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Index

1. Executive Summary

All pilot events might benefit from MONICA's technologies. The Active Sound Field Control system, the silent showers, and the real time monitoring will improve the experience of professionals, spectators and local residents. Since neither noise oriented surveys nor sound level measurements have been done during these events, this first report is highlighting the current local situation on partner's sites and the needs expressed.
The iterative process of the MONICA project will allow pilot partners to refine the noise assessment methodology with Acoucité. Year one, the objective is to evaluate current situation and define needs. Year two with adapted sound level monitoring, sound recordings and specific surveys, partners will have an accurate idea of the impact of the large scale event. Year three, the technologies provided by DTU and B&K will be optimised according to the collected information about sound environment and their efficiency at reducing the noise impact during the events will be tested.

In the end, the outcomes of this part of the MONICA project should be:

- Improve well-being of inhabitants and preserve health of spectators,
- Reduce noise-related complaints
- Provide a better knowledge of their territory to local authorities and establish links towards citizens
- Help to maintain large scale events in urban areas despite the challenges of noise issues

2. Introduction

The general objective of the Work Package 10 of the MONICA project is to assess the situation of the pilot sites in terms of acoustics and security and to propose an acoustic process.

This approach acts as an intermediary between the experts in the MONICA project (who will develop the solutions) and the local teams of the different pilot sites (who will test the solutions).

Acoucité is more particularly in charge of the acoustic part of the task 10.2.

Large scale events disturb the usual soundscapes in urban areas: gathering of thousands of people, streets circulation modified, amplified music propagating through public spaces… The MONICA project effectively integrates a wide range of solutions and tools to improve the sound quality for the spectators as well as the control of the noise annoyance of the neighbourhood. The noise effects on health have been identified by the World Health Organisation and the European Union decades ago. Large scale events are creating noise not always well identified or prevented. The MONICA project will provide technologies to take care of these issues.

The purpose of task 10.2 is to:

- propose the tools and methodologies for monitoring and assessing sound environments, in physical (sound level measurements), psychoacoustic and perceptual (surveys) terms.

- carry out an initial assessment of the acoustic expectations and needs (in the broad sense of the term) of the pilots,

This report presents, in the first part, assessment tools and methods (in physical and perceptual terms), and the proposed monitoring and survey solutions. These tools and methods may be adapted to the emerging needs of the pilot sites on a case-by-case basis. Acoucité will offer follow-up and assistance for their implementation in real situations on the different pilot sites by the pilot partners.

The second part of the report presents the assessment of the pilot sites to date. This assessment constitutes a stock of the situation, a diagnosis in the sixth month of the project. It is by no means definitive and will be enriched over the coming months.

This report therefore proposes an initial assessment of the pilot sites, following the meetings, on-site visits and returns of the questionnaires.

It also proposes the tools, methods and indicators to analyse the impact of the solutions deployed on the pilot sites; the proposed methods should allow identifying and characterizing, throughout the project, the variations of the noise sources that come from the events of the pilot sites and which affect the life of the neighbourhood.

The proposed tools, methods and diagnostics are not meant to replace national standards and regulations. Instead, they constitute a "tool box" that is most adapted to the project's problems.

In summary, the final objective of the approach presented in this report is to propose on the one hand, an initial state and on the other hand, a methodology capable of assessing the acoustic changes generated by the solutions developed to minimize the impact of the events on the neighbourhood.

3. Noise consulting

3.1 The different kinds of expectations in monitoring

Task 10.2 of the MONICA project consists in assessing the needs of the six pilots concerning the noise problem in urban areas and advising the pilot partners on the different solutions proposed within the acoustic ecosystem (Work Package 4).

This ecosystem can be divided into three main parts:

- **Monitoring** is a complete solution consisting of the use of IoT Sound Level Meters (SLM) developed by B&K to measure sound levels at strategic locations and send the collected information in real time to event organisers, public services, spectators and the neighbourhood. This solution can be enriched by sound levels recorded by other IoT devices such as mobile phones or wristbands. It will be necessary to evaluate the uncertainty associated with these connected objects in their acoustic measurements.
- The **Sound Field Control system** is a system that allows sound to be focused on the spectators' area and reduced outside of it to preserve the neighbourhood.
- **Silent showers** are active systems to reduce sound levels on a localized area for health workers or event organisers.

Monitoring can have two purposes which might be complementary:

- Monitoring compliance with **regulations**
- **Information** from event organisers and the public

As a first step, monitoring ensures that regulatory levels are respected. Often, this condition is attached to the right of exploitation. If sound levels exceed thresholds, sound engineers may be forced to lower the volume of the amplified music or have their permit cancelled. Indicators and limit values are defined in regulatory texts such as laws, decrees, ordinances or orders. This aspect is very important for private companies: Tivoli, Kappa Future Festival...

In a second step, monitoring can be a tool to get information that can have several uses. Sound levels can be cross-checked with health data to study health aspects (section 3.2), be correlated with the annoyance expressed by the neighbourhood, and serve as a basis for communication between local elected representatives and the neighbourhood. The information obtained can lead to the evolution of the practices of the stakeholders as well as an evolution of the regulations.

Communication of results can be envisaged at different levels and for different audiences:

- Local authorities
- Neighbourhood
- Spectators

The choice of informing the public involves a work on the indicators or indexes to make the information easy to access and understandable.

The pilot sites followed during these three years (2017-2019) will be totally or partially equipped with the MONICA ecosystem: Sound Field Control system, apps, monitoring and silent showers. The deployment of technical resources will be linked to the needs expressed by the pilot sites and will also depend on the logistics of the project.

When the system is installed, special attention will be paid to the sound quality of the event experienced by the spectators. The assessment of the perception of sound reproduction becomes important as there is a direct action on the sound system. Apprehensions can then be felt by event organisers and public services.

3.2 Noise effects on health and acoustic discomfort

"*Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity."* **(W.H.O. 1948)**

The scientific studies focus more on the effects of transportation noise on health. Nevertheless, whatever the source of noise is (industrial noise, construction noise, even musical "noise", etc.) its effects, direct or indirect, on health are now fairly well identified.

Sound environment in general and noise in particular are a major concern of citizens in their approach to the problems of everyday life:

- within their dwelling
- in their leisure activities
- when traveling
- at their workplaces

The health, social and economic costs of noise are difficult to estimate, but several studies converge in the same direction. Globally, 1.1 billion teenagers and young adults are exposed to the risk of hearing loss due to high-volume listening (music and night clubs) over long periods of time (1 hour per day is already too much for the ear) (Sminkey, 2015).

At the European level, 587,000 healthy years of life are lost due to noise pollution and 903,000 years of sleep disturbances (Fritschi et al., 2011). A third of the population is annoyed during the day and a fifth is disrupted in its sleep (road noise, railway, air) (WHO, 2011).

Noise is currently experienced as endemic pollution. It is an inevitable feature of the city, corresponding to a densification of the urban environment. This reality is common to all industrialized countries.

However, a noise, as a result of sound emissions, can also be experienced as pleasant (like the sounds of nature, music).
The sound signals are also useful as a source of information to mark a danger (horn), to compensate for the deficiency of a meaning for the visually impaired, to express life and communication ... If we are not reducing them only to the notion of "annoying emission source" then we no longer speak of noise but of sound environment or soundscape.

Today, any action in favour of the sound environment must take into account these two aspects:
- one defensive: fight against noise and annoyance,
- one proactive: sound quality and enhancement of living spaces.

The following scales illustrate this concept of variable perception, for the same noise level, depending mainly on two factors (the type of source and its evolution over a period of time).

POTENTIALLY "PLEASANT" NOISES	LEVEL IN dB(A)	POTENTIALLY "UNPLEASANT" NOISES
Open air rock concert	110	*Airplane taking off at 200 m*
Dancing pub	100	*Drill*
Fair soundscape	90	*Motorcycle without muffle at 2 m*
Storm *Indoor sport match*	80	*Vacuum cleaner*
School exit, pedestrian street , violent wind, movie theatre	70	*Significant traffic à 5 m*
Market, residential street	60	*Vehicle at idle speed at 10 m*
Quiet street without traffic	50	*Neighbour's television*
Courtyard, sheltered garden library	40	*Mosquito around your ear*

Table 1: Scales of noise

Damage to the ear

The main lesions

For the external ear: increasing stiffness of the eardrum.
For the middle ear: dislocation of the ossicle chain.
For the inner ear: lesions of the muscles constituting the hair cells.

<85 dB (A): no lesion
Between 85 and 105 dB (A): wrinkling
> 105 dB (A): tearing or even rupture

But the level reached is not the only important factor: the duration of exposure is a factor of harmfulness whatever the level is. The impulsive character of the noise and its frequency distribution (bass, high pitch) are also important.

3.2.1 Hearing effects

If you are exposed to a high level of sound, you may experience a temporary hearing loss: auditory fatigue or transient deafness. It operates beyond 80 dB (A) after an exposure of several hours. Then, our ear needs a higher sound level to detect a given noise. Recovery time in a quiet environment is necessary to regain normal hearing. Recovery is faster in the bass than in the treble. It must be regarded as an alarm signal. Pliny the Elder (23-79 BC) was already reporting that residents near major waterfalls became deaf.

In the case of prolonged exposure to noise or too frequent exposure, deafness occurs, whether it is traumatic (short but violent) or progressive (sound environment greater than 80 dB (A)). Deafness can be total or partial. These are caused by the permanent destruction of a number of hair cells in the inner ear.

In order to maintain all of its hearing abilities, the following noise exposures durations must not be exceeded:
• 80 dB (A) over 8 hours per day,
• 110 dB (A) peak (highest sound level for about 20 seconds!).

This led the European Community to issue a directive in 1986 requiring employers to protect employees (headset protection systems, daily rest periods, alternating workstations and, of course, very regular auditory tests) in order to preserve their auditory capital.

For a working day (8 hours), it is considered that the hearing is in danger from 80 dB (A). To know a noise dose received it is necessary to multiply the sound level of the source by the duration of exposure to this source. The table below shows the equivalences according to the exposure time: a 15 minutes exposure at 95 dB (A) is equivalent to an 8 hours exposure at 80 dB (A).

Sound level in dB(A)	Duration of exposure
80	8 h
83	4 h
86	2 h
89	1 h
92	30 min
95	15 min
98	7,5 min

Table 2: Sound level and exposure

To prevent hearing damage it is recommended:

- Not to stand next to the loudspeakers during amplified music concerts in large scale events
- To have “quiet breaks” regularly to rest the ear
- To wear earplugs or ear protection for people having experienced tinnitus once

A single evening of exposure to high noise level can lead to irremediable hearing damage!

3.2.2 The extra-hearing effects of noise on health: general point of view

Noise is also responsible for a set of psycho-physiological disorders. It does not only limit its effects to hearing, but it involves the whole organism in several complex ways. Noise, defined as a noise pain, becomes a stressor and causes immediate but temporary effects:

- functional impairment, such as heart palpitations, digestive problems, high blood pressure and heart rate,
- decreased attention,
- visual field narrowing
- difficulty to achieve memorization...

According to some studies, noise-related stress can also lead to more chronic effects: depressive behaviour, chronic anxiety... In areas of intense noise (airport), studies show that the family space (the home sweet home) can lose its rest, leisure or community functions.

For undisturbed sleep, the constant noise level within a room must be below 40 dB (A). In general, there is no physiological habituation to noise from the organism. At work, noise has consequences on the painfulness of work: it hinders communication, and increases the risk of work accidents on the spot and during journeys.

Finally, noise is responsible for relational difficulties that can arise in the social and family life: aggressiveness, disturbance of recovery time necessary in case of auditory fatigue, isolation by deafness ... It is also a factor of degradation of communication.

Today, not all the consequences of exposure to noise are fully known, but it is accepted that it can have health implications, in particular if reference is made to the broad definition of **health** by the WHO. (quoted at the beginning of this chapter). In March 2015, the WHO also published a “Deafness and hearing loss" checklist summarizing the magnitude of the problem. its causes, its economic and social consequences and how to prevent hearing loss.

3.2.3 Noise effects on sleep

According to different studies, 14 to 20% of the population suffers from sleep disorders, regardless of acoustic conditions. The following results are therefore based on research to isolate the effects of noise from other factors that may influence quality of sleep.
But the simple observation of our own experiences shows that noise disturbs sleep (difficulty of falling asleep, hard wake-ups, awakening during the night ...), resulting in excessive exhaustion and irritability.

Sleep is a restorative process necessary to maintain the optimal functioning of the human body, its level of vigilance and its well-being during the day. Sleep disorders must be taken into account because they reduce the physical and mental recovery of individuals. According to another research (Soames, 2008), there are two sets of causes of sleep disturbances, one internal and one external. The internal cause is caused by sleep disorders (sleep apnea), somatic diseases (infections, cough) as well as psychological-based factors (anxiety, stress). **The most important cause of external sleep disturbance is noise pollution.**

Dose LAeq dB(A)	Effects	Peak in dB	Effects
75	Unable to sleep	85	Child and adult waking up
65	Adult waking up	60	Heartbeat alterations
55	Child waking up	55	Beginning of heart rhythm changes
45	Altered paradoxal sleep	45	Disturbances of electroencephalogram in children
35	Beginning of possible disturbances of electroencephalogram		

Table 3: Dose and effects

Reminder:
Exposure to noise during sleep can cause:
- a disrupted day-to-day vigilance,
- a weakened nervous balance,
- cardiovascular or respiratory reactions,
- a permanent sensation of exhaustion,
- other side effects.

Nocturnal chronic exposure to noise causes changes in the structure of sleep.
However, diurnal chronic exposure to noise can also lead to changes in the quality of sleep.

3.2.4 Annoyance

Annoyance is different from nuisance which had a more neutral and generic aspect. Annoyance is the possible result of a perceived nuisance. According to (McLean et al., 1977), the annoyance covers three different types of reactions:

- the feeling of being embarrassed, irritated, seeing his intimacy invaded by noise, which could be called subjective annoyance,
- hindrance for everyday activities,
- symptoms recognized in medical terminology as due to stress and psychosomatic predominance.

(WHO, 1980) proposes the following definition:
"Annoyance can be defined as a feeling of disturbance, displeasure caused by an environmental factor that the individual (or group) knows or imagines having the power to affect his or her health."
Etymological approach as well as psychological or institutional approach show the miscellaneous character of the annoyance: it is not limited to a judgment, an opinion necessarily symbolized through language, but it assumes various forms. These extensive definitions of annoyance suggest the difficulty of

assessing it only by noise monitoring. These complex relations between a subject and his environment are illustrated in the results presented in Figure 1.

The annoyance does not depend exclusively on the sound level measured. It is also due to several others parameters that are often more difficult to quantify, such as the impulse, repetitive nature of noise, the conditions under which it occurs (work, home, night ...), the impossibility of controlling it, or even the disturbance caused at low intensity.

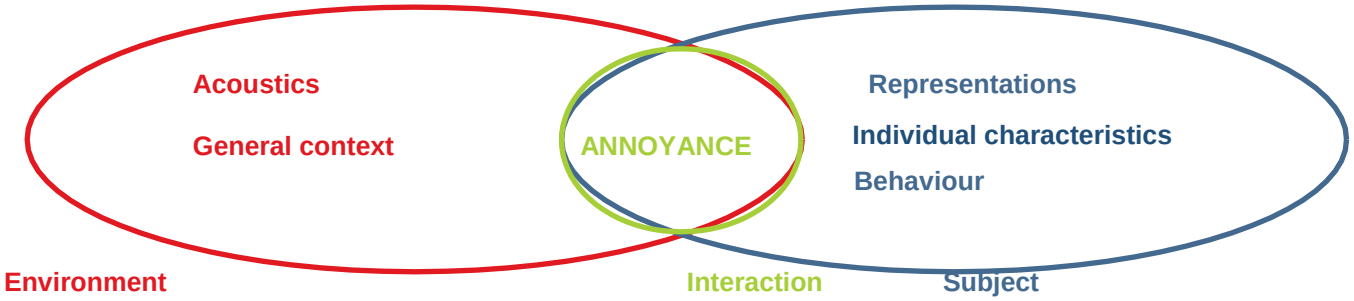


Figure 1: Annoyance: a complex link between the subject and its environment (Vincent, 1995)

In addition, the noise sensation is not the same for everyone. Reactions to noise are modulated by individual biological characteristics, socio-cultural habits, state of stress, and general environment of individuals. Therefore, at equal levels of noise, two individuals can express very different annoyances.

Noise then becomes also psychological and sociological, with an emotional content, beyond the physical, acoustic fact. This approach to noise annoyance allows a first presentation of the various ways of its genesis. Indeed, many authors agree that the annoyance, especially for low noise levels, is due to three factors in comparable proportions:

- **the noise level measured on the front of the house,**
- **the criteria of environment, living environment, contextual factors ...,**
    - the characteristics of the source,
    - moments of emergence, context of listening,
    - housing exposure,
    - lifestyle, activity,
    - the type of area and housing (residential, skyscrapers, etc.),
- **personal characteristics of sensitivity,**
    - social belonging,
    - individual characteristics (gender, age, etc.),
    - family composition,
    - the reference culture, socio-economic level,
    - the personality, experience, history of the subject,
    - the representation, symbolic of noise, control of space.

However, although the individual nature of the notion of annoyance is indisputable, studies have determined the intensity or percentage of annoyed people (statistically) according to the observed noise levels. These studies were used to set up the regulatory thresholds adopted by various laws relating to noise.

Finally, noise has effects on communication (masking) and creates a loss of intelligibility of speech in everyday situations (at home, on the street) but also in professional or learning contexts (at school or at work). It can, therefore, especially with children, cause difficulties of understanding and learning.
Mental health can be defined as a psychic state of mind allowing a subject to enter into an emotional and social relationship and to face the demands of everyday life. For now, direct links between mental health and noise have not been established. However, recent international surveys suggest that exposure to long-term noise is associated with mental health problems such as anxiety and depression.
Annoyance is the most common response in noise exposed populations. It can lead to discomfort that disrupts everyday activities and might be accompanied by negative responses from noise exposed persons such as anger, unhappiness or exhaustion. The annoyance therefore contributes to the burden of environmental noise, as shown in the Figure 2.

The WHO created a metric called: **Disability-Adjusted Life Year** (DALY) to quantify the Burden of Disease from mortality and morbidity

Definition
One DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.
DALYs for a disease or health condition are calculated as the sum of the Years of Life Lost (YLL) due to premature mortality in the population and the Years Lost due to Disability (YLD) for people living with the health condition or its consequences. Noise annoyance is estimated around 654 000 DALYS.

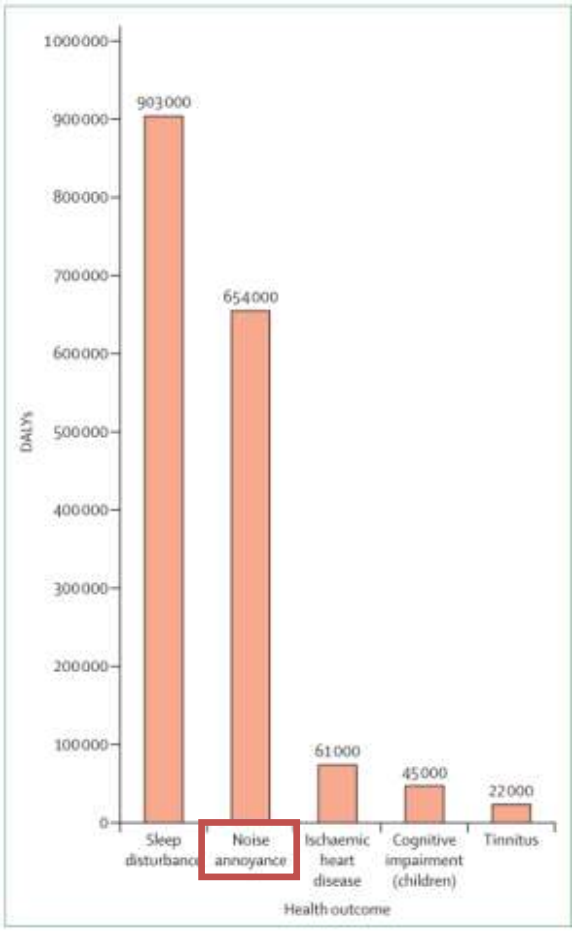


Figure 2 - DALYs caused by environmental noise exposure in Europe (Fritschi et al., 2011)

To sum it up, over the past forty years, international experts have been working on the effects of noise on health at ICBEN, the International Commission on Biological Effects of Noise. In general, this work focuses on environmental noise related to transport. Indeed, few studies deal with the discomfort and the effects due to the noise of musical activities. However, it should be noted that sound levels linked to a musical activity are likely to generate direct and/ or indirect effects on the various exposed populations (professionals, neighbours, spectators).

3.3 Some Tools to assess the sound environment

This section will present various tools used to assess the sound environment in its complex form, with physical and perceptual variables. The assessment has a threefold temporal approach:

- Before the event (initial state)
- During the event (exceptional sound environment)
- After the event (return to normal)

3.3.1 Strategic noise map and GIS

A geographical information system (GIS) is an information system designed to collect, store, handle, analyse, manage and display all types of spatial and geographical data. A distinction is made between vector data, which allow storing information located in objects form (points, lines, areas) and raster files (images, noise maps).

The **GIS** has the advantage of allowing a good overview of the events throughout the entire site.

Whether it is in the case of a well located event (Kappa Future Festival, Tivoli) or a large-scale event (Rhein in Flammen, Fête des Lumières), the GIS allows a global vision and enables a focus on strategic points.

This tool offers real assets for the installation of a monitoring solution or the deployment of an active sound field control system (ASFC part 3.5).

Figure 3: Screenshot of a GIS representation of Torino (place: Kappa Future Festival)

The tool allows locating the residential buildings, to count the exposed populations and to calculate distances of propagation.

The GIS also favours the identification of the soundscape and noise sensitiveness of populations with the location of the transport infrastructures.

European Commission has drafted and ratified the European Directive 2002/49/CE, which requires the agglomeration of more than 100 000 inhabitants to calculate their sound maps and to make afterwards an action plan.

The sources, modelled from calculation standards, are the rail, road, air and industrial infrastructures.

The indicators, which are recommended by the Commission (Lden and Ln, defined in part 3.4.2), are color-coded with a grid usually made up of 10x10m tiles.

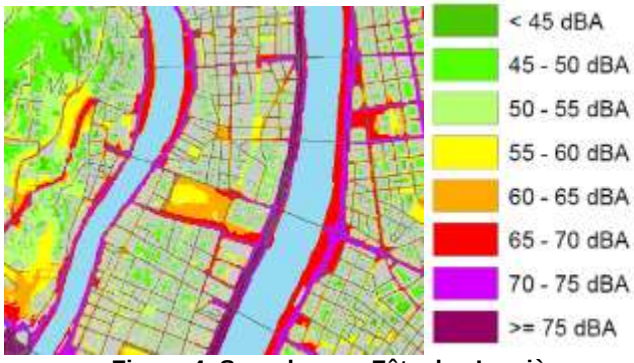


Figure 4: Sound map - Fête des Lumières

The sound maps allow understanding the situation of a district with its habitual activities, to anticipate the sensitivity of a neighbourhood and to understand the changes, which may occur during festivals.

With the Fête des Lumières for example, the background noise, largely due to the road infrastructures, is entirely replaced with the noise of the passers-by and of the sound and light shows.

Specific modelling may be done as part of the MONICA project for some events.

The GIS, combined with acoustic calculation software, enables the propagation calculation of the sound emitted by the loudspeakers on the show place. The software usually used are CadnaA, Mithra and Soundplan … The modelling can help choosing the appropriate positions of sound level meters from the visualization of critical points, which need special attention whether noisy or quiet.

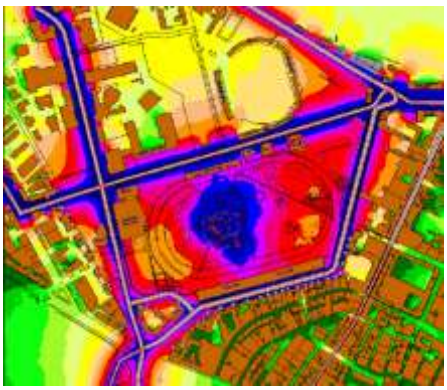


Figure 5: Propagation example: Forward Model (e.g. Nord2000): Predicts sound field according to input parameters

3.3.2 Survey of the acoustic perception

Perception surveys are tools used in assessing the sound environment in order to evaluate the subjective dimension related to noise. At the same sound level, feelings are very different from one individual to another. Therefore, a perception survey remains the most appropriate psychoacoustic tool. Acoucité advise to use this tool during the MONICA project to complete the monitoring approach for large scale events.
The objective is to propose a methodological framework and a common baseline questionnaire for all the pilot sites.
Each pilot partner will choose to use all or part of the questionnaire. It will have to be adapted to local issues and specificities and to the methods of reaching target respondents (web, apps, face-to-face…). Acoucité will bring the methodological support.
This protocol is partially based from recommendations of the ISO 12913-1:2014 (Acoustics – Soundscape: Definition and conceptual framework) and ISO/TS 15666:2003 (Acoustics – Assessment of noise annoyance by means of social and socio-acoustic surveys) standards. The noise disturbance and annoyance are assessed following two types of rating scale:

- A qualitative rating scale of noise disturbance or annoyance, with five possible responses: Not at all, Slightly, Moderately, Very or Extremely
- A rating from 0 to 10

After exchanges (in particular with Torino city), it has been decided that the duration of a questionnaire in a face-to-face interview should not exceed ten minutes.
In order to have a satisfying response rate, it is recommended to not overpass five minutes for a web form.
Finally, some questions can be used separately on an app dedicated to the event (for example, level of noise disturbance perceived by the neighbourhood). **The questionnaire, ready to adapt, is in Appendix A.**

Target respondents:

Depending on the feedbacks of the pilot partners, three target respondents are identified:

- The users/consumers
- The neighbourhood
- The professionals and the elected representatives

Let's underline that the objective, in perspective with the Monica project, is not to achieve an opinion poll. It would need to use a sampling technique with a statistical representativeness of the target population. It seems not necessary and difficult to set up for our case. The objective is thus to:

- Allow publics to express their own sound experience
- Obtain diversified information about their expectations
- Know their judgements on the deployed solutions

In return, statistical adjustments can be made a posteriori, according to the structure of the target population (gender, age…). We will also have to make sure that the respondents belong to the three identified target populations (users/consumers, neighbourhood, professionals and elected representatives).
Therefore, the questionnaires will bring us a description of the sound atmosphere perceived by the respondents.

Problematics to explore:

A first list of interests to explore is proposed here. It has been drown up from the analysis of surveys conducted on noise and/or soundscapes perception.
In perspective with the Monica problematic, we suggest to take an interest in two sets of thematic at a minimum:

- Those in relation with global sound and/or noise perception
  - global satisfaction, comfort, audibility, perceived sound quality (rather aimed to the users/consumers)
  - potential noise annoyance

- Those in relation with the temporality of the sound and/or the noise disturbance
  - real-time feedbacks liable to get an instant response (adapted to the target respondent)
  - delayed feedbacks liable to assess the evolutions generated by the solutions entailed by the Monica project

Method of reaching target respondents:

The proposed enclosed questionnaire covers the main identified themes. Furthermore, these themes are chosen in order to allow a reporting and an assessment of the acoustic perception of both the events AND the proposed solutions entailed by the Monica project.
We recommend to the pilot partners, who wish to set up these reporting and assessment of the acoustic perception, to try these tools from the first year of the project. On the one hand, it will allow to complete an experiment in-situ and on the other, to constitute an initial statement.
The questionnaire will have to be adapted to the method(s) of reaching target respondents chosen by each pilot site (face-to-face, Apps, website, telephone…). It will assure the homogeneity of the conditions to reach target respondents. In addition, should be attached to the questionnaire:

- simple instructions for each question, in the case of a self-administered questionnaire;
- a questionnaire process guide (commentaries about what it is wanted to be known behind each question) for the interviewers, in the case of a face-to-face questionnaire;
- an interview process guide (initial instructions on how to conduct the interview), in the case of a qualitative approach with persons of interest (e.g. elected representatives, technicians, artists…);

- Therefore, this intermediate report is currently an adaptable framework within which each pilot partner can take over its own tools and methods. It is proposed to review it with feedbacks of the pilot partner in the second half of 2017. Then, a final version will be proposed in order to be shared by all the pilot sites for the next two years of the project.

Communication medium:

Depending on the target public and the problematic, the questionnaire will be developed in electronic or printed form:

- implemented on one of the apps or websites developed by the Monica group
- distributed in the mailboxes or by other means
- used for door-to-door survey on the identified sites

Coding scheme:

The methodology to code the target responses will have to respect format compatibility. These data can thus be analysed and processed in a harmonized and open database. The database will have to respect at a minimum the following rules:

- the data inputs of a questionnaire is a succession of alphanumeric codes separated by a tabulation,
- all the questionnaires and questions will have the same codes for data input, regardless of the used language,
- the database completed by the responses will be sent to Acoucité which will provide the processing.

Implementation on the pilot sites:

Each pilot partner will use all or part of the questions, depending on local specificities (e.g. free-of-charge outdoor event, paying indoor event…)
Questions can be contextualized (for example by adding the name of the festival…) but won't have to be modified. The purpose is to have repeatability and make the collected data comparable between different years and events.
The proposed questionnaire will thus be adapted to the event AND the method of reaching target respondents. A comprehension guide and an instruction leaflet will come with the questionnaire for each developed form.

Questionnaires' translation:

Acoucité will propose simultaneously an English (UK) version AND a French version of the questionnaire. Each pilot partner will adapt the questionnaire in the local language. In order to respect the important points of each instruction and ensure a translation close to the original, the translation will be double checked.

3.3.3 Noise Measurement and Measurement protocol

Noise Measurement consists of the use of Sound Level Meters (SLM) in order to quantify physically sound pressure level over a given time. It is measured in dB or dB(A). The levels can be averaged over different periods and broken down into frequency in terms of octaves or third octave bands.

The **monitoring** is a performing tool made up of several IoT Sound Level Meters and a server that enables mid or long-term continuous measurements. An analysis of the need is essential for a proper installation of this tool.

This deliverable suggests a standard installation protocol in order to stimulate the pilot's consideration. All of this is provided in Appendix B.

3.3.3.1 The targets

The different targets likely to be affected by the monitoring are:

- public services
- local residents
- spectators
- event organisers
- employees present on the event and their supervisors

Each target will be interested in information adapted to his function. For instance, the public services will be more concerned with neighbourhood noise while an employer, whose employees are onsite during the event, will be attentive to the compliance with noise regulations at work.

3.3.3.2 The objectives of the Monitoring

The main objectives of the monitoring of a festive event are:

- To monitor compliance with regulations
    - threshold of a 105 dB(A) sound level at the sound engineer's console (French regulation on musical places)
    - threshold of a sound level in the front of a residential building (70 dB(A) at the Kappa festival in Torino)
    - sound levels to which the staff is exposed (noise regulation at work)
- To provide information in real time to the event organisers and the public on exposure levels within the site.
- To provide public authorities a precise knowledge of the impact of such an event on the soundscape of public spaces and residential buildings (communication tool)
    - under normal circumstances
    - during the period of the event. This can be reflected in the impact of the sound propagation of the amplified music, but also by the spectator's contribution close to the site.

3.3.3.3 Where can Monitoring be done?

Inside the site ("Event" monitoring)
On the site, all the zones aren't similarly exposed to the amplified music:

- the place in front of the stage is the most exposed area
- spaces away from the stage and accessible to the public (toilets, catering ...)

Figure 6: Kappa Festival in Torino, Crowd in front of the stage; Nuits Sonores, outdoor areas in Lyon

Outdoor public spaces ("Public spaces" monitoring)
On the public spaces outside the event, the soundscape is composed of:

- sound sources usually present on the site (except in the case of traffic restrictions and lane closures),
- a musical background sound coming from the sound diffusion system inside the event,
- a human contribution of the spectators coming or going out to the event. This contribution often deals with emergences like voices/cries, or behaviours that might disturb the sound environment of the site at night.

Most exposed residential building ("Neighbourhood" monitoring)

- Facades of the most exposed residential buildings
- Buildings that are not the most exposed but whose inhabitants complain about the noise disturbance related to the event

3.3.3.4 Realization of an initial acoustic state

In the case of "**Public spaces**" and "**Neighbourhood**" monitoring, a measurement campaign will have to be put in place upstream of the event. These acoustic measurements will determine an "initial state" of the sound situation, to have a clear understanding of the sound environment of the site in "normal times". They will have to:

- be made before the event, during the same days of the week,
- be made during a period of normal use (no building site, traffic outside school holidays, weather observing the standards of measurements), that is as representative as possible of the neighbourhood's sound environment
- be reproducible during the event

It will allow to:

- know the sound levels of the district (depending on the time of day or night, by day of the week), its background sound, the density of its emergence…
- know the operating rhythms of the neighbourhood (is there night activity, at what time is the neighbourhood awakened, is the soundscape rather permeable?...)
- determine if this is the custom thresholds not to be exceeded during the event
- assess the sound impact of the event by comparison with the initial state

3.3.4 Sound recording

The sound recording is perfectly completing the other sound analysis tools by providing different information and is also particularly useful to illustrate a soundscape. This process has a patrimonial role because it also allows to supply (or create if they do not exist) sound libraries, saving specific sounds from specific places at a specific time. But the role of sound recording is not limited to simple illustration. Sound recordings are also useful to:

- Supply a database that will be used for the construction of the machine learning algorithm.
- Characterize outdoor public spaces before, during and after a musical event. The recordings will allow to assess:
    - the sound spectrum, the impact of low frequencies
    - their propagation (some monitoring points may not be emerging, while the audio will make it possible to hear if part of the sound spectrum coming from the musical event remains audible).
    - the tightness of the local sound source (can the local sound sources be audible and emerge, or are they masked by the musical sound background?
    - the audibility of the voice, (is it possible to understand a voice message and how far?)
- Qualitative valuation. During the Festival of Lights in Lyon, traffic restrictions (or even traffic ban) considerably modify the sound landscape. The vehicle sound source is replaced by a crowd of pedestrians and animations. A decrease (or increase) in the noise level will not necessarily be observed, but in all cases the contribution of mechanical sources will decrease to the benefit of human sound sources.

There are no sound recording standards established for musical events. The technician doing the sound recording will have to adapt the material and the process chosen according to several parameters (distances to the sources, obstacles ...). Below are different types of sound recordings:

- Monophony (one microphone)
- Stereophony (two microphones)
- Binaural (two microphones arranged to create a 3D stereo sound sensation for the listener)

As often as possible, the technician should describe the recorder used, such as the choice of microphones, the directivity of the capsules (omni, cardio, hyper cardio, MS ...).

In the case of stereophonic recording, particular attention must be paid to the choice of the microphone pair (directivity, microphone spacing, pickup angle, etc.).

The binaural recording should be re-listened with special headphones in order to reconstitute the soundscape in three dimensions.

The format of the files must be a compromise between a sufficient quality and a format that can be used by all (for example the format wav in 44.1 or 48 kilo hertz and 16 or 24 bits). An audio recording aiming towards simple recognition of the source can be done in MP3 (320 kbits/s) or wav.

3.3.5 Sound maps

Concept
Sound maps are digital tools developed by Acoucité, notably as part of its pedagogical and patrimonial activities. Their aim is to illustrate and integrate the sound recordings of an event or a place. Their particularity stems from the location of the sound recording on a map (e.g. Google Maps), therefore the use of the wording "sound map". Indeed, a use of the sound recording is to be able to represent a soundscape (definition in (IOS, 2014)) with the help of its hearing memory. The addition of a map then allows the sound recording to be linked with other objects that provide an additional representation of the perceived sound environment. Thus, a sound map let a patrimonial record and allows:

- the illustration of what is heard and perceived
- the preservation of a complementary trace of the noise level
- the creation of a medium raising the awareness of the sound environment

Depending on the possibilities offered by digital, several types of sound maps have been developed, and have led to several applications: soundscapes, interviews, nature or urban sounds, etc.

Examples of current sound maps
A first example is the pedagogical interface for publishing and consulting sound postcards[1]. The aim is to recreate the soundscape of an immediate environment with several components (sound, visuals, plans ...) and to share this "sound postcard" on a website where everyone will access it. The sound can take different shapes depending on the type of soundscape studied (testimonies of an inhabitant, footsteps in the forest ...). They are currently captured in the form of a binaural sound recording. There is not necessarily a level measurement.

A second example is the interactive sound map. The difference from the previous map is that you focus on a particular area to describe its sound environment at a given time. The last developed map offers to discover the normal soundscape (without the event) of the main locations of the Festival of Lights 2016. This sound map allows mixing several evaluation information related to sound environment into the same medium: exposure of populations, sonometric measurements, sound recording, and written description of the recording.

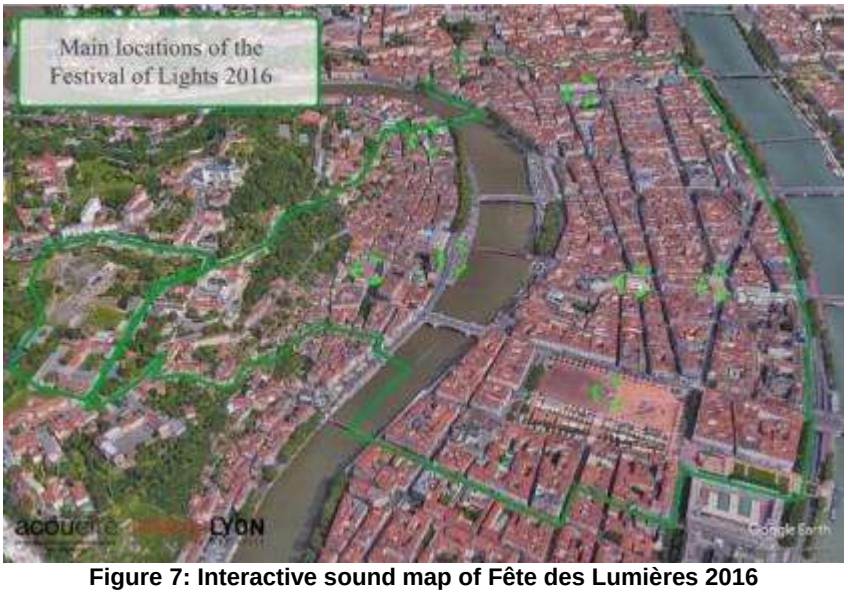


Figure 7: Interactive sound map of Fête des Lumières 2016

Other examples:
Miami sounding city
Nature sound map
Mapa sonoro de Bahia Blanca
MOMA Studio Sound Map

[1] http://cartes-sonores.acoucite.org/

This tool can have several interests within the framework of the MONICA project, such as:

- Assess the influence of the IoT technologies developed during the MONICA project on the sound landscape. A sound map such as the Festival of Lights can be used, for example, to compare the soundscapes of common areas of the 2017 edition (without MONICA technology) with the 2018 edition (including MONICA technology). This tool can be extended to other pilot events.

- To be used in addition to surveys on the sound perception of cultural events with the stakeholders (residents, users, organisers, professionals). Pictures and sound recordings taken during interviews would be posted on a shared website. This would make it easy to locate the places where people were interviewed (e.g., a spot close to an event such as a balcony overlooking a musical festival) and to keep a record of these interviews.

- Be able to compare on a map the different points of view around the same event from a person interviewed behind the stage, a spectator in the first row or professional without a silent shower(system developed by DTU, see section 3.6).

- Gather real-time recording on a map (e.g. click on a location and see how the noise level changes on the site).

- As a communication and information mean, allowing adding the recordings + photos of various people interviewed throughout the Monica project (organisers, artists).

- Combine all pilot events on one map.

- Feel even more immersed in the event with pictures taken from different points of view or at different times of the day.

3.4 The components of monitoring

This section presents an overview of IoT devices and the developments linked that will build the monitoring part of the acoustic ecosystem. The WP4 will be in charge of developing the acoustic ecosystem and the WP6 the development of the app.

3.4.1 The Sound Level Meters

The IoT sound level meters will be developed by B&K during the MONICA project. They will be instruments of high precision (Class 1, standard IEC 61672, expert class) and will be able to record and transfer a signal and its geolocation to the MONICA cloud. The connection can be established in Wi-Fi, 3g or Bluetooth. They will be able to withstand the weather. The formats chosen to record the sound levels must be in open data in order to be easily usable by all the partners of the MONICA project and to contribute to the transparency of the information.

Figure 8: IoT Sound Level Meters[2]

3.4.2 Units

The units that can be used are:

- The dB, decibel
- The dB (A) or A-weighted decibel
- The dB (C) or C-weighted decibel

The dB, decibel

The decibel (dB) is a logarithmic unit commonly used in acoustics as a unit of sound pressure level.

A sound pressure level expressed in dB is noted Lp and calculated with the formula:

$$Lp = 10 \log(p^2 / p0^2)$$

where p is a sound pressure level in pascals and p0 is the standard reference sound pressure of 20 micropascals.

The frequency

The frequency is expressed in Hertz (Hz) and is used in sound to define the pitch. It counts the number of cycles done by a sound wave into a given time. One Hz means the event repeats itself once per second.

The frequencies an ear can hear are limited to a specific range of frequencies. The audible frequency range for humans is from around 20 Hz to 20,000 Hz.

[2] Presentation of B&K at a plenary meeting

Frequency-weighted units

The human ear is not sensitive in the same way to low frequency or high frequency sounds. To take this into account while using noise level meters, several weightings of the levels measured per frequency band have been standardized.

The dB (A) or A-weighted decibel

A weighting is based on the frequency sensitivity of quiet sounds (about 40 dB) but commonly applied for other levels. With quiet sounds, ear is less sensitive to bass and treble sounds than to medium sounds (especially between 500 and 2000 Hz). As a result, the high and low frequencies are greatly attenuated.

The dB (C) or C-weighted decibel

The weighting C is based on the sensitivity of the human ear to the high sound levels (airports, festivals ...). In this level range, the ear is more sensitive to bass sounds. For this weighting, the attenuation at low frequencies is therefore lower.

A comparison of the corrections made by the A and C weightings to a few frequencies is presented Table 4: Weighting A and C(defined by IEC 61672: 2003 (BS EN 61672-1: 2003)).

Frequency (Hz)	63	125	250	500	1k	2k	4k	8k	16k
A weighting (dB)	– 26.2	– 16.1	– 8.6	– 3.2	0	+ 1.2	+ 1.0	-1.1	– 6.6
C weighting (dB)	– 0.8	– 0.2	0	0	0	– 0.2	– 0.8	– 3.0	– 8.5

Table 4: Weighting A and C

3.4.3 Indexes and Indicators

This paragraph briefly presents a number of existing noise indicators and indexes that may be relevant to the MONICA project.

An indicator is a physical quantity describing noise in the environment, which is correlated to a noisy effect. In monitoring, they are used to assess discomfort from physical measurements. They are used in regulation.

An index is also calculated on the basis of physical measurements but it is presented in the form of an integer and makes it possible to evaluate the discomfort relative to a reference value. They facilitate the understanding of acoustics by an uninitiated public (residents, users).

Energy Indicators:

- **Leq,T**

The Leq,T is used to evaluate the total noise dose received over a specified period of time, as the noise risk depends on the duration as well as the noise level. It is obtained by a calculation in dB over a period T. It represents the constant noise level that would have been produced with the same energy as the noise actually perceived during this period. This is expressed by the notion of Level Equivalent, of which Leq is the contraction.

The Leq,T is the level mainly measured with the sound level meters. The acronyms LAeq are also used if they are weighted A.

- **European Indicators**

These noise indicators are used by the Member States of the European Union, in accordance with Directive 2002/49/EC (EP et al., 2002), for the preparation and revision of strategic noise maps.

Ld or Lday

Ld (diurnal period noise indicator) is the noise indicator associated with discomfort during the day period (6h-18h). It corresponds to the A-weighted average long-term sound level, determined over all the day periods of a year.

Le or Levening

Le (noise indicator for the evening) is the noise indicator associated with discomfort at night. It corresponds to the A-weighted average long-term sound level determined over all the evening periods (18h-22h) of a year.

Ln or Lnight

Lnight (Nocturnal Noise Indicator) is the noise indicator associated with sleep disturbances. It corresponds to the A-weighted mean long-term sound level determined over all the night periods (22h-6h) of a year.

Lden

The Lden (day-night-night level) is the noise indicator globally associated with discomfort, synthesizing the previous indicators. It corresponds to the "dose" of noise received in one day. It is expressed in dB and is calculated from the indicators Ld, Le and Ln by the following formula:

$$L_{den} = 10 * log \frac{1}{24}\left(12 * 10^{\frac{L_d}{10}} + 4 * 10^{\frac{L_e+5}{10}} + 8 * 10^{\frac{L_n+10}{10}}\right)$$

A penalty of several decibels is added to the evening and night sounds. For this, weights are applied to the Le (+ 5dB) and the Ln (+ 10dB).

Statistical indicators

These indicators are calculated numerically from the measurements carried out (for example from the values of LAeq). All these indicators are expressed in dB or dB (A).

L10

Level exceeded for 10% of the time. It indicates the average level of noise peaks that emerges from the background noise.

L90

Level exceeded for 90% of the time. It indicates "background noise".

L50

Level exceeded for 50% of the time.

One of their interests is to be able to describe more precisely the components of a sound landscape. For example, their comparison with the average noise level LAeq makes it possible to know whether the background noise is high (LAeq close to L90) or whether there is little emergence (LAeq close to L10). These indices can serve in this sense to characterize the sound landscapes of the different pilot sites.

Harmonica index

The Harmonica index has been developed in order to make information about the sound environment easier to understand by the authorities and the general public.

The creation of the strategic noise maps required by European directive 2002/49/EC has initiated a new dynamic with sound environment being taken into account by the authorities and the public being provided with more information on the subject.

Nevertheless, whether the information about sound/noise is presented in the form of strategic noise maps or in the form of measurement results, it currently remains difficult for general public to understand. Indeed, the indicators used (energy or statistical, described above) are complex to explain and relatively distant from inhabitants' perception. Furthermore, the unit used by these indicators, the decibel, has the disadvantage of being complex, with the addition of two sound levels expressed in decibels being logarithmic rather than arithmetic: two sound sources of same level add 3 decibels. Two cars measured at 80dB each are 83 dB together, not 80+80=160 dB!

The Harmonica index is an alternative to these indicators by having the following characteristics:

- based on a scale of 0 to 10, easier to understand than the decibel (the higher the score, the poorer the sound environment);
- easy to calculate using the type of measurement data usually collected by sound measurement devices, namely the $LA_{eq,1s}$ levels (A-weighted, equivalent continuous sound level for 1s);
- possible to calculate for one-hour time slots;
- relevant in terms of acoustic physics, taking into account the two major components that affect the sound environment: background sound and sound events that exceed this background sound (sound peaks);
- according to surveys conducted during the project, more representative of people's perceptions of their sound environment than the environmental noise indicators currently used in French and European regulations (consideration of the public's opinion and perceptions for the construction of the index).

Figure 9 shows an example of calculating the Harmonica index for one-hour time and its corresponding graphical representation:

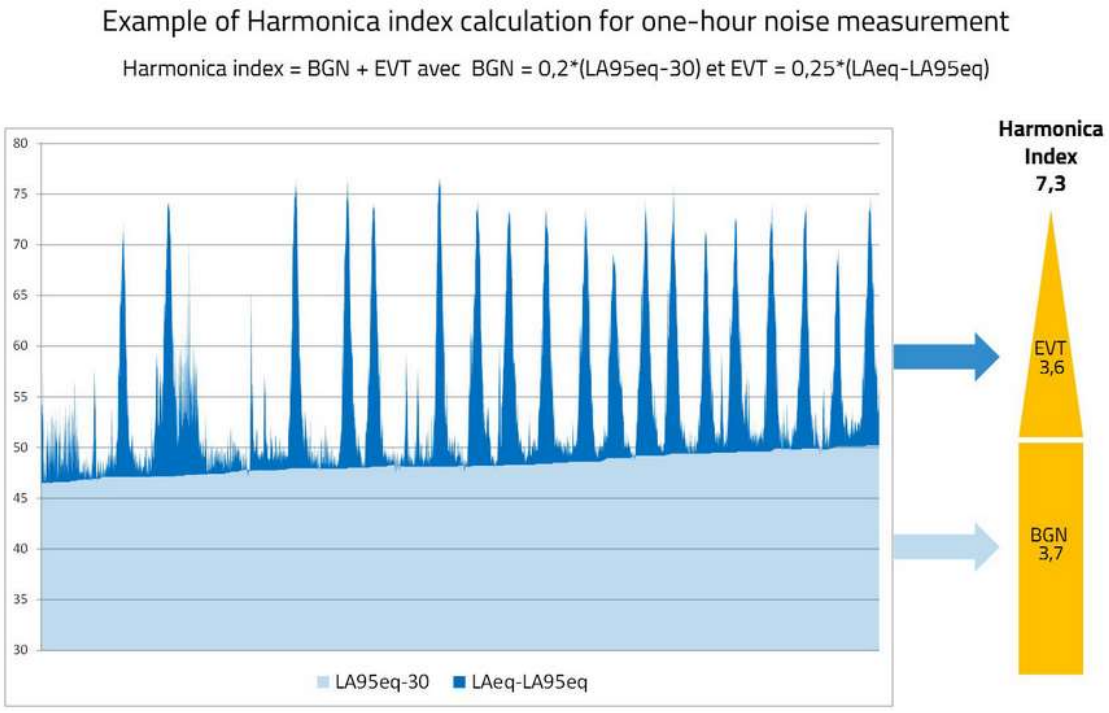


Figure 9: Example of Harmonica index calculation (source: NoiseInEU portal)

$LA95_{eq}$ is the equivalent background sound level during the hour period, the background sound being evaluated every second by the sound level exceeded 95 % of the time during the 10 minutes period before.

LAeq is the equivalent sound level during the hour period.

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

- The rectangle represents the component related to background noise (BGN);
- The triangle represents the event-based component (EVT), related to sound dynamics and the number of sound peaks that disturb the calm.

A colour is then applied to the index. The colour (green/orange/red) indicates how the sound environment compares to the WHO's environmental quality objectives[3] 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.

Colour	Day from 6 am to 10 pm	Night from 10 pm to 6 am
	between 0 and 4	between 0 and 3
	between 4 and 8	between 3 and 7
	over 8	over 7

Figure 10: Harmonica index colour scale (source: NoiseInEU portal)

Finally, the hourly variation of the Harmonica index over a 24h period is depicted as Figure 11:

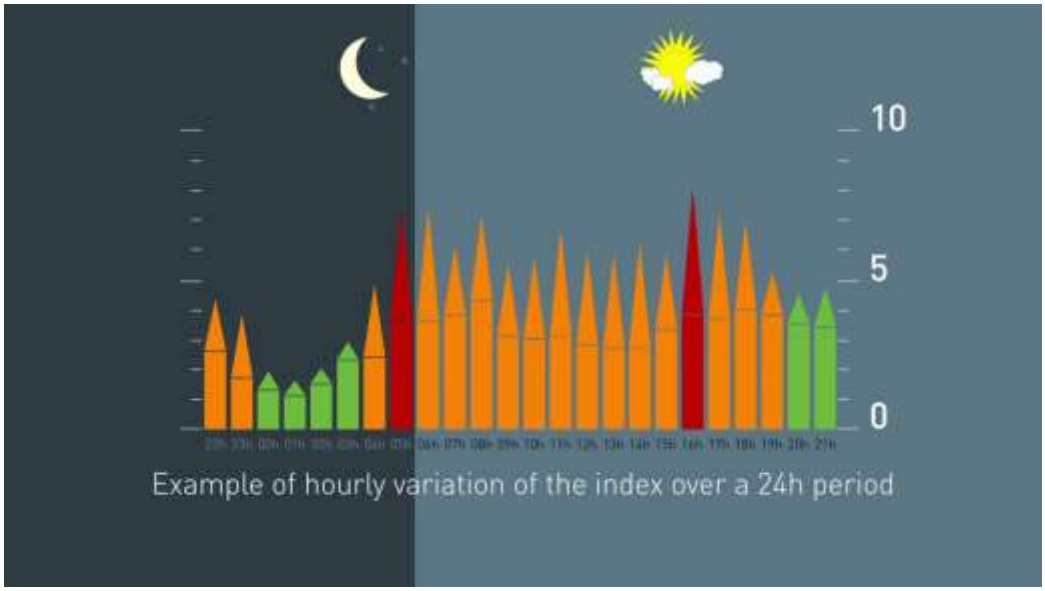


Figure 11: Example of hourly variation of the Harmonica index over a 24h period (source: NoiseInEU portal)

Additional information and resources are available on the website *http://www.harmonica-project.eu/en*.

[3] European Environment Agency (2014). Noise in Europe 2014 (Luxembourg: Publications Office).

Loudness (sone)

Loudness and loudness level are two perceptual attributes of sound describing absolute and relative sensations of sound strength perceived by a listener under specific listening conditions

Loudness is therefore an indicator of sound volume that is expressed in sone. A pure sound of a frequency of 1000 Hertz and a level of 40 dB has by definition a loudness of 40 sone (Figure 12).

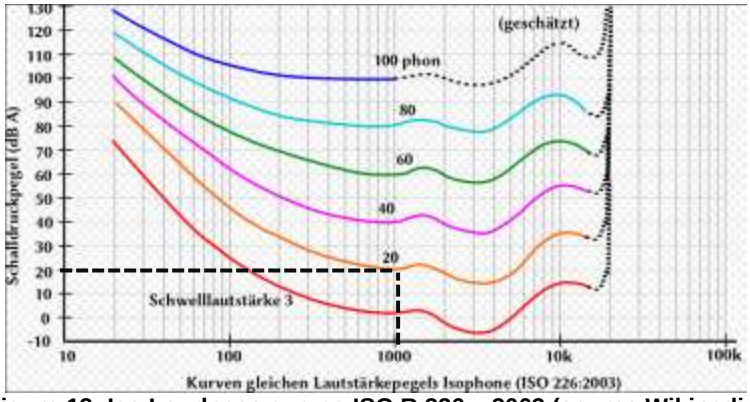


Figure 12: Iso Loudness curves ISO R 226 – 2003 (source Wikipedia)

Intelligibility

Speech Transmission Index (STI) characterizes the percentage of error in the comprehension of words by the subjects. It varies from 0 to 1, as shown Figure 13:

STI	0 - 0,3	0,3 - 0,45	0,45 - 0,6	0,60 - 0,75	0,75 - 1,0
	unintelligible	weak	satisfying	good	excellent

Figure 13: STI

It could be used to assess the effectiveness of silent showers, for example, if they are to be used for a medical emergency (there must be sufficient intelligibility between the first-aid helpers and the person to be rescued so that the care provided is appropriate).

Noise Dose $L_{EX,8h}$

This noise indicator is used in France as a legal criterion for assessing the daily dose of noise received by workers within a company. This indicator is calculated from the A-weighted equivalent sound level measured and the actual daily working time. As the actual working time may vary by working group, this indicator is standardized. Thus it brings back an equivalent level over a period fixed at 8h (Figure 14).

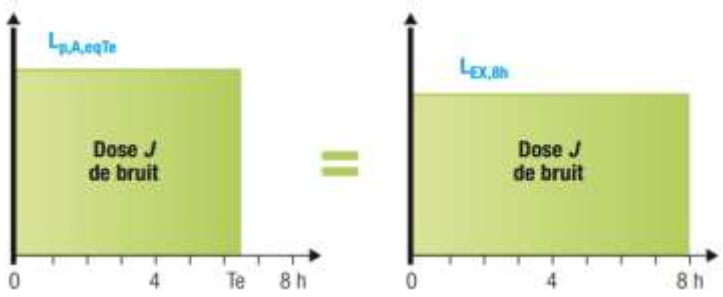


Figure 14: Dose[4]

This indicator could be calculated for a person exposed during a show (measurement of noise via an app, a bracelet.) To the 8h reference period, it might be interesting to compare this value with other types of exposure (workers on an airport runway, in a railway station, in a factory, etc.).

[4] Guide INRS 2009, Evaluer et mesurer l'exposition professionnelle au bruit

3.4.4 Wristbands and Smartphones

Sound level meters are instruments dedicated to the measurement of the sound level. They will be representative of a defined location and will therefore be fixed.

IoT devices and wearables such as UWB-based wristbands, smartphones or smartwatches have another interest. They have a microphone and can be used to evaluate the sound level in a complementary way.

Bigger uncertainties and a smaller spectral band are the main disadvantages of these solutions. Addressing regulatory aspects is impossible with IoT devices and wearables. An additional uncertainty is associated with their use: wearing them under clothing or jackets. **An assessment of the uncertainty of these devices should be carried out**.

The main advantage is **the mobility of the device** linked to that of the user. It allows a different approach based on sound exposure similar to a dosimeter and to correlate the geolocation with the sound levels. Thus, a good number of mobile apps can be envisaged, that can be developed for information purposes for the services of the cities and spectators, such as:

- Real-time maps with sound levels or indexes (see 3.4.2) recorded during performances
- Correlation of feelings of the spectators (positive or negative, pleasant or unpleasant) with sound levels or indexes

Smartphones can also be used by local residents to make sound level measurements or **sound recording** at events. It should be noted that more and more residents are making sound levels measurements with their smartphones and dedicated mobile apps are already available.

Figure 15: UWB-based wristbands- Smartphone- Smartwatch

Acoucité will be able to write the specifications for Work Package 6 (recommendations) for sound level measurement apps developed for the three identified IoT devices (Figure 15), based on existing apps:

- The first app is **NoiseCapture** developed on Android by the research centre IFFSTAR, partner of Acoucité (http://noise-planet.org/en/noisecapture.html). The descriptive video of the app is available here: https://youtu.be/W3Ki_dbbChs. It is an open source app whose code is available for project experts.
- The city of Turin has developed an app called **OpeNoise** that measures the sound level: https://play.google.com/store/apps/details?id=it.piemonte.arpa.openoise&hl=en
- The INRIa research centre has also developed a sound level measurement app on smartphones. This app was then taken over by a start-up that pursued the development and made it available on Android market and App store (https://www.inria.fr/en/centre/paris/news/launch-of-soundcity-mobile-application). The name of the application is **Ambicity**.
- Another open source app is **NoiseTube** (http://www.noisetube.net/index.html#&panel1-1).

Additionnal information about apps:

NoiseCapture

"NoiseCapture App is an Android App project for measuring environmental noise using a smartphone. The goal is to produce relevant noise indicators from audio measurements, including a geospatial representation. Measurements can be shared with the community in order to produce participatory noise maps. NoiseCapture App is a component of a global infrastructure, i.e. a Spatial Data Infrastructure (SDI), called the OnoMap SDI, that allows to process and represent the geospatial information, like noise maps.

- *A full description of the whole OnoMap SDI, including the NoiseCapture App, is given in the wiki pages.*
- *An user guide, for the use of the NoiseCapture App, is proposed within the NoiseCapture App (see the 'Help' page in the menu of NoiseCapture App)."*

OpeNoise

Figure 16 : OpenNoise on the PlayStore

3.4.5 Contribution Algorithm

To assess annoyance of local residents and acoustic comfort of the audience, an interesting strategy may be to separate the contribution of each sound source in the signal at a given location:

- The first approach is to have access to the source signal, to the geolocation of the connected sound level meter and to use the transmissibility relationship.
- The second approach consists of using machine learning techniques to create and use a database that will allow the recognition of sources by similarity.

Figure 17: Contribution algorithm[5]

3.5 Active Sound Field Control

The principle behind Sound Field Control and Sound Zone Systems have been tested and validated in laboratory conditions. An important contribution is the cancelation of an outer sound field using double loudspeakers. The laboratory conditions are controlled environments with constant climate conditions and low noise levels, making the sound field easy to predict. However, the MONICA ASFC will take these results to real life outdoor conditions. In doing so, the system is to be adaptive, using model updating, in order to compensate for variations in sound speed and sound speed gradients, which occurs due to varying atmospheric conditions. Also the variations in audience density will be compensated for. The input data for the model updating will be provided by IoT sensors and devices, including subjective data in form of sound quality and annoyance assessment using smartphone apps. Moreover, the possible noise annoyance in regions outside the audience area will also be estimated using noise monitoring systems combined with sound propagation models.

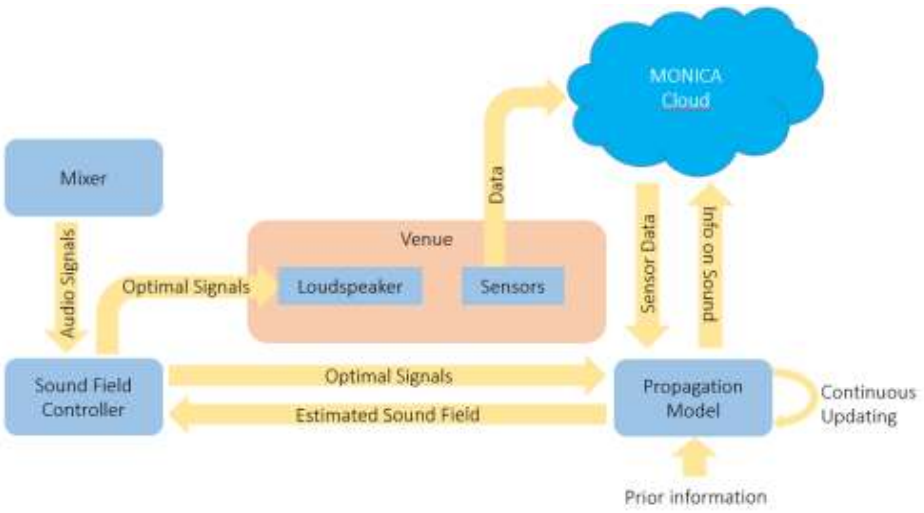


Figure 18: ASFC synoptic[6]

[5] Presentation of B&K during a plenary meeting
[6] DTU Presentation at a technical meeting

3.6 Silence showers

The product aims at reducing the sound level in a small area (approximatively unipersonal) based on active and passive acoustic principles. The system combines active elements (loudspeakers) at low frequencies, and passive elements (absorbers) for the higher frequency range. The active part will make use of Multichannel Active Noise Control where we integrate a novel approach which can be described as a feedforward mechanism which measures and makes use of the transfer function within the quite zone in relation to the sound signal originating from the sound engineer's console. The passive part might look like a shield or screen with absorptive properties. The final dimensions depend on the specific needs of the pilots and can be adapted appropriately within a viable range.

3.7 Passive absorbers

The sound control system is essentially effective in low frequencies, which are often the most problematic part because of their widespread propagation. For spectral portion that includes the treble and midrange, absorbent passive solutions may be used as the focus with the line array, the acoustic screens or absorbent materials.

Passive absorbers: **RING will write the Master Thesis introduction** and **communicate with DTU** for refinement and further internal sharing if required.

RING showed a scaled model of a tree-structure "Tubular Resonant Audio Energy absorber for applications in free field outdoor environments". If passive structures are to be Applied in MONICA set-ups within restricted, architected amusement gardens such as Tivoli, Copenhagen, then such passive absorbers must not obstruct the original architectural design, but blend-in with the existing surroundings.

So the structures could be covered with damping material to disguise it as a tree. Tubes should resonate from the low E-string on the bass and two octaves up and filled to absorb the resonant energy.

Figure 19: Tubular Resonant Audio Energy absorber

4. Acoustic assessment of pilots' event

DISCLAIMER
This part assessing the pilots' needs was built with information provided to Acoucité by the 31 of May 2017. Missing information was gathered by Acoucité to even the events but might contain approximations or dated values.

Note for the monitoring proposal: to help the set-up of sound measurement, a protocol is proposed in Appendix B: Measurement Protocol. Tables containing detailed information on recommended material configuration (e.g. sound level meter characteristics) are also available. They can be sent by Acoucité if needed by the pilot partners.

4.1 Turin

4.1.1 Kappa Future Festival

4.1.1.1 Description of the event

Date: 08/07/2017 and 09/07/2017

Opening hours: 12:00 to 00:00

Public: 20,000 per day (about 40,000 in total). Young audience.

Figure 20: Kappa Future Festival

4.1.1.2 Description of the site

Dimension: Urban park of 45000 m². The main stage is under a metal structure 150 meters long by 20 meters wide.

The other two (smaller) stages are in the open air.

Relief: Open place, no obstacle between the stages and the nearest houses.

Land use: Urban park, skate boarding area.

How it works: In an urban park near the city centre, this former industrial wasteland of the Fiat factories houses 3 venues.

Figure 21: Geolocation of Kappa Future Festival

Figure 22: Parco Dora

Figure 23: Road traffic noise - Lden (24h)

Figure 23: Road traffic noise - Lnight (22.00-6.00)

4.1.1.3 Noise sources

Off event:

- Air traffic (near the airport)
- human sounds of walkers in the park (voices and footsteps)
- natural sounds (bird songs in trees)
- road traffic in the background (little present)

During the event:

- amplified electronic music

4.1.1.4 Regulation

Application of regulations applied in industrial noise. The sound level LAeq (1h) must not exceed 70 dB (A) on the front panel.

The municipal police in Torino carries out control measures during the festival. The fine is € 2000 to the organiser.

4.1.1.5 Expectations

- Continue to organise a music festival, maintain the offer for the public, while improving the acceptability of the event by local residents (management of complaints from local residents for high levels of noise)
- Public Health (hearing hazards).
- Improve exchanges between organisers and public authorities (information on sound systems used)
- Decrease in the number of complaints.
- Compliance with regulatory thresholds (70 decibels A on the building facade).
- Real-time application (measured sound levels)

4.1.1.6 Monitoring proposal

- Handing out questionnaires to local residents
- Monitoring (installation of sound level meters) + sound recording

4.1.2 La Movida

4.1.2.1 Description of the event

Every evening of the week, with the exception of Monday, a rather young public arrives in the neighbourhood (and more precisely the streets close to the Largo Saluzzo square).

Date: a full-time event that takes place throughout the year. Several evenings / nights a week (this is not limited to the weekend).

Opening hours: around 22:00 to 03:00

Figure 24: Picture of La Movida

4.1.2.2 Description of the site

<u>Area San Salvario</u>

Dimension: Downtown area, close to Porta Nuova railway station. **(red dot on picture below)**

Relief: Dense urban environment, old buildings, high facades, narrow streets.

Occupation of the soil: buildings of houses, trade, bars and restaurants.

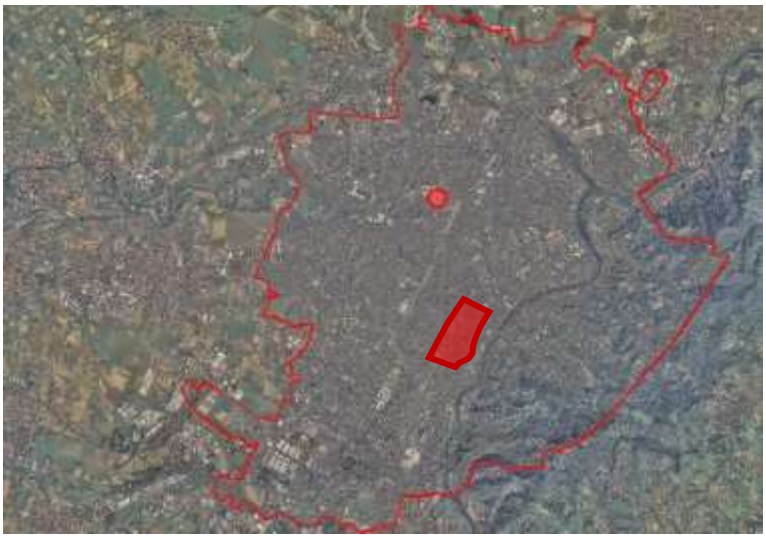


Figure 25: Geolocation of La Movida (red rectangle)

Figure 26: Road traffic noise - Lden (24hours)

Figure 27: Road traffic noise - Lnight (22.00-6.00)

4.1.2.3 Noise sources

Off event:

- road traffic. Mainly cars passing by slowly. Their passage does not necessarily hide the other present sources.
- traffic on neighbouring streets is hardly audible, urban forms protect the place from distant noises.
- human sounds of passers-by (voices and footsteps)
- natural sounds (bird songs in trees)
- home sounds coming from the dwellings (sounds of cutlery that collide during the meal, or music escaping through a mid-open window).

During the event:

- voice, shouting, laughter.
- amplified music from bars whose doors and windows remain open.
- glass breakage.

4.1.2.4 Expectations

- Decrease in the number of complaints.
- Decrease in the sound levels.
- Public health (residents' sleep).
- Disturbance of public order.
- Real-time application (measured sound levels).

4.1.2.5 Monitoring proposal

- handing out questionnaires to local residents
- Monitoring (installation of sound level meters) and sound recording

4.2 Lyon

French regulation overview

The paragraphs below summarize the reference limit values for the French regulations on noise at work, neighbourhood noise and musical places. A more detailed description of these regulations and links to additional resources is provided in Appendix C.

Noise at work

The regulation on noise at work is defined in the Labour Code. An event is not restricted by the regulations if the noise dose of the workers does not exceed 80 dB (A), for a duration of exposure of 8 hours (cf. health part for the equivalences of noise dose, depending on the duration of exposure).

Beyond this threshold, preventive measures are required by the employer. They become higher according to the measured noise dose.

Neighbourhood noise

Neighbourhood noise regulations are defined by the Public Health Code. An event complies with the regulations as long as the global emergence of the particular nuisance noise is below limit values.

The global emergence corresponds to the difference between the ambient noise level at the event and the residual noise made by all the usual noises. It is calculated from the perceived noise inside the main rooms of any dwelling unit, opened or closed windows.

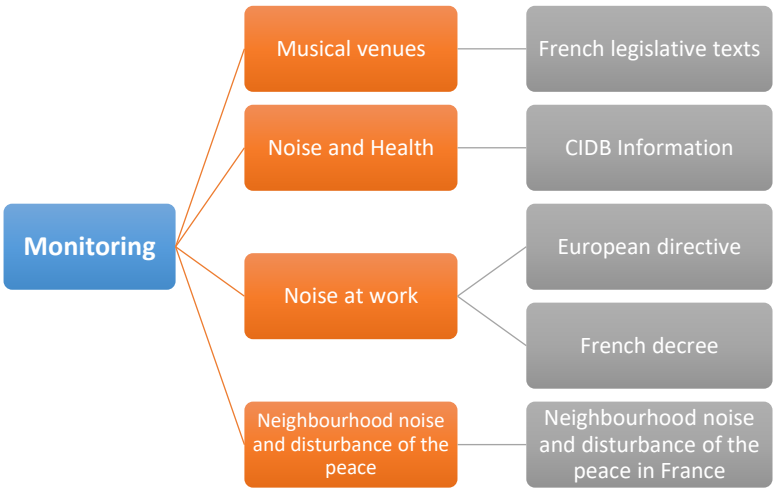
The limit values for emergence are 5 dB (A) in the daytime period (7 to 22 hours) and 3 dB (A) in the night period (22 to 7 hours), plus one corrective term in dB (A) as a function of the cumulative duration of the occurrence of the particular noise.

To the regulations set by the Public Health Code is added the notion of disturbing the peace, defined in the Penal Code. A noise from the event could fall into this category if it is found, without acoustic measurement, that it is audible in the complainant's dwelling and disturbs his / her tranquillity between sunset and sunrise (as a rule between 22h and 7h).

Musical venues

Musical venues, as noisy activities, are governed by the Environmental Code. To comply with regulations, the sound pressure level in these places should not exceed 105 dB (A) in average and 120 dB peak level in the measurement conditions set by decree.

An event may or may not be considered as a musical venue depending on its usual character (see Appendix C for the definition of usual).



4.2.1 Fête des Lumières

4.2.1.1 Description of the event

Fête des Lumières is a free cultural event hosted by the city of Lyon. It is a festival composed of light installations with, for some of them, sound animations.

Date: 8, 9 and 10 December 2017
Opening hours: 20.00 to 00.00
Public: diverse (young people, families, elderly people, inhabitants of Lyon, tourists ...). This site welcomed approximately 2 000 000 visitors in 2016

Figure 28: Photos taken during the 2010 edition (on the left) and the 2011 edition (on the right) of Fête des Lumières (CC BY Acoucité)

4.2.1.2 Description of the site

The configuration of the site is re-evaluated each year by the event organisers. The size of the site may vary according to the editions. In order to prevent terrorism-related risks, the perimeter of the 2016 edition had been particularly limited. Fête des Lumières was held for the most part on a perimeter closed to traffic on the peninsula of Lyon with checkpoints. Among public transports services (bus, tramway, underground, funicular), only the underground service was accessible within the perimeter. The checking was carried out at the exit of the underground station. Figure 29 is the plan of the 2016 edition:

Figure 29: Plan of the 2016 edition (source: website of Fête des Lumières, screenshot)

E: Entry points (every 100 m) accessible for pedestrians with random checking.

Dotted line: perimeter of Fête des Lumières. Pedestrian exits are possible on the whole perimeter.

Every year, the perimeter evolves according to the local authorities decision based on accessibility, maintenance work, etc.. Fête des Lumières should a priori take place over the nine districts of Lyon but each part of the site might remain fenced and accessible through checkpoints.

The installations are located in well-known public venues of Lyon (places, streets, squares, parks ...). Most of the shows take place outdoors (two projects indoors in 2016 at the Regional Council Building and the Part-Dieu shopping centre). A few days before and after the event, an area is reserved on the venues for the assembly and dismantling of the installations. During this time, the most part of the venues remain accessible to the public.

Sound equipment: its location and its direction depend on each installation. It is usually directed towards the spectators of the installation.

Located in the town centre, the site has a relief of a dense urban environment. Land use is defined by the perimeter of security (e.g. streets of the peninsula crossed by visitors) and the location of the installations (e.g. Place des Terreaux).

The strategic noise maps were calculated in 2012 on the territory of Greater Lyon. On the site of the peninsula, road traffic noise is most present. There are significant noise levels along the riverbanks (greater than 70 dB (A), Lden 24 hours) and calmer areas if moving away from the main axes.

Figure 30: Road traffic noise – Lden (24 hours)

Figure 31: Road traffic noise – Lnight (22.00-6.00)

4.2.1.3 Noise sources

As venues are usually used throughout the year, there is a hierarchical redistribution of sound sources during the period of the event.

Outside of the event, the venues (Place Bellecour, Place Saint-Jean, Place des Terreaux ...) are crossed by people going to the town centre for shopping, tourism, work. Some venues are pedestrian areas (Rue de la République, Place Saint-Jean). Others venues have road traffic, are located near main traffic axes (Place Saint-Paul, exposed to traffic noise coming from the banks of the Saône River) or are very well served by public transport (bus lines around Place des Terreaux). Sound sources are therefore road traffic noise and human sounds (voices and footsteps).

Before the event, the installations are assembled on the venues and tested. Road and pedestrian traffics are still present. Road traffic noise and human sounds are thus complicated by disturbances linked to the assembly operations and the testing of sound animations if this is the case.

During the event, the venues are closed to road traffic. Visitors wander around the perimeter in order to see the installations. In the streets, between each installation, the human sources (voices, laughs, cries, footsteps) thus become predominant in relation to road traffic noise. Arriving at the venues, the visitors gather around the installations and enjoy of the light show and the sound animations if this is the case. The sound sources are therefore the sounds of the shows and the noise of the crowd.

After the event, the installations are dismantled. Venues are re-opened to road traffic. Noise disturbances linked to the dismantling operations are added to road traffic noise and human sounds.

4.2.1.4 Acoustic regulation

The professionals (event organisers, technicians, artists and security staff) are a priori subjected to the regulations on noise at work. They must comply with the texts on the protection of workers and the working environment (see paragraph 3.4.3). According to the regulatory exceeded thresholds, different measures must be taken by the employers: provision of individual protections (ear muffs, ear plugs), signalling at risk places, and reinforcing medical supervision of employees...

Fête des Lumières is a festival and is not subject to the regulation of musical places. On the other hand, it is subject to the regulation on neighbourhood noise (Public Health Code and night-time noise). In order not to be in a situation of harming the quietness of the neighbourhood or human health and risk penal sanctions (fine, possibility of confiscation of equipment, possibility of payment of damages ...), the event organisers must avoid complaints from the neighbours.

4.2.1.5 Challenges

This popular event is well accepted by the inhabitants of Lyon. There have been very few complaints about noise in previous editions. The challenge in relation with the disturbance of the neighbourhood is thus not major. Nevertheless, understanding the impact of noise in the city remains an interesting problem. It can improve the acceptability of the event by the neighbours, notably by pursuing:

- information provided to the neighbours around the installations,
- awareness of the staff to preserve the quietness of the neighbours during the assembly and dismantling operations.

There is currently a non-systematic acoustic monitoring by the event organisers. There is therefore room to improve the sound quality of shows and to ensure a safe level of sound for the visitors, in particular by pursuing:

- management of sound levels during performances.

4.2.1.6 Expectations

An expectation (not expressed) for the event organisers could be the decrease in complaints. Monitoring in front of the dwellings near the noisiest installations would enable to know the sound level and to adjust the sound system to comply with the regulations.

Another expectation (not expressed) could be the access to a real-time app (measured sound levels) for the visitors, the technical team and the event organisers:

- Visitors could be informed of their sound level exposure and act to mitigate hearing hazards.
- For the technical team, this may be relevant for the staff posted near the loudspeakers for a long time.
- The technical team could also use it for scenario 6 (D2.1) where the technician estimates that the noise level needs to be increased to cover crowd noise. A look at this app would allow him to validate his setting both by visualizing the range of the sound and checking that the level is safe for the crowd.
- The event organisers could compare measured noise levels with city ordinance noise regulations.

4.2.1.7 Monitoring proposal

- handing out questionnaires to local residents
- Monitoring (installation of sound level meters) and sound recording

4.2.2 Nuits Sonores

4.2.2.1 Description of the event

Nuits Sonores is a paid cultural event taking place in the city of Lyon. It is a festival that dives in the world of design, image, graphic art, food culture, architecture and particularly music.

Date: once a year for five days and five nights, from the 24th and the 28th May
Opening hours: Day: 15.00 to 21.00 / Night : 21.00 to 5.00. (Day and night events take place on different sites)
Public: The attendance is about 14,000 visitors at night and 6000 visitors the day (for the 2017 edition).

Figure 32: Inside (photo on the left) and outside (photo on the right) of the site of Fagor-Brandt factories during the 2017 edition of Nuits Sonores (CC BY Acoucité)

4.2.2.2 Description of the site

For each edition, the festival invests emblematic venues in the city of Lyon: museums, cultural sites and industrial wastelands. For its 15th birthday, the festival took place on several sites in parallel. The day events took place in the town centre at events venues (the Subsistances, the Sucrière and the Sucre nightclub). The night events took place in the old Fagor-Brandt factories in Gerland in the 7th district of Lyon.

In this report, we restricted the acoustic study to the site of Fagor-Brandt factories. Its architecture (uncultivated and non-insulated factory), its location (close to residential areas) and its schedules (at night), makes it the venue in the festival with several challenges and most likely to generate an annoyance for the neighbourhood.

These old factories can gather up to 14,000 visitors around three stages. The stages are installed in old industrial warehouses, whose doors remain open (mixed indoors/outdoors configuration).

The site has a size of approximately 70,000 m² (see Figure 33). It is located in a mixed urban environment (residential areas, industrial areas, railways …) without relief. The closest residential facades are within a hundred meters of the festival.

Figure 33: In pink, site of Fagor-Brandt factories for the 2017 edition of Nuits Sonores (source: Google Earth, satellite view)

Figure 34: Map of the site of Fagor-Brandt factories for the 2017 edition of Nuits Sonores (source: website of Nuits Sonores)

The strategic noise maps were calculated in 2012 for the territory of Greater Lyon. On the site of Fagor-Brandt factories, road traffic noise and rail traffic noise are present. Road traffic noise is responsible for background noise and the passage of trains causes sound emergences.

Figure 35: Rail traffic noise – Lden (24 hours)

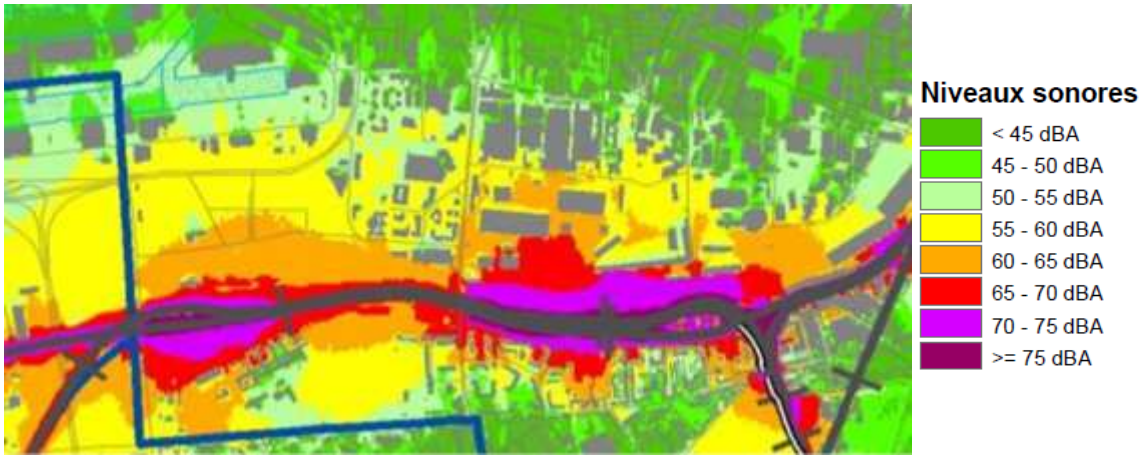


Figure 36: Rail traffic noise – Lnight (22.00-6.00)

Figure 37: Road traffic noise – Lden (24 hours)

Figure 38: Road traffic noise – Lnight (22.00-6.00)

4.2.2.3 Noise sources

Outside the event, the identified sources are:

- road traffic,
- rail traffic,
- human sounds (voices and footsteps),
- natural sounds (bird songs in the trees).

During the event, the identified source is:

- amplified electronic music.

4.2.2.4 Acoustic regulation

The professionals (event organisers, technicians, artists and security staff) are a priori subject to regulations on noise at work. Depending on the regulatory thresholds exceeded, different measures have to be taken by the employers.

Nuits Sonores is a festival and is not subject to the regulation of musical places. However, it is subject to regulations on neighbourhood noise. To not be in a position to affect the quietness of the neighbourhood or the human health and risk penal sanctions, the event organisers must avoid complaints from the neighbours.

The event organisers of Nuits Sonores position themselves in relation to these regulations by setting the maximum sound level adjustable by the sound engineers to 101 dB (A). They also offer solutions before the event to prevent complaints from the neighbours (see below).

4.2.2.5 Challenges

The event is partly organised in non-acoustically insulated industrial heritage sites. The high sound levels of the concerts easily reach the neighbours.

The neighbours have already expressed their discomfort by filing complaints with the event organisers in previous editions. As an alternative, there is a lot of communication by the event organisers before the event to improve its acceptability. For example, it is proposed to the neighbours to be accommodated in a hotel during the event.

The main challenge for this pilot site is thus to find appropriate measures to reduce the complaints of the neighbours due to noise. The event organisers hope to pursue the festival by maintaining the offer for the visitors, while improving the acceptability of the event by the neighbours.

The high sound levels of the concerts also impact the audience (visitors, staff, artists…). There is currently no acoustic monitoring. A second challenge is to evaluate the sound exposure and to act accordingly for the audience health (auditory risks).

4.2.2.6 Expectations

Stakeholders from this pilot mentioned particular interest in apps and solutions that deal with:

- real-time display of measured sound levels,
- sound level monitoring,
- citizen engagement.

- a reduction in complaints through:
  - a better knowledge of the annoyance of the neighbourhood
  - a sound level monitoring in the nearest streets and in front of the dwellings
  - minimization of noise impact on the neighbourhood
- protection of audience health through:
  - an assessment of noise exposure of visitors and event organisers
  - a sound level monitoring in the audience
  - creation of quiet spots close to the audience area

4.2.2.7 Monitoring proposal

- Delivery of questionnaires to the neighbours
- Monitoring (set-up of sound level meters) and audio recording

4.3 Copenhagen

4.3.1 Tivoli

4.3.1.1 Description of the event

Tivoli A/S is a publicly traded Danish company that manages the Tivoli Gardens and all related activities: amusement park, hotel, casino and gaming, restaurants, concerts. The park is open for three seasons: summer (April to September), Halloween from mid-October to early November and Christmas from mid-November to end of December.

Date: every Friday during the summer season (more than 20 concerts a year)

Opening hours: 22.00 to 00.00

Public:there are up to 500,000 spectators on a Friday Rock season

4.3.1.2 Description of the site

The location of the event is practically in the centre of the park and the main loudspeakers on the main stage are oriented towards the south. Satellite speakers are fixed in the middle of the spectator area.

The site that during the day is a place for the amusement park is reconfigured for evening concerts on Fridays. The pictures below describe the implantation.

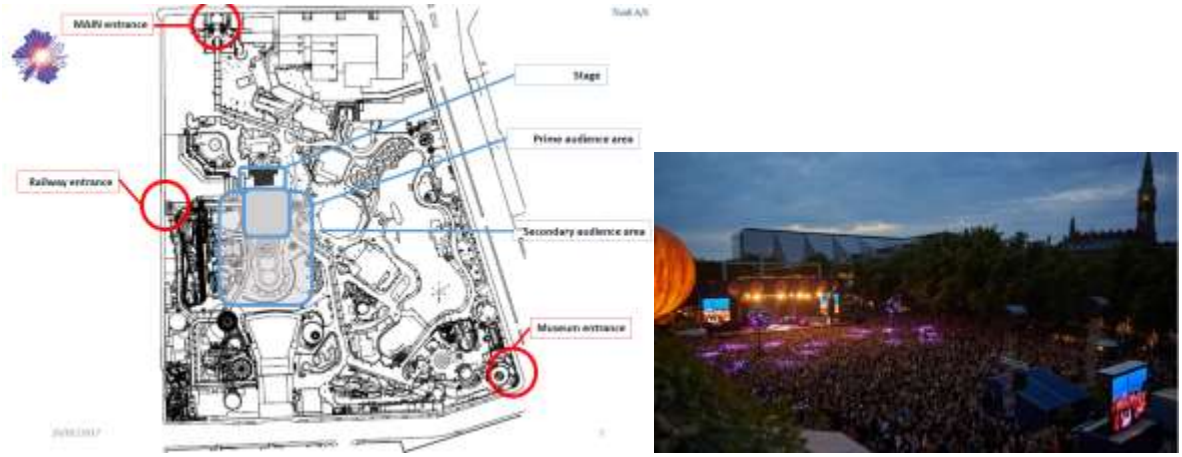


Figure 39: GIS and Map of the site

Strategic noise maps were calculated in 2012 on Copenhagen territory. On Tivoli site, road noise is quite important and rail noise is slightly present. Road noise is responsible for background noise and train passages cause sound emergences. The road traffic is especially high on H.C. Andersen's Boulevard and on Bernstorffsgade.

Figure 40: Road traffic noise - Lden (24 hours)

Figure 41: Road traffic noise - Lnight (22.00-6.00)

Figure 42: Rail noise - Lden (24 hours)

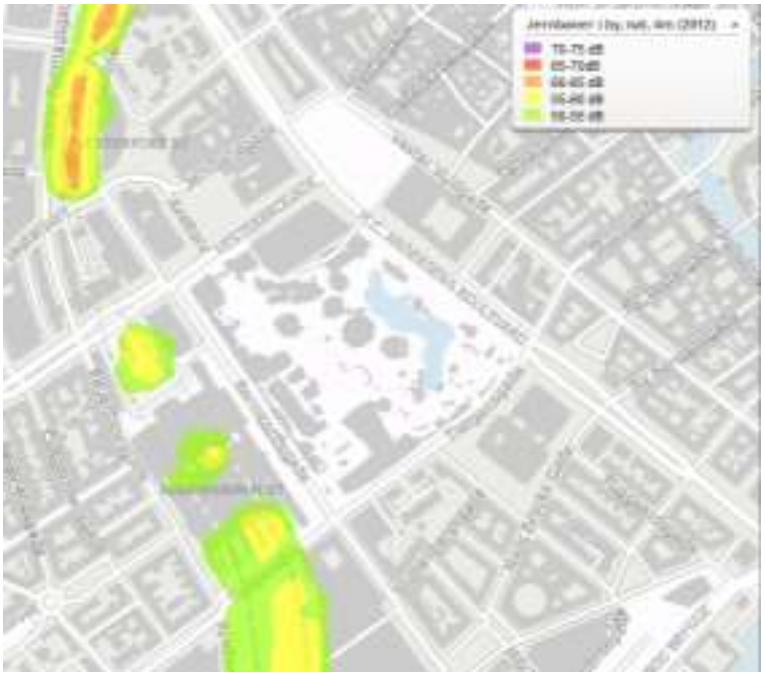


Figure 43: Rail noise - Lnight (22.00-6.00)

4.3.1.3 Noise sources

The sound sources are music and spectators which are added to the road traffic. In normal configuration, the sources are main PA, delay speakers.

Monitoring is possible only inside the Tivoli Gardens.

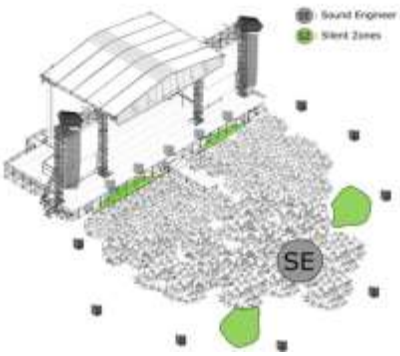


Figure 44: ASFC Loudspeakers[7]

4.3.1.4 Challenges

The stated goal for the Monica project is to have maximum satisfaction from spectators and performing artists while respecting the regulations.

The dwellings are located at the south of the park on Stoltenbergsgade. There are essentially commercial buildings, public offices and public transport centres on the other sides of the park.

Figure 45: The area of Friday rock (red)

4.3.1.5 Regulation

Noise emissions from Tivoli are subject to regulations defined within the environmental permit. Noise emissions (Leq) from outdoor activities should not exceed 60 dB (LEQ 60 minutes) at Stoltenbergsgade.

Figure 46: Friday rock's area

A sound level meter is fixed on the roof of the Tivoli Concert Hall and indicates the Leq 60 minutes. This should not exceed 77 DB (A), which according to the permit replicates maximum 60 dB (A) at Stoltenbergsgade and approximately 89 - 91 dB (A) LEQ 15 minutes at FOH.

[7] DTU Presentation at a plenary meeting

4.3.1.6 Expectations

Outdoor concert sound emissions may not exceed the existing limits in Tivoli's environmental permit during the experiment of the project MONICA.

The wind will be a parameter to take into account for the monitoring. The wind from south west can be particularly strong.

4.3.1.7 Monitoring proposal

Tivoli as a private company is primarily interested in the regulatory aspects and is not interested in communicating about the sound levels. Tivoli shall serve as a benchmark for similar outdoor concert venues that seek to improve sound emissions within a confined area, for the benefit of performers and spectators, while respecting existing regulatory limits. Consequently monitoring outside Tivoli Gardens is not critical. Monitoring inside the gardens, if requested is possible and may be accompanied by measurements made by bracelets or mobile phones.

4.4 Bonn

4.4.1 Pützchens Markt

Figure 47: Picture © Foto: Volker Lannert/Bundesstadt Bonn

4.4.1.1 Description of the event

"Pützchens Markt" (vernacular for "Fair of the Well") is a street festival that takes place every year in the second weekend of September. This annual fair dates back to 1367 and has mainly been held on the Market Meadows of Pützchen since the start of the 18th century. It is one of Germany´s biggest fairs in terms of turnover.

The festival lasts five days. It opens on Friday and the end of the fair is marked by a majestic fireworks around ten o´clock on Tuesday night. The event opens at noon and closes every night at around 1-3 am. It offers attractions of all kinds, visitors can find a mixture of traditional merry-go-rounds, modern fun-fair high-tech and nostalgic stalls

Figure 48: Market Meadows of Pützchen

The event welcomes nearly one million visitors in total. They can enjoy the festival for free. There are approximately 550 businesses and fairground amusements with a front length of 4.5 kilometres.

4.4.1.2 Description of the site

The site has a total area of 80,000 m² and is located in the heart of a dense residential area.

Figure 49: Geolocation of Pützchens Markt

Noise maps of the site were calculated in 2012 for road, rail, air and industrial noise. It appears that only road noise has an impact on the site of the event, due to the road traffic in Marktstraβe and in Holzlarer Weg.

Road noise maps are presented below.

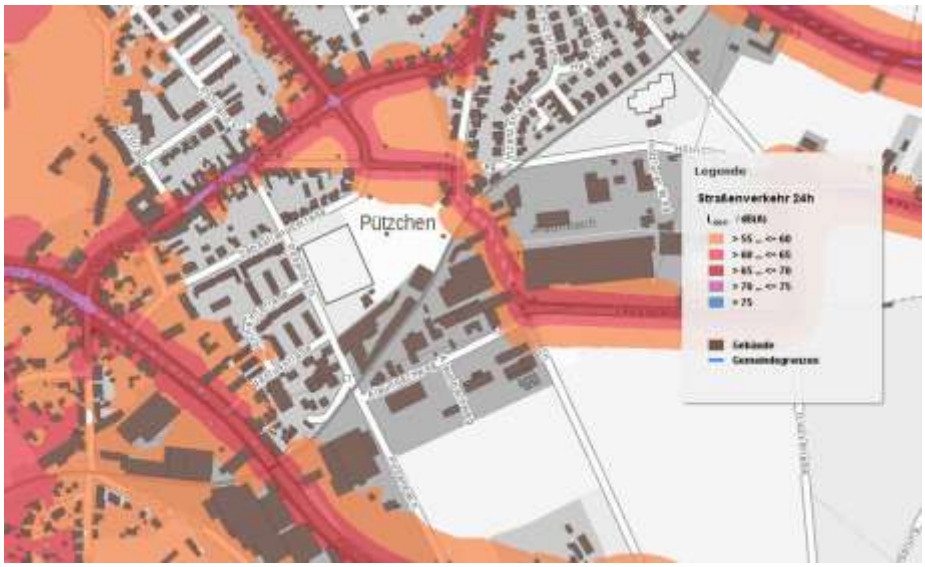


Figure 50: Road traffic noise - Lden (24 hours)

Figure 51: Road traffic noise – Lnight (6.00 – 22.00)

4.4.1.3 Acoustic regulation

The fair enjoys a special acoustic regulation as it is one of the five annual events in Bonn, for which regulation is specific: a noise level of 80 dB (A) is exceptionally accepted on the façade of the nearest residents.

4.4.1.4 Noise sources

The main noise source in normal periods (excluding festival) is road traffic from Marktstraβe and Holzlarer Weg

During the festival, the main noise sources are:

- loudspeakers broadcasting announcements
- stands for the fair with amplified music
- Human voices

4.4.1.5 Expectation

There are no expectations expressed by the pilot Bonn regarding the sound management of this event. Indeed, it is a historical event that is part of the culture of the city and therefore very well accepted. Despite very high noise levels, no complaint has been filed in recent years

4.4.1.6 Monitoring proposal

The pilot expressed no needs in terms of monitoring for this event.

4.4.2 Rhein in Flammen

4.4.2.1 Description of the event

Rhein in Flammen is a festival happening every year in early May in the Rheinaue, a public park located next to the Rhein River in the city of Bonn. Visitors can join the free event from Friday to Sunday. During this time, a variety of concerts take place in three different stages. On Saturday evening, the most crowded day out of the three, thousands of people join the firework show and the illuminated boat parade along the Rhein. This part of the program is considered to be the highlight of the event.

Rhein in Flammen has been held for 32 years and welcomes an average of 90,000-120,000 visitors per day making it one of the most popular festivals in the area.

4.4.2.2 Description of the site

The festival takes place in a fence-free area of about 200,000 m2

Figure 52: Map of Rhein in Flammen

There are residential areas near the park that are impacted by the sound emissions of the event. They are identified by red circles on the map below.

Figure 53: Residential area

According to the noise maps calculated in 2012, these residential areas are exposed to rail noise from 55 to 75 dB(A) (Lden 24h). Moreover, the dwellings located next to important roads are particularly exposed to traffic noise: A562, Petra-Kelly-allee, Ludwig-Erhard-allee.

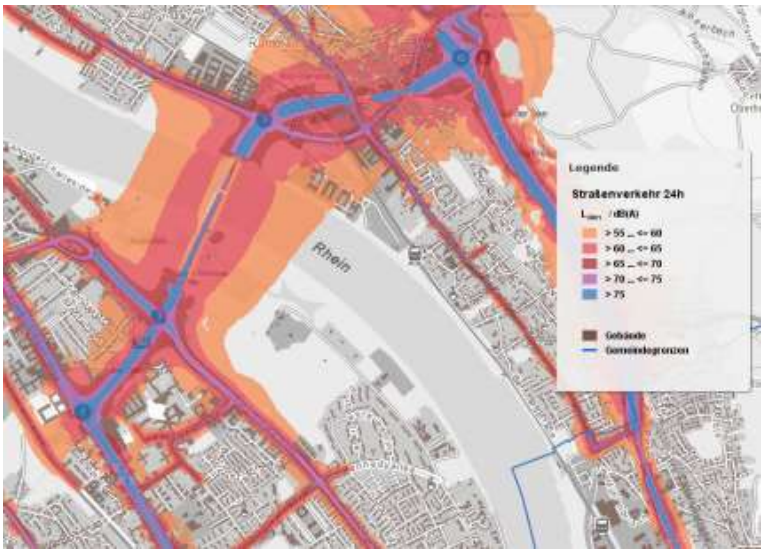


Figure 54: Road traffic noise - Lden (24 hours)

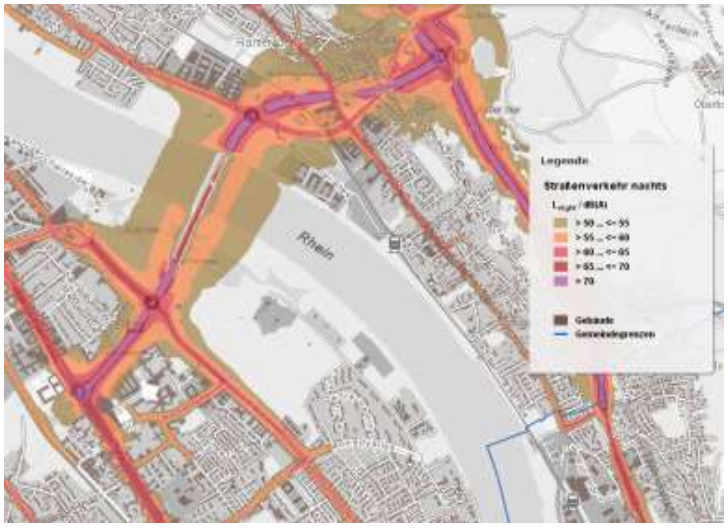


Figure 55: Road noise – Lnight (6.00 – 22.00)

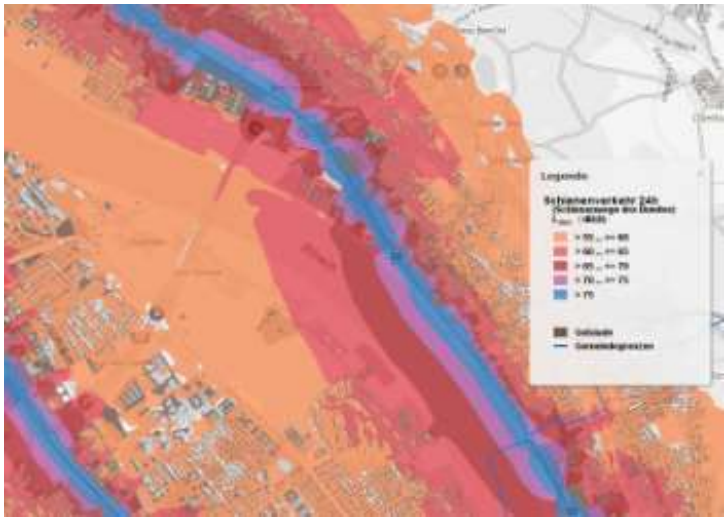


Figure 56: Rail noise - Lden (24 hours)

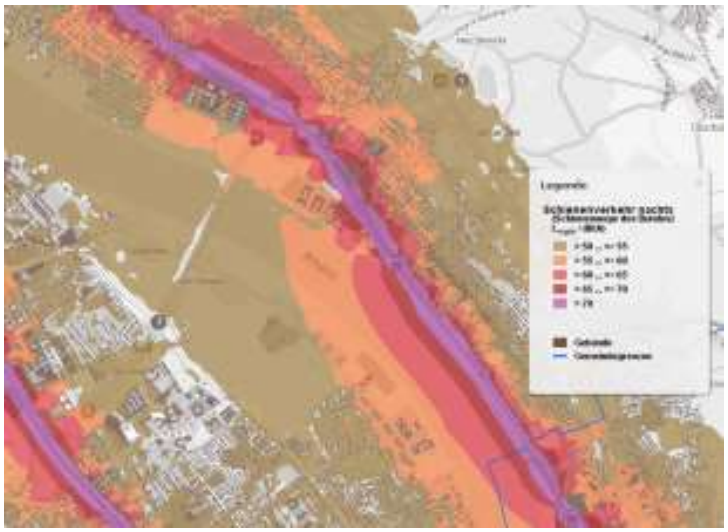


Figure 57: Rail noise – Lnight (6.00 – 22.00)

4.4.2.3 Acoustic regulation

The festival enjoys a special acoustic regulation as it is one of the five annual events in Bonn, for which regulation is specific: a noise level of 80 dB (A) is exceptionally accepted on the facade of the nearest residents.

4.4.2.4 Noise sources

The main noise sources in normal periods (excluding festival) are road traffic and rail traffic.
During the festival, this background noise is covered by the music coming from the 3 stages, and the noise produced by visitors.

4.4.2.5 Expectations

The organisers would like to install a robust and long-lasting monitoring system in order to assess noise levels in several locations.

4.4.2.6 Monitoring proposal

It could be interesting to monitor noise close to each of the stages (3 spots) and at the facade of the most exposed dwellings (about 8 spots).

4.4.3 Kunst!Rasen

4.4.3.1 Description of the event

Kunst!Rasen is a private open air music festival that takes place every year in the Rheinauepark. The festival offers various concerts during June and July attracting between 50,000 and 70,000 visitors per year. The festival area is close to the Rhein river. It has a capacity of 10,000 people and its size is 18,000 m2. In the venue, visitors can find one main stage and a beer garden. With the exception of one classic concert that is offered free of charge to the audience, visitors have to buy a ticket either online or directly at the box office to attend the concerts that take place at the festival.

4.4.3.2 Description of the site

The festival takes place in the Rheinauepark, that's why the observations made for Rhein in Flammen are applicable here as well.

4.4.3.3 Acoustic regulation

The noise level accepted on the facades close to the event depends on the type of zone and on the time of day. The regulations distinguish five areas and three periods. The maximum noise levels admitted (in dBA) are presented in Table 5.

	Working days during working hours	**Working days during rest periods**	**At night**
Industrial areas	70	70	70
Commercial areas	65	60	50
Core areas, village areas and mixed areas	60	55	45
General residential areas and small residential areas	55	50	40
Pure residential areas	50	45	35
Spa areas, hospitals and nursing homes	45	45	35

Table 5: Acoustic Regulation

The surroundings of the site fall into the category "general residential areas and small residential areas". The maximum sound level allowed by night is 40 dB(A).

4.4.3.4 Noise sources

The main noise sources in normal periods (excluding festival) are road traffic and rail traffic.

During the concert, this background noise is covered by the music coming from the stage, and the noise produced by visitors.

4.4.3.5 Expectations

Kunst!Rasen is struggling with complaints from the neighbours who live close to the venue. The nearest neighbour is only 440 metres away from the sound systems and there is a real difficulty to comply with the regulatory limit of 40 dB(A). At the moment, sound engineers are able to stay within the required limits but the problem still remains since the artists are using more and stronger low frequencies in their music. The Rhein River is between the venue and the neighbour and there are no obstacles to prevent sound propagation.

There is a need to find new techniques to reduce noise impact on local residents while still maintaining a sound level around the stage that satisfies both the visitors and the artists. Kunst!Rasen has an increasing need to find technical solutions to solve this problem that they have been facing for years.

4.4.3.6 Monitoring proposal

The proposal is to use the same noise monitoring as for Rhein in Flammen: 1 microphone closed to the stage, and others at the facade of the most exposed dwellings (about 8 spots).

4.5 Hamburg

4.5.1 DOM

4.5.1.1 Description of the event

The Hamburg DOM is the largest fun fair in Northern Germany. It is on for 30 days every summer, winter and spring at Heiligengeistfeld, an event area right next to the St. Pauli stadium. A maximum of 250.000 people come every day to visit around 250 stands. The annual visitor count is around 10 to 12 million.

Figure 58: ***2 pictures of the DOM***

Opening hours:
Summer edition, from 28 July to 27 August 2017
Mon to Thu: 3:00 p.m. to 11:00 p.m.
Fri to Sat: 3:00 p.m. to 00:00 a.m.
Sun: 2:00 p.m. to 11:00 p.m.

4.5.1.2 Description of the site

Figure 59: ***DOM, Digital Orthophoto 2014*** **(source: FHH – Landesbetrieb Geoinformation und Vermessung 2017*)***

The DOM (green colour on picture) is inside the city of Hamburg and is surrounded by dwellings and activities except:
- Millerntor-Stadion: stadium on the East
- Planten un Bloomen: park on the West
Dimension: 160.000 m², almost flat ground
There are nine free entries without gates and people pay only on attractions or food stands.

Noise maps of the site were calculated in 2012 for road, rail, air and industrial noise (http://www.hamburg.de/laermkarten/). It appears that only road noise has an impact on the site of the event, due to the road traffic in Budapester Straβe, in Feldstraβe and in Glacischausee.

Road noise maps are presented below.

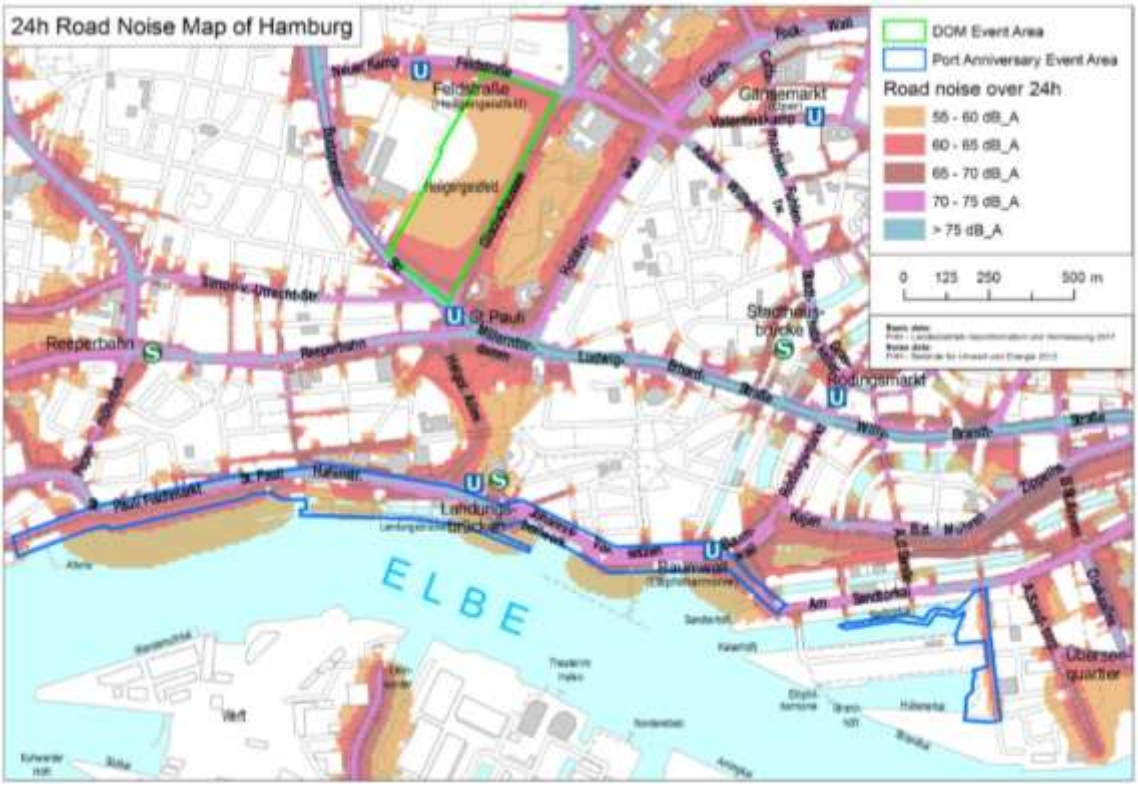


Figure 60: Road traffic noise - Lden (24hours)

Figure 61: Road traffic noise – Lnight (6.00 – 22.00)

4.5.1.3 Sources of noise

We are in a dense urban area so the daily soundscape is never really quiet.
Without event:

- Road traffic
- Human noise (voices and footsteps)

During event:

- Noisy fun rides and food stands
- Uncoordinated speakers announcements
- Crowd noise (voices, shouting, laughter)

Law and regulations: A guideline is given with the "Freizeitlärmrichtlinie".

4.5.1.4 Stakes

The city is interested in identifying quiet spots inside and around the fair to help tired people to rest.
The stakeholders are: the City Administration (Economy, Transport and Innovation BWVI, Environment and energy BUE), the Police force, the Fire department.

4.5.1.5 Expectations

Real time display of noise levels to individualise the « rest areas »

4.5.1.6 Monitoring proposal

- Before/during event monitoring
- Computer simulation to estimate quiet spots locations

4.5.2 Hafengeburtstag (Port Anniversary)

4.5.2.1 Description of the event

The Hamburg Port Anniversary is the largest German port festival.

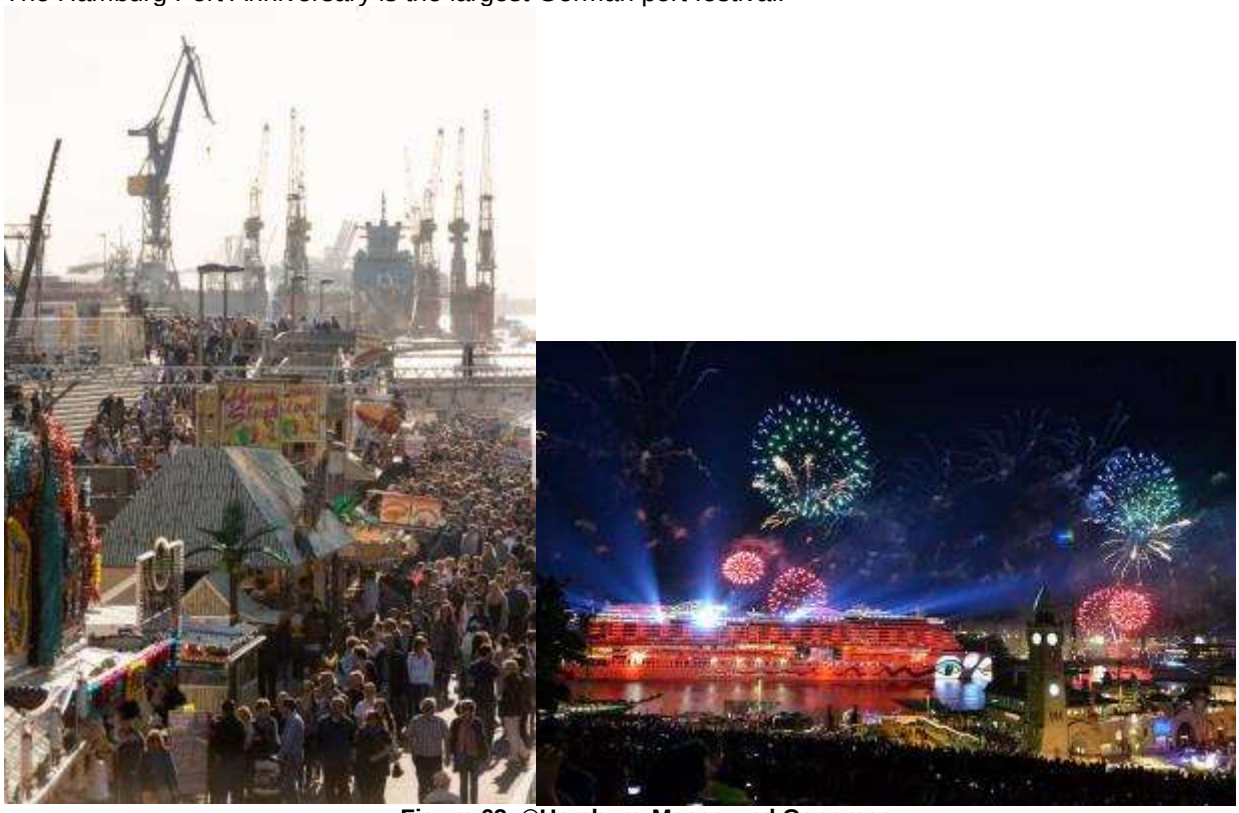


Figure 62: ©Hamburg Messe und Congress

Date: It takes place every year in early May and lasts 3 days
Opening hours:
Friday and Saturday from 10 am to midnight
Sunday: 10am to 9 pm
Public: In 2016, more than a million visitors visited the city during the event.

4.5.2.2 Description of the site

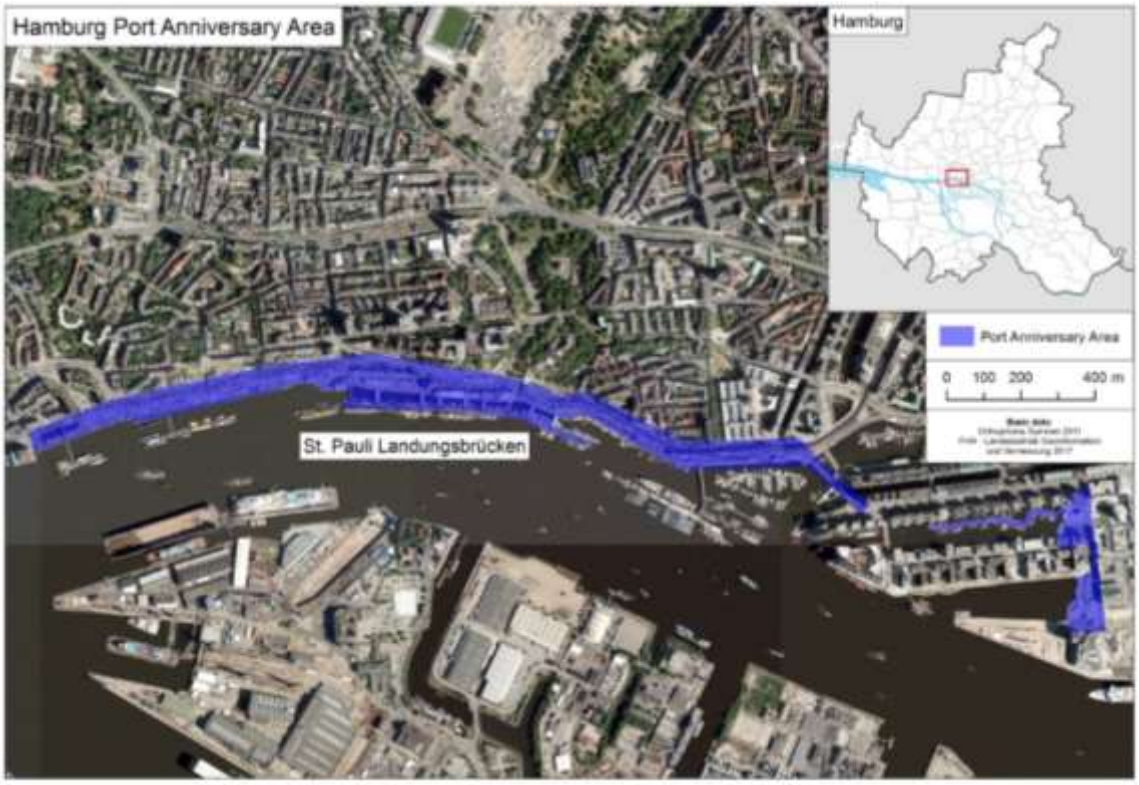


Figure 63: ***Hamburg, port festival area, Digital Ortophoto 2011 (*****source: FHH – Landesbetrieb Geoinformation und Vermessung 2017*****)***

The six kilometres-long riverbank where the celebration is going on (blue) is surrounded by a dense urban area. On south are located mainly companies related to harbour activities. The North part of the festival is a mix of dwellings and shops.
Dimension: 800.000 m², flat ground

Sound maps of the site were calculated in 2012 for road, rail, air and industrial noise (http://www.hamburg.de/laermkarten/). It appears that only road noise has an impact on the site of the event, due to the road traffic on the docks (St Pauli Fischmarkt, St Pauli Hafenstraβe, Johannisbollwerk and Vorsetzen). These roads are nevertheless closed to traffic during the event.

Road noise maps are presented below.

Figure 64: Road traffic noise - Lden (24hours)

Figure 65: Road traffic noise – Lnight (6.00 – 22.00)

4.5.2.3 Noise sources

We are near a dense urban area with a lot of river activities so the daily soundscape is never really quiet.
Without event:

- Road traffic
- Port activities
- Human noise (voice and footsteps)

During event

- speakers announcements even with wind direction taken into account
- music from stages
- Crowd noise (voices, shouting, laughter)
- Boat parade

Law and regulations:
The BWVI is responsible to control the sound emission, the guideline is the "Freizeitlärmrichtlinie".

4.5.2.4 Stakes

The city is interested in identifying quiet spots near the riverbank to help tired people rest.
The stakeholders are: the City Administration (Economy, Transport and Innovation BWVI, Environment and energy BUE), the Police force, the Fire department, the THW, the Hamburg-Convention.

4.5.2.5 Expectations

Real time display of noise levels to individualise the « rest areas ».

4.5.2.6 Monitoring proposal

There was not any previous noise monitoring so a first step could be to set up several sound level meters along the riverside to have an exact idea of what is going on: average noise, increasing of noise during the day, maximum etc. To find out quiet spots, some sound level meters can be dispatched in the neighbourhood. Noise monitoring before and during event might help to estimate the needs for local residents and visitors.

4.6 Leeds

4.6.1 Headingley Carnegie Stadium

Figure 66: Headingley Carnegie Stadium

4.6.1.1 Description of the event

Headingley Stadium outside Leeds is the home of Yorkshire County Cricket Club, Leeds Rhinos rugby league team and Yorkshire Carnegie rugby union team. The stadium has two separate grounds: Headingley Carnegie Cricket Stadium and Headingley Carnegie Rugby Stadium with a two-sided stand housing common facilities.

The cricket ground has been used for test matches since 1899 and has a seated capacity of 17,500.

The rugby ground consists of three stands: one stand is seated, one standing and one mixed. It has a capacity of 21,000.

4.6.1.2 Description of the site

Figure 67: Geolocation of the stadium © GoogleMaps

The stadium is located about 3 km North West of the centre of Leeds, in a residential area.

Noise maps of the site were calculated in 2012, for transport infrastructures. It appears that the closest noisy infrastructure is a rail way on south side of the site.

Figure 68: Rail traffioc noise - Lden (24 hours)

Figure 69: Rail traffic noise – Lnight (6.00 – 22.00)

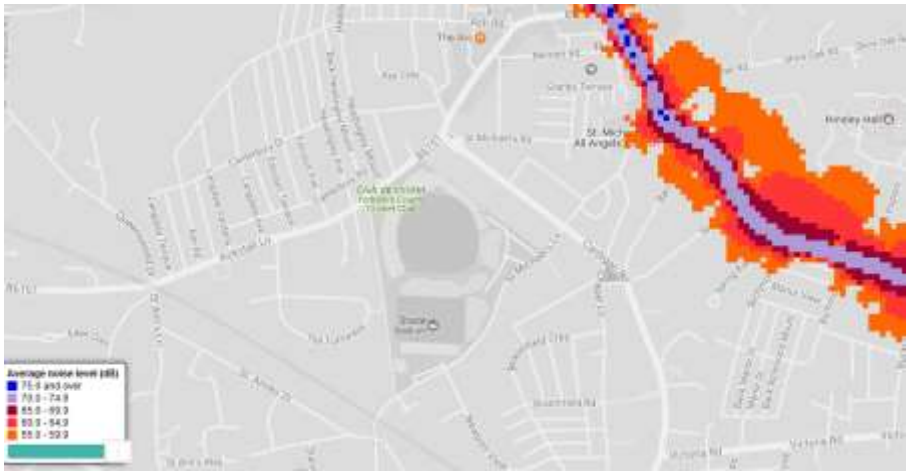


Figure 70: Road noise - Lden (24 hours)

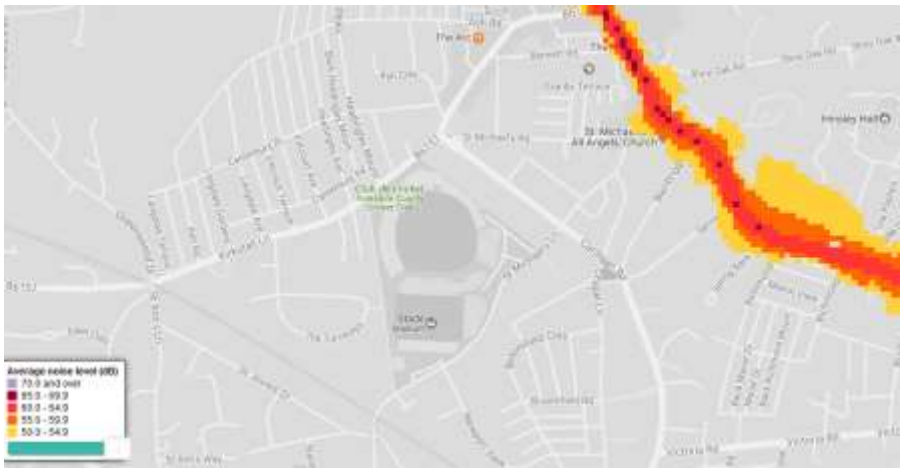


Figure 71: Road traffic noise – Lnight (6.00 – 22.00)

4.6.1.3 Noise sources

During matches, the sound sources are:

- loudspeakers broadcasting announcements or music
- human voices
- road traffic noise before and after the match

In 2015, a concert was organised in the cricket stadium. This has not been repeated because of complaints from local residents feeling that noise levels were too high. At this moment, there was no measurement of the sound levels on the facade of the nearest houses or anywhere in the vicinity.

4.6.1.4 Expectations

There is a possibility that the venue will wish to organise concerts again in the future and an understanding of noise pollution would be helpful to planning.

4.6.1.5 Monitoring proposal

The organisers would like to be able to install a system for monitoring the sound levels. It is impossible to install these on the facade of the nearest houses and the suggestion is to use hand held monitors as anything fixed will require permission from the relevant authorities.

5. Survey results of Kappa Futur Festival 2017

5.1 Introduction

This chapter presents the first analysis of the answers to the questionnaire presented in 3.3.2. This first field test was carried out in Turin during the KAPPA Futur Festival in July 2017 in collaboration with the city of Torino (Italy). It validated the questionnaire and the procurement methodology.

Figure 72: In the middle, satellite view of the festival site. On top: view from a neighbouring balcony. At the bottom: goers attending the show at Jager stage (photos taken by Acoucité during KFF in July 2017).

5.2 Context and Protocol

The Kappa Futur Festival is an electronic music festival that takes place every summer at the beginning of July in Dora Park in Turin, Italy.
The festival runs from noon to midnight for two days (Saturday and Sunday) on three stages and welcomes 12,000 spectators per day.

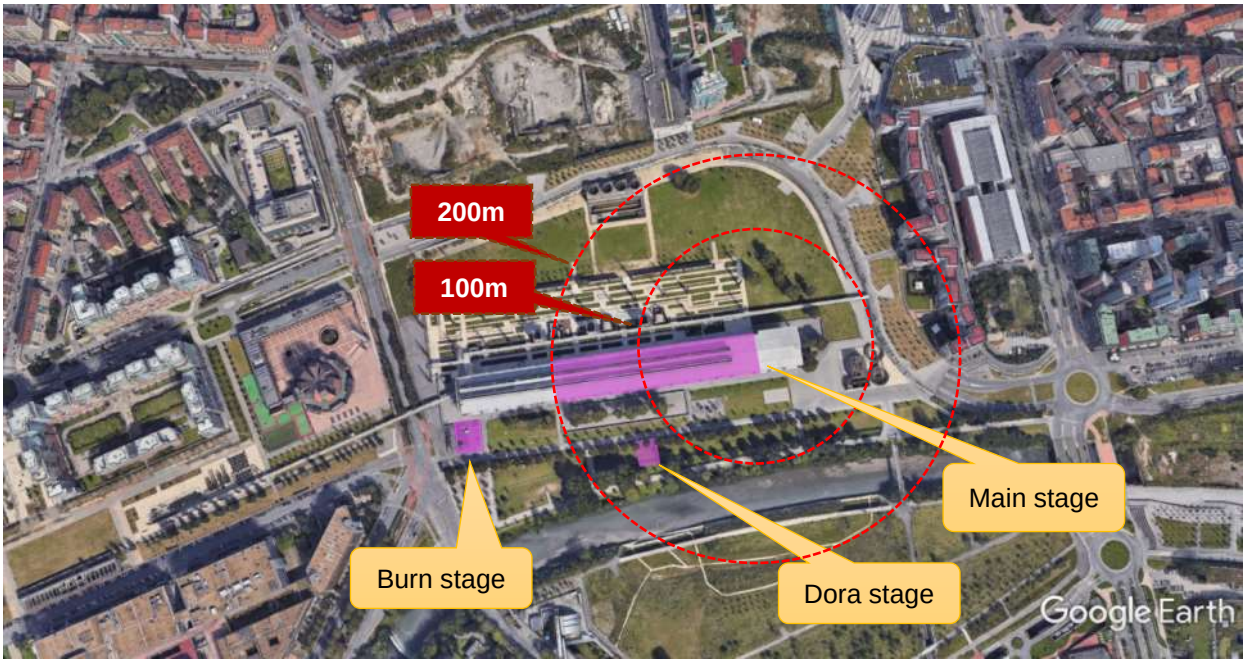


Figure 73: The three stages of KFF's venue

The Dora park covers an area of 450,000 m². Close to the city centre, this urban park highlights the industrial past of Turin. One of the festival's distinctiveness is that it takes place in the open air, in an urban environment, with habitat. Nine hundred residents are directly exposed (see picture below).

Figure 74: Closest dwellings and inhabitants number

The questionnaires were administered during face-to-face interviews with a sample of 128 people (residents close to the site selected by the city of Turin). The interviews were conducted between 8 July 2017 and 20 July 2017 at the residents' homes. The original questionnaire in English and French was translated by the city of Turin into Italian. The completion of the questionnaire did not pose any particular difficulties. The analysis of the results was made by Dr Bruno VINCENT (Acoucité, PHD in psychoacoustics).

5.3 Sample Characteristics (respondents and dwellings)

	Number	Frequency
No answer	7	5,5%
Men	71	55,5%
Women	50	39,1%
Total	128	100,0%

Table 6: Gender Information

	Average	Min	Max	Number	No answer
Age	46,2	14	77	123	5
Amount of years the respondents has lived in their dwellings	9,34	1	39	125	3
Floor	5,4	0	18	121	7
Distance to the event area (m)	434,6	1	2 000	111	17

Table 7: Global Statistics

The average age of the respondents is 46 years and they have been living in their dwellings for an average of almost 10 years. The dwelling were located between the Ground Floor and the 18th floor (average floor =5) and are on average less than 500 meters from one of the stages of the KAPPA festival.

	Number	Frequency
No answer	1	0,8%
Not at all	48	37,5%
Partly	50	39,1%
Yes completely	29	22,7%
Total	128	100,0%

Table 8: From your apartment, can you see the event area?

	Number	Frequency
No answer	46	35,9%
Bedrooms	14	10,9%
Both	36	28,1%
Hall/Kitchen	32	25,0%
Total	128	100,0%

Table 9: If yes, from which room?

Nearly 2/3 of the respondents have a straight view to the KAPPA festival location, 10% have their bedrooms and 28% both their bedroom and another living room. A quarter has another room towards the festival without the bedroom.
A total of 64% of the respondents therefore have at least one room in open fields towards the festival.

5.4 Questionnaire

	Number	Frequency
No answer	1	0,8%
I appreciate it very much	7	5,5%
I appreciate it enough	25	19,5%
I appreciate it little	25	19,5%
I don't appreciate it at all	**70**	**54,7%**
Total	128	100,0%

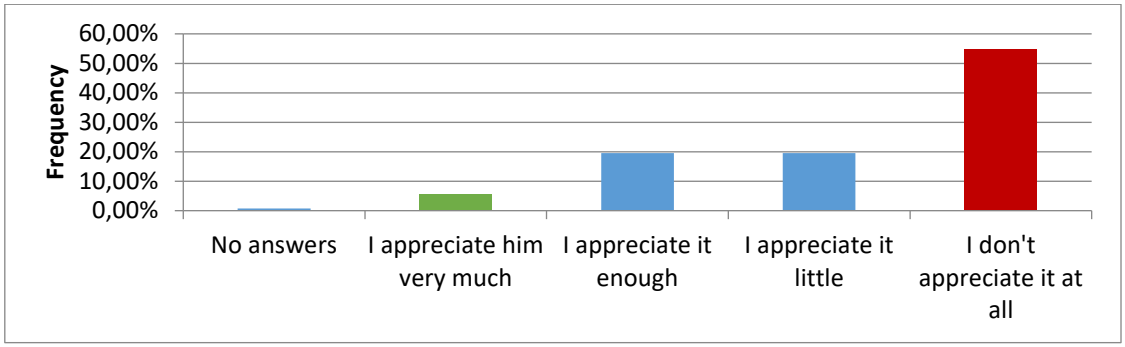


Table 10 and Figure 75: In general, what do you think of the Kappa Futur Festival?

Less than one-quarter of residents like the festival very much or somewhat, and almost 55% do not like it at all.

	Number	Frequency
No answer	1	0,8%
not at all	10	7,8%
Not very much	29	22,7%
yes, a little bit	**24**	**18,8%**
Yes, absolutely	**64**	**50,0%**
Total	128	100,0%

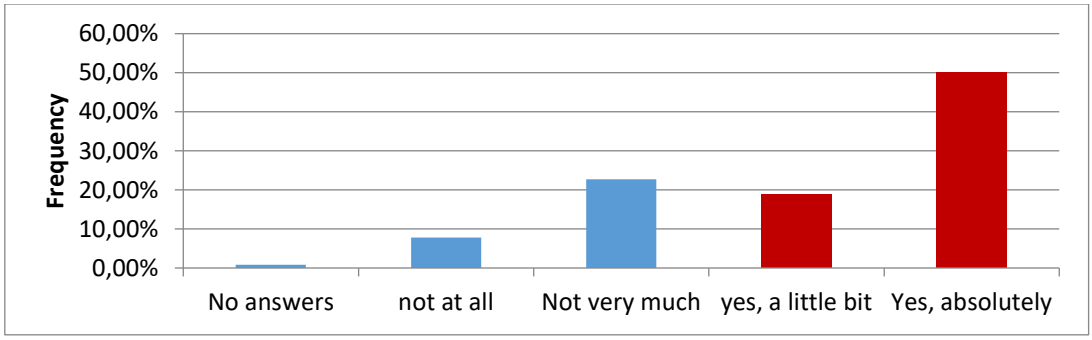


Table 11 and Figure 76: Do you think this event creates annoyance and discomfort for your home?

The festival represents a strong or moderate nuisance for the local residents.

	Number	Frequency
Noise	**90**	**70,3%**
Waste	69	53,9%
Inability to use the park area	50	39,1%
Insecurity	35	27,3%
Difficult access to your home	11	8,6%

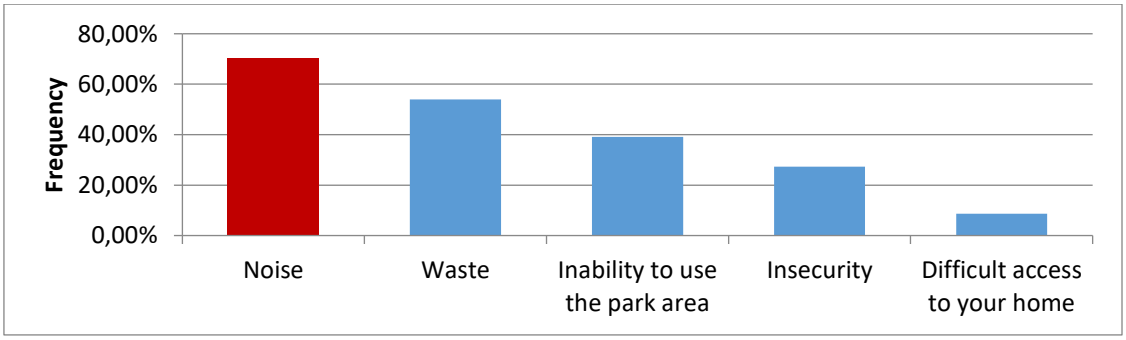


Table 12 and Figure 77: If so, for what (more than one response)

This nuisance is mainly related to noise, waste, inability to access to the park during the festival and insecurity.

To the open-ended question "what is the most relevant in your opinion?" Noise is the only response with a significant score (54.7%) followed by waste (10.9%) and park inaccessibility (6.3%). Other items with scores below 4 (see appendices).

	Number	Frequency
No answer	2	1,6%
Not annoyed	29	22,7%
The annoyance is equal throughout the whole period	**88**	**68,8%**
The annoyance is stronger on the first day	3	2,3%
The annoyance is stronger on the second day	6	4,7%
Total	128	100,0%

Table 13: Annoyance about the 2 days of the event

For those expressing discomfort, it is equivalent during the two days. Only a few respondents felt that there was a difference between those two days.

	Number	Frequency
No answer	2	1,6%
Not annoyed	30	23,4%
The annoyance is stronger during the day	3	2,3%
The annoyance is stronger after 8 pm	11	8,6%
The annoyance is stronger after 10 pm	15	11,7%
The annoyance is continuous	67	52,3%
Total	128	100,0%

Table 14: Annoyance about the 2 days of the event

For the majority of respondents, the discomfort is constant but for 20% of respondents it starts to increase after 8 pm.

	Number	Frequency
No answer	5	3,9%
Equal	**70**	**54,7%**
Greater	17	13,3%
minor	36	28,1%
Total	128	100,0%

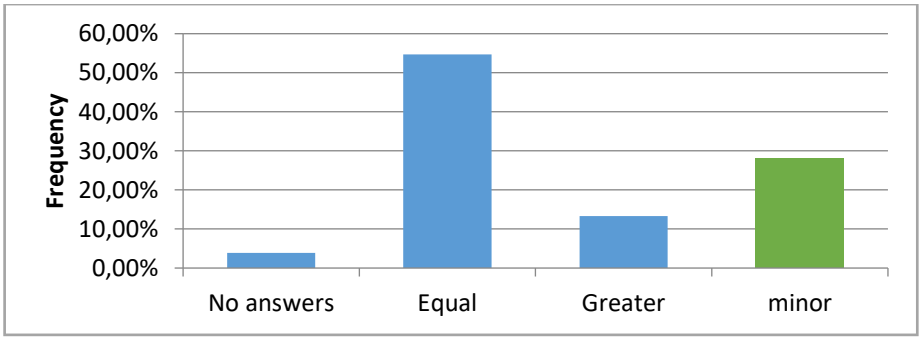


Table 15 and Figure 78: The event caused a disturbance compared to previous years

For 55% of respondents, the inconvenience is the same this year as in previous years, but for more than a quarter of respondents, the inconvenience is perceived as minor, while 13% consider it to be a greater inconvenience.

	Number	Frequency
No answer	2	1,6%
Both	**34**	**26,6%**
I don't feel anything	19	14,8%
low frequency sounds (rhythm, bass, vibrations)	**73**	**57,0%**
Total	128	100,0%

Table 16: The sounds you hear in your home are sounds:

It is mainly the low frequencies that are mostly perceived by local residents. By combining the "low-frequency+both" respondents, 83% of respondents said they were exposed to low frequencies.

	Number	Frequency
No answer	2	1,6%
Both	**54**	**42,2%**
hight-pitched n	7	5,5%
low frequency noise	**35**	**27,3%**
Not annoyed	30	23,4%
Total	128	100,0%

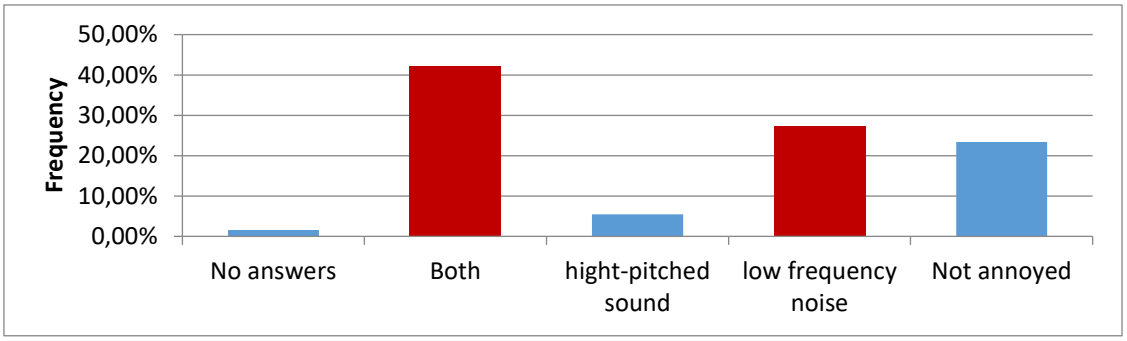


Table 17 and Figure 79: What are the sounds that annoy you the most?

The discomfort felt by residents is as much related to bass as high frequencies for 42% of respondents. According the sum of the answers:

47.7% of the respondents are bothered by high frequencies (42.2+5.5)
69.5% by low frequencies (42.5+27.3)

	Number	Frequency
No answer	1	0,8%
Do not annoy me	34	26,6%
I get annoyed sometimes because they are stronger	27	21,1%
They continually annoy me because they are too strong	**66**	**51,6%**
Total	128	100,0%

Table 18: The sounds coming from the Kappa Futur Festival

The sounds from the festival are a constant source of discomfort for more than half of the respondents.

	Number	Frequency
Does not represent a disturbance	18	14,1%
Gives less disturbance than other events	6	4,7%
Gives an equal disturbance to other events	33	25,8%
Gives greater disturbance to other events	**71**	**55,5%**
Total	128	100,0%

Table 19: According to you, the Kappa Futur Festival,

The festival is perceived as a musical event generating a greater inconvenience than other events for 55% of respondents.

	No answer	Absolutely	Enough	Not at all	Not so much
I can't sleep well	10,20%	45,30%	17,20%	20,30%	7,00%
Vibration feeling	9,40%	48,40%	17,20%	9,40%	15,60%
I close the windows despite the heat	14,80%	47,70%	12,50%	16,40%	8,60%
I leave my apartment at that time	21,10%	13,30%	18,80%	40,60%	6,30%
I can't read or rest	17,20%	32,80%	19,50%	24,20%	6,30%

Table 20: Perception of effect of noise

The sounds/noises perceived by the residents of the festival have an effect in particular in terms of (absolutely or enough):

- 62.5% sleep effects
- Vibration for 65.6%.
- Need to close windows for 60.2%.
- Incentive to leave their home for 34.4% - Incentive to leave their dwelling
- Unable to read for 53.3%.

5.5 Some analysis

	Number	Frequency
Do not annoy me	34	46,941
I get annoyed in some moments because they are stronger	27	46,407
They continually annoy me because they are too strong	62	45,71
GLOBAL	123	46,203

Table 21: Statistics: Age*The sounds coming from the Kappa Futur Festival

F - test = 0,134 p=0,125
There is no difference in answers while linking age of respondent to annoyance.

	Number	Average
Do not annoy me	34	9,353
I get annoyed in some moments because they are stronger	27	9,556
They continually annoy me because they are too strong	64	9,234
GLOBAL	125	9,336

Table 22: Statistics: For how many years you have lived here*The sounds coming from the Kappa Futur Festival

F - test = 0,045 p=0,044
There is no difference about number of years living here and annoyance.

	Number	Average
Do not annoy me	33	6,212
I get annoyed in some moments because they are stronger	26	5,577
They continually annoy me because they are too strong	62	4,903
GLOBAL	121	5,405

Table 23: Statistics: floor*The sounds coming from the Kappa Futur Festival

F - test = 1,429 p=0,242
There is not statistical difference on level floor and annoyance.
It is just possible to see that peoples more annoyed lives in flats with average floor down (4.9), and people not annoyed lives in flats with average floor up (6.2).

	Number	Average
Do not annoy me	30	575,033
I get annoyed in some moments because they are stronger	23	322,609
They continually annoy me because they are too strong	58	406,379
GLOBAL	111	434,604

Table 24: Statistics: distance to the event area*The sounds coming from the Kappa Futur Festival

F - test = 3,072 p=0,049

There is a statistically significant difference in the estimated distance between the dwelling and the stage, and annoyance:

- Respondents who report that they are not embarrassed are, on average, at an estimated distance of more than 575 metres from the scene.
- Respondents who say they are constantly or often embarrassed are, on average, less than 406 metres from the scene.

5.6 Discussion and conclusion

These results were obtained at the Kappa Futur Festival at Turin in July 2017. The survey items are available on Appendix D: Survey items. The questionnaires were managed by the services of the city of Torino. The orientation and the insulation of dwellings were not collected in order to maintain fast interviews. Acoucité particularly thanks the Torino pilot for testing version 1 of this questionnaire.

These results highlight particularly well:

- **A nuisance felt by 3/4 of the residents who responded to this questionnaire;**
- **An annoyance associated with noise for more than half of the respondents;**
- **A predominance of low frequencies in the emergence of this discomfort;**
- **But also an improvement over the previous year for 28% of respondents;**

On the other hand, these first results can serve as an example for other pilot partners wishing to use this questionnaire, to adjust the methodology for implementing it on their own events:

Entering the answers:
A Microsoft Excel or Open-source Office file with one questionnaire per line and one question per column, giving priority to code input, not answers should be used.

Example:

Q1	Sex	1- men	2- women
Q2	Annoyance	1-annoyed	2- not annoyed
Q3	Floor	only 1 number and O for ground floor	

	Q1	Q2	Q3	……..	Qn
Respondent 1	1	2	12		
Respondent 3	2	2	3		
Respondent 3	1	1	0		
Respondent-m	2	2	2		

Questionnaire:
At least one quantitative question from 0 to 10 and one qualitative question on the perceived annoyance due to noise (ISO conformity) should be included:

In the end, how would you rate your noise annoyance regarding this event?

- ***RATING from 0 to 10:***

In the end, how would you qualify your noise annoyance regarding this event?

- □ not at all □ slightly □ moderately □ very □ extremely

Methodology:
Pilots should contact Acoucité for upcoming surveys, before hiring subcontractor and then:

- Adapt the structure of the questionnaire to the event
- Think about the structure of the response entry database
- Take care of the selected procurement protocol and methodology

A balancing solution would be the development of a dedicated MONICA application in the next months of the project for use on different terminals (Smartphones, tablets, and computers) and integrating all these recommendations.

6. Conclusion

The scientific and technical literature about transportation noise effects on exposed population is particularly rich and documented. Conversely, there is virtually no documentation directly addressing the effects of noise from musical or cultural large scale events on local population. In other words, if the noise of transport is easily associated with the notion of annoyance due to noise, recreational “noise” is very rarely the subject of studies about its effects on the residents.
This report therefore deals with the noise effects of large scale events on population, regardless of the characteristics of the source. The results (monitoring, recordings, surveys) that will be collected during the 3 years of the MONICA project should therefore indirectly allow us to better understand the specificities of the impact of large scale events noise on the surrounding populations (noise effect on health, annoyance).
On this basis, and in order to meet the objectives of the MONICA project, this report was structured around the two axis of work carried out during the first six months of the project.
The first axis was to offer the tools and methods that will make it possible to carry out the acoustic evaluation and monitoring of the pilot sites. These tools and methods will be adapted to the specific needs of each pilot site.
The second axis consisted of collecting the existing elements, known and identified by the six pilot sites, descriptive of the initial acoustic context. These elements made it possible to constitute an initial inventory of the acoustic data available at each site.
This report thus constitutes an open framework where each pilot can take ownership of these tools and methods.
The first results obtained from the Kappa FuturFestival 2017 stressed out that low frequencies are the main source of annoyance for inhabitants. These perceptive results have been confirmed by our first measurement at different events in 2017: Nuits Sonores, Woodstower and Kappa Futur Festival.
Therefore, we strongly advise our partners to adapt their methodology (hardware and measurements) with a focus on low frequencies.
Some sound recordings showing what could be perceived by the respondents during the Kappa Futur Festival 2017: http://www.acoucite.org/cartes/2017-KFF/KappaFutur-EN.html

7. Appendix A: Survey

BASE SURVEY TO ADAPT WITH EVERY PILOT

PART 0: GENERAL INFORMATION

CITY **COUNTRY**

FESTIVAL/EVENT: **LOCATION:**

DATES OF FESTIVAL:

WAY OF REACHING:

DATE AND TIME OF ANSWER:

STATUS (while answering) □living nearby □ Spectator □ Professional

Gender □ *man* □ *woman*

Age, in years:

PART 1 : FEELING OF THE EVENT

Introduction: *You inhabit around a location where an event is taking place…*

OR *You are joining as a spectator/ /professional …*

…a musical / cultural / or party event.

We would like to have your opinion about a few points concerning this event

Generally speaking, what would you say about this event?

□ *I don't enjoy it at all* □ *I enjoy it a little*

□ *I mostly enjoy it* □ *I enjoy it a lot*

a/ if living nearby: do you consider that this event is creating annoyance, disturbance in your home?

b/ if spectator: do you consider that this event is creating annoyance, disturbance for the neighbourhood?

□ *I strongly agree* □ *I agree*

□ *I disagree* □ *I strongly disagree*

If you consider that this event is creating annoyance, disturbance, you would say it's (quote, several answers possible)

□ *Safety* □ *Noise*

□ *Smells* □ *Dust*

□ *Public space is not accessible during this event* □ *I can't easily access my home*

□ Other

Among the one you quoted, pick the most important in your opinion:

□ *Safety* □ *Noise*

□ *Smells* □ *Dust*

□ *Public space is not accessible during this event* □ *I can't easily access my home*

□ *Other, be specific:*

PART 2: SOUND ASSESSMENT OF THE EVENT

Now, we will focus on noise, the sound you are hearing during the event. You would say that:

□ *There is no annoyance*
□ *Noise annoyance is stronger on day* □ *1,* □ *2,* □ *3, and* □ *4?*
□ *Noise annoyance is the same during the whole event*

Generally speaking about the event, you would say that:

□ *There is no annoyance*
□ *Noise annoyance is stronger before 8pm*
□ *Noise annoyance is stronger after 8pm*
□ *Noise annoyance is stronger after midnight*
□ *There is annoyance during the whole event*

If you compare to last year, would you say that the event is:

□ *more annoying this year*
□ *less annoying this year*
□ *the same as last year*

Sounds, music, noise you hear from your home are mostly:

□ *Bass sounds*
□ *Both*
□ *I hardly hear anything*
□ *Treble sounds*
□ *I hear something but it's hard to tell what*

What is the most annoying?

□ *Bass sounds*
□ *Both*
□ *Treble sounds*
□ *It's doesn't annoy me*

Sounds coming from the event:

□ *Don't annoy me*
□ *Are continuously annoying me*
□ *Annoy me sometimes*

When comparing this event to other events taking place here, would you say that THIS EVENT:

□ *Is more annoying as other events*
□ *Is less annoying as other events*
□ *Is equally annoying as other events*
□ *Is not annoying*

During the whole event, please state your mind about the following proposals:

	Strongly agree	*Agree*	*Disagree*	*Strongly disagree*
I can't sleep well				
I feel vibes				
The neighbourhood is livelier				
I close my windows despite the heat				
I'm no longer safe in the neighbourhood				
I leave my home during this event				
I can't read or rest				

In the end, how would you rate your noise annoyance regarding this event?

RATING:

In the end, how would you qualify your noise annoyance regarding this event?

□ not at all □ slightly □ moderately □ very □ extremely

(helemaal niet, een beetje, tamelijk, erg of extreme) (not at all, slightly, moderately, very, or extremely)

To sum it up, are you expecting noise abatement actions from:

□ Event planners, □ Local authorities (police, city hall…),

□ Spectators, crowd □ No expectations

PART 3: IF LIVING NEARBY

Estimated distance to the closest event:

Since when do you live here?

Years:

Can you see the event from your home?

□ *Yes, totally* □ *partially* □ *not at all*

Do you have soundproof windows?

□ *Yes, totally* □ *partially* □ *not at all*

The closest rooms from the event are:

□ *living room, kitchen* □ *Bedrooms* □ *Both*

Thank you for your time, do you have any comment you wish to add?

8. Appendix B: Measurement Protocol

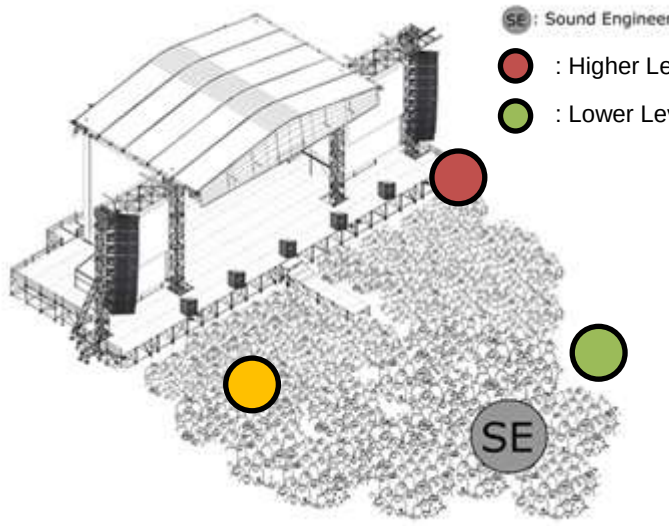
The protocol will present recommendations for the monitoring of a festive event (music festival type). In order not to constrain some cities or structures to technical obstacles (lack of material means), the protocol provides a minimal deployment version (minimal configuration), and then another version with the availability of material and diverse measuring equipment (optimal configuration).

8.1 Measuring points

8.1.1 Inside the site

Depending on the chosen configuration (minimal or optimal), measuring points are proposed to assess the exposure to the amplified music in the different areas of the event enclosure:

- in the place in front of the stage, the most exposed area



based from DTU presentation

- in the spaces away from the stage and accessible to the public (toilets, catering ...)

: Preserved area
: Exchange area

© Kappa Festival, festival map

SE point
Description: a measuring point in the space reserved to the **S**ound **E**ngineer
Interest:

- reference point, common to all pilot sites
- inside an area well-exposed to the sound diffusion systems
- secure space for the installation of a sound level meter

Location: in the space reserved to the sound engineer

Higher Level point
Description: a measuring point giving information on the maximal sound level of exposure
Interest:
- compare the energy dose perceived by a spectator equipped with a UWB-based wristband with the maximal value

Location:
- if possible, location selection with the help of modelling (e.g. as part of an impact study)
- otherwise, location most relevant according to the organisers (e.g. closest to the loudspeaker)

Lower Level point (in the area facing the stage)
Description: a measuring point in an area where sound levels are lower, while remaining in the area facing the stage
Interest:
- information on the minimum dose received by a spectator who remain facing the stage
- with the Higher Level point, information on the maximum and minimum doses to which the spectators can be exposed, which will make it possible to give recommendations in terms of health on the duration of exposure (cf. section 3.2.1 and section 3.4.3, part on the noise dose)

Location: if possible, localization of areas less exposed to music amplified through the impact study

Crowd point
Description: a spectator equipped with a UWB-based wristband
Interest:
- to have the sound level of exposure of a spectator
- localization of his/her movements
- information on the distribution of time spent on highly/less exposed areas and therefore more precise knowledge of the exposure dose

Location: moving point, according to the movements of the spectator

Preserved area
Description: areas such as the emergency area or the infirmary may need to be protected to facilitate staff communication. A sound level meter can be installed in these areas.
Interest:
- information on the quality of exchanges (cf. section 3.4.3, part on the intelligibility)
- information on the performance of the quiet zones if set up

Location: in the emergency zone, the infirmary or in the quiet zones

Exchange area
Description: the term includes areas accessible to the public, including access to toilets, catering, tables and benches (see picture below, NS Night). These very successful areas are the occasion for the festival-goers to converse and relax. A sound level meter could be set up in these areas.

In terms of soundscape, this space is composed of sounds from (orange arrows on the picture below):

- Hall B, left on the picture
- Hall C, at the bottom left of the picture
- Hall D at the bottom right of the picture
- Crowd sounds (festivalgoers' voices)

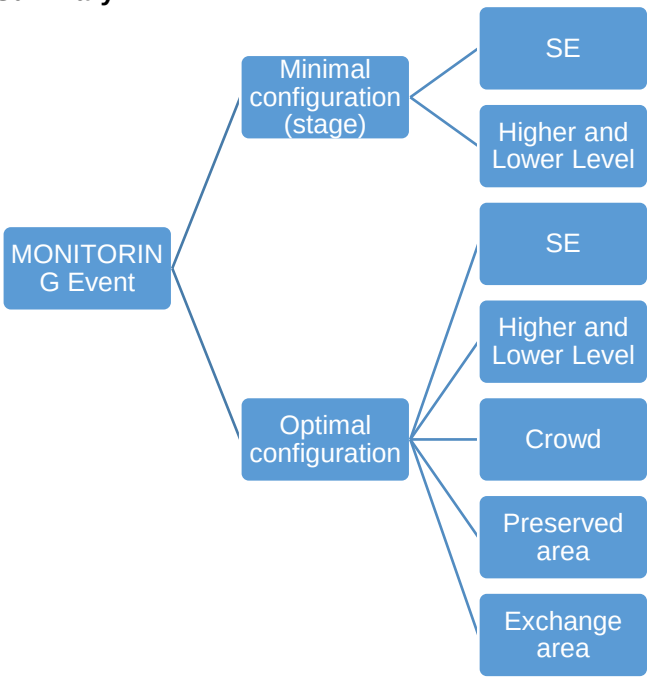
Interest:
Beyond the observation of sound levels, a reflection on the sound quality could be carried out. Indeed it is very difficult to perceive a musicality of what one hears at this area. This can be explained because:

- The direct waves of the sound diffusion systems do not reach these areas (since the sound diffusion systems are oriented and positioned to the sound of a scene and its gauge). Thus, only a part of the musical spectrum reaches the exchange area, mainly low frequencies.
- In this space, the sound waves emitted by the three halls will mix, which cannot be harmonious.

In terms of perception, the festival-goer is more exposed to a sound energy (not necessary of significant intensity) than to amplified music. In terms of sound quality, it is difficult to locate and identify sound sources (as they mix and overlap), as it is complex to hear a musical harmony.

Location: in one of these areas accessible to the public

Summary:



8.1.2 Outdoor public spaces

Depending on the chosen configuration (minimal or optimal), measuring points are proposed to assess the impact of amplified music on outdoor public spaces and the sound contribution of spectators around the event.

The measuring points for the initial state and during the event must be as close as possible in terms of measurement characteristics (place, time, weather ...). The initial state must reflect a moment of normal use and may be performed several times to achieve this objective (e.g. one week before/after the event).

Measuring point's location

Selection of the location of the sensors should be made according to the urban configuration of the venue of the event, in particular:

- town planning of the neighbourhood
- the nature and function of the neighbourhood (rather residential, or former industrial wasteland, or tertiary). Historic district or recent development area. Presence or not of sensitive buildings (school or hospitals)

By default, to be the most relevant on neighbourhood impact assessment, focus on places of residence and places with the highest population density.

The choice of the location of measuring points may be made in consultation with:

- health and hygiene city services. Their knowledge of the territory and its sensitive points will be useful to choose the most strategic locations possible.
- the technical and urban planning departments of cities to have access to GIS data, likely to guide the choice of location
- organisers who have a global vision of the event
- acousticians in charge of data processing

Below are two examples of very different urban configurations:

Example 1 : Nuits Sonores Days

Nuits Sonores (pilot site of Lyon) takes place during the day at La Sucrière. It is located in a recent district on an area:

- dedicated to tertiary and leisure activities (several establishments such as bars/restaurants or nightclub)
- with no residential buildings less than 200m
- close to railways and the motorway A7

The problem here should be for the public space crossed by the spectators going to NS Days (blue area). At this distance, the background sound of this area should be little impacted by the sound diffusion of the event. On the other hand, it will be more permeable to sound peaks and will therefore be more sensitive to the noise due to the behaviour of the spectators going or leaving the premises.

Yellow dotted line: example of the route taken by spectators to access the site from public transport
Highlighted area in **blue**: mixed area (residential/tertiary)

Route point
Description: one or more measuring points placed on the course taken by the spectators
Interest:

- Observe the exposure to public spaces of noise due to the behaviour of spectators going or leaving the premises

Example 2 : Kappa festival

In the vicinity of Parco Dora, there are dwellings, public spaces, sensitive buildings (hospital). In this case, the problem is twofold: to observe the impact of the sound diffusion of the amplified music, but also the human contribution to the park's surroundings, on the routes to access and leave the site.

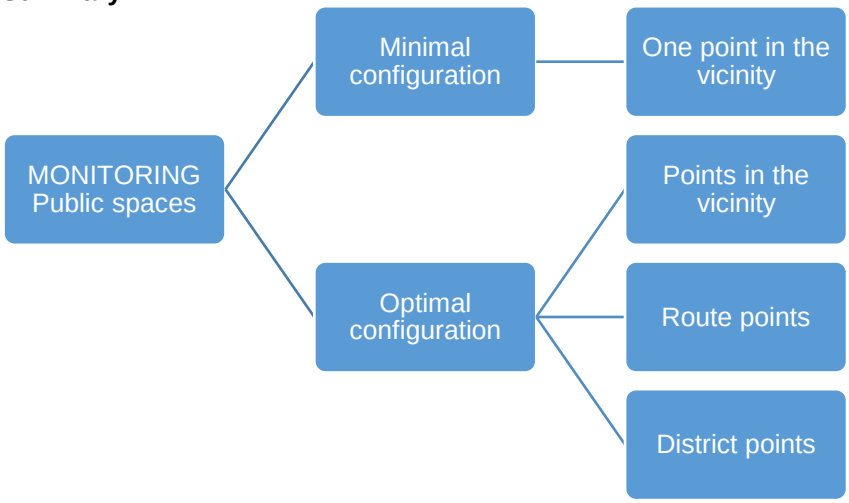
Point in the vicinity
Description: measuring point in the vicinity of the event
Interest:

- Assess the impact of the diffusion of amplified music on public spaces outside the site, in direct diffusion
- Evaluate the sound contribution of spectators around the event, which often results in sound peaks (shouting, laughter, shock ...) and can disturb the neighbourhood at night

District point
Description: measuring point in a sensitive area that can be impacted by the event
Interest:

- Evaluate the impact of the event in a nearby sensitive area

Summary:



8.1.3 Most exposed residential building

Depending on the chosen configuration (minimal or optimal), measurement points are provided to assess the exposure of residential buildings to amplified music.

Measurement points for the initial state and during the event. Same conditions on the initial state should be respected as for the monitoring “Public spaces”

Most exposed building point
Description: monitoring on the façade of the most exposed residential buildings or buildings that are not the most exposed but whose inhabitants complain about the noise related to the event (see left-side picture above, houses at 250m on the other bank of the Saône during the NS Days).
Interest:

- Know the level of noise related to local residents' complaints

Location: the selection of locations can be done with consultation between the municipal services of the city, local residents, event organisers and acousticians. Different tools could also help in decision-making:

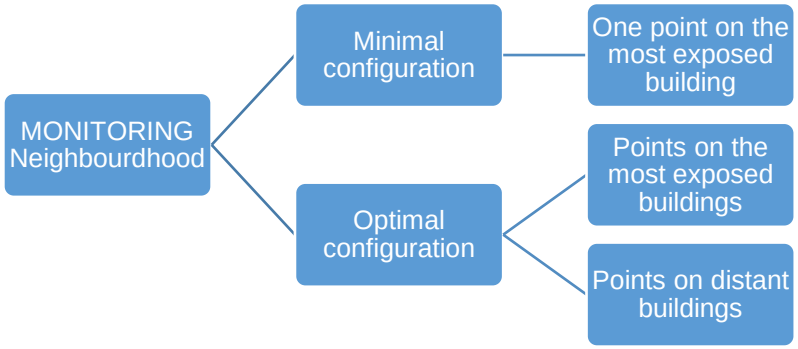
- acoustic modelling of the impact study of the event (if this has been done)
- strategic noise maps
- a map of complaints that have been identified

Distant building point
Description: several measurement points simultaneously (see right-side picture above during the NS Night)
Interest:

- observe the propagation
- observe the behaviour of low frequencies and the exposure of local residents to these frequencies

Location: same as the most exposed building point

Summary:



8.1.4 Protocol by type of measurement

In France, the standard NF S 31-010 - "Description and measurement of environmental noise" (AFNOR, 1996) will serve as reference for making acoustic measurements.

Since these measures are for observation (and not aimed for use in a legal framework), it is possible that all measuring conditions cannot be respected (e.g. rain, wind…). However, these particular measuring conditions shall be indicated in the measurement report.

General note: transfer and communication options will need to be adapted as required. The measurement time shall be adapted according to the human resources provided.

Type of monitoring	Minimal configuration (total of 5 sound level meters)	Optimal configuration (+5 sound level meters/sensors)
Event	3 sound level meters for 3 measuring points (SE, Higher Level et Lower Level)	Park of several class 1 sensors: sound level meters, UWB-based wristbands, dosimeters
		Capable of storing and transferring a large amount of data (spectrum + audio).
	Minimum transfer and communication options	Remote communication: management of the sends of measurements, management of coding ...
	Able to communicate with a server to transfer their data if the measurements have to be viewed in real time	Capable of communicating their raw (and / or calculated) data in real time with a server or cloud
	Measurement time: to be defined	
	Fixing of the material: • Possibility to deport the microphone to fit a maximum of configurations • The lightest possible • Fixing types: screwed to a tripod, bundled on a pole-type or scaffolding-type support, fastening clip	
Public spaces	1 sound level meter for the measuring point in the vicinity	Park of several class 1 sensors: sound level meters
	Waterproof sound level meter, or remote microphone (and sheltered sound level meter)	
	Transfer and communication options: same as the monitoring “Event”	Transfer and communication options: same as the monitoring “Event”
		Recognition of sources
	Measurement time: to be defined	
	Fixing of the material: same as the monitoring “Event”	
Neighbour-hood	1 sound level meter for the measuring point on the façade of the most exposed building	Park of several class 1 sensors: sound level meters
	Waterproof sound level meter, or remote microphone (and sheltered sound level meter)	
	Transfer and communication options: same as the monitoring “Event”	Transfer and communication options: same as the monitoring “Event”
		Recognition of sources
	Measuring time: provide several days of measurement (one week for the initial state and a week during the event)	
	Fixing of the material: identical to the monitoring “Event” but with possibility of being deported from the facade of the building (use of a sound boom if need)	

Fixing types:

Tripods mount with adaptable screw

Possibility of bundling the sensor regardless of the shape or diameter of the pole

Fastening clamp, adaptable to different supports

9. Appendix C: Noise Regulation

Noise at work

The Centre d'Information et de Documentation sur le Bruit (CIDB) has published a summary sheet on noise at work (CIDB link *Bruit au travail*).

The main texts applicable are:

- Protection of workers
  - Decree 2006-892 of 19 July 2006 on safety and health requirements for worker exposure to noise hazards and amending the Labour Code (Part II: decrees issued by the Council of State).
  - Decree of 19 July 2006 taken for the application of Articles R. 231-126, R. 231-128 and R. 231-129 of the Labour Code.
- Working environment
  - Decree 88-930 of 20 September 1988 on the provisions applicable to construction operations in the interests of health and safety.
  - Decree of August 30, 1990 taken for the application of article R. 235-2-11 of the Labour Code and relating to the acoustic correction of the work premises.

Neighbourhood noise

By a decree dated 31 August 2006, regulatory provisions relating to harm to the tranquillity of the neighbourhood or human health by noise have been introduced in the Public Health Code.

"*No particular noise shall, by its duration, repetition or intensity, affect the tranquillity of the neighbourhood or the human health, in a public or private place, whether a person is himself origin or whether through a person, a thing she has custody or animal under his responsibility*". This is the content of Article R. 1334-31 of the Public Health Code.

Further information on French regulation: CIDB link *Bruits de voisinage*

Musical venues

In France, musical venues, as noisy activities, are governed by the Environment Code (articles R571-25 à R571-30). These texts stem from a specific decree issued under the Noise Act of December 1992: the decree of 15 December 1998 on the requirements applicable to establishments or premises receiving from the public and broadcasting amplified music on a regular basis. Since 16 December 1999, existing establishments have been required to comply with the relevant provisions.

What are the places affected by this regulation?

The designation assumes three cumulative conditions. These are establishments:

- receiving from the public;
- broadcasting amplified music in the usual way;
- closed or open.

Festivals and other punctual events do not meet all the conditions (broadcast in the usual way).

Nevertheless, according to the circular, a demonstration may be regarded as "usual" within the meaning of the regulation, *since the broadcasting of amplified music has a repeated character and a sufficient frequency*.

Meet this condition, establishments:

- open all year round, when the frequency of the amplified music broadcast is greater than or equal to 12 times per year
- having a seasonal activity, when the amplified music broadcast frequency is greater than or equal to **3** times for a period of less than or equal to thirty consecutive days

Further information on the French regulations: CIDB link *Lieux musicaux*

10. Appendix D: Survey items of Kappa Futur Festival 2017

	Number	Frequency
No answer	22	17,2%
Difficult access to your home	1	0,8%
Inability to use the park area	3	2,3%
Insecurity	1	0,8%
Insecurity, noise	6	4,7%
Insecurity, noise, delinquenza e atti vandalici	1	0,8%
Insecurity, noise, Inability to use the park area	4	3,1%
Insecurity, tantissimi giovani che fanno confusione nelle aree attorno a quelle dell'evento	1	0,8%
Insecurity, Waste	1	0,8%
Insecurity, Waste, Inability to use the park area, Devastazione del.parco. Poca sicurezza visto che in giro trovi ragazzi in stato alterato	1	0,8%
Insecurity, Waste, noise	8	6,3%
Insecurity, Waste, noise, Difficult access to your home, Vengono a drogarsi sotto casa nostra per entrare gia fatti, fanno o bisogni, rompono le piante nostre, urlano	1	0,8%
Insecurity, Waste, noise, il degrado che ci lasciano	1	0,8%
Insecurity, Waste, noise, in casa non si può vivere per noise	1	0,8%
Insecurity, Waste, noise, Inability to use the park area	9	7,0%
Insecurity, Waste, noise, Inability to use the park area, Difficult access to your home	1	0,8%
Insecurity, Waste, noise, Inability to use the park area, Difficult access to your home, Il menefreghismo totale nei confronti della normale quotidianità	1	0,8%
Insecurity, Waste, noise, Inability to use the park area, Difficult access to your home, Mancanza totale di controllo e sicurezza	1	0,8%
Insecurity, Waste, noise, Questo posto diventa invivibile	1	0,8%
noise	13	10,2%
noise, Difficult access to your home	1	0,8%
noise, Inability to use the park area	5	3,9%
Waste	2	1,6%
Waste, Difficult access to your home	1	0,8%
Waste, Inability to use the park area	2	1,6%
Waste, Inability to use the park area, l'improvviso aumento di persone che si accampano attorno all'area e che disturbano più dell'evento in sé	1	0,8%
Waste, noise	12	9,4%
Waste, noise, Difficult access to your home	1	0,8%
Waste, noise, Difficult access to your home, parcheggio	1	0,8%
Waste, noise, Inability to use the park area	15	11,7%
Waste, noise, Inability to use the park area, After the festival, other unauthorized people feel the right to disturb	1	0,8%
Waste, noise, Inability to use the park area, Difficult access to your home	2	1,6%
Waste, noise, Inability to use the park area, Difficult access to your home, Qualita' della vita diminuita, pedita valore immobile causati da vari fattori: vandalismo, schiamazzi, parcheggio selvaggio delle auto sul prato del parco (mancano divieti a	1	0,8%
Waste, noise, Inability to use the park area, Il viavai di persone poco educate	1	0,8%
Waste, noise, Inability to use the park area, La devastazione delle aree verdi i dei prati	1	0,8%
Waste, noise, Inability to use the park area, Parcheggi già carenti normalmente	1	0,8%
Waste, noise, Inability to use the park area, Personaggi poco	1	0,8%

raccomanda ili in giro per il quartiere		
Waste, noise, Parcheggio selvaggio anche sul verde pubblico che viene ignorato e comunque non rispettato.	1	0,8%
Total	128	100,0%

Table 25: Do you think this event creates annoyance and discomfort for your home? If so, for what more? (You can give multiple answers)

	Number	Frequency
No answer	23	18,0%
Difficult access to your home	3	2,3%
Inability to use the park area	8	6,3%
Insecurity	4	3,1%
many young people who make confusion in the areas around the event and who are often more annoying than the event itself	1	0,8%
noise	70	54,7%
parcheggio	1	0,8%
Really excessive durability	1	0,8%
the presence of maleducated, alcoholic and sometimes drugged young people in the area	1	0,8%
the sudden increase in the number of people who camp around the area and disturb more than the event itself	1	0,8%
Waste	14	10,9%
We pay for the cleanliness of the square, it is private for public use, and they destroy it....	1	0,8%
Total	128	100,0%

Table 26: Do you think this event creates annoyance and discomfort for your home? If so, for what (more than one response) If so, what is the most relevant in your opinion?

	Frequency	Number
No answer	13	10,2%
Absolutely	58	45,3%
Enough	22	17,2%
Not at all	26	20,3%
Not so much	9	7,0%
Total	128	100,0%

Table 27: I can't sleep well

	Number	Frequency
No answer	12	9,4%
Absolutely	62	48,4%
Enough	22	17,2%
Not at all	12	9,4%
Not so much	20	15,6%
Total	128	100,0%

Table 28: Vibration feeling

	Number	Frequency
No answer	19	14,8%
Absolutely	61	47,7%
Enough	16	12,5%
Not at all	21	16,4%
Not so much	11	8,6%
Total	128	100,0%

Table 29: I close the windows despite the heat

	Number	Frequency
No answer	27	21,1%
Absolutely	17	13,3%
Enough	24	18,8%
Not at all	52	40,6%
Not so much	8	6,3%
Total	128	100,0%

Table 30: I leave my apartment at that time

	Number	Frequency
No answer	22	17,2%
Absolutely	42	32,8%
Enough	25	19,5%
Not at all	31	24,2%
Not so much	8	6,3%
Total	128	100,0%

Table 31: I can't read or rest

11. List of Figures and Tables

11.1 List of Figures

11.2 List of Tables

12. References

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Noise impact of cultural/musical events on the neighbourhood

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