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One year of sound monitoring since July 2020 during COVID-19 pandemic at one neighborhood in Lima, Peru

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Abstract

In Lima City, it is not possible to know the sound levels previous to the COVID-19 because there is no governmental sound monitoring network. A private noise monitoring has been conducted since July 2020 at one neighborhood in this city, and, consequently, the changes in the soundscape produced by different sound levels that were a concern of the successive quarantines and lockdown due to COVID-19 have been registered. In the residential area under analysis, one of the noise sources comes from the circulation of cars and buses; the other one is produced by aircraft night overflights. The emergence of the virus new variants had forced the authorities to implement different social confinement orders prohibiting people's mobility; therefore, it was possible to measure the lowest possible sound levels ever. This paper analyzes in one neighborhood in Lima, Peru, the environmental sound levels since July 2020 during different periods due to the COVID-19.

Keywords: acoustics, sound monitoring, COVID-19, soundscape, aircraft noise, environmental sound levels, statistics.

Один год тщательного мониторинга с июля 2020 года во время пандемии COVID-19 в одном районе в Лиме, Перу

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Аннотация

В Лиме отсутствуют данные об уровнях звука до COVID-19, поскольку в городе отсутствует государственная сеть мониторинга звука. С июля 2020 года в одном из районов города проводится частный мониторинг шума. Были зарегистрированы изменения в звуковом ландшафте, которые были вызваны последовательными карантинами и блокировками из-за COVID-19. В анализируемом жилом районе один из источников шума исходит от движения автомобилей и автобусов; другой-от ночных полетов самолетов. Появление новых вариантов вируса вынудило власти ввести различные постановления о социальном ограничении, запрещающие мобильность людей; поэтому стало возможным измерить максимально низкий уровень шума, когда-либо существовавший. В этой статье анализируется уровень шума окружающей среды с июля 2020 года в одном районе Лимы, Перу в разные периоды COVID-19.

Ключевые слова: *акустика, мониторинг звука, COVID-19, звуковой ландшафт, авиационный шум, уровни шума окружающей среды, статистика.*

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Introduction

The emergence and rapid spread in 2020 of the SARS-CoV-2 (*Severe acute respiratory syndrome coronavirus 2*) around the world, and now in 2021 its new variants surprised everyone equally. As of July 28^{th}, 2021, unfortunately, Peru is at the top of the toll death worldwide per one million population (the US is at fifth place) [1] [2]; therefore, it is for this reason that health prevention policies are maintained throughout Peru, and specifically in Lima City there is a nighttime curfew, restriction of traffic on the streets in daytime, and a ban on circulation of private vehicles on Sundays, all of these to reduce and prevent the coronavirus spreading, which resulted in an overall reduction of the urban sound levels.

In 2020 the authorities of each country were forced to impose different public health measures to prevent contagions. The immediate international airports' shutdown was the first action taken, and to prevent the people movement to ensure their quarantine, the temporary closure of all nonessential activities and ban of vehicles circulation in streets disrupted traffic patterns; all of these were decisive for a radical change in the soundscape perception because the amount of background noise in cities has fallen substantially. It is now an emerging topic of paramount importance to register this unique soundscape motivated by an observable effect on urban sound levels.

The general lockdown around the world had a relevant impact on the cities' soundscape, associated with people's confinement and the closure of nonessential activities such as in-person education, leisure activities, tourism, etc. Worldwide acousticians had the opportunity to measure the atypical soundscape due to COVID-19-related sound levels reductions, and others have taken different initiatives to track the soundscape changes by means of questionnaires to citizens, perception, sound recordings, etc., to try and attain subjective data. Among dozens of articles about the sound levels decreasing due to COVID-19 lockdowns, it is possible to mention a few of them about: the noise from port in Ljubljana, Slovenia [3]; noise from music festival areas in Montreal, Canada [4]; aircraft noise in Lima, Peru [5]; in large cities of Italy [6] or Stockholm, Sweden [7]; global seismic noise [8]; in quiet residential areas in Tokyo, Japan [9]; and so on. Also, taxonomy and some method of sound levels evaluation for this unusual situation have been proposed from Spain by Ascencio et al. [10].

