Spatial Modelling and Analysis

Capital Greenspace Report

Greenspace and Recreation: A GIS Study on Access to Recreational Quality in Public Greenspaces Across Edinburgh, Scotland

Abstract

A novel index is developed to assess how spatial access to recreational quality in public greenspaces differ across datazones within the City of Edinburgh. Using criteria identified from literature, all larger urban greenspaces are scored and weighted to produce a final score. An 800m service area, equivalent to a 20-minute walk, is defined from each greenspace's access points and all scores summed to produce the index (ARQI) showing access to recreational quality for each datazone. The quintiles of datazones are then compared to the SIMD (2020) through a statistical test to observe the relation between the two indices. Results showed that there is a relation between the ARQI and the SIMD (2020) and further visual evaluation suggests the association to be negative. Using this information, we suggest improving greenspace access by using underused, larger spaces which would additionally need to be transformed to meet the recreational quality standards of the local community as well of the GreenFlag Award.

Acknowledgements

We would like to thank Bruce, Neil and Zhiqiang for their verbal and written feedback provided in the field and online. We would also like to thank Tony and Gary from the Edinburgh Council for allowing us to acquire various datasets from the Council data webmap.

Table of Contents

List of Figures

List of Tables

List of Acronyms

AHP	Analytic Hierarchy Process
ARQI	Access to Recreational Quality Index
ha	Hectares
MAUP	Modifiable Areal Unit Problem
MCE	Multi-criteria Evaluation
OS	Ordnance Survey
OSM	OpenStreetMap
RDBMS	Relational Database Management System
SIMD	Scottish Index of Multiple Deprivation

1. Introduction

Both access to and quality of greenspaces can influence an area's level of environmental deprivation and subsequent planning interventions (Van Dillen et al., 2012). Environmental deprivation is defined as the state in which an agent or community experiences poorer access to recreational quality in greenspaces (Townsend, 1979). Existing studies have explored the two facets separately, however given the Scottish Government's commitment to 20-minutes neighbourhoods, there is a discrepancy of research focusing on the *quality*, *proximity* and *diversity* of environmental activities (O'Gorman and Dillon-Robinson, 2021). We develop a novel index to assess spatial access to recreational quality and to aid greenspace planning decisions across Edinburgh. Recreation is broadly defined here as the pursuit of walking for leisure irrespective of social demographic. In particular, urban design features and the overall atmosphere of the greenspace are key. Figure 1.1 outlines the research question and the objectives of this study.

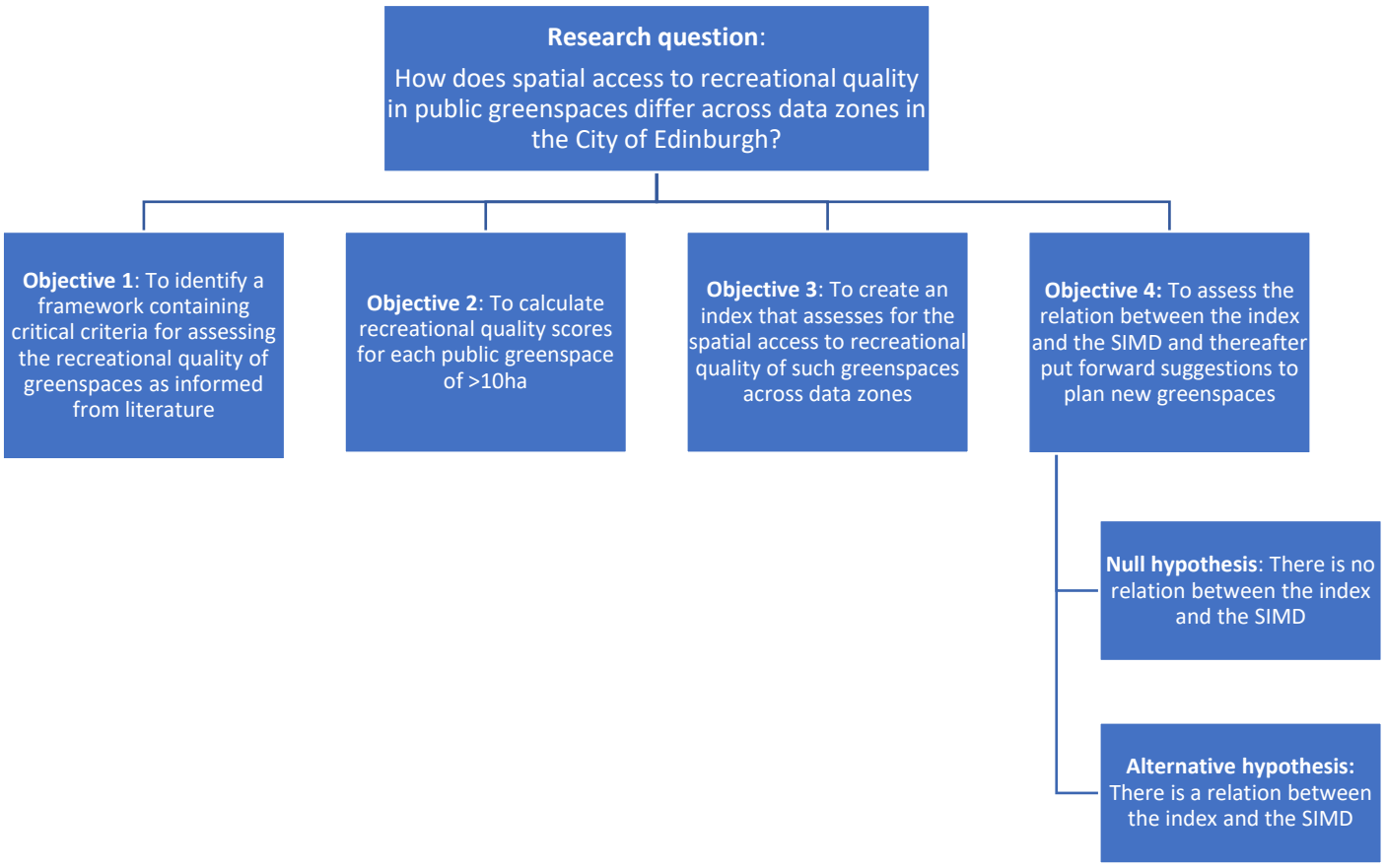


***Figure 1.1**: Research aim, objectives and hypotheses of the project*

2. Literature Review

Public demand for access to multifunctional, quality greenspaces are high due to the known benefits to individual and community health (Jennings and Bamkole, 2019; Maas et al., 2006). Access standards vary, but the 300m standard is commonly used in UK spatial planning and policy (Handley et al, 2003). Quality, a more recent concept, arose following its deterioration in UK greenspaces (Greenhalgh and Worpole, 1996), and much research has since been devoted to developing quality audits (see Gidlow et al., 2012; Knobel et al., 2021). Despite such influences, government aspirations lack potency, and thus, environmental injustices remain (Pearce et al., 2010; Shaw et al., 2005).

The plethora of quality assessments is reflective of the multifarious and subjective nature of the topic, and whilst most are produced for local needs (Greenspace Scotland, 2008), these lack legislative support (Greenhalgh and Worpole, 1996). The *GreenFlag Award* is recognised as the current benchmark for UK greenspaces allowing improvements to be lobbied based on a park's 'status' (Ellicott, 2016). The award's criteria, though rather exhaustive, does not reflect a broad consideration of park use and is time-consuming to assess (Gidlow et al., 2012). With open data access under the INSPIRE Directive, this confers greater flexibility beyond field studies (Rajabifard et al., 2010).

Spatial patterns of environmental deprivation remain fuzzy. Some report a negative association between level of deprivation and greenspace access (Jennings et al., 2012; Talen, 1997), whilst Macintyre et al.'s (2008) study in Glasgow shows that access is concentrated in more deprived communities. Jones et al. (2009) also confirms this further citing safety concerns as a barrier to public use, but such a focus on quality is too narrow. Beyond this, there has been a lack of studies combining access, quality and deprivation perhaps as multiple factors are likely to simultaneously influence the outcome (Pearce et al., 2010).

3. Methodology

3.1 Data Sources, Methods and Creation of the ARQI

An MCE model was constructed to assess recreational quality. This was chosen due to its ability to capture independent variables whilst assigning variable weights to reflect the sample population's perceptual differences (Chen et al., 2010).

Taking into account the literature which identified the key urban design factors that affected recreation (see Laing et al., 2009; Schipperijn et al., 2010; Zhang et al., 2013), and the ability to obtain readily accessible data, nine sub-criteria across four criteria were selected [Table 3.1].

Amenities	Safety	Accessibility	Aesthetics
Public Toilets	CCTV Cameras	Core Path Networks	Conservation Areas
Seating Locations	Crime Rates		Trees
Bins			
Play Areas			

***Table 3.1**: Four identified criteria and nine sub-criteria*

The Edinburgh Open Space Audit greenspace dataset has identified 1394 greenspaces of which most are limited to public recreational use due to prohibited access and necessary fees involved. In line with the concept of environmental justice which advocates for equal access to recreation, only public greenspaces were included in the study. With size being another factor in influencing the extent to which recreation can be carried out, the threshold was chosen to reflect the observation that encompassed all of the study's amenities. In Edinburgh, parks over 10ha were deemed to be most suitable for recreational activities; greenspaces whose size did not meet the requirement were filtered out. In total, 33 greenspaces were chosen for the study [Figure 3.1].

Figure 3.1*: A map showing all 33 public greenspaces over 10ha in area (All maps in this section is produced by B211600)*

All data were acquired through open data portals and initially assessed for its accuracy and suitability before analyses [Table 3.2].

A five-point scoring system was chosen for greenspace scoring and this is congruent with studies such as (Carver, 1991) and (Gül et al., 2006). Since a variety of factors were included, several scoring systems were required to suitably capture the scores in a standardised form [Table 3.3]. Following discussion, each sub-criteria were assigned to one scoring system [Table 3.3] and ArcGIS Pro was used to aid scoring. During scoring, the data were ground-truthed using aerial imagery [Table 3.2].

Criteria	Sub-criteria	Dataset	Source	Date	Format	Resolution
Amenities	Public toilets	Edinburgh Council	Edinburgh Council	2021	Vector	-
	Seating locations	Edinburgh Council	Edinburgh Council	2021	Vector	-
	Bins	Edinburgh Council	Edinburgh Council	2021	Vector	-
	Play areas	Edinburgh Council	Edinburgh Council	2021	Vector	-
Safety	CCTV Cameras	Edinburgh Council	Edinburgh Council	2021	Vector	-
	Crime count	Edinburgh Council	Scottish Government	2020	Vector	-
Accessibility	Core path networks	Edinburgh Council	Edinburgh Council	2021	Vector	-
Aesthetics	Conservation areas	Edinburgh Council	Edinburgh Council	2021	Vector	-
	Trees	OSM	OSM	2004-2020	Vector	-
Additional	-		Getmapping PLC	2020	Raster	25cm
	-	OS Open Greenspace	OS	2020	Vector	-
	-	OS MasterMap Highways Network	OS	2020	Vector	-
	-	SIMD	Scottish Government	2020	Vector	-

Table 3.2: *Datasets, sources, formats and resolution for the project*

	Sub-criteria Scoring System					
	0	**1**	**2**	**3**	**4**	**5**
Quantity	No Presence	Almost no Presence	Scattered Presence	Mix of Scattered and Clusters	High Presence with Fair Distribution	High Presence with Great Distribution
Coverage	No Presence	1-15%	16-35%	36-50%	51-70%	>70%
Crime Rating	No Presence	>225	151-225	76-150	1-75	0
Core Paths Network	No Presence	1	2	3	4	5

Quantity	**Coverage**	**Crime Rating**	**Core Paths Network**
Play Areas	Trees	Crime Count (Average amongst neighbouring datazones)	Core Paths Network (count within a 400m radius of Greenspace)
CCTV Cameras (within a 10m radius of greenspace)	Conservation Areas		
Public Toilets			
Bins			
Seating Locations			

***Table 3.3**: Tables showing the four scoring systems (top), and a breakdown of the scoring system used to score each sub-criteria (bottom)*

The weighting of each sub-criteria was defined using a public survey and AHP due to the specialised nature of our criteria [Table 3.4] [Appendix A and B]. In-person visits to four parks (risk-assessed approved) were chosen to reflect the various perceptions of recreation across four quintile levels of the SIMD (2020) to diversify the sample population's opinions.

