sustainability

MDPI

Article

A Methodology for Quantifying the Spatial Distribution and Social Equity of Urban Green and Blue Spaces

Benjamin Guinaudeau [1], Mark Brink [2], Beat Schäffer [3] and Martin A. Schlaepfer [1,*]

[1] Institute of Environmental Sciences, University of Geneva, Boulevard Carl Vogt 66, 1205 Geneva, Switzerland; benjamin.guinaudeau@unige.ch
[2] Federal Office for the Environment, 3003 Bern, Switzerland; mark.brink@bafu.admin.ch
[3] Empa, Swiss Federal Laboratories for Materials Science and Technology, Laboratory for Acoustics/Noise Control, Überlandstrasse 129, 8600 Dübendorf, Switzerland; beat.schaeffer@empa.ch
* Correspondence: martin.schlaepfer@unige.ch; Tel.: +41-22-37-90801

Abstract: Urban green and blue space (UGBS) contribute to a variety of nature-based values and human health benefits. As such, they play a critical role for the quality of life and sustainability in cities. Here, we use the metropolitan area of Geneva, Switzerland, as a case study to illustrate that UGBS are heterogeneous in spatial characteristics, such as surface area, naturality, or noise levels, which are associated with key cultural ecosystems services. For each characteristic, we defined a threshold with the realization of an associated cultural ecosystem service, including a novel noise threshold (LAeq < 45 dB) compatible with the notion of "quiet". We then used geospatial information to generate place-based and people-based indicators that collectively describe the variation in key dimensions of UGBS. We found that, in Geneva, the typical (median) resident has access to 4.7 ha of UGBS, and 89% of residents live within 300 m of the nearest UGBS. Accessible surfaces of UGBS per capita, however, were highly variable by type of UGBS and across neighbourhoods. For example, residents from precarious neighbourhoods are less likely to live within 300 m of quiet UGBS than residents of privileged neighbourhoods, and when they do, these UGBS tend to be smaller. The proposed methodology categorizes UGBS in a manner that both captures their distinct social roles and highlights potential social injustice issues.

Keywords: recreation; relaxation; network analysis; accessibility; socio-economic status; ecosystem services; sustainability

check for updates

Citation: Guinaudeau, B.; Brink, M.; Schäffer, B.; Schlaepfer, M.A. A Methodology for Quantifying the Spatial Distribution and Social Equity of Urban Green and Blue Spaces. *Sustainability* **2023**, *15*, 16886. https://doi.org/10.3390/su152416886

Academic Editor: Simon Bell

Received: 15 November 2023
Revised: 4 December 2023
Accepted: 12 December 2023
Published: 15 December 2023

1. Introduction

Urban green and blue spaces (UGBS) are currently viewed as key components in the urban fabric both for their role in supporting biodiversity [1,2] and to provide multiple human health benefits [3–8] such as the reduction of thermal discomfort [9]. UGBS are also correlated with human life longevity [10,11], and with self-reported improvements in mental and physical health [12–15]. UGBS also support a range of recreational activities, including opportunities for physical activity, relaxation, wildlife observation, and social gatherings, which all contribute to quality of life in urban centres [16].

UGBS vary in their spatial, natural and environmental characteristics, which likely influence the types of social and cultural co-benefits that they generate. The health and well-being contributions of UGBS depend not only on their availability and accessibility but also on their intrinsic qualities (soundscape, amenities, landscape) [17].

However, in the scientific literature, UGBS are generally treated as homogeneous objects. For instance, to date, the analysis of existing UGBS has not attempted to describe the variability in characteristics of UGBS, nor to link these characteristics to the delivery of socio-cultural and relational benefits [18]. The used UGBS data sources are mostly of poor resolution (satellite, and urban atlas) which does not allow for the discrimination of the quality and characteristics of green and blue spaces. Future studies should consider using improved sources of spatial data [15]. This hinders the ability of urban planners to identify neighbourhoods that are currently underserviced in specific types of UGBS [19–24].

In the context of land scarcity and competing land usages, it becomes essential to correctly value green and blue spaces. This will guide policy makers and practitioners in choosing the right option to capitalize on the benefits of green and blue planning for health and well-being [17]. There are several potential obstacles to guaranteeing equitable access to the benefits associated with UGBS in an urban context. First, efforts to restrict urban sprawl have led to calls to densify cities and to "build inward" [25], which, paradoxically, could present a threat to UGBS [26,27]. Second, UGBS are inextricably linked to questions of social and environmental justice, as the amount of UGBS is generally correlated with socio-economic indicators and ethnicity [28–31].

Missing to date has been a methodology that can group UGBS according to key physical characteristics that are associated with putative social benefits. To fill this scientific gap, we propose a Geographic Information System (GIS) methodology that distinguishes UGBS based on a limited set of key physical characteristics. Then, we analyse the availability of each type of UGBS within neighbourhoods. We use the Geneva urban centre perimeter as a case study to show the feasibility of the methodology. We hypothesize that estimates of access to different types of UGBS can reveal important socio-economic disparities in demand and offer different types of recreational activities.

This study outlines a novel methodology for quantifying and mapping key bio-physical characteristics of urban green and blue space that represent an integral component of sustainable cities, and that establishes the extent to which these characteristics are correlated with socio-economic indicators.

2. Materials and Methods

In this section, the objectives of this study, the study area and the rationales are given, and the methodology is developed.

2.1. Main Objectives and Study Area

The urban perimeter of the city of Geneva (Figure 1) was defined by the cantonal authorities of Geneva, Switzerland, for nature-based initiatives, with a 500 m buffer to account for residents' access to UGBS situated just outside the urban perimeter. The urban perimeter of Geneva represents 7914 ha, and currently covers roughly one third of the total canton surface and captures 88% of its population (456,634 of 517,802 inhabitants in 2021, around 10,000 inhabitants per square meter). All place-based and people-based statistics are restricted to the urban perimeter.

Our workflow methodology is summarized in the following steps. We first defined urban green space characteristics that could be quantified using publicly available GIS-Data and that were likely to be correlated with the supply of different cultural ecosystem services (minimum surface, natural habitat map, sources of anthropogenic noise, and public access). We then identified thresholds likely to predict the recreational activity potential (noise emission, greenness index) of each UGBS to generate place-based statistics. Subsequently, accessibility analysis was made to generate people-based statistics (Figure 2). Finally, we cross-referenced accessibility parameters with socio-economic information by neighbourhood to test for the possibility of social inequality. All data used are open access.

2.2. Defining Urban Green and Blue Spaces

UGBS were identified (i) by the union of different types of natural areas such as parks, open areas, forests, rivers, lakes, wetlands, or agricultural surfaces within the study perimeter, (ii) at least 0.5 ha [32] and (iii) public property or within 10 m of a publicly accessible road or trail (Figure 3). This latter criterion accounts for the putative benefits of viewsheds when near UGBS [33,34], even though they are not directly accessible. We use a UGBS definition that includes water surfaces (wetlands, rivers, and lakes) because of their importance in Geneva (with its lake front and numerous rivers), and their potential to positively influence the quality of services they provide [35–38].

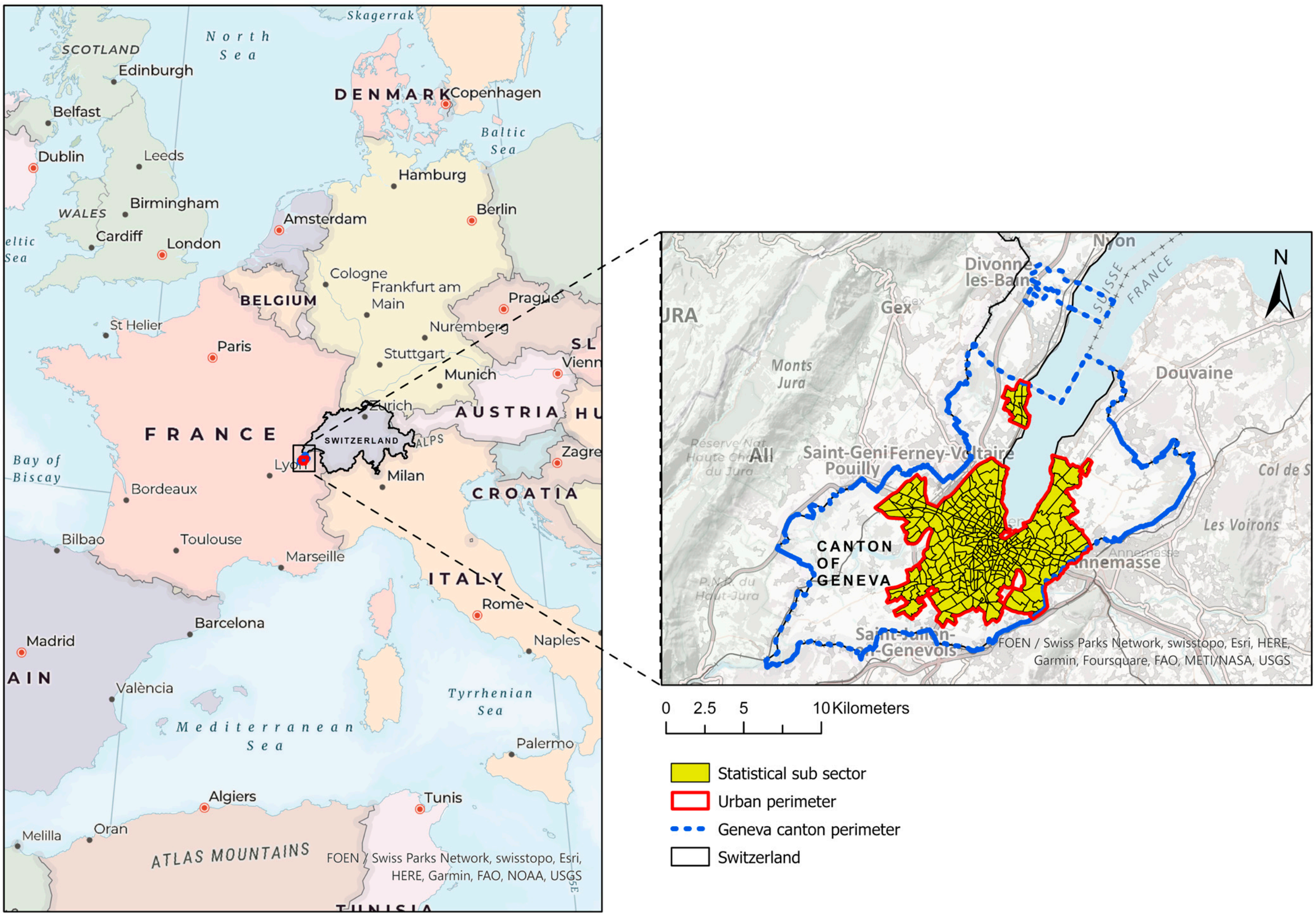

Figure 1. The urban perimeter of Geneva canton in Switzerland, with its socio-economic sub-sectors.