Because the present research does not have external funding, this article is limited to analyzing the soundscape changes at one neighborhood in Magdalena del Mar, one of the 43 Lima districts, produced by traffic noises during daytime and evening time and by airplane noises on night hours, from July 2020 to June 2021, and how the background environmental sound changed through the time span under analysis, accompanying the different phases of social confinement to prevent the virus dissemination.

1. Materials and methods

1.1. Defining the interval timewise to analyze the measurements by period

The soundscape analysis presented in this article covers four distinguishable selected timewise periods:

- Period 1: From July 1^{st} to October 31^{st}, 2020, COVID-19 first-wave partial reopening.
- Period 2: From November 1^{st} (when the Lima international airport was opened) to December 31^{st}, 2020.
- Period 3: From January 1^{st} to February 28^{th}, 2021, COVID-19 second-wave.
- Period 4: From March 1^{st} to June 30^{th}, 2021, flight restriction from Peru due to new variants and several partial closing/opening of nonessential activities.

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a complete analysis of the Lima soundscape registered before and during the first phase of the COVID-19 outbreak form March 1^{st} to June 30^{th}, 2020, which was published as an article in [3], but the location of the monitoring station since July 2020 onwards is different, therefore the results presented here cannot be directly compared with those.

1.2. Sound monitoring station location and description

The authors' office is in a neighborhood in Magdalena del Mar, one of Lima's City districts, and because of the surrounding urbanization is under the flight pass-by of airplanes which take off from Lima International Airport at 7.75 km from the monitoring location, they decided to measure the aircraft noise impact using their own noise monitoring station, which is on a fourth-floor rooftop, and this spot is in the middle of a block far away from any avenue (12^o05'24"S-77^o03'50"O). This position (see Figure 1) is important because the city background noise is low enough on nighttime to measure properly the noise from passing airplanes flying to the west-south toward the Pacific Ocean to leave Lima City.

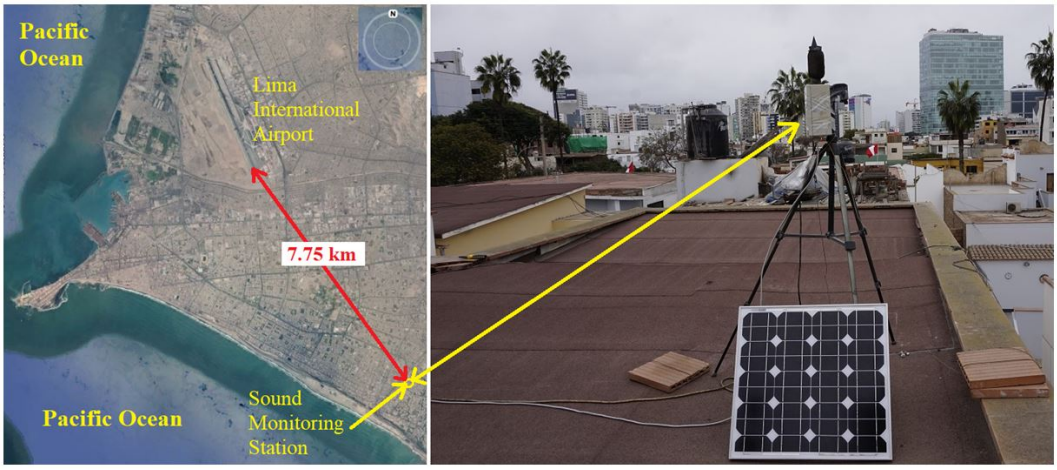

Fig. 1. Picture of Lima's airport and the monitoring station location

While the monitoring station is located to the south-east of the Lima airport runway, even so, it is within the aircraft noise footprint. Considering that this location is at 1.45 km from the Pacific Ocean, therefore, the marine inversion layer has an important effect on sound waves propagation: *'When planes fly above an inversion layer the aircraft noise reaching the ground is spread out farther at a lower intensity, when the aircraft is below the inversion layer the overall sound will be greater and spread over a farther distance'* [11].

