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NOISE CONTROL FOR QUALITY OF LIFE

Noise generated by late-night establishments: a new monitoring and management tool

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ABSTRACT

In France, the application in 2008 of the smoking ban in public places increased tensions between the owners of late-night bars and residents due to noise nuisance issues. The City of Paris is required to solve conflicts related to the use of public space between the stakeholders of cultural life, their customers, and local residents, and to try to provide solutions that meet the needs of all parties.

In this context, with the cooperation of the City of Paris, Bruitparif led a pilot experiment on rue Jean-Pierre Timbaud, in the 11th arrondissement of Paris. The noise generated on the street by the activity of four bars was monitored for six months, from May to October 2012, with five innovative noise measuring devices. This monitoring system allowed us to identify the noise fluctuations during the day, depending on the type of day, and to obtain objective information on the noise impact of the bars in a context of concern for social dialogue. The main objective was achieved through the development of a noise management tool, alerting the bars' owners with a SMS's in real time when threshold noise levels were exceeded.

This article aims to present the results and the lessons learned during the experiment.

Keywords: Noise monitoring, Recreational Noise, Noise events, Late-night establishments noise.

1. INTRODUCTION

Since the start of the ban on smoking in public places, tensions are mounting between locals and the owners of bars, concert halls and clubs, on the issue of noise nuisances. It's a fact: more and more customers stand outside or in the street around bars and restaurants, thereby generating more noise, and potentially greater disturbance, for locals, but without necessarily being aware of it. Moreover, customers going in and out of concert halls and clubs generate a greater propagation of music in the surrounding area when these bars are not fitted with a double door.

In Paris, the mayors of each arrondissement and public players are under great pressure to resolve conflicts on the use of public space between the owners of night-life venues, their customers, and the inhabitants of the neighbourhoods. Local elected officials are under pressure to provide solutions that meet the needs of all parties involved. This issue has already been the subject of discussions and proposals in the context of the *Etats-Généraux de la Nuit* (a symposium to fight against noise pollution) organised by the City of Paris.

In order to facilitate the consultation process, the association Bruitparif, a noise observatory in the Ile-de-France region, suggested an experiment on noise measurement and management systems in order to provide the different stakeholders with objective data for characterising noise levels. This

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approach allowed the various parties to work together to find solutions and define objectives to improve the current situation. With support from the City of Paris, and as part of the European project Life+ Harmonica, coordinated by Bruitparif, this experiment was carried out on a pilot neighbourhood in the 11th arrondissement of Paris (rue Jean-Pierre Timbaud). In this neighbourhood, a consultation has already been started by the town hall of the 11th arrondissement.

2. ACOUSTIC INDICATORS USED

Three acoustic indicators, considered relevant for translating the sound environment, were used:

- The momentary noise level measured, called LAeq1s;
- The average noise level over a period T, called LAeqT[2] ;
- The background noise level over a period T, called LA90T[3].

Figure 1 shows an illustration of these different indicators on a sample noise measurement carried out over a half-hour period. In this figure, the momentary noise level LAeq1s is represented by the blue line. The LAeq1s levels vary between 38 dB(A) and 70 dB(A) over the period. The average noise level LAeq30min over the 30-minute period studied is represented by the blue dotted line (LAeq30min = 53 dB(A)). And finally, the level exceeded for 90 % of the time over the period is shown by a red dotted line (LA90,30min = 45 dB(A)).

