A method for quantifying equity of access to local services for different demographic groups: combining network analysis with logistic regression using the example of greenspace

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1. Introduction

There is much concern about provision of various local amenity goods and services to different societal groups. These concerns relate to the provision of facilities and fair, equitable access to them, and range from public transport and recreation facilities, to cultural events, education and welfare provision. Local and national governments are under pressure to assess and quantify the extent of their provision of such facilities in order to demonstrate equitability or to be able to target resources to rectify any disparities in provision. Often the drivers for these concerns relate to wider social and economic development targets, initiatives and legislation. This paper presents a generic method for quantifying the provision of such goods and services based on a GIS network analysis of access to greenspaces by different socio-economic groups linked to logistic regression. The method quantifies the extent to which different sections of the population (as identified in census data in this example) are discriminated against in terms of the provision of goods and services. This work quantifies the provision of greenspace in a city in the English Midlands. The study shows how combining network analysis with logistic regression of socio-economic data can be used to strategically inform local decision-making in relation to national or international (e.g. EU) guidelines and legislation. In the example study, greenspace access for different religious and ethnic groups was analysed and contrasted. The technique of combining network analyses with regression coefficients of census or other geodemographic data allows the accessibility to those services amongst different social groups to be quantified.

2. Background

2.1 Equitable provision environmental services

The UK government is committed to "making sure that public spaces are accessible to all members of our society, able and disabled, young and old …[and to]…producing a review of social and environmental exclusion" (ODPM, 2002, p8). To this end town planning should aim to eliminate discrimination and to promote equality of opportunity. It therefore requires clear and equitable decision-making frameworks in order to reduce social and spatial inequalities (RTPI, 2001). However the concept of 'institutional discrimination' includes situations where policies and/or practices fail to provide a fair and equal service to one or more groups of people. This includes planning policies that take no account of the spatial concentrations of persons with shared characteristics (Heriot-Watt University/ ODPM, 2005). Part of the problem is that population characteristics vary enormously between different areas: in some places the cultural background of the population is changing rapidly, whilst in others the age profile is changing.

Evidence shows that in some cases issues about diversity and equity of access are not well understood in planning. For instance, the report by Sheffield Hallam University and the

ODPM (2004) noted that appraisal of the impacts of development plans and policies on different groups is weak and that planners and development control officers may find it difficult to make the connections between development proposals and diversity. UK government concerns about ensuring equitable access to local authority services are now in the mainstream of planning with planners take positive action to ensure that their practice and policies are inclusive and do not result in systematic disadvantaging of some communities or individuals (Heriot-Watt University/ ODPM, 2005). To this planners are advised to use demographic data such as census data to provide a disaggregated analysis of people and trends in their area in order to demonstrate that they deliver a fair service to everyone (Heriot-Watt University/ ODPM, 2005).

2.2 Guidelines for greenspace access

In many countries guidelines exists for the provision of greenspace. For instance in Flanders the environmental report "Milieu-en Natuurrapport Vlaanderen" (MIRA – see Van Herzele et al., 2000) specifies the different sizes, functions and proximities to which each urban resident ought to have access. Similarly in the UK English Nature (now called 'Natural England') have provided a set of standards for the provision natural places called 'Accessible Natural Greenspace Standards' (ANGSt). Such standards aim to provide benchmarks for the provision of places where people can experience and enjoy nature The ANGSt model recommend at least 2ha of accessible natural greenspace per 1000 population should be provided and specifies minimum standards for greenspace access related to greenspace area and proximity (Table 1. The standards originate from work by Harrison et al. (1995) as described in Handley *et al*. (2003) and English Nature's *A Space for Nature* (English Nature, 1996).

Table 1. ANGSt guidelines for minimum stands for greenspace

Maximum distance from home (km)	Minimum greenspace surface area (ha)
0.3	2
2	20
5	100
10	500

3. Method

The greenspace data used in the analysis was provided by the local council:

- Site of Importance for Nature Conservation
- Local Nature Reserves
- Cemeteries
- Natural Open spaces and Parks

These are areas that are accessible to the general public for everyday use. Points of access (gates, fence breaks etc) were mapped from OS 1:25,000 scale colour raster data and manually digitised. These represented the 'supply' for the network analysis. The output area polygons were provided by the Office of National Statistics and the output area census data were downloaded from Casweb (http://www.census.ac.uk/casweb/) Output area centroids represented the 'demand' for the analysis. To illustrate the equity of access amongst different sections of the community, census data on ethnicity and on religion were collated for each census output area. The road data was from Ordnance Survey Meridian 2 (1:50,000) data (©Crown Copyright/database right 2007, supplied via EDINA).

