Measuring Perceived Accessibility to Urban Green Space: An Integration of GIS and Participatory Map

Fariba Sotoudehnia, Lex Comber

[1,2] Department of Geography, University of Leicester, UK

ABSTRACT

Urban green space (UGS) provides free breathing space to take time out from the stresses of contemporary life. This paper aims to measure both physical and perceived accessibility to UGS by using GIS and three qualitative methods and make a comparison between the actual travelled path and the analytically calculated ones. GIS-based network analysis determine only 15% of the total population in Leicester meets physical access up to 300m which has been significantly distributed in the most deprived areas. The results derived from 455 questionnaire show a significant relationship between people age, occupation, car ownership, actual travel time and mode of travel with the frequency of use. The average of actual travelled path (come from 270 routes drawn by people) show a longer travelling distance compared to the average calculated by network analysis. People's drawn routes show more travels towards GS in the centre of the City compared to those in the north direction.

INTRODUCTION

A wide range of evidence demonstrates the contribution of UGS can improve the quality of life and physical and mental health and wellbeing. Cultural and recreational services provided by safe UGS networks are central to the quality of life and promotes the social cohesion and the sense of community ownership across different social groups (Peters et al., 2010). Findings from reviewing ninety articles by Matsuoka and Kaplan (2008) on human interaction with different types of GS support strong contribution of nearby access to GS in ensuring human wellbeing due to increasing physical activity and community involvement.

In GS literature, "access" is mainly measured as a physical distance or travelling time from a residential house to a GS. The UK benchmark standard recommends that to make the best of GS, no-one should live more than 300m from nearest green area of at least 2ha in size. Several studies addressed the negative association between physical distance to GS and the frequency of use (Grahn and Stigsdotter, 2003; Hansen -Møller and Oustrup, 2004; Schipperijn et al., 2010). Amongst from different qualitative and/or quantitative methods applied to measure accessibility Omer and Or (2005); Barbosa et al. (2007); and Kessel et al. (2009); Comber et al., (2008) used a GIS-based network analysis to quantify accessibility amongst ethnic and religious groups in a UK city. Results show the inequity of access amongst Hindus with 44% less access to GS than Christians. used different qualitative and/or quantitative methods against individual factors. Their findings show inequality provision of and access to GS for different social groups.

Despite the wide range of studies on physical accessibility, those focusing on perception and preferences of people about GS are rather scarce. Whilst, Natural England highlights the importance of conducting more national research on perceived accessibility to discover the relationships between GS perception and physical activity by population sub-group. This paper aims to address "who use green space" according to the way different social groups prescribe their use and perception about GS. GIS-based network analysis is used to quantify physical accessibility along with qualitative methods (questionnaire, participatory map and interview) to measure perceived accessibility and the factors can influence it.

METHODS

Study area

The data used in this study were gathered in Leicester, an English city, with a population of 294,700. Leicester local authority manages some 1,250 hectares (10% of the total area) of publicly accessible open spaces across the City. Although Leicester supplies sufficient amount of GS, the provision of areas is unevenly distributed across the City.

UGS in this paper are defined as all types of GS which are publicly owned and accessible. The areas can have a designed or planned as well as a more natural character (e.g. parks and public gardens, green corridors, local nature reserves, spinneys, washland areas and cemeteries).

Collection of data on green space

Data on GS were provided by Leicester City Council and used for creating a GS layer in GIS system. GS within a 3 Km buffer from the City borders were included in all analysis to make sure about the participation of residents living close to the borders. GS polygons were digitised into access points to measure physical accessibility. Further to GS, the other three layers, the City road network (roads network data was Ordnance Survey Meridian 2, 1:50,000), census areas (Output Areas are publically available) and census attributes data (obtained from the CASWEB service) were added to GIS system.

Data collection – questionnaire, participatory map and interview

The questionnaire methods along with participatory map and interview were used to measure perceived accessibility by addressing who use green space.

In summer 2010, the aim and objective of the study were advertised on posters and displays around different UGS to attract attention and participants. To inform more participants, the questionnaire was advertised on-line via local community websites and magazines. People who were using GS either for attending summer festivals and events or just for normal visit were asked to participate. Participation included completing a 5 page questionnaire and a participatory map (i.e. draw the routes to the green space and within it). To make it more convenient, participants were provided with the chance of participation either within the time they were at the areas or later on by posting the completed questionnaire and map through a pre-paid envelope. The option of on-line participation was also open to them.

