

Acoustic quality and health in urban environments - First methodological experiences of the pilot study SALVE

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ABSTRACT

In cities, sound can characterize urban environments just as land-use types and patterns, which can impact well-being and health of the population. To identify which criteria are important for health-promoting acoustic environments, a two year interdisciplinary MERCUR Research Center Ruhr funded pilot study “acouStic quALity and heaLth in urban enVironmEnts (SALVE) - analysis of the interrelationships between soundscapes and health” was launched in October 2018. SALVE aims to establish one of the largest multi-seasonal urban sound datasets in Germany by making year-long direct and automated auditory measurements. The calculation of a wide array of metrics (WAM) over a large heterogeneous urban area will enable analysis of associations to health outcomes from the long-term, population-based Heinz Nixdorf Recall study.

SALVE is a starting point for an innovative approach to understand the associations of acoustic quality on urban public health – beyond noise mitigation. We will present methodological aspects of study design, like the operation of direct and automated measurement devices in urban environments and spatial epidemiological analyses. Furthermore, we will give first results, as well as insights into practical experiences of acceptance, data protection and into opportunities as well as pitfalls which arise during a large sound data collection and analysis project in urban areas.

Keywords: Sound, acoustic environment, acoustic quality, SALVE, health, pilot study

1. INTRODUCTION

Especially in cities, a large part of the population lives in an environment exposed to noise (1). Reducing overall noise decibel levels is an important agenda and necessary for public health (2). However, in addition to noise mitigation it is also important to consider further aspects below noise thresholds (3). Due to rapid urbanization it is expected that urban spaces, such as parks or green areas, will increasingly become scarce and the variation of different acoustic environments within the city will fade away (4). This is especially of concern, as for example parks are needed for people to withdraw from stress and for recreational use (4,5, 6).

We urgently need more knowledge on how to better plan and design our cities so that they are worth living in and are beneficial for human health. Knowledge on the link between the built environment, acoustic quality and health as well as wellbeing is needed. Further research could enable us to understand the factors that influence high quality acoustic environments in cities. The quality of sounds in human settlements below noise thresholds has hardly been investigated. Additionally, the question arises how acoustic quality is related to the urban environment and structure, and what positive and negative health effects can be expected for those people living in urban areas.

SALVE, which is short for “acouStic quALity and heaLth in urban enVironmEnts” is a two year pilot study in the city of Bochum in the Metropolitan Ruhr region in Germany (7). The pilot study was launched in October 2018. Our innovative study deals with the investigation of urban acoustic environments. By this we mean, the environment that encompasses all natural and man-made sounds. We are an interdisciplinary research team of the University Hospital Essen of the University Duisburg-Essen and the TU Dortmund University. Supported by the Mercator Research Center Ruhr

(MERCUR), we want to jointly research urban acoustic environments.

The aims of SALVE are to measure spatial-temporal differences in acoustic environments, taking into account the built environment, defined as land use types, and temporal changes. Sound metrics as used in Soundscape Ecology will be calculated and assigned to specific land use types. Spatial-statistical models will be applied to analyze health effects of identified types of acoustic environments in urban neighborhoods. Additionally, residents in Bochum will be asked about their soundscape perception. As part of the pilot study, knowledge on data protection issues, acceptance and feasibility of measurement devices is gathered (7).

The overall study design is described elsewhere (7). Therefore, here we will present a short overview of SALVE. Our widened array of metrics approach (WAM) is described in these proceedings (8).

1.1 Sound Measurements

For over a year we will measure all sounds at approximately 730 locations in Bochum at different times of day, night and year. During the pilot study we carry out two different measurement procedures: (i) direct and (ii) automated sound measurements. These measurements started in March and May 2019 and will be carried out for 365 days. The measuring locations were selected on the basis of different land use types. These include, for example, residential and mixed land use, parks and green areas as well as forests. This helps to identify a wide range of acoustic environments, which are typical for urban regions in which people live and work. Sound measurements in green spaces will provide an understanding of the differences between acoustic quality in built-up areas versus acoustic quality in green areas near to or adjacent to built-up areas.

