Environmental acoustics: Comparison of noise exposure measurements recorded in dosimeters and sound level meters

Acústica ambiental: Comparación de las medidas de exposición al ruido registradas en dosímetros y sonómetros

Acústica ambiental: Comparação das medições de exposição ao ruído registadas por dosímetros e sonómetros

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ABSTRACT
A methodological development is proposed to compare the results of measurements of the equivalent level of noise exposure (ambient sound) and SEL in urban areas near traffic routes obtained in the conventional way by using a fixed-point sound level meter and noise dosimeters. Class I calibrated equipment is used for the sound level meter and Class II for the dosimeter. Comparisons are made by maintaining a fixed point location for the sound level meter and using dosimeters for measurements in different media moving with reference to the fixed point. The research is ongoing. To simulate the measured scenarios a mathematical model, from the Department of Mechanical and Energy Engineering of the Miguel Hernandez University of Elche (Spain), is used to compare measured results against model results. The field values are used to calibrate the model, validating it for use when it is necessary to have exposure values at different points and at different heights. The first results show an appreciable difference between noise exposure measured in the conventional way and that inferred from ambient sound pressure levels measured with a sound level meter, for different environments in urban areas close to traffic routes, with the highest incidence on pedestrians.
Key words: dosimeters, sound level meters, environmental noise exposure.

RESUMEN
Se propone un desarrollo metodológico para comparar los resultados de las mediciones del nivel equivalente de exposición al ruido (sonido ambiente) y SEL en zonas urbanas próximas a vías de tráfico obtenidos de forma convencional mediante un sonómetro de punto fijo y dosímetros de ruido. Se utilizan equipos calibrados de clase I para el sonómetro y de clase II para el dosímetro. Las comparaciones se realizan manteniendo una ubicación de punto fijo para el sonómetro y utilizando dosímetros para mediciones en diferentes medios que se mueven con referencia al punto fijo. La investigación está en curso. Para simular los escenarios medidos se utiliza un modelo matemático, del Departamento de Ingeniería Mecánica y Energética de la Universidad Miguel Hernández de Elche (España), para comparar los resultados medidos con los resultados del modelo. Los valores de campo se utilizan para calibrar el modelo, validándolo para su uso cuando sea necesario disponer de valores de exposición en diferentes puntos y a diferentes alturas. Los primeros resultados muestran una diferencia apreciable entre la exposición al ruido medida de forma convencional y la inferida a partir de los niveles de presión sonora ambiental medidos con un sonómetro, para diferentes ambientes en zonas urbanas próximas a vías de tráfico, con mayor incidencia en peatones.
Palabras clave: dosímetros, sonómetros, exposición al ruido ambiental.

RESUMO
Propõe-se um desenvolvimento metodológico para comparar os resultados das medições do nível de exposição sonora equivalente (som ambiente) e do SEL em zonas urbanas próximas de vias de tráfego, obtidas convencionalmente por meio de um sonómetro de ponto fixo e de dosímetros de ruído. É utilizado equipamento calibrado de classe I para o sonómetro e de classe II para o dosímetro. As comparações são efectuadas mantendo um ponto fixo de localização para o sonómetro e utilizando dosímetros para medições em diferentes meios que se deslocam com referência ao ponto fixo. A investigação está em curso. Para simular os cenários medidos, é utilizado um modelo matemático, do Departamento de Engenharia Mecânica e Energética da Universidade Miguel Hernández de Elche (Espanha), para comparar os resultados medidos com os resultados do modelo. Os valores de campo são utilizados para calibrar o modelo, validando-o para utilização quando são necessários valores de exposição em diferentes pontos e a diferentes alturas. Os primeiros resultados mostram uma diferença apreciável entre a exposição ao ruído medida convencionalmente e a inferida a partir dos níveis de pressão sonora ambiente medidos com um sonómetro, para diferentes ambientes em zonas urbanas próximas de vias de tráfego, com maior incidência nos peões.
Palavras-chave: dosímetros, sonómetros, exposição ao ruído ambiente.

1. INTRODUCTION

This paper presents some results of the Doctoral Thesis in Environmental Engineering being carried out by the main author at the School of Engineering of the Universidad de la República, under the supervision of the co-authors of the article.

The aim is to compare the results of noise exposure of users of the Urban Mobility system, based on measurements recorded with dosimeters and sound level meters. The users are pedestrians and drivers and/or passengers of public transport, bicycles, skateboards and automobiles. Environmental measurements (using a sound level meter) and personal measurements (using a dosimeter) are taken in each case; comparisons are made and conclusions are drawn from the results obtained.

A noise dosimetry is a measurement, accumulated on the person, of the level of exposure to noise above a given reference level and during a given period. The reference environmental dose is derived from WHO recommendations (70 dBA for a 24-hour exposure time).

The research questions guiding the roadmap are as follows:

– How similar are the directly measured received dose and the dose inferred from an environmental measurement?
– Is $L_{Aeq,1\ hour}$ useful to describe these doses, or can other measurement intervals be used?
– How much does the mode of transport affect the dose received?
– Are the Noise Maps representative of the level of exposure of people?

2. BACKGROUND

There are results of studies relating noise and health that would justify this thesis to be used in public health predictions based on environmental measurements. Results have been found that relates traffic noise to health. Traffic noise is related to heart disease (Vienneau & Schindler,.2015), Parkinson's disease (Díaz, 2018), and traffic noise is also linked to cardiovascular, respiratory and metabolic health loss (Recio, 2016). In these cases, it is of interest to compare the environmental dose and the personal dose received by urban mobility users. The results can be used as input by researchers when making public health predictions.

