



Proceeding Paper Conscious Walk Methodology Design for Acoustic, Air Quality and Biodiversity Evaluation in Urban Environments [†]

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Abstract: Environmental noise and air pollution, as well as poor green infrastructure quality, are major concerns for the European population due to their impacts on citizens' health, especially for those citizens living in urban environments, which materializes in a rising number of complaints to public administration. This issue is further stressed for urban areas located close to aggressive sources of such pollutants, such as airports, railways, highways, or leisure areas. To attend to this situation from the viewpoint of citizens' everyday lives, this paper proposes a hybrid methodology in the form of a collective campaign in which citizens, especially those from environments that have a stronger impact, cooperate with scientists to collect high quality acoustic, chemical, and biodiversity data. The campaign consists of a conscious walk that considers acoustic measurements conducted by both experts and citizens, coupled with air quality measurements and biodiversity descriptions. The final goal of the method is to obtain subjective and objective data on the soundscape, air quality, and biodiversity in order to evaluate a pre-designed route in an urban location, namely, in the surroundings of Parc de la Ciutadella, Barcelona, Spain.

Keywords: acoustic pollution; air pollution; biodiversity; citizen science; sensors

1. Introduction

Many studies have shown that several pollutants existing in urban environments severely affect citizens' health [1]. From the acoustics point of view, the perception of the quality of the environment is defined as the *soundscape*, a term coined in the 1960s by M. Southworth [2]. The soundscape concept considers the acoustic environment in the context of its perception by humans. There are other impacts on people in addition to sound. Air pollution and the biodiversity existing in their living environment affect peoples' perception of the quality of their surroundings. A study by the Institute of Global Health of Barcelona (ISGlobal) reveals that NO₂ is responsible for more than 9150 premature deaths per year in Spain alone [3]. Pollution and traffic noise is an invisible killer, as citizens are not really aware of the impact of combustion cars. A radical change in citizens' mobility would imply a direct reduction in premature deaths [3]. Biodiversity in urban environments has wide benefits as well. Air pollution is reduced thanks to vegetation, which decreases breathing illnesses in citizens as well as the probability of having serious diseases [4], heart conditions, endocrine disorders or mental disorders, among others. In addition, vegetation



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Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (https:// creativecommons.org/licenses/by/ 4.0/). regulates temperature and humidity, which in turn improve peoples' comfort without any additional cost, mitigating the effects of climate change in cities. Being surrounded by *green* and *blue* environments has been shown to decrease stress and improve cognitive development, tranquillity and calm, specially in children.

In this case, conscious walks, understood as a practice of mindfulness, bring participants to a deep state of relaxation that can only be experienced by the absence of mental chatter. Specifically, conscious walks are organized activities in which citizens are invited to follow a guided route while paying special attention to their environment in three different axes: soundscape, air quality, and biodiversity [5]. In this sense, conscious walks involving investigators from different sociocultural backgrounds and disciplines can become a very efficient tool to explore several dimensions by means of different approaches:

- **Soundscape:** The soundscape is usually characterized by soundmarks. The perception is dominated by acoustic comfort. Nevertheless, soundscape descriptors have been used s well [6] in the development of predictive models of perceived affective quality.
- Air quality: air quality is measured by scientists using different approaches. First, the Copernicus European system provides maps with high coverage and 7 × 7 km² spatial sampling all around Europe [7]. An example of a map can be seen in Figure 1. However, this resolution does not allow for the identification of air pollution at the level of different streets in a neighbourhood. The European Commission provides information on the current air quality situation based on measurements carried out at more than 2000 air quality measurement stations across Europe. In Spain, control and surveillance of air quality are carried out through networks maintained by the autonomous communities and local entities. Thus, national and regional authorities use maps generated from the interpolation of measurements acquired at reference stations located in relevant points of the territory, among others [8].
- Biodiversity: biodiversity is usually analyzed by biologists, who identify different species and characterize the different habitats that are present in the city. There are an increasing number of apps which allow citizens to identify species in a collaborative way, e.g., Inaturalist (https://www.inaturalist.org (accessed on 14 December 2022)).



Figure 1. NO₂ levels in Europe in March 2021. ©DEFIS_EU.

This paper describes the design of a conscious walk activity that took place on May 2022 in the city centre of Barcelona, Spain. The next two sections detail the conscious walk concept and design, with the aim of encouraging scientists worldwide to organize

similar activities in their locations to promote environmental conscience among the general population. Finally, several conclusions and future work is detailed.