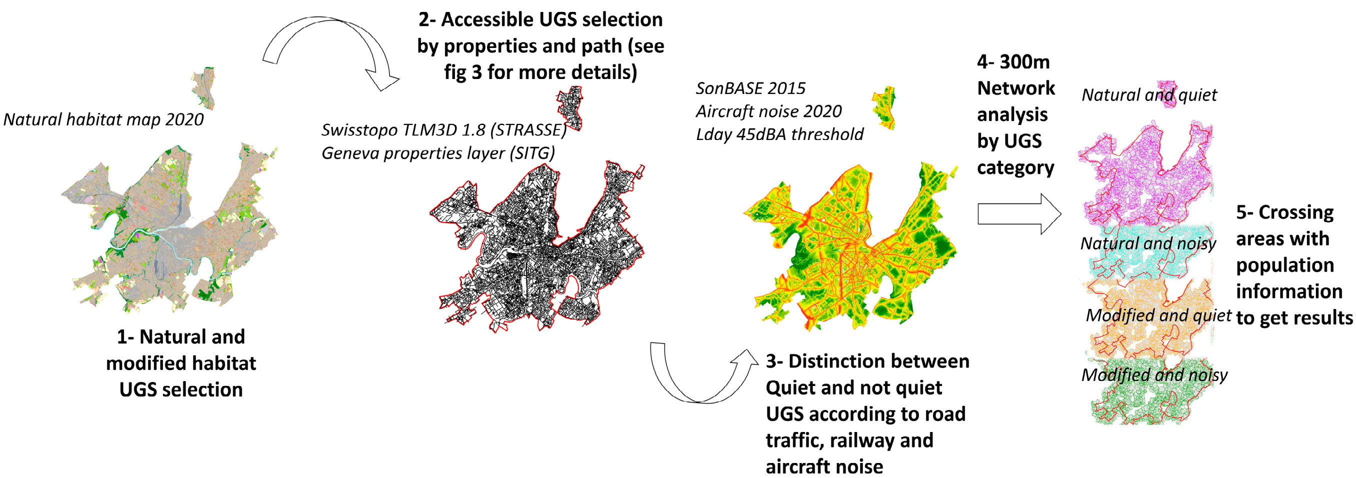

Figure 2. Geomatic steps to realize separate network analysis via UGBS and population characteristics by neighbourhoods. Only road traffic noise is mapped in the figure for visual clarity.

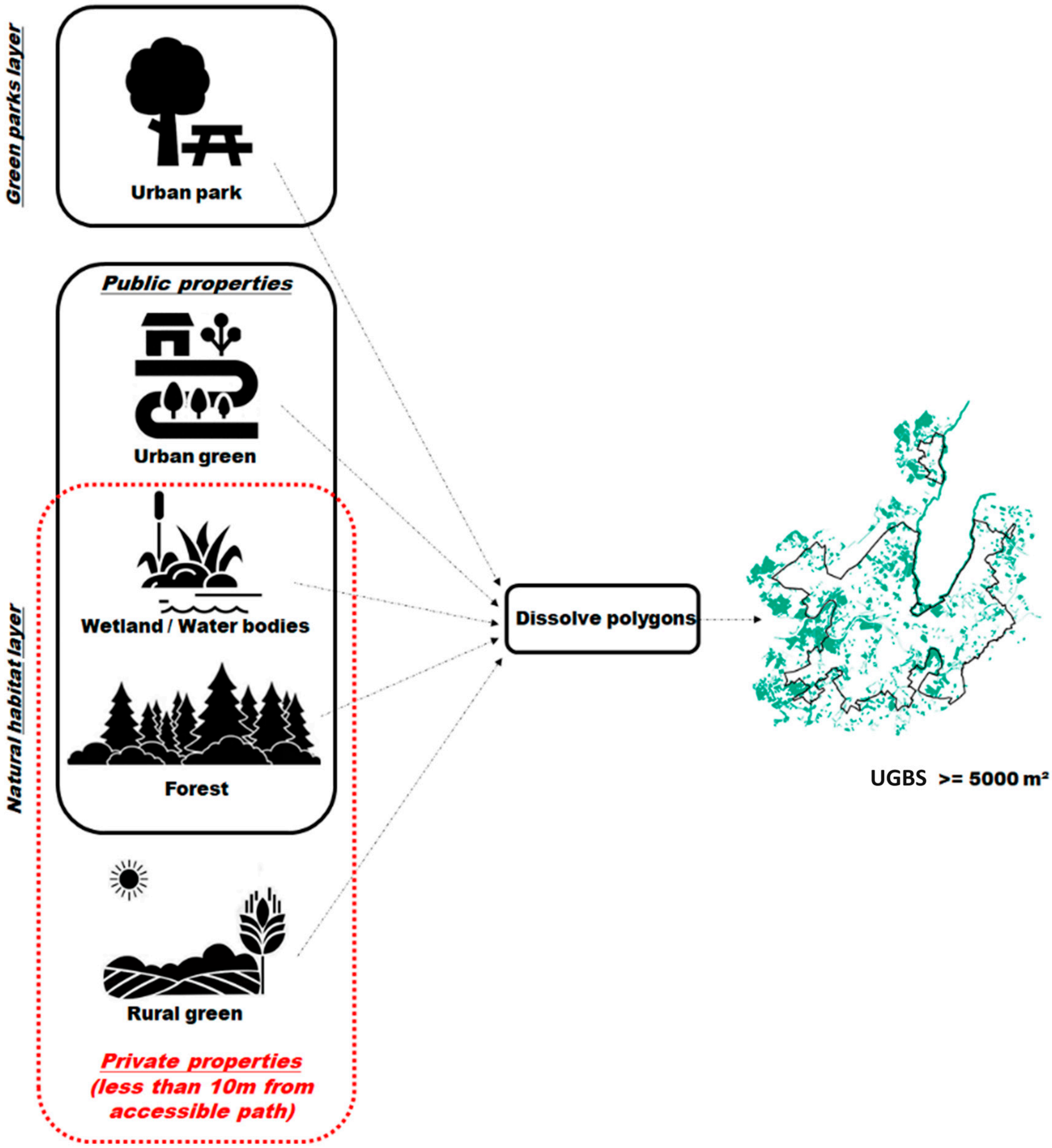

Figure 3. Schematic synthesis of the GIS data layers used to define urban green and blue spaces in metropolitan area of Geneva, Switzerland. See text for details.

The base layers for these analyses were a detailed land-use map of Geneva [39], an urban green parks layer [40] and the swissTLM3D 1.8 "Strasse" (roads) layer of the Federal Office of Topography (swisstopo), which are all open data. Around 1 percent of UGBS surfaces located on public lands were manually removed because they were considered inaccessible (e.g., median strip on motor freeway; grasslands around the runway within the premises of Geneva International Airport).

2.3. Matching Recreational Activities to UGBS Characteristics

We focus on the following four types of activities and their associated human health benefits [41]: (i) physical activities (e.g., jogging, vigorous walking) for physical health and de-stressing; (ii) social interactions (talking while sitting or playing) for physical health, de-stressing and social bonding; (iii) observations of nature (animals and plants) for intellectual and aesthetic pleasure; and (iv) relaxation (e.g., passive interactions, walking slowly or sitting in silence) for de-stressing, spiritual enrichment and improved mental health. Here, we focus on the quality of nature and anthropogenic noise exposure as key UGBS traits to distinguish UGBS type (Table 1). We assumed that physical activities could take place in any UGBS. Although adults tend to jog or play sports in larger UGBS, younger children are active in smaller UGBS, so no minimum size criterion was used. We further assumed that social interactions are most likely to occur in "modified" UGBS such as parks with open areas (lawns) and benches, and that, by contrast, the observation of wildlife and plants requires relatively natural surfaces. Finally, we posit that nature-based relaxation depends upon a relatively quiet environment. Table 1 summarizes these assumptions. Such associations are likely more complex than what is presented here, as they are known to vary according to individual traits (e.g., age, and gender) and also culture. As a first step, our study seeks to quantify the variation in these key UGBS characteristics. In the future, these associations may be refined if new insights from the literature or field surveys become available.

Table 1. Putative association between the availability of different ecosystem services (rows) and their environmental characteristics (column headings) of urban green and blue spaces in Geneva, Switzerland.

	UGBS Characteristics			
Type of Activities	**Natural and Quiet**	**Natural and Noisy**	**Modified and Quiet**	**Modified and Noisy**
Physical activities	√	√	√	√
Social interactions			√	√
Observation of nature	√	√		
Relaxation	√		√	

The quality of nature captures the degree of naturality of an UGBS. This trait is highly variable within UGBS, from public squares with a large proportion of impermeable surface to relatively "wild" nature reserves, and is expected to have a strong influence on the types of activities provided. The state of naturality of an UGBS was calculated by qualifying each of 32 land-use categories [39] as either "modified" (monocultural agriculture, sports fields, lawns, and parks) or "natural" (remaining natural and semi-natural land-use categories; Appendix A). Ambient noise likely hinders relaxation. We therefore set out to characterize transportation noise sources in each UGBS. We define that relaxation can occur when a threshold for the A-weighted equivalent continuous sound pressure levels (LAeq) of 45 dB during daytime is not exceeded by any transportation noise source. This threshold was identified by re-analysing data from a Swiss-wide socio-acoustic survey conducted within the SiRENE study, where residents reported their level of annoyance to road traffic, railway, and aircraft noise [42]. In that survey, respondents reported their noise annoyance on the ICBEN 5-point verbal scale (from "not at all annoyed" to "extremely annoyed") [43] individually for each transportation noise source (road, rail, air). We assumed that relaxation and mental recovery associated with the cultural ecosystem service "relaxation" can take place when 75% of individuals are "not at all" or only "slightly" annoyed (lowest two of the 5-point scale). The corresponding threshold values for the LAeq during daytime, i.e., from 6 to 22 h ("LDay"), are located between 45 and 50 dB depending on the noise source (Figure 4). Finally, the lowest of the three thresholds determined this way (45 dB) was used to define the general threshold in this exercise. This approach is similar, but in a mirrored fashion, to the one used by the Swiss legislation, which uses a criterion of 25% of people being highly annoyed to determine the basic noise exposure limits in the Noise Abatement Ordinance (NAO) [44]. Our threshold roughly matches the noise exposure level (LDay = 40–50 dB) found in "quiet areas" or associated with relaxation in other studies [45–47]. This corroborates a unified threshold of LDay < 45 dB for defining a "quiet" UGBS that is compatible with relaxation.

