

The "soundwalk" as an operational component for urban design

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ABSTRACT: In a previous paper, based on the case study of Place Paul Doumer, the hypothesis that urban soundscape contributes to the environmental quality of urban areas in the same way as microclimatic data does, was proposed. This paper now deals with the way in which soundscape analysis data could be used in urban design strategy. The concept of soundscape was developed in order to study the acoustic dimension of a site. It supplements traditional acoustic measurements, which only give a quantitative point of view; qualitative data is extracted from binaural audio recordings. The recordings were carried out several times per day for one week and are representative of sound ambiances on urban routes. The data are presented here in the form of acoustic images which correspond to time, frequency and sound level representation of the soundscape. As part of Silence Search Project, we will highlight the relationship between a site's soundscape, use and urban components. The aim of this study is to propose operational solutions to the urban designer so that he/she is able to carry out modifications in the city accordingly.

Keywords: urban design, comfort, soundscape

1. INTRODUCTION

In a previous study performed on Paul Doumer Square [1], the hypothesis that soundscape data are as important as microclimatic data [2] for public space users, was proposed.

In this new study the relationship between the morphology of public spaces and the soundscape is made explicit. The aim is to improve the tools to be used by the urban-planners in charge of rehabilitating existing public spaces. These tools will enable them to take the acoustic dimension of the site into account and to anticipate modifications accordingly.

The soundwalk method was chosen to provide soundscape data. It has to be performed before any rehabilitation, in order to be representative of the original environment of a site.

On one hand, as he/she has access to data from the soundwalk binaural recordings, plus architectural information, in addition to the aforementioned tools, the urban-planner will be able to measure the impact of modifications and understand how his/her choices might alter the soundscape.

2. METHODOLOGY

2.1 The soundwalk

The concept of soundscape, proposed by R.M. Schafer [3], enables us to describe acoustic ambience in an overall way, without any judgment on what is heard. Thanks to that, all urban noises contribute to the image of the city and to appropriation by its users. In fact, only noises which provoke some discomfort because of their intensity or because they blur the

perception of the most representative sounds of the city, have to be limited.

Listening to a city is trying to seize a mental representation, which is essential for the comfort of city-dwellers and inevitably, it has to be taken into account by decision-makers and urban planners alike.

The chief difficulty on the evaluation and the analysis of the urban soundscape lies in the multiplicity of sources to be characterized and in the appreciation of their predominance. More especially, the nature of the urban fabric, the morphology of the public spaces, the texture of façade materials, for example, have great influence on the diffusion of sounds and thus on the auditory impression they produce.

As it belongs to a school of architecture and landscape, the GRECAU research team is particularly interested in the relationship between urban space and generated ambiances. As a consequence, we have developed research methodology which can highlight them.

The introductory observations were inspired by the approach proposed by K. Lynch [4]. The interest induced by phonography is that every sound event can be preserved in a way which enables us to identify it. This is in contrast with the classical measurement of the spectrum which only keeps track of the A Equivalent Sound Level or others metrics like L10, L50, L90,...

The recordings are performed with a binaural microphone system (equivalent to a "dummy head") loaded by a walker and plugged to a DAT recorder. Thanks to the calibration of the tape it is possible to investigate each track in the laboratory afterwards. Sorting binaural digital audio recordings enables us to highlight well-differentiated urban forms: the simi-

larity of the 2 tracks means an almost closed space like a canyon street, for example.

Great differences between the 2 tracks characterize an open space, like a big square, for instance.[5].

Finally, because these recordings are performed at the soundwalker's height, and not at standard height (height of 5m and 2m away from the facade), the obtained signals are like the ones perceived by pedestrians.

This fact gives us relevant, real and significant information which can be added to the data obtained from the acoustic measurements. The combination of the two can be used while performing the interviews during which people listen to recorded sounds in order to know the opinion they have about their sound environment.

The resulting data can be analyzed either in the form of a 3D spectrum or in the form of an "acoustic image". This 2D representation corresponds to the evolution of the Equivalent Sound Level versus frequency during the soundwalk time, and gives, as such, a visual translation of the auditory impression.

Every image, with key (Fig. 1), which attributes a colour (or a grey shade) to every range of Sound Pressure Level (SPL) according to a scale, which goes from 10 dB to 100 dB, is related to its evolution versus time.