Criteria	**Weight**
Play Areas	0.03
Public Toilets	0.08
CCTV Cameras	0.08
Bins	0.18
Seating Locations	0.08
Trees	0.19
Conservation Areas	0.08
Crime	0.08
Core Paths Network	0.20
Consistency ratio (CR)	0.02 (<0.10 threshold)

***Table 3.4:** Individual weighting for each criteria based on the results from the public survey*

Using a linear weighted combination approach, unique scores for each greenspace were weighted to produce a final recreational quality score [Eq. 1]. Consistent with the GreenFlag Award, the scores were then further split into three grades of equal intervals [Table 3.5].

$$Recreational\ Quality\ Score = \sum^{(W_{PA}) + (W_{CCTV}) + (W_{PT}) + (W_B) + (W_{SL})}_{+ (W_T) + (W_{CA}) + (W_{CC}) + (W_{CPN})} \quad (1)$$

where:

Wi =weight of each sub-criteria

Grade	Recreational Quality Score
A	3.34-5
B	1.68-3.33
C	0-1.67

***Table 3.5**: Recreational quality score required for each grade*

Finally, the ARQI was created by taking an 800m service area around each greenspace's access points, and its recreational quality scores summed and further split into quintiles, as consistent with the SIMD. Using the frequencies of data zones per quintiles, a Chi-Squared Test for Association was conducted to observe the relation between the SIMD (2020) and the ARQI.

3.2 Database for Users

The Oracle RDBMS is used here due to its simplicity of use and its integrative capability with the interactive webmap (not discussed here) (Candan et al., 2001). The normalised database holds seven entity sets and relational integrity is introduced to enable joins for querying [Figure 3.2] [see Appendix C for SQL statements]. The entity sets were chosen to reflect the information which would be of greatest benefit to the public and planners to aid decision-making on either park visits or greenspace planning, respectively, and two example relationship sets are illustrated in Figure 3.3.

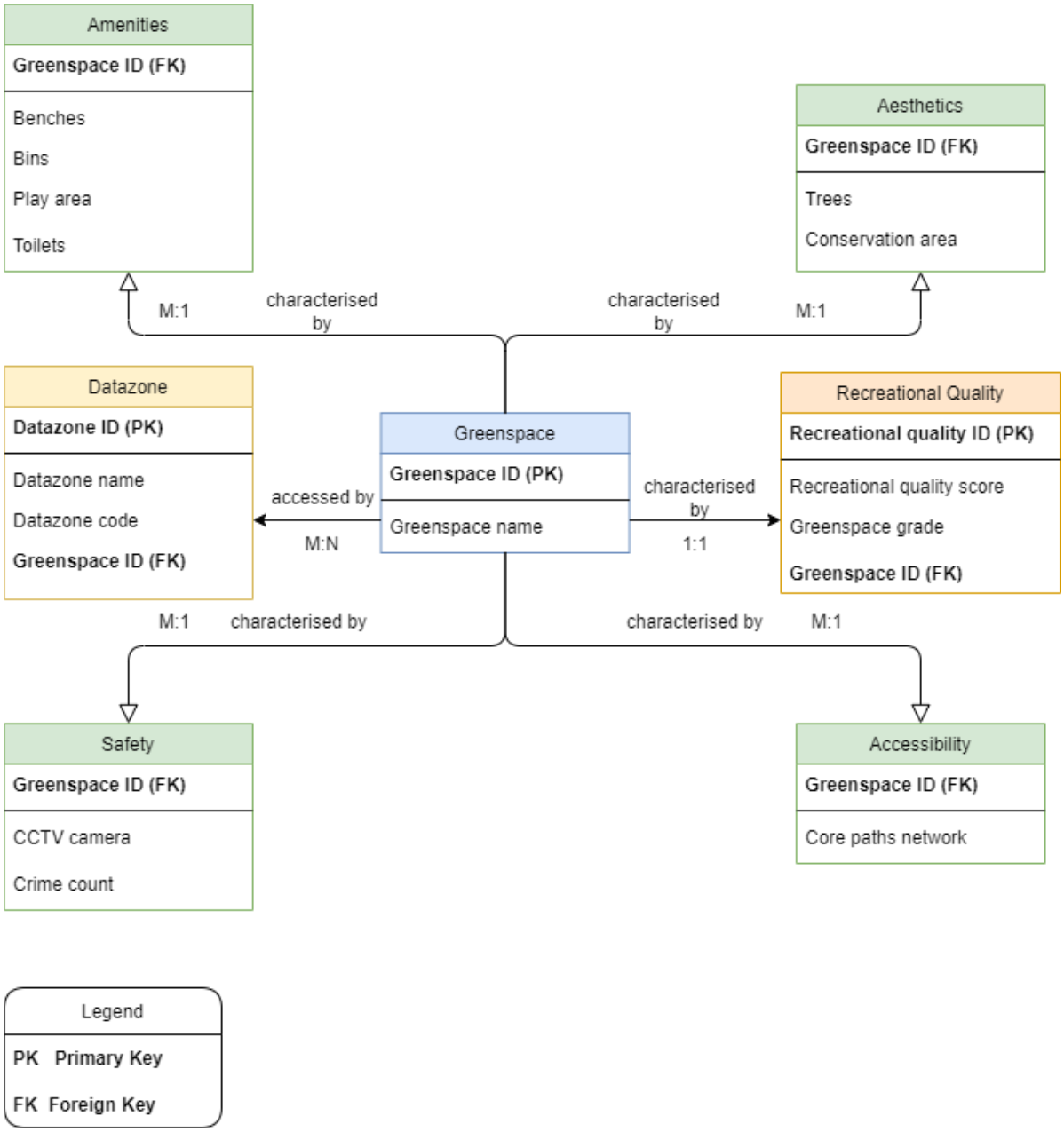


***Figure 3.2**: Normalised database structure and its relationships*

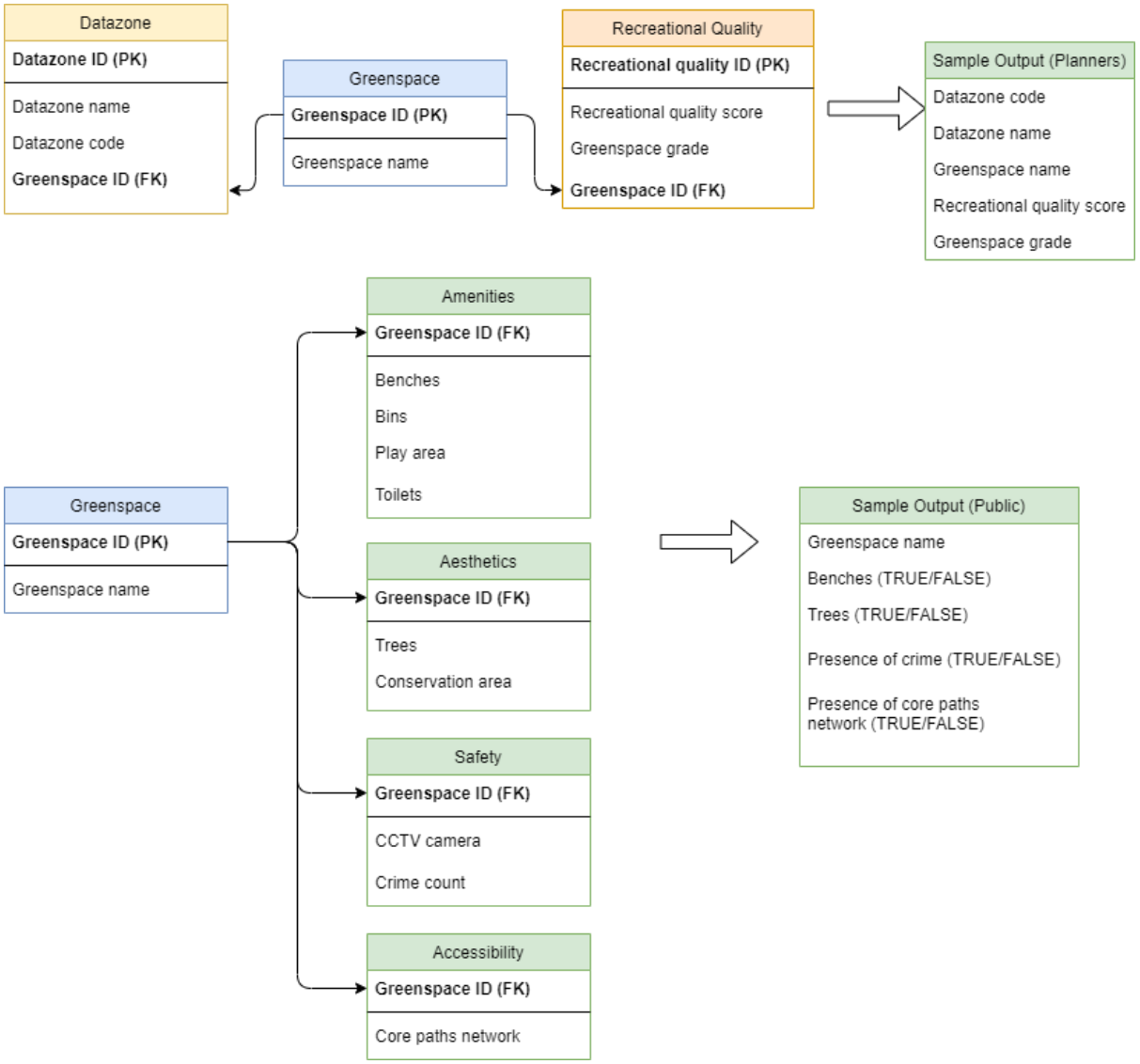


Figure 3.3: *Example relationship sets for: 1) the benefit of the planner (top) in the assessment of spatial access to recreational quality per datazone, and 2) the benefit of the public (bottom) in the decision making around park visits depending on the presence/absence of factors*

3.3. Project Management

In maximising time efficiency through collaboration, tasks were distributed across 'three levels' to which each member were given choice over their preference of work based on area of interest and their skillsets [Figure 3.4]. In most cases, members had dual responsibilities working both individually as well as part of a subgroup. In connecting the three levels, individual and subgroup progresses were made clear in the weekly group meetings. Any issues were immediately addressed which allowed collective decision over its resolution.