As a background of studies using dosimetry is the one developed in Montevideo with bicycle users. It is a study related to environmental noise exposure of cyclists in Montevideo (Uruguay). The main objective of this study was to find the most important parameters related to noise exposure of cyclists in the city. It warned that a good approximation of noise exposure could not always be obtained by measuring ambient levels and that noise dosimetry was necessary in that case. The variability of sound pressure levels means that it is not always easy to obtain a good approximation of the sound pressure levels to which a receptor is exposed by measuring ambient levels. In such cases, noise dosimetry must be carried out (González et al., 2023).

Another case is the one analyzed in palm oil mills. These are the noisiest industrial workplaces. The objective of the study was to determine the association between noise exposure and stress levels among workers. It focused on the non-auditory effects of excessive noise. Individual noise exposure level and ambient sound level were examined. To minimize uncertainty, this study suggested the use of sound level meters and dosimeters, as well as the observation of workers' behavior during testing. The results show that the level of noise exposure is not only related to the ambient sound level, since in some of the noisy areas the dosimeters did not register the expected noise level. There were uncontrollable limitations that prevented a final conclusion. The limitations were due to several factors such as the temporal and spatial variability of the noise levels and the specific acoustic characteristics of the noise sources. Some of the limitations are related to the consistency of the position of workers in the work area, the variability of exposure times, and the limited duration of noise measurements.

For the linkage with stress, the noise level is not the only source of annoyance, but the type of noise, communication and activity interference, noise source control, time, work pressure, social environment and workers' status, which are the other important factors to increase the stress level (Latifi Naeini & Bahri Hj, 2014).

According to the "Basic guide of recommendations for the application of common noise assessment methods in Europe (CNOSSOS-EU)" Recommendations for application to the assessment of noise from industrial sources, roads, railroads and agglomerations (Unión Europea, 2003), which responds to Directive 2022/49/EC of the European Parliament and of the Council on Environmental Noise Assessment and Management (END) requires all member states of the European Union to prepare Strategic Noise Maps (SRM) for all major roads, railways, airports and agglomerations, to be reviewed every 5 years. To these are added the Noise Action Plans (RAP), also reviewed every 5 years.

The control of environmental noise is an important health and social problem. Numerous policies worldwide require noise maps to be drawn up to establish an inventory of the acoustic environment and

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propose action plans to improve its health and social quality.
In general, these maps are produced by numerical simulations, which may not be sufficiently representative, for example, in terms of the temporal dynamics of noise levels.
More recently, an alternative approach has been proposed consisting of using citizens as data producers by using smartphones as geolocated acoustic measurement tools (Ayoub Boumchich, 2024).
Regarding background in Montevideo, the model generated at the University of Elche corresponding to the noise map of the City of Montevideo is supported, and in particular reference will be made to the calibration of the model for Avenida 18 de Julio (DIA-IMFIA, 2021).
It is noted that the dosimeters can operate with a threshold below 70 dB that must be controlled so that this condition does not affect the measurement or the subsequent developments of the analysis. In the case of the Pulsar Instruments dosimeters used, the threshold is 65 dBA.

3. FIELD WORK

The work methodology to be followed included:
– Exploratory dosimetry,
– Choice of equipment to be used,
– Check of equipment to be used,
– Review of available Smartphone Apps for comparison of results,
– Review of work methodology,
– Choice of measurement points.

3.1 Choice of measurement points. Criteria.

The selected criteria (Table 1) had to do with the passage or not of buses, the direction of traffic, the condition of the road, its traffic volume, the surrounding buildings, the existence or not of a central divider, the existence or not of traffic lights, and the type of road pavement.
Based on the elements to be considered, possible streets or avenues meeting the established conditions were investigated. The points chosen in the first instance to carry out the measurements can be seen in Table 2 as well as their geographic location.

Table 1. Elements to consider for the choice of sampling points.

BUSES	MANOS	ESTADO DE LA VIA	TRANSITO	EDIFICIOS	CANTERO CENTRAL	SEMAFOROS	TIPO PAVIMENTO
si/no	1 o 2	b/r/mal	alto/medio/bajo	altos/bajos	si/no	si/no	horm/asf/empedrado
Si hay o no presencia de buses en esa via	Si es via de 1 o 2 sentidos	Refiere a si el estado de la via es bueno, regular o malo. Bueno es sin fisuras ni baches con circulacion sin problemas. Malos es con dificultades para circular importantes por deficiencias de la via. Regular son las situaciones intermedias. Se puede tomar como porcentaje de afectacion de la via en superficie: hasta 5% Bueno. Por encima de 60% malo. Entre 5 y 60% Regular.	Bajo transito es menor a 100 vehiculos hora. Alto en por encima de 400 vehiculos hora. Entre 100 y 400 transito medio.	Altos es por encima de 12 metros. El resto bajos.	Presencia de separador central mayor a 1 metro.	Presencia de semaforos proximo al lugar de medida en esa via	Lor tipo pueden ser Hormigon, Asfalto, empedrado o adoquines de hormigon, balasto.

