

www.noiseineu.eu: New tools to inform the public about environmental noise in cities and to assist decision-making

Fanny Mietlicki, Christophe Mietlicki, Carlos Ribeiro, Piotr Gaudibert
Bruitparif, Noise observatory of the Paris region, Pantin, France.

Bruno Vincent, Vincent Gissinger
Acoucity, Soundscape and noise observatory of Greater Lyons, Lyons, France.

Summary

The complexity for citizens and policymakers of understanding usual noise indicators expressed in decibels is a limit to their acceptability and to decision-making. Thus, within the framework of the HARMONICA project financed by the European Commission (LIFE program), an easy-to-understand and easy-to-use noise pollution index was created. Based on a score from 0 to 10 and taking into account both background noise and noise peaks, the HARMONICA noise index is closer to the feeling of the population than usual noise indicators. This new index is also very easy to calculate on an hourly basis, using data collected by noise measurement devices.

In order to promote this new approach, to raise awareness of noise pollution and to share experience about best practice to fight against noise around Europe, a website www.noiseineu.eu has been developed. This website contains an on-line platform displaying, in an easy-to-understand graphical representation, the results of the HARMONICA index in the European cities which have decided to join the initiative. It also promotes concrete noise reduction initiatives carried out by local authorities and their partners, in order to help local authorities draw up their action plans for implementing the 2002/49/EC directive. For cities interested, it is very easy to join the platform and to contribute to the database of noise abatement best practices around Europe.

This article presents a description of the tools which are available on-line on the www.noiseineu.eu website and the methodological approach to create them.

1. Introduction

Transport, industry, commercial and leisure activities... There are so many noise sources, especially in dense urban areas. Noise pollution is very intense in cities and most of the time is considered as unavoidable for citizens and policymakers. They can sometimes feel helpless.

Increased awareness of noise pollution by the general public and the authorities is a necessary and indispensable lever for improving the effectiveness of policies to reduce environmental noise.

It was in this context and to meet this objective that Bruitparif and its partner Acoucity, two local French non-profit associations specialising in the observation of environmental noise, in their respective regions (Ile-de-France for Bruitparif and

Greater Lyons for Acoucity), asked the European Commission to support the HARMONICA project (Harmonized Noise Information for Citizens and Authorities).

The HARMONICA project had several objectives:

- Make information on noise more accessible and closer to people's perceptions by eliminating the technical terms that are difficult for laymen to understand.
- Assess noise abatement actions in a harmonised way and promote effective actions, in order to help the authorities to draw up their action plans to implement the 2002/49/EC Directive.
- Facilitate the transfer of this approach to European cities.
- Contribute to the development of a common and shared culture allowing everyone to better understand the noise to act.

Three new tools have thus been developed during the project:

- The HARMONICA index, a noise pollution index that is easier to understand and more closely reflects the reality of noise nuisances as they are perceived by the public.
- A collaborative database of noise abatement actions carried out in European cities in order to facilitate discussions between stakeholders and boost noise prevention policies.
- An on-line platform www.noiseineu.eu to display the results of the HARMONICA index in European cities and to share best practice.

This article presents a description of these tools and the methodological approach to create them. A methodological guide [1] is also available to provide keys to use these new tools.

2. The HARMONICA index

2.1. Why a new index?

Whether the information about noise is presented in the form of strategic noise maps or in the form of measurement results, it currently remains difficult for laypeople to understand because of the many indicators used (L_{den} , L_n , L_{Aeq} , L_{A10} , L_{A90} , NA , and L_{Amax} , to name just a few), which are complicated to explain and relatively far-removed from inhabitants' perception. Furthermore, the unit used by these indicators - namely the decibel - has the disadvantage of being complex, with the addition of two noise levels expressed in decibels being logarithmic rather than arithmetic. All these reasons make it even more difficult for the authorities and the general public to take ownership of the noise issue.

A survey of 800 people [2] was conducted at the beginning of the HARMONICA project, in order to evaluate the general public's current level of knowledge and expectations in terms of information on the noise environment. The results obtained confirmed the idea that the public has difficulty understanding the information currently provided about noise. The survey confirmed that respondents' understanding of acoustics is very fragmented and that they have difficulty estimating noise levels of everyday events and situations. The survey also revealed that the public believes that information about noise peaks that occur during

the day would effectively complement the measurements of noise levels.

It was therefore becoming essential to provide information that is easier to understand and more closely reflects the reality of noise nuisances as they are perceived by the public.

