# Greener and quieter: a Swiss participatory mapping study on the choice of places for everyday restoration

Natalia Kolecka1, Lukas Graz2, María García-Martín1, Christian Ginzler1, Silvia Tobias1

**Affiliations:** *Please check your affiliations!*

1 WSL, Swiss Federal Research Institute, Land Change Science Research Unit, Birmensdorf, Switzerland

2 ETH Zürich, Seminar for Statistics, Switzerland

**ORCIDs:** *Please check your ORCIDs!*

Natalia Kolecka: 0000-0001-6143-0870

Lukas Graz: [0009-0003-5147-8370](https://orcid.org/0009-0003-5147-8370)

María García-Martín: [0000-0003-4616-3844](javascript:popup_orcidDetail('https://orcid.org'%20,'0000-0003-4616-3844');)

Christian Ginzler: [0000-0001-6365-2151](https://orcid.org/0000-0001-6365-2151)

Silvia Tobias: 0000-0002-7865-005X

**\*Corresponding author:**

Natalia? Silvia?

**Highlights**

* Places chosen for everyday outdoor recreation are usually greener and quieter than home locations.
* People living at noisy places are disadvantaged in terms of quiet restorative places.
* Higher traffic noise levels impair perceived soundscape quality and restorativeness.
* We recommend a limit of Lday < 55dB for anthropogenic noise in recreational green spaces.

# Greener and quieter: a Swiss participatory mapping study on the choice of places for everyday restoration

## Abstract

Urban areas continuously grow in population and mobility leading to increased noise exposure of the residents. Public green spaces within and around the settlements, therefore, become increasingly important for everyday restoration. We conducted a PP-GIS survey among the Swiss population in which the respondents mapped the place of their most recent outdoor recreational activity and described the perceived restorativeness, feeling of being in nature, and soundscape quality. We assessed greenness (NDVI), land cover and road traffic noise level at the respondents’ restorative places and home locations. . Exploratory data analysis revealed that people usually choose greener and quieter places than their homes for restoration. However, the restorative locations of people living at noisy places were the least quiet and covered with artificial surfaces up to 17%. Road traffic noise impaired self-reported soundscape quality and perceived restorativeness of the mapped places, whereas our results confirm the upper limit of 55 dB (Lday) for quiet areas suggested by the European Environment Agency. Using out-of-sample prediction of machine learning methods (linear regression, random forest, XGBoost), we explained up to 25% of the variance in perceived restorativeness by questionnaire results. Whereas the geodata variables had little predictive performance on perceived restorativeness of a place, additional regression analysis showed that some were significantly correlated with the mediators feeling of being in nature (NDVI) and soundscape quality (road traffic noise level). Urban planners are challenged to preserve green and quiet areas and design green spaces as sanctuaries from noise to provide restorative environments for the population.

**Keywords** *any other suggestions that are* ***not*** *given in the title or abstract?*

restorative environments; quiet areas; road traffic noise; soundscape; GIS-based analysis

## 1. Introduction

In today’s increasingly urbanized world, stress and mental fatigue are pervasive challenges to public health and well-being. Urban environments—marked by noise, pollution, and limited natural elements—can worsen stress, reduce quality of life, and impair cognitive function (Bell, 2010; EEA, 2010; Schlittmeier, Feil, Liebl, & Hellbrück, 2015). Traffic and industrial noise increase stress levels, lead to noise annoyance or sleep disturbance (Basner & McGuire, 2018), and thus promote risk factors such as high blood pressure and cardiovascular diseases, or even mortality (Babisch, 2002). In contrast, the presence of green spaces and natural environments such as parks, urban forests, and vegetated areas, can mitigate the negative effects of traffic noise through physical (Schäffer, Brink, Schlatter, Vienneau, & Wunderli, 2020; Van Renterghem, 2019) and psychological (Hartig, 2004; Hartig, Evans, Jamner, Davis, & Gärling, 2003) effects. Vegetation, especially dense shrubs and trees, provide physical separation from traffic and can absorb and scatter sound waves, leading to a reduction in noise levels by up to 10 dB (Ow & Ghosh, 2017). Moreover, even in areas with high traffic noise, exposure to green spaces reduces annoyance caused by traffic noise and is associated with lower levels of perceived stress, better mental health and well-being, enhanced restoration experience, and improved residents' overall satisfaction with their living environment (Dzhambov et al., 2018; Palliwoda, Banzhaf, & Priess, 2020).

Since a considerable share of the European population is exposed to environmental noise, researchers and policy makers have increasingly focused on the preservation of quiet places. In its “good practice guide on quiet areas” (EEA, 2014) the European Environment Agency provides criteria and thresholds to define a quietness suitability index (QSI) for specific areas inside and outside urban areas. It further provides thresholds for acoustic parameters of quiet areas in urban and open country settings. However, noise pressure level is not the only parameter influencing perceived restorativeness. The type of sound matters as well. Various studies revealed in VR experiments and qualitative interviews that natural sounds foster restoration and anthropogenic sounds impede it (e.g. Kawai et al., 2024; Uebel et al., 2021; Ratcliff et al., 2013). Various models have been developed to describe perceived soundscapes of urban settings by means of psychoacoustic characteristics, such as roughness, sharpness, fluctuation, tonality (Axelsson et al., 2010; Farina and Pieretti, 2012; Torija et al., 2013; Farina, 2014; Aletta and Kang, 2018). Soundscape experts standardised the methodology of soundscape assessment for practical applications in urban planning (Fiebig and Schulte-Fortkamp, 2019). This resulted in the technical standard ISO TS 12913 published in 2014 (part 1), 2018 (part 2) and 2019 (part 3). This standard defines a scale to assess soundscape quality with interviews or questionnaires.

Green spaces and natural environments, frequently dominated by natural features such as vegetation, water, and diverse landforms, provide opportunities for restoration as theorized by frameworks such as the Stress Recovery Theory (SRT) and the Attention Restoration Theory (ART) formulated by (Ulrich et al., 1991) and (R. Kaplan & Kaplan, 1989), respectively. The SRT posits that exposure to natural environments leads to a reduction in physiological and psychological stress, marked by decreased blood pressure, heart rate, and cortisol levels, alongside improved mood and mental well-being (Ulrich et al., 1991). The ART specifies four main factors to identify restorative environments: fascination, being-away, extent, and compatibility. Fascination, defined as an effortless attention towards the environment, is a central component of a restorative experience. The three remaining components are integral to what makes an environment restorative: distance from problems and daily concerns; richness, space and coherence; and match between a person’s needs and expectations and the environment (S. Kaplan, 1995, 2001). Based on the ART, Pheasant et al. (R. Pheasant, Horoshenkov, Watts, & Barrett, 2008; R. J. Pheasant, Watts, & Horoshenkov, 2009) developed a concept of “tranquil places”, that is areas where natural sounds dominate over artificial noise, and featuring unspoiled, visually calming landscapes. Their studies highlight the balance between soundscapes and visual aesthetics, emphasizing that tranquillity arises from both sensory harmony and the absence of disruptive, human-made elements.

