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NOISE CONTROL FOR A BETTER ENVIRONMENT

Evaluation of environmental noise in Mexico City – Previous initiatives and proposal for future improvement

Chagoya, Servando[1]
Ramírez, Alexandra[2]
ITESM, Mexico City Campus
Calle del Puente 222, Mexico City

ABSTRACT

Mexico City is one of the largest cities in Latin America and the world, with over 9 million inhabitants and, according to the WHO, it is also one of the most polluted cities. Although many policies and plans have been implemented with considerably satisfying results, noise pollution remains a problem with little to no attention. There have recently been private and public initiatives to improve people's awareness towards noise and its adverse health effects, with no success; furthermore, the lack of information together with high noise levels in streets, public transportation and even work centres, have led to a generalized insensitivity, resulting in noise regulations of the city not being under strict observation.

This study seeks to update and improve environmental noise measurements, according to the ISO 1996-1:2006, to evaluate the current noise pollution conditions in the city, as well as to compare the applicable regulations to the ones from different cities in the world, in order to evaluate their strategies for noise control. Finally, it looks to identify both achievements and flaws of previous initiatives to develop a feasible proposal for the incoming city government to implement.

Keywords: Noise, Environment, Urban planning
I-INCE Classification of Subject Number: 60

1. INTRODUCTION

Noise pollution nowadays is an increasing field of study and an area of interest for specialists around the world; however, in Mexico there's almost no awareness about the problem. Although some scarce initiatives for both, the evaluation of environmental noise and the spread of information among citizens have been fostered, they turn out to be either insufficient or misleading, sometimes being even inadequate, not providing accurate information. Furthermore, these initiatives are irregular, and they are not supported by any public or private organization, in order to implement the proposed solutions.

[1] servando.acs@gmail.com
[2] a01332509@itesm.com

It is of great importance to update both data and information regarding noise levels in the city, as well as to review the current methods of evaluation and the regulations, in order to achieve better results when spreading information regarding the problem of noise pollution, together with the psychophysiological effects of it in humans, and the most vulnerable population.

2. BACKGROUND

An important part of the investigation is to evaluate what has already been done in the city as a way to reduce noise levels and to raise awareness among the population. Furthermore, regulations for the maximum permitted street level in either daytime and night-time are intended to be reviewed and discussed, as well as compared to the ones form different cities around the world for more strict observation of the authorities.

2.1 Noise pollution in Mexico City: state of the art

As of January 2011, the Metropolitan Autonomous University, together with the Metropolitan Environmental Commission, Mexico's City government and the Mexico City Ministry for the Environment developed the first noise map for the Valley of Mexico Metropolitan Area (hereinafter ZMVM, so called after its Spanish initials). This study served as a milestone for the field of environmental acoustics, and noise as an important pollutant, although focused mainly on the noise on the city's roads (1).

However, as mentioned above, the study focused on the emission of noise caused by vehicular traffic on the streets of the city (1). Thus, it is very important to highlight that there are many more sources of contamination that were not taken into account within the discussion, and that represent direct sources of pollution for pedestrians, being even more preventable and manageable in a public initiative for the improvement of the current status of noise levels. This, without a doubt, is relevant data on the different factors that lead to high levels of noise on pavements and that ought to be considered when addressing environmental noise.

On the other hand, there is a private initiative called #RuidoCDMX, which seeks to incentivise awareness among the population of the capital about the adverse effects of prolonged exposure to high levels of noise, through testimonies and real time measurements of some noisy spots of the city, displaying the data in a graphical and easy-to-understand manner. Additionally, it also seeks to promote the use of technology in the implementation of initiatives that collect information and generate data for the sake of the city. Finally, with regard to noise pollution, according to #RuidoCDMX webpage, most of the complaints that are reported are primarily caused by high noise levels (2). It is striking how population has a vague notion of the implications of noise and that it generates a concrete annoyance but does not know what originates it and how it can be prevented. That is why it is important to start sharing accurate information for the mitigation of unnecessary noise sources and the achievement of better noise levels.

2.2 Mexico City's regulations regarding noise

Nowadays, according to the Mexico City's Environmental Regulation, the maximum permissible limits of sound emissions are 65 decibels during daytime and 62 during the night-time (3). However, noise emission is just considered a mild administrative fault, whose penalty ranges from 10 to 40 minimum wages (between 800 and 3,200 Mexican Pesos approximately or 40 to 160 US Dollars) or arrests of up to 24 hours.

Within the United States of America, when comparing the largest 500 cities in the country there are huge discrepancies regarding regulations for noise control and noise pollution, as well as the corresponding sanctions, ranging from a simple verbal sanction or a $ 10 fine, to one year in prison or fines of 53,000USD for holding a noisy party (4). On the other hand, as for the classification of noise as a fault, it is mostly considered *"without classification",* while some states consider it a crime and some others a civil fault; this is important, since it is from the classification of the fault that the sanctions are determined.