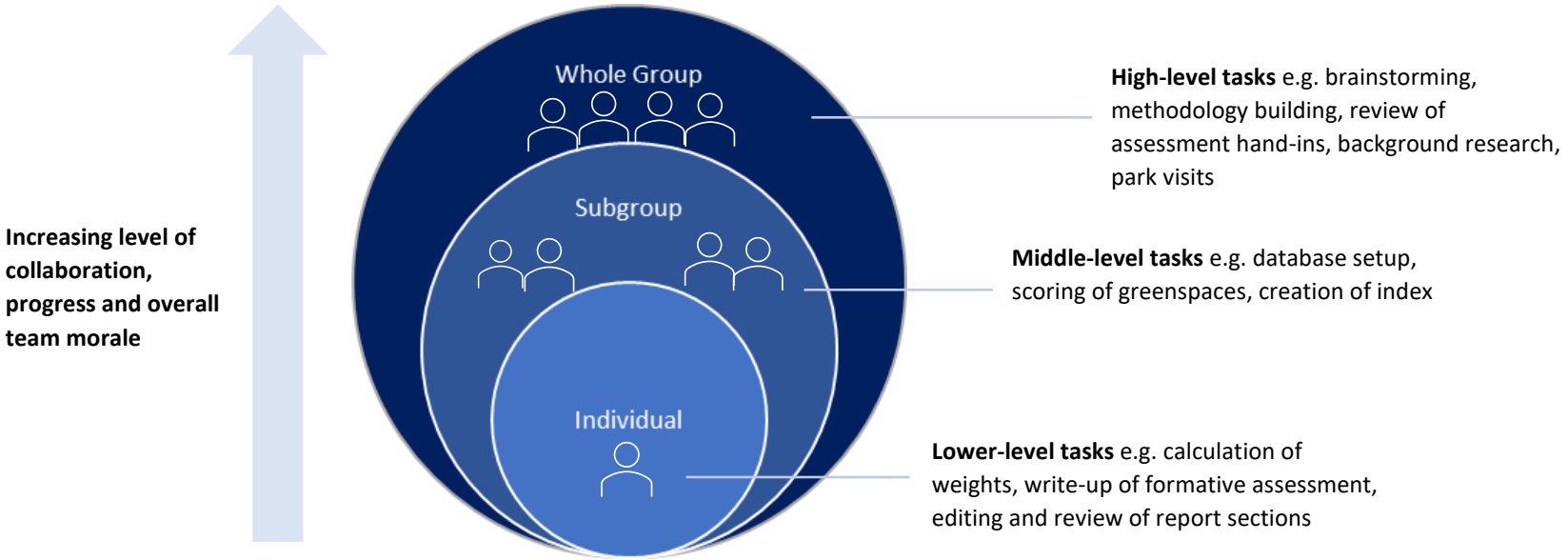


***Figure 3.4**: Three-level approach to agile project management and example tasks distributed across the team*

4. Results

4.1. Public greenspace recreational quality

Of the 30 greenspaces studied, only *The Meadows and Bruntsfield Links* is of high recreational quality. Greenspace scores are centred on *The Meadows and Bruntsfield Links* and appears to decrease outward [Figure 4.1]. The grade of most greenspaces is of moderate recreational quality [Table 4.1].

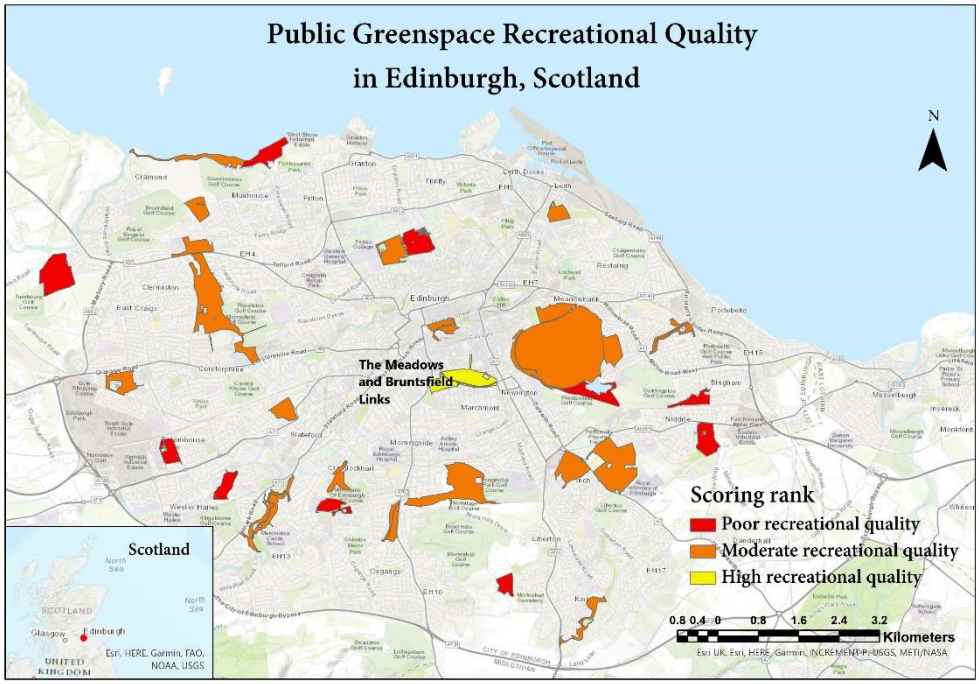


Figure 4.1: *Public greenspace recreational quality in Edinburgh, Scotland. (All maps created in this section are produced by B197550)*

Public Greenspace Recreational Quality Summary Table

Greenspace grade	Range	Quantity
High recreational quality	3.34-5	1 [3.33%]
Moderate recreational quality	1.68-3.33	19 [63.33%]
Poor recreational quality	0-1.67	10 [33.33%]

Table 4.1*: Public greenspace recreational quality score summary*

4.2. Chi-squared test

As p-value is less than 0.05 [Table 4.2], we can reject the null hypothesis [see Figure 1.1] at the 5% significance level. This therefore shows that there is a relation between the ARQI and the SIMD.

Chi-squared Test Result	
X^2	52.16
df	16
p-value	0.00001

***Table 4.2**: Chi-squared test result*

4.3. Relationship between ARQI and SIMD

There are datazones of the same quintile between the ARQI and SIMD, but these only represent a small number of the total population [Figure 4.2]. Contrastingly, the lowest and highest quintile levels of the ARQI and SIMD show a distinct opposing pattern [Figure 4.3]. In quintiles 2-4, however, the relation remains unclear.

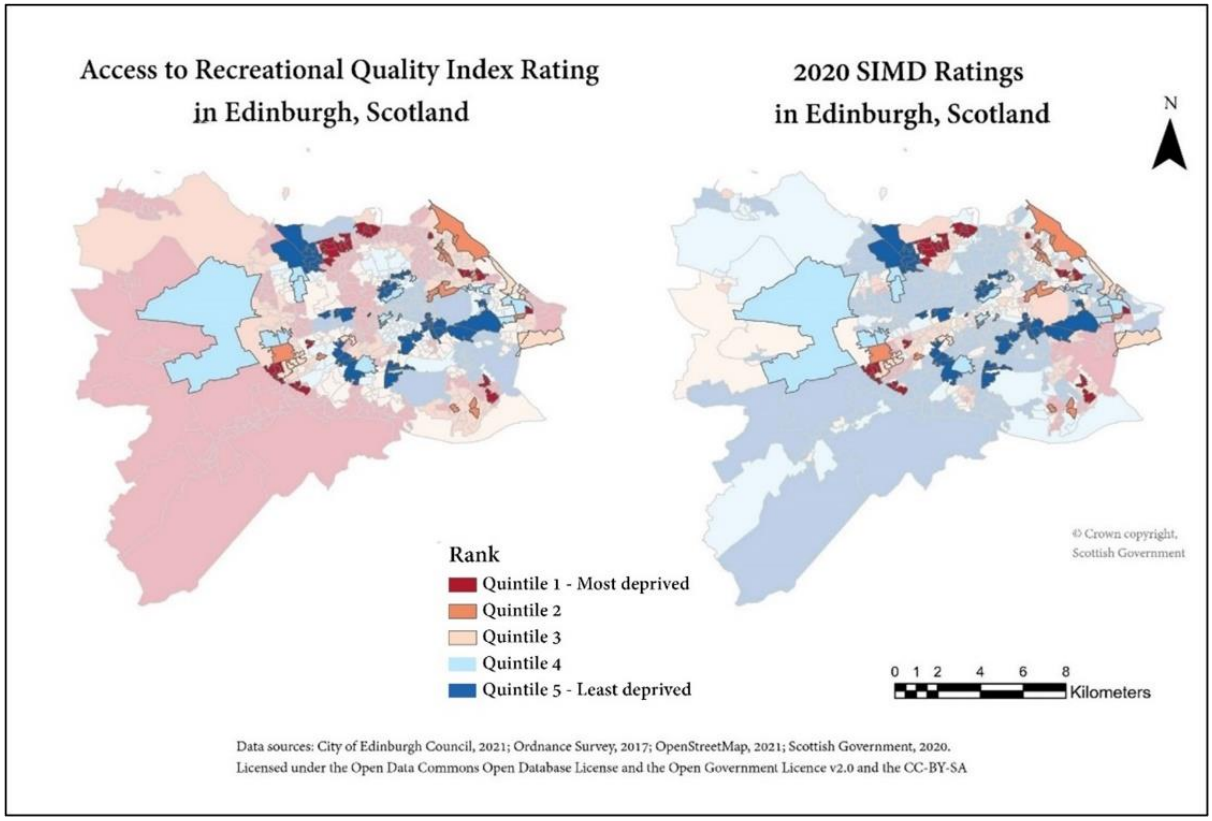


***Figure 4.2**: The datazones where the quintiles of the ARQI and SIMD are the same*

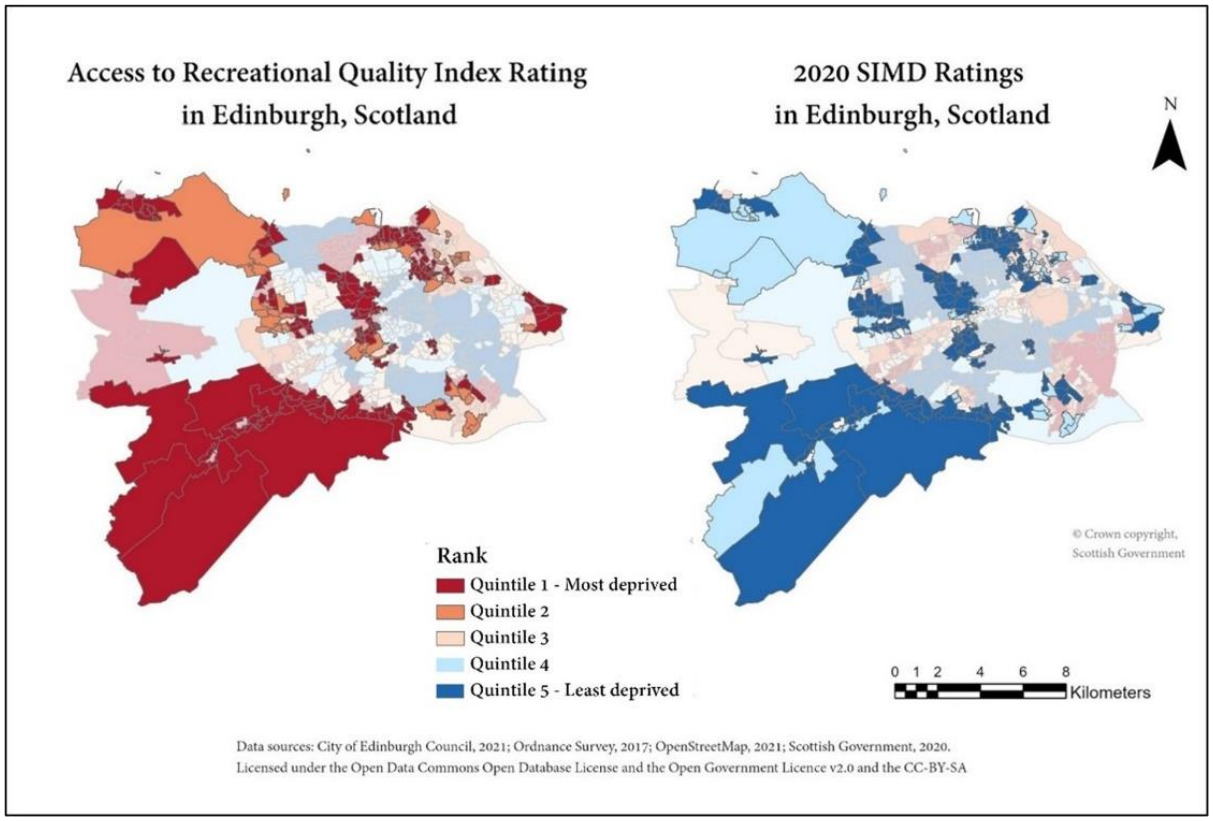


***Figure 4.3**: The datazones where the quintiles of the ARQI and SIMD are the opposite*

4.4. Distribution of access to recreational quality relative to the ARQI and SIMD

Public greenspaces of poor recreational quality (e.g. *Cammo Estate, Sighthill Park* and *Mortonhall Caravan Park*) are generally located in areas of lower quintile in the ARQI, therefore implying such areas as being located further from access to recreational quality [Figure 4.4]. Contrastingly, public greenspaces of moderate and high recreational quality (e.g. T*he Meadows and Bruntsfield Links, Corstorphine Hill* and *Hermitage of Braid*) are mainly located in areas of lower social deprivation, meaning more affluent areas have access to higher quality greenspaces [Figure 4.5]. There are, however, some exceptions. For example, poor recreational quality greenspaces (e.g. *Duddingston* and *Wester Craiglockhart Hill*) are found in areas of lower environmental deprivation in the ARQI [Figure 4.6], while moderately rated parks (e.g. *Craigmillar Castle Park*) neighbour datazones of greatest social deprivation [Figure 4.7].