Table 2. Location of sampling points chosen

COORDENADAS (GRADOS)			
PUNTO	UBICACIÓN	SUR	OESTE
Bvar. Artigas	Hospital Pereira Rosell	-34,898478	-56,164359
Acevedo Diaz	Brandsen y Ana Monterroso de Lavalleja	-34,899525	-56,166923
18 de Julio	Arenal Grande y Fernández Crespo	-34,901166	-56,174449
Arenal Grande	Uruguay y Paysandú	-34,898263	-56,176788
Brandsen	Joaquín Requena y Juan Paullier	-34,899776	-56,168935
Chaná	Joaquín de Salterain y Joaquín Requena	-34,904088	-56,169492
Rivera	Acevedo Diaz y Juan Paullier	-34,902011	-56,167218
Patria	Itapua y Ibiray	-34,917289	-56,164799

Table 3 shows the detailed conditions that motivated the choice of these points. An attempt was made to include in the selection as many variables as possible to cover all the aspects chosen. An important aspect was the type of pavement because of its incidence,

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together with the type of vehicle involved, on the average sound pressure level.
The chosen point indicates, in each case, the location of the fixed sound level meter and then movements are made around that location and in different modes of transport carrying the dosimeters. We have: 1 Class 1 sound level meter (Bruel - Kjaer 2250) (Figure 3), 6 Class 2 dosimeters Pulsar Noisepen Model 26 (Figure 1), 1 Zoom H1 recorder, Quest and Casella calibrators (Figure 2), and 1 Zoom H1 recorder (Figure 1).

Table 3. Elements considered at each sampling point.

PUNTO	UBICACIÓN	BUSES	MANOS	ESTADO DE LA VIA	TRANSITO	EDIFICIOS	CANTERO CENTRAL	SEMAFOROS	TIPO PAVIMENTO
Bvar. Artigas	Hospital Pereira Rosell	Si	2	Bueno	Alto	Alto	Si	Si	Asfalto
Acevedo Diaz	Brandsen y Ana Monterroso de Lavalleja	No	1	Bueno	Bajo	Alto	No	No	Hormigon
18 de Julio	Arenal Grande y Fernández Crespo	Si	2	Bueno	Alto	Bajo	No	Si	Asfalto
Arenal Grande	Uruguay y Paysandú	Si	1	Regular	Alto	Alto	No	Si	Hormigon
Brandsen	Joaquín Requena y Juan Paullier	No	1	Regular	Bajo	Bajo	No	Si	Hormigon
Chaná	Joaquín de Salterain y Joaquín Requena	No	1	Regular	Bajo	Alto	No	No	Hormigon
Rivera	Acevedo Diaz y Juan Paullier	Si	1	Bueno	Alto	Alto	No	Si	Asfalto
Patria	Itapua y Ibiray	No	2	Bueno	Bajo	Bajo	No	No	Hormigon

SONOMETER BRUEL & KJAER 2250	DOSIMETER NOISEPEN
	

Figure 1. Equipment used

3.2 Characteristics of the measurement campaign

Several measurement campaigns were carried out with some differences between them due to the work methodology adjustments that were adopted before each measurement. Two campaigns will be analyzed below. For these campaigns the sampling points chosen are located in:

– Avda. 18 de Julio entre Tristán Narvaja y Martín C. Martínez
– Julio Herrera y Reissig entre Benito Nardone y José H. Figueira

In both cases, a fixed sound level meter and a mobile dosimeter were used, varying between modes of transport. On Avenida 18 de Julio: pedestrian, bus passenger, cyclist, skateboarder, car passenger, and in the case of Julio Herrera y Reissig only pedestrian and bus passenger.

4. RESULTS OF THE CAMPAIGN

In the measurement campaigns, in addition to recording the values in a sound level meter and dosimeter, vehicle counts were performed. Noise models are generally based on traffic composition. As an example, in the campaign on 18 de Julio Avenue, vehicle counts were taken at the fixed sound level meter station, resulting in the hourly average shown in Table 4.

Spectra were obtained in thirds of octave bands related to the characteristics of the interior of the bus and of the traffic lanes. The spectrum of Avda. 18 de Julio is compared with that of Julio Herrera y Reissig street (secondary street with bus presence) as shown in Figure 2.
It can be seen that the spectra for the traffic routes are similar with the difference that in J. H y Reissig there are higher components at 8000 and 10000 Hz. The energy levels in 18 de Julio are higher than those of J. H y Reissig street. Higher energy levels are seen in the bus in general. Low frequency components are seen in the vicinity of 25 Hz and high frequency components between 6300 and 16000 Hz, as the main difference from the open space measurement on the busways.
The record of all values for sound level meter and dosimeter are shown in Figure 3.
It is clearly seen that the sound level meter registers a wider range than the dosimeters that have their registers from 65 dBA. There is a valley in the dosimeter measurements, which corresponds to the period when the dosimeter was inside the car.
Figure 4 shows the interior of a bus and how the dosimeter is placed on the bus passenger.
In the case of the skateboard (Figure 5), we see that the values recorded in the dosimeter are higher than

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those recorded in the sound level meter. This is repeated in general for all modes of transport.
The stabilization time (Figure 6) of sound level meter measurements is less than required by the dosimeter. The dosimeter stabilizes in twice the time required by the sound level meter.