Other countries, mainly in Europe, have strict regulations for different noise sources. For example, in the Netherlands, for the emission of noise by vehicular traffic there are strict standards, also for all the new road infrastructure and in maintenance. In Germany there are regulations for all noise related to public places and entertainment areas such as clubs, discos or any place that emits noise as part of their activities, in which there must be a minimum isolation factor of 72 dB SPL. In Sweden there are also standards for the emission of noise in this type of sites, where a level of 25 dB or higher is considered annoying (5). In Belgium and Denmark there are regulations for the selection and preservation of so-called quiet areas, as in Lyon, France, where noise maps are made to determine where it is most appropriate to locate these areas (5).

2.3 Noise pollution

According to a study carried out at Harvard University, by Dr. Orfeu Buxton, brain activity was detected under different environments with noise. The brain activities of different healthy volunteers were monitored, and a 10-second clip of these environments was reproduced while they slept. These environments included talks, phones ringing, doors opening and closing, machinery, bathrooms, vehicular traffic, among others. He found it quite interesting to find that the brain waves of the volunteers manifested as if they were awake and disturbed (6).

Not only are sleep disturbances a problem caused by noise, but also several other more complex, related to long term exposure to high noise levels. There is research indicating correlation between noise exposure and heart disease's, stress, depression, and even cognitive impairment.

3. METHODOLOGY

The methodology for this research was divided into two main parts: evaluation of environmental noise of some busy spots in the city and the discussion of the previous proposals and initiatives for a better auditory culture in the city.

3.1 Noise measurements

In order to show the noise levels in the city, in different social environments. It is important to address, that the measurement locations/spots were chosen due to the affluence of people, so they could better represent the noise levels to which most of the population are exposed during their daily routines.

For the evaluation of environmental noise, an IEC/ANSI type 2 free-field transducer was used. Measurements were taken at a height of 1.5 metres through the Real Time Analyser of the AudioTools iOS software for 5 minutes straight in each spot. Decay time was set to *average*, and both maximum and minimum levels were also measured, in order to stablish a better comparison. Finally, measurements were carried out using octave bands suggested by ISO 266, also to present the results.