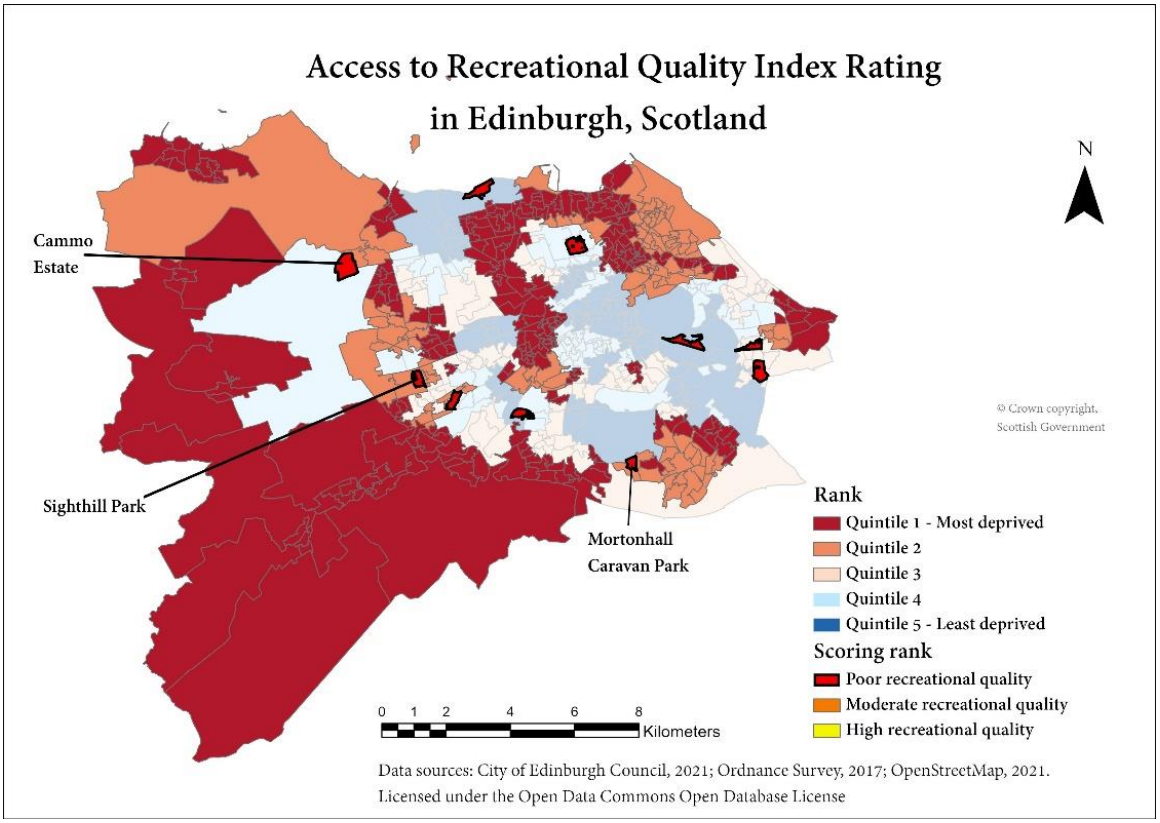


***Figure 4.4**: Public greenspaces with poor recreational quality and ARQI at lower quintile levels*

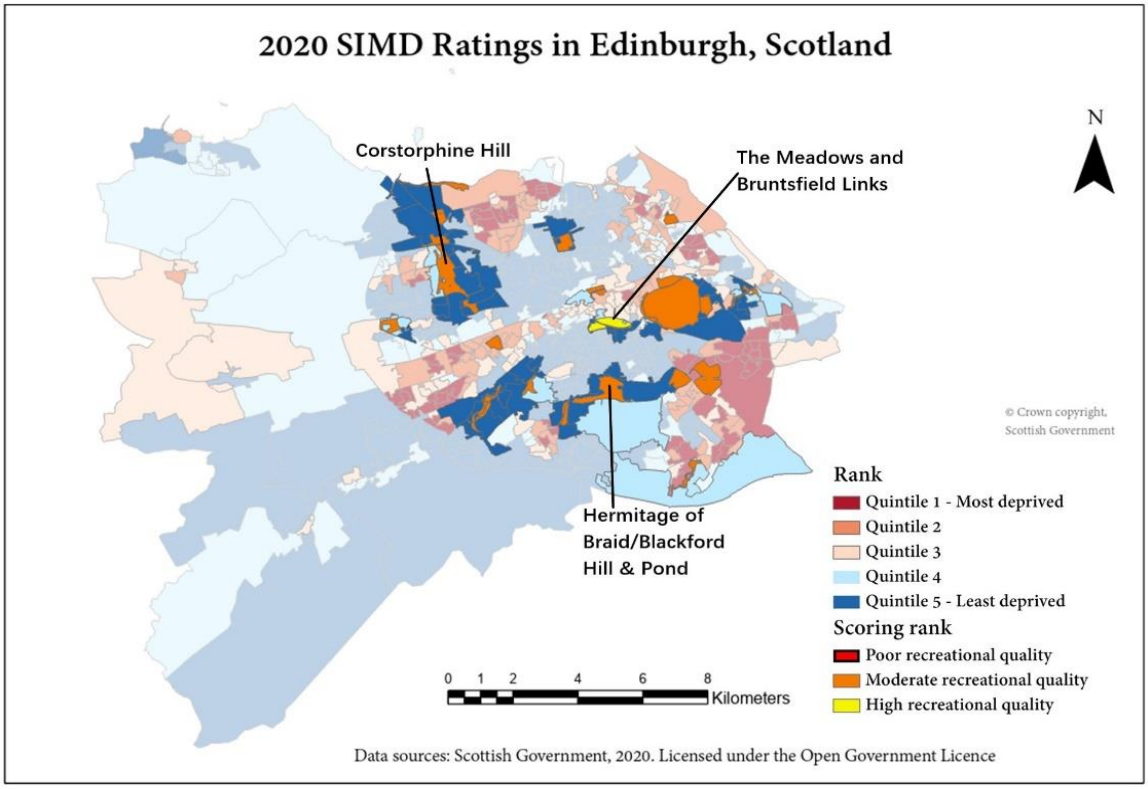


***Figure 4.5**: Public greenspaces with high and moderate recreational quality and SIMD at higher quintile levels*

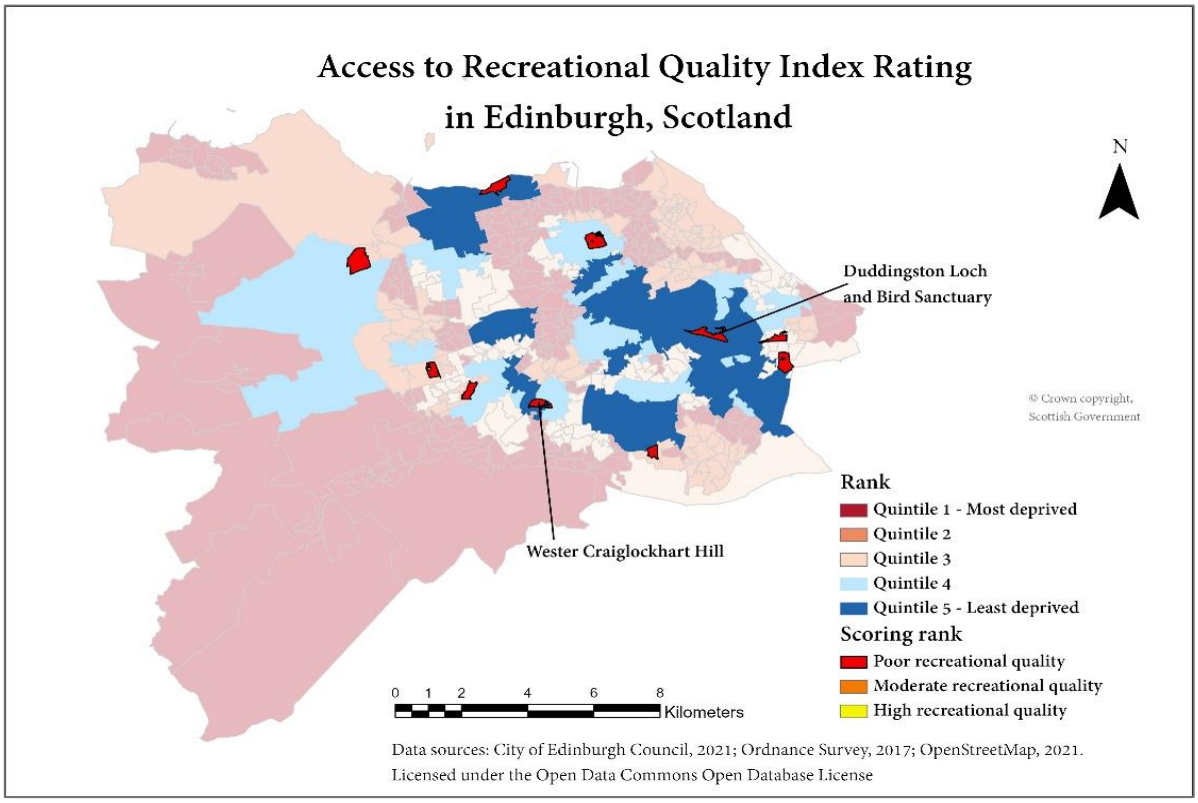


***Figure 4.6**: Public greenspaces with poor recreational quality and ARQI at higher quintile levels*

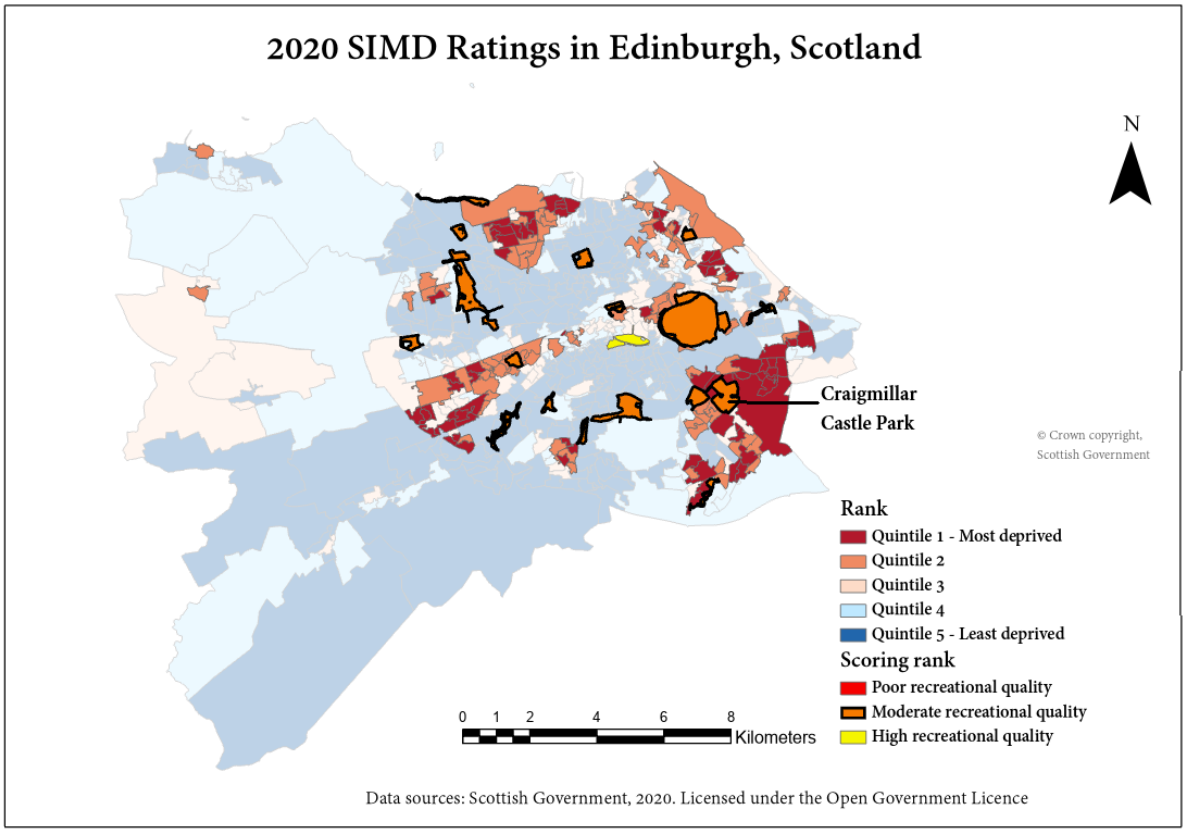


***Figure 4.7**: Public green spaces with high and moderate recreational quality and SIMD at lower quintile levels*

5. Discussion

5.1 Discussion of Spatial Patterns and Reasoning

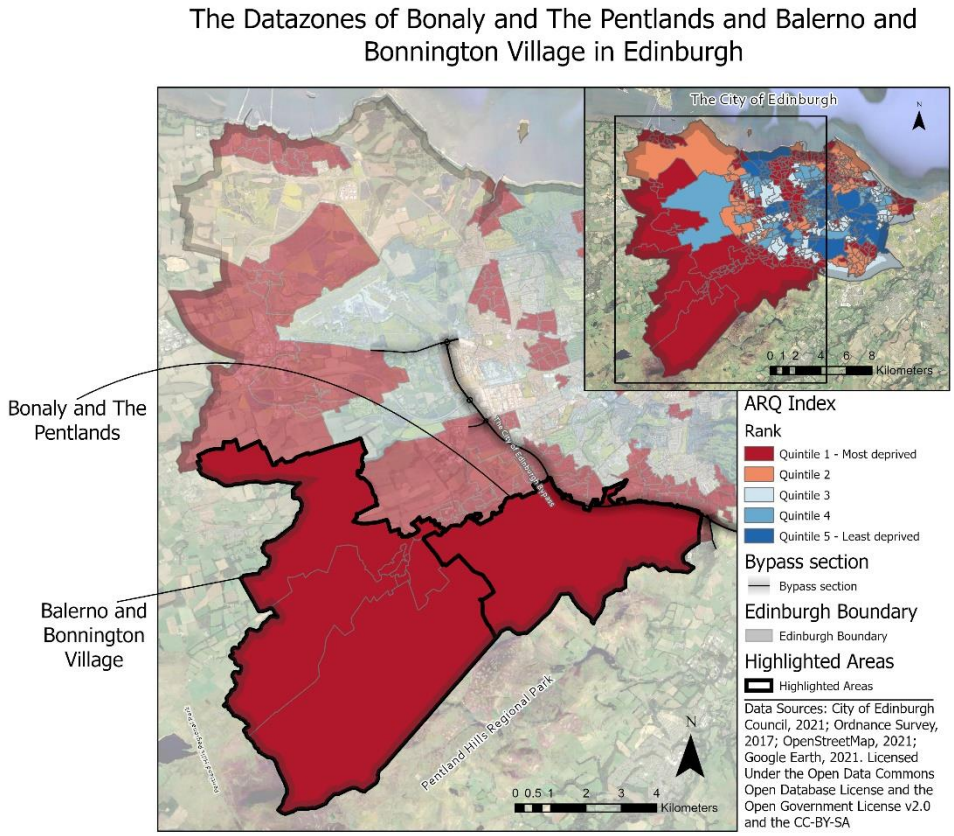


***Figure 5.1**: The datazones outside the city bypass which have close access to the Pentland Hills Regional Park (All maps in this section are produced by B192256)*

The results suggest that there are datazones such as *Balerno and Bonnington Village* and *Bonaly and The Pentlands* [Figure 5.1] that are identified as least socially deprived by the SIMD but more environmentally deprived by the ARQI. One reason for this is because they are located further from access to higher quality greenspaces that are included in the ARQI. However, it cannot be stated that they are more environmentally deprived as they have access to private gardens and regional parks such as the Pentland Hills. Furthermore, in these areas environmental deprivation cannot be viewed as a lack of planning and focus on access because councils put more emphasis towards environment protection through nature reserves (Cloke and Park, 1980).

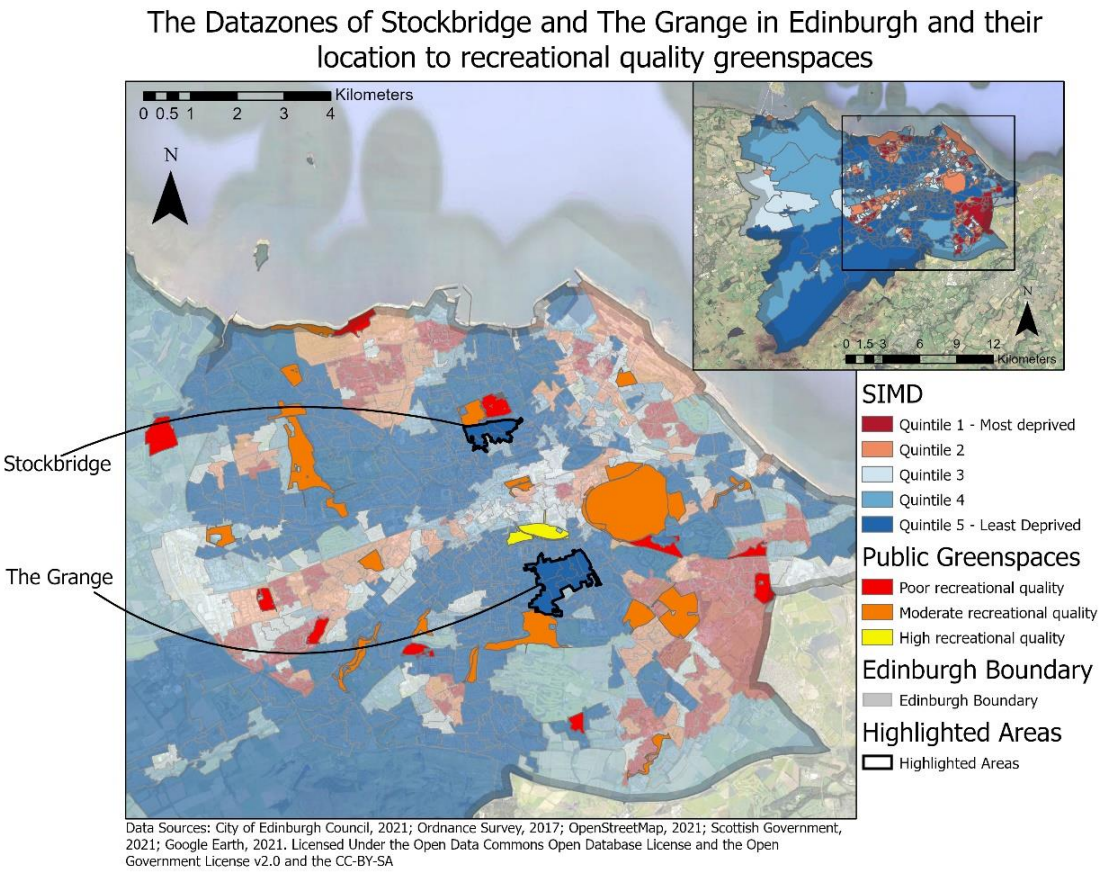