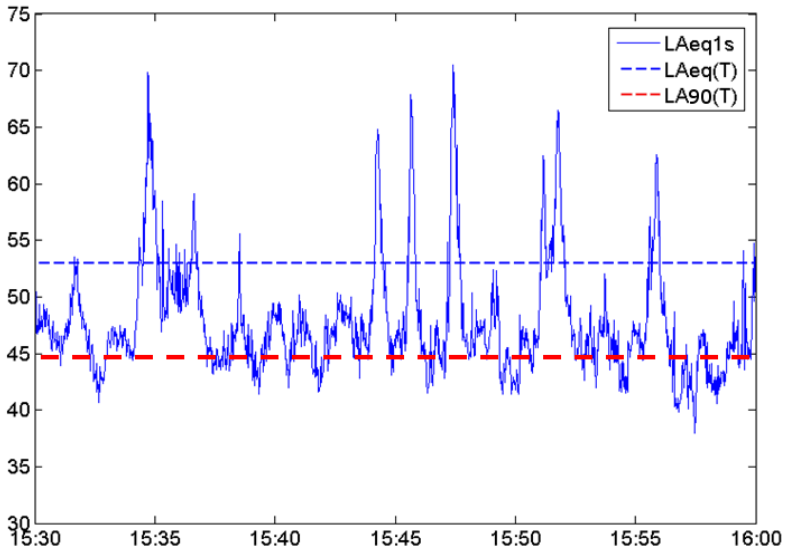

Figure 1 - Acoustic indicators used

3. PRESENTATION OF THE EXPERIMENT

Throughout the experiment, Bruitparif took part in meetings bringing together all the stakeholders involved (representatives of the town hall of the 11th arrondissement of Paris, residents' associations, and owners of bars). These meetings were the opportunity to present the system used and the results obtained.

3.1 Process of the experiment

The pilot experiment took place over a seven-month period between April and November 2012 and included six full months of operational noise measurement. The different stages of the experiment are presented below:

- Mid-April to end of April 2012: Finalisation of the plan for setting up measurement devices;
- Beginning of May 2012: Installation of noise measurement devices in the area of experimentation;

[2]Averages were calculated for different times of day: 6 am to 10 pm, 10 pm to 6 am, the period between 10 pm and the bars' closing time (2 am or 5 am depending on the bar), and the average over a quarter of an hour or an hour.
[3]This is the noise level that is exceeded for 90 % of the time over the period T. It is the relatively constant noise that remains in the absence of noise events. It can be evaluated for the same periods as for the LAeqT indicator.

- Beginning of May 2012 to mid-July 2012: Initial diagnostic phase. The measurements carried out over these two and a half months made it possible to establish a review of the situation near the bars and to set the alert threshold levels to be used during the implementation of the operational phase;
- Mid-July 2012 to mid-November 2012: Operational phase. The devices send SMS's to the bars' owners when the thresholds levels set during the initial diagnostic phase are exceeded;
- Mid-November 2012: End of the experiment. Presentation of the results obtained from the full six months of measurements. Comparison of the results obtained during the first ten weeks (initial situation) with those obtained during the following sixteen weeks (implementation of alert mode and sending of SMS's), discussions with all participant, prospects and outlook.

3.2 Presentation of measurement equipment

The measurement system was based on five energy-autonomous measurement devices. Easy to set up, the Greenbee® devices, designed by Azimut Monitoring, were rented by Bruitparif for the specific needs of the experiment.

Figure 2 – Greenbee® device by Azimut Monitoring

These devices do not satisfy all the criteria of conformity defined by the order of 27 October 1989 pertaining to the construction and control of sonometers that may be used in the application of legislative and regulatory texts, or in the context of expert studies.

However, these devices have the advantage of being energy-autonomous. The power is supplied by a built-in solar panel, fitted with an internal battery with a life of 60 days without any sunlight, and they are particularly light (less than 2 kg). They allow the continuous measurement and storage of the noise level expressed in dB(A), second by second (LAeq1s) for noise levels between 35 and 105 dB(A). This acoustic range is suitable for the phenomena that we want to measure. The devices do not make digital audio recordings, which guarantees the privacy of persons nearby (it is impossible to listen back over conversations). The data stored on the devices is transferred to Azimut Monitoring's central server and then to Bruitparif on a daily basis thanks to a GPRS modem built into the devices. All of these technical characteristics made it particularly easy to set-up the measurement devices on the façades of residents' homes (easy to attach to any building using a simple clamp band, without damaging the buildings - cf. figure 3).

Figure 3 - Quick attachment system

It was therefore necessary to obtain the authorisation of the bars' owners and the residents to install the measurement devices on the façades of their homes.