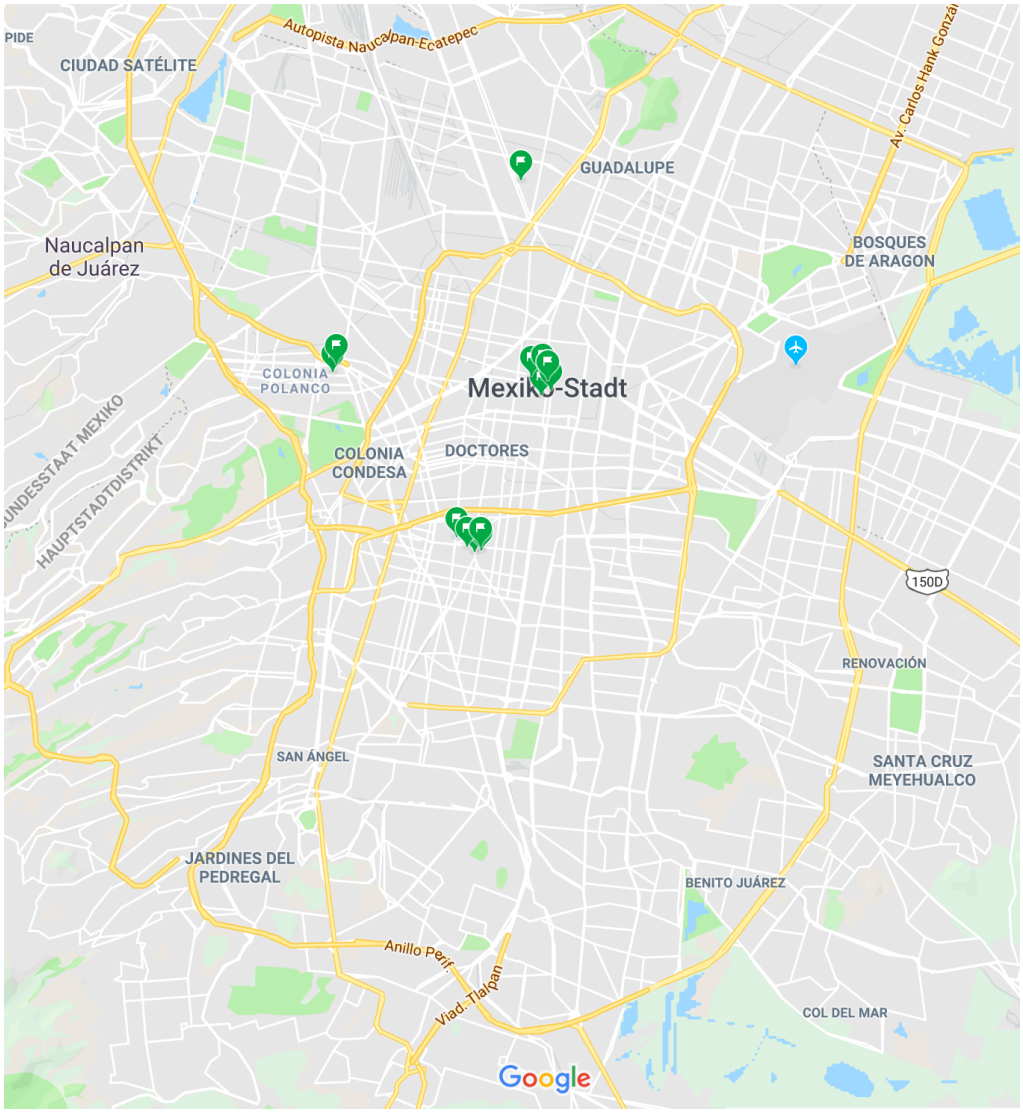

Fig.1 - Mexico City map displaying measurement spots

(1) 19.433,-99.134

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	44.20	62.30	31.30
63	55.70	76.30	45.60
125	68.10	80.90	60.50
250	76.30	88.20	69.50
500	86.80	108.60	76.50
1K	86.50	109.50	76.00
2K	82.70	102.70	72.90
4K	72.60	94.10	65.90
8K	55.50	77.50	47.30
16K	40.20	58.40	29.20
OV	93.4		

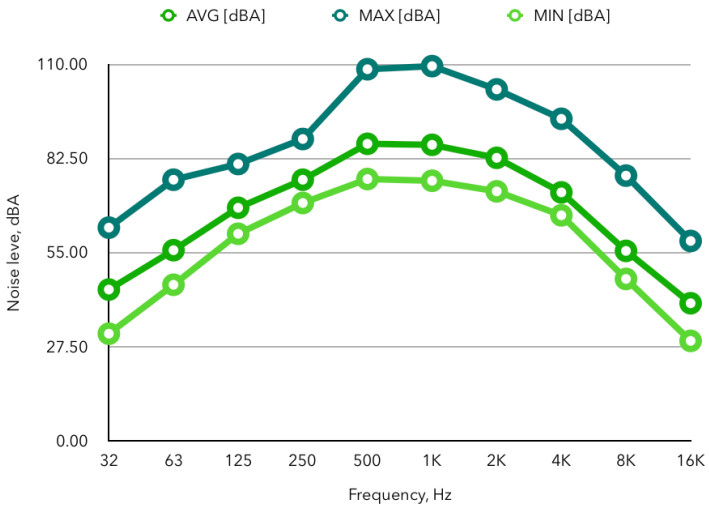

Fig. 2 – table and graph of measurements in the downtown area

(2) 19.429,-99.135

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	47.50	67.20	28.40
63	65.10	75.90	47.10
125	77.10	90.30	59.30
250	78.50	93.80	66.40
500	84.00	101.60	71.60
1K	84.30	100.20	70.90
2K	81.30	95.40	68.60
4K	73.80	86.10	59.60
8K	57.30	84.00	42.10
16K	43.70	84.30	23.60
OV	90.7		

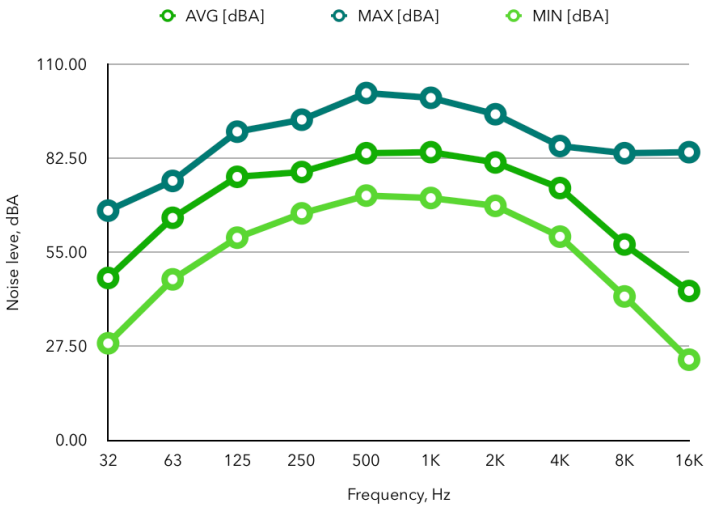

Fig. 3 – table and graph of measurements in the downtown area

(3) 19.434,-99.137

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	44.50	52.30	34.60
63	70.20	72.70	56.30
125	79.70	85.50	71.30
250	87.10	95.00	79.70
500	91.40	97.90	83.20
1K	89.50	94.40	81.30
2K	85.40	89.60	76.50
4K	78.50	83.30	69.40
8K	65.50	71.20	53.10
16K	43.10	52.00	32.30
OV	96		

