbourhood and city levels in this index. The only two urban form or access-related variables included in this model are 'not having a garden' (negative) and 'nonresidential and mixed uses' (positive). This last relationship is consistent with 'new urbanist' views that mixed use promotes community. The former may be an indirect selection effect, proxying people without a longer term commitment to place. Families, larger households, non-elderly households and nonwhite households participate more in collective activities; private renters and higher income households participate less. The associations with subarea socioeconomic status are weak.

The overall index for 'use of neighbourhood facilities' shows relationships with a number of access and urban form variables, and the direction of these relationships is, as expected, rather different from that of many of those outlined above. Use of local services is less at greater distances from the city centre and more where the MCA accessibility indicator is greater. There is a negative relationship with the proportion of residential gardens and greenspace, with residential gardens in particular a general 'suburban' proxy. These relationships are as expected from the literature, but the negative relationship with net residential density is not (although, as shown in table 2, the relationship with density is a bit ambiguous). Where respondents find it less easy to access public transport on foot and where services are less frequent, there is a significant negative association with use of neighbourhood facilities. In other words, better public transport goes with more use of local services, and vice versa. Older and family/larger households are more likely to use neighbourhood services, whereas younger and single-person households are less likely use them. Renters are more likely, and working households less likely to use such services. There are negative associations both with area deprivation and with 'rundown' areas, suggesting that for these places there may be safety and quality issues which deter use of services.

The last two outcome measures disaggregate services into two types: everyday 'utility' services and more discretionary 'leisure' and cultural services. They also measure usage by annual frequency (estimated from banded data). There are some detailed differences when these variables are used, but broad consistency.

4.4 Urban form, access, and other effects

In order to get a fair picture of the effects of urban form on social outcomes it is necessary to calculate the effects of all of the relevant variables included in each model. We have therefore constructed 'component' measures which are the product of the value of each included variable within a category (for example, urban form) and its estimated coefficient from the model, with a constant term to ensure that each component is centred on the same overall mean score. Components were calculated in this way for each outcome by each of four categories: urban form, location/access, demography; and socioeconomics. If we take a particular measure of urban form (for example, net density) as a representative measure, we can then plot these components against this to show the general pattern of urban form and other effects, which go to make up the overall outcome pattern. Figure 1 illustrates this for three of our outcome measures: neighbourhood pride and attachment, social interaction, and use of neighbourhood services. As anticipated at the end of section 3, the urban form component as plotted in