Table 4. Traffic count on 18 de Julio (vehicles per hour)

VEHICLE COUNT Average vehicles per hour - Avda. 18 de Julio						
CARS	BUSES	TRUCKS	MOTORCYCLES	UTILITIES	OTHER (BICYCLES, SKATEBOATS, ETC)	TOTAL
651	97	6	64	34	86	938

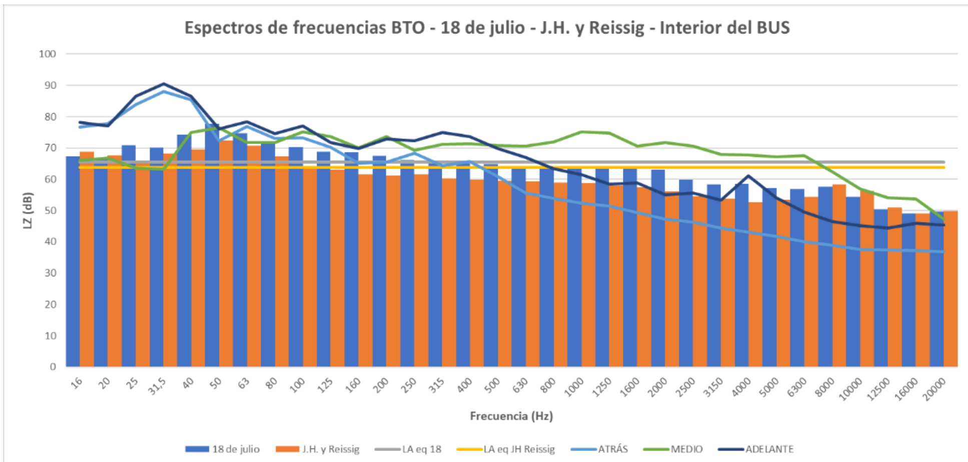

Figure 2. Frequency spectra Avda. 18 de Julio (blue bars) - Calle J. H. y Resissig (orange bars) and inside the Bus (blue-green and cyan lines).

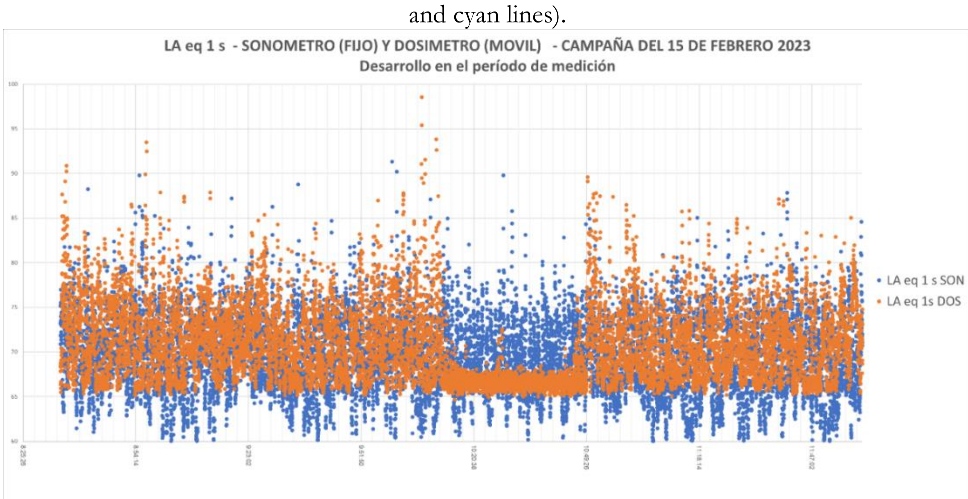

Figure 3. Values recorded in dosimeter and sound level meter. $L_{A,1s}$ (dB)

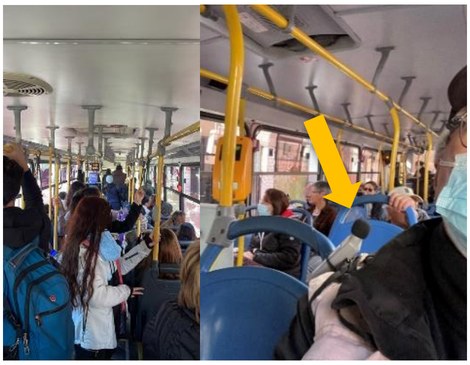

Figure 4. Passengers in Montevideo's public transportation system. Dosimeter in place.

This difference in stabilization time could be explained by the difference between the static condition for the sound level meter (sound level meter placed at a fixed point) and the dynamic condition of the dosimeter (dosimeter attached to a moving pedestrian, a passenger of a moving mode of transport or a moving driver).
Other conditions that could influence stabilization are the construction and internal operating conditions of each equipment.