2. Conscious Walk Description

The conscious walk design attempts to describe several different urban environments from the three aforementioned axes: (*i*) soundscape, (*ii*) air quality, and (*iii*) biodiversity. This impacts directly on the design of the places where the volunteers walk, the stops they make, and the intermediate stages from one stop to the other, as well as the starting and ending point.

From the soundscape approach, the method of soundwalking was initially explored by Murray Schafer in the 1970s in the framework of the World Soundscape Project (WSP). He wanted to explore the relationship between humans and the sounds in their environment and what happens to human perception when the sounds change [9]. From his point of view, a soundwalk is defined as "any excursion whose main purpose is listening to the environment" [10,11]. The main difference between a soundwalk and a conscious walk is that whereas the first only assesses the acoustic environment, the latter explores the three axes described above.

During a conscious walk, the participants assess the acoustic environment and provide feedback about their perceptions. Air pollution is invisible to citizens. Only when approaching a can city the pollution cloud be clearly observed. For the most part, it cannot be detected by smell. Thus, air pollution is an almost invisible enemy for citizens. Simply through the effort of observing their surroundings and measuring some pollutants in real time [12], citizen can become really aware of the actual situation in their neighbourhood. Finally, from the biodiversity point of view, citizens are usually aware of which streets or squares are greener; however, this does not mean that they understand what these trees, plants, and the whole habitat (or microhabitat) mean. A conscious walk can help volunteers to discover the species of trees and birds, and whether these are indigenous or not; e.g., in Barcelona there are 75 species of indigenous birds registered, of which only 55 are protected by law, and there are several others that are non-indigenous (such as small street parrots). The conscious walk concept allows for the discovery of biodiversity isles. These spaces reproduce Mediterranean habitats on a small scale, and provide the city with wider biodiversity in terms of both plant and animal species.

3. Conscious Walk Design

The conscious walk was designed to be conducted by a small number of participants (a total of seven in the end), and took place on 23 May 2022 starting at 3 p.m.

3.1. Route Design

The conscious walk path was designed in such a way that very different areas of the city were visited. Starting from the harbour, one of the main noisy and polluted area of the city, the walkers moved through wide avenues, isolated squares, and two green parks. The evident contrasts in biodiversity and city uses in these spots allowed the participants to easily be aware of the daily noisy and polluted surroundings. The route is detailed in Figure 2, showing the starting point and the five selected stopping points. Figure 3 shows images captured at the above points.



Figure 2. Conscious Walk Route Design.



(**a**) Starting point.

(**b**) First stop.







(**d**) Third stop.





(e) Fourth stop.(f) final stop.Figure 3. Images of the stopping points on the Conscious Walk.

3.2. Evaluation of Stopping Points

The main goals of the conscious walk were introduced during the first stop at the harbour. Next, we walked to reach the first stop at *Plaça Comercial*, a pedestrian square in front of *Mercat del Born*. The participants were asked to examine the soundscape, air pollution, and biodiversity with the help of an online survey. The second stop was inside *Parc de la Ciutadella*, next to its entrance from *Passeig Picasso*. Here, we focused on the soundscape and biodiversity, again asking the participants to complete the survey for this location. The third stop was performed in another part of the same park, close to a meteorological station used by the city council to measure air pollution. This provided us with a perfect scenario to discuss the background air pollution in the city. The fourth stop was next to a waterfall inside the park, which is known to be pleasant from a soundscape point of view [13]. Sound, biodiversity, and urbanism were again topics of discussion. The last stop was performed in another green area, *Parc de l'Estació del Nord*, in which the soundscape, biodiversity, and air pollution were again examined. A summary of the conscious walk was made, with the participants sharing their conclusions and impressions.

4. Conclusions

The conclusions of this first work are encouraging. The results of the first Conscious Walk were surprising, due to the great diversity of knowledge that was transmitted to the volunteer participants by the leading researchers and to the precision with which all the participants were able to analyze all of the stops on the three axes of sound, air quality, and biodiversity. Very interesting discussions were held at each stop related to what the participants had personally observed and how these observations compared with the objective results measured at each point by air quality sensors and sound level meters.

Not all of the objective data measured by the air quality sensors and sound level meters and recorders that we carried during the Conscious Walk have yet been compared with the subjective data collected through the LimeSurvey link used by the participants to fill out the surveys. This final part of our study, which will allow us to evaluate the consistency between the measured objective and the participants' perceptions, remains as a future line of inquiry.

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Abbreviation

The following abbreviations are used in this manuscript:

WSP World Soundscape Project

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