The sound monitoring station being used is a TA120 noise sensor manufactured by CESVA® from Barcelona [12], the instrument comprises a Class 1 sound level meter that records the $L_{Aeq,1s}$ and transmits it every second to NoisePlarform® cloud located in Spain, that allows to download the data in csv format.

1.3. Metrics and sound descriptors

To correlate the results of the sound levels registered in this survey with similar data from European studies, the day-evening-night L_{den} noise indicator as is defined in ISO 1996-1:2016 [13] is used in this article. To processes the data, modular programming was used and all functions were written into .NET framework computer language to use the large math library available on the Internet.

1.3.1. Sound levels metrics

The TA20 monitoring station uses the A and C-weighting curve defined in IEC 61672-1:2013 [14]. For L_{den} calculation of the day-evening-night noise indicator, equation 1 is used with the penalties as defined in Directive 2002/49/EC [15].

$$L_{den} = 10 \cdot \lg \frac{1}{24} \left(12 \cdot 10^{\frac{L_{day}}{10}} + 4 \cdot 10^{\frac{L_{evening}+5}{10}} + 8 \cdot 10^{\frac{L_{night}+10}{10}} \right), dBA \tag{1}$$

The reference time intervals chosen to calculate the L_{den} are the following [15]:

- $L_{Day,12h}$ (or L_D) is the continuous equivalent sound level from 06.00 h to 18.00 h,
- $L_{Evening,4h}$ (or L_E) is the continuous equivalent sound level from 18.00 h to 22.00 h,
- $L_{Night,8h}$ (or L_N) is the continuous equivalent sound level from 22.00 h to 06.00 h.

1.3.2. Statistical functions

The statistical function used for this article are the following: (**i**) Percentile sound levels, they are not normalized descriptors yet, but there is an agreement about their meaning: L_{10}, 10% percentile level which describes the contribution of emergent sound events; L_{90}, 90% percentile level, used to estimate the background noise; (**ii**) trend, it is useful for extracting an underlying pattern of environmental sound level behavior in a time-history which would otherwise be partly or nearly completely hidden by the sound levels fluctuation; (**iii**) boxplot, it is a significant tool to conduct special analysis, where the boxes indicate the sound levels range in which the middle 50% of all sound levels registered are placed, into the box the solid lines indicate the median and the dashed lines the mean value, all points (above and below) are considered outliers that are further away than 1.5 times from the interquartile sound levels values; (**iv**) range, is the difference between the max and min sound levels.

1.3.3. Soundscape concept

For this article, the term 'soundscape' is used to describe a subjective acoustic environment perception as defined by the Canadian composer and acoustician Murray Schafer in the 1970s: *'psychoacoustic concept in which a soundscape is an acoustic environment as perceived and analyzed by humans'* [16], and it is not used like ISO metric [17].

2. Soundscape after the economic opening on July 1st, 2020

The Peruvian government decreed on July 1st, 2020, a controlled opening to non-essential activities applying several public health procedures to ensure social distancing and to reduce the possibility of people meetings or family reunions. Figure 2 shows the $L_{Aeq,24h}$ time-history (red line) from July 1st, 2020, to June 30th, 2021, in which is identified the four timewise periods previously indicated (that were marked by the advance of the COVID-19 and its new variants in 2021) from spreading, with their long-term trend (dashed lines).