Figure 1: Key explaining the colours corresponding to SPL range in dB

Thus, the soundwalk methodology is accessible to users, urban-planners, and city decision-makers. It also keeps track of the soundscapes in relation to the heritage of the city..

2.2 Analysis grid

The use of a grid in order to structure thinking methodology has already been tested in a former study [6]. It enables us to integrate varied and very different data (qualitative, quantitative, intuitive...) organising it without necessarily ranking it. A grid can be developed by using either ascending or descending methodology:

Ascending methodology:

The analysis grid is based upon the overall amount of measurable or quantifiable data which seems to have a relation with what we want to highlight. Afterwards, these data are grouped into categories or topics and subtopics (Fig. 2).

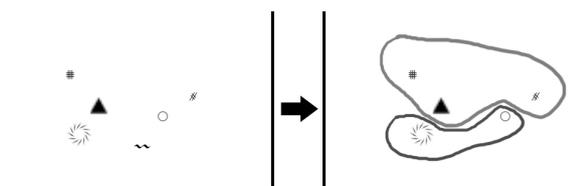


Figure 2: Ascending methodology

Descending methodology:

Series of complementary categories are defined. They are detailed using criteria and sub-criteria so as to obtain elements which can be assessed (Fig. 3).

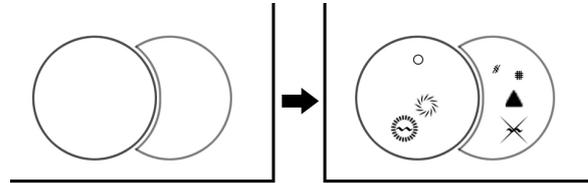


Figure 3: Descending methodology

In general, both methodologies are used in an iterative way. A list of everything that seems to be in relation can be highlighted: topics or categories and measurable or quantifiable parameters at the same time.

So, the elements in topics or families are organised so that every identified parameter finds one position only. Now, certain parameters can be reorganised so that they relate to just one topic. Otherwise the topic series which seem to not be complementary can be taken into consideration (Fig. 4).

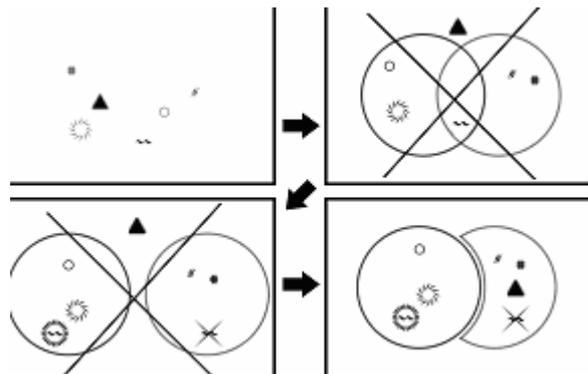


Figure 4: Ascending-descending combined methodology.

We are interested in the data which highlights the relationship between a site's soundscape and its morphology. Morphology is regarded as the element the urban-planner will modify.

The soundscape will be identified using soundwalk methodology and morphology, using traditional space representation techniques (plans, façades, elevations, side views).

While modifying the site's morphology, the urban-planner will also change the locations of different activities, therefore the sound sources will also be changed. The elements related to these activities must also be integrated in the grid.

Two categories have been defined so far, the site's morphology and the site's sound source layout. Actually, it is the combination of these two families which enables us to define the soundscape as such:

- Morphology of the hollow volume constituting the site's space.
- Use of noise sources

Secondly, we decided to add a topic which includes elements which do not involve 'use' but which

belong to the soundscape. Each topic is then detailed into criteria defined by measurable parameters.

Morphology constituting the public space under study:

- Ground.
- Buildings.
- Plants and trees.
- Urban furniture.

Activities present (noise sources):

- Means of transport.
- Human activities.
- Mechanical activities.

Other elements (noise sources):

- Water
- Air
- Animals

Regarding the category "Means of transport.", even though it could be a part of either "human activities" or "mechanical activities", we chose to create a separate classification as transport constitutes an essential element of the Silence Project.

The two other classifications are "human activities" and "mechanical activities" and not "human sources" and "mechanical sources" because in this study, not only acoustic parameters, but also spatial and temporal parameters have been taken into account

2.3 Complementary use of the soundwalk and the grid.

The soundwalk will be used as a part of the aural memory in the same way photographs will be used as a part of the visual memory. The data obtained after the soundwalk study will enrich the analysis of the site in the same way as architectural information will give elements about the site's morphology.