2.2. The development of the index

A combination of statistical analysis carried out on database of measurements and of interviews with residents, as well as tests in laboratory conditions enables to propose the formula of the HARMONICA index. A three-stage methodology was thus designed for the creation of the new index.

1st step: proposals for the index

The choice of the parameters involved in the construction of the index was based on a preliminary statistical analysis carried out on a database of elementary acoustic measurements ($L_{Aeq,1s}$) from 24 sites that are representative of various types of noise exposure (road noise, railway noise, aircraft noise, multi-exposure and quiet areas) in a variety of environments (urban, suburban, and rural). Around 60 different energy- and event-based descriptors used in the available literature or proposed by the teams were calculated on an hourly basis using this elementary data from all 24 sites. By running a Principal Component Analysis (PCA), the correlation between the 60 descriptors was studied in order to evaluate the descriptors that were interrelated (redundancy), thereby eliminating those that measure the same thing and defining families of descriptors that are uncorrelated and, therefore, which provide complementary information.

Using this PCA, it was possible to retain two main families of interdependent and complementary physical descriptors, which explained more than two thirds of the variance of data:

- Descriptors of average noise levels or percentile levels (level of noise exceeded for x% of the hour) in blue in figure 1.
- Descriptors of the variation of noise related to events (noise peaks that emerge from the background noise) in orange in figure 1.

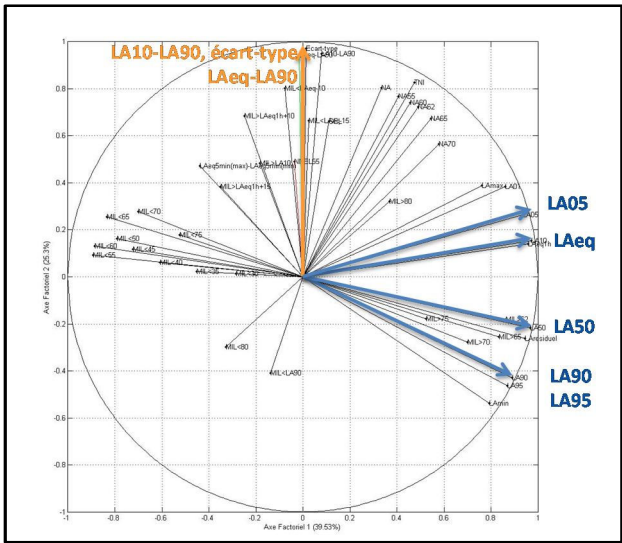


Figure 1: Results of PCA

Then the teams suggested 4 proposals for principles of the index based on various compositions of descriptors corresponding to these two families (see figure 2).

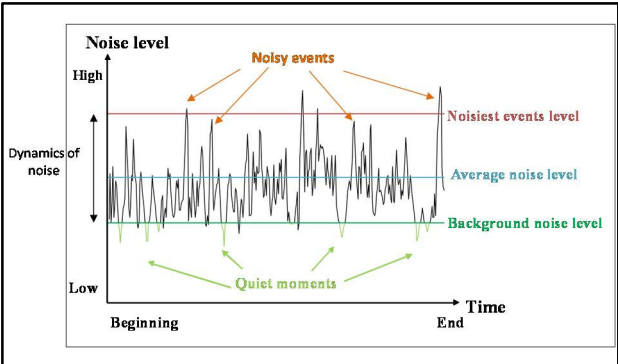


Figure 2: Descriptors which have been used for the 4 proposals for the new index

The 4 proposals were based on the following composition of descriptors:

- IND-1: background noise, dynamics of noise and number of noisy events.
- IND-2: periods during which noise levels remain below thresholds.
- IND-3: average noise, background noise, number and duration of the quiet moments, level of the noisiest events.
- IND-4 (reference): average noise.

2nd step: Consideration of the public's opinion and perceptions

The suggested proposals were compared with the public's impressions using face-to-face interviews with 246 residents from 8 areas chosen for the

diversity of their exposure to noise, and tests in laboratory conditions (individual interviews following binaural playback) on three groups of respondents: general public, associations, and local authorities (130 people in total) [2].

The aim of this research phase was to evaluate the comprehensibility, the acceptability, and the relevance of the suggested indices and to take into account people's responses in the final design of the index.

The results obtained for the surveys show that no index can be excluded because of its non-understanding.