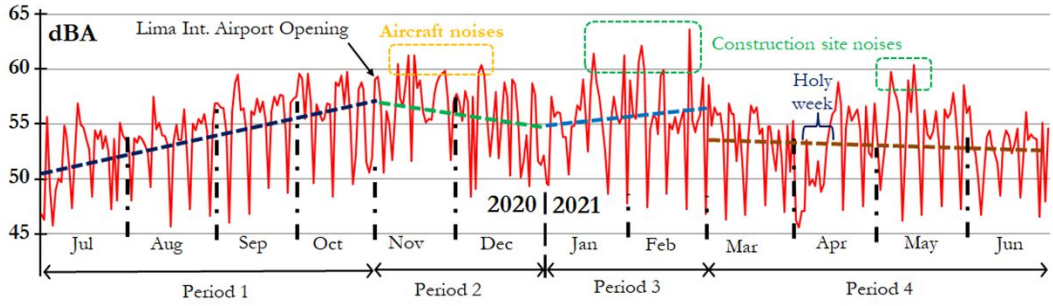

Fig. 2. $L_{Aeq,24h}$ sound levels evolution from July 2020 to June 2021 [red line], and the statistical trend by each time period under analysis [dashed lines] (dB re 20 μPa)

2.1. Period 1: Lima soundscape from July 1st to October 31st, 2020

The state of emergency was partially lifted on July 1st, 2020, however all educational institutions remained closed (also some nonessential activities), and social life showed a gradual tendency 'to return to normal,' it is likely that the life patterns of people did not change significantly from those during the mandatory quarantine. The soundscape after this 'abnormal' opening (first-wave partial reopening) after the total quarantine and general lockdown, was really atypical because 'the opening' didn't include those such as in-person education as well as leisure events.

Building construction and industrial activities started gradually, public passenger transport services were increased as the numbers of people were authorized to circulate in the street increased, and the authorities in some days had to backtrack on decisions by imposing momentary restrictions on people's mobility in order to ensure an adequate social distancing among people. In Figure 2 for this period 1, it is observed that the $L_{Aeq,24h}$ long-term trend (blue dashed line), regarding over the span of four months the opening to some non-essential activities, increased by 6.3 dBA.

Some important facts to highlight on the part of Lima's authorities are that they imposed a restriction on circulation of buses and other public transportation on Sundays to ensure social distancing (it was requested for everyone to self-restraint at home) and reduce the possibility of people meetings or family reunions, then it is possible to see in Figure 2 a regular pattern due to those sanitary decision: The sound levels leap down regularly, meaning a noiseless soundscape perception on Sundays.

2.2. Period 2: Lima soundscape from November 1st to December 31st, 2020

On November 1st, 2020, the Lima international airport has been partially opened only to commercial flights (internationals and nationals) but not for tourism proposes. It is interesting to observe in Figure 2 that the $L_{Aeq,24h}$ long-term trend (green dashed line) for this period 2, shows a decreasing of 3.5 dBA, albeit the fact that there were aircraft flights every day; therefore, this overall reduction of the $L_{Aeq,24h}$ is due to the fact that the authorities imposed several measures of partial closures and openings to gradually reduce people's mobility by cars/buses throughout the city, which resulted in a consequent diminishing of the environmental noise. A few spikes were produced by some night aircraft overflights which are highlighted in the orange square. The most strict confinement order was given for Christmas Eve and New Year's night, family reunions were not allowed for more than ten people, and as a results of these, the $L_{Aeq,24h}$ of those days was lower than 50 dBA.

2.3. Period 3: Lima soundscape from January 1st to February 28th, 2021

In Peru the year 2021 started with the COVID-19 second wave, and then Peruvian authorities were forced to restrict people's mobility even more. January 2021 began with a confinement order which was tightened between January 15th and 31st, 2021 because people were reluctant to self- restraint at home. Despite this, the number of contagions continued to rise, the quarantine measure was extended to February 2021, reinforcing controls to prevent people from circulation in the streets on Sundays, introducing a ban on the circulation of buses and private cars.

In Figure 2 for this period 3, it is observed that the $L_{Aeq,24h}$ long-term trend (light-blue dashed line) increased around 1.2 dBA. As a result of the street construction works carried out around the block where the monitoring station is located, anomalous noise events have resulted in an erratic behavioral pattern (see in Figure 2 the green square); therefore, it is possible to be sure that the increase in the noise levels are due to the aforementioned works in this time span.