The soundwalk will then enable us to have the quantitative and qualitative data concerning the site's acoustic aspects. It will also give us some information about some of the parameters included in the grid.

3. CASE STUDIES

For the Silence research project, four European cities are in partnership, urban sites were put forward according to the following criteria:

- The site should either have been studied already, or should be part of a rehabilitation project.
- The site should suffer from acoustic pollution caused by transport.
- The site should be used by pedestrians.
- Pedestrians will be able to stay there for a substantial length of time.
- Quality of outside space and comfort of pedestrians should be important.

The protocol described in the second paragraph was applied on the following four sites:

- Barcelona, a section of the Rambla
- Brussels, section II of the Roi Baudouin Park
- Genoa, the historical city centre
- Bristol, Queen square to the Centre.

The case study presented here deals with some results from the Brussels soundwalks.

3.1 Description of the site

The Roi Baudouin Park stretches over a large area in the North West part of the city and is bordered by a railway-line. It is split into 3 sections by busy roads. The section chosen for the study is located close to a dual carriage-way/two-lane road (Fig.5).



Figure 5: Map of the Roi Baudouin Park (Section II) and detailed site.

In spite of a planted earth mound (berm), as a noise barrier, IBGE, Brussels-Capital, the institution which manages all the city parks in Brussels, has noted a bad frequenting this part of section II. That is why IBGE has requested solutions from the team in order to improve the soundscape within the context of global planning of new parks.

One of the other interesting features of this part of section II is the presence of a fountain (X in Fig 6) which does not work all year around.

Soundwalks were carried out in the whole area of section II but only data from one part's recordings are presented here. They were conducted 3 times per day (in the morning, around noon and at the end of the afternoon) on 3 specific days in the week: Thursday, Friday and Saturday. During the soundwalks, the fountain never worked, whichever day it was.

Two soundwalks (route A and route B) were performed at the same time (Fig 6 and 7), one on each side of the earth berm enabling us to know the impact of the mound on the soundscape.