During the experiment, the equipment's supplier, Azimut Monitoring, was asked to include a function to automatically send SMS's when acoustic thresholds set by the user are exceeded. The acoustic thresholds and the criteria for sending SMS's were determined for each device based on the results from the initial diagnostic phase (cf. section 4.3.1).

3.3 Map of the location of measurement devices

Five measurement sites along rue Jean-Pierre Timbaud were chosen (cf. figure 4). Four devices were set up with direct exposure to noise nuisances generated by bars having accepted to take part in the experiment (Petit Garage, Pili-Pili, Alimentation Générale, and U.F.O). The fifth device (site no. 5) was set up in the middle of the road in order to measure the street's general acoustic environment (atmosphere created by all the activity in the road, pedestrian traffic, and bar's customers).

Figure 4 – Location of measurement devices on rue Jean-Pierre Timbaud

In order to ensure relatively consistent conditions for comparing the results, the devices were systematically installed above the bars, on the 1st floor above the closest residents. The device measuring the general atmosphere on rue Jean-Pierre Timbaud was installed on the second floor for logistic reasons (apartment on the 1st floor uninhabited).

4. RESULTS OBTAINED

4.1 Data analysis and approval period

Table 1 presents the measurement period and the amount of data exploited for each site studied. The data was unexploited for certain periods because of one of the following reasons:

- Invalidation of the data because of a technical problem (a particularly rare occurrence over the six-month measurement period);
- Invalidation of the data because of data measured during unusual events that is unrepresentative, e.g. temporary roadworks near a measurement device, whose acoustic impact masked the phenomena that we wanted to measure (most frequent reason for the invalidation of data during the six-month measurement period);
- Data not taken into account during an exceptional event (evening and night of 21 June, because of the "Fête de la Musique" music festival). In this case, the data remains valid but it is excluded from the calculations of average daily and hourly indicators.

Table 1 – Measurement analysis periods

Name of site	Measurement period	Percentage of data exploited
Petit Garage	1 May to 31 October 2012	98.7%
Pili Pili	4 May to 31 October 2012	98.2%
Alimentation Générale	1 May to 31 October 2012	98.7%
U.F.O	1 May to 31 October 2012	98.7%
Site no. 5 in the middle of the road	1 May to 31 October 2012	98.1%

4.2 Variation in noise levels depending on the time and type of day

4.2.1 Importance of the background noise indicator LA90

The daily variations in noise levels as recorded by the experiment's measurement device have different profiles depending on whether there is a low or high level of nocturnal human activity (Monday and Friday respectively for example - cf. figures 5 and 6).

Although the bars' activity shows a marked increase in average noise levels during the night, it is characterised in particular by a significant rise in the minimum noise level. Among the acoustic indicators calculated, the background noise level represented by LA90 is a good reflection of these characteristics. Indeed, in figures 5 and 6 we can see a strong increase (up to 10 dB(A)) in the minimum levels over the 10 pm to 2 am period between days with high and low activity, whereas the increase on an average day is more like 5 dB(A).

Moreover, the background noise indicator allows us to eliminate all noise events that are not characteristic of the bars' activity (horns, motorbikes, sirens, etc.), which can contribute significantly to the average noise level.

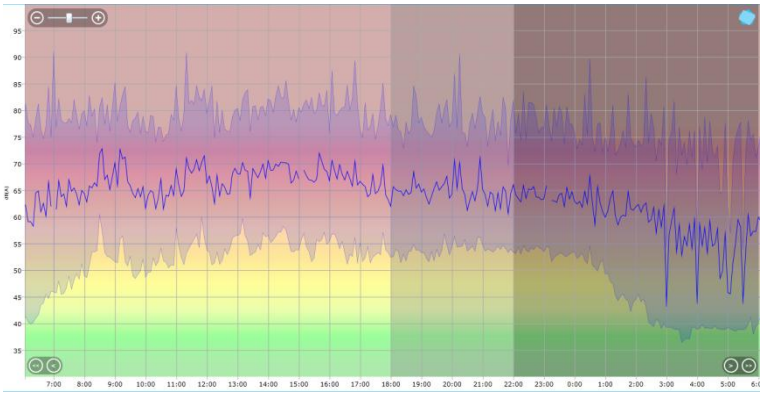

Figure 5 - Variation in the noise level of site no. 5 on a low activity day for the bars