2.4. Period 4: Lima soundscape from March 1st to June 30th, 2021

Many US and European airports were temporarily closed to flights from Peru due to the resurgence of COVID-19 in this country. At this fact, the fewer night flights, the lower the noise, and taking into account that during the days prior to and during the entire Holy Week there was an almost total ban on people's mobility (to reduce the spread of the COVID-19 variants), very low noise levels were achieved within this time span. In Figure 2 for this period 4, it is observed that the $L_{Aeq,24h}$ long-term trend (dark-orange dashed line) displays a gradual decay of the sound levels around 1.2 dBA. In 3.2 a further analysis will be presented.

3. Analysis of sound levels measurements

The evaluation that provides the more noticeable information is the soundscape comparison between period 1 vs. period 4, basically because during March-June 2021, the Peruvian economy was almost entirely open (except for in-person classes and leisure activities) and the Lima international airport was operating but not for tourism; and despite all this, the noise levels were lower than those of the July-October 2020 interval.

3.1. Soundscape evaluation using percentile sound levels

Since January 2021, the Peruvian government have imposed a strict curfew between 20.00 h and 06.00 h (in April it was prolonged from 22.00 h to 04.00 h), which resulted in a low background sound levels during nighttime, providing a soundscape perception as never before imagined. Figure 3 shows the L_{90} sound levels evolution as follow: Daytime background represented by the $L_{90,Day}$ (blue line), being the 90th percentile level calculated for daytime hours (from 06:00 h to 18:00 h); nighttime background represented by the $L_{90,Night}$ (red line), being the 90th percentile level calculated for nighttime hours (from 22:00 h to 06:00 h). The $L_{90,Evening}$ is not presented here because it has a random behavior, consequently it does not offer conclusive information.

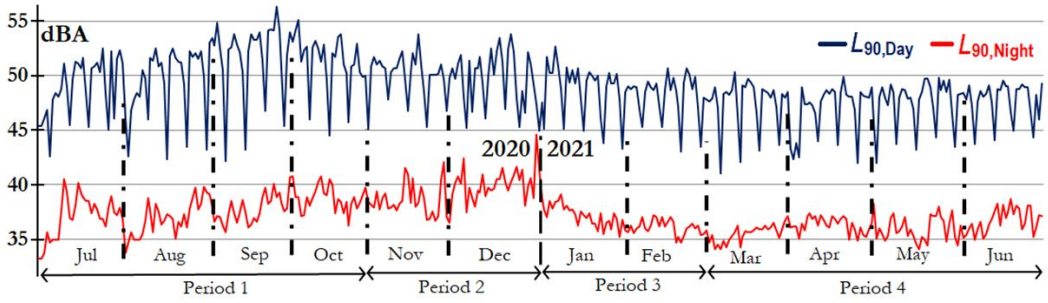

Fig. 3. $L_{90,D}$ and $L_{90,N}$ sound levels evolution from July 2020 to June 2021 (dB re 20 μPa)

With respect to daytime background sound levels evolution, it is noteworthy that they have a fluctuating behavior (for period 1 among 42.2 dBA and 56.3 dBA and for period 4 among 41 dBA to 50.3 dBA). Despite the sound levels decreased on Sundays and increased again on Mondays, a gradual diminution over time can be determined since January 1^{st}.

The $L_{90,N}$ sound levels evolution increased close to 5 dBA considering period 1 and period 2 together. On the contrary, since January to June 2021 the $L_{90,N}$ sound levels have fallen and the $L_{90,N}$ shows a median pattern around of 36.5 $\pm$2.3 dBA, being this as a consequence of the elimination of some night flights besides the ban on circulation in streets and strict curfew. The nighttime background sound levels were low as never before.

3.2. L_D, L_E and L_N boxplots comparison of each period under analysis

The boxplot is a significant tool to conduct special analysis, some examples of the use of this statistical function for this unusual environmental situation (marked by the COVID-19-related sound levels variation) are presented in [18] [19]. Figure 4 shows the sound levels averaged by L_D, L_E and L_N of each period under analysis (from July 1^{st}, 2020, to June 30^{th}, 2021) distributed by means of a boxplot.