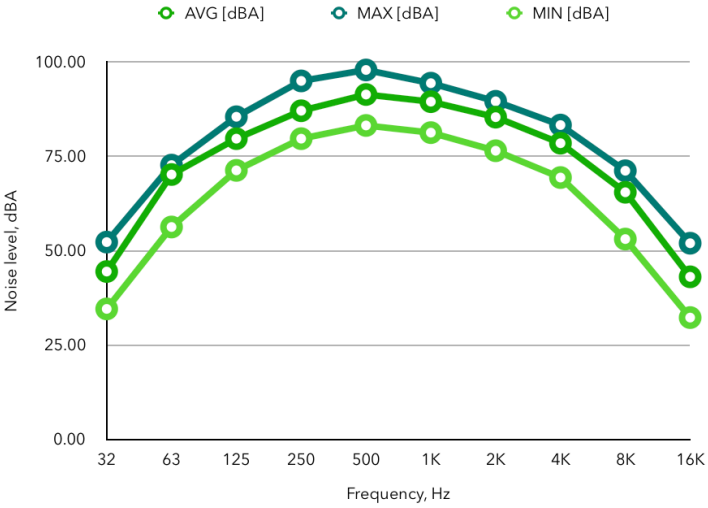

Fig. 4 – table and graph of measurements in the downtown area

(4) 19.433,-99.133

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	45.50	63.30	29.60
63	57.20	72.10	45.40
125	73.70	83.00	61.40
250	78.90	87.00	69.80
500	74.40	87.40	68.30
1K	74.10	96.40	66.20
2K	70.80	93.10	62.70
4K	60.70	83.50	51.30
8K	44.40	73.40	35.10
16K	28.50	58.00	22.00
OV	83		

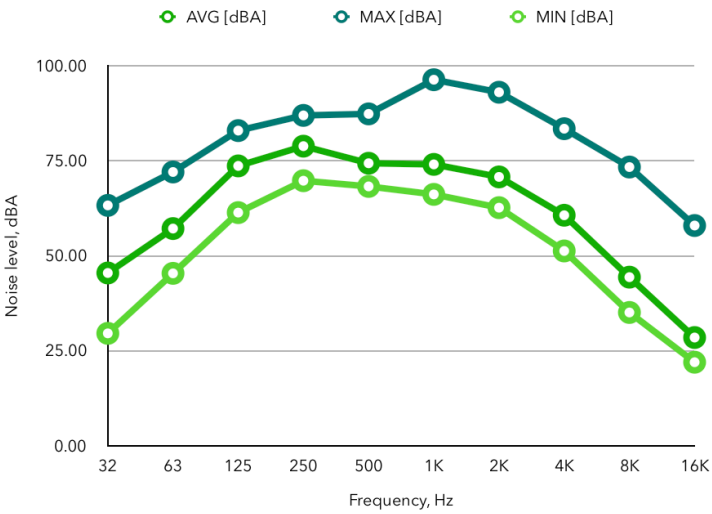

Fig. 5 – table and graph of measurements in the downtown area

(5) 19.43-99.132

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	45.40	53.10	33.40
63	65.90	76.50	52.90
125	78.20	87.90	68.90
250	85.50	101.20	73.30
500	87.90	98.90	73.50
1K	86.90	97.50	75.90
2K	86.90	99.00	74.20
4K	85.10	95.20	73.10
8K	69.20	81.60	57.70
16K	44.60	57.90	33.10
OV	95.5		