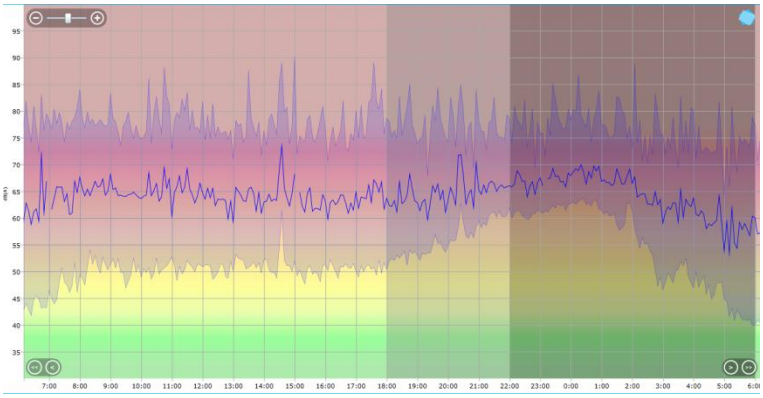

Figure 6 - Variation in the noise level of site no. 5 on a day of high activity for the bars

4.2.2 Presentation of the results for one site

This section presents the results of one of the five sites studied, as an example. The variations in noise during the day are analysed for the different types of day. Several graphs and tables are presented for this site:

- Variation in background noise levels by fifteen-minute periods (LA90,15min) for the entire six-month measurement period[4] (cf. figure 7);
- Background noise level for the period between 10 pm and 6 am (LA90,22h-06h) by type of day (cf. figure 8);
- Background noise level for the period of activity (LA90,22h-02h) by type of day (cf. figure 9);
- The 10 noisiest nights and their noise levels (LA90 22-2h) (cf. figure 10).

[4] "Radar"-style representation of LA90,15 minutes, with all levels observed for every 15 minute period and the average values depending on the type of day.

For the purposes of this study, we consider that a 24-hour cycle starts at 6 am and ends at 6 am the next day.

Moreover, as described in section 4.2.1, the background noise level is a particularly pertinent indicator for highlighting the acoustic impact of bars' activity, and more generally the overall activity on rue Jean Pierre Timbaud. Therefore, the interpretation of graphs focuses mostly on the background noise indicator (LA90), even if the trends highlighted are also seen in the average level indicator (LAeq).

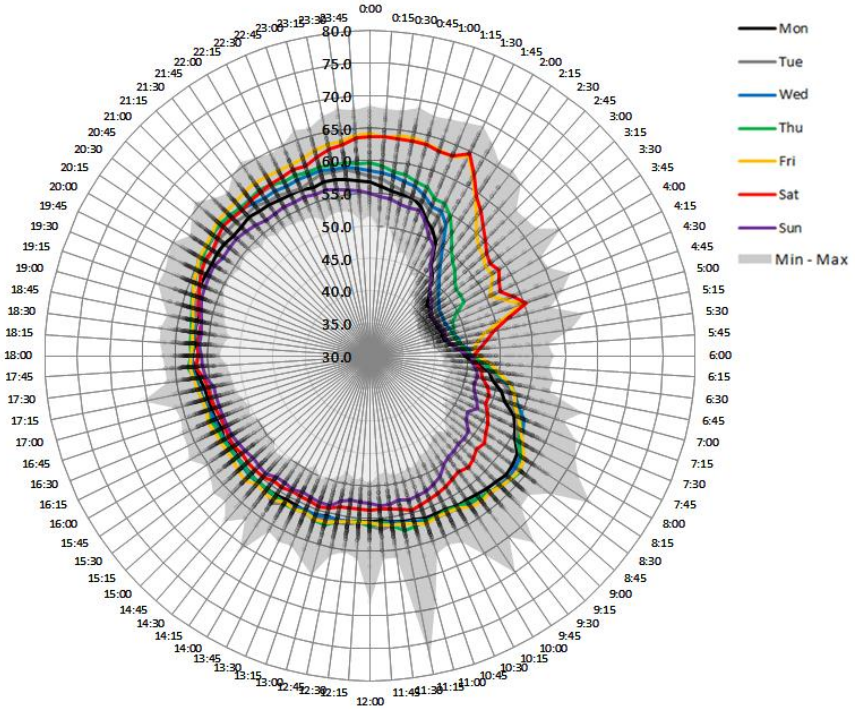

Figure 7 – LA90,15minutes noise levels (average by type of day, 1 May to 31 October 2012)