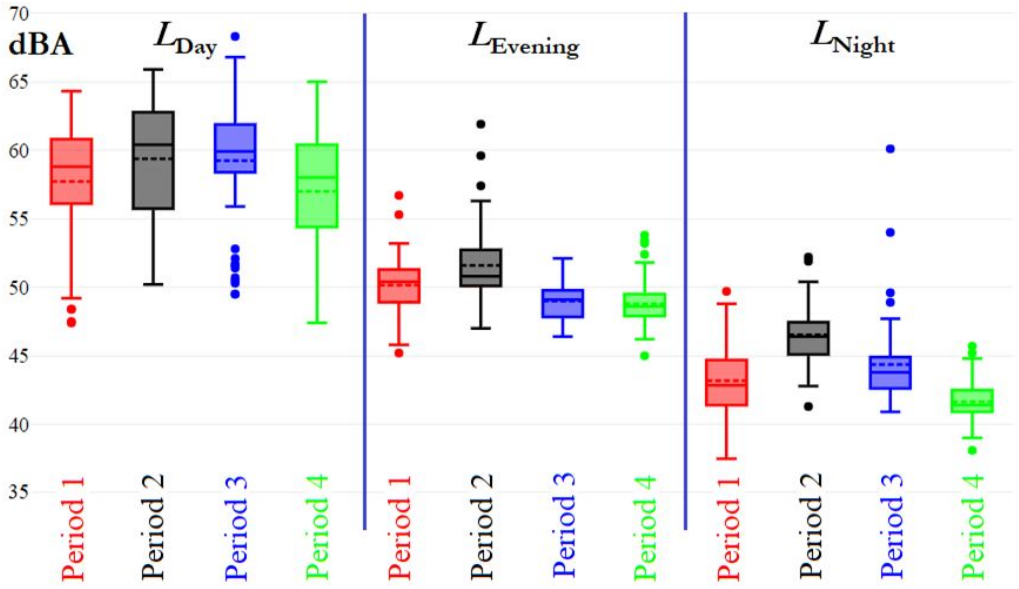

Fig. 4. L_D, L_E and L_N boxplots ordered by period under analysis from July 1^{st}, 2020, to June 30^{th}, 2021 (dB re 20 μPa)

In Figure 4 it is observed the following:

• **The daytime levels (L_{Day})**, whereas period 1 and period 4 have almost the same range (±0.5 dBA), the 50% of the sound levels in period 4 (with the economy very nearly open and the Lima airport operating) are more distributed than period 1 (with the economy partially closed and the Lima international airport under lockdown). For period 2 the sound levels are more distributed than period 1. For period 3 the sound levels are concentrated around 60 dBA, but this was a consequence of noise from construction activities on surrounded streets where the sound monitoring station is installed.

• **The evening time levels ($L_{Evening}$)**, for all periods the quartiles Q1 and Q3, which are 'close' to each other the 50% of their sound levels are highly concentrated around 50 dBA (±2.5 dBA), this is because people had to be at their homes before the curfew, so the traffic noise levels due to cars and buses were high.

• **The nighttime levels (L_{Night})**, in period 1 during the first-wave partial reopening, the range of L_N levels is 12.2 dBA and its median is 42.9 ±1.6 dBA. On the contrary, in period 4 (although the night aircraft overflights) the range of L_N levels is 7.2 dBA and its median is 41.4 ±0.8 dBA, meaning that they are lower and highly concentrated than in period 1 when the Lima airport was under lockdown.

4. Summary of sound levels measurements registered during one year

4.1. L_{den} sound levels comparison among periods under analysis

In order to understand the COVID-19-related sound levels reduction in this Lima City district, due to different confinement orders, lockdown and curfew, Table 1 summarizes straightforward the L_D, L_E, L_N sound levels of each period and their corresponding L_{den} noise indicator calculated by means of Eq. 1.