For each output area, the distance to each greenspace was calculated, allowing the shortest distance to different greenspace types, as defined by Handley *et al*. (2003) and English Nature (1996) to be quantified. The distribution of access that was analysed according to the ANGSt model: the numbers of people with and without access to different ANGSt categories in each census areas were summed for the different classes contained within the census attributes of

religion and ethnicity. Generalised linear models were used to estimate likelihood of access as a function of either religion or ethnicity. A table of counts was drawn up where the rows designated whether individuals had access to green space (under rule 2) and the columns designated either the religion or the ethnicity of individuals. The count in column *i* and row *j* is denoted by c_{ij}. To test whether there is an association between the row and column effects, the Poisson regression model was applied:

$$\mathrm{E}(c_{ij}) = \log(r + A_i + F_j) \quad (1)$$

where c_{ij} has a Poisson distribution with mean $\mathrm{E}(c_{ij})$, r is an intercept term, A_i is a column effect and F_j is a row effect, is compared against the model

$$\mathrm{E}(c_{ij}) = \log(r + A_i + F_j + I_{ij}) \quad (2)$$

where the extra term I_{ij} is an interaction effect between rows and columns. If this is significantly different from zero, this suggests some degree of association between the row and column effects. In this study, it may be used to test for association between either religion or ethnicity and access to green space. Values of I_{ij} were estimated by fitting Equation 2 to each of the tables using the R statistical software package. It is possible to relate these coefficients to a comparative index of access for each of the row categories, using the formula

$$ACCESS = 100\left(\exp\left(I_{ij}\right) - 1\right) \quad (3)$$

Due to the way the interaction terms are calibrated, this quantity compares each column *category j* against a 'reference' category. A value of 0 suggests the likelihood of access for *category j* is the same as for the reference category. A value of 50 for *category j* suggests access is one-and-a-half times as likely as the reference category, a value of -50 that it is half as likely, and so on. The reference categories for ethnicity and religion are 'British' and 'Christian' respectively. For each of the coefficients, the *ACCESS* was calculated. An overview of the approach is presented in Figure 1.

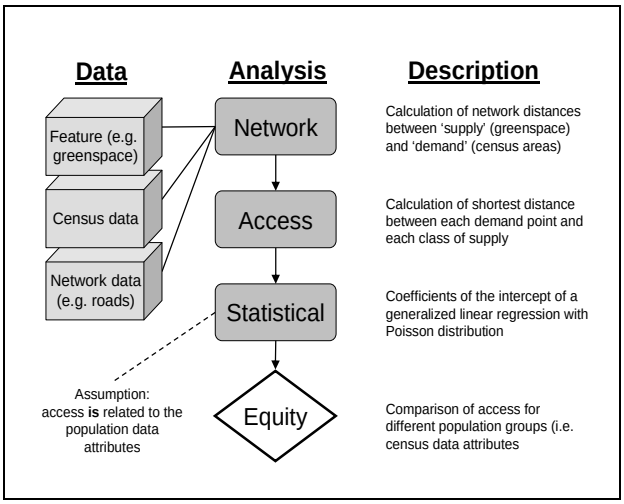

Figure 1. The analysis processing stages, with the data and analysis descriptions

4. Results and discussion

Mosaic plots are a convenient method to analyse and visualise the differences between the predicted and observed values. They plots visualise standardised residuals (often referred to as a standard normal distribution) of a loglinear model using variations in the shade, hatching and outline of the mosaic's tiles. The plots show the access to greenspace in terms of Rule 2

(20ha within 2km) for different ethnic groups (Figure 2) and religious groups (Figure 3) and the tile areas are proportional to the numbers of people affected. Negative residuals are shaded and with broken outlines and positive ones are hatched with solid outlines.