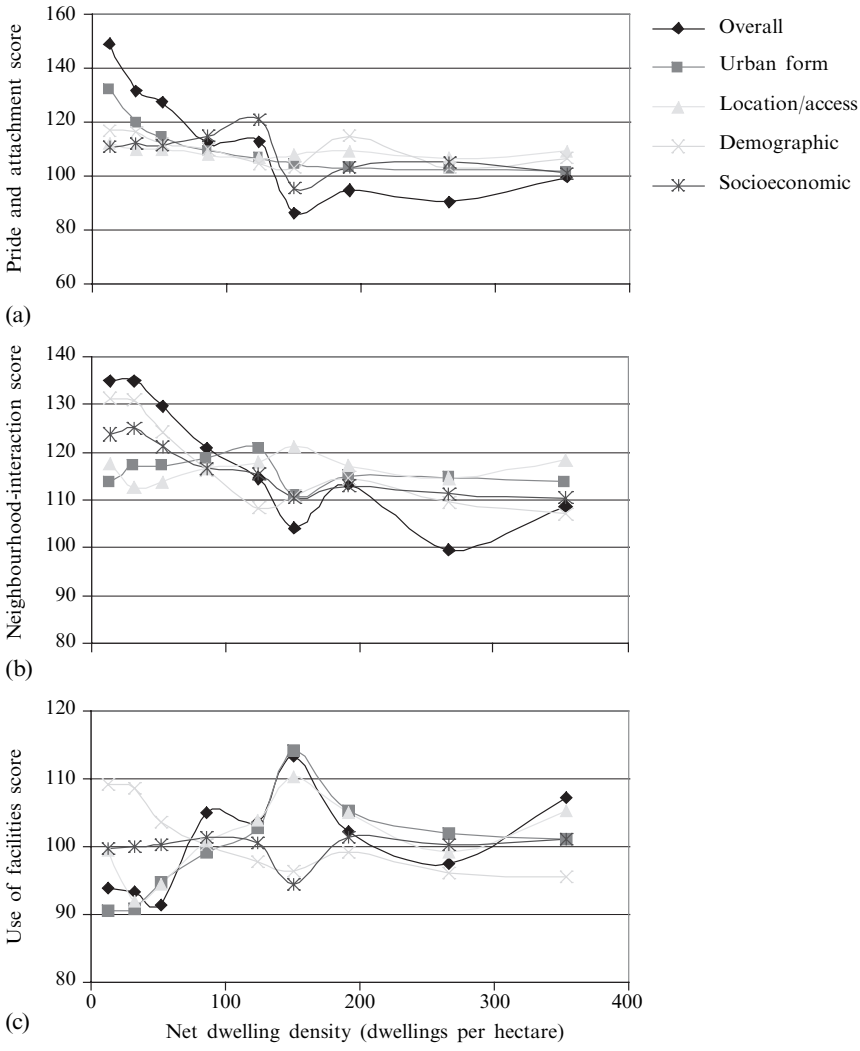

Figure 1. (a) Pride and attachment by density, (b) social interaction by density, (c) use of neighbourhood facilities by density.

this way does not in general have a linear relationship with density—despite the fact that the specific relationships underlying this component are generally linear.

Figure 1(a) shows how the overall index for neighbourhood pride and attachment drops as density rises, from nearly 150 in the lowest density band to just under 90 at a net density level of 150 DPH (net), with a more or less constant score at higher levels. The figure also shows how urban form and other components contribute to this outcome. Urban form also has a negative but diminishing (that is, nonlinear) effect on pride and attachment, but does not account for all of the overall decline. Demographic factors also play a part, along with a slight effect from location/access and a very sharp negative effect from socioeconomic factors in the 100 – 150 DPH range. This figure illustrates a common pattern across quite a number of the outcomes, whereby apparently quite strong negative associations between density and social outcomes are actually somewhat attenuated when allowance is made for other factors.

Figure 1(b) presents a similar picture for social interaction. Here, although there is a similar overall relationship with density (negative, diminishing), the role of the different categories of variable is quite different. Social interaction increases up to a density level of 100 DPH (net), before dropping off somewhat at higher levels. The effect of location/access is similar, raising interaction up to a density level of 150 DPH, then falling slightly. However, these effects are offset by quite negative effects in the range up to 100 – 150 DPH both from demographic and from socioeconomic factors. This figure helps to underline the messages from the specific variable effects, that a number of features associated with medium density are most productive of social interaction.

Figure 1(c) presents a similar analysis for use of neighbourhood facilities, where the pattern is, as expected, rather different. Here, the overall score rises strongly to a peak around 150 DPH, then falls off before rising somewhat in the very highest density band. The relationship with density up to the peak and beyond is strongly driven both by urban form and by location/access effects. These are not offset by moderate countervailing demographic and socioeconomic effects.

Reviewing graphs of this kind across all the outcomes suggests that our ten measures of social sustainability fall into three main groups in terms of their performance across the urban form spectrum. These three groups favour lower density (pride/attachment, safety, environment, home satisfaction, stability), medium density (interaction and participation), and higher density (access to and use of local services), respectively.

5 Concluding discussion

In this paper we consider the relationship between urban form and aspects of the social sustainability of communities, in the context of existing medium-sized British cities. The measurement of density itself is not simple, and our findings suggest the need to take account of housing-type mix, the role of gardens and greenspace, land-use mix, and network-connectivity characteristics.