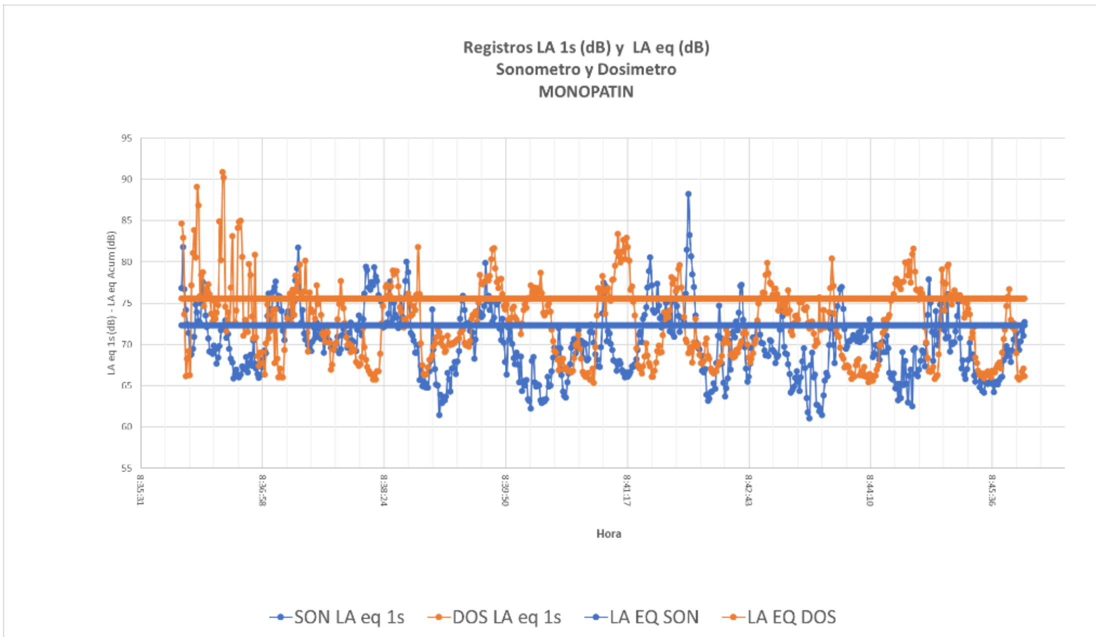

Figure 5. Values recorded on dosimeter (orange) and sound level meter (blue) - Skateboard – $L_{A\,1s}$ (dB) and L_{AEq} (dB)

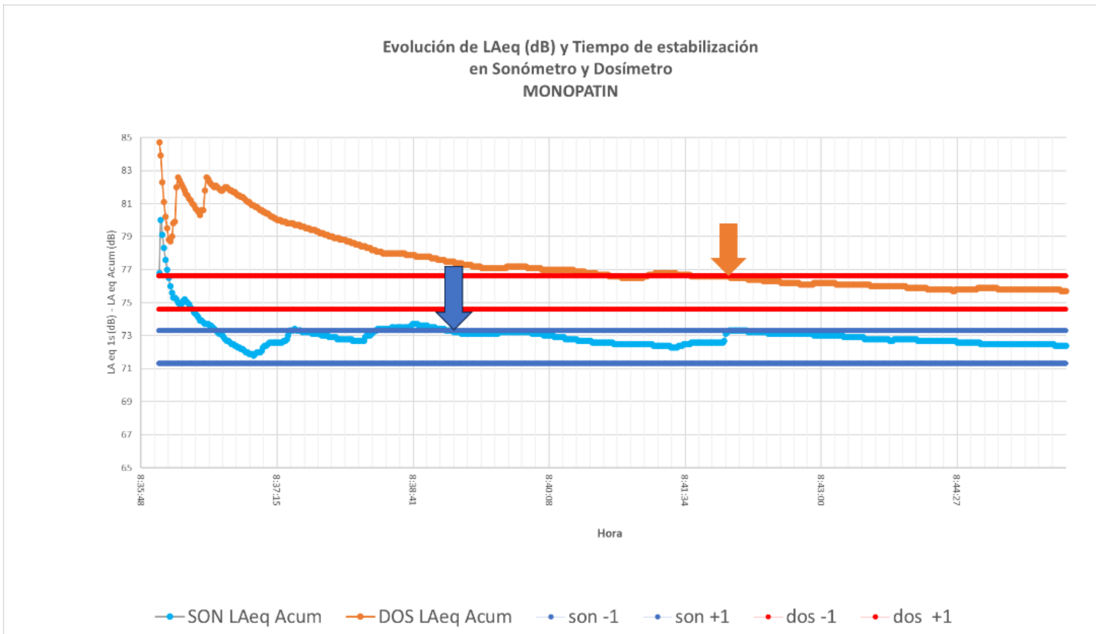

Figure 6. Evolution of $L_{A\,eq}$ in dosimeter (orange) and sound level meter (blue) - Arrows indicate stabilization times - Skateboard – L_{AEq} (dB).

4.1 Use of the University of Elche model

A comparison was made between the values measured in the field and those obtained from the University of Elche model (Figure 7). The resulting values of the model are in a band of +/- 2 dB with respect to the values measured in the field, which is considered acceptable for noise maps oriented to environmental management (The accuracy for legislated models is +/- 3 dB).

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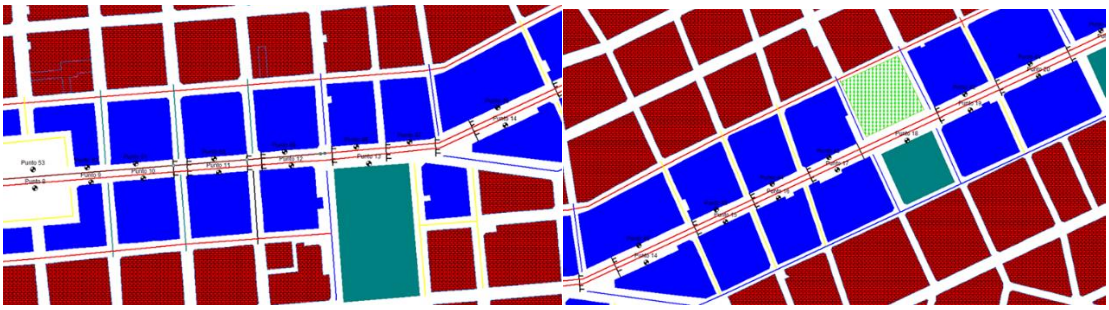

COMPARISON OF VALUES VALUES OBTAINED FROM MODEL - MEASURED VALUES (LAeq (dB))			
South Sidewalk	Obtained from model		72,3
	measured value		70,3
	+/- 2dB of measured value	68,3	72,3
North Sidewalk	Obtained from model		72,4
	measured value		74,1
	+/- 2dB of measured value	72,1	76,1

Figure 7. Use of the University of Elche model. Measured and modeled values.