The widely used tools for evaluating how individuals experience restorative environments are the Perceived Restorativeness Scale (PRS) and the Restoration Outcome Scale (ROS). PRS assesses an environment’s capacity to provide a sense of being away, fascination, coherence, and compatibility, while ROS captures psychological recovery outcomes, such as reduced stress and increased positive affect (Song et al., 2022; Tyrväinen et al., 2014). These subjective assessments are likely to vary due to the persons’ individual characteristics, such as attitude towards nature, stress in every-day life or noise sensitivity (for example, (García-Martín et al., 2025; Kadmon & Harari-Kremer, 1992; Ojala, Korpela, Tyrväinen, Tiittanen, & Lanki, 2019). However, there is also some evidence that restorative outcomes vary due to the physical characteristics of a place (Hartig, Mitchell, De Vries, & Frumkin, 2014; Holland et al., 2021). Studies consistently report that green spaces, such as extensively managed nature areas, forests, urban parks, waterside environments, and exercise and hobby areas, are strongly associated with higher PRS and ROS scores (Huang, Qi, Li, Dong, & van den Bosch, 2021; Korpela, Ylén, Tyrväinen, & Silvennoinen, 2008, 2010; Ojala et al., 2019; Simkin, Ojala, & Tyrväinen, 2020; Song et al., 2022; Tyrväinen et al., 2014), and that attributes like abundance of vegetation, varied topography, proximity to water, and absence of roadways, play a key role in the restoration process (De Valck et al., 2017). In this study, we are interested in the restorative characteristics of a place rather than the restorative effects of the place on people. Therefore, we use the PRS in our analyses, not the ROS.

Despite the strong evidence of the positive effect of green spaces and the negative effects of traffic noise on health (Arregi et al., 2024; Hegewald et al., 2020; Markevych et al., 2017), significant gaps remain in understanding the environmental attributes that drive restorative experiences. First, much of the existing research on restorative locations used approaches that are not sufficient to capture the thematical and spatial variability of urban and natural environments. Some rely on restoration assessment of landscapes presented in images including virtual reality (VR) (Kang & Kim, 2019; Li, Yuan, Sun, & Sun, 2022), and fail to account for the real experience while visiting such a place. Others investigate self-reported restorativeness of general land use types: natural, urban, and urban green settings (Hartig, Korpela, Evans, & Gärling, 1997; Korpela et al., 2008, 2010; Tyrväinen et al., 2014; Weber & Trojan, 2018), or investigate a specific type of green spaces, for example forests (Simkin et al., 2020). The settings are often characterized descriptively by survey respondents or by researchers. The studies which describe landscape features based on geodata, largely rely on Normalized Difference Vegetation Index (NDVI) to quantify greenness (Holland et al., 2021; Reyes-Riveros et al., 2021), while only a few take into account more physical and spatial variables (Komossa, van der Zanden, Schulp, & Verburg, 2018; Lehto, Hedblom, Öckinger, & Ranius, 2022). The advent of detailed topographic and remote sensing data offers unprecedented opportunities to adequately quantify the fine-grained biophysical landscape characteristics.

Another critical gap concerns the role of soundscape. High levels of noise, particularly in urban environments, disrupt cognitive functioning and hinder stress recovery, leading to lower PRS scores (Alvarsson, Wiens, & Nilsson, 2010; Yin, Bratman, Browning, Spengler, & Olvera-Alvarez, 2022). Quieter settings are more likely to be assessed as “tranquil”, and thus suitable for relaxation (Watts & Pheasant, 2015). However, as natural features, such as vegetation and diverse landforms, can buffer these effects by acting as visual and auditory barriers (Ow & Ghosh, 2017; Aletta et al., 2018), it is unclear how far visual and/or acoustical properties determine restorativeness of a place.

This study examined everyday restoration patterns of inhabitants of Switzerland and the relationships between PRS and detailed environmental attributes derived from geodata. It was driven by the following three questions: (1) What are the environmental characteristics of places selected for everyday restoration? (2) How restorative are these places perceived and what role does the soundscape play? and (3) how well can the restorativeness of a particular place be predicted with its physical characteristics? It further investigated whether these questions were answered differently according to people’s noise exposure at home, i.e. for people living at loud vs. quiet places. For simplicity reasons, we use the expression “green space” in the manuscript, though we include any (semi)natural area which people may visit for recreation (urban parks, forests, shores of water bodies, agricultural land etc.).

## 2. Methods and materials

This study was based on a country-wide participatory mapping survey conducted among Swiss residents. The survey participants were asked about the perceived restorativeness of the place of their last outdoor activity and its geographical location. The responses were integrated with the quantitative spatial information (biophysical landscape characteristics, referred to as metrics) on the visited locations, obtained from GIS and remote sensing data (referred to as geodata), and subsequently analysed to investigate the relations between the objective (geodata-based) features of a place and their perceived (subjective) restorativeness.

### 2.1 Study area

Switzerland is an Alpine country with almost 9 million inhabitants whereas 75% live in the lowlands in urban and periurban areas of population density of 440 inhabitants per km2. According to the Federal Office for the Environment (BAFU, 2018b), about 1.1 million inhabitants are exposed to day-time traffic noise levels above the tolerable limits according to the Federal Ordinance of Noise Abatement, which is e.g. 60 dB (Lday) for pure residential areas. At the same time, people in Switzerland are aware of the importance of outdoor physical activity for both body and mind; spending time in the nature and doing outdoor sports is for many part of a lifestyle (Bundesamt für Sport BASPO, 2020). For many Swiss residents living in (suburban) villages or small towns, the usual recreational areas are forests, agricultural land and the shores of water bodies, rather than urban parks in city centres.

### 2.2 Data collection and preparation

Data was collected via an online participatory mapping survey targeting residents of urban, peri-urban, and rural areas across Switzerland. Respondents were selected using a stratified random sampling method, considering the greenness and noise exposure of their home locations, as well as age, gender, and language region. To maintain a focus on road traffic noise, individuals exposed to high levels of aircraft and railway noise at home were excluded from the survey.