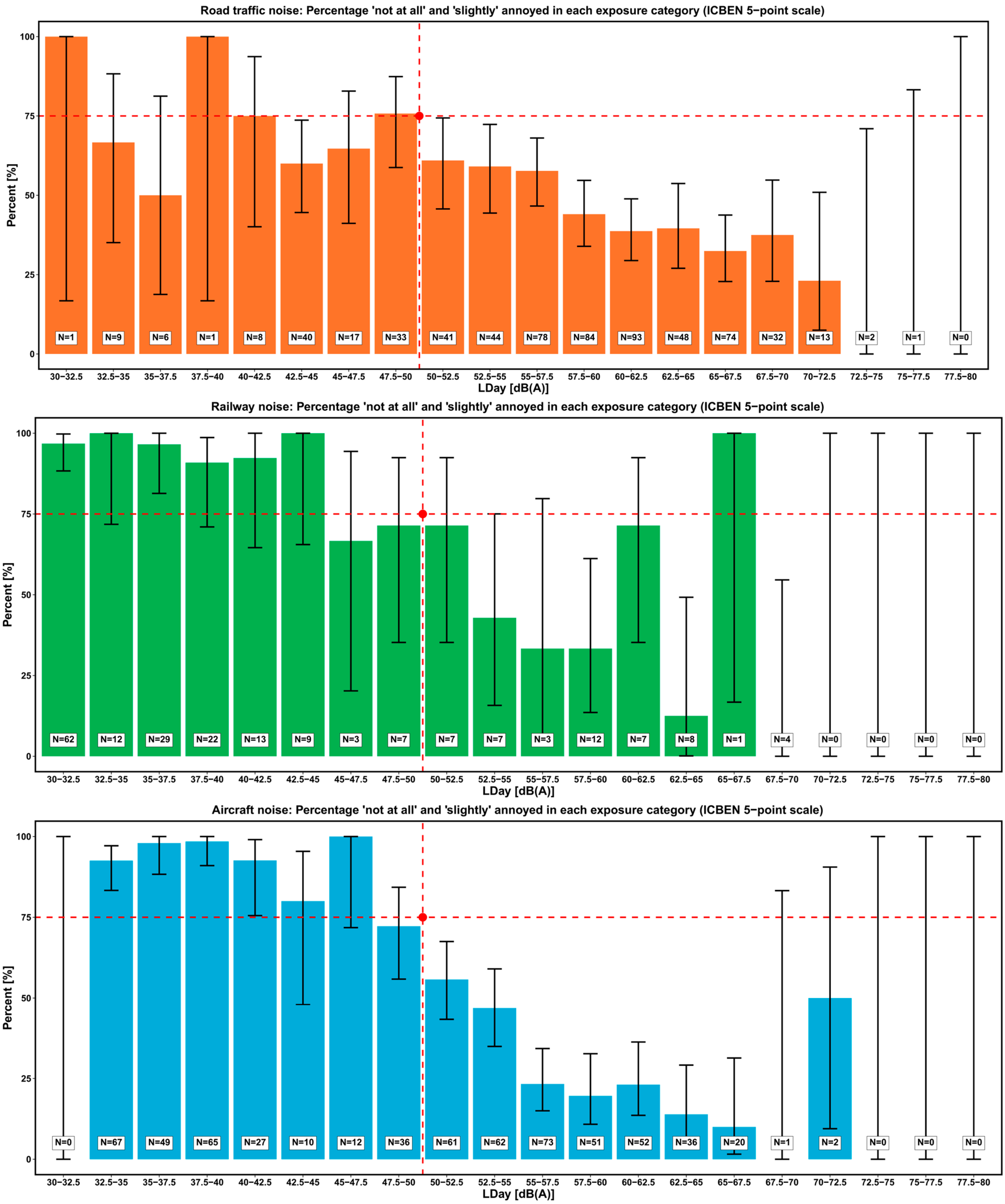

Figure 4. Percentage of respondents for Geneva in a survey by Brink et al., 2019 [42] that report being “not at all” or “slightly annoyed” in response to transportation noise exposure (road traffic, railway, aircraft). The dashed vertical lines define the threshold noise exposure level for at least 75% “lowly annoyed” persons. Sample size is indicated within each exposure category. The 95% Agresti–Coull confidence intervals for the proportion are also shown.

To identify surfaces in our study perimeter that are “quiet” according to the 45 dB criterion, we first merged GIS layers of road traffic and railway noise [48] as well as a noise exposure calculation (prognosis 2022) of aircraft noise [49]. The rasters were provided in rating sound levels Lr for the day according to the Swiss NAO [44], which roughly corresponds to the LDay, with the exception of railway noise where a level correction of −5 to −15 dB ("railway bonus") is applied depending on the number of train journeys per day (see NAO [44], for details). An UGBS was assigned to the "quiet" category if >50% of its surface had an LDay exposure below 45 dB.

2.4. Distance Threshold for UGBS Access

Distance to UGBS is a continuous variable that is quantified by pathway distance (m) between a residence and the nearest UGBS. The travel distance to a UGBS is a key predictor for the probability that a person will access and use the space provided [50–52]. There is no single distance that defines a threshold, as the probability of travel also depends on a host of factors including ecological, medical, psychological, economical, sociological, and geographical [53,54]. Here, we illustrate the use of this method (using arcmap service area network analysis) with a relatively conservative distance threshold of 300 m (pathway distance, see below) on the premise that we wanted to capture the perspective of so-called vulnerable users (elderly, mobility-impaired, and children). This distance is roughly equivalent to a 5–10-min walk.

2.5. Number of People with Access to UGBS

We estimated the pathway distance from each residence to the nearest UGBS with a network analysis, which provides a more realistic estimate than a linear Euclidean distance [55–57]. Publicly available data provided an address identifier and the number of inhabitants for all residences of the canton of Geneva [58]. Access routes were defined as (i) all paths and roads narrower than 6 m (for which we supposed that road traffic does not discourage pedestrian use) and (ii) all roads up to 10 m wide, but with sidewalks. These elements were extracted from the "STRASSE" layer in the national georeferenced TLM^{3D} 1.8 STRASSE database [59]. Because the exact location of the entrance point to each UGBS was unknown, we assumed that potential entrance points were available every 250 m along the perimeter of each UGBS [53,55,60]. The Esri ArcGIS Network Analyst extension (ArcGIS 10.7) estimated the surface by type of cultural ecosystem service and the number of people within a given access threshold (300 m, see previous section for justification) from each UGBS entrance point.

2.6. Socio-Economic Information

The Centre for Territorial Analysis of Inequalities in Geneva (CATI, by its French acronym) conducts regular surveys to estimate six socio-economic indicators: median gross annual income (IB1), the share of low-income taxpayers (IB2), the share of schoolchildren from a modest social class (IB3), the share of registered unemployed as a percentage of the population aged 15–64 years (IB4), the share of recipients receiving public assistance (IB5) and the share of recipients living in public housing (IB6) [61]. To preserve anonymity, indicator statistics are reported by socio-economic "statistical sub-sectors", of which there are 475 in the canton of Geneva, and 310 in our study area (Figure 1). Henceforth, statistical sub-sectors will be referred to as "neighbourhoods". The median (5th–95th percentile) number of people living in a neighbourhood is 1365 (179–4111). For each indicator, a neighbourhood is labelled as "precarious" if its rank is in the bottom quartile of the canton for the indicator median income (IB1), or in the top quartile of the canton for the other five indicators (IB2–IB6). An index of precariousness for each neighbourhood is defined by the sum of the six indicators (Figure 5, Table 2).

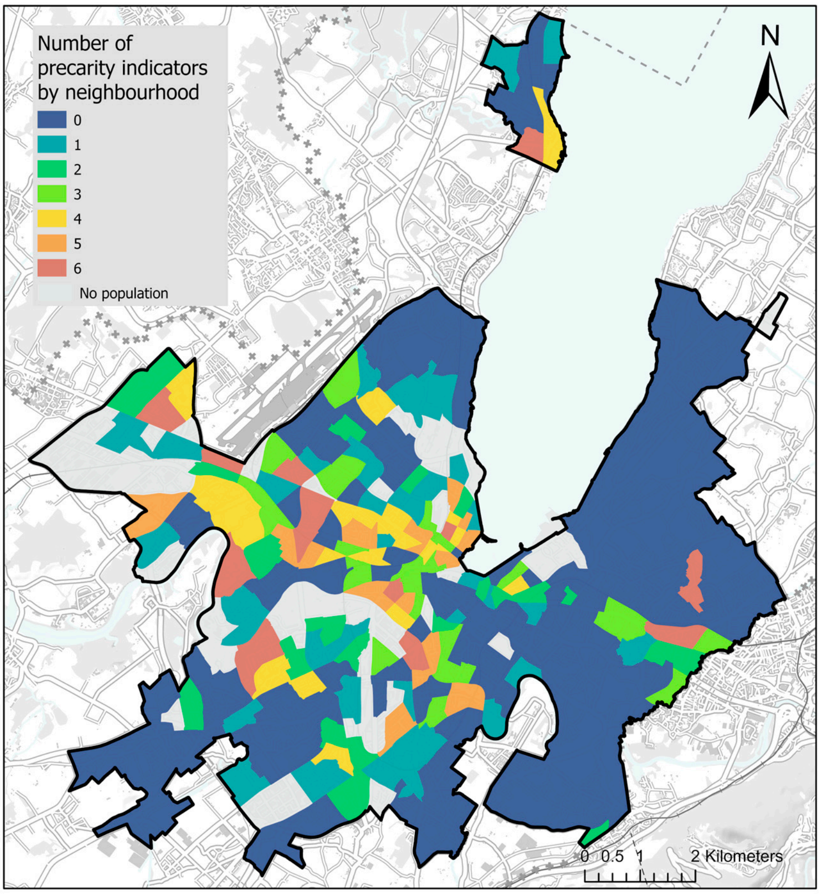

Figure 5. Index of precariousness defined by the number of indicators (out of 6) labelled as "relatively precarious", by neighbourhood, within the study perimeter of Geneva, Switzerland (2020). Grey surfaces represent neighbourhoods with no population.

Table 2. Proportion of neighbourhoods and population by precariousness index (0 = low precariousness; 6 = high precariousness).

Index of Precariousness	Number of Neighborhoods	Percentage of Population
0	123	34
1	38	13
2	22	10
3	25	9
4	21	13
5	21	9
6	17	11

3. Application

We suggest that two types of metrics should be reported. First, place-based metrics capture the "offer" of UGBS and a recreational potential they may provide. These statistics describe the number of people within a given perimeter (e.g., 300 m) of each UGBS, and the number of people whose access depends on a single UGBS. Second, people-based metrics capture the number of people and residences that do not have access to certain types of UGBS. We tested for correlations between indicators of relative precariousness and the available surface areas for each type of UGBS with a non-parametric test (Spearman's rank correlation test) in R 4.0.0, (R Core Team 2021, Team 2021). All of our analyses are paired with maps, as these can reveal geographic disparities in associated recreational activities and socio-economic information.