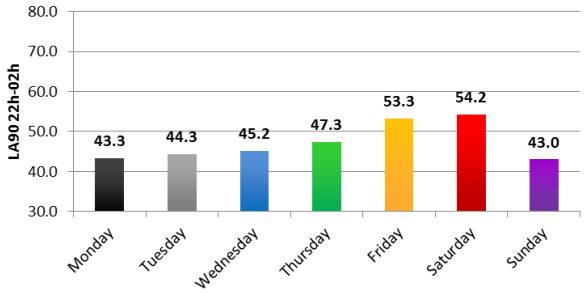

Figure 8 – LA90 22h-06h noise levels (average by type of day)

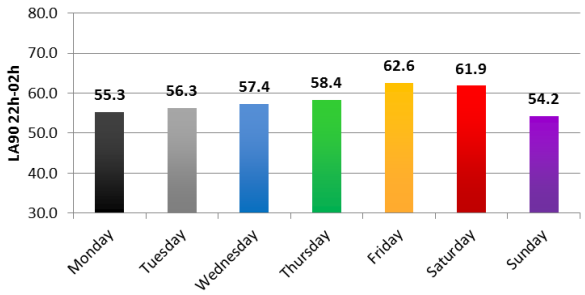

Figure 9 – LA90 22h-02h noise levels (average by type of day)

	fri 12/10	fri 11/05	fri 07/09	sat 29/09	fri 29/06	fri 28/09	sat 02/06	fri 19/10	fri 05/10	fri 08/06
LA90,22h-02h	65.4	64.9	64.9	64.5	64.2	64.2	63.8	63.8	63.8	63.7

Figure 10 – LA90 22h-02h noise levels (average for the 10 noisiest nights recorded on the site)

The analysis of variations in the LA90,15min background noise levels (cf. figure 7) highlights four distinct acoustic periods over any 24-hour period:

- 6 am to 3 pm: On week-days, the background noise level increases rapidly between 6 and 8 am - a phenomenon linked to the street "waking up" - before levelling off at 55 dB(A) from 8 am. On Saturdays and Sundays, the background noise levels rise progressively to reach 55 dB(A) at

around 3 pm;

- 3 pm to 6 pm: Over this period, there is no difference in background noise levels on different days of the week. The level remains relatively constant for the duration of this period (around 55 dB(A));
- 6 pm - 2 am: Over this period, we can see a progressive increase in the background noise. The maximum level is reached between 8 and 10 pm at night from Sunday to Thursday and around 2 am on Friday and Saturday nights. The highest daily levels over any 24-hour period are systematically reached during this period. They are closely linked to the day of the week (in ascending order): 57.7 dB(A) on Sundays, 58.4 dB(A) on Mondays, 59.4 dB(A) on Tuesdays, 60.7 dB(A) on Wednesdays, 60.8 dB(A) on Thursdays, 64.3 dB(A) on Fridays, and 64.6 dB(A) on Saturdays). The background noise levels start falling after midnight, except on Fridays and Saturdays, when it remains stable until 2 am.
- 2 am – 6 am: The bar is closed during this period. After a slight peak at 2 am, the background noise level falls progressively until 5 am (closing time of the last bar on the street) on Fridays and Saturdays. After a noise peak at around 5 am, the background noise level drops off rapidly. On other days of the week, the background noise level falls significantly after 2 am and reaches its lowest level after 3 am.