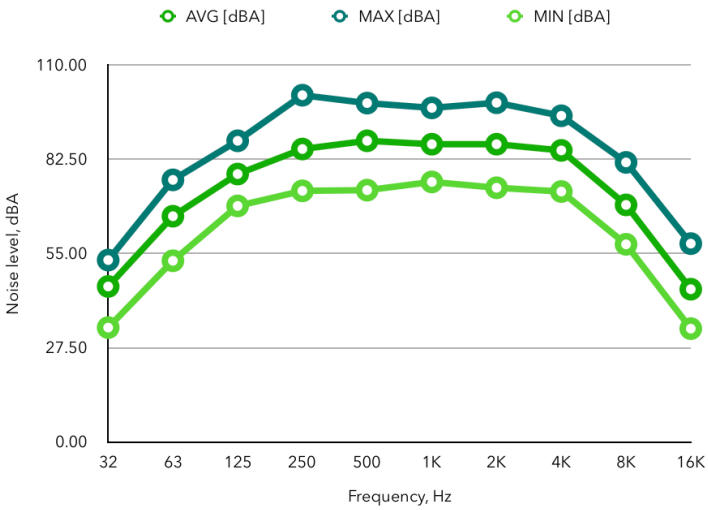

Fig. 6 – table and graph of measurements in the downtown area

(6) 19.396,-99.156

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	51.20	68.50	36.60
63	66.00	81.40	52.60
125	72.90	94.80	61.20
250	77.50	91.70	65.30
500	79.20	92.60	68.30
1K	79.90	101.30	69.70
2K	76.20	94.60	66.20
4K	69.40	94.70	56.30
8K	54.90	81.70	40.80
16K	39.10	68.40	23.00
OV	86.6		

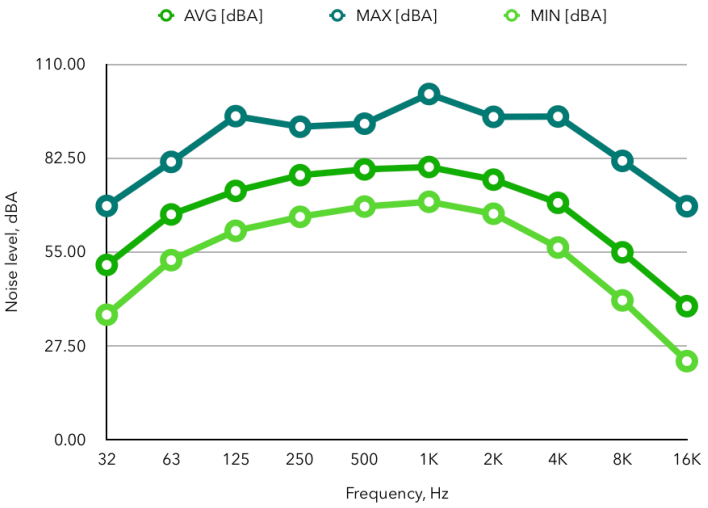

Fig. 7 – table and graph of measurements in a middle-upper class residential area

(7) 19.394,-99.15

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	46.10	67.00	29.20
63	60.20	77.00	45.30
125	65.80	85.10	50.70
250	71.00	93.10	55.00
500	73.70	91.40	55.30
1K	75.20	99.50	56.50
2K	71.10	94.50	51.60
4K	62.60	86.00	41.50
8K	46.70	71.00	27.60
16K	30.10	58.00	20.40
OV	82.2		

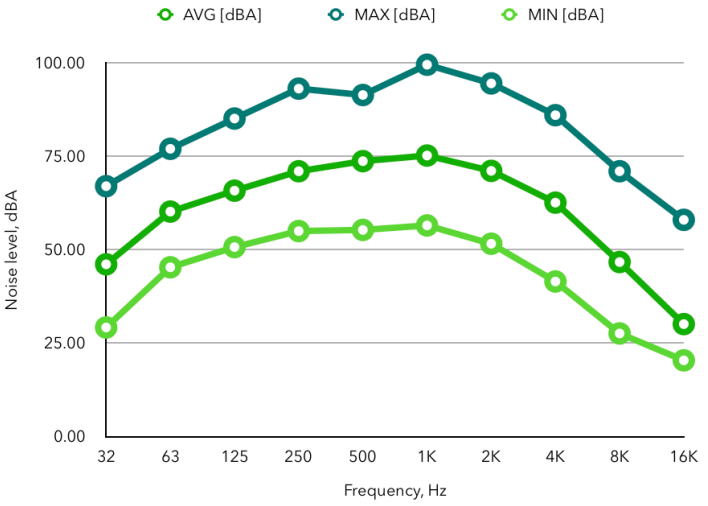

Fig. 8 – table and graph of measurements in a middle-upper class residential area

(8) 19.393,-99.151

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	51.70	66.40	35.40
63	67.00	84.30	48.80
125	74.20	91.80	60.90
250	76.00	94.30	62.90
500	77.20	92.10	67.40
1K	79.20	101.10	70.10
2K	76.50	98.40	66.30
4K	69.10	94.70	56.60
8K	54.20	77.50	38.50
16K	43.80	82.70	22.20
OV	86.2		