3.1. Place-Based Statistics: The Offer of UGBS

Our definition of a UGBS yielded 505 units, which collectively represent 20% of the study area (1624 of 7914 ha Table 3). UGBS are present throughout the entire urban area, but with a clear over-representation in the peri-urban zones (Figure 6). Overall, there are 36 m^2 of UGBS per capita in the Geneva urban area, but this statistic fails to capture the high variance in both types of UGBS and their spatial distribution.

Table 3. Place-based metrics for the offer and demand of different categories of urban green and blue space (UGBS) of Geneva (2020).

Type of UGBS [1]	Total Surface (ha)	Number of UGBS Units	Median Size (ha; 5th–95th Percentile)	Median (5th–95th Percentile) Number of People within 300 m per UGBS	Surface (ha) of UGBS Units That Represent the Sole Surface for at Least One Resident (% of Total UGBS Type)	Number of UGBS Units That Represent the Sole Surface for at Least One Resident (% of Total UGBS Type)
All	1624	505	1.2 (0.5–11.5)	984 (5–6847)	1076 (66.3)	239 (47.3)
Modified	523	253	1.0 (0.5–6.6)	1697 (15–8216)	401 (76.7)	182 (72.2)
Natural	1101	252	1.5 (0.5–23)	632 (0–4792)	868 (78.8)	152 (60.3)
Quiet	154	47	1.97 (0.6–12)	493 (24.8–3555)	137.1 (88.7)	35 (74.5)
Urban perimeter surface	7914	/	/		/	/

[1] The number of UGBS does not add up, as quiet UGBS are also either natural or modified (ALL = Natural + Modified) (i.e., see Table 1).

The four types of UGBS defined by the combinations of quality of nature and noise exposure (Table 1) varied within our study area as follows: About 50% of the 505 UGBS are "natural", and 50% are "modified". A small minority of UGBS (10%) are quiet (Lday < 45 dB), regardless of the quality of nature (Table 3; Figure 6).

Some two thirds of UGBS represent the sole accessible UGBS for at least one resident (Table 3), but this ratio increases to nearly 90% for quiet and natural UGBS. Modified UGBS tend to be relatively small (median 1 ha) and with a large population within 300 m (median 1697 people), whereas quiet UGBS tend to be relatively large (median 1.97 ha) and with fewer people within 300 m (median 493 people) (Table 3). Quiet UGBS are relatively scarce, as 85% (6741 ha) of the urban perimeter area is noisy (LDay $\geq$ 45 dB, Figure 7). A total of 6137 ha (77%) of the study area exceeded the threshold for quietness because of road traffic, 2597 ha (33%) due to aircraft noise, and 298 ha (4%) due to railway noise. The contribution of the three transportation noise sources to "noisy" areas partly overlap (mostly in the north-west part of the perimeter).

3.2. People-Based Metrics: Access to UGBS

People-based metrics summarise the number and fraction of people without access to different types of UGBS. In our study, 11% of the urban population live further than 300 m from the nearest UGBS (yellow-dot physical activities, Figure 8). These residents are likely "under-serviced" in terms of nature-based activities and cultural ecosystem services.

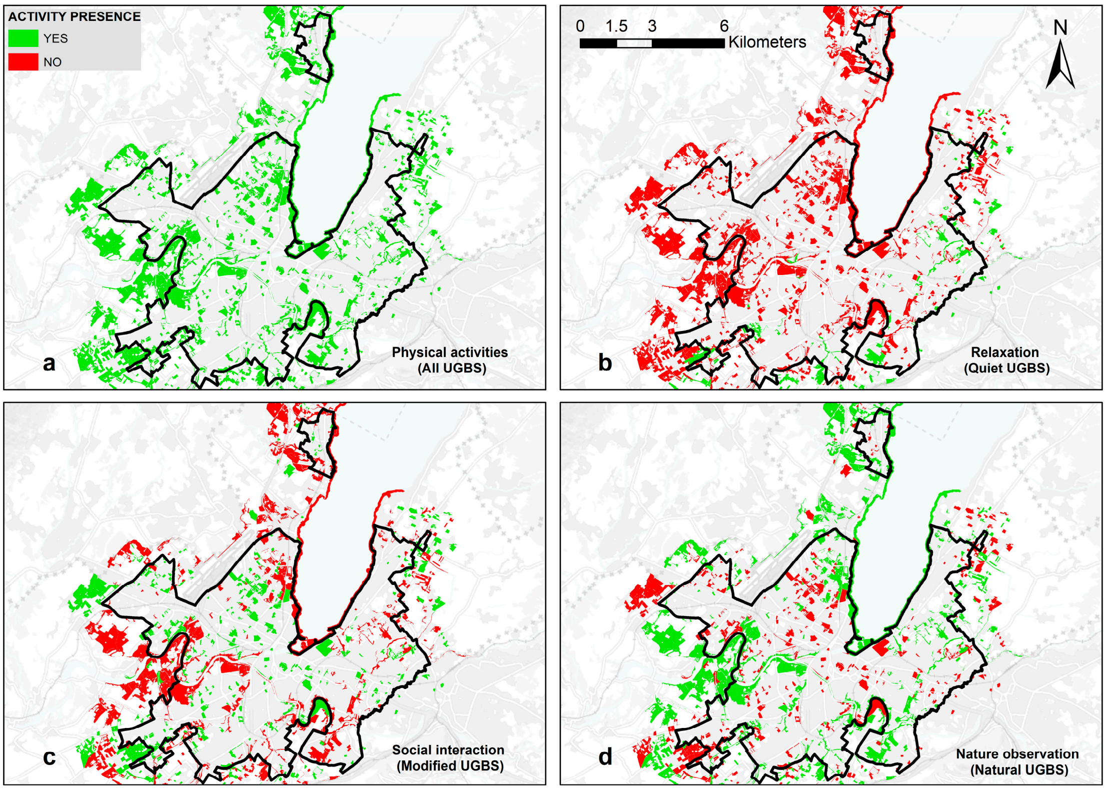

Figure 6. Distribution of type of activity based on UGBS characteristics (cf. Table 1). (**a**). Physical activities are assumed to occur in all UGBS. (**b**). Relaxation is facilitated in quiet UGBS. (**c**). Social interactions are facilitated in "modified" UGBS. (**d**). Whereas observation of nature is assumed to occur primarily in more "natural" UGBS.

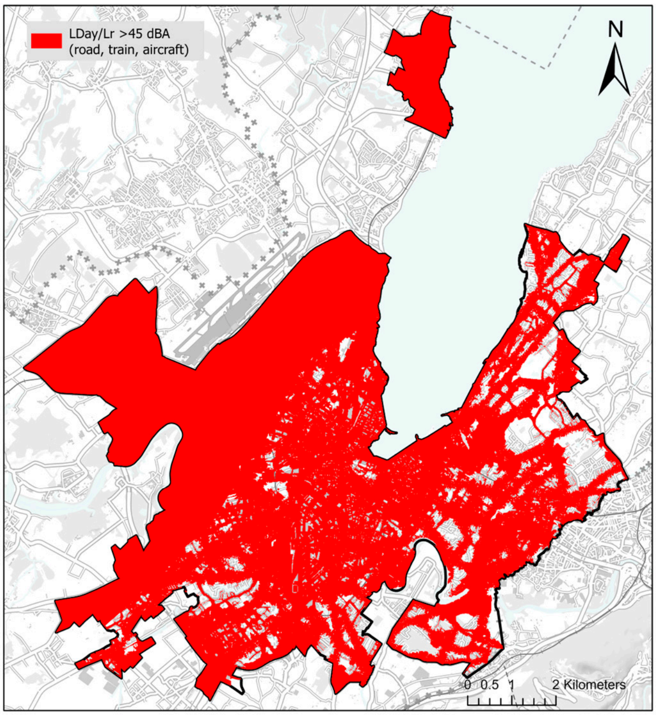

Figure 7. Coloured places represent road traffic, railway (Lr according to sonBASE 2015) or LDay aircraft noise level (prognosis 2022) greater than 45 dB.

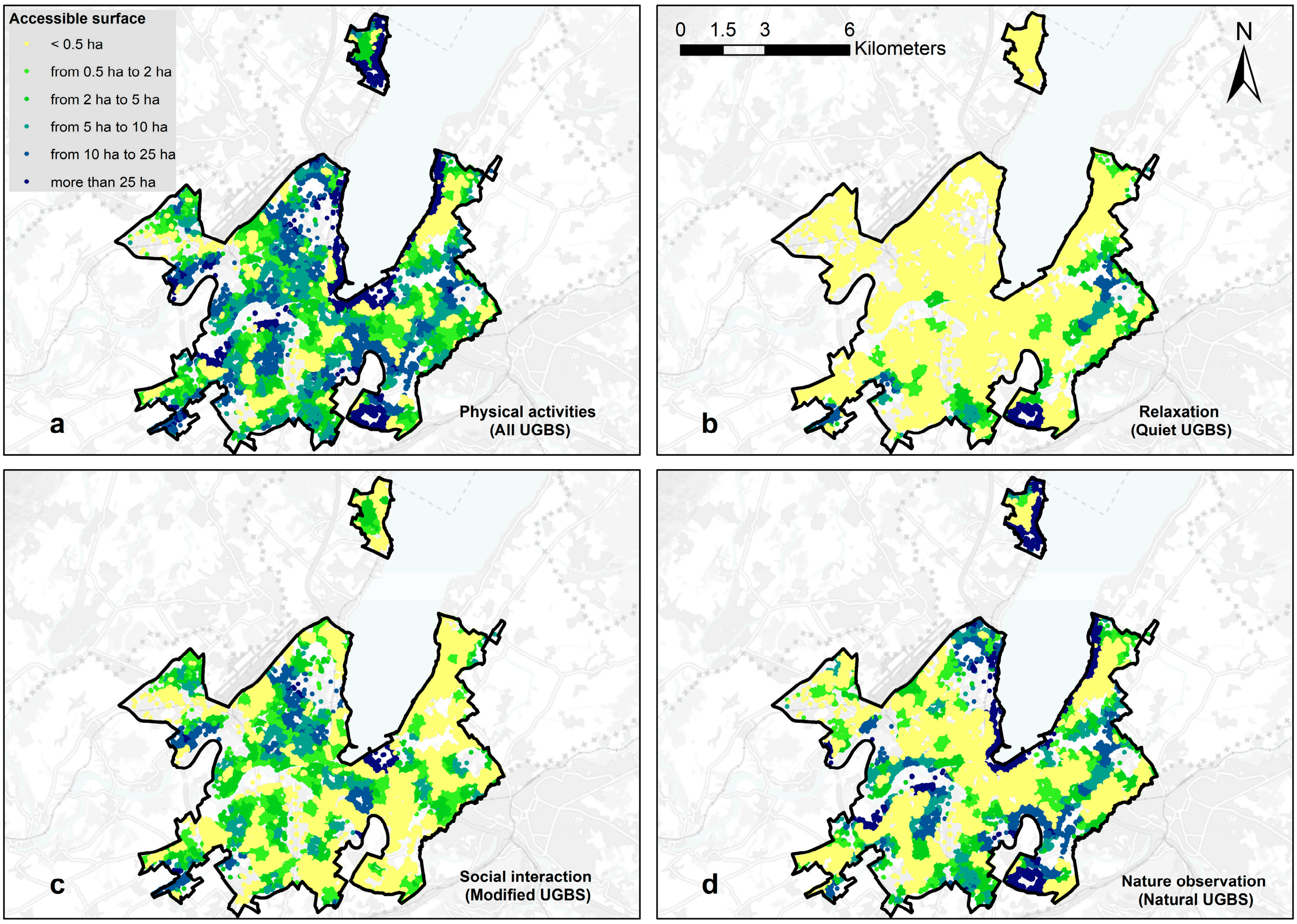

Figure 8. Accessible surfaces by address and urban green and blue space type for (**a**) physical activities, (**b**) relaxation, (**c**) social interactions and (**d**) observation of nature. No colour indicates surfaces without residential addresses.

