Socio-cultural differences in sound perception using soundwalks in a public park and interviews with residents of the surroundings

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Introduction

Recently, several studies related to the soundscape quality of urban parks were conducted to confirm whether the sonic environment of this type of area is promoting and preserving the health of citizens [1], [2], [3].

According to the International Organization for Standardization [4], soundscape is defined as "acoustic environment as perceived and, or understood by a person or people, in context".

The context includes all non-acoustical components of a place, related to persons, between the interaction of person-place and the motivation for undertaking an activity in this place [5]. It is also shaped by visual stimuli, knowledge accumulated on the place and cultural meanings [6].

As mentioned above, persons and their preferences play a significant role in the soundscape evaluation, thus it is important to know the profiles of users who are evaluating the soundscape, making understandable the interaction person-place and the influence of the sonic environment on their everyday lives.

A good way to perform user profiling is through a two-step cluster analysis, which is capable of handling continuous and categorical variables or attributes [7].

This study is part of a project that aims at analyzing the development of an environmental noise cost index. Beside acoustical, spatial, thermal-comfort and economical parameters, this index also evaluates whether the social-cultural aspects provide positive influences on the sound perception and pricing.

Study Area

This study was conducted in the public park Westpark in Aachen, Germany (Fig.1).

The park is close to the university campus, where the student population lives nearby and uses it during leisure time.

In this study soundwalks were conducted in Westpark with 30 participants. They were asked to evaluate the environment in various aspects, including acoustic, thermal-comfort, air quality, landscape, and suitability for their lifestyle. The evaluated locations are represented as green dots and the trekked routes in light orange (Fig.1). Each participant was asked to evaluate three locations during the soundwalk. Additionally, interviews were conducted with inhabitants of the surrounding areas of Westpark (yellow

dots). The sample of interviews is composed by 30 participants.
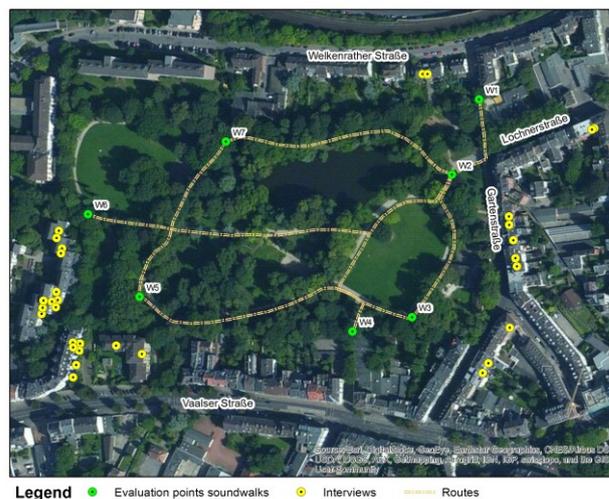
Fig. 1: Study area in Westpark in Aachen, Germany

Methods

According to the International Organization for Standardization [8], a soundscape study must do a triangulation through a combination of several different investigative methods, as shown in Fig.2.

Soundwalking is used to empirically evaluate a soundscape and its components in several locations [9]. It is important to use a set of binaural microphones to ensure the sound characteristics of the perceived signal of a human [10], to record sound during soundwalks. The recordings were made simultaneously with the subjective data collection through questionnaires or sound perception interviews.

For sound monitoring a set of Sennheiser KE-4 capsules, an omnidirectional microphone, KE-3 binaural microphones were used. The sound was recorded with a Zoom-H6 multitrack recording device with a sampling rate of 44.1 kHz during the entire time of soundwalk. The microphone calibration was performed with a B&K 4231 calibrator. The recording device was calibrated with a voltage calibrator (0.01V).

Through the subjective sample collected during the soundwalks, the study provides an overview of the sound perception of the users of the park. With the interviews conducted with the inhabitants, this study is collecting subjective data with whom is familiar with the acoustic environments of the park area evaluated.
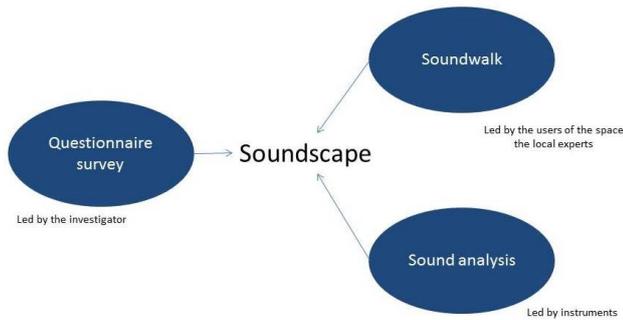
Fig. 2: Triangulation: combination of evaluation methods for the soundscape approach (adapted from NWIP ISO 12913-2:2014)

For this study, similar questions were made on the soundwalks and in the questionnaire survey.