i. Direct sound measurements

Our SALVE team using audio equipment (NTi XL2) carries out the direct sound measurements. For each location, 5-minute sound measurements are recorded. All measurements are made on weekdays between 09:00 and 17:00 hours. Each location is measured once in all four seasons.

ii. Automated sound measurements

With our 24 automated recording devices (SM 4 Acoustic recorder), three-minute sound recordings are automated every half hour for the duration of one year - independent of day and night times as well as working hours and holidays. These devices are temporarily located for 365 days at the same location which means approximately nine maintenance days during the year (data and battery check). At each of the nine maintenance days we will also make binaural audio recordings for use in soundscape perception studies according to ISO 12913-1 and 2 (9).

1.2 Heinz Nixdorf Recall Study

Health and social data from the already georeferenced longitudinal Heinz Nixdorf Recall (HNR) study will be used, initiated in the year 1999 (10). It is a large epidemiological cohort study conducted in the Cities of Bochum, Mülheim/Ruhr and Essen, located in the densely populated Metropolitan Ruhr region. The study was designed as an individual based observational study with a sample size of 4814 men and women, aged 45-74 years. The participants were drawn from the mandatory registries of the three cities (10).

In order to be eligible for the SALVE study, the following inclusion criteria were applied: (i) participant in the HNR study in the third follow up (2011-2015), (ii) Participant residing in the city of Bochum. For the purpose of the SALVE study, seven health-related variables - mental health, neighborhood satisfaction, blood pressure, sleep medication intake, smoking behavior, Body Mass Index (BMI) and comorbidity - were obtained from the HNR study.

1.3 Soundscape Perception

Soundscape perception analysis will also be conducted to assess the preference of participants for measured acoustic environments, recruited as a convenient sample via press and radio. Participants rank their perception preferences for different sounds using the software Turning Point. To ensure standardization of the sound perception part of the study, the turning point questionnaire is taken from the soundscape method A in ISO 12913-2 (9). Knowledge on identified acoustic environments will be used to identify how people experience and perceive these sounds within their environment.

2. RESULTS

In March 2019, we started with our direct sound measurements. Since then, SALVE field members have carried out direct sound measurements approximately twice per week. We divided the different measurement locations into 35 clusters. These clusters consist of approximately 20 to 32 measurements points. Specific routes have been created within these clusters with ArcGIS Network Analyst to reach the locations as easily and efficiently as possible. As devices are very sensitive to rain, days with heavy rainfall had to be postponed to another day. All field days were accomplished in the first two months. Overall, our field members walk approximately 12km during these field days. Furthermore, they record data on temperature (in Celsius), humidity, air pressure and wind speed.

In May 2019, we located all 24 automated devices on trees either on public ground (18 devices) or in private gardens (6 devices). In order to inform the public that specific recording are in place, we created leaflets with all the information as well as worked in close contact with the city of Bochum. In order to place such devices, either a consent form (according to newest data protection laws) as well as consent from the city was needed. As we are recording audio data in a densely populated area we needed to make sure that we inform the population in a correct manner.

As we recently started recoding sound, we will present further methodological aspects of SALVE during the conference. Furthermore, we will give first results, as well as insights into practical experiences of acceptance, data protection and into opportunities as well as pitfalls, which arise during a large sound data collection and analysis project in urban and densely populated areas.

3. CONCLUSIONS

This paper shortly presents SALVE and its novelty (7). A large set of recordings from the urban environment with both automated and direct recordings will be collected thus resulting in a large sound dataset, which can also be applied for follow up studies. SALVE is a combination of measuring the acoustic quality in urban environments and considering people's perception of these acoustic environments, also known as soundscapes (7).

As this is a pilot study we will be testing possibilities and approaches during different stages of the implementation phase. SALVE will give first insights into possibilities that can lead to further research projects in urban environments on acoustic quality and health. Overall, the application of sound metrics in urban environments will provide a deeper understanding of sound than traditional decibel focused metrics used in noise-related studies. In any case, the pilot study will achieve important preliminary results that will allow the description of the quality of acoustic environments in a comprehensive manner and the investigation of possible implications of urban soundscapes for a healthy urban environment.

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