The percentage of the population without access to a UGBS increases as one considers the different types of UGBS with more stringent criteria: 28% of people do not have access to a modified UGBS, which is presumably conducive for social interactions; 52% of people do not have access to a natural UGBS, which is presumably conducive to nature observation, and 91% do not have access to a quiet UGBS, which is presumably conducive to forms of relaxation (Table 4). Furthermore, UGBS are not distributed equally in space. For example, quiet UGBS are clustered in the south and eastern part of the urban perimeter, which is furthest away from Geneva airport. Indeed, aircraft noise exceeding 45 dB covers large parts (33%) of the urban zone (and canton) of Geneva (Figure 7).

Our results also illustrate low redundancy in access to UGBS. Indeed, one quarter of the population (27%) has access only to a single UGBS from their residence (Table 4), and the majority of residents who have access to a quiet UGBS compatible with relaxation have only single access for that UGBS category (80%) (Table 4).

3.3. Socio-Economic Factors

A visual analysis of the spatial distribution of different UGBS types (Figure 8) suggests that people living close to the lake, near a large urban forest, far from the city centre and far from the airport are more likely to have access to a UGBS in general, and to quiet and natural UGBS in particular (Figure 8b,d). The surface of UGBS that is accessible to each address is spatially heterogeneous (Figure 8a) and prompts the question whether these values correlate with socio-economic factors. The median UGBS surface available to residents of a neighbourhood and the percentage of neighbourhood residents with access to UGBS surfaces were both highly variable within categories of precariousness (Figure 9). Overall, we found no significant relationship between the precariousness index of a neighbourhood and the median accessible UGBS surface, nor with the percentage of residents with access to any kind of UGBS (Figure 9a,b).

Table 4. People-based metrics: number and percentage of population with access to different types of urban green and blue space (UGBS) 2020.

Type of UGBS	Putative Cultural ES	Number of Residents with Access	Percentage of Total Study Population with Access	Number of Residents with Only Access to One UGBS	Percentage of Residents with Access to Only One UGBS	Median (5th–95th Percentile) Surface (ha) of Accessible UGBS per Resident
All	Physical activities	406,511	89.3	109,732	27.0	4.7 (0–45.4)
Modified	Social	328,927	72.3	143,950	43.8	0.9 (0–13.8)
Natural	Wildlife observation	220,379	48.4	125,658	57.0	1.1 (0–39.3)
Quiet	Relaxation	41,152	9.3	32,731	79.5	0 (0–7)
Total (urban perimeter)		455,106	/	/	/	/

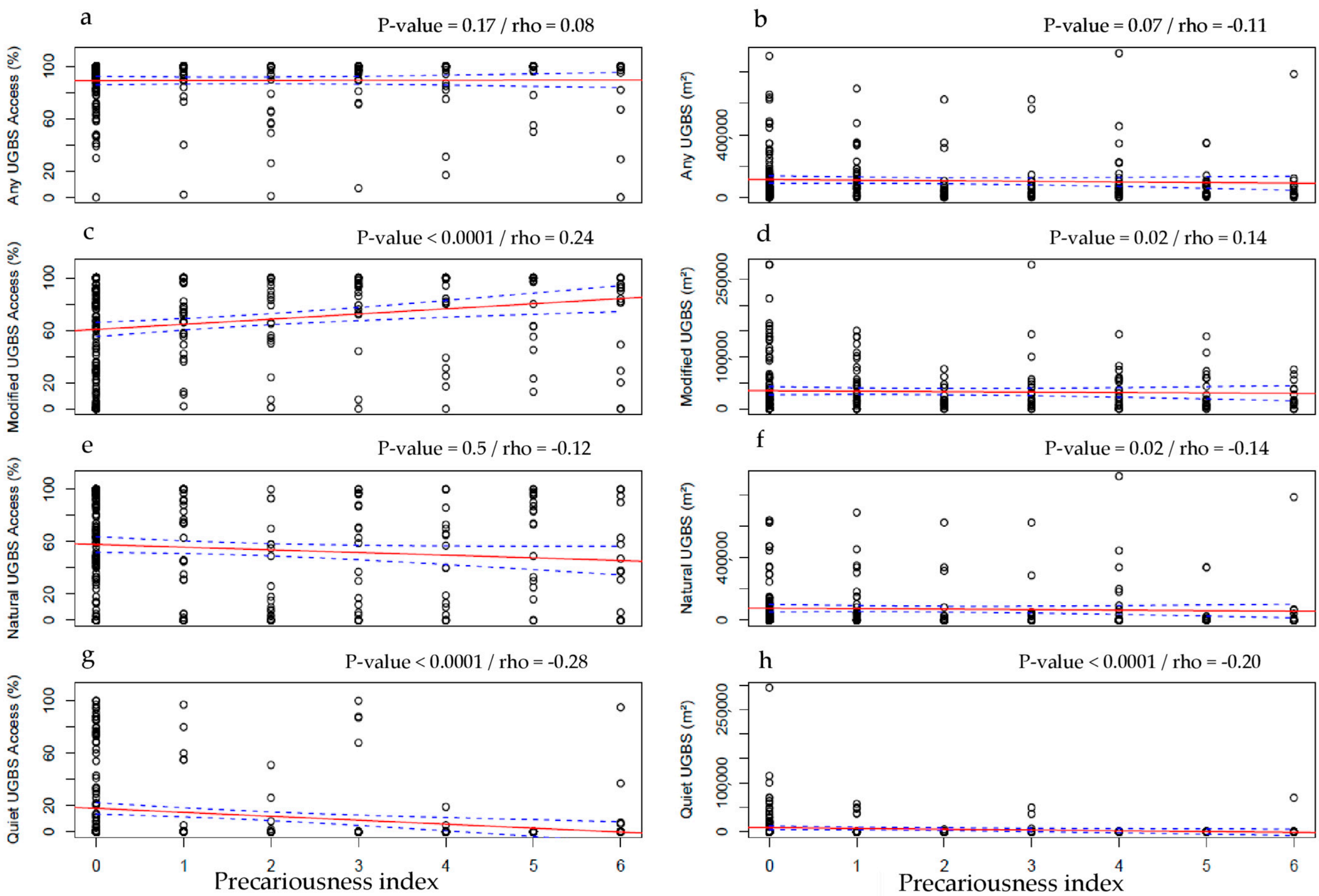

Figure 9. Percentage of neighbourhood residents with access (>300 m) to different types of urban green and blue space (UGBS) and by neighbourhood precariousness score (horizontal axis) (**left**), and available areas per resident (**right**). Regression line (red) plus 95% confidence intervals (dashed blue lines): All UGBS (**a**,**b**), Modified UGBS (**c**,**d**), Natural UGBS (**e**,**f**), and Quiet UGBS (**g**,**h**).

We found weak but significant statistical associations between a neighbourhood's precariousness index and the percentage of neighbourhood residents for two UGBS sub-types. The percentage of residents with access to modified UGBS increased with socio-economic precariousness ($p < 0.001$, Spearman rho = 0.24, Figure 9c), whereas the percentage of residents with access to quiet UGBS decreased with socio-economic precariousness ($p < 0.0001$ and Spearman rho = -0.28, Figure 9g). The precariousness score of a neighbourhood is negatively correlated both with the proportion of residents who have access to a quiet UGBS and with the mean surface area of quiet UGBS. Similarly, residents from precarious neighbourhoods not only are less likely to live within 300 m of quiet or natural UGBS, but when they do, they are relatively small (Figure 9f,g).

4. Discussion

In this paper, we developed a novel methodology that quantifies and maps the variation in UGBS characteristics that are likely linked to cultural ecosystem services (Table 1). The field of UGBS studies is marked by a great diversity of summary statistics. A common indicator of green space availability is the average green space surface per capita [62,63], which gives a good overview of UGBS availability, but suffers from the risk of obscuring important spatial heterogeneity, including differences between neighbourhoods. Our novel approach provides not only an overall view of the availability of UGBS in general, but also an insight to potential environmental injustice issues within urban centres by providing a blueprint for how to calculate the percentage of residents in the lowest income quintile (lowest 20%) living within a walkable distance of a public, open-access natural area. It reveals how many residents have or do not have access to specific activities associated with different UGBS types, where under-serviced residents or areas are located, and which UGBS types may need to be enhanced under future city planning.

Our analysis illustrates that, in Geneva, Switzerland, overall access to UGBS was relatively equitable, with 89% of residents living within 300 m of a UGBS. This result corroborates the findings of a similar study [26] that found that 70–84% of the population have access in less than 5 min to a green space in the canton of Geneva. A 300 m threshold became a reference distance in a range of studies [62,64–67] investigating access to green spaces, as well as in public policy recommendations [32,57,68,69], in part because it also is aligned with a walkable city (e.g., "15 min neighbourhoods") [70,71]. Although there was significant variation in the amount (and percent surface) of UGBS across neighbourhoods, we found no association between all UGBS and the index for precariousness suggesting that, generally, UGBS are distributed relatively equally across the socio-economic spectrum.