When asking for the relevance of the suggested indices to reflect the respondents feeling, proposals IND-1 and IND-3 appear to be the most appropriate (see figure 3), with more than 79% positive responses in field survey as well as in laboratory survey.

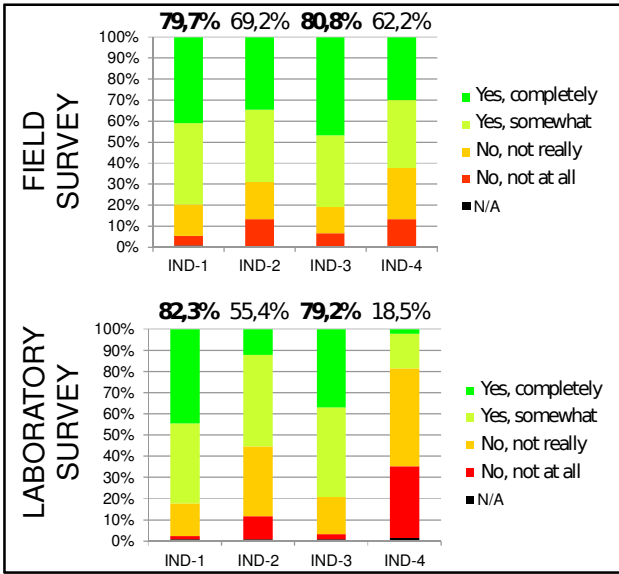


Figure 3: Results of the surveys regarding the relevance of the new index

Taking into account these surveys' results, the teams decided to design the new index as a sum of two components which proved to be both easy to understand and appropriate to reflect the people perception:

- a component relating to the background noise (BGN);
- a component relating to the sound events (EVT).

3rd step: Development of the formula of the index

The precise formula for the index was then defined by testing different descriptors selected to represent the two components (BGN and EVT) in operational conditions, on all the operational measurement data stored by noise observatory Bruitparif for year 2013, in order to take into account the diversity of environmental noise situations.

These tests led to the elimination of some descriptors that proved to be insufficiently robust and the adjustment of the coefficients of the index formula, in order to present the variations in hourly noise levels on a scale of 0 to 10.

This last stage resulted in the following formula, as described in figure 4:

$$\text{HARMONICA index} = \text{BGN} + \text{EVT}$$

$$\text{BGN} = 0.2 \times (\text{LA95eq} - 30)$$

$$\text{EVT} = 0.25 \times (\text{LAeq} - \text{LA95eq})$$

Where:

- *LA95eq* is the equivalent background noise level during the one-hour period, the background noise being evaluated every second by the noise level exceeded 95 % of the time during the previous 10-minute period.
- *LAeq* is the equivalent noise level during a one-hour period.

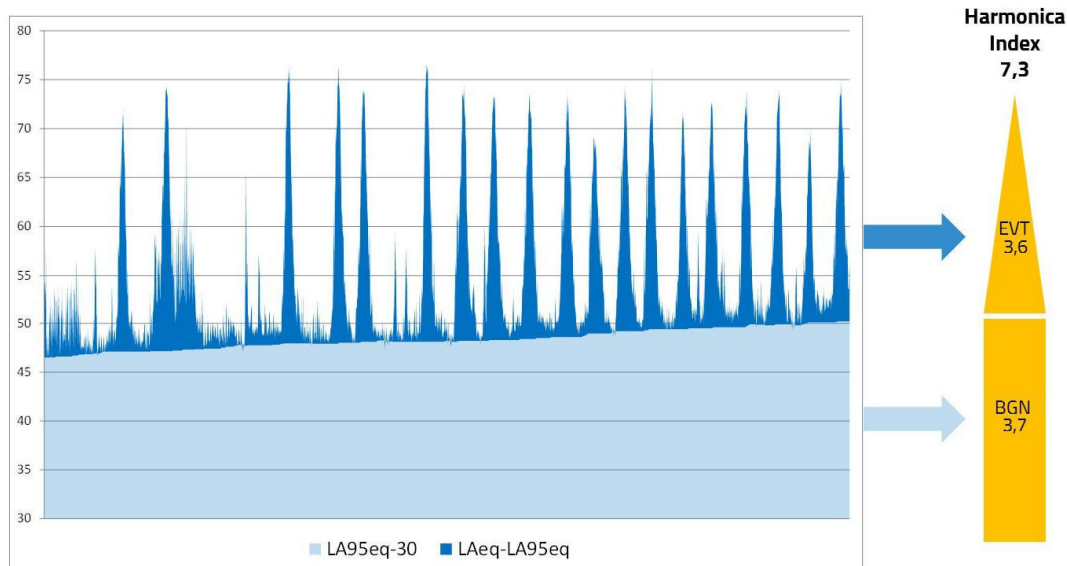


Figure 4: the HARMONICA index calculation for one hour measurement.