If we exclusively analyse the nocturnal activity of the bar (10 pm to 2 am), different types of days stand out (cf. figures 8 and 9):

- Sunday nights: The quietest night of the week (LAeq,22h-2h= 63.2 dB(A) and LA90,22h-02h = 54.2 dB(A));
- Monday to Thursday nights: The noise increases progressively (LAeq,22h-2h between 64.0 and 65.5 dB(A), and LA90,22h-02h between 55.3 and 58.4 dB(A));
- Friday and Saturday nights: The noisiest nights of the week (LAeq,22h-2h of 68.6 and 68.2 dB(A) respectively, and LA90,22h-02h of 62.6 and 61.9 dB(A) respectively).

4.3 Comparison of results before and after implementation of alert mode

The experiment was reinforced during July 2012 to allow the development of a system for sending SMS alerts to the owners of bars when levels reached or exceeded a predetermined threshold for each bar. The purpose of this system was to inform owners in real time when the alert threshold is exceeded. They can then ask their customers to "lower their voices" in order to respect the tranquillity of the locals. Section 4.3.2 compares the results obtained during periods before and after the SMS alert system was set up, i.e. from 1 May to 14 July 2012 and from 15 July to 31 October 2012.

4.3.1 Criteria for setting off the "alert" mode and sending out SMS's

The criteria for setting off the "alert" mode were defined using the analysis of the results from the first two months of measurements during the initial diagnostic phase (May-June 2012). The principle of sounding the alert when the background noise level was exceeded was chosen. The choice of this indicator avoids sending SMS's because of one-off noise events that we cannot be sure are caused by human activity on the site (passage of noisy two-wheeled vehicles, horns, car doors slamming, etc.). Furthermore, considering that the device is installed in a different situation for each bar, it was decided preferable to define a specific alert threshold level for each bar.

The alert threshold level is based on a background noise level that is exceeded for 10 % of the time (on Thursday, Friday, and Saturday evenings when the bar is open). The statistical analysis was carried out on data recorded during the first phase of objectivisation of noise nuisances (May-June 2012). The objective of setting an "alert" mode consists, firstly, in "taking action" on the 10 % of the noisiest periods for residents. The thresholds chosen are summarised in table 2.

Table 2 – Determination of the alert threshold levels for the "alert" mode

Name of site	Excess level recorded	Threshold level for alert mode
Bar no.1	63.5 dB(A)	63 dB(A)
Bar no.2	70.6 dB(A)	70 dB(A)
Bar no.3	65.1 dB(A)	65 dB(A)
Bar no.4	66.3 dB(A)	66 dB(A)

In order to set up an "alert" mode, the average background noise level is calculated every two minutes in real time. The system is configured to send SMS's to the bars' owners if the noise levels

exceed a pre-defined threshold for a total period of six minutes (e.g. three periods of two consecutive minutes). In the event that the threshold level continues to be exceeded, a second SMS is sent after 15 minutes, 30 minutes, 1 hour, and then every hour. An illustration of the principle for activating/deactivating the alert mode and the sending of SMS's is presented in figure 11.

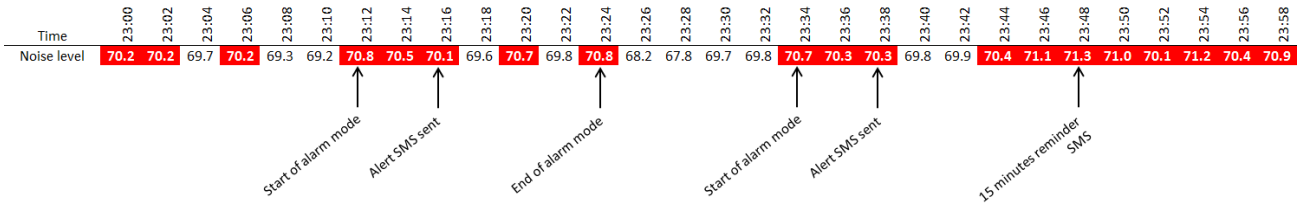

Figure 11 - Principle of activation/deactivation of the alert mode and the sending of SMS's

The alert system was set up during the weekend of 14 July 2012, and the SMS system was active on the days that the bar was open from 10 pm to 2 am and from 10 pm to 5 am for bar no.1. The system was well received by the bars' owners but technical problems (SMS's not sent if the "alert mode" remained on, non-delivery of SMS's to the bars' owners in certain cases, etc.) were encountered at the beginning of the project in July and August, which limited the system's effectiveness. These problems were progressively resolved. Moreover, it appeared that the bars' owners were not necessarily available to intervene in the street in certain cases, having other tasks to manage.