On the two-step cluster analysis, the parameters denote a set of predictors and evaluation fields.

All socio-cultural parameters in this study are considered as evaluation fields predictors and leaded to users' profiles from each formed cluster. The evaluated socio-cultural parameters are depicted in Table 1.

The evaluated predictors related to landscape and acoustic included the following, with scales indicated in parentheses:

- What do you think of the current location? (6-point scale: very uncomfortable, uncomfortable, rather uncomfortable, rather comfortable, comfortable, very comfortable);

- The general background noise at this place is acceptable? (7-point scale: yes, at daytime; yes, at evening time; yes, at nighttime; yes, at day and evening time; yes, at evening and nighttime; yes, at any time; no, it is not acceptable);

- Please evaluate the background noise according it's: intensity (5-point scale: noisy, slightly noisy, neutral, slightly quiet, quiet); comfort (5-point scale: uncomfortable, slightly uncomfortable, neutral, slightly comfortable, comfortable); nuisance (5-point scale: annoying, slightly annoying, neutral, slightly not annoying, not annoying); restoration (5-point scale: exhausting, slightly exhausting, neutral, slightly relaxing, relaxing).

Nationality	Profession	Gender	Age	How long you lived in Aachen?	Why do you live in Aachen?
German Iranian Chilean Chinese Dutch Russian Bulgarian Indian French Turkish Swiss Italian	Student Research assistant Teacher Acoustician Electrical engineer Office clerk Senior citizen - retired CEO Baby-sitter Industrial mechanic Housekeeper Musician Elderly caregiver Social worker Cultural manager Graphic designer Consultant Artist Employee Unemployed No answer	Male Female	17 – 21 years 22 – 30 years 31 – 40 years 41 – 50 years 51 – 60 years 61 – 70 years 71 years and over	Less than 1 year 1 – 2 years 2 – 5 years Over 5 years No answer	Education Work Was born in Aachen Husband studies Random Good life quality No answer

Table 1: Socio-cultural parameters

Results and Discussion

The results are discussed in three parts: Part 1 – predictors' importance, Part 2 – cluster analysis soundwalks and Part 3 – cluster analysis interviews.

Part 1 – Predictors importance

The predictors' importance shows the relative importance of each field in estimating the model. As mentioned before the socio-cultural aspects are the evaluation fields in this work.

In Figure 3 is possible to see the comparison between the predictors importance from soundwalks and interviews cluster models.

The acoustical and landscape parameters of the soundwalks shows that who is going to the soundwalks behaves in a similar way as a user of the park, whose visits are intended primarily for health restoration. The visual aspect of the landscape is not as critical important as the acoustical importance. The socio-cultural aspects in the extracted model indicate that age, gender and profession had major importance, since the sample is mainly composed by students and research assistants.

Moreover the acoustical and landscape parameters from interviews, shows that who is living near to the park, is more concerned about the nuisance, intensity of the background noise, comfort and restoration related to the background noise. The importance of those parameters is ranked over 50%. The landscape perception was ranked better than on the soundwalks sample. The visual aspect about the landscape is still less important as the acoustical importance. The socio-cultural aspects in the extracted model indicate that the motivation to live in Aachen is even more important than landscape perception. Gender, profession and age are the most important aspects of the socio-cultural parameters.
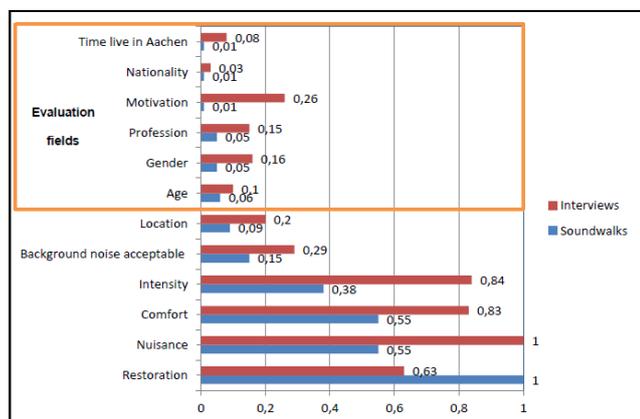

Fig. 3: Comparison between predictors importance from soundwalks and interviews models

Part 2 – Cluster analysis soundwalks

The clusters quality according to the silhouette measure of cohesion and separation is fair, reaching an average of 0.2 in a scale between -1.0 and 1.0.