Table 1
L_{den} noise indicator comparison for each period under analysis from July 1^{st}, 2020, to June 30^{th}, 2021 (dB re 20 μPa)

Period	L_D	L_E	L_N	L_{den}
Period 1: July 1^{st} to October 31^{st}, 2020. 'Abnormal' opening and limited de-escalation	59.0	50.6	43.9	57.3
Period 2: November 1^{st} to December 31^{st}, 2020. Airport opening (not for tourism)	61.1	52.8	47.1	59.7
Period 3: January 1^{st} to February 28^{th}, 2021. New curfew order and partials lockdowns	61.1	49.2	46.8	59.2
Period 4: March 1^{st} to June 30^{th}, 2021. Flight restriction from Peru due to new strains + strict night curfew	58.3	49.0	42.1	56.4

In Table 1 it is interesting to note that:

• In period 2 the L_D, L_E and L_N are higher than in period 1, because more people in streets were allowed to circulate due to de-escalation and more nonessential activities were partially open, besides the Lima International airport was opened.

• In period 3 the L_D was equal than period 2, despite the restriction on circulation, but it was as a consequence of the construction noises (it was commented above).

• In period 4 the sound levels are 1 dBA lower (with the economy very nearly open and the Lima airport operating) compared to period 1 (with the economy partially closed and the Lima international airport under lockdown).

• In period 4 the L_N is 5 dBA lower than in period 2, due to the strict nighttime curfew. It has to keep in mind, also, that the quantity of flights in period 4 are much higher than in period 2, and yet despite this, the sound level is lower; therefore, the noise levels were produced by cars/busses traffic.

• In period 4 the L_D and L_E are 3 dBA lower than period 2, basically as a consequence of the health policies about restriction on circulation in streets, not because 'there is less movement of people.'

4.2. L_{den} of one year of sound monitoring during the COVID-19

As previously mentioned, the results of this monitoring can be correlated with European studies, Table 2 summarizes the L_{den} results by Equation 1, averaged by each semester and annually from July 1^{st}, 2020, to June 30^{th}, 2021.

Table 2
L_{den} noise indicator summary from July 1^{st}, 2020, to June 30^{th}, 2021 (dB re 20 μPa)

Interval time	L_D	L_E	L_N	L_{den}
July 1^{st} to December 31^{st}, 2020 (first semester)	60.0	51.5	45.3	58.4
January 1^{st} to June 30^{th}, 2021(second semester)	59.6	49.1	44.1	57.7
July 1^{st}, 2020 to June 30^{th}, 2021	59.8	50.4	44.7	58.0

5. A suggestion to make about the special soundscape derived from people's mobility restriction: 'Car-free Sunday' after the pandemic is overcome

Important health policies decisions have been implemented by Lima's authorities to note on Sundays (which is still maintained today), a temporary scenario defined by (**i**) a restriction on circulation in the avenues of buses/private cars from 07.00 h to 13.00 h, and (**ii**) people self-restrain at home, all of this in order to reduce outdoor people's mobility and preventing the COVID-19 spreading. Whereby, the soundscape on Sundays is healthier; therefore, it is important to analyze the unique opportunity that these policies offer temporarily. Figure 5 shows a comparison of daytime [06.00 h–18.00 h] sound levels between weekdays (red box) and Sundays (light-blue box) from July 1^{st}, 2020, to June 30^{th}, 2021.