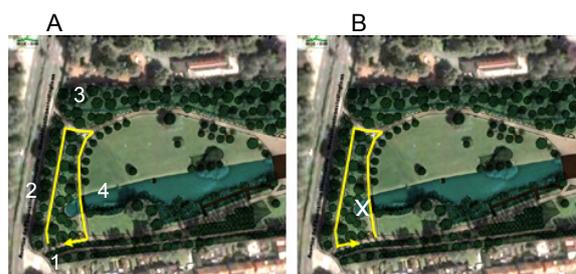
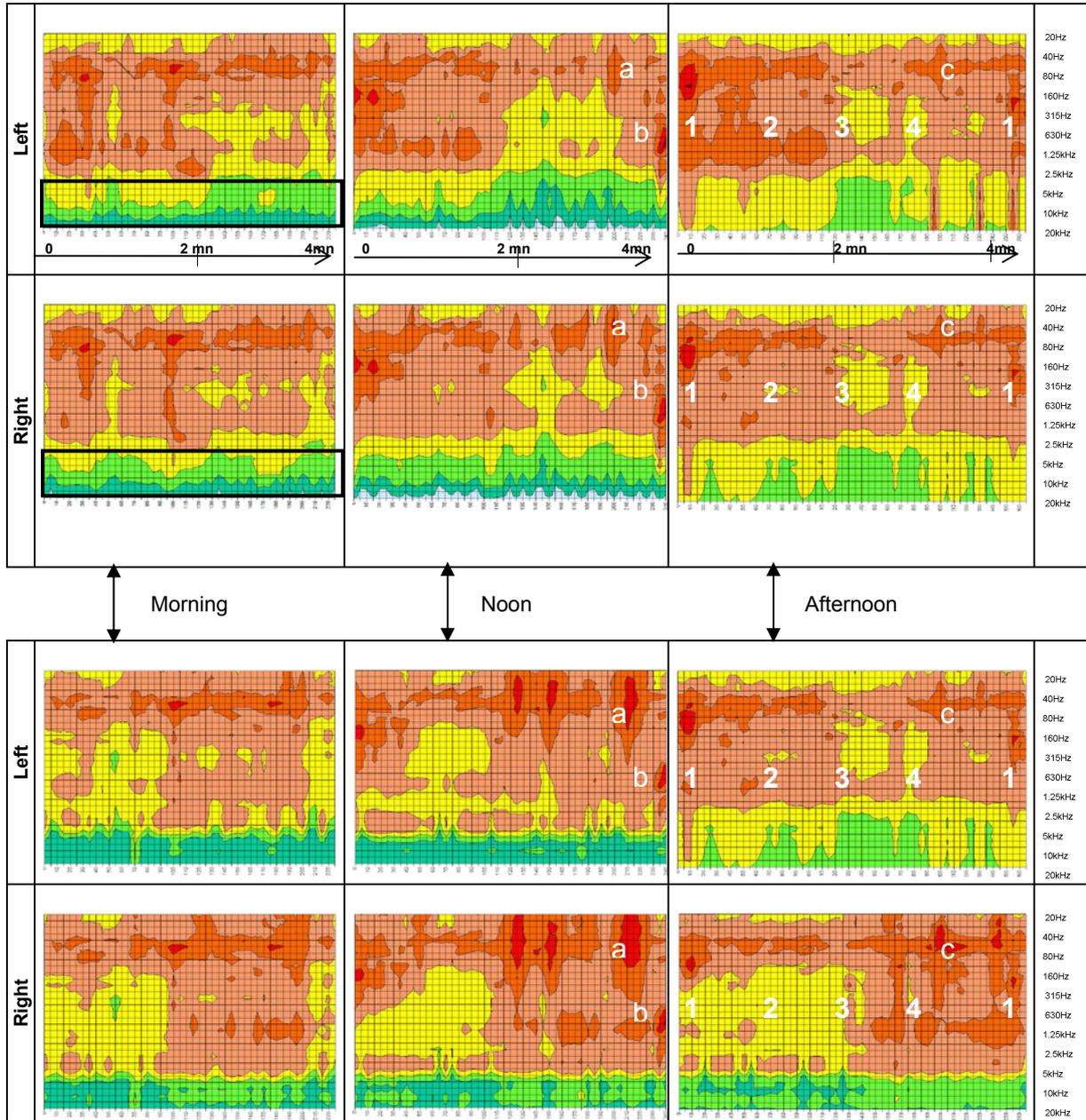


Figure 6: Soundwalks A and B



Figure 7: View at the start of each route (A and B)

Soundwalk A



Soundwalk B

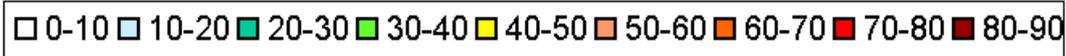


Figure 8: Thursday soundwalks left and right acoustic images

3.2 Comparison between soundwalks A and B

For each soundwalk, the binaural recordings enable us to underline the masking effect of the walker's head in a high frequency range when the site is an open space: for example, see the black rectangular frames on the left and the right ears in soundwalk A (Fig 8).

Moreover, each part of the route is clearly identified on the acoustic images of both soundwalks: from

the first edge of the berm (point 1), in front of it on the road side (point 2), at the second edge of the berm (point 3) and behind the berm on the park side (point 4) (Fig 6 and 8).

The comparison of the binaural recordings from soundwalks A and B enables us to highlight the impact of the earth berm on the sound level. The efficiency of the noise barrier in a large medium frequency range is effective. The decrease in SPL is due

to the masking effect in the wavelength range, corresponding to the height of the berm.

Because this height is not regular over the whole length of the berm, the efficiency varies when the walker is moving. The fact that walker B is smaller than walker A increases this effect, particularly in the high medium frequency range. So, one can conclude that increasing the height of the berm engenders better efficiency as a noise barrier in this frequency range and for the area behind the mound.

The acoustic images enabling us to highlight the spectral signatures of recorded sound sources [7]. This masking effect can be verified for a lot of activities, human, mechanical or natural. For example, on the noon soundwalks A and B (Fig 8) the "a" marks correspond to a gust of wind in the area in front of the berm (road side) so the SPL is higher for walker B than for A at that moment.

A little bit later during the same soundwalk the "b" mark refers to a van's siren on the road side. During the afternoon soundwalks, the "c" mark corresponds to the passing-by of a train from section III to section II. The SPL is always higher on the road side (route B) because the train is in direct view. At this moment, route A is partly hidden by buildings located between the park and the railway-line.