The survey was conducted using Maptionnaire (<https://maptionnaire.com>), a community engagement map-based online platform, which enables map-based and traditional surveys. Participants were asked to map the location of their outdoor activity (referred to as restorative locations, RLs), describe the type and duration of the activity, indicate the perceived restorativeness of the place, and report the subjective experience during the visit at that location, as well as to indicate the reasons why they chose the particular location and how often they go there (García-Martín and Tobias, 2025).We inquired about the most recent outdoor restorative location, instead of the favourite or the most frequently visited place as other authors, e.g., (Hartig et al., 1997; Korpela et al., 2008; Tyrväinen et al., 2014), in order to prevent bias towards "high-quality" environments.

Two survey campaigns were conducted in spring and summer 2022. Each addressed 10,000 inhabitants of Switzerland, and the total response rate was 14% (2850 persons filled in the survey). From the resulting database, we excluded records with missing information, and records if respondents (1) reported wearing headphones during the outdoor activity, (2) reported activity duration of more than 2 hours, or (3) indicated a restorative place farther away than 33 km from home, as beyond everyday recreation. The thresholds for criteria (2) and (3) equalled to 90th percentile of the given values. The cleaned database contained 1494 records.

To check for differences according to noise exposure, we split the survey respondents in three groups (referred to as noise groups) based on the noise exposure at home (HM) (details on the noise exposure assessment are explained in section 2.4.1). The groups were defined according to the sound-pressure levels (Lday) related to perceived acoustic quality given in the EEA Technical report ”Good practice guide on quiet areas” (EEA, 2014: p. 9): Lday < 45 dB, where >90 % of visitors perceive acoustic quality as good, 45 dB < Lday < 55 dB, where 50 to 90 % of visitors perceive acoustic quality as good, and Lday > 55 dB, where the percentage of visitors perceiving acoustic quality as good is falling rapidly with rising sound-pressure levels. We further refer to these groups of respondents as N1, N2, N3, and assume that they were exposed to low, moderate, and high sounds levels, respectively. The groups included N1: 642 (44% of total), N2: 468 (32%), and N3: 354 (24%) respondents.

### 2.3 Perceived restorativeness and soundscape assessment

We used a self-reported scale to measure the perceived restorativeness of the place, where Swiss inhabitants performed an outdoor activity, i.e. the PRS-11 developed by (Pasini, Berto, Brondino, Hall, & Ortner, 2014), which is a short form of PRS (Hartig et al., 1997). The PRS-11 consists of 11 items in 4 groups: fascination, being away, coherence, and scope, which were judged on a 7-point Likert scale.

We asked how strongly different types of sound dominated at the restorative places (natural, human, traffic, other technical sounds) and assessed noise annoyance by these sound sources with the 11-point scale ISO/TS15666 (ISO, 2003). The respondents were asked to assess the soundscape quality at the restorative locations on a 5-point scale according to ISO/TS12913-2 (ISO, 2019).

In parallel, we defined two variables describing the subjective experience during the restorative visit: (1) feeling of being in nature (FEELNAT), and (2) the perceived overall soundscape quality (LNOISE). The respondents judged FEELNAT on a 7-point Likert scale, where 1 = strongly disagree, and 7 = strongly agree, and LNOISE on a 5-point scale, where 1 = strongly disagree / very bad, and 5 = strongly agree / very good. The list of variables and questions used for this study can be found in Table 1.

Table 1 Survey questions

|  |  |  |
| --- | --- | --- |
| Perceived restorativeness of the place (PRS-11 scale, (Pasini et al., 2014)) | This place is fascinating (FA) | 1 = strongly disagree  7 = strongly agree |
| In this place my attention is drawn to many interesting things (FA) |
| In this place It's hard to get bored (FA) |
| This place is a refuge from annoyance (BA) |
| In this place I can get away from things that normally occupy my attention (BA) |
| In this place I can stop thinking about the things I still have to do (BA) |
| There is a clear order of things in this place (EC) |
| In this place it is easy to see how things are organized (EC) |
| In this place everything seems to have its right place (EC) |
| This place is big enough to allow exploration in many directions (ES) |
| In this place there are few boundaries that restrict my movements (ES) |
| Sensory perceptions:  What did you notice at this place? | Sensations, such as wind in my hair, sunshine on my face | 1 = strongly disagree  5 = strongly agree |
| Sounds, such as twittering of birds, rustling of leaves |
| Scents and odours, e.g. from flowers or earth |
| Visual elements: colours, forms, structures, patterns of light and shadows |
| Vegetation and its changes, e.g. blooming flowers, colourful leaves of trees |
| Wild animals in their habitat |
| Feeling of being in nature (FEELNAT) | How true is the following statement for the place you indicated on the map? I had the feeling of being in nature at this place | 1 = strongly disagree  7 = strongly agree |
| General soundscape (LNOISE) | How would you describe the noise environment at the site in the map in general? | 1 = very bad  5 = very good |

### **2.4 Geodata and** Landscape metrics / Modelling variables

#### 2.4.1 Geodata

To account for greenness of a place, we used the Normalized Difference Vegetation Index (NDVI) map of Switzerland derived from the Sentinel-2 (S2) Level-1C (orthoimage, Top-Of-Atmosphere) satellite imagery (<https://sentinel.esa.int/web/sentinel/sentinel-data-access/sentinel-products>) accessed in Google Earth Engine (GEE, <https://earthengine.google.com>) platform, showing whether the investigated places contain green healthy vegetation or not. We limited the input images to those collected between 1 April and 31 October in the years 2019-2021 (leaf-on season and no-snow conditions) with cloud coverage not exceeding 30%, and applied additional cloud masking algorithms to ensure high quality.

To determine the noise exposure in the restorative locations (RL), data from the most recent edition (2015) of the Swiss noise database sonBASE were used (BAFU, 2018a). The 10 m spatial resolution raster represents the daytime road traffic noise level Leq(6–22h) (in dBA, referred to as Lday), i.e., the yearly averaged A-weighted equivalent continuous sound pressure level over 16 hours, from 6 a.m. to 10 p.m. For the noise exposures at the home locations (HM), we used the daytime road traffic noise level at the loudest point of the façades (maximum Leq(6–22h), i.e. maximum Lday, (dBA)) in the height of the dwellings’ floors. Both noise datasets were provided by the Federal Office for the Environment FOEN (Bundesamt für Umwelt BAFU).

To calculate the proportions of different land cover types and land cover heterogeneity in the surroundings of the RLs, we used the Land Cover Map of Europe 2017 (Malinowski et al., 2020). The 10 m spatial resolution raster was produced based on multi-temporal Sentinel-2 with accuracy of 86% and is composed of 13 land cover classes, such as artificial surfaces, broadleaf and coniferous tree cover, herbaceous vegetation, cultivated areas, and natural material surfaces. The dataset is freely available online (<https://s2glc.cbk.waw.pl/>).