***Figure 5.2**: Datazones with urban areas which have close access to high recreational quality parks*

Moreover, several of the least socially deprived areas in Edinburgh, such as *Stockbridge* and *The Grange* [Figure 5.2] have greater access to higher quality greenspaces. This is because traditionally in the UK, local councils put more emphasis on greenspace management in affluent neighbourhoods. (Greenhalgh and Worpole, 1996). This has changed, and councils are now focusing on increasing the quality of greenspaces in more socially deprived areas such as Craigmillar in Edinburgh (Pearce et al., 2010).

However, not all homes in affluent areas are located within close access to recreational quality greenspaces. In areas such as *Drylaw* and *Murrayfield and Ravelston* [Figure 5.3] where it is more environmentally deprived but less socially deprived, these are located further from access to recreational quality, and homes here have access private gardens and residential gardens. Although these homes may have access to domestic greenspaces, Brindley et al. (2018) argue that smaller gardens do not promote recreational walking as much as publicly accessible greenspaces. The need for larger greenspaces can therefore be argued.

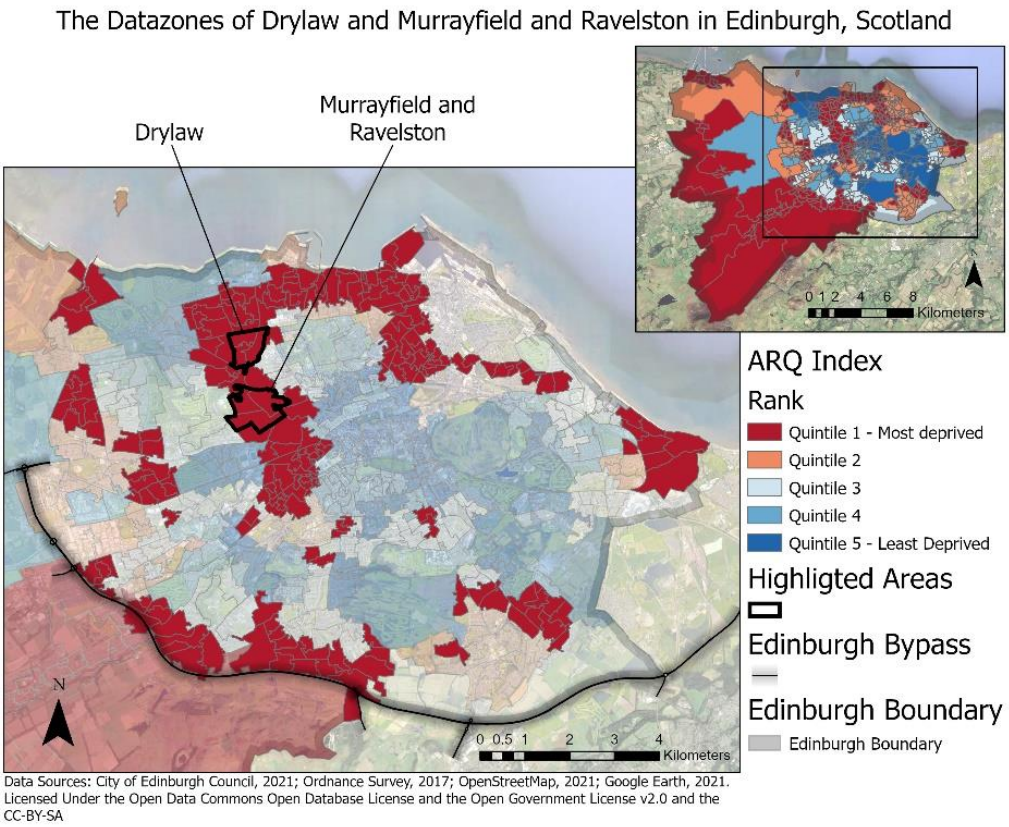


***Figure 5.3**: Datazones in urban areas with a low ARQ Index*

5.2 Policy Recommendations

To aid greenspace planning for recreation, we recommend the regeneration and transformation of underused, larger spaces such as car parks given the densely built environment of Edinburgh. Effective greenspace design would require the addition of and improvements to access and facilities specific to different communities. In partly resolving the social and environmental injustices, we suggest the use of the GreenFlag Award in increasing the quality of the parks up to a recognised standard, but that it would require broader considerations around social provisions and aesthetics in the assessment (Gidlow et al., 2012).