The comparison between the HARMONICA index results and the perception score given by people during face-to-face interviews with residents from the selected sites for field survey shows a very good correlation ($R^2=0.96$) (see figure 5). That permits to think that the new index gives a good representation of public perception of environmental noise, in various situations.

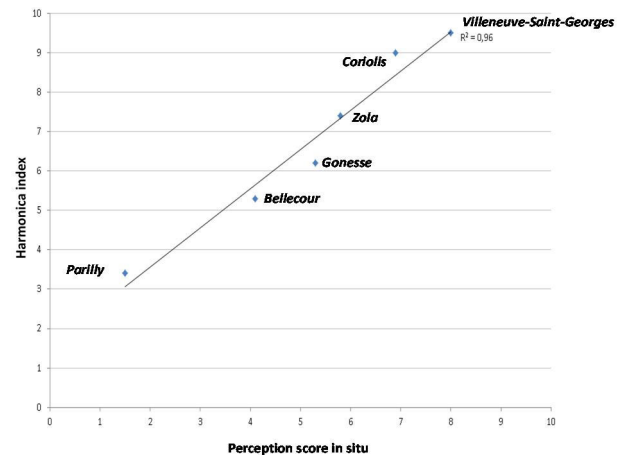


Figure 5: The HARMONICA index results versus perception score in situ

2.3. The representation of the HARMONICA index

The graphical representation of the HARMONICA index provides several elements of information about the noise environment in a concise manner.

One score for the noise pollution level

The HARMONICA index gives a score of 0 to 10, rounded to one decimal place. The higher the score, the poorer the noise environment is.

Two shapes to distinguish between the background noise and noise peaks

The graphical representation of the index is in two parts, a triangle on top of a rectangle, in order to clearly translate its components BGN and EVT.

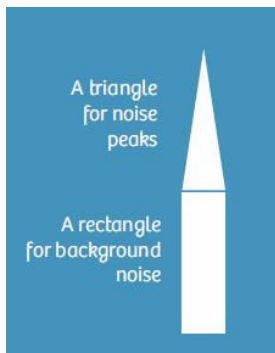


Figure 6: The components of the HARMONICA index.

One colour to indicate the situation compared to threshold values

The colour of the index (green/orange/red) indicates how the noise environment compares to the WHO's environmental quality objectives and the values recognised as critical for noise. These colours also take the time of day into account, as people are more sensitive to noise at night.

One index per hour and per period

The HARMONICA index is calculated for hourly time slots. An average value is also calculated every day for the day period, for the night period and one for the entire day (24h). It is then easy to calculate the average values for the index over longer periods (week, month, year) by simply averaging the daily indices.

To help users understand the new HARMONICA noise index, an informative and humorous animated film is available on the home page of the www.noiseineu.eu website and on YouTube: <https://www.youtube.com/watch?v=q6crbXu0pq4>

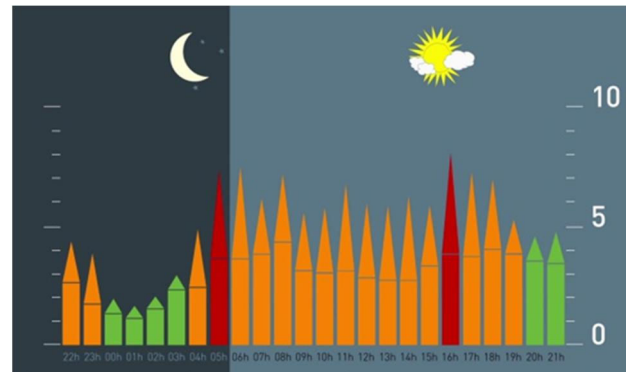


Figure 7: Example of hourly variation of the HARMONICA index over a 24h period.