The model of the University of Elche, calibrated with field data, allows obtaining, in different traffic conditions, the values of $L_{A,\,eq}$ at different points of the road and at different heights. Knowing the demographic data of the area, this model allows to obtain the level of noise impact on the population.

4.2 Dose calculation

In this work, one of the research questions is related to the incidence of noise pollution on pedestrians or due to the use of different modes of transportation. For this purpose, a first approach is made by calculating the environmental doses in each case.

The calculation of environmental doses (Table 5) was made for each section measured in each mode of transport. It was compared in all cases against the values inferred from the $L_{A\ eq}$ records of the sound level meter.

These results were calculated for each road measurement section.

Table 5. Results calculated by section and modes of transport, 18 de Julio.

MEDIO	HORA INICIO	HORA FIN	TOTAL	LAeq SON	LA eq DOS	DOSIS AMBIENTAL DA SONOMETRO	DOSIS AMBIENTAL DA DOSIMETRO
MONOPATIN	8:36:00	8:45:59	0:09:59	72,3	75,6	2,1	4,9
	10:00:00	10:09:59	0:09:59	72,5	76,6	0,9	8,2
BICICLETA	8:51:00	8:58:59	0:07:59	73,0	75,7	0,4	4,2
	10:52:00	10:58:59	0:06:59	71,6	74,3	0,1	1,7
AUTO	10:43:00	10:50:59	0:07:59	72,4	73,7	0,2	1,7
BUS PASAJERO	9:05:00	9:06:59	0:01:59	71,0	74,9	0,1	0,8
	9:09:00	9:10:59	0:01:59	71,4	72,6	0,0	0,5
	9:20:00	9:21:59	0:01:59	72,2	71,7	0,0	0,3
	9:24:00	9:25:59	0:01:59	70,8	74,3	0,0	0,7
	11:06:00	11:07:59	0:01:59	71,3	74,2	0,0	0,3
	11:40:00	11:41:59	0:01:59	74,8	74,6	0,1	1,7
	11:46:00	11:47:59	0:01:59	70,8	71,9	0,1	1,7
	11:51:00	11:53:59	0:02:59	68,8	71,3	0,1	1,7
	11:56:00	11:56:59	0:00:59	73,9	70,6	0,0	0,1
PEATON	8:59:00	9:04:59	0:05:59	71,1	73,7	0,1	1,9
	9:07:00	9:08:59	0:01:59	73,1	72,1	0,0	0,4
	9:11:00	9:19:59	0:08:59	72,0	73,3	0,0	2,5
	9:22:00	9:23:59	0:01:59	74,4	74,5	0,0	0,7
	9:26:00	9:52:59	0:26:59	71,6	73,0	0,2	6,6
	11:08:00	11:34:59	0:26:59	71,2	72,6	0,2	5,9
	11:42:00	11:45:59	0:03:59	72,4	72,2	0,1	1,7
	11:48:00	11:50:59	0:02:59	70,5	71,1	0,1	1,7
	11:54:00	11:55:59	0:01:59	71,8	74,8	0,1	1,7
	11:57:00	12:02:06	0:05:06	72,7	76,0	0,2	3,0

In all cases it can be seen that the ambient dose values are, in general, higher for dosimeters than for sound level meters. Graphically the data set is shown in the following figure (Figure 8):

Analyzing each mode and the period corresponding to the measured section, we have environmental dose values (Figure 9) obtained for both the sound level meter (blue) and the dosimeter (orange).

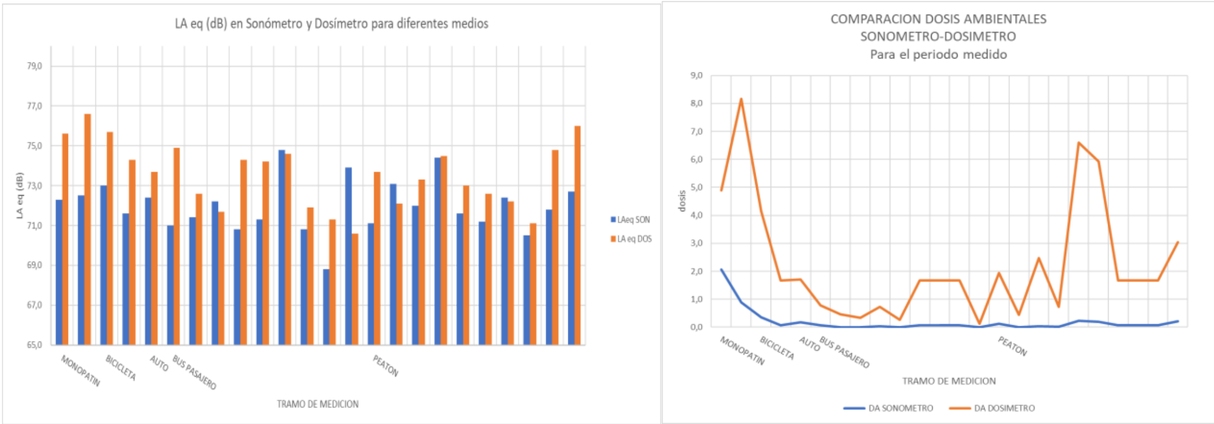

Figure 8. L_{Aeq} (izq.) and dose (der.) per section and per mode of transport (sound level meter (blue); dosimeter (orange))

