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Processing of long-term acoustic measurements

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Many standards and European directives relative to noise are used to assess an acoustic situation, based on long-term indicators such as L_{day} , L_{night} or L_{evening} . These indicators are defined mainly as the mean yearly equivalent acoustic level on a particular part of the day. Acoustic measurements are performed on reference periods representative of the typical acoustic situation. An Oper@ monitoring system performed measurements for two years on several points. An acoustic database of the one-second integration time measurement was created. Different kinds of calculations were performed on these data, the variant being the measurement time considered. This study evaluates the convergence of the classic equivalent level with these long-term indicators.

1 Introduction

Environmental acoustics has progressed step by step: from the direct instantaneous measurement to the integration during 30 minutes. Then, it has been increased from 30 minutes to 8 hours measurements and now the electronic improvements allow to perform measurement during more than a month. In each steps of evolution, new acoustic indicators have been created to give a better evaluation of the situation: from Fast, Slow or Impulse L_p to L_{eq} , from L_{eq} to Statistics. Reference periods have also been extended.

Concerning assessment and management of environmental noise, the indicator L_{den} is one of the indicators presented to be relevant of the long term noise exposition level. In other cases such as construction areas, it may be a dose calculation or a sliding L_{eq} which is defined to be representative. In each case, the evaluation or the measurement of these indicators are defined on a reference period: a day, a month, a year.

This paper presents the exploitation of a long term measurement and the assessment of the L_{den} values. This value will be recomposed on different period durations.

2 Measurement point

Since several years, 01dB-metravib has proposed acoustic monitoring systems. Several key points have been monitored during more than two years in order to evaluate the instrumentation capabilities. The typical approach consists in recording the L_{Aeq} with 1s integration time. A database has been realized which allows to extract, compute and view the recorded measurements.

LMCU (Lille Métropole Communauté Urbaine) has been equipped of acoustic monitoring systems from several years [1]. Systems are used to evaluate the acoustic situation day by day on each point. Automatic reports are created every night taking into account the last 24h measurement acquired. This allows to be as reactive as possible when a complaint is sent to the organism.

Based on this fruitful experience and using the 01dB-Metravib measurement database, the computation of the results has been performed in order to study the recomposition period.

2.1 Location

The measurement is performed on the top of a house, more or less at 5m above the grown. The system has been setup beginning of 2005 and is now operating without interruption.

2.2 Measurement devices

The measurement system is an Oper@ Ex and several smaller units Oper@ RF (with radio frequency data transmission). Microphones are protected by a weatherproof windscreen. An mounting kit has been used on each point to enable the fixation of the devices.



Fig.1: Monitoring measurement system: Expert Oper@ unit

The measurement files are automatically transferred every day on a remote FTP server (located in 01dB-Metravib main office in Limonest). An automatic process integrates measurement results into a large database with other measurement point. A specific software dBdat@ allows to access to all the noise data received by the collection server.

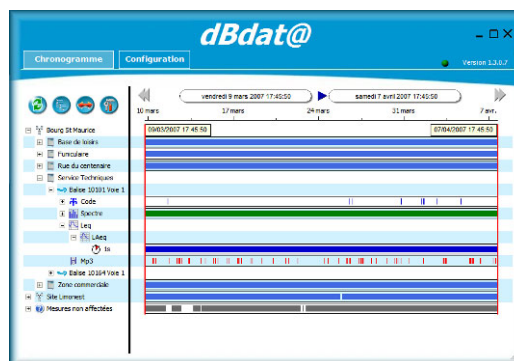


Fig.2: dBdat@ data collection software

2.3 Setup

The Oper@ has been setup for a hardness measurement configuration: each second the system measures the LAeq, and spectrum values. This configuration has been performed remotely using a specific VPN network and dB@dmin software.

3 Computation

For this study, only the LAeq indicator is computed. The conclusions will deal with this A frequency weighting but very few calculations may demonstrate that the same approach may be used. The approach consists in a comparison of different measurement years.

3.1 Classical approach

In the very beginning, the first step is to have a rather classical overview of the measurement (Table 1).

Year	Leq	L ₉₀	L ₁₀
2005 (second half)	54.3 dBA	47.2 dBA	55.3 dBA
2006	55.0 dBA	47.2 dBA	56.3 dBA
2007	59.4 dBA	47.4 dBA	56.5 dBA

Table 1: Classical computation of several years on the same point

From this table, the main conclusion may be that the Leq values have been increased in 2007 while the statistical indicator L₉₀ and L₁₀ did not change so much. Considering the A-weighted Leq time history, the comparison is not directly useful. The following of the study will consider only the last 2 complete years 2006 and 2007.

Table 2 confirms that 2007 had more important noisy periods in terms of acoustic level.

