



FORUM ACUSTICUM EURONOISE 2025

CHARACTERISTICS DETERMINING THE ATTRACTIVENESS OF URBAN GREEN SPACES: INSIGHTS FROM THE RESTORE PROJECT

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ABSTRACT

Literature provides strong evidence that nature can potentially alleviate negative mental as well as physiological health effects of excessive traffic noise exposure. As green spaces (GSs) not only help mitigating negative noise impact, but also improve public health in general, GS planning has become an important task for cities. We conducted a field study in the city of Zurich, Switzerland, to investigate which characteristics of GSs determine their attractiveness. In three waves in the summer periods of 2022 and 2023, 1,129 participants filled out an online questionnaire that included a participatory geographical information system approach to specify and characterize their most visited GS. Interestingly, while the distance to the nearest GS was important for how frequently residents visited GSs spaces, 64% of the participants still did not indicate their closest GS as their most visited one. We found that large GSs, which in general exhibit lower traffic noise exposure, attract more visitors than small ones. Water bodies were also identified as attractive.

Our study highlights the relevance of these features for city planners and urbanists when planning, designing and/or maintaining urban GSs.

Keywords: *green space, urban planning, attractiveness, visits, traffic noise*

1. INTRODUCTION

Urban areas are continuously expanding. As urbanization increases, permanent noise-related activities within these areas also rise. In Europe, a large proportion of the population in urban areas is currently exposed to harmful environmental noise, particularly from road traffic [1]. With rising demand of mobility, exposure of the population and corresponding undesirable health outcomes are likely to aggravate. Environmental resources, specifically green spaces (GSs), have been identified as potential elements to alleviate the adverse noise-induced health impacts. However, urban densification not only entails an increase in noise pollution, but usually also a loss of GSs.

One of the goals of the RESTORE project (Restorative potential of green spaces in noise polluted environments; www.restore-project.ch) was to determine how frequently GSs are used and what features make them attractive.

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2. METHODS

The concept and methodology of the survey (i.e., noise and green exposure assessment, stratification to identify study areas, participant selection and inclusion/exclusion criteria, recruitment, etc.) follows the study protocol by Dopico et al. [2]. In the following, we give a short methodological overview of this cross-sectional study.

The survey was conducted in a stratified population sample across the municipality of the city of Zurich, Switzerland, according to varying levels of road traffic noise exposure and the degree of access to GSs at home.

The city of Zurich has 139 publicly accessible GSs. All GSs were characterized by size, modelled road traffic noise exposure, type (i.e., bathing area, botanic garden, cemetery, meadow, miscellaneous, playground, sports complex, urban forest and urban park) and the presence of natural water bodies (stream, river or lake: with vs. without). In addition, 156 audio and video recordings of five minutes length were taken in 48 GSs close to the sampling areas, to characterize landscape and soundscape in more detail.

A total of 7,368 potential participants were randomly selected within the stratified sample and contacted with an invitation letter, followed by a reminder letter in case of no response by the specified deadline, in three waves in the summer periods of 2022 and 2023.

The participants filled in an online survey in German covering, among others, questions about noise annoyance and leisure time activities, where participants were asked about the main reason for GS visits. In addition, they were asked to pinpoint a location in their most visited GS on a map. The participants were also presented the ISO 12913-2 soundscape assessment scale [3], to retrospectively describe the soundscape in their most visited GS. The soundscape variables Pleasantness and Eventfulness were derived according to ISO 12913-3 [4].

Each participant was assigned an anonymized identification number, and a building code was linked to each identification number, enabling the merging of survey and geospatial data, which were extracted from public sources. Data from public sources comprised (i) modelled road traffic noise exposure data (L_{den}) across the city of Zurich for façade points of all buildings for the year 2020 to quantify the noise situation at home, (ii) road traffic noise exposure data for the day (L_{day}) from sonBASE, the Swiss-wide noise data base, for the year 2015 to quantify the noise exposure of the GSs, (iii) location (as polygons) and properties of public GSs, and (iv), quantification of greenness around participant's dwellings (within a 300 m euclidean buffer) with the mean value of the satellite-derived Normalized Difference Vegetation Index (NDVI).

A total of 1,129 participants across Zurich took part in the online survey (response rate of 15.3%). From those, 282 participants were excluded due to wrong or missing indication of their preferred GSs location or due to missing data (either L_{den} or questionnaire data). The final sample comprised 847 participants. Figure 1 shows a density heat map of the home locations of the study participants, as well as the locations of publicly accessible GSs and water bodies.