#### 2.4.2 Geodata-based metrics / Modelling variables

We calculated the landscape metrics based on 2D geodata within 250 m buffers around the RLs to account for the PP-GIS mapping uncertainty. These data described the environmental characteristics related to land use and land cover, greenness (NDVI), vegetation height and structure, altitude and relief, road traffic noise levels, length of roads and railways, length of rivers, as well as the proportions of visible/not-visible area. We accounted for proximity from home to the respective RL expressed by the Euclidean distances calculated from their spatial locations, and the travel time as indicated in the survey. As precise home locations were known, we applied 50-meter buffer around home locations to calculate NDVI and included the exact values of the daytime road traffic noise level at the loudest point of the façades in the height of the dwellings’ floors (Table 2).

|  |  |
| --- | --- |
| Table 2 Landscape metrics used in this study. ‘\*' indicates if the square-root transformation was appliled for a given variable for the statiscial analyses in Section XXX(2.5).**Acronym** | **Explanation** |
| LCARTIF\* | proportion of artificial surfaces within 250 m buffer |
| LCFOREST\* | proportion of forest within 250 m buffer |
| HETER | land cover heterogeneity in 250 m buffer |
| OVDIST\* | distance to the nearest public transport stop |
| VIS5K\* | percentage of visible area within a radius of 5 km |
| RL\_NDVI | mean NDVI in 250 m buffer around RL |
| RL\_NOISE | mean road traffic noise in 250 m buffer around RL |
| HM\_NOISE | person’s noise exposure at home (facade) |
| DISTKM\* | Euclidean distance between home and RL |
| JNYTIME\* | travel time from home to RL (as indicated in the survey) |
| STRIMP123 | length of roads with high traffic intensity |
| STRIMP999\* | length of other roads (low traffic intensity) |
| HM\_NDVI | mean NDVI in 50 m buffer around HM |
| DIFNDVI | difference between NDVI at RL and NDVI at HM |
| DIFNOISE | difference between noise at RL and noise at HM |

### **2.5 Statistical analyses**

#### 2.5.1 Exploring environmental characteristics of restorative locations

To answer our research questions 1 (What are the environmental characteristics of places selected for everyday restoration?) and 2 (How restorative are these places perceived and what role does the soundscape play?), we assessed the geodata based metrics of the restorative locations (RL) with descriptive statistics. We initially explored the entire dataset to gather an overview of the RLs, the respondents’ living conditions and restoration patterns. Subsequently, to **emphasize the impact of traffic noise in housing conditions, the** analyses were performed separately for the survey respondents exposed to different noise levels at home (low, moderate, and high sound levels: Lday < 55 dB (N1), 45 dB < Lday < 55 dB (N2), Lday >= 55 dB (N3); cf. section 2.2).

Further, we investigated distributions of geodata-based metrics between the noise groups. We used a parametric ANOVA (Analysis of Variance) test for numerical, and two-way frequency tables for categorical metrics.

#### 2.5.2 Modelling perceived restorativeness

To answer our research question 3 (how well can the restorativeness of a particular place be predicted with its physical characteristics?) we used machine learning methods to assess how much information each of two disjoint sets of variables have on the dependent variable, how redundant this information is, and if there is a mediation path.

As illustrated in Figure 1, we predicted a) the feeling of being in nature (FEELNAT), sensations, and overall soundscape quality (LNOISE) with geodata, and the PRS outcomes with b) geodata only, c) feeling of being in nature, sensations, and overall soundscape quality only as mediators; d) geodata and mediators combined. Here, we briefly describe the procedure. For details see supplementary material XXX.



Fig. 1 Principle of our mediation analysis to predict the PRS outcomes.

**Data preparation** included transforming right-skewed GIS variables (c.f. Table2XXX). Missing values were imputed using MissForest (doi:10.1093/bioinformatics/btr597), for each variable set (cf. figure 1) separately to avoid introducing spurious correlations. This method leverages conditional dependencies between variables to predict missing values through an iterative random forest approach.

Our **dependent variables** were the four dimensions of the PRS, i.e., ‘fascination’ (FA), ‘being away’ (BA), ‘extent and coherence’ (EC), ‘scope and compatibility’ (ES), and the aggregated mean of all dimensions. Verification with principal component analysis (PCA) showed that the data could well be approximated with three to four dimensions, whereas the first dimension was close to the weighted average of all variables (correlation >0.99). Extent and Coherence (EC) showed the most divergence (PC2). Soft fascination (FA) and being away (BA) showed similarities (PC1, PC3). The PCA results justified the use of the aggregated mean of the PRS variables.

The machine learning methods to quantify the **predictive power** of different variable sets are: i) ordinary least squares (OLS) as a baseline; ii) XGBoost (gradient boosting with tree-based models and hyperparameter tuning for learning rate and tree depth) (arxiv:1603.02754); iii) Random Forests (with default parameters) (doi:10.1023/A:1010933404324). Computations were performed using the mlr3 framework (doi:10.21105/joss.01903). Performance was measured as percentage of explained variance on hold-out data via 5-fold cross-validation, calculated as (1 - MSE/Variance(y)), where MSE represents mean squared error.

Using **multiple linear regression** (OLS), we investigated i) which Geodata and Mediator variables influenced Perceived Restorativeness, and ii) which Geodata variables influenced the Mediators. Since in both cases we have a set of dependent variables, we perform the following steps for each variable separately. As we consider all two-way interactions, we first perform a forward stepwise feature selection using Bayesian Information Criterion on the training data (50%) to mitigate the multiple testing problem. Selected features were subsequently used to fit models on the test set (50%) to obtain valid p-values. Missing values were imputed as above, but for the train and test sets separately to avoid contamination of the test set. Computations were carried out using the basic utilities of the stats package of the R programming language (Cite R XXX).

## 3. Results

### 3.1 Sample description

The sample included the respondents who fulfilled the data base cleaning criteria. There were 1494 participants (50% women and 50% men) from all four language regions: German and Romansh (73.5%), French (20.4%) and Italian (6.1%) in age from 18 to 99 years (mean = 52±15). 37% of them worked full time, 30% part time, and 26% were retired, while the remaining were not employed, training or looking for a job. Splitting the respondents according to their traffic noise exposure at home revealed that the majority lives at rather quiet places with Lday < 55 dB (76%), however, 24% of the respondents live at places with Lday > 55 dB (Table 3). Nearly 80% lived in a single or double family house, and the others in an apartment. Overall, 87.5% of those surveyed had a balcony or terrace, whereas the housing situation differed between the three noise exposure groups (Table 3). The group N3 with noise exposure (Lday) of >55 dB had the highest share of respondents living in apartments and without private balcony, terrace or garden. This is not surprising, as they usually live in urban areas.