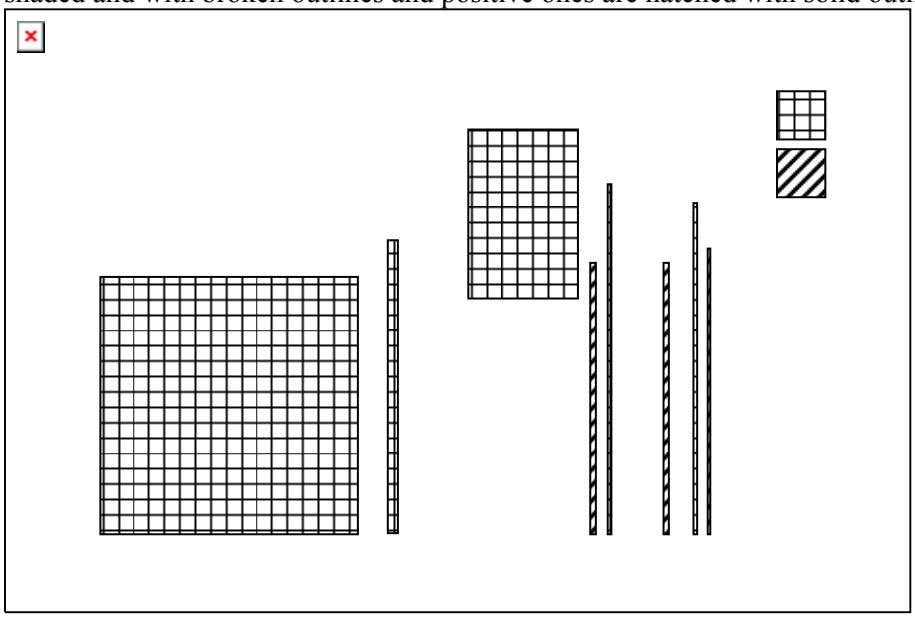

Figure 2. The mosaic plot of access ("True") to greenspace by ethnicity. Mixed1 is 'White and Black Caribbean', Mixed2 is 'White and Black African', Mixed3 is 'White and Asian' and Mixed 4 is 'Other Mixed'.

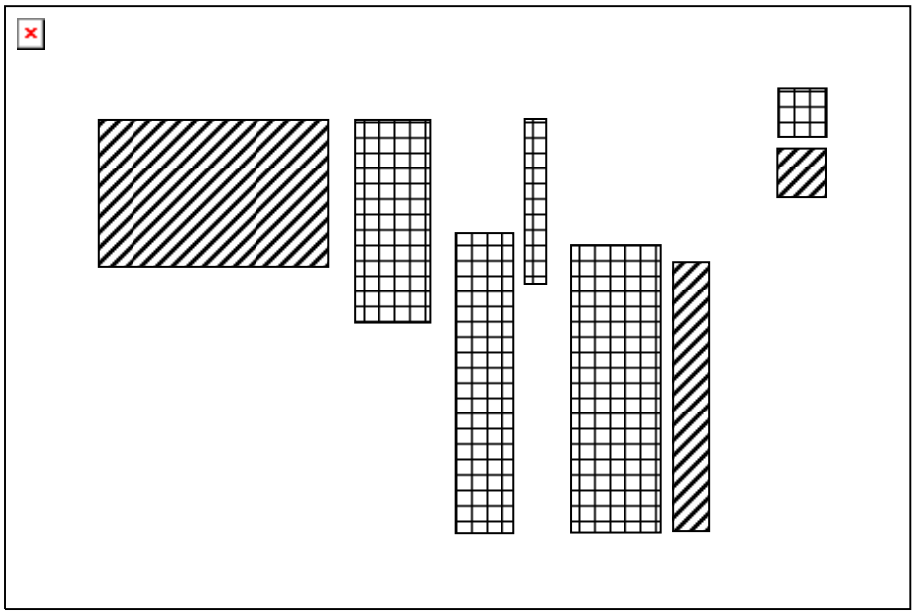

Figure 3. Mosaicplot of access ("True") to greenspace by religion

This paper presents a generic method for quantifying equity of access to some facility for different community groups. In this work we have analysed access to greenspace. But, the approach can be applied to a wide variety of demographic data, including other census variables (deprivation, disability, occupation, economic activity, household tenure and types, age and health) and other geographies such as detailed geodemographic data at household or post-code level.

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