Beyond a focus on recreational quality, other factors such as climate change, biodiversity loss, flood prevention and air pollution should also be considered in decisions overall.

5.3 Limitations

One limitation is that the OS greenspace access points used in the service area calculation are not complete thereby leading to some areas being inaccurately identified as environmentally deprived. Furthermore, the results suggest that the ARQI is the same throughout the datazones, however the figures are aggregated in each datazone which refers to the MAUP (Openshaw and Taylor, 1979).

5.4 Future Work

We will develop a website featuring an interactive, informative webmap integrating the ARQI and the database. We plan to tailor the website's services to the public and planners, for example, where the former will be able to utilise the webmap to aid decision-making on park visits and to suggest additional factors to be included in the ARQI, and the latter, to retrieve specific greenspace information for monitoring and improvements.

6. Conclusion

Our project has developed a novel index that assesses for the spatial access to recreational quality in public greenspaces across Edinburgh. Generally, most greenspaces are of moderate recreational quality meaning that overall quality can continually be improved. We find statistical evidence that there is a relation between the ARQI and the SIMD (2020). From visual evaluation, this relation is generally negative in the most extreme quintiles. As such, in more environmentally, but less socially deprived areas, access to regional parks and private gardens are exhibited. In partly resolving the environmental injustices of access to recreational quality, particularly in more deprived datazones, we recommend the use of underused spaces which can be transformed into quality parks.

Appendix

Appendix A – Weights process using AHP: Assigning 1-9 scores (top), normalisation (middle) and consistency ratio calculation (bottom)

Criteria	Play areas	Public toilets	CCTV cameras	Bins	Benches	Trees	Conservation area	Crime count	Core paths network
Play areas	1.00	0.25	0.25	0.20	0.25	0.20	0.25	0.25	0.25
Public toilets	4.00	1.00	1.00	0.33	1.00	0.33	1.00	1.00	0.33
CCTV cameras	4.00	1.00	1.00	0.33	1.00	0.33	1.00	1.00	0.33
Bins	5.00	3.00	3.00	1.00	2.00	1.00	2.00	2.00	1.00
Benches	4.00	1.00	1.00	0.50	1.00	0.33	1.00	1.00	0.33
Trees	5.00	3.00	3.00	1.00	3.00	1.00	2.00	2.00	1.00
Conservation area	4.00	1.00	1.00	0.50	1.00	0.50	1.00	1.00	0.33
Crime count	4.00	1.00	1.00	0.50	1.00	0.50	1.00	1.00	0.33
Core paths network	4.00	3.00	3.00	1.00	3.00	1.00	3.00	3.00	1.00
Total	35.00	14.25	14.25	5.37	13.25	5.20	12.25	12.25	4.92

Criteria	Play areas	Public toilets	CCTV cameras	Bins	Benches	Trees	Conservation area	Crime count	Core paths network
Play areas	0.03	0.02	0.02	0.04	0.02	0.04	0.02	0.02	0.05
Public toilets	0.11	0.07	0.07	0.06	0.08	0.06	0.08	0.08	0.07
CCTV cameras	0.11	0.07	0.07	0.06	0.08	0.06	0.08	0.08	0.07

Bins	0.14	0.21	0.21	0.19	0.15	0.19	0.16	0.16	0.20
Benches	0.11	0.07	0.07	0.09	0.08	0.06	0.08	0.08	0.07
Trees	0.14	0.21	0.21	0.19	0.23	0.19	0.16	0.16	0.20
Conservation area	0.11	0.07	0.07	0.09	0.08	0.10	0.08	0.08	0.07
Crime count	0.11	0.07	0.07	0.09	0.08	0.10	0.08	0.08	0.07
Core paths network	0.11	0.21	0.21	0.19	0.23	0.19	0.24	0.24	0.20

λmax	9.20
CI (consistency index)	0.03
CR (consistency ratio) =CI/RCI	0.02
RCI	1.45
Threshold for acceptance (Saaty, 1977)	0.10

Appendix B – Public survey used to gain responses to inform weighting

Greenspace and Recreation

Dear participant,

Thank you for taking the time to complete this survey. We are a group of researchers at the University of Edinburgh currently undertaking field research for a project. The project assesses the quality of public greenspaces in Edinburgh to create a recreational quality index.

This survey will ask you to rate how important several greenspace and built environment features are for your walk in this greenspace today.

All submitted responses will be kept confidential and anonymous. Obtained responses will be used only by the researchers and discarded on the 3rd December at 12:00 pm.

For additional queries, please contact me at s1729202@ed.ac.uk.

Thank you.

What is your gender?*

- Female
- Male
- Other
- Prefer not to say

What is your age?*

- 18-24
- 25-34
- 35-44
- 45-64
- 65+

What is the purpose of your visit to this greenspace?*

- Recreation
- Socialise
- Other

Importance of Amenities

How important are play areas for your visit?*

Extremely unimportant | Unimportant | Neutral | Important | Extremely important

How important are benches for your visit?*

Extremely unimportant | Unimportant | Neutral | Important | Extremely important

How important are public toilets for your visit?*

Extremely unimportant | Unimportant | Neutral | Important | Extremely important

How important are bins for your visit?*

Extremely unimportant | Unimportant | Neutral | Important | Extremely important

Importance of Safety

How important do you feel CCTV cameras are in safeguarding your visit to this greenspace?*

Extremely unimportant | Unimportant | Neutral | Important | Extremely important

How much do past incidences in this greenspace influence your visit?*

Extremely unimportant | Unimportant | Neutral | Important | Extremely important

Importance of Accessibility

How important is it that this greenspace is within a walkable distance?*

Extremely unimportant | Unimportant | Neutral | Important | Extremely important

Importance of Aesthetics

How important is the presence of trees for your visit?*

Extremely unimportant | Unimportant | Neutral | Important | Extremely important

How important is it that this greenspace is located in a historic area?*

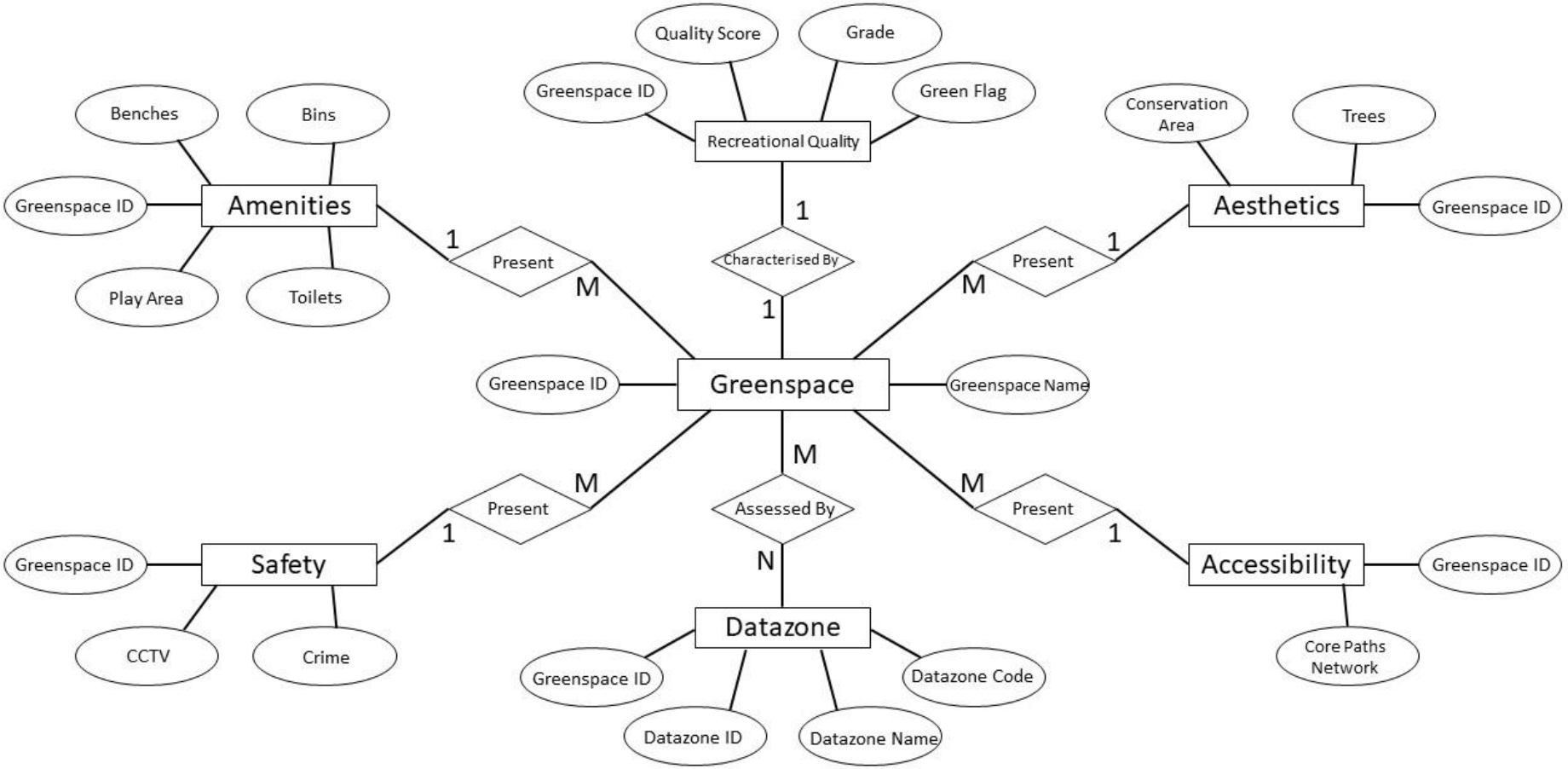
Extremely unimportant | Unimportant | Neutral | Important | Extremely important

What other factors are important for your visit?*

e.g. public sports facilities, public art etc.