Table 3 Sample description: percentage within noise group, unless indicated differently

|  |  |  |  |
| --- | --- | --- | --- |
| **Group of noise exposure at home (Lday)** | **N1: <45 dB** | **N2: 45–55 dB** | **N3: >55 dB** |
| Number of respondents (% of entire sample) | 642 (44%) | 468 (32%) | 354 (24%) |
| Residents in single/double family houses | 86.1% | 77.0% | 70.1% |
| Residents in apartments | 13.9% | 23.0% | 29.9% |
| Respondents with balcony/terrace at home | 90.8% | 88.9% | 79.1% |
| Respondents with garden at home | 92.8% | 85.3% | 79.4% |

### 3.2 Physical characteristics of the places selected for every-day restoration

The places for every-day restoration were usually close to the respondents’ homes. In average, the restorative places were in 1.38 km distance or 12 minutes travel time away from home, and places in closer vicinity of home were visited more often than those located farther away, even though they were usually noisier and less green. The results show significant (p < 0.001) negative correlations between NDVI and noise levels at both HM and RL (R = -0.247 and R = -0.285, respectively), which indicates that the greener the places, the quieter they were. Additionally, significant (p < 0.001) positive correlations exist between noise levels at HM and at RL (R = 0.195) and between NDVI at HM and at RL (R = 0.091), which means that people living in greener and quieter locations dispose of greener and quieter places for restoration. Figure 2 shows the indicated RLs on two maps of urban regions.



Figure 2 Two examples of the geographic locations of the indicated places for restoration (dots) and the day-time road traffic noise levels according to SonBASE (underlying heat map). The colours of the dots indicate the affiliation of the respondents to the different groups of noise exposure at their place of residence (N1 (Lday < 45 dB): green; N2 (45 dB < Lday < 55 dB): yellow; N3 (Lday > 55 dB): red).

Generally, the restorative locations were quieter and greener than the home locations (Figure 3; Table 4). Nevertheless, almost one third (31%) of the respondents visited noisier RL than their home locations. However, this rather applies to respondents living at quiet places. The lower the noise level at HM, the more likely it was that the noise level at RL was higher than at HM (48.9, 26.1, 5.9% for N1, N2, N3 noise groups, respectively). The longer it took to get to the restorative place, the quieter and greener it was, in general and compared to the corresponding HM (statistically significant relationships, p<.001).



Figure 3 Distribution of NDVI and noise at home (HM) and restorative locations (RL) by noise group. N1: Lday < 45 dB; N2: 45 dB < Lday < 55 dB; N3: Lday > 55 dB.

Table 4 Median values of noise exposure and greenness at home (HM) and at the place of restoration (RL) for each noise group; difference of noise and greenness between home and the place of restoration; distance and travel time between the two places. ANOVA revealed significant differences between the noise groups for Lday at RL and difference of Lday HM-RL (P > 0.001).

|  |  |  |  |
| --- | --- | --- | --- |
| **Group of noise exposure at home (Lday)** | **N1: <45 dB** | **N2: 45–55 dB** | **N3: >55 dB** |
| Noise level (Lday) at HM1 | 40.40 | 48.70 | 63.20 |
| Greenness (NDVI) at HM2 | 0.55 | 0.52 | 0.51 |
| Noise level (Lday) at RL3 | 39.30\*\*\* | 42.20\*\*\* | 45.50\*\*\* |
| Greenness (NDVI) at RL3 | 0.72 | 0.68 | 0.65 |
| Difference of Lday (HM – RL)4 | 0.00\*\*\* | -7.40\*\*\* | -18.50\*\*\* |
| Difference of NDVI (HM – RL)4 | 0.13 | 0.19 | 0.14 |
| Distance between HM and RL (km) | 1.25 | 1.54 | 1.44 |
| Travel time from HM to RL | 15 | 10 | 10 |

1loudest point of façade; 2mean value within a 50 m buffer; 3mean value within a 250 m buffer; 4difference of mean values.

Figure 3 shows that people generally choose places for restoration where they can escape from traffic noise. This holds particularly true for people living at noisy places (N3). For this group, the difference of noise levels between HM and RL is the largest and differs significantly from the noise level differences for the other noise groups (P < 0.001) (Table 4). However, the RL of the respondents from N3 group are still the noisiest, and the noise levels at RL between the groups differ significantly as well. In addition, 20% of N3 respondents indicated restorative locations at noise levels >55 dB, whereas only 10% of respondents from N1 and N2 indicated places with noise levels of this category (Table 5).

Table 5 Percentage of RL indicated by the respondents according to the different noise categories

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Noise level at RL** | | |
| **Noise exposure at HM** | **<45 dB** | **45–55 dB** | **>55 dB** |
| N1: <45 dB | 72.9% | 18.2% | 8.9% |
| N2: 45–55 dB | 59.4% | 30.8% | 9.8% |
| N3: >55 dB | 52.3% | 26.8% | 20.9% |

The land cover types at RL were broadleaf and coniferous forests, herbaceous vegetation, cultivated land, artificial surfaces, open water, vineyards, and others. The noisiest places were dominated by artificial surfaces and vineyards, and the quietest by coniferous forests. Consequently, the higher the noise level at the respondents’ homes, the higher the share of artificial surfaces at RL (Figure 4). The extent of artificial surfaces differs significantly between N1 and N3 (P=0.05), but not between N1 and N2 or N2 and N3. RL dominated by open water were located farthest away from home (in terms of distance and travel time), whereas the nearest locations were most often dominated by vineyards, artificial surfaces and agricultural land. Artificial surfaces dominated also in locations visited every day and were noticeably less frequent in those visited less often.



Figure 4 Pie charts of land cover types at the restorative locations grouped according to the respondents’ noise exposure (Lday) at home (left: N1 <45 dB; middle: N2 45–55 dB; N3 >55 dB at home)

### 3.3 Soundscape description of the places of restoration

The respondents’ assessments of the RL soundscapes are presented in Table 6. Overall, the respondents indicated sounds of nature (birds, wind, leaves and water noise) as dominating and described the sounds at RL as “pleasant” and “tranquil”. They did not strongly feel annoyed by noise; most annoying were road traffic, aircraft noise and music of others. The assessments do not differ significantly between the noise groups, however, N3 respondents provided the lowest scores to positive attributes (e.g. nature sounds; pleasantness) and the highest scores to negative attributes (e.g. loud, road traffic noise).