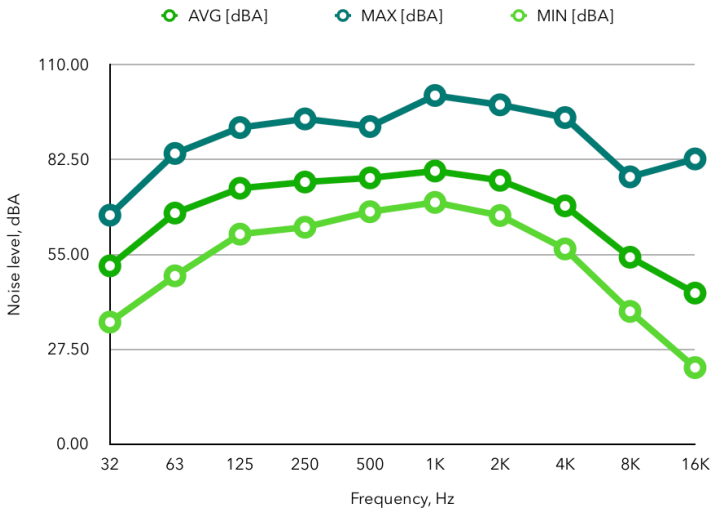

Fig. 9 – table and graph of measurements in a middle-upper class residential area

(9) 19.433,-99.133

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	48.60	60.60	30.60
63	62.70	77.90	47.60
125	69.40	83.70	53.10
250	71.40	85.30	58.30
500	73.30	86.40	62.70
1K	73.90	86.10	61.90
2K	70.40	87.90	59.60
4K	63.00	78.10	52.30
8K	52.70	94.00	36.10
16K	36.20	77.20	21.60
OV	81		

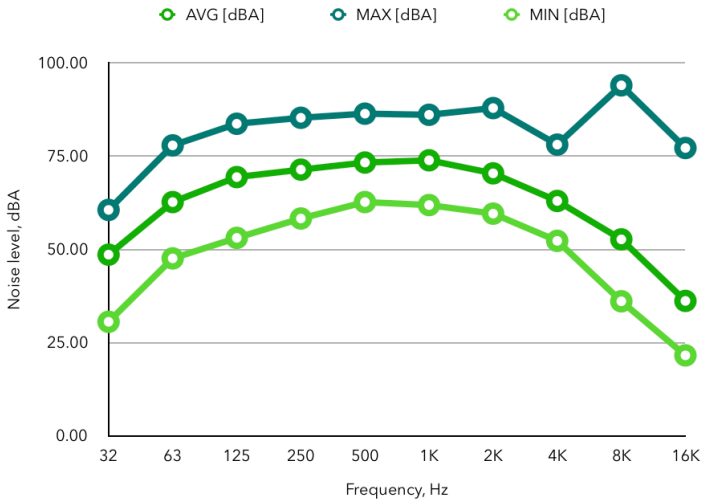

Fig. 10 – table and graph of measurements in a middle-upper class residential area

19.395,-99.15

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	48.20	66.80	28.00
63	63.10	80.00	42.60
125	70.70	90.50	50.90
250	76.10	97.80	55.00
500	78.20	100.50	58.10
1K	79.00	94.50	60.00
2K	75.70	97.10	55.80
4K	68.20	97.20	45.30
8K	51.30	73.00	31.00
16K	34.70	72.10	21.20
OV	86		

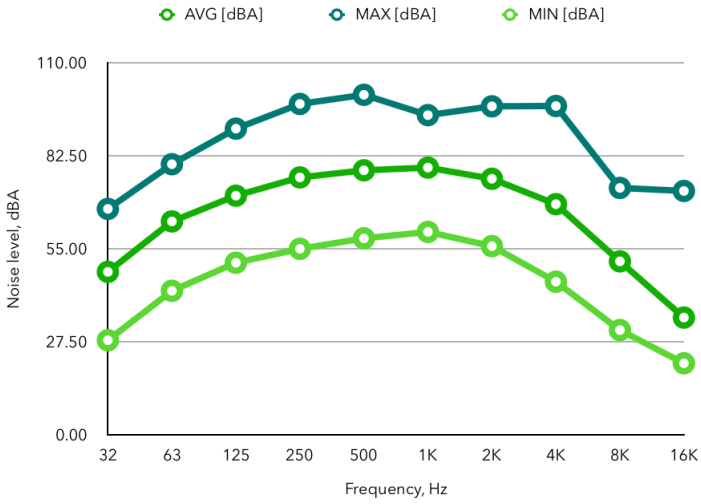

Fig. 11 – table and graph of measurements in a middle-upper class residential area