1000

Appendix C – ER Diagram and SQL statements used in the creation of the database tables



Accessibility:

Table creation

```
CREATE TABLE ACCESSI
(GREENSPACE_ID VARCHAR2(15),
CORE_PATHS VARCHAR2(9),
PRIMARY KEY (GREENSPACE_ID))
/
```

Formatting Macro File

```
REM ACCESSIBILITY TABLE
TTITLE LEFT 'Group 6' -
  RIGHT  'University of Edinburgh' -
  SKIP CENTER '' -
  SKIP CENTER 'Accessibility Table' SKIP SKIP
  BTITLE SKIP ' Page ' SQL.PNO
SET PAGESIZE 40
SET LINESIZE 51
COLUMN GREENSPACE_ID HEADING 'Greenspace ID'
COLUMN GREENSPACE_ID FORMAT A25
COLUMN CORE_PATHS HEADING 'Core Paths'
COLUMN CORE_PATHS FORMAT A25
SELECT * FROM ACCESSI;
```

Table Output

```
SQL> start access_macro.sql

Group 6                    University of Edinburgh

                Accessibility Table

Greenspace ID            |Core Paths
-------------------------|-------------------------
1                        |TRUE
2                        |TRUE
3                        |TRUE
4                        |TRUE
5                        |TRUE
6                        |TRUE
7                        |TRUE
8                        |FALSE
9                        |TRUE
10                       |TRUE
11                       |TRUE
12                       |TRUE
13                       |TRUE
14                       |TRUE
15                       |TRUE
16                       |TRUE
17                       |TRUE
18                       |TRUE
19                       |TRUE
20                       |TRUE
21                       |FALSE
22                       |TRUE
23                       |TRUE
24                       |TRUE
25                       |TRUE
26                       |TRUE
27                       |FALSE
28                       |TRUE
29                       |TRUE
30                       |TRUE


 Page          1

30 rows selected.

SQL>
```

Aesthetics:

Table creation

```
CREATE TABLE AESTHE
(GREENSPACE_ID VARCHAR2(15),
TREES VARCHAR2(9),
CONSERVATION_AREA VARCHAR2(9),
PRIMARY KEY (GREENSPACE_ID))
/
```

Formatting Macro

```
REM AESTHETICS TABLE
TTITLE LEFT 'Group 6' -
  RIGHT  'University of Edinburgh' -
  SKIP CENTER '' -
  SKIP CENTER 'Aesthetics Table' SKIP SKIP
  BTITLE SKIP ' Page ' SQL.PNO
SET PAGESIZE 40
SET LINESIZE 53
COLUMN GREENSPACE_ID HEADING 'Greenspace ID'
COLUMN GREENSPACE_ID FORMAT A17
COLUMN TREES HEADING 'Trees'
COLUMN TREES FORMAT A17
COLUMN CONSERVATION_AREA HEADING 'Conservation Area'
COLUMN CONSERVATION_AREA FORMAT A17
SELECT * FROM AESTHE;
```

Table Output

```
SQL> start aesthetics_macro.sql

Group 6                         University of Edinburgh

                    Aesthetics Table

Greenspace ID    |Trees           |Conservation Area
-----------------|----------------|-----------------
1                |TRUE            |FALSE
2                |TRUE            |TRUE
3                |TRUE            |FALSE
4                |TRUE            |TRUE
5                |TRUE            |FALSE
6                |TRUE            |TRUE
7                |TRUE            |TRUE
8                |TRUE            |TRUE
9                |TRUE            |FALSE
10               |TRUE            |TRUE
11               |TRUE            |TRUE
12               |TRUE            |TRUE
13               |TRUE            |FALSE
14               |TRUE            |FALSE
15               |TRUE            |FALSE
16               |TRUE            |TRUE
17               |TRUE            |FALSE
18               |TRUE            |TRUE
19               |TRUE            |FALSE
20               |TRUE            |TRUE
21               |TRUE            |FALSE
22               |TRUE            |FALSE
23               |TRUE            |FALSE
24               |TRUE            |FALSE
25               |TRUE            |FALSE
26               |TRUE            |FALSE
27               |TRUE            |FALSE
28               |TRUE            |TRUE
29               |TRUE            |FALSE
30               |TRUE            |FALSE


 Page          1

30 rows selected.

SQL>
```

Amenities:

Table creation:

```
CREATE TABLE AMENIT
(GREENSPACE_ID VARCHAR2(15),
BENCHES VARCHAR(9),
BINS VARCHAR(9),
PLAY_AREA VARCHAR(9),
TOILETS VARCHAR(9),
PRIMARY KEY (GREENSPACE_ID))
/
```

Formatting Macro

```
REM AMENITIES TABLE
TTITLE LEFT 'Group 6' -
  RIGHT  'University of Edinburgh' -
  SKIP CENTER '' -
  SKIP CENTER 'Amenities Table' SKIP SKIP
  BTITLE SKIP ' Page ' SQL.PNO
SET PAGESIZE 40
SET LINESIZE 80
COLUMN GREENSPACE_ID HEADING 'Greenspace ID'
COLUMN GREENSPACE_ID FORMAT A15
COLUMN BENCHES HEADING 'Benches'
COLUMN BENCHES FORMAT A15
COLUMN BINS HEADING 'Bins'
COLUMN BINS FORMAT A15
COLUMN PLAY_AREA HEADING 'Play Area'
COLUMN PLAY_AREA FORMAT A15
COLUMN TOILETS HEADING 'Public Toilets'
COLUMN TOILETS FORMAT A15
SELECT * FROM AMENIT;
```

Table Output

```
SQL> start amenities_macro.sql

Group 6                                                University of Edinburgh

                                  Amenities Table

Greenspace ID  |Benches        |Bins           |Play Area      |Public Toilets
---------------|---------------|---------------|---------------|---------------
1              |FALSE          |FALSE          |FALSE          |FALSE
2              |TRUE           |TRUE           |TRUE           |FALSE
3              |FALSE          |TRUE           |TRUE           |FALSE
4              |FALSE          |TRUE           |FALSE          |FALSE
5              |FALSE          |TRUE           |TRUE           |FALSE
6              |TRUE           |TRUE           |FALSE          |TRUE
7              |FALSE          |TRUE           |FALSE          |FALSE
8              |TRUE           |TRUE           |FALSE          |FALSE
9              |TRUE           |TRUE           |TRUE           |TRUE
10             |TRUE           |TRUE           |TRUE           |FALSE
11             |TRUE           |TRUE           |TRUE           |TRUE
12             |TRUE           |TRUE           |TRUE           |TRUE
13             |FALSE          |TRUE           |TRUE           |TRUE
14             |FALSE          |TRUE           |TRUE           |FALSE
15             |FALSE          |TRUE           |TRUE           |FALSE
16             |FALSE          |FALSE          |TRUE           |FALSE
17             |FALSE          |TRUE           |FALSE          |FALSE
18             |TRUE           |TRUE           |TRUE           |FALSE
19             |TRUE           |TRUE           |TRUE           |TRUE
20             |TRUE           |TRUE           |FALSE          |TRUE
21             |TRUE           |TRUE           |TRUE           |TRUE
22             |TRUE           |TRUE           |FALSE          |FALSE
23             |TRUE           |TRUE           |FALSE          |TRUE
24             |TRUE           |TRUE           |TRUE           |TRUE
25             |TRUE           |TRUE           |TRUE           |FALSE
26             |TRUE           |TRUE           |TRUE           |FALSE
27             |FALSE          |TRUE           |TRUE           |TRUE
28             |TRUE           |TRUE           |FALSE          |TRUE
29             |TRUE           |TRUE           |FALSE          |FALSE
30             |TRUE           |TRUE           |FALSE          |FALSE


 Page          1

30 rows selected.

SQL>
```

Safety:

Table creation

```
CREATE TABLE SAFET
(GREENSPACE_ID VARCHAR2(15),
CCTV VARCHAR2(9),
CRIME VARCHAR2(9),
PRIMARY KEY (GREENSPACE_ID))
/
```

Formatting Macro

```
REM SAFETY TABLE
TTITLE LEFT 'Group 6' -
  RIGHT 'University of Edinburgh' -
  SKIP CENTER '' -
  SKIP CENTER 'Safety Table' SKIP SKIP
  BTITLE SKIP ' Page ' SQL.PNO
SET PAGESIZE 40
SET LINESIZE 49
COLUMN GREENSPACE_ID HEADING 'Greenspace ID'
COLUMN CCTV FORMAT A15
COLUMN CCTV HEADING 'CCTV'
COLUMN CCTV FORMAT A15
COLUMN CRIME HEADING 'Crime'
COLUMN CRIME FORMAT A15
SELECT * FROM SAFET;
```

Table Output

```
SQL> start safetytable_macro.sql

Group 6                    University of Edinburgh

                     Safety Table

Greenspace ID    |CCTV           |Crime
-----------------|---------------|---------------
1                |FALSE          |TRUE
2                |FALSE          |TRUE
3                |FALSE          |TRUE
4                |FALSE          |TRUE
5                |FALSE          |TRUE
6                |FALSE          |TRUE
7                |FALSE          |TRUE
8                |FALSE          |TRUE
9                |FALSE          |TRUE
10               |FALSE          |TRUE
11               |FALSE          |TRUE
12               |TRUE           |TRUE
13               |TRUE           |TRUE
14               |FALSE          |TRUE
15               |FALSE          |TRUE
16               |TRUE           |TRUE
17               |FALSE          |TRUE
18               |FALSE          |TRUE
19               |FALSE          |TRUE
20               |FALSE          |TRUE
21               |FALSE          |TRUE
22               |FALSE          |TRUE
23               |FALSE          |TRUE
24               |TRUE           |TRUE
25               |FALSE          |TRUE
26               |FALSE          |TRUE
27               |FALSE          |TRUE
28               |FALSE          |TRUE
29               |FALSE          |TRUE
30               |FALSE          |TRUE


 Page          1

30 rows selected.

SQL>
```

Greenspaces:

Table creation

```
CREATE TABLE GREENSPACE
(GREENSPACE_ID NUMBER,
GREENSPACE_NAME VARCHAR(50),
PRIMARY KEY (GREENSPACE_ID),
FOREIGN KEY (GREENSPACE_ID)
REFERENCES AMENIT (GREENSPACE_ID),
FOREIGN KEY (GREENSPACE_ID)
REFERENCES SAFET (GREENSPACE_ID),
FOREIGN KEY (GREENSPACE_ID)
REFERENCES AESTHE (GREENSPACE_ID),
FOREIGN KEY (GREENSPACE_ID)
REFERENCES ACCESSI (GREENSPACE_ID),
FOREIGN KEY (GREENSPACE_ID)
REFERENCES QUALI (GREENSPACE_ID))
/
```

Formatting Macro

```
REM GREENSPACES TABLE
TTITLE LEFT 'Group 6' -
  RIGHT 'University of Edinburgh' -
  SKIP CENTER '' -
  SKIP CENTER 'Greenspaces Table' SKIP SKIP
  BTITLE SKIP ' Page ' SQL.PNO
SET PAGESIZE 40
SET LINESIZE 65
COLUMN GREENSPACE_ID HEADING 'Greenspace ID' FORMAT 99
COLUMN GREENSPACE_NAME HEADING 'Greenspace Name'
COLUMN GREENSPACE_NAME FORMAT A50
SELECT * FROM GREENSPACE;
```

Table output

```
SQL> start greenspace_macro.sql

Group 6                                 University of Edinburgh

                        Greenspaces Table

Greenspace ID|Greenspace Name
-------------|--------------------------------------------------
           0|None
           1|Mortonhall Caravan Park
           2|Leith Links
           3|Jewel Park
           4|Wester Craiglockhart Hill
           5|Hailes Quarry Park
           6|Cramond Foreshore
           7|Duddingston Loch and Bird Sanctuary
           8|Royal Botanic Gardens
           9|Inch Park
          10|Craigmillar Castle Park
          11|The Meadows and Bruntsfield Links
          12|Princes Street Gardens East & West
          13|Burdiehouse Burn Valley Park
          14|Sighthill Park
          15|Davidsons Mains Park
          16|Holyrood Park
          17|Gypsy Brae Recreation Ground
          18|Inverleith Park
          19|Hermitage of Braid/Blackford Hill & Pond
          20|Easter Craiglockhart Hill
          21|Figgate Burn Park
          22|Braidburn Valley Park
          23|Lauriston Castle
          24|Saughton Park
          25|Gyle Park & Playing Fields
          26|Meadowfield Park
          27|Hunters Hall Park
          28|Colinton & Craiglockhart Dells
          29|Cammo Estate
          30|Corstorphine Hill

 Page          1

31 rows selected.

SQL>
```

Quality:

Table creation

```
CREATE TABLE QUALI
(GREENSPACE_ID VARCHAR2(15),
QUALITY_SCORE VARCHAR2(9),
GRADE VARCHAR2(9),
GREEN_FLAG VARCHAR2(9),
PRIMARY KEY (GREENSPACE_ID))
/
```