Year	Loudest period		Quietest Period	
Year	period	Leq	period	Leq
2006	05/07	69.3 dBA	01/01	48.8 dBA
2007	19/06	74.2 dBA	16/12	48.1 dBA

Table 2: Noisiest periods in 2006 / 2007

3.2 L_{den} approach

Considering now that the L_{den} defined in [2] and requested in [3] may be more representative than the classical Leq values, The L_{den} has been computed for each week and compared one by one in the Figures 3 to 5

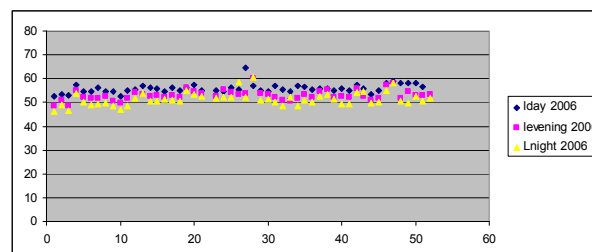


Fig.3: 2006 weekly indicators

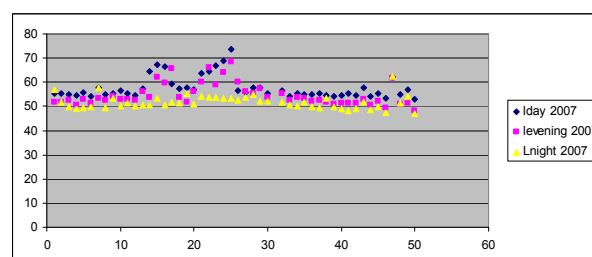


Fig.4: 2007 weekly indicators

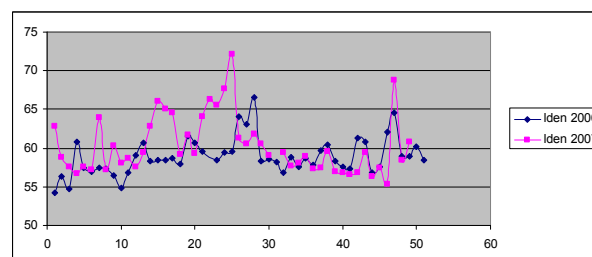


Fig.5: Lden comparison between 2006/2007

The annual mean calculation of L_{den} indicates a difference of 1.9 dBA. Considering that the situation is announced changed when a gap of 5dBA is proved, it is necessary to assess the indicator in a tolerance of 2.5dBA

A maximum of more than 10 dBA is observed in weekly indicators (L_{day}, L_{evening}, L_{night}). Considering that the more accurate value may be the L_{den} on the complete year, the question is: from which integration time the indicator will converge to the final value? Each indicator is recomposed successively over one week, two weeks, three weeks, (...) and the result is compared to the means of all values from the 52 weeks. Figure4 presents the 2006 convergence factor observed versus the number of weeks considered.

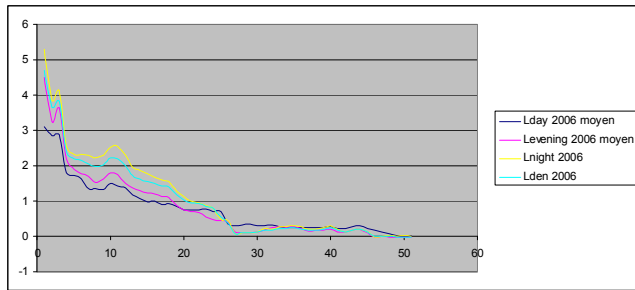


Fig.6: 2006 convergence factor for several indicators

The convergence is conforming to 2.5 dBA around 10 weeks integration time, meaning more than 2 months. Figure 6 presents the same calculation for 2007.

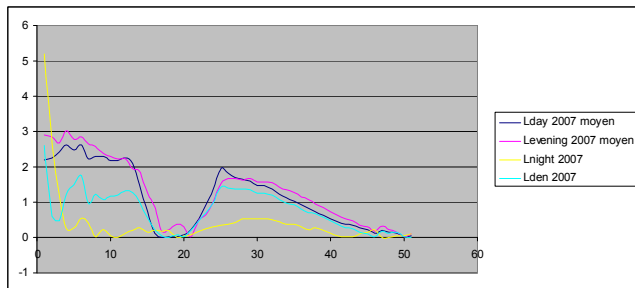


Fig.7: 2007 convergence factor for several indicators

The figure 7 presents the same convergence but notice that from the 20th week, the curve increases up to 2 dBA. It may be due to a construction that took place near the measurement point.

3.3 Synthesis

In both classical and L_{den} approaches the increase of the noise has been validated between 2006 and 2007. The weekly computation of the data presents a 10 dBA variation or more. The assessment of a convergent value has been obtained with computation of 20 weeks at least. The convergence may be disturbed by specific events that occur around the measurement. So knowledge of the major events during the measurement is necessary to validate the result.

David Ecotièrre [4] explains that, considering the meteorological modification, the assessment of an accurate and representative long term value may be obtained considering at least 10 years measurement and integration.

3.4 To continue

The same calculation must be achieved in other type of locations to quantify the convergence in each kind of situations (construction area, urban noise, traffic noise, ...). This convergence may be defined for each situation the representative period is to analyse.

A library of major events must be created in order to monitor as extensively as possible a situation (roadwork, new equipment, or traffic change for example) in the same way of thinking that, today, acousticians notice the measurement events occurring during a classical 8h calculation (dogs, cars, horn, meteorological condition, ...).

5 Conclusion

From a data collection on a simple case, the calculation of several indicators has presented a convergence factor that may be used to evaluate properly a situation. The conclusions of a situation must include this vision in order to avoid basic weekly approach mainly used. A collection of situations or an evaluation of this factor must be done before running evaluation. The assessment of a long term result by measurement is one of the new challenges of acousticians. The previous evaluation of a noisy situation must be readapted for the new time period. Large collection of data creates new calculation and new way of measuring.

References

- [1] F. Chopard, S. Bloquet, L. Faiget, C. Aujard (01dB-metravib), P. Thomas(LMCU) - "The fundamental contribution of noise measurement networks to the application of European Directive 2002/49/EC", *Internoise 2007, Ref. 585EN*
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