Our recommendation to categorise UGBS by transportation noise exposure and naturalness provided interesting insights that also revealed nuance to our first-order analysis. First, it illustrates how certain UGBS types are relatively uncommon. Quiet UGBS (with at least 50% of its surface LDay < 45 dB) may be essential for relaxation, and yet only 9% of residents have access within 300 m of their residence. This highlights the potential importance of noise sources in modifying the quality of UGBS. Noise from anthropogenic sources will limit the quality and enjoyment of some activities, but, to date, no noise exposure threshold has been identified below which relaxation or passive interactions can take place. Surveys conducted in the UK and the Netherlands report that "quietness" is a prerequisite for relaxation in rural and natural settings [72–74]. A feeling of "tranquillity" is reported in environments that combine a high percentage of natural features and low level of anthropogenic noise [75–77]. These results clearly support plans for noise reduction, such as the "National plan of measures to reduce noise pollution" for Switzerland [78], which focuses on reducing noise emissions at the sources and promoting tranquillity and relaxation in urban development and psychological well-being in general. Future work could identify whether other factors (olfactory, human density, and visual) also influence the ability to relax within UGBS [79].

Second, our analysis highlights low redundancy in access to UGBS, with one quarter of the population (27%) having access only to a single UGBS from their residence. Thus, UGBS transformation into another land-use (e.g., housing development), will frequently lead to the direct loss of activities' offer for at least some residents. It also allows to estimate the relative importance of each UGBS by counting the number of residents that depend on a particular UGBS.

Finally, the analysis of the amount of surface available to residents by UGBS type revealed strong differences between neighbourhoods that are correlated with the precariousness index (see [80]). Residents from neighbourhoods with high socio-economic precariousness (low income, high unemployment, etc.; CATI scores 4–6) only had a 3% likelihood of having access to a quiet UGBS, whereas this probability was 5 times greater (15%) for residents living in neighbourhoods with low precariousness scores (CATI scores 0–3) (see also [81]). The opposite trend was seen for highly modified UGBS, where the likelihood for a resident having access was greater (80%) in neighbourhoods with high precariousness scores than in those with low precariousness scores (71%). Furthermore, per capita surface area decreases with precariousness for exclusive UGBS types (quiet; natural), which could indicate a decreasing quality of these UGBS. Thus, the more refined categorisation of UGBS defined by their bio-physical attributes revealed important differences in the recreational activities they offer, and associated health benefits.

This work highlights at least three important gaps in our work. First, we could only speculate regarding which bio-physical characteristics of UGBS correlate with specific activities as we lack observational data on UGBS-users that can be combined with GIS characteristics [82]. Individual preferences alter the perception of natural environments and thus the enjoyment of certain ecosystem services [83]. Thus, recreational activities should not be explained or appreciated solely on the basis of physical attributes of UGBS such as noise or naturalness but also by personal characteristics such as gender, age or income. Second, future work should verify not only the frequency of activities in UGBS, but also the motivation and distance travelled by UGBS users [31,84–87], and the park characteristics they appreciate [88,89]. Green-space attractiveness may depend on numerous factors such as the presence of facilities, culture and history, safety, amenities, quality of the biodiversity, and public transport [28,66,90–94]. Third, we do not know what types of activities residents would like to engage in, ideally, and therefore where there might be unmet demands (and, by extension, potential social injustice).

Public participatory GIS (PPGIS) could provide an additional source of information on personal experiences and preferences [88], in particular by identifying preferred green spaces and asking specific questions about these. Surprisingly, this research approach has only rarely been applied to accessibility studies so far [95,96]. If it turns out, for example, that relaxation is the characteristic that most people seek out, then it would imply both a large unmet demand (given the low fraction of quiet UGBS) and a current socio-economic disparity (at least in Geneva) that should be redressed.

5. Conclusions

Our work is premised on the observation that UGBS vary in key characteristics that will likely influence the nature and magnitude of cultural ecosystem services. Our analysis provides insights into the frequency of different UGBS characteristics, and illustrated how accessibility to certain UGBS types differs between neighbourhoods with different precarity scores. We suggest that our methodology could be used as additional indicators for social urban sustainability. This approach can be applied to other cities, as the necessary data for conducting such an analysis include geospatial information layers of urban green and blue space (becoming increasingly open data), the bio-physical characteristics that are believed to be correlated with the possibility to enjoy different activities, such as noise and naturalness [97] and finally some measure of socio-economic status (e.g., precariousness). As urban centres remain under pressure to increase population density, there will inevitably be a concomitant pressure to develop "empty spaces". Maps of UGBS types can provide quantitative and qualitative evidence of the different types of contribution that UGBS can make to human well-being, and contribute to the discussion and decision whether and where UGBS could be created to increase the quality of life [98]. It will provide policy makers and urban planners with valuable new information that will help them favourably developing urban areas to improve the quality of life of urban dwellers.

Author Contributions: Conceptualization, B.G., M.A.S., M.B. and B.S.; methodology, B.G., M.A.S., M.B., and B.S.; software, B.G.; validation, B.G., M.A.S., M.B. and B.S.; formal analysis, B.G.; investigation, B.G. and M.A.S.; writing—original draft preparation, B.G. and M.A.S.; writing—review and editing, B.G., M.A.S., M.B. and B.S.; supervision, M.A.S.; project administration, M.A.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Publicly available datasets were analysed in this study. These data can be found here: https://osf.io/tjfvb/ (accessed on 11 December 2023).

Acknowledgments: We thank members of GE-21 for feedback on earlier versions of this manuscript, and the Geneva analysis centre of territorial inequality (CATI-GE) for providing socio-economic information.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Natural Habitat Classification (French and English), Surface Areas within the Study Area, and Attributes for the Category "Natural".

Habitat Name FR	Habitat Name EN	Code	Area [m^2]	Category	Naturalness
Pinèdes ouvertes	Open pine forest	11	228,653.03	FOREST	YES
Plantations d'arbres	Tree plantation	15	2,575,080.8	FOREST	YES
Forêts inondables	Flood-prone forest	16	3,030,017.2	FOREST	YES
Hêtraies	Beech groves	17	497,229.63	FOREST	YES
Autres forêts	Other forest	18	9,102,878.8	FOREST	YES
Chênaies	Oak groves	19	24,381,848	FOREST	YES
Lisières—Régénérations forestières	Forest regeneration	20	1,221,297.9	FOREST	YES
Saulaies buissonnantes	Bushy willow trees	22	361,964.93	FOREST	YES
Gazons—Massifs entretenus	Lawns	8	34,452,192	URBAN GREEN	NO
Bosquets urbains	Urban groves	9	3,398,056.8	URBAN GREEN	NO
Arbres isolés—Alignements	Isolated trees	30	1,903,949.6	URBAN GREEN	NO
Prairies sèches	Dry meadows	10	534,026.13	HERBACEOUS NATURE	YES
Milieux herbacés intensifs	Intensive herbaceous environments	12	23,114,194	HERBACEOUS NATURE	NO
Milieux herbacés extensifs	Extensive herbaceous environments	13	5,422,785.8	HERBACEOUS NATURE	NO
Prairies humides	Wet meadows	14	249,401.28	HERBACEOUS NATURE	YES
Rudérales—Jachères	Ruderal—Fallow land	14	4,374,590.6	HERBACEOUS NATURE	NO

Table A1. *Cont.*

Habitat Name FR	Habitat Name EN	Code	Area [m^2]	Category	Naturalness
Pépinières	Nursery	23	931,926.31	HERBACEOUS NATURE	NO
Vergers	Orchards	24	2,240,531.3	HERBACEOUS NATURE	NO
Vignes	Vineyards	27	13,135,085	HERBACEOUS NATURE	NO
Autres surfaces dures	Other pervious surface	0	24,958,111	NOT USED	NO
Glariers nus	Bare glarus	5	47,262.589	NOT USED	NO
Sols et substrats nus	Bare soils and substrates	6	2,145,691.8	NOT USED	NO
Gravières	Gravel pits	7	1,128,611.1	NOT USED	NO
Buissons—Ronciers	Bushes—Brambles	21	1,883,612.4	NOT USED	NO
Grandes cultures et flore adventice	Field crops	25	64,895,716	NOT USED	NO
Cultures maraîchères—Potagers	Vegetable crops—Vegetable gardens	26	3,099,707.1	NOT USED	NO
Routes—Bâtiments	Roads or Building	28	27,388,353	NOT USED	NO
Voies ferrées	Railways	29	969,906.4	NOT USED	NO
Eaux calmes	Calm waters	1	25,499,655	WATER	YES
Eaux courantes	Running waters	1	4,394,698	WATER	YES
Eaux calmes végétalisées	Calm vegetated waters	31	13,677,739	WATER	YES
Végétations des rivages	Shore vegetation	2	308,318.98	WETLAND	YES
Roselières	Reed beds	3	314,462.32	WETLAND	YES
Bas marais	Swamp	4	157,445.54	WETLAND	YES

References

1. Methorst, J.; Bonn, A.; Marselle, M.; Böhning-Gaese, K.; Rehdanz, K. Species richness is positively related to mental health—A study for germany. *Landsc. Urban Plan.* **2021**, *211*, 104084. [CrossRef]
2. Endreny, T.A. Strategically growing the urban forest will improve our world. *Nat. Commun.* **2018**, *9*, 1160. [CrossRef]
3. Coutts, C.; Hahn, M. Green infrastructure, ecosystem services, and human health. *Int. J. Environ. Res. Public Health* **2015**, *12*, 9768–9798. [CrossRef] [PubMed]
4. Henke, J. A gis-based exploration of the relationships between human health, social deprivation and ecosystem services: The case of wales, UK. *Appl. Geogr.* **2013**, *45*, 77–88. [CrossRef]
5. Jackson, L.E.; Daniel, J.; McCorkle, B.; Sears, A.; Bush, K.F. Linking ecosystem services and human health: The eco-health relationship browser. *Int. J. Public Health* **2013**, *58*, 747–755. [CrossRef]
6. Sandifer, P.A.; Sutton-Grier, A.E.; Ward, B.P. Exploring connections among nature, biodiversity, ecosystem services, and human health and well-being: Opportunities to enhance health and biodiversity conservation. *Ecosyst. Serv.* **2015**, *12*, 1–15. [CrossRef]
7. Clark, N.E.; Lovell, R.; Wheeler, B.W.; Higgins, S.L.; Depledge, M.H.; Norris, K. Biodiversity, cultural pathways, and human health: A framework. *Trends Ecol. Evol.* **2014**, *29*, 198–204. [CrossRef]
8. Brückner, A.; Falkenberg, T.; Heinzel, C.; Kistemann, T. The regeneration of urban blue spaces: A public health intervention? Reviewing the evidence. *Front. Public Health* **2022**, *9*, 782101. [CrossRef]
9. Thompson, C.W. Urban open space in the 21st century. *Landsc. Urban Plan.* **2002**, *60*, 59–72. [CrossRef]
10. Takano, T.; Nakamura, K.; Watanabe, M. Urban residential environments and senior citizens' longevity in megacity areas: The importance of walkable green spaces. *J. Epidemiol. Community Health* **2002**, *56*, 913–918. [CrossRef]
11. Lee, A.C.K.; Maheswaran, R. The health benefits of urban green spaces: A review of the evidence. *J. Public Health* **2011**, *33*, 212–222. [CrossRef] [PubMed]
12. Năstase, I.I.; Pătru-Stupariu, I.; Kienast, F. Landscape preferences and distance decay analysis for mapping the recreational potential of an urban area. *Sustainability* **2019**, *11*, 3620. [CrossRef]