(10) 19.435,-99.186

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	46.30	68.10	30.10
63	58.60	75.20	45.20
125	65.50	84.70	52.90
250	68.90	91.90	57.30
500	71.60	90.70	60.10
1K	73.40	92.80	62.80
2K	71.20	91.60	60.80
4K	64.00	90.10	50.90
8K	49.60	83.60	33.30
16K	36.80	70.30	20.90
OV	80.5		

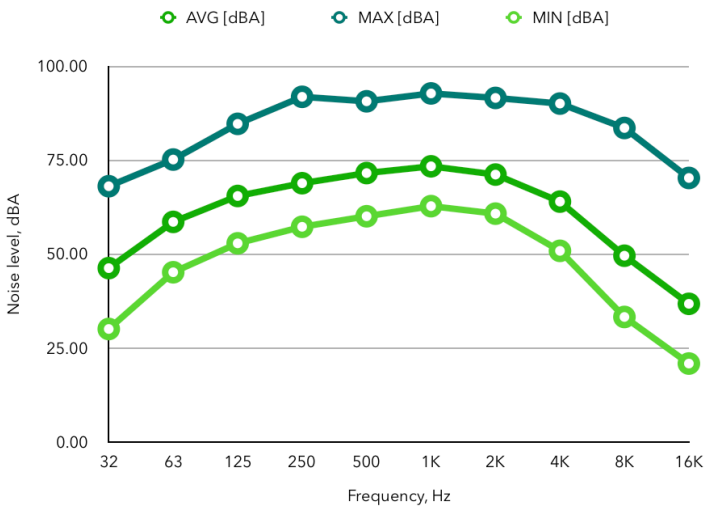

Fig. 12 – table and graph of measurements in an upper-class residential area

(11) 19.435,-99.188

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	48.00	59.50	29.70
63	61.30	77.30	44.80
125	68.10	87.00	53.50
250	72.20	90.30	60.60
500	71.60	82.70	61.30
1K	76.50	101.40	64.30
2K	74.80	100.50	61.20
4K	66.60	86.10	53.00
8K	52.30	75.50	35.20
16K	40.30	84.50	21.30
OV	84.5		

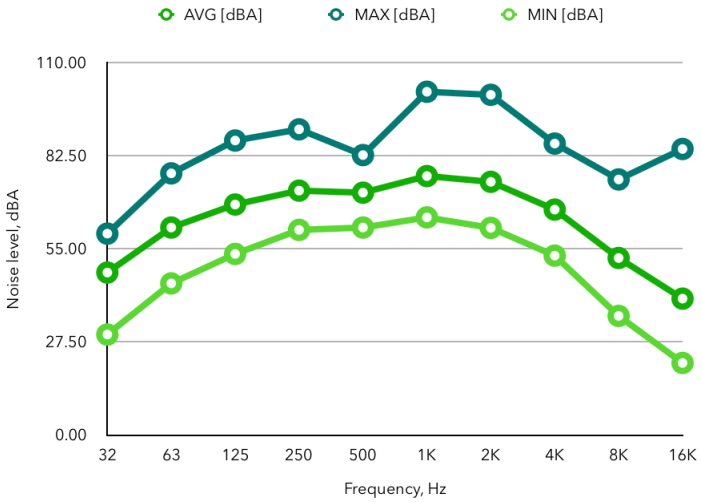

Fig. 13 – table and graph of measurements in an upper-class residential area

(12) 19.434,-99.137

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	43.60	62.70	26.90
63	55.20	77.40	41.80
125	62.00	87.50	50.00
250	63.50	87.40	53.20
500	67.00	93.80	56.80
1K	67.40	89.70	58.70
2K	65.70	89.70	54.50
4K	60.40	87.80	45.20
8K	48.80	82.90	28.40
16K	35.60	72.10	20.50
OV	78.6		