2.4. How to test and publish the HARMONICA index?

The aim of the HARMONICA project is to get as many European cities as possible to distribute their observation data via the HARMONICA index on the platform developed for that purpose and hosted on www.noiseineu.eu

A Windows program named “Toots” was developed in order to calculate the HARMONICA index. It is licensed free of charge for use by any organisation or person. It can be requested by sending an e-mail to the address: join@noiseineu.eu. “Toots” permits to convert measurement values (LAeq,1s) into HARMONICA index results and to transfer them into the platform if wanted. Thus the noise data are automatically being made available alongside other European towns that are part of the network, in a simple and comparable format.

View results



Figure 8: The HARMONICA index platform.

For now, the platform essentially contains data coming from monitoring sites from the HARMONICA project's partners, Bruitparif (around 50 sites) and Acoucity (around 10 sites).

3. The collaborative database of noise abatement actions

The HARMONICA project also aims to share and promote noise abatement initiatives carried out by the project's various partners in European towns.

To do so, a database of best practice and noise abatement initiatives carried out by regional authorities, transport infrastructure companies, and their European partners has been created. For now, the database essentially features initiatives that have been listed and documented in the regions of the HARMONICA project's two partners, namely Île-de-France and Greater Lyons. To make it easier to diffuse and include as many initiatives as possible, this database is available online through the dedicated website www.noiseineu.eu

The database is structured in such a way as to promote different types of noise abatement solutions depending on their source: road traffic noise, rail traffic noise, air traffic noise, industrial/construction/commercial noise, recreational noise, quiet areas, town planning and development, prevention and raising awareness.

If a local authority wants to share the noise abatement initiatives that have been implemented, that is quite possible by simply completing the form template, available on the website and returning it, with any documents and illustrations, by email to the following address: join@noiseineu.eu. Initiatives will then be put on line as soon as possible.

4. The Noise in EU platform

Aimed at both the general public and the authorities responsible for managing the issue of noise nuisances, the web site www.noiseineu.eu comprises several general sections with clear and exhaustive editorial content about noise in Europe, the new HARMONICA index, its contributors and how to join the project. In addition, users can access the two technical modules (HARMONICA index results platform and noise initiatives database) and their useful user interfaces.

A survey conducted with a questionnaire at the end of the project on a panel of 843 people allowed to get the public's opinion on the Noise in EU website. 88% of people surveyed found the site's

sections interesting. 85% of people found the information clear. 83% of people improved their understanding of noise by visiting the website. This website, therefore, seems to perfectly meet the objectives set but improving understanding and ownership of the noise issue.

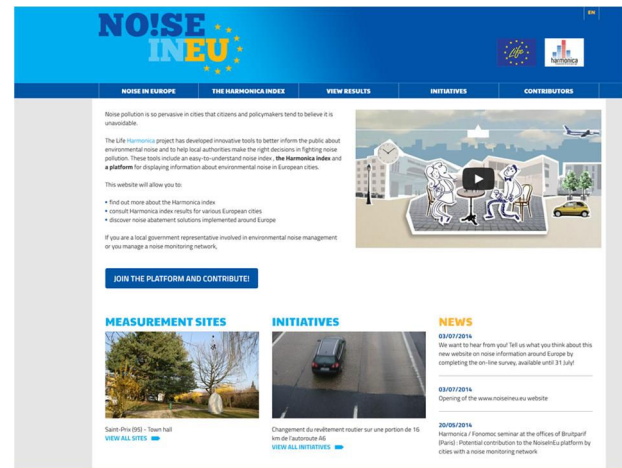


Figure 9: Home page of the Noise in EU website.

5. Conclusions

By communicating in a transparent manner using the HARMONICA index and by sharing the best practices and initiatives conducted in urban communities by the various stakeholders, the Noise in EU platform intends to become a key reference tool for reporting on environmental noise and decision-making at the European level. The aim now is to disseminate this approach and the tools among urban areas.

Acknowledgement

The project's partners want to thank the European Commission, the Regional Council of Île-de-France, the Urban Community of Greater Lyons as well as all the members of Bruitparif and Acouité for their confidence and financial support in the HARMONICA project. They would particularly like to thank also the members of Eurocities' WGN (working group on noise) who supported very actively the HARMONICA project.

References

- [1] F. Mietlicki: Methodological guide "Use of tools developed in the Life HARMONICA project". <http://www.noiseineu.eu/link/gm>
- [2] B. Vincent, V. Gissinger, J. Vallet, F. Mietlicki, P. Champevolier, S. Carra: How to characterize environmental noise closer to people's expectations. Internoise 2013.