13. Triguero-Mas, M.; Dadvand, P.; Cirach, M.; Martínez, D.; Medina, A.; Mompart, A.; Basagaña, X.; Gražulevičienė, R.; Nieuwenhuijsen, M.J. Natural outdoor environments and mental and physical health: Relationships and mechanisms. *Environ. Int.* **2015**, *77*, 35–41. [CrossRef] [PubMed]
14. Schäffer, B.; Brink, M.; Schlatter, F.; Vienneau, D.; Wunderli, J.M. Residential green is associated with reduced annoyance to road traffic and railway noise but increased annoyance to aircraft noise exposure. *Environ. Int.* **2020**, *143*, 105885. [CrossRef] [PubMed]
15. Labib, S.M.; Lindley, S.; Huck, J.J. Spatial dimensions of the influence of urban green-blue spaces on human health: A systematic review. *Environ. Res.* **2020**, *180*, 108869. [CrossRef] [PubMed]
16. Maas, J.; van Dillen, S.M.E.; Verheij, R.A.; Groenewegen, P.P. Social contacts as a possible mechanism behind the relation between green space and health. *Health Place* **2009**, *15*, 586–595. [CrossRef] [PubMed]
17. WHO. *Assessing the Value of Urban Green and Blue Spaces for Health and Well-Being*; WHO: Geneva, Switzerland, 2021; p. 48.
18. Jennings, V.; Gaither, C.J. Approaching environmental health disparities and green spaces: An ecosystem services perspective. *Int. J. Environ. Res. Public Health* **2015**, *12*, 1952–1968. [CrossRef]
19. Locke, D.H.; Hall, B.; Grove, J.M.; Pickett, S.T.A.; Ogden, L.A.; Aoki, C.; Boone, C.G.; O'Neil-Dunne, J.P.M. Residential housing segregation and urban tree canopy in 37 us cities. *npj Urban Sustain.* **2021**, *1*, 15. [CrossRef]
20. Kabisch, N.; Haase, D. Green justice or just green? Provision of urban green spaces in berlin, germany. *Landsc. Urban Plan.* **2014**, *122*, 129–139. [CrossRef]
21. Astell-Burt, T.; Feng, X.; Mavoa, S.; Badland, H.M.; Giles-Corti, B. Do low-income neighbourhoods have the least green space? A cross-sectional study of australia's most populous cities. *BMC Public Health* **2014**, *14*, 292. [CrossRef]
22. Byrne, J.; Wolch, J. Nature, race, and parks: Past research and future directions for geographic research. *Prog. Hum. Geogr.* **2009**, *33*, 743–765. [CrossRef]
23. Dai, D. Racial/ethnic and socioeconomic disparities in urban green space accessibility: Where to intervene? *Landsc. Urban Plan.* **2011**, *102*, 234–244. [CrossRef]
24. Cole, H.V.S.; Lamarca, M.G.; Connolly, J.J.T.; Anguelovski, I. Are green cities healthy and equitable? Unpacking the relationship between health, green space and gentrification. *J. Epidemiol. Community Health* **2017**, *71*, 1118. [PubMed]
25. Wellmann, T.; Haase, D.; Knapp, S.; Salbach, C.; Selsam, P.; Lausch, A. Urban land use intensity assessment: The potential of spatio-temporal spectral traits with remote sensing. *Ecol. Indic.* **2018**, *85*, 190–203. [CrossRef]
26. Giuliani, G.; Petri, E.; Interwies, E.; Vysna, V.; Guigoz, Y.; Ray, N.; Dickie, I. Modelling accessibility to urban green areas using open earth observations data: A novel approach to support the urban sdg in four european cities. *Remote Sens.* **2021**, *13*, 422. [CrossRef]
27. Bosch, M.; Jaligot, R.; Chenal, J. Spatiotemporal patterns of urbanization in three swiss urban agglomerations: Insights from landscape metrics, growth modes and fractal analysis. *Landsc. Ecol.* **2020**, *35*, 879–891. [CrossRef]
28. Alcock, I.; White, M.P.; Lovell, R.; Higgins, S.L.; Osborne, N.J.; Husk, K.; Wheeler, B.W. What accounts for 'england's green and pleasant land'? A panel data analysis of mental health and land cover types in rural england. *Landsc. Urban Plan.* **2015**, *142*, 38–46. [CrossRef]
29. Powell, L.; Slater, S.; Chaloupka, F. The relationship between community physical activity settings and race, ethnicity and socioeconomic status. *Evid. Based Prev. Med.* **2004**, *1*, 135–144.
30. Wai, S.S. Urban Green Space Accessibility and Environmental Justice: A Gis—Based Analysis in the City of Phoenix, Arizon. Doctoral Dissertation, University of Southern California, Los Angeles, CA, USA, 2016; p. 89.
31. Suárez, M.; Barton, D.N.; Cimburova, Z.; Rusch, G.M.; Gómez-Baggethun, E.; Onaindia, M. Environmental justice and outdoor recreation opportunities: A spatially explicit assessment in oslo metropolitan area, norway. *Environ. Sci. Policy* **2020**, *108*, 133–143. [CrossRef]
32. WHO. *Urban Green Spaces: A Brief for Action*; UN City: Copenhagen, Denmark, 2017; p. 24.
33. Honold, J.; Lakes, T.; Beyer, R.; van der Meer, E. Restoration in urban spaces: Nature views from home, greenways, and public parks. *Environ. Behav.* **2015**, *48*, 796–825. [CrossRef]
34. Van Renterghem, T.; Botteldooren, D. View on outdoor vegetation reduces noise annoyance for dwellers near busy roads. *Landsc. Urban Plan.* **2016**, *148*, 203–215. [CrossRef]
35. Gascon, M.; Triguero-Mas, M.; Martínez, D.; Dadvand, P.; Forns, J.; Plasència, A.; Nieuwenhuijsen, M.J. Mental health benefits of long-term exposure to residential green and blue spaces: A systematic review. *Int. J. Environ. Res. Public Health* **2015**, *12*, 4354–4379. [CrossRef] [PubMed]
36. La Rosa, D.; Privitera, R. Characterization of non-urbanized areas for land-use planning of agricultural and green infrastructure in urban contexts. *Landsc. Urban Plan.* **2013**, *109*, 94–106. [CrossRef]
37. White, M.P.; Alcock, I.; Wheeler, B.W.; Depledge, M.H. Coastal proximity, health and well-being: Results from a longitudinal panel survey. *Health Place* **2010**, *23*, 97–103. [CrossRef] [PubMed]
38. Völker, S.; Kistemann, T. The impact of blue space on human health and well-being—Salutogenetic health effects of inland surface waters: A review. *Int. J. Hyg. Environ. Health* **2011**, *214*, 449–460. [CrossRef] [PubMed]
39. Geneva Botanical Garden. *Carte des Milieux Naturels*; SITG: Houston, TX, USA, 2020.
40. Direction de la Planification. *Espaces Verts*; SITG: Houston, TX, USA, 2020.
41. Chiesura, A. The role of urban parks for the sustainable city. *Landsc. Urban Plan.* **2004**, *68*, 129–138. [CrossRef]