Table 6 Respondents’ descriptions of soundscape at RLs for the single noise groups. All items were rated on a scale of 1 (low) to 5 (high).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **N1** | | **N2** | | **N3** | |
| **Dominating sound** | **mean** | **SD** | **mean** | **SD** | **mean** | **SD** |
| Nature sounds | 3.83 | 1.15 | 3.80 | 1.20 | 3.72 | 1.22 |
| Human sounds | 2.03 | 1.28 | 2.05 | 1.36 | 2.36 | 1.43 |
| Traffic noise | 1.65 | 1.01 | 1.81 | 1.15 | 2.18 | 1.48 |
| Other technical noise | 1.46 | 0.88 | 1.45 | 0.84 | 1.50 | 0.94 |
|  |  |  |  |  |  |  |
| **Soundscape attributes** |  |  |  |  |  |  |
| Pleasant | 4.45 | 0.64 | 4.41 | 0.71 | 4.28 | 0.86 |
| Chaotic | 1.41 | 0.72 | 1.42 | 0.77 | 1.66 | 0.97 |
| Vibrant | 3.70 | 1.06 | 3.69 | 1.06 | 3.66 | 1.09 |
| Uneventful | 2.79 | 1.18 | 2.74 | 1.24 | 2.72 | 1.18 |
| Tranquil | 4.11 | 0.88 | 4.11 | 0.89 | 3.84 | 1.07 |
| Bothering | 1.40 | 0.72 | 1.42 | 0.76 | 1.56 | 0.95 |
| Eventful | 2.56 | 1.17 | 2.61 | 1.17 | 2.61 | 1.14 |
| Monotone | 1.86 | 0.94 | 1.86 | 0.97 | 1.87 | 0.99 |
| Loud | 1.67 | 0.85 | 1.76 | 0.96 | 2.04 | 1.09 |
|  |  |  |  |  |  |  |
| **Noise annoyance by** |  |  |  |  |  |  |
| Road traffic | 2.71 | 2.13 | 3.20 | 2.52 | 3.80 | 3.19 |
| Public transport | 1.51 | 1.34 | 1.73 | 1.71 | 2.09 | 2.04 |
| Railway | 1.62 | 1.56 | 1.77 | 1.81 | 1.91 | 1.99 |
| Aircraft | 2.70 | 2.18 | 2.65 | 2.31 | 2.50 | 2.16 |
| Leisure activities | 1.60 | 1.43 | 1.58 | 1.48 | 1.90 | 1.85 |
| Music of others | 2.31 | 1.94 | 2.36 | 2.06 | 2.75 | 2.25 |
| Construction work | 1.69 | 1.65 | 1.76 | 1.82 | 1.88 | 1.82 |

The respondents assessed the overall soundscape quality at the recently visited restorative locations positively in general, but Figure 5 shows a difference between the answers of N3 and the other noise groups. In noisier areas (N3), only 79% of the respondents perceive the overall soundscape as good, whereas in less noisy areas (N1, N2), this share of people is 88% and 91% respectively. These assessments correspond to the fact that N3 group had the largest share of respondents (21%) indicating RLs at places with noise levels higher than 55 dB, a threshold at which perceived soundscape quality is rapidly dropping with increased sound pressure levels (EEA, 2014; cf. section 2.2). This influence of the noise level on perceived soundscape quality is even stronger when comparing the noise levels at the restorative locations with the respondents’ judgements regardless of their affiliations to specific noise groups. For RLs with Lday > 55 dB (12% of all RLs), the share of respondents indicating perceived overall soundscape quality as “rather good” or “very good” was 73%, whereas for RLs with with Lday < 45 dB this share was 92%, and for RLs with noise levels between these thresholds it was 82%.

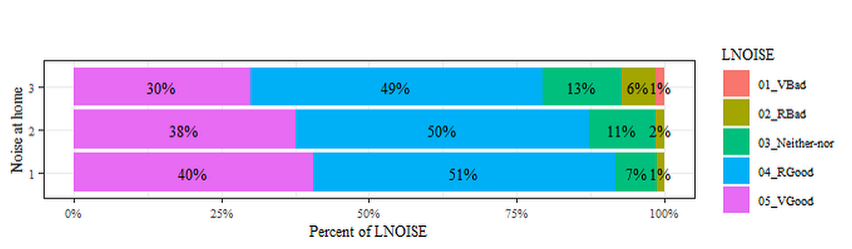


Figure 5 Respondents’ ratings of the overall soundscape quality according to the noise groups

### 3.4 Perceived restorativeness of the places selected for restoration

The respondents perceived the restorativeness of the visited outdoor locations (RLs) as rather high (in average score 5 on a scale 1 to 7) for most PRS dimensions, regardless of the noise exposure at home, i.e. noise group, nor the noise level at the places of restoration (RLs). The scores for the latter case are given in Table 7 as an example. The mean values of the aggregated PRS, ‘fascination’ and ‘being away’ are slightly dropping with increasing noise level at RL. However, we did not detect any significant differences. In addition, the median values are rather high, indicating that independently of the noise levels more than 50% of the respondents assessed their RLs as rather restorative.

Table 7 PRS scores of the respondents according to the noise levels (Lday) at the locations of restoration (RL): mean, standard deviation (SD), median (Med.)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Lday at RL** (N) | **<45 dB** (931) | | | **45–55 dB** (356) | | | **>55 dB** (177) | | |
|  | Mean | SD | Med. | Mean | SD | Med. | Mean | SD | Med. |
| **PRS aggregated** | 5.14 | 1.12 | 5 | 5.12 | 1.15 | 5 | 4.99 | 1.07 | 5 |
| **Fascination** (FA) | 5.30 | 1.22 | 5 | 5.18 | 1.33 | 5 | 5.13 | 1.22 | 5 |
| **Being away** (BA) | 5.13 | 1.32 | 5 | 5.13 | 1.32 | 5 | 5.11 | 1.19 | 5 |
| **Extent & coherence** (EC) | 4.37 | 1.47 | 4 | 4.62 | 1.49 | 5 | 4.41 | 1.44 | 4 |
| **Scope & compatibility** (ES) | 5.00 | 1.43 | 5 | 4.62 | 1.70 | 5 | 4.62 | 1.54 | 5 |

### 3.5 Predicting perceived restorativeness

The prediction of the PRS dimensions and the aggregated PRS revealed that the three models used performed rather similarly, with XGBoost being slightly superior, OLS in the middle, and Random Forest slightly inferior on average. The best out-of-sample performance was achieved with the combination of geodata and the mediators explaining 25% of variance for the aggregated PRS mean and for 'fascination', whereas for the other PRS dimensions less than 17% of variance was explained. Removing geodata only reduced predictive performance for ES noteworthily, suggesting that it did not carry much information for the other PRS dimensions. This is consistent with the geodata alone explaining any variance for 'scope and compatibility' (ES) with the value of ca. 5%. On the other hand, the geodata showed some influence on the mediators ‘feeling of being in nature’ and ‘overall soundscape quality’, explaining ca. 13% and almost 10% of variance, respectively. All tables with the exact figures are given in supplementary material XXX.