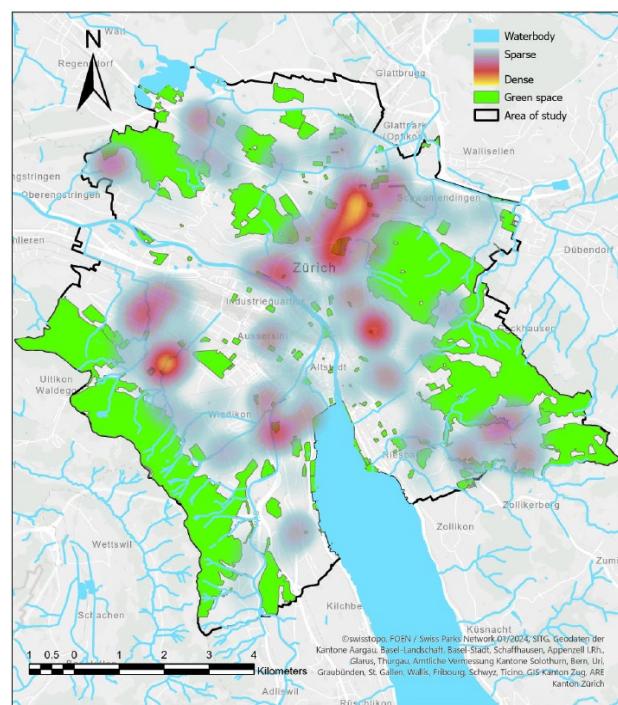


Figure 1. Density heat map of the city of Zurich showing the home locations of the study participants.

Two outcome variables were explored by means of negative binomial regression models analysis:

- a) The **frequency of visits**, which reflects the individual perspective and is based on the question how often participants visit their most frequented GS.
- b) The **number of visitors of a specific GS**, which serves as an indicator of attractiveness by reflecting the number of visits a GS generates.

As predictor variables, the characteristics of the home environment (L_{den} , NDVI, gardens), individual factors (noise annoyance, perceived free time) as well as GS characteristics (L_{day} , size, water bodies, soundscape variables Eventfulness and Pleasantness) were explored.





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3. RESULTS

A share of 68% of the participants reported to visit their most frequented GS at least once a week, confirming the importance of public GSs in their daily routine. Urban forests and parks as well as GSs close to water bodies were visited very frequently and seem to be specifically attractive. Interestingly, 64% of the participants did not indicate their closest GS as their most visited one. In total, 91 GSs were selected by the participants, while 48 GSs remained unvisited in this study. An explorative analysis comparing the properties of visited vs. non-visited GSs showed that visited GSs tended to be substantially larger than the non-visited ones. In addition, visited GSs had considerably lower noise exposure, with a median L_{day} of 44 dBA and of 57 dBA for visited compared to non-visited GSs, respectively. This raises the question which factor is more relevant for people to visit a GS; low noise exposure or the size of the GS.

The statistical analysis revealed the following associations: The individuals' frequency of visits to GSs significantly increased with (i) increasing greenness (NDVI) at home, (ii) increasing road traffic noise annoyance at home (particularly for females), (iii) increasing perceived free time (particularly for males), (iv) decreasing distance from home to the most visited GSs, and (v) increasing individually perceived eventfulness of the GS's soundscape. The finding about the soundscape variables should be interpreted with caution. All GSs exhibited neutral to pleasant and medium eventful soundscapes. The fact that pleasantness did not show any significant associations might be attributable to the small variability of pleasantness scores in the dataset. On the other hand, the positive association with eventfulness could be a coincidence, as the sound recordings revealed that positively connotated events like bird song or human voices were present in some locations, while in others negatively connotated events like individual vehicle pass-bys dominated.

The attractiveness of urban GSs, as measured by the number of visitors (our study sample only), was found to increase with (i) increasing size, and (ii) when water bodies are present. Here, one should note that size and noise exposure were negatively correlated, i.e., the importance of (large) size indicates also the importance of (low) road traffic noise exposure.

4. CONCLUSION

This cross-sectional study investigated the determinants for the frequency of GS visits in an urban environment in the municipality of Zurich, Switzerland. It also assessed the

attractiveness of GS by the number of visitors they received from the study sample. The size of GSs and the presence of water bodies emerged as the main attributes to attract visitors. The visited GSs were generally also rather quiet. Our study highlights the relevance of these features for city planners and urbanists when planning, designing and/or maintaining urban GSs.

5. REFERENCES

- [1] European Environment Agency (EEA) (2020). Environmental noise in Europe — 2020. Luxembourg, Publications Office of the European Union. 2020.
- [2] Dopico, J., Schäffer, B., Brink, M., Röösli, M., Vienneau, D., Binz, T. M., Wunderli, J. M.: "How do road traffic noise and residential greenness correlate with noise annoyance and long-term stress? Protocol and pilot study for a large field survey with a cross-sectional design." *International Journal of Environmental Research and Public Health*, 20(4), 3203 (2023).
- [3] ISO/TS 12913-2. "Acoustics—Soundscape—Part 2: Data collection and reporting requirements." International Organisation for Standardization. (2018)
- [4] ISO/TS 12913-3:2019, "Acoustics—Soundscape—Part 3: Data analysis." International Organization for Standardization. (2019)