4.3.2 Comparison of threshold limits exceeded before and after the SMS system was set up.

This section presents the comparison of the noise levels before and after the SMS system was set up for a specific site, chosen for the purposes of illustration. The analysis essentially concerns the evolution of background noise levels by 15 minute periods, and the evolution of background noise levels for the bars' periods of nocturnal activity (10 pm to 2 am or 10 pm to 5 am).

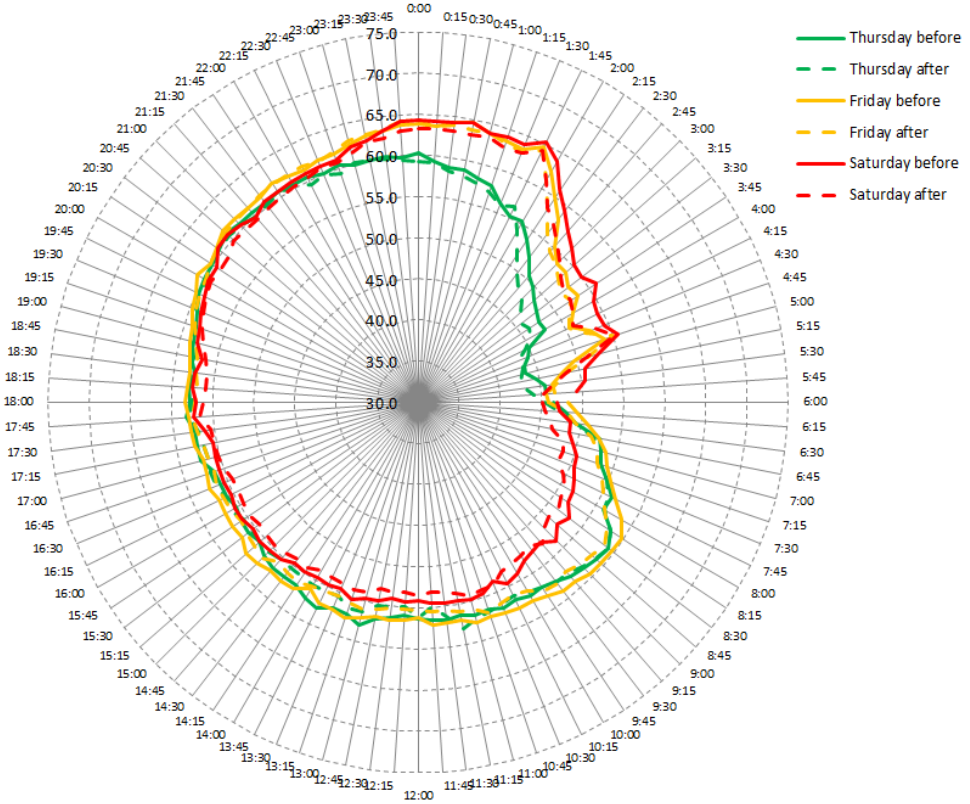

Figure 12 - Comparison of the evolution of the daily background noise level by 15-minute periods by type of day, before and after setting up the "alert" mode

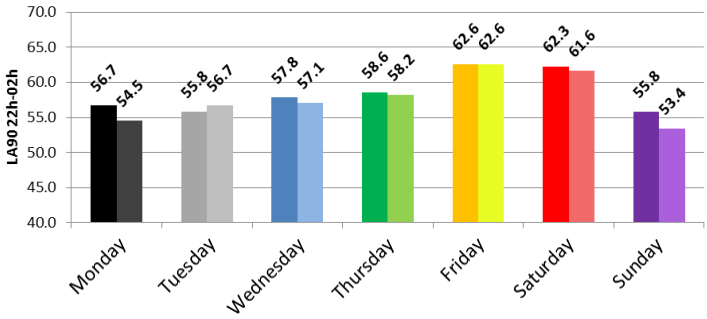

Figure 13 - Comparison of the evolution of the daily background noise levels over the 10 pm - 2 am period by type of day, before and after setting up the "alert" mode