OLS, performing competitively to the other models, justifies further modeling and inferring linear effects (as described in Section XXX). To keep the coefficients interpretable in the presence of interactions, each variable was scaled to mean 0 and standard deviation 1. In this way, if A increases by one standard deviation, Y increases by β times its standard deviation (assuming everything else stays constant). Tables XXX and XXX present the linear regression coefficients for i) which Geodata and Mediator variables influenced Perceived Restorativeness, and ii) which Geodata variables influenced the Mediators. The complete regression summaries are provided in supplementary material XXX.

#### Table 8: Regression coefficients of regressing Mediators(rows) including all two-way interactions on the geodata variables (columns) after variable selection on a train-set. *\*\*\*p<0.001, \*\*p<0.01, \*p<0.05*

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Covariate | FEELNAT | LNOISE | LOC\_SENS | LOC\_SOUN | LOC\_SCEN | LOC\_VISE | LOC\_VEGE | LOC\_FAUN |
| (Intercept) | 0.062 | -0.001 | -0.000 | 0.000 | -0.001 | -0.000 | -0.019 | -0.001 |
| HETER |  |  | 0.130\*\*\* | 0.109\*\* |  |  |  |  |
| JNYTIME\_sqrt |  |  |  |  |  |  | -0.114\*\* |  |
| LCARTIF\_sqrt | -0.152\*\* | -0.124\* |  | -0.175\*\*\* |  | -0.071 |  | -0.214\*\*\* |
| LCARTIF\_sqrt:RL\_NDVI | 0.115\*\* |  |  |  |  |  |  |  |
| OVDIST\_sqrt | 0.027 |  |  |  |  |  |  |  |
| RL\_NDVI | 0.150\*\*\* |  |  |  | 0.217\*\*\* |  | 0.219\*\*\* |  |
| RL\_NOISE |  | -0.242\*\*\* |  |  |  |  |  |  |
| STRIMP999\_sqrt |  |  | -0.073 |  |  |  |  |  |

#### Table 9: Regression coefficients of regressing Geodata and Mediators(rows) including all two-way interactions on the PRS (columns) after variable selection on a train-set. *\*\*\*p<0.001, \*\*p<0.01, \*p<0.05*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Covariate | MEAN | FA | BA | EC | ES |
| (Intercept) | -0.008 | -0.003 | -0.008 | -0.009 | 0.031 |
| DISTKM\_sqrt |  |  |  |  | 0.081\* |
| FEELNAT | 0.202\*\*\* | 0.169\*\*\* | 0.188\*\*\* |  | 0.258\*\*\* |
| FEELNAT:LOC\_SCEN |  | -0.002 |  |  |  |
| FEELNAT:LOC\_SENS | 0.054 |  |  |  |  |
| LCFOREST\_sqrt |  |  |  | -0.090\* |  |
| LNOISE | 0.177\*\*\* | 0.133\*\*\* |  |  | 0.133\*\* |
| LNOISE:FEELNAT |  |  |  |  | -0.006 |
| LOC\_FAUN |  | 0.176\*\*\* |  |  |  |
| LOC\_SCEN |  | 0.164\*\*\* |  | 0.004 |  |
| LOC\_SENS | 0.104\* |  | 0.147\*\*\* | 0.142\*\*\* | 0.096\* |
| LOC\_VISE | 0.173\*\*\* | 0.128\*\* | 0.122\*\* |  |  |
| RL\_NDVI |  | -0.133\*\*\* |  |  |  |
| RL\_NDVI:LOC\_SCEN |  | 0.024 |  |  |  |



## 4. Discussion

In this study, we combined the results of a Swiss-wide representative PP-GIS survey about the places people choose for outdoor recreation with the geodata describing the physical characteristics of these places. We were particularly interested in the importance of soundscape and noise level and, therefore, grouped the restorative (RL) and home locations (HM) according to the EEA noise pressure thresholds of perceived acoustic quality (EEA, 2014) for the descriptive analyses. Our sample was evenly distributed and representative of the Swiss population considering age, gender, language region and residential buildings. However, 24% of the respondents lived at places (HMs) with road traffic noise levels (Lday) >55 dB.

Proximity in terms of distance and time needed to reach the restorative place, turned out to be substantial for everyday outings and triggered more frequent outdoor activities. This aligns with studies from other countries, e.g. in Sweden the median travel distance to the recreational area was 2 km (Lehto et al., 2022). In Finland, recreational areas located closer to people’s homes were visited more often (Neuvonen, Sievänen, Tönnes, & Koskela, 2007). The latter was also found for urban green spaces in Zurich, Switzerland (Dopico Magadan et al., 2025). However, proximity was not the only criterion for the choices of the restorative places (RLs). The respondents generally chose greener and quieter places for restoration than their home locations. They visited forests, water bodies, agricultural land and vineyards and avoided traffic noise, which is in line with the findings of Lehto et al. (2024) from another Swedish PP-GIS study. We found that particularly people living at rather noisy places (Lday > 55 dB) try to escape from road traffic noise. However, for this group (N3) significantly louder green spaces are available in the neighbourhoods than for people living at quieter places (N1 and N2). The restorative locations (RLs) of the noise group N3 also show the highest share of artificial surfaces, as they mostly represent urban surroundings.

Road traffic noise was more dominant at RLs of N3 respondents, and these were more annoyed by traffic noise than respondents of N1 or N2. N3 respondents rated their RLs the least tranquil and most loud, although the differences of the scores between the noise groups were small. However, in the N3 group only 4 out of 5 people rated overall soundscape quality at their RLs as “good” or “rather good”, whereas in the other two noise groups it was 9 out of 10 people. This finding is noteworthy, as Medvedev et al. (2015) showed that soundscape quality affects physiological restoration (heart rate and skin conductance). People living at rather noisy places in urban areas are obviously disadvantaged in terms of green spaces with good soundscape quality. However, public green spaces are most important for this group of the population, as every fifth of them does not dispose of a private garden or balcony (Table 3).