Three clusters are formed with the soundwalks sample. The cluster sizes are 42.2%, 36.7%, and 21.1% respectively. The ratio size from the largest to the smallest cluster is 2.

Figure 4 shows the three clusters extracted from this model, with response division according to sound and landscape perception. The histograms of Cluster 3 show that this group of participants exhibited a tendency to neutral answers to background noise. Participants in Cluster 2 tend to respond positive ratings, while those in Cluster 1 tend to provide negative ratings related to background noise. For the perception on landscape, the most frequent response was comfortable in cluster 2. In the other clusters it is considered slightly comfortable.

For the socio-cultural aspects, the age division in cluster 3 and 2 was similar. Persons who rated a neutral and positive tendency are mainly aged between 22 – 30 years (63.2% - cluster 3 and 72.8% - cluster 2). Cluster 2 included also participants aged between 17 and 21 years (9%), indicating that younger participants tend to give positive responses related to background noise. In cluster 1, which had a negative rating tendency, the age categories are similar to cluster 3 and 2 aged between 22-30 years (63.2%), added by persons aged between 51 and 60 years old (21%), indicating that older persons tend to give negative responses related to background noise.

For gender, Cluster 3 had more male participants (55.3%) and Clusters 2 and 1 more female participants (75 and 66.7 %). It suggests that female participants avoided to rate neutral responses related to background noise and landscape perception. As previously mentioned, the division of professions in all clusters was similar. They are composed mainly by students and research assistants.
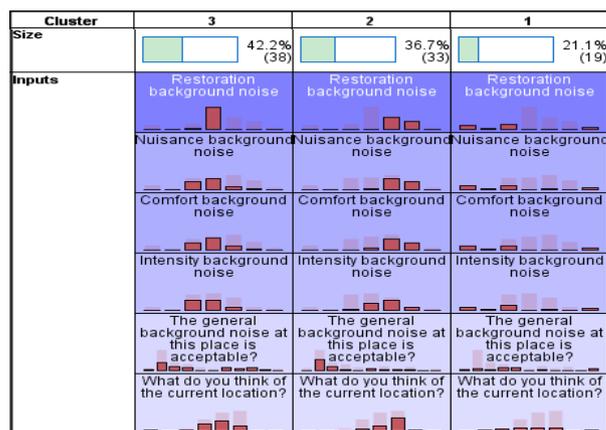

Fig. 4: Soundwalks clusters division related to acoustics and landscape perception

Part 3 – Cluster analysis interviews with inhabitants

The clusters quality according to the silhouette measure of cohesion and separation is also fair, reaching an average of 0.3 in a scale between -1.0 and 1.0.

Two clusters were formed with the interviews sample, with the sizes of 67.7% and 32.3%, respectively. The ratio size between the largest to the smallest cluster is 2.1.

In Figure 5 shows the subdivision of neutral to positive responses on cluster 2, and neutral to negative responses on cluster 1, related to sound and landscape perception.

Fig. 5: Interviews clusters division related to acoustics and landscape perception

Related to the socio-cultural responses the clusters are divided as follow: even in cluster 2 and 1 the main motivation to live in Aachen is education (30% - cluster 1 and 74.4% - cluster 2) and work (30% - cluster 1 and 14.3% - cluster 2); female (57.2% - cluster 2) participants gave more positive responses and male (70% - cluster 1) participants tended to give negative responses related to background noise and landscape perception. The major profession answered in both clusters is student (20% in cluster 1 and 52.4% in cluster 2). There was a bigger variability of profession answers on cluster 2. On cluster 2 the categorization of age encompasses a range from 17 to 71 years. The majority of the participants informed that they have between 22 and 30 years old (47.6%). On cluster 1 the variability of age groups is lower (22 to 70 years) and the main age response was between 22 and 30 years old (40%).

Conclusion

The Two-Step Cluster analysis showed that nationality and duration of residence in Aachen are not important predictors for social-cultural aspects.

There are differences in the importance of several acoustical parameters evaluated through soundwalks and participant in the survey. Who is using the park as a visitor, pays more attention on restoration, nuisance, comfort and then on intensity. The inhabitants have different preferences. They value more heavily on nuisance, intensity, comfort and finally restoration.

Due to the lack of knowledge related to the sonic environment of the park, participants in the soundwalks formed a cluster that tend provide neutral responses.

Related to socio-cultural aspects, the most important predictors on the soundwalks sample are: age, gender, profession; and on the interviews with inhabitants sample: motivation to live in Aachen, gender and profession.

Acknowledgment

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