The questionnaire included 20 questions in 5 sections: a) participants' postcode; b) the activities they would involve in GS; c) the characteristics of GS they would like to use; d) their personal demographic data, and e) a space for any comments. The latter was to encourage them to identify the factors related to the provision of and access to GS which can improve the quality and attractiveness of the areas and getting more people into the places. An invitation letter was enclosed for those who would like to discuss about the subject in more details. Each interview planned about 20-30 minutes with more precisely focus about the questions they were asked through the questionnaire as well as the routes they drawn to show how they get into a GS. Additionally, they were asked about their satisfaction with the quality of their GS, factors which can either positively or negatively influence their willingness to use and the characteristic of an ideal GS along with the ideal distance and travelling time to get into such places. Interviewee's responses consider as a valuable source of information on perceived accessibility.

From the total number of 455 questionnaires were gathered, 270 enclosed with a completed participatory map and 180 positive responses for taking an interview.

Data analysis

In order to quantify physical access to GS, a GIS-based network analysis was applied to measure road distance from each OAs to each the nearest UGS under the premise that shorter distances are associated with greater and more frequently use. This was done within 3 distance constraints: a) distance up to 300 metres ('good access'), b) distance between 300 to 1000 metres ('average access'), and c) distance more than 1000 metres ('poor access). A mosaic plot was used to visualise the

relationships between physical access and deprivation. The approach was first proposed by Hartigan and Kleiner (1981) and extended in by Friendly (1994). The plots demonstrate access to GS for different deprived groups as tiles whose area is proportional to the numbers of people affected.

With regard to exploring people perception towards accessibility, the statistical coloration and regression tests will be applied to show to what extent individual and/or environmental factors can influence the frequency of the use the nearest UGS. In addition to statistical analysis, qualitative data analysis such as coding interviews will be used as a complementary method to discover people experience about perceived accessibility in more details. Furthermore, spatial analysis will be used to evaluate people satisfaction with access in each OAs. It will be go through locating people's postcode in each OAs. The routes people drawn to show their actual path from their location to GS will be used to make a comparison between analytical path travelled by people to the closest GS and the actual travelled path addressed by people.

RESULT

The results of network analysis show only 15% of the total population in Leicester were found to be within 300m of a GS (good access) whilst 40% have an access between 300 and 1000m (average access) and 45% are an access over 1000m (poor access). Mosaic plot results address in the more deprived (5%) parts of Leicester there is significantly more provision of and access to GS than 90% of the City (average) and the least deprived areas (5%).

The data were obtained from questionnaires imported in GIS system through postcode to combine with the other source of data. Figure 1 shows the City road network, OAs, GS and the geographical location of each participant. Whilst the figure demonstrates the more concentration of use around GS in the centre of the City, the use is not limited only to those who live in within the City boarders. A 3Km buffer surrounds the geographical location of both participants and GSs.

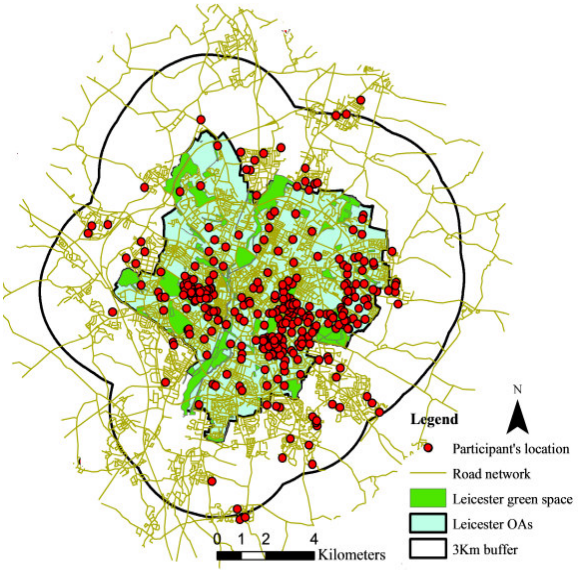

***Figure 1*:** The geographical location of 455 participants surrounding by a 3Km buffer.

Figure 2 illustrates the digitised routes people drawn to specify their actual travelled path from a presented postcode to a GS. The aim is to comprise the actual travelled path with analytically calculated path by GIS-based network analysis. Compromising results reveal a longer average travelled path drawn by people than the calculated distance by network analysis (closest facility function). As the figure demonstrates more travel path direct towards GS located in the centre of the City compared to those in north direction.