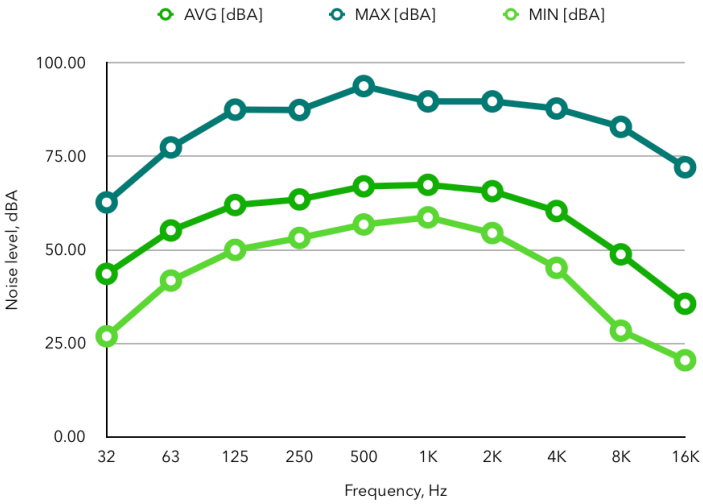

Fig. 14 – table and graph of measurements in an upper-class residential area

(13) 19.479,-99.14

f [Hz]	AVG [dBA]	MAX [dBA]	MIN [dBA]
32	49.10	63.50	34.60
63	63.60	74.70	49.80
125	69.10	79.50	58.10
250	71.00	82.60	60.00
500	72.40	87.30	64.60
1K	72.60	88.20	66.30
2K	70.30	87.90	63.00
4K	63.00	87.00	53.70
8K	47.10	65.10	37.50
16K	30.40	49.40	22.20
OV		79.2	

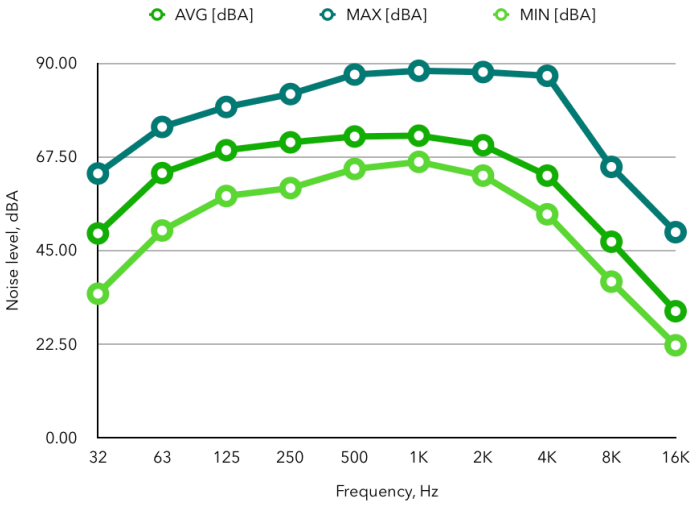

Fig. 15 – table and graph of measurements ouside a bus station

3.2 Discussion of previous proposals

As it was partly mentioned in the background section, previous research and initiatives carried out in the city were partly successful, since they began to open the debate about the topic among specialists but were less friendly with the general public. #RuidoCDMX was quite a better step toward information spreading, oriented to the public and, since acoustics is a subject of which almost no one knows about, it was really important to get to them with accessible and illustrative information regarding health and noise pollution.

However, there has not been complete participation of the authorities, resulting into a truncated path for the proposals to completely success. Both the proposals lack of some aspects to develop a complete and feasible implementation, and the authorities do not prioritize noise pollution as part of their agendas. The most prominent aspects of previous initiatives are on one hand, the rigorous methodology and reliability of the resulting data, and on the other, the aim of developing not only a documented research, but an accessible display of punctual information for people with little to no idea of acoustics and noise; these aspects must be fully integrated into one general and complete proposal for the authorities, so they support it and coordinate the collaboration with public and private parties, willing to improve current noise pollution conditions in Mexico City

4. DISCUSSION

Noise levels turned out to be extremely high, mainly in the downtown area, which reached 96 dB at street level in a commercial pathway. The higher background noise is, the noisier people tend to be, so it's understandable why in areas where restaurants and stores are part of a noisy soundscape, people start talking louder and even shouting, without even being aware that they're contributing to noise pollution.

In residential areas, narrow streets with a considerable flow of public transportation (which tends to be noisy) are a great problem, since sound level is increased by reflections and not only pedestrians are affected by noise, but also residents, because there are no requirements for acoustic insulation in buildings whatsoever. Furthermore, airplanes also are a problem. For some neighbourhoods, aircraft noise is an annoyance, due to the airport being located within the city and being the busiest of the country, air traffic is constant, resulting in incredibly high noise levels.

However, average noise levels in residential areas are closer to the minimum levels registered, although minimum are still high. On the other hand, in busier and

crowded places, average measurements tend to be closer to the maximum levels, being those even greater than 100 dBA in sensitive bands like 500Hz and 1KHz

5. CONCLUSIONS

Mexico City faces a serious problem regarding noise pollution. Even in residential areas, noise levels in the streets, with measurements that easily surpass 80 dBA, levels found most commonly in workshops and certain factories. However, it is not a completely impossible to solve problem. Most of it comes from cultural aspects, which can be certainly improved by presenting accurate information. A formal proposal for a campaign supporting a better acoustic culture in the city will be presented to the new administration of the government, working hand by hand for a better hand healthier soundcape.

6. ACKNOWLEDGEMENTS

A thank you to our professors and collaborators, who directly or indirectly made this research possible, always believing in us and giving their best to help us.

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