The overall trend is that of a reduction in the background noise level between 10 pm and 5 am after setting up the SMS system (cf. figure 12). The most significant improvement is in the 2 am to 5 am period on Thursday to Saturday nights. For these days, we can see an improvement of between 0.4 and 0.7 dB(A) for the LA90,22h-02h indicator (cf. figure 13). The threshold level is exceeded between one and five times every Friday and Saturday evening (cf. figures 14 and 15). Setting up the "alert" mode does not seem to have had an influence on the number or duration of "alerts".

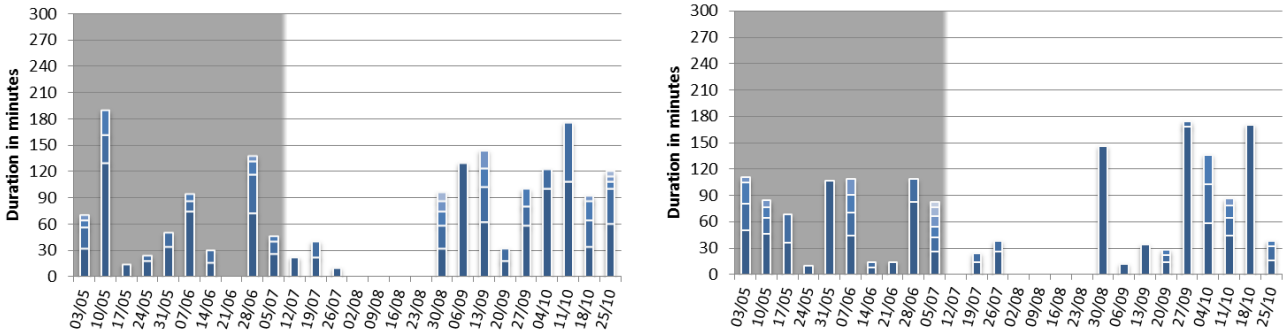

Figure 14 - Histogram of the number and duration of periods that exceed the threshold for Fridays (left) and Saturdays (right)

5. CONCLUSION

The experiment allowed us to better understand the variations in noise levels during the day, depending on the type of day, and provided us with objective elements for characterising the increase in noise generated by customers frequenting the bars. The analysis of the variations in levels measured depending on the times and types of day highlighted a significant increase in noise when the bars are open and when there is a large number of customers. This increase is particularly marked on Friday and Saturday nights, when the background noise increases by between 8.4 and 13.9 dB(A), depending on the site, and the LAeq,22h-2h average noise level increases by between 3.9 and 7dB(A) compared to Sunday nights (the quietest night for all sites). The detailed analysis of noise variations during the day, in particular periods in the evening and the first part of the night, highlighted the fact that the noise nuisances generated by customers frequenting the bars manifests itself by an increase in the background noise level and the absence of a quiet time for residents.

The bars' owners reacted positively to receiving SMS's. They played along by communicating with their customers when the threshold levels were exceeded. This system did, however, show certain limits during the experiment, essentially linked to technical problems encountered at the start of the experiment concerning sending and receiving SMS's. The system could be improved by also warning customers in real time, and at the same time as the owners, when the noise levels become excessive.

ACKNOWLEDGEMENTS

We would like to thank Paris City Councillor and deputy mayor for the 11th arrondissement, Stéphane Martinet, who is responsible for Culture and Heritage, for his involvement in mediation between residents' associations and the owners of bars, and for being behind the experiment suggested

by Bruitparif. We also want to thank the owners of the bars that took part in the experiment, for their time and faith in the exploitation in the measurement data. And finally, we could like to thank the residents' associations for their help installing the measurement devices, as well as their feedback on their impressions during the experiment.

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