Who are green space users?

Results show that women (55%) use GS most. The age profile of respondents reveals (63%) of respondents age between 20-49 years compared to (26%) between 50-74 years, (3%) over 75 years and (8%) 16 or under to19 years. The majority of participants described their ethnic status as White and Asian or Asian British. From the economic aspect (60%) of the respondents described themselves employed, (14%) retired, (22 %) students and (4%) unemployed and others. With regard to annual income, (29%) of participants left the question unanswered, (17%) described it up to £15k, (16%) between £15-25k, (21%) between £ 25-50k and only (3%) over £50k.

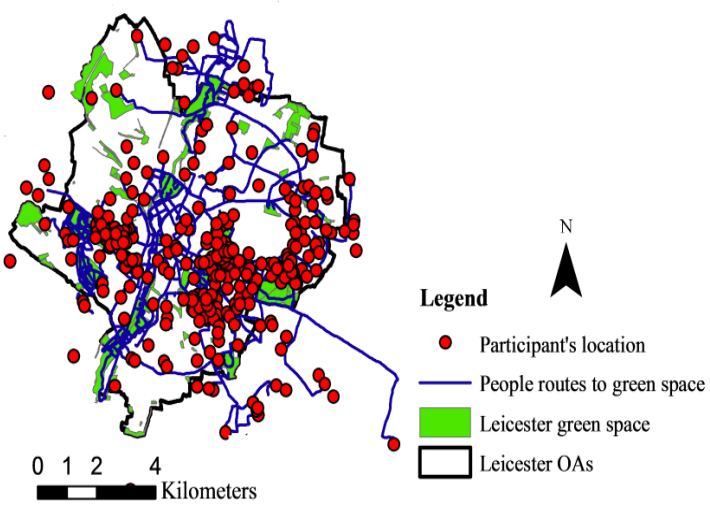

***Figure 2*:** Digitised routes by 270 participants from their postcode to a GS

Figure 3 shows the frequency of use of GS against percentage in Leicester. The most frequency of the use was "once a week" by slightly over one quarter of respondents. Seasons not only influence frequency of the use during summer and winter but also the duration of stay. For instance, the frequency of use increased in summer to (6%) by those who visited GS "everyday", (25%) "most of days" and (30%) "once a fortnight", compared to the same people who only visited areas "everyday" (4%), "most of days" (13%) and "once a fortnight" (20%) in winter.

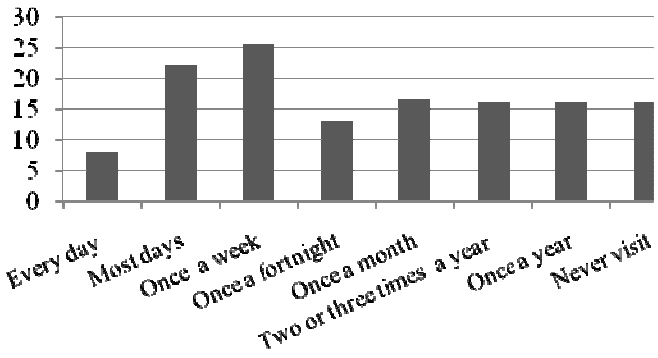

Figure 3: The frequency of using green space by participants.

The most common modes of travel are by walk (60%); car (26%) and bike (10%). Over (90%) respondents they travel directly from home to get to GS. Travel time by (21%) has been reported less than 5 minutes, over (40%) between 5-10 minutes, (17%) 10-15 minutes and by around (20%) more than 15 minutes. The ideal closest distance for over (75%) of users is up to 300m and 500m.

The results of the statistical correlation tests reveal there is a significant relationship between the frequency of visit and the participants age (X^2 (49, N= 452) = 80.482, p = 0.002); car ownership (X^2 (7, N= 448) = 20.147, p = 0.005); and occupation (X^2 (49, N= 444) = 75.581, p = 0.009). The results also identify a significant relationship between the frequency of visit and the factors such as actual travel time (X^2 (42, N= 455) = 88.055, p = 0.001); mode of travel (X^2 (30, N= 455) = 50.744, p = 0.010); and satisfaction with current access (X^2 (7, N= 458) = 17.772, p = 0.013). Further work will apply Multi Logistic Regression to measure the degree of relationships between variables and the use of GS.