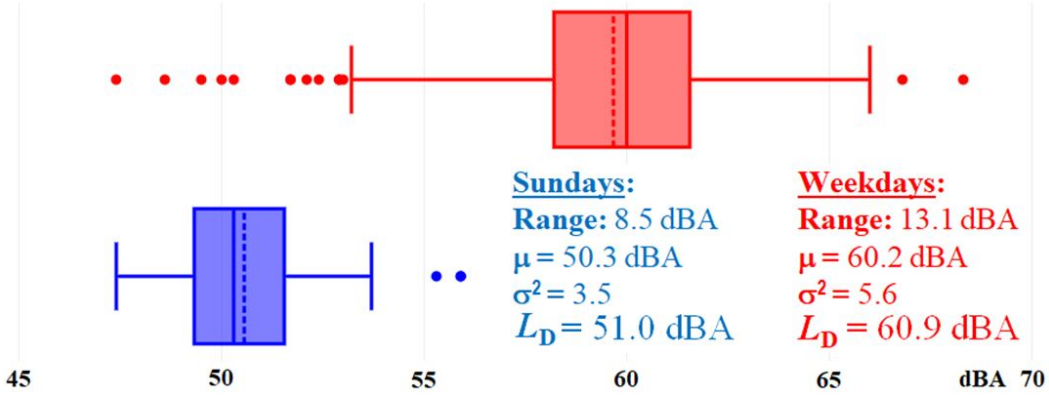

Fig. 5. L_D Sundays vs L_D weekdays from July 1^{st}, 2020, to June 30^{th}, 2021 (dB re 20 μPa)

For the weekdays' boxplot, the holidays are not considered as data for the analysis. In Fig. 5 it is observed that 50% of the sound levels on Sundays are more concentrated at

lower values than on weekdays. The L_D Sundays are 10 dBA fewer, which means at least 500% off acoustic energy under the environmental scenario described above concurrently during the COVID-19 pandemic. At this point, a forthcoming suggestion to make to the governmental authorities by the authors is having a 'Car-free Sundays' after the pandemic is overcome, to minimize the risk on people of having noisy soundscape on a day that it supposes should be quiet.

Conclusions

In this paper the authors have presented the measurements results of the sound levels in this location with the sound pressure level of the Magdalena del Mar as a whole. Unlike the case of Lima City, the results shown here are only an example of this neighborhood (and those which are under the aircraft footprint of Lima international airport) and are not intended to be generalized since differences in behavioral patterns are likely to occur in other areas of Lima City, depending on the attributes of the people living there and the surrounding environment. Rather, it is easy to imagine that each city neighborhood has its own unique behavior and that it is not easy to generalize the results from a specific one to others, but it is considered necessary to accumulate examples from various locations to gain insight.

The noise levels that were registered during the COVID-19 at this residential neighborhood in Lima City, seems to be quite different with those reported in other large cities, mainly because there was no gradual lockdown de-escalation in Peru, on the contrary, the activities and people's mobility increased but applying a strong traffic circulation restriction in the streets, then, this is why in June 2021 the night noise level is lower than in July 2020, although in 2021 there is much more commercial activity than a year ago, also taking into account that the Lima airport now is currently open: This may seem like a paradox, but it is certainly not.

It has to be noted that the traffic restriction measures and the strict nighttime curfew are the key to retain the noise level low during nighttime hours; therefore, aircraft overflight noise is one of the components of environmental noise, but it is not a sound source capable of raising sound levels averaged at night; perhaps overflights that occur at dawn, when people are in the most sensitive sleeping period, can be considered a nuisance.

The sound levels immediately after the lifting of the quarantine in July 2020 was high, perhaps it was due to people needing to leave their homes after four months of mandatory confinement, and also maybe rather unusual behavior of people to reorganize their activities under the atypical social situation signed by the COVID-19 outbreak. The sound levels during the four periods under analysis have fluctuated as a function of several factors; one of them was defined by cars and buses circulation because as the streets and avenues were empty, they circulated at high speed.

The COVID-19 outbreak has changed the way of life sending everyone to confinement for months. The Worldwide acousticians have been able to register a distinct soundscape during the lockdown, being this exceptional situation a historic fact which will be important to keep the sound monitoring survey going into the future for further comprehension of what the SARS-CoV-2 had done on urban sound issues.

Unfortunately: (**i**) the results obtained in this survey cannot be directly correlated with sound monitoring carried out in other cities of the world, because the 'random' measures of temporary closures and openings taken by the Peruvian authorities have caused the sound levels to vary 'disorderly,' i.e., it is not possible to analyze the long-term trend sound evolution, but only for undersized periods of time; (**ii**) it was not possible to conduct a subjective investigation, such as questionnaