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NOISE CONTROL FOR A BETTER ENVIRONMENT

Medusa, a new approach for noise management and control in urban environment

Nave Laetitia¹, Mietlicki Fanny²

Bruitparif

32 Boulevard Ornano

93200 Saint Denis

FRANCE

ABSTRACT

Five years ago, BRUITPARIF conducted a study in some lively districts of Paris, using standard noise monitoring stations. One of the difficulties encountered was the inability to assign a noise to a particular source, especially when several bars or restaurants are located around the same place.

In order to know exactly which one is accountable for the noise, BRUITPARIF designed and patented a noise-monitoring device, called MEDUSA (due to its typical shape). It combines four microphones and one optical system in a way that it is now possible to represent noise levels on a 360° picture of the environment, by projecting these "geo-located noise levels" as coloured hexagons. The colour code used makes it possible to account intuitively for the intensity of the sound levels.

This new approach certifies that a dominant noise comes from a particular area. It makes the regulation by the authorities easier and it opens new perspectives for the management by constructing objective indicators, which will allow the implementation of mechanisms to limit nuisance where it is possible. A website and a companion mobile application complete the device and enable people to examine noise spatial distribution at any time.

Keywords: Noise, Environment, Annoyance

I-INCE Classification of Subject Number: 30 (noise control elements / general)

1. INTRODUCTION

BRUITPARIF is the Île-de-France's technical evaluation centre for environmental noise. It is an association, created in 2004 by the regional council of the Ile-de-France district in order to address the people and the environmental protection association expectations to have some reliable, independent and transparent information about noise levels in the area and to help the authorities to build their strategy on how to fix noise issues.

¹ laetitia.nave@bruitparif.fr

² fanny.mietlicli@bruitparif.fr

BRUITPARIF federates today more than one hundred members into four categories, such as the French government and its various public entities and structures, territorials collectives (cities, department, district), Economic activities, Associations, professionals, qualified personalities.

BRUITPARIF has three missions of general interest:

1.1 Observation and sound evaluation in Île-de-France district

BRUITPARIF enforces every observation and description means (measurements, mediation and surveys) and makes studies for characterizing the sound environment and noise exposure evaluation. The noise sources mainly studied are those related to road, rail and airport infrastructures and more recently, the economic and industrial activities, and the recreations activities.

1.2 Providing support to the different district actors dealing with noise issues in public politics

The technical evaluation centre for environmental noise allows federating many actors in order to define, improve, and evaluate the public politics about preventing and fighting against noise annoyances all over the district. It also helps the territorial collectivities (cities, department, district), to enforce the directive 2002/49/EC of the European parliament relating to the assessment and management of environmental noise and animates the ACTORS' FORUM, a network that valorises and broadcasts good practices of preventing noise environment.

1.3 Information and sensibilisation

BRUITPARIF releases data, studies and information about noise environment in the Ile-de-France district and sometimes participates in sensitization operations targeted to the public.

2. CONTEXT

Since the smoking ban in public places like restaurants, bars, many difficulties had occurred between residents, bars, restaurants and entertainment establishment's owners about noise annoyances. Today with the societal changes, people who want to have fun are gathering henceforth in the street and public areas that has become the extension of the establishments and their terraces. Those customers generate more noise annoyances than before for the residents, without even being conscious.

According to the results of one survey on 3000 Ile de France residents [1], 12% claim to be concerned about the noise produced by the restaurants and bars customers and 6% by the music. Indeed, comings and goings of the customers indoor and outdoor from the entertainment establishments bring about music in the neighbourhood, especially when there is no airlock to avoid noise propagation.

In the city of Paris, the cultural actors, customers, residents of these lively districts strongly expect authorities to solve the conflicts about the way they are using the public areas and to find answers. To do so, BRUITPARIF conducted five years ago a study in

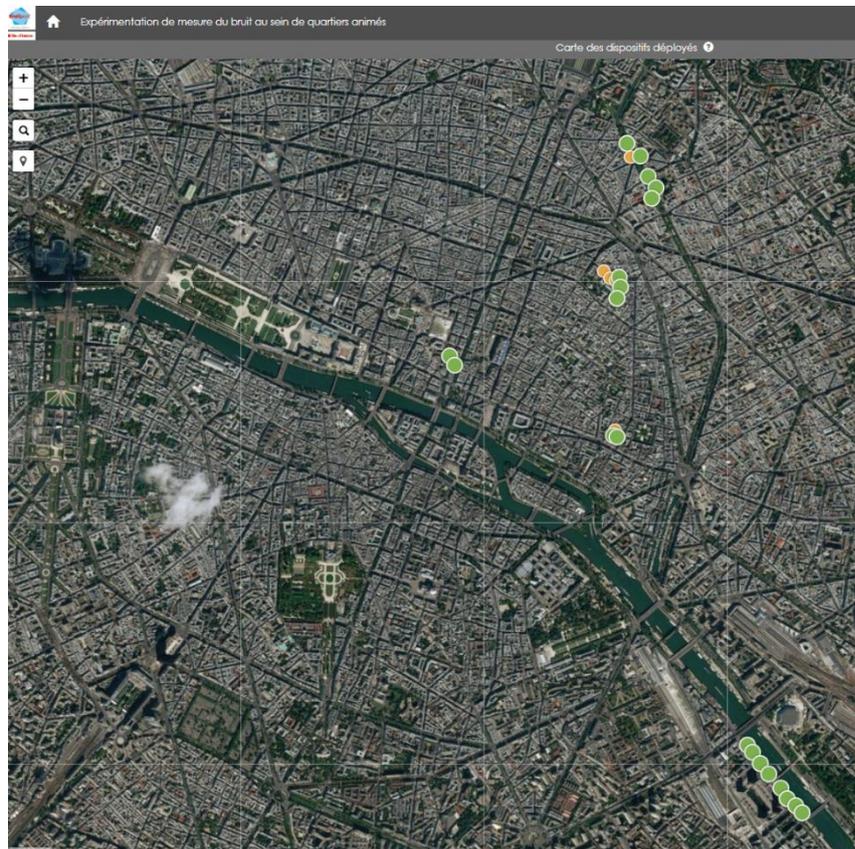
some lively districts of Paris [2], using standard noise monitoring stations. However, one of the main difficulties encountered was the inability to assign a noise to a particular source, especially when several bars or restaurants are located at the same place.

BRUITPARIF made the observation of that issue and decided to enforce the means to develop a measurement system that give authorities an independent and public management tool that helps them to regulate the noise annoyance in their districts.

3. PROJECT DESCRIPTION

3.1 The choice of the priority districts

With the help of residents associations and Bruitparif, the city of Paris has chosen five priority districts to study in 2017. Bruitparif has held a meeting in each district, gathering all the actors: establishment owners, residents, authorities, police forces in order to present the system, and validate the location of each sensor.



Plan of the five priority districts

At the beginning, Bruitparif installed twenty-five sensors, from two to eight, per district. The number of them is function of the district, the number of establishments, the technical constraints, etc. The sensors need electricity and are attached to the façade of the building, to be more representative of the resident's noise exposure, or on a street lamppost, as shown on the following pictures:



Medusa sensor on façade



Medusa sensor on street lamppost

3.2 The MEDUSA noise-monitoring device

In order to know exactly which establishment is accountable of the noise or where the noise comes from, BRUITPARIF designed and patented a noise-monitoring device, called MEDUSA, due to its typical shape.

Four microphones specifically positioned like a regular tetrahedron compose the MEDUSA. All the microphones can detect the little time lag when the sound hits differently the microphones several times per second and so, it can indicate the direction where the sound comes from as ears do.



The MEDUSA sensor 2018

The MEDUSA sensor is a class 2 metrology sonometer, that measures the sound levels every second, in dB(A) and dB(C), per frequency band, to distinguish the type of the noise: voices, music, road traffic, two motorized wheels, etc. In order to locate the noise origin, MEDUSA has also a camera that takes 360° pictures every minute.

The data transmission takes place through the mobile networks of national operators. The measurement data are transmitted every minute and the photos in timelapse every 15 minutes. A real-time micro-stream also makes it possible to be able to record the instantaneous sound level for each sensor (every second). Once integrated, the raw data is kept in a database for the duration of the project while the timelapse photos are kept for a maximum of 3 months.

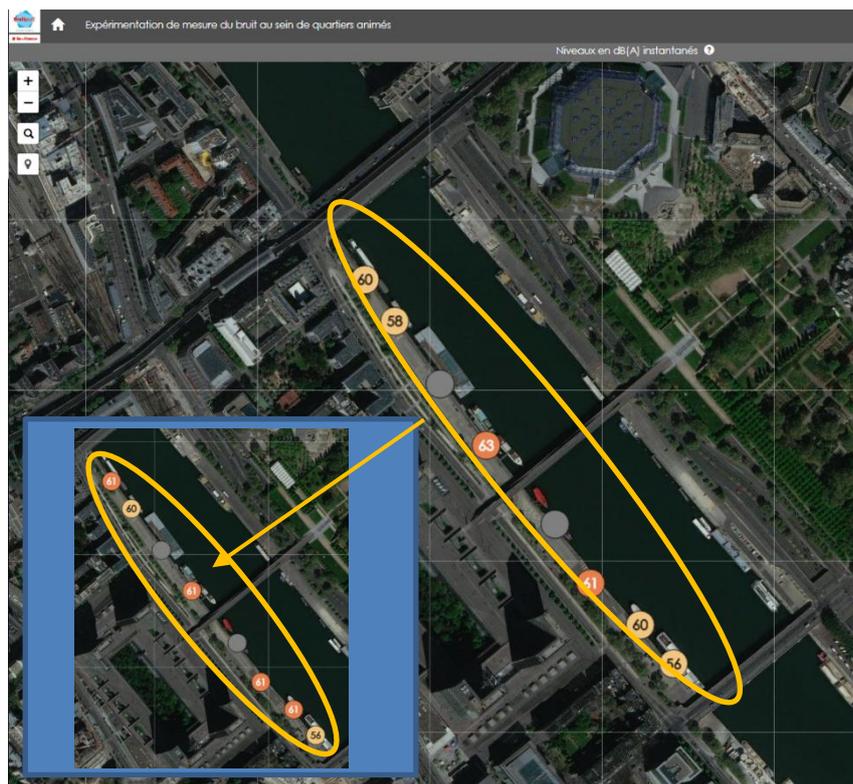
The average sound levels over 15 minutes ($LA_{eq,15min}$) as well as immersive views are calculated on the fly by a calculation server that is reached by mobile applications through a web server. It will store them upon receipt in a database, calculate a number of predefined indicators and disseminate information (raw data and calculated indicators) in near real time on the internet (with a maximum delay of 5 minutes), within the internet platform (cf section 4.1) administered by BRUITPARIF.

4. THE DATA VIEWER

BRUITPARIF established several illustration types for data access, in “real time” (with little gap of 5 min maximum).

4.1 Data access in real time

Each MEDUSA of each priority district is located on an aerial picture (available on the website <https://medusa-experiment.bruitparif.fr> searchable on computer or smartphone) with a little coloured chip. This chip indicates the sound level measured each second and its colour depends on the level. In the case of several sensors are in a district, each real time sound level is available at the same time in the same view.



Screen capture of the dynamic viewer indicates the sound level ($LA_{eq,1s}$) in real time in the district, changing every second

The sound level is expressed in decibel (A), with the following colour code: from blue (lowest levels) to purple (highest levels) as shown on the scale below:

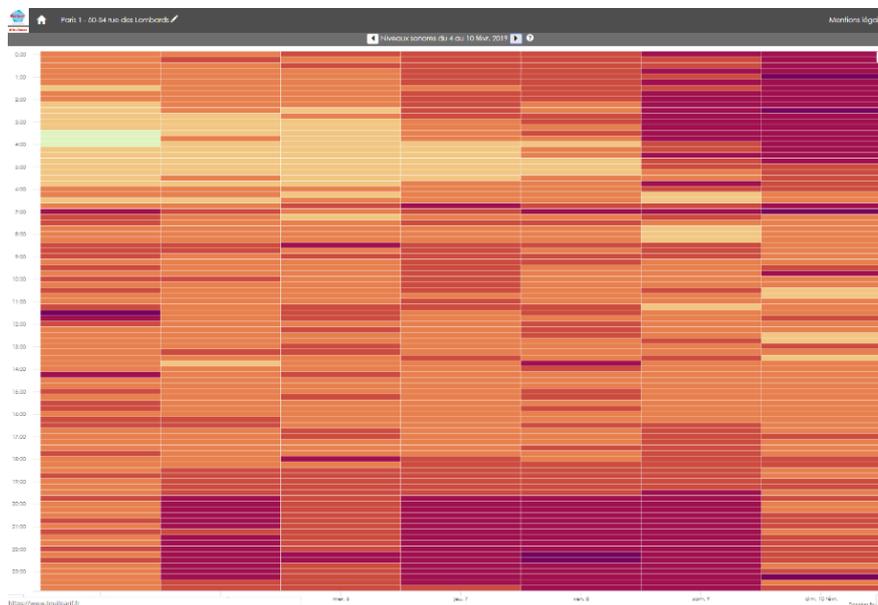
Sound level in dB(A)	Feeling
<div style="display: flex; gap: 5px;"> <div style="width: 15px; height: 15px; background-color: #a0c0ff; border: 1px solid black;"></div> < 40 <div style="width: 15px; height: 15px; background-color: #c0e0ff; border: 1px solid black;"></div> 40 – 45 </div>	Quiet
<div style="display: flex; gap: 5px;"> <div style="width: 15px; height: 15px; background-color: #a0ffa0; border: 1px solid black;"></div> 45 – 50 <div style="width: 15px; height: 15px; background-color: #c0ffc0; border: 1px solid black;"></div> 50 – 55 </div>	
<div style="display: flex; gap: 5px;"> <div style="width: 15px; height: 15px; background-color: #ffa0a0; border: 1px solid black;"></div> 55 – 60 <div style="width: 15px; height: 15px; background-color: #ffc0a0; border: 1px solid black;"></div> 60 – 65 </div>	Moderately noisy
<div style="display: flex; gap: 5px;"> <div style="width: 15px; height: 15px; background-color: #ffa000; border: 1px solid black;"></div> 65 – 70 <div style="width: 15px; height: 15px; background-color: #ff8000; border: 1px solid black;"></div> 70 – 75 </div>	
<div style="display: flex; gap: 5px;"> <div style="width: 15px; height: 15px; background-color: #ff00ff; border: 1px solid black;"></div> 75 – 80 <div style="width: 15px; height: 15px; background-color: #800080; border: 1px solid black;"></div> > 80 </div>	Very Noisy

Colour scale used for the instant noise levels in dB(A)

4.2 The « Weekview » illustration

The «weekview» is the representation of the average sound levels over 15 minutes (Laeq,15min), all along the week, between Monday 0h00 to Sunday 24h00. This view gives, as an agenda would do, a quick overview of the noise evolution during the week and makes the search of the noisiest periods easier.

The colour code is the same as the one used for the real time levels (cf.§4.1).

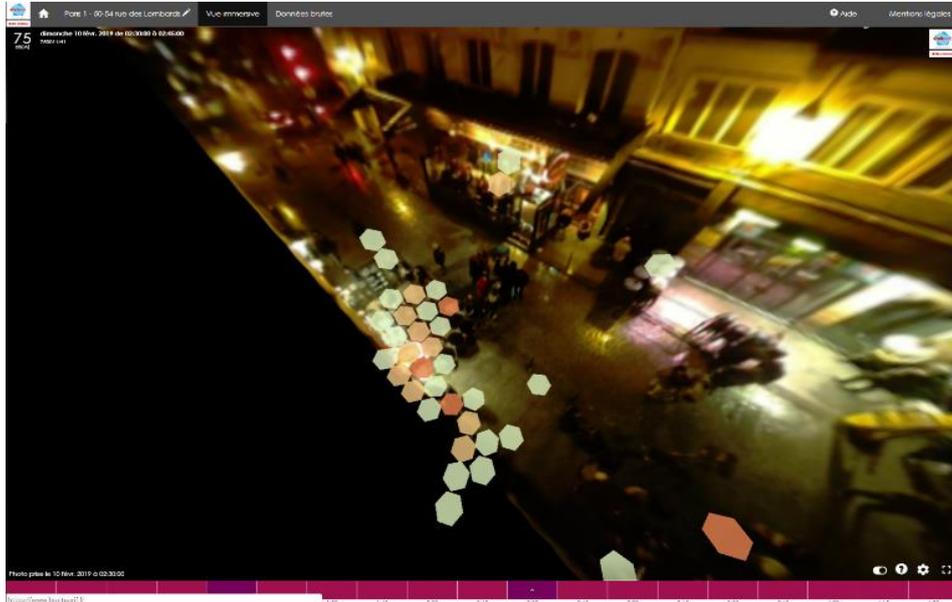


Example of a “weekview” for the MEDUSA sensor in a lively district of Paris the week between de 4th and 10th of February 2019

This “weekview” shows that the sound levels are very high four nights a week on Tuesday, Thursday, Friday and Saturday evenings. The noise annoyances are very important all Friday and Saturday nights until the morning.

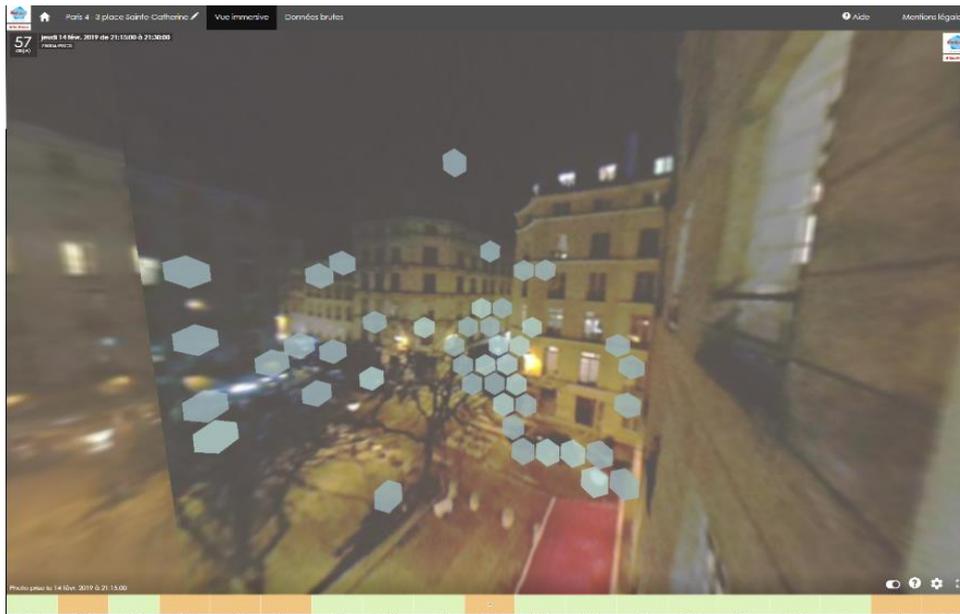
4.3. The immersive view in 360°

The system projects some coloured hexagons on the 360° picture, which represents the around of the sensor, at the exact place where the sound comes from. The colour code used makes it possible to account intuitively for the intensity of the sound levels and the probability of the origin of the sound. The more the colour is deep, the more the origin of the sound is sure. Therefore, this view allows a clear display of the origin of the noise.



Example of immersive view with the origin direction of the noise

This view shows that at this time of the night, the main sound comes from the customers of the establishment below the sensor. For an easier reading, the view represents only the hexagons with the maximum energy during the quarter of hour. At the opposite, if the hexagons are too numerous, scattered and with cold colour, it means that the noise is not located precisely and the sound is diffuse.

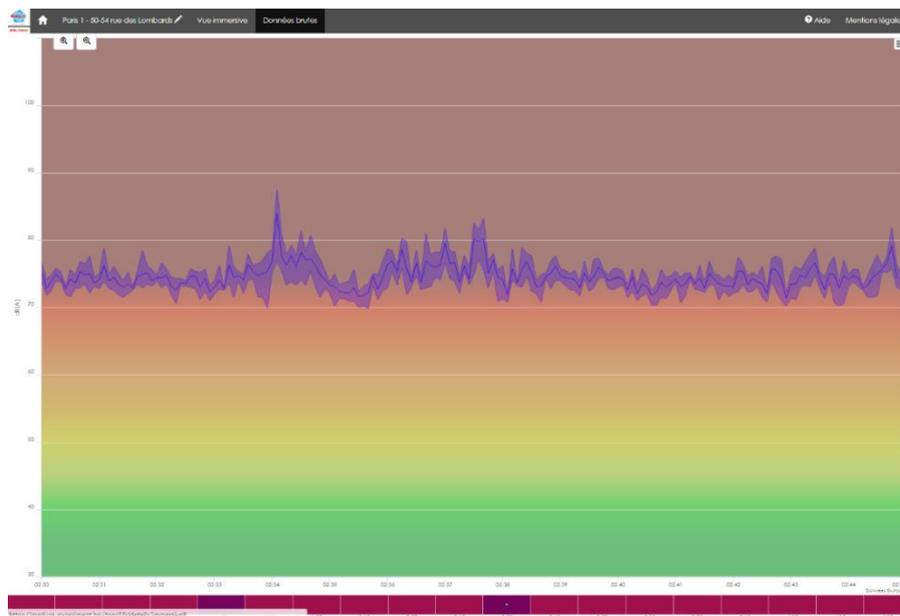


Example of a noise without precise origin

At last, we can read the sound level average over 15 minutes in the upper left corner of the screen of the immersive view.

4.4. Sound level per second access during a quarter of hour

For each quarter of hour available, it is possible to access to the view of the sound level data per second (LAeq,1s). This view below illustrates the way the sound has fluctuated during the fifteen minutes.



Sound level variation each second (LAeq,1s) during a quarter of hour

5. RESULTS

5.1 The first observations

At the end of the summer season, in each priority district, the authorities plan a meeting gathering Bruitparif and the establishment owners, residents associations, police forces to present the results that give an unbiased view of the situation.

Bruitparif products daily, weekly, monthly reports with sound levels and will product soon the origin indicators. The first observations show that the results are different according to the district. Some points are mainly impacted by the noise of the costumers on the street or on the terrace. The other points are concerned about people in the street, not necessarily beside an establishment or who are gathered on the shore of the Seine or the Saint Martin waterway.

Thanks to these indicators, Bruitparif will define some threshold of vigilance at first and for intervention in second, in agreement with all the actors, beyond which the establishments have to do some actions and the police forces can focus their controls. Then, all the actors will receive a message to inform them when the sounds levels exceed the limit.

For example, in the Les Halles district, in the heart of Paris, one medusa sensor measures noise levels above 65 dB(A) during 50% of the time and above 70 dB (A) during

17% of the time. More important, these levels frequently appear at night and so could be defined as threshold for triggering management actions.

But before setting such thresholds, which will be conditioned to local situations, it is necessary for Bruitparif to collect the feeling and the perception of local residents in relation to the noise levels generated by these festive activities. The time at which these annoyances occur is also important because at equal noise level, the impact on the trouble and the health of the residents is not the same.

5.2 The companion mobile application

The next step in this experiment is now to match the observations made from the sensors, with the perception of local residents, which is information that is not always known or representative. Indeed, residents often do not report noise annoyance to the police forces because they are not always available at the time of the facts and the time to come, there is nothing more to see. This can generate frustration for residents on the one hand and for the police forces who have moved unnecessarily.

In addition, the reports take a lot of time for residents for unfortunately efficiency more than limited. The official number of reports against an establishment, on which the authorities are based, can therefore also be underestimated, not really reflect the real situation, and lead to bad management of nuisances in the neighbourhood.

To allow an objectification of the situation, Bruitparif intend to develop a mobile application whose main purpose is to facilitate the reporting for a resident and which be able to be an annoyance-reporting tool, suitable for a computer or mobile device (smartphone / tablet). Easy to use for registrants, it would disseminate information to a group of people, predefined in agreement with the partners, according to the sector in which one is, by SMS or email. The expected features of the application would be the reporting in less than one minute, respond to a local problem (in a limited sector / instrumented by the Medusa device), involve concerned and identified people (authorities, establishments owners, police forces), quickly inform the local actors, in order to objectify the annoyances and improve their management.

6. CONCLUSION

The project has to be a strong partnership between each actor involved in the public tranquillity and sound annoyances in their lively districts. More than a standard noise monitoring system, the actors must consider and use the device as a noise management tool in order to reduce noise levels and annoyance. To be successful, it must be a collaborative approach between residents, restaurants and bar owners, authorities, etc.

In 2019, BRUITPARIF will install eighteen other MEDUSA sensors into three other priority districts and develop the mobile application.

7. REFERENCES

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