Formatting Macro

```
REM QUALITY TABLE
TTITLE LEFT 'Group 6' -
  RIGHT 'University of Edinburgh' -
  SKIP CENTER '' -
  SKIP CENTER 'Quality Table' SKIP SKIP
  BTITLE SKIP ' Page ' SQL.PNO
SET PAGESIZE 40
SET LINESIZE 64
COLUMN GREENSPACE_ID TEMPORARY
COLUMN QUALITY_SCORE TEMPORARY
COLUMN GRADE TEMPORARY
COLUMN GREEN_FLAG TEMPORARY
COLUMN GREENSPACE_ID HEADING 'Greenspace ID'
COLUMN GREENSPACE_ID FORMAT A15
COLUMN QUALITY_SCORE HEADING 'Quality Score'
COLUMN QUALITY_SCORE FORMAT A15
COLUMN GRADE HEADING 'Grade'
COLUMN GRADE FORMAT A15
COLUMN GREEN_FLAG HEADING 'Green Flag'
COLUMN GREEN_FLAG FORMAT A15
SELECT * FROM QUALI;
```

Table Output

```
SQL> start quality_macro.sql

Group 6                                 University of Edinburgh

                          Quality Table

Greenspace ID   Quality Score   Grade           Green Flag
--------------- --------------- --------------- ---------------
1               0.79            Grade C         FALSE
2               2.15            Grade B         FALSE
3               1.22            Grade C         FALSE
4               1.48            Grade C         FALSE
5               1.42            Grade C         TRUE
6               2.34            Grade B         FALSE
7               1.67            Grade C         FALSE
8               1.51            Grade C         FALSE
9               2.3             Grade B         FALSE
10              2.86            Grade B         TRUE
11              3.66            Grade A         FALSE
12              3.18            Grade B         TRUE
13              1.71            Grade B         FALSE
14              1.23            Grade C         FALSE
15              2.36            Grade B         FALSE
16              2.14            Grade B         TRUE
17              1.46            Grade C         TRUE
18              2.52            Grade B         TRUE
19              2.31            Grade B         FALSE
20              1.99            Grade B         TRUE
21              2.2             Grade B         TRUE
22              2.78            Grade B         TRUE
23              2.66            Grade B         TRUE
24              2.75            Grade B         TRUE
25              1.68            Grade B         FALSE
26              1.68            Grade B         FALSE
27              1.48            Grade C         FALSE
28              2.25            Grade B         FALSE
29              1.66            Grade C         FALSE
30              2.31            Grade B         TRUE


 Page          1

30 rows selected.

SQL>
```

Datazones:

Table creation

```
CREATE TABLE DATAZ
(GREENSPACE_ID NUMBER(2),
DATAZONE_ID VARCHAR2(9),
DATAZONE_CODE VARCHAR2(39),
DATAZONE_NAME VARCHAR2(50),
PRIMARY KEY (GREENSPACE_ID),
FOREIGN KEY (GREENSPACE_ID)
REFERENCES GREENSPACE
(GREENSPACE_ID))
/
```

Formatting Macro

```
REM DATAZONE TABLE
TTITLE LEFT 'Group 6' -
  RIGHT 'University of Edinburgh' -
  SKIP CENTER '' -
  SKIP CENTER 'Datazone Table' SKIP SKIP
  BTITLE SKIP ' Page ' SQL.PNO
SET PAGESIZE 120
SET LINESIZE 100
COLUMN GREENSPACE_ID TEMPORARY
COLUMN DATAZONE_ID TEMPORARY
COLUMN DATAZONE_CODE TEMPORARY
COLUMN DATAZONE_NAME TEMPORARY
COLUMN GREENSPACE_ID HEADING 'Greenspace ID' FORMAT 99
COLUMN DATAZONE_ID HEADING 'Datazone ID'
COLUMN DATAZONE_ID FORMAT A15
COLUMN DATAZONE_CODE HEADING 'Datazone Code'
COLUMN DATAZONE_CODE FORMAT A15
COLUMN DATAZONE_NAME HEADING 'Datazone Name'
COLUMN DATAZONE_NAME FORMAT A50
SELECT * FROM DATAZ;
```

Table Output (sample only shown here due to 770 records)

```
          11|226           |S01008602      |Newington and Dalkeith Road - 04
          16|227           |S01008602      |Newington and Dalkeith Road - 04
           7|228           |S01008602      |Newington and Dalkeith Road - 04
          11|229           |S01008603      |Newington and Dalkeith Road - 05
          16|230           |S01008603      |Newington and Dalkeith Road - 05
           7|231           |S01008603      |Newington and Dalkeith Road - 05
          11|232           |S01008604      |The Grange - 01
          16|233           |S01008604      |The Grange - 01
          11|234           |S01008605      |The Grange - 02
           0|235           |S01008606      |The Grange - 03
          11|236           |S01008607      |The Grange - 04
          19|237           |S01008608      |The Grange - 05
          19|238           |S01008609      |The Grange - 06

 Page          6

Group 6                                                          University of Edinburgh

                                    Datazone Table

Greenspace ID|Datazone ID    |Datazone Code  |Datazone Name
-------------|---------------|---------------|--------------------------------------------------
          11|239           |S01008610      |The Grange - 07
          19|240           |S01008610      |The Grange - 07
          11|241           |S01008611      |Marchmont East and Sciennes - 01
          16|242           |S01008611      |Marchmont East and Sciennes - 01
          11|243           |S01008612      |Marchmont East and Sciennes - 02
          16|244           |S01008612      |Marchmont East and Sciennes - 02
          11|245           |S01008613      |Marchmont East and Sciennes - 03
          11|246           |S01008614      |Marchmont East and Sciennes - 04
          11|247           |S01008615      |Marchmont East and Sciennes - 05
          11|248           |S01008616      |Marchmont East and Sciennes - 06
          11|249           |S01008617      |Marchmont West - 01
          11|250           |S01008618      |Marchmont West - 02
          11|251           |S01008619      |Marchmont West - 03
          11|252           |S01008620      |Marchmont West - 04
          11|253           |S01008621      |Marchmont West - 05
          11|254           |S01008622      |Marchmont West - 06
          11|255           |S01008623      |Marchmont West - 07
          19|256           |S01008624      |Morningside - 01
          11|257           |S01008624      |Morningside - 01
          19|258           |S01008625      |Morningside - 02
          19|259           |S01008626      |Morningside - 03
          22|260           |S01008626      |Morningside - 03
          19|261           |S01008627      |Morningside - 04
          19|262           |S01008628      |Morningside - 05
           0|263           |S01008629      |Morningside - 06
```

References

Brindley, P., Jorgensen, A. and Maheswaran, R., 2018. Domestic gardens and self-reported health: a national population study. *International Journal of Health Geographics*, 17(1).

Candan, K.S., Li, W.S., Luo, Q., Hsiung, W.P. and Agrawal, D., 2001, May. Enabling dynamic content caching for database-driven web sites. In *Proceedings of the 2001 ACM SIGMOD International Conference on Management of Data*. pp. 532-543.

Carver, S.J., 1991. Integrating multi-criteria evaluation with geographical information systems. *International Journal of Geographical Information System*, 5(3), pp.321-339.

Chen, Y., Yu, J. and Khan, S., 2010. Spatial sensitivity analysis of multi-criteria weights in GIS-based land suitability evaluation. *Environmental Modelling & Software*, 25(12), pp.1582-1591

Cloke, P. and Park, C., 1980. Deprivation, resources and planning: Some implications for applied rural geography. *Geoforum*, 11(1), pp.57-61.

Ellicott, K., 2016. *Raising the standard: The Green Flag Award Guidance Manual*. Keep Britain Tidy. Available at: green-flag-award-guidelines.pdf (greenflagaward.org). [Accessed: 18/11/2021].

Gidlow, C.J., Ellis, N.J. and Bostock, S., 2012. Development of the neighbourhood green space tool (NGST). *Landscape and Urban Planning*, *106*(4), pp.347-358.

Greenhalgh, L. and Worpole, K., 1996. *People, parks and cities: a guide to current good practice in urban parks*. HMSO Publications Centre.

Greenspace Scotland, 2008. Greenspace Quality: A Guide to Assessment, Planning and Strategic Development. Greenspace Scotland. Available at: https://www.gcvgreennetwork.gov.uk . [Accessed: 19/11/2021].

Gül, A., Gezer, A. and Kane, B., 2006. Multi-criteria analysis for locating new urban forests: An example from Isparta, Turkey. *Urban Forestry & Urban Greening*, *5*(2), pp.57-71.

Handley, J., Pauleit, S., Slinn, P., Barber, A., Baker, M., Jones, C. and Lindley, S., 2003. Accessible natural green space standards in towns and cities: a review and toolkit for their implementation. *English Nature Research Reports*, *526*.

Jennings, V. and Bamkole, O., 2019. The relationship between social cohesion and urban green space: An avenue for health promotion. *International Journal of Environmental Research and Public Health*, *16*(3), p.452.

Jennings, V., Johnson Gaither, C. and Gragg, R.S., 2012. Promoting environmental justice through urban green space access: A synopsis. *Environmental Justice*, *5*(1), pp.1-7.

Jones, A., Hillsdon, M. and Coombes, E., 2009. Greenspace access, use, and physical activity: Understanding the effects of area deprivation. *Preventive Medicine*, *49*(6), pp.500-505.

Knobel, P., Dadvand, P., Alonso, L., Costa, L., Español, M. and Maneja, R., 2021. Development of the urban green space quality assessment tool (RECITAL). *Urban Forestry & Urban Greening*, *57*, p.126895.

Laing, R., Davies, A.M., Miller, D., Conniff, A., Scott, S. and Morrice, J., 2009. The application of visual environmental economics in the study of public preference and urban greenspace. *Environment and Planning B: Planning and Design*, *36*(2), pp.355-375.

Maas, J., Verheij, R.A., Groenewegen, P.P., De Vries, S. and Spreeuwenberg, P., 2006. Green space, urbanity, and health: how strong is the relation?. *Journal of Epidemiology & Community Health*, *60*(7), pp.587-592.

Macintyre, S., Macdonald, L. and Ellaway, A., 2008. Do poorer people have poorer access to local resources and facilities? The distribution of local resources by area deprivation in Glasgow, Scotland. *Social Science & Medicine*, *67*(6), pp.900-914.

O'Gorman, S. and Dillon-Robinson, R., 2021. *20 Minute Neighbourhoods in a Scottish Context*. Ramboll.

Openshaw, S. and Taylor, P.J., 1979. A million or so correlation coefficients: three experiments on the modifiable area unit problem.[In] Wrigley, H.(ed) Statistical applications in the spatial sciences. *Pion: London.* pp.127-144.

Pearce, J.R., Richardson, E.A., Mitchell, R.J. and Shortt, N.K., 2010. Environmental justice and health: the implications of the socio-spatial distribution of multiple environmental deprivation for health inequalities in the United Kingdom. *Transactions of the Institute of British Geographers*, *35*(4), pp.522-539.

Rajabifard, A., Crompvoets, J., Kalantari, M. and Kok, B., 2010. Spatially enabling society. *Research, Emerging Trends and Critical Assessment*, *246*.

Schipperijn, J., Ekholm, O., Stigsdotter, U.K., Toftager, M., Bentsen, P., Kamper-Jørgensen, F. and Randrup, T.B., 2010. Factors influencing the use of green space: Results from a Danish national representative survey. *Landscape and Urban Planning*, *95*(3), pp.130-137.

Shaw, M., Davey Smith, G. and Dorling, D., 2005. Health inequalities and New Labour: how the promises compare with real progress. *British Medical Journal.* 330, 1016–1021.

Talen, E., 1997. The social equity of urban service distribution: An exploration of park access in Pueblo, Colorado, and Macon, Georgia. *Urban Geography*, *18*(6), pp.521-541.

Townsend, P., 1979. Poverty in the United Kingdom: a survey of household resources and standards of living. *University of California Press*.

Van Dillen, S.M., de Vries, S., Groenewegen, P.P. and Spreeuwenberg, P., 2012. Greenspace in urban neighbourhoods and residents' health: adding quality to quantity. *Journal of Epidemiology and Community Health*, *66*(6), pp.e8-e8.

Zhang, H., Chen, B., Sun, Z. and Bao, Z., 2013. Landscape perception and recreation needs in urban green space in Fuyang, Hangzhou, China. *Urban Forestry & Urban Greening*, *12*(1), pp.44-52.