To explore the influence of environmental factors on the frequency of use, respondents provided with a 7-point scale ranging from "very important" to "no opinion" and "do not know". Figure 4 reflects the "very importance" influence of the fifteen environmental factors.

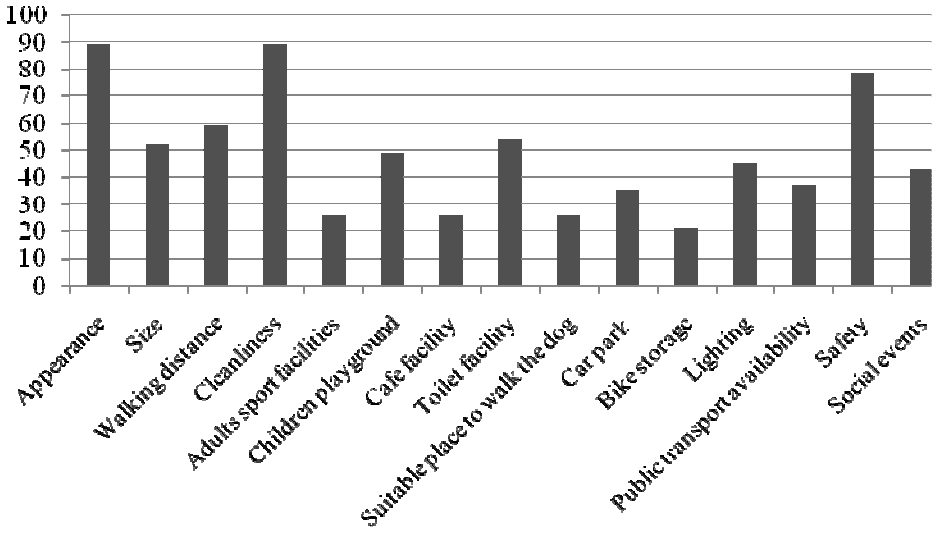

Figure 4: Percentage of the fifteen "very important" environmental factors in the use of green space.

According to the figures, "cleanliness", "safety" and "appearance" have the top three influences on users. Although statistics show the "very important" influence of sport facility and playground only by (30%) and (10%) of respondents, respectively, findings from the informal investigation (talking to park users) revealed that parents of children and young people count on running competitive challenges and at risk activities as encourage factors to get them more often into GS.

DISCUSSION and CONCLUSION

This study analysed physical access to GS according to the UK, ANGSt benchmark standards. The results show that for the majority of population in Leicester (85%) there is not any physical access to GS with up to 300m. The figure supports findings by Barbosa (2007) who addressed that (64%) of households in Sheffield, UK, fail to meet the physical access with up to 300m. The results of mosaic plot demonstrate significantly more physical access to GS in the most deprived OAs areas of the City compared to the average and least deprived areas. Whilst similar results addressed by Kessel, et al. (2009); Omer and Or (2005) found more affluent people in Israeli cities have greater access to GS than the other social groups.

To address perceived accessibility, although figures show women use GS most, statistically there was no significant relationship between men and women in using the areas. Whilst results show a significant relationship between the age of participants, occupation and their car ownership situation

with the frequency of the use. The results also illustrate a significant relationship between the actual time of travel, mode of travel and the satisfaction with current access with the frequency of use. Over 80% of the respondent counted on the top three environmental characteristics: a) cleanliness of green space, b) walking distance and c) feeling safe as the most encouraging factor to use the areas more often. In addition, people commented that better provision of equipments in designated playground, challenging activities, social events and seeing park keepers within GS would also encourage them to use GS more often.

Network analyses was applied to measure analytical travelled path from each respondents OAs to a nearest GS in order to compared it to the actual travelled path drawn by people. Whilst GIS-network analysis is a complicated technique which needs more details data and a greater degree of technical expertise to implement, it is the optimal method for evaluating a more realistic picture of site catchment zones by calculating the actual distance from site access points. Applying an integration of GIS-based network analysis and qualitative methods can be generally applied as an optimal method to address which type of community goods and services access is most lacking and where community access need to be improved.

Further work will apply complementary statistical analysis to study the degree of relationship between the variables and frequency use of GS. Integration of coding interview's transcriptions and digitised routes will be used to reveal more precise image of perceived accessibility. Findings will add new source of information in GS literature in order to measure perceived accessibility. Findings can be in interest to local authorities and city planners in well managing the quality of GS to get more people into the areas as well as improving the perception of an area and make people feel good and have pride in where they live.

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