42. Brink, M.; Schäffer, B.; Vienneau, D.; Foraster, M.; Pieren, R.; Eze, I.C.; Cajochen, C.; Probst-Hensch, N.; Röösli, M.; Wunderli, J.-M. A survey on exposure-response relationships for road, rail, and aircraft noise annoyance: Differences between continuous and intermittent noise. *Environ. Int.* **2019**, *125*, 277–290. [CrossRef]
43. Fields, J.M.; De Jong, R.G.; Gjestland, T.; Flindell, I.H.; Job, R.F.S.; Kurra, S.; Lercher, P.; Vallet, M.; Yano, T.; Guski, R.; et al. Standardized general-purpose noise reaction questions for community noise surveys: Research and a recommendation. *J. Sound Vib.* **2001**, *242*, 641–679. [CrossRef]
44. Swiss Federal Council. *Noise Abatement Ordinance*; Swiss Federal Council: Cham, Switzerland, 1986.
45. Öhrström, E.; Skånberg, A.; Svensson, H.; Gidlöf-Gunnarsson, A. Effects of road traffic noise and the benefit of access to quietness. *J. Sound Vib.* **2006**, *295*, 40–59. [CrossRef]
46. MNilsson, E.; Berglund, B. Soundscape quality in suburban green areas and city parks. *Acta Acust. United Acust.* **2006**, *92*, 903–911.
47. European Commission. *Position Paper on eu Noise Indicators*; European Commission: Brussels, Belgium, 2000; p. 75.
48. sonBASE Ofev. *Daytime Road and Railway Traffic Noise Exposure*; Open Data Swiss: Neuchâtel, Switzerland, 2015.
49. Genève-Aéroport. *Courbes D'exposition au Bruit des Aéronefs*; SITG: Houston, TX, USA, 2020.
50. Wüstemann, H.; Kalisch, D.; Kolbe, J. Access to urban green space and environmental inequalities in germany. *Landsc. Urban Plan.* **2017**, *164*, 124–131. [CrossRef]
51. Biernacka, M.; Kronenberg, J. Classification of institutional barriers affecting the availability, accessibility and attractiveness of urban green spaces. *Urban For. Urban Green.* **2018**, *36*, 22–33. [CrossRef]
52. Wolff, M.; Scheuer, S.; Haase, D. Looking beyond boundaries: Revisiting the rural-urban interface of green space accessibility in europe. *Ecol. Indic.* **2020**, *113*, 106245. [CrossRef]
53. Higgs, G.; Fry, R.; Langford, M. Investigating the implications of using alternative gis-based techniques to measure accessibility to green space. *Environ. Plan. B Plan. Des.* **2012**, *39*, 326–343. [CrossRef]
54. Neutens, T.; Schwanen, T.; Witlox, F.; De Maeyer, P. Equity of urban service delivery: A comparison of different accessibility measures. *Environ. Plan. A Econ. Space* **2010**, *42*, 1613–1635. [CrossRef]
55. Nicholls, S.; Shafer, C. Measuring accessibility and equity in a local park system: The utility of geospatial technologies to park and recreation professionals. *J. Park Recreat. Adm.* **2001**, *19*, 102–124.
56. Tang, B.-S.; Wong, K.K.H.; Tang, K.S.S.; Wong, S.W. Walking accessibility to neighbourhood open space in a multi-level urban environment of hong kong. *Environ. Plan. B Urban Anal. City Sci.* **2020**, *48*, 1340–1356. [CrossRef]
57. Pafi, M.; Siragusa, A.; Ferri, S.; Halkia, M. *Measuring the Accessibility of Urban Green Areas: A Comparison of the Green Esm with Other Datasets in Four European Cities*; JRC Science Hub: Luxembourg, 2016; p. 40.
58. Office Cantonal de la Statistique. *Statistique Cantonale de la Population*; SITG: Houston, TX, USA, 2020.
59. *Swisstlm 3D*; Version 1.8; Swisstopo: Bern, Switzerlands, 2020.
60. Sander, H.A.; Ghosh, D.; van Riper, D.; Manson, S.M. How do you measure distance in spatial models? An example using open-space valuation. *Environ. Plan. B Plan. Des.* **2010**, *37*, 874–894. [CrossRef]
61. Centre Analyse Territoriale des Inégalités à Genève. *Analyse des Inégalités Dans le Canton de Genève*; HES SO, IREG; Université de Genève: Geneva, Switzerland, 2020; p. 114.
62. Kabisch, N.; Strohbach, M.; Haase, D.; Kronenberg, J. Urban green space availability in european cities. *Ecol. Indic.* **2016**, *70*, 586–596. [CrossRef]
63. Badiu, D.L.; Iojă, C.I.; Pătroescu, M.; Breuste, J.; Artmann, M.; Ni, M.R.; Grădinaru, S.R.; Hossu, C.A.; Onose, D.A. Is urban green space per capita a valuable target to achieve cities' sustainability goals? Romania as a case study. *Ecol. Indic.* **2016**, *70*, 53–66. [CrossRef]
64. van den Bosch, M.A.; Mudu, P.; Uscila, V.; Barrdahl, M.; Kulinkina, A.; Staatsen, B.; Swart, W.; Kruize, H.; Zurlyte, I.; Egorov, A.I. Development of an urban green space indicator and the public health rationale. *Scand. J. Public Health* **2015**, *44*, 159–167. [CrossRef] [PubMed]
65. Coombes, E.; Jones, A.P.; Hillsdon, M. The relationship of physical activity and overweight to objectively measured green space accessibility and use. *Soc. Sci. Med.* **2010**, *70*, 816–822. [CrossRef] [PubMed]
66. Siljeg, S.; Maric, I.; Nikolj, G.; Siljeg, A. Accessibility analysis of urban green spaces in the settlement of zadar in croatia. *Sumar. List.* **2018**, *142*, 487–496.
67. Nieuwenhuijsen, M.J.; Dadvand, P.; Márquez, S.; Bartoll, X.; Barboza, E.P.; Cirach, M.; Borrell, C.; Zijlema, W.L. The evaluation of the 3–30-300 green space rule and mental health. *Environ. Res.* **2022**, *215*, 114387. [CrossRef] [PubMed]
68. Natural England. *Nature Nearby, Accessible Natural Greenspace Guidance*; Natural England: Peterborough, UK, 2010; p. 98.
69. IUCN. *The Iucn Urban Nature Index: A Tool for Measuring the Ecological Performance of Cities*; IUCN: Cambridge, UK, 2022; p. 32.
70. Patricios, N. Urban design principles of the original neighbourhood concepts. *Urban Morphol.* **2002**, *6*, 21–32. [CrossRef]
71. Pozoukidou, G.; Chatziyiannaki, Z. 15-minute city: Decomposing the new urban planning eutopia. *Sustainability* **2021**, *13*, 928. [CrossRef]
72. Defra. *Survey of Public Attitudes to Quality of Life and to the Environment—2001*; Defra: London, UK, 2002.
73. Watts, G.; Miah, A.; Pheasant, R. Tranquillity and soundscapes in urban green spaces—Predicted and actual assessments from a questionnaire survey. *Environ. Plan. B Plan. Des.* **2013**, *40*, 170–181. [CrossRef]

74. Coeterier, B.d. *Ruimte, Rust, en Stilte, Beleving Door Burgers en Indicaties Voorbeheer en Beleid*; Alterra Report No. 423; Alterra: Wageningen, The Netherlands, 2001; p. 78.
75. Pheasant, R.; Horoshenkov, K.; Watts, G.; Barrett, B. The acoustic and visual factors influencing the construction of tranquil space in urban and rural environments tranquil spaces-quiet places? *J. Acoust. Soc. Am.* **2008**, *123*, 1446–1457. [CrossRef]
76. Uebel, K.; Marselle, M.; Dean, A.J.; Rhodes, J.R.; Bonn, A. Urban green space soundscapes and their perceived restorativeness. *People Nat.* **2021**, *3*, 756–769. [CrossRef]
77. Tsaligopoulos, A.; Kyvelou, S.; Votsi, N.-E.; Karapostoli, A.; Economou, C.; Matsinos, Y.G. Revisiting the concept of quietness in the urban environment—Towards ecosystems' health and human well-being. *Int. J. Environ. Res. Public Health* **2021**, *18*, 3151. [CrossRef]
78. Conseil Fédéral. *Plan National de Mesures Pour Diminuer les Nuisances Sonores*; Conseil Fédéral: Chêne-Bougeries, Switzerlands, 2017; p. 40.
79. Hegetschweiler, K.T.; de Vries, S.; Arnberger, A.; Bell, S.; Brennan, M.; Siter, N.; Olafsson, A.S.; Voigt, A.; Hunziker, M. Linking demand and supply factors in identifying cultural ecosystem services of urban green infrastructures: A review of european studies. *Urban For. Urban Green.* **2017**, *21*, 48–59. [CrossRef]
80. Wu, J.; He, Q.; Chen, Y.; Lin, J.; Wang, S. Dismantling the fence for social justice? Evidence based on the inequity of urban green space accessibility in the central urban area of beijing. *Environ. Plan. B Urban Anal. City Sci.* **2020**, *47*, 626–644. [CrossRef]
81. Derkzen, M.L.; van Teeffelen, A.J.A.; Verburg, P.H. Green infrastructure for urban climate adaptation: How do residents' views on climate impacts and green infrastructure shape adaptation preferences? *Landsc. Urban Plan.* **2017**, *157*, 106–130. [CrossRef]
82. Emmelin, L.; Fredman, P.; Sandell, K.; Jensen, E.L. *Planera för Friluftsliv: Natur Samhälle Upplevelser*; Carlsson Bokförlag: Stockholm, Sweden, 2010.
83. Fish, R.; Church, A.; Winter, M. Conceptualising cultural ecosystem services: A novel framework for research and critical engagement. *Ecosyst. Serv.* **2016**, *21*, 208–217. [CrossRef]
84. Koppen, G.; Sang, Å.O.; Tveit, M.S. Managing the potential for outdoor recreation: Adequate mapping and measuring of accessibility to urban recreational landscapes. *Urban For. Urban Green.* **2014**, *13*, 71–83. [CrossRef]
85. Taylor, L.; Hochuli, D.F. Defining greenspace: Multiple uses across multiple disciplines. *Landsc. Urban Plan.* **2017**, *158*, 25–38. [CrossRef]
86. Reyes, M.; Páez, A.; Morency, C. Walking accessibility to urban parks by children: A case study of montreal. *Landsc. Urban Plan.* **2014**, *125*, 38–47. [CrossRef]
87. Zhu, Z.; Lang, W.; Tao, X.; Feng, J.; Liu, K. Exploring the quality of urban green spaces based on urban neighborhood green index—A case study of guangzhou city. *Sustainability* **2019**, *11*, 5507. [CrossRef]
88. Laatikainen, T.; Tenkanen, H.; Kyttä, M.; Toivonen, T. Comparing conventional and ppgis approaches in measuring equality of access to urban aquatic environments. *Landsc. Urban Plan.* **2015**, *144*, 22–33. [CrossRef]
89. Kiplagat, A.K.; Koech, J.K.; Ng'etich, J.K.; Lagat, M.J.; Khazenzi, J.A.; Odhiambo, K.O. Urban green space characteristics, visitation patterns and influence of visitors' socio-economic attributes on visitation in kisumu city and eldoret municipality, kenya. *Trees For. People* **2022**, *7*, 100175. [CrossRef]
90. Van Herzele, A.; Wiedemann, T. A monitoring tool for the provision of accessible and attractive urban green spaces. *Landsc. Urban Plan.* **2003**, *63*, 109–126. [CrossRef]
91. Hamilton, K. Park Usage and Physical Activity: An Exploration of Park Features, Neighbourhoods, and Park Programs. Doctoral Dissertation, Queen's University, Kingston, ON, Canada, 2011.
92. Colesca, S.E.; Alpopi, C. The quality of bucharest's green spaces. *Theor. Empir. Res. Urban Manag.* **2011**, *6*, 45–59.
93. Wheeler, B.W.; Lovell, R.; Higgins, S.L.; White, M.P.; Alcock, I.; Osborne, N.J.; Husk, K.; Sabel, C.E.; Depledge, M.H. Beyond greenspace: An ecological study of population general health and indicators of natural environment type and quality. *Int. J. Health Geogr.* **2015**, *14*, 17. [CrossRef] [PubMed]
94. Votsi, N.-E.P.; Mazaris, A.D.; Kallimanis, A.S.; Drakou, E.G.; Pantis, J.D. Landscape structure and diseases profile: Associating land use type composition with disease distribution. *Int. J. Environ. Health Res.* **2014**, *24*, 176–187. [CrossRef]
95. Wang, D.; Brown, G.; Liu, Y.; Mateo-Babiano, I. A comparison of perceived and geographic access to predict urban park use. *Cities* **2015**, *42*, 85–96. [CrossRef]
96. Salonen, M.; Broberg, A.; Kyttä, M.; Toivonen, T. Do suburban residents prefer the fastest or low-carbon travel modes? Combining public participation gis and multimodal travel time analysis for daily mobility research. *Appl. Geogr.* **2014**, *53*, 438–448. [CrossRef]
97. Voigt, A.; Kabisch, N.; Wurster, D.; Haase, D.; Breuste, J. Structural diversity: A multi-dimensional approach to assess recreational services in urban parks. *Ambio* **2014**, *43*, 480–491. [CrossRef]
98. Grün Stadt Zürich. *Die Freiraumversorgung der Stadt Zürich Und Ihre Berechnung Methodenbeschrieb Und Anwendung*; Grün Stadt Zürich: Zurich, Switzerland, 2019; p. 57.