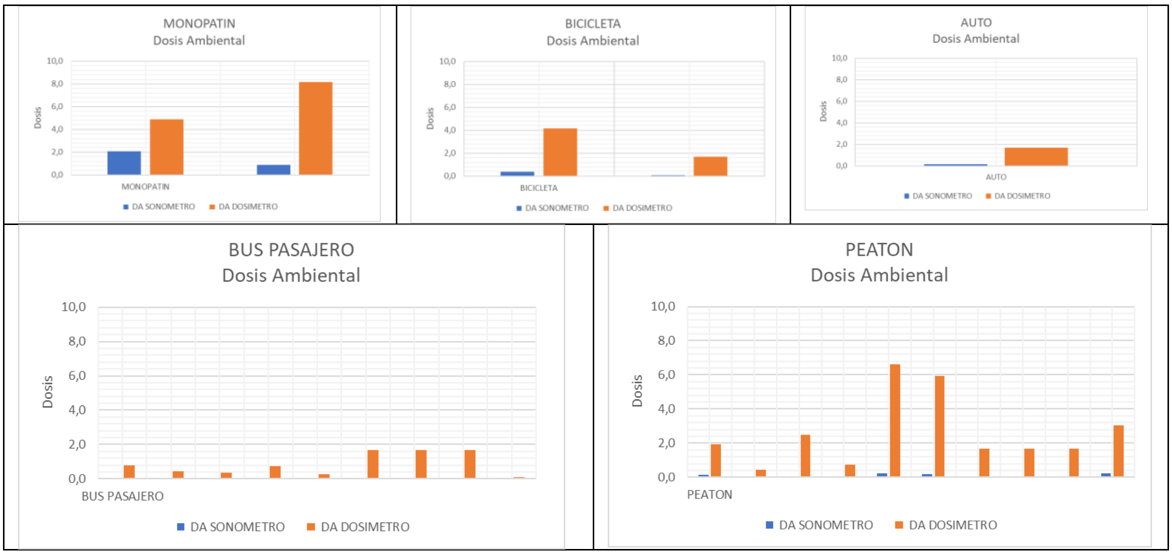

Figure 9. Calculated doses for each medium and in each recorded section.

At first glance, the highest doses are received by the skateboard user and the pedestrian. It can be seen that the maximum dose values for the car's and the bus passenger are similar. These graphs show differences between the different modes of transportation, but they are not comparable.

5 COMPARISONS BASED ON SEL

For data comparison, the SEL (IEC 61672-1:2013 standard) will be used, which allows us to be independent of the measurement time for the comparison of scenarios.

The sound exposure level (SEL, Figure 10) is an acoustic parameter that measures the total energy of a sound event, which allows a standardized comparison of noise events and the evaluation of their impact on the environment and human health.

The form of calculation (Equation 1) is taken from IEC 61672-1:2013, thus obtaining a standardization that allows comparison of results between different transportation modes.

$$SEL = L_{AE,T} = 10 * log\left[\frac{\int_{t_1}^{t_2} p_A{}^2(t)*dt}{p_0{}^2*T_0}\right] dB = 10 * log\left(\frac{E_{A,T}}{E_0}\right) dB = L_{A_{eq},T} + 10 * log\left(\frac{T}{T_0}\right) dB \quad (1)$$

Where

$E_{A,T}$ is la L_{AE} in the interval T

E_0= is the reference value given by $P_0{}^2 * T_0 = (20\ \mu Pa)^2 * (1s) = 400 * 10^{-12} P_a{}^2 * s$
T = is the time measurement interval in seconds starting at t_1 and ending in t_2
T_0 = is the reference value of 1 second of sound exposure level.

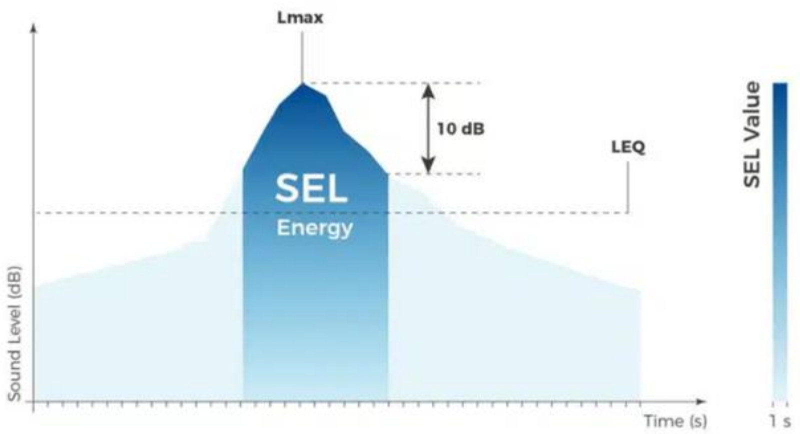

Figure 10. SEL representation (Taken from Svantek, s.f.)