4. APPLICATION OF THE GRID

Only general comments about each grid topic are presented here. In a comprehensive study, each topic is detailed through relevant criteria and presented in single graphic documents.

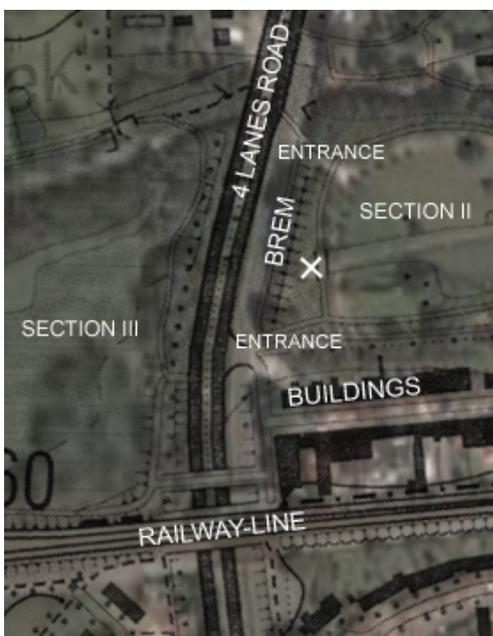


Figure 9 : Different elements of the site

Morphology constituting the public space under study:

Ground

Here the soil plays an important role due to the presence of the planted earth berm. The foot paths are paved (Fig 6).

Buildings

The buildings along the railway-line close to the site have an impact on the soundscape (Fig 9).

Plants and trees

Deciduous vegetation is present on the berm. This is an important fact because during the period of the soundwalks (April) there were no leaves on the trees and almost no plants on the mound (Fig 7). In summertime, (Fig 10) thick vegetation increases the efficiency in high the medium frequency range by absorbing sound.

Urban furniture

No relevant parameter in this case study, because there is no urban furniture on the site which could have an impact.

Activities present (noise sources):

Means of transport.

Several means of transport. are audible: cars, buses, trucks, motorbikes, airplanes, trains and cyclists.

Human activities

On the site there are two entrances to the park which are used by a lot of pedestrians (adults and children).

Mechanical activities

The maintenance of green spaces is the main activity which has real influence on the soundscape.

Other elements (noise sources)



Figure 10 : The fountain in summertime

Water

The fountain situated at the foot of the berm is a very interesting feature of the site (Fig 10). Unfortunately, it was not working during the soundwalks and for that reason its lack of presence is a negative feature in the soundscape. Indeed, a previous study showed how the spectral signature of the falling water is determining factor[8].

Air

Some gusts of wind are audible but only slightly. The direction, the intensity and the frequency of wind is related to the seasons and climatic conditions, that is why there is a need to perform soundwalks during other periods of the year.

Animals

Birds, and more particularly ducks and geese, are representative of the natural aspect of the site. Once again bird song depends on seasons and may represent only a temporary feature of the soundscape

5. SUGGESTIONS FOR MODIFICATIONS

The analysis of acoustic images and the data in the grid for improvement of the soundscape of this part of the park, enables us to propose the following solutions:

1 – Increase the height of the berm either by bringing more earth and/or changing the type of vegetation: evergreen rather the deciduous.

2 – Re- design the entrances to the park in order to filter sound in the low frequency range. The size of the zigzag must allow council vehicles only to access other road noises would be reduced

3 – We recommend the use of the existing fountain with powerful water jets, all year round.

6. CONCLUSION

The study and analysis of the data obtained from the different cities, can be used as a means of validation for the methodology .

If too many adaptations were necessary for it to be operational in every context, we would understand that it is not appropriate. However, if it seems adequate for these four, very different cities, it shows that this methodology could be validated as it has a wide enough reach.

Because the recordings are provided in movement in spaces in which sound sources are also in movement, the data are not to be used for the auralisation of streetscapes. Likewise these recordings carried out in situ are characterized by the site's morphology and are not suitable for supplying simulation software.

However, part of the data can be used by the cities to propose virtual visits of typical urban sites with pictures and sound, in CD form or on the city website. Those data could also be a patrimonial testimony of the former urban landscape and soundscape, after some urban redevelopment.

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