Our results revealed that the noise levels at the places of restoration had a direct influence on perceived overall soundscape quality. Higher levels of road traffic noise reduced the number of respondents judging the soundscape at their RLs as “rather good” or “very good”; at RLs with Lday >55 dB (12% of all indicated points), it dropped to 73% of the corresponding respondents. This is less than the target value of 80% of visitors stipulated by the Swedish Environment Agency (2005: p. 16) for nearby recreation areas in urban regions. Nilsson and Berglund (2006) recommend that traffic noise level (Lday) in urban parks should be below 50 dB, so that at least 80% of the visitors perceived soundscape quality as good. Our findings also support the EEA’s “Good practice guide on quiet areas” that recommends noise levels (Lday) below 55 dB for quiet areas (EEA, 2014).

Despite the differences in the physical properties of the places of restoration between the noise groups, all respondents judged their RLs as rather restorative, independently of the noise level at the RL (Table 7), which is surprising at first glance. The reason for these generally high restorativeness scores might be the fact that the respondents were outdoors in natural settings and walking or doing other physical activities which fosters mental restoration (Ryan et al., 2010; Fuegen and Breitenbecher, 2018); or simply the fact that they visited these places with the purpose of restoration. However, we found a tendency that perceived restorativeness decreased with higher road traffic noise levels which is in line with the results of surveys and soundwalks in an urban park in Norway (Evensen et al., 2016).

The similar ratings of perceived restorativeness of a place might be one reason why prediction with the questionnaire items and geodata explained only 25% of PRS variance, independently of the model used (linear model, XGBoost, Random Forest). The explained variance is, however, in line with similar studies attempting to predict restoration outcomes, forest attractiveness or the PRS in an outdoor environment (García-Martín et al., 2025; Hegetschweiler et al., 2020; Sella et al., 2023). Perceived restorativeness of a place seems to be mainly a matter of personal factors which are hard to assess.

The PRS mean as well as all PRS dimensions were only predicted by the mediators and not by geodata, except the contribution of NDVI to ‘fascination’ (see Table 8). The self-reported variables ‘feeling of being in nature’ and ‘overall soundscape quality’ revealed to be significant predictors of perceived restorativeness, and particularly of ‘fascination’. This is in line with the concept of “tranquil places” developed by Pheasant et al. (2009; 2010) that combines noise pressure levels and the occurrence of natural and cultural landscape features. They based their concept on the attention restoration theory (ART) and argue that ‘fascination’ is key for attention restoration. Interestingly, the correlation between NDVI and ‘fascination’ is negative, which might be due to a bias towards rather high NDVI values, i.e. forests, at the restorative locations (RLs). The ART is based on the theory that humans prefer Savannah-like open landscapes due to their evolution (Bourassa, 1991; Kaplan and Kaplan, 1989). Empirical studies also showed that dense forests were less preferred (Hunziker and Kienast, 1999; Hegetschweiler et al., 2022).

The geodata, however, a had some influence on the mediator variables, ‘feeling of being in nature’, ‘sensory perceptions’ and ‘overall soundscape quality’. Among the geodata, NDVI revealed as a rather good predictor of perceived naturalness of a place; it had a high statistically significant influence on the ‘feeling of being in nature’, ‘smells/odours’, and ‘perceived vegetation’. Although NDVI mainly correlates with the chlorophyll content of green plants, its values also indicate vegetation type (grass, shrubs, trees) and density (de la Iglesia and Labib, 2023), which makes it a useful proxy to describe perceived naturalness of a place.

Noise level at the place of restoration revealed to be a highly significant predictor of ‘overall soundscape quality’ at this place. This means that, beside the type of sound (natural or anthropogenic), sound pressure level has an influence on perceived soundscape quality. This is in line with our results of the descriptive statistics and it, again, supports the recommendations of the EEA guidelines about quiet areas (EEA, 2014).

As a limitation it has to be mentioned that with 14% the response rate of our survey was rather low. However, it is still in the range of what can be expected from online-only surveys (Daikeler et al., 2020).

## 5. Conclusions

With ongoing urban development and, particularly, densification, public green spaces become increasingly important for everyday restoration. Our study revealed that people generally choose places for restoration that are not only greener but also quieter than their home locations. This means that quiet areas around settlements should be preserved and that anthropogenic noise, particularly traffic noise, should be limited in public green spaces. Our results suggest a limit of Lday < 55 dB for road traffic noise. Urban planners are challenged to design green spaces as sanctuaries from traffic noise (Spano et al., 2023), e.g. by using buildings or earth banks as noise barriers, or by carefully evaluating the locations of by-pass roads around settlements. Although perceived restorativeness of a place could hardly be predicted with geodata, greenness (NDVI) and noise level might be used as rough proxies, as they influence the feeling of being in nature and perceived soundscape quality.

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**Title suggestions by ChatGPT**

**1. "Escaping the Noise: Where Urban Residents in Switzerland Find Everyday Restoration"**

* **Strengths:** Evocative and accessible; highlights both the stressor (noise) and the solution (restoration).
* **Use case:** Suitable for interdisciplinary or policy-oriented journals.

**2. "Restorative Environments in a Noisy World: A Participatory GIS Study from Switzerland"**

* **Strengths:** Emphasizes the methodological approach and geographic scope.
* **Use case:** Appropriate for environmental psychology or landscape planning journals.

**3. "Greener and Quieter: Predicting Everyday Restorative Place Selection with GIS and Perceived Soundscape Quality"**

* **Strengths:** Highlights key variables (greenness, quietness), the predictive element, and mixed methods.
* **Use case:** Ideal for data-driven or applied spatial analysis publications.

For ***Urban Forestry & Urban Greening***, your title should be **clear, descriptive, and methodologically grounded**, ideally referencing both **restorative experiences** and **urban green space**. Here are three tailored suggestions:

**4. "Everyday Restoration in Urban Green Spaces: A GIS-Based Study on Noise-Exposed Residents in Switzerland"**

* **Why it works:** Clearly signals the context (urban green spaces), method (GIS), and population (noise-exposed residents).
* **Tone:** Academic and journal-appropriate.

**5. "Seeking Silence and Green: How Noise-Exposed Urban Residents Use Natural Spaces for Everyday Restoration"**

* **Why it works:** Evocative but grounded; combines sensory stressor (noise) with environmental relief (green spaces).
* **Tone:** Slightly more narrative but still suitable.

**6. "Predicting Perceived Restorativeness in Urban Green Areas: Integrating Geospatial Metrics and Subjective Soundscape Quality"**

* **Why it works:** Emphasizes the predictive and integrative aspects of your study, which is valuable for applied urban planning audiences.
* **Tone:** Technical, for a methods-focused readership.