The SEL values were calculated for pedestrians and for different modes of transport users, regardless of the measurement time used and based on the reference value of 1second used in the SEL.
It then turns out that (Figure 11):

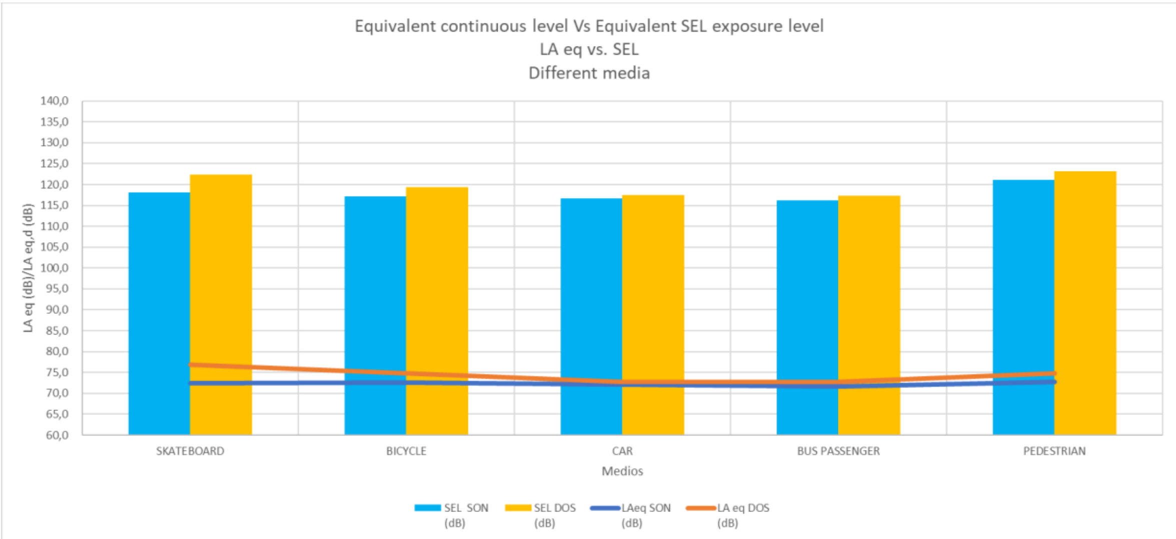

Figure 11. Comparación en equivalentes 1s – SEL de nivel continuo equivalente y SEL.

It can be seen that the highest equivalent continuous level value is for the pedestrian, with the skateboard in second place. The lowest value corresponds to the car passenger and the values for bicycle and bus passenger behave similarly.

5. CONCLUSIONS

Noise exposure measurement campaigns were carried out using Bruel-Kjaer 2250 type 1 sound level meter and Noisepen model 26 dosimeters. The campaigns included adjustments to the methodology and differences in its implementation according to the progress of the results.
The experiences showed a tendency to higher dose values obtained with dosimeters with respect to those calculated from the sound level meter. This tendency was not maintained in all cases, so it is concluded that it is necessary to carry out more measurement campaigns considering the anomalous aspects that can condition the results of the measurements, mainly in the behavior at a distance from the sound level meter station. Comparisons with the calibrated model of the noise map of Avenida 18 de Julio (DIA-IMFIA, 2020)

showed acceptable values for acoustic maps for environmental management purposes.

As a first conclusion, to be verified with more results, it is understood that noise maps constructed with sound level meter values are not always representative of the exposure values of the population. More campaigns should be carried out to consolidate this statement. Based on these first results, the possibility remains open to consider the construction of maps based on values obtained with dosimeters, with a greater number of values obtained and considering the possibility of their implementation based on collaborative systems for the creation of information with cross-checks that guarantee the quality of the data.

In response to the research questions we ask ourselves, we can say that:

– How are the directly measured received dose and the dose inferred from an environmental measurement similar?

The differences arising from the comparison of results suggest that the measured doses are higher than those inferred from environmental measurements.

– Is $L_{Aeq,1\ hour}$ useful to describe these doses, or can other measurement intervals be used?

It has been seen in this first analysis that $L_{A\ eq}$ stabilization values in sound level meters occur at intervals of less than 1 hour, but not in dosimeters. The current data make it prudent to maintain the 1-hour period until another measurement interval is solidly established.

– How much does the mode of transport affect the dose received?

The results obtained so far show that the mode of transport has an impact on people's exposure to noise.

– Are the Noise Maps representative of the level of exposure of people?

Doubts remain about this representativeness. From the results so far obtained it can be thought that the selection of points to develop a noise map locates only in proximity to traffic routes may not be representative of the level of exposure of people to noise. Consideration should be given to the presence of other sources and the possibility of dynamic updating of such noise maps if there are changes in sound generating sources or sound pressure levels or other reason why such updating is deemed desirable. Consideration of the use of participatory mapping with appropriate cross-referencing to ensure data quality is one of the current trends to achieve this.

All the work is integrated to the need to raise awareness about the relationship between exposure to noise (environmental noise pollution) and health to motivate the generation of better living conditions and to keep in mind that the main source of acoustic energy associated with environmental noise pollution is due to the exposure of people to noise coming from the transportation system. The model of the University of Elche has the potential to determine the level of noise affectation of the population included in the study area in the city of Montevideo.

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