There are, nevertheless, certain typical patterns in the relationship of social outcomes with density and location. Broadly, social outcomes relating to attachment, satisfaction, safety, and environment are more positive at lower densities and in less central locations, while outcomes relating to use of local services display the opposite tendency. Even these simple bivariate patterns suggest some nonlinearities, and also that some outcomes are more strongly related to urban form than others.

Multilevel regression models linking these outcomes to a wide range of individual and small area attributes typically explain 25% of total individual variance, but in most cases 60% – 85% of between-subarea variance. The regression models serve to control for the potentially confounding effects of demography and socioeconomic status, and it turns out that allowing for these controls significantly

modifies relationships between many of the social outcomes and urban form and/or location/access.

Firstly, outcomes relating to neighbourhood pride and attachment, stability, safety, environmental quality, and home satisfaction all display a negative, nonlinear relationship with density. Secondly, outcomes relating to social interaction and group participation tend to improve as density rises up to a medium level, and then fall off at higher levels. Thirdly, outcomes relating to the use of local services are broadly positively related to density. This third group represents the 'equity' aspect of social sustainability, whereas the previous two groups represent the 'community' aspect. However, greater use of local services also contributes to greater sustainability in terms of travel and transport, which itself displays a similar pattern over density.

The outcomes with the strongest negative relationship with density are home satisfaction and safety, both important factors influencing residential location choices, suggesting that housing-market choices are still likely to favour lower density options where available. The outcome which is least related to urban form is participation in collective community activities, frequently used as a marker of 'social capital'. Some of the specific variable effects are particularly interesting in their own right: for example, the positive role of gardens, not just in relation to environmental benefits but also in terms of outcomes such as social interaction.

The findings suggest that there is a kind of 'density divide' at around 100 – 140 DPM (net). The main relationships identified apply up to this level; beyond this density, relationships are either different or not apparent at all. We would be reluctant to draw any strong conclusions about the merits or otherwise of 'superdensity' from this evidence.[6] The numbers of observations in these higher reaches of the density spectrum are rather sparse, and the building forms involved may not be representative of contemporary 'super density' design proposals.

It is clear that, when other dimensions of sustainability are brought into account, the patterns of outcomes on these may be different from those we have found for the social dimensions. Policy assessment is likely to involve trade-offs. The obvious case will be transport and travel, and indeed we can demonstrate from this dataset that sustainable travel is likely to favour higher densities and compact forms (see also Ferguson and Woods, 2009). This clearly conflicts with, or must be traded off against, the 'community'/'attachment' aspects of social sustainability, but is actually rather similar to the 'equity' aspect of social sustainability, at least insofar as this is captured by measures of use of local services.

The most important policy implication of these findings is that care is needed in planning new urban developments or redevelopments if these are to be socially acceptable and successful communities. An exclusive emphasis on high density, particularly if this takes the form of apartment accommodation with little provision of gardens, is unlikely to produce happy, well-functioning communities. Compromises between the arguments (particularly from the sustainable transport perspective) for high density and the social and quality of life considerations will be needed. The socioeconomic and demographic mix of communities is also shown in this study to be very significant for social outcomes, implying that policy should also promote mix and balance in this respect.

In planning for future urban developments, or the reshaping of existing cities, it is also clear that 'one size does not fit all' and that there will be a need to provide a range of environments for different groups in different locations. There is a need for 'whole system' simulations, allowing for the different locational and lifestyle choices which

[6] See Design for London (2007) for a recent perspective on superdensity.

different groups will make and the likely outcomes which result. The data generated in this study can contribute to the prediction of what those outcomes would be likely to be. However, it would be valuable to extend the database to take account of behaviour and outcomes in a broader range of urban form and settlement contexts. Such work should clearly also consider social and demographic mix of population, alongside urban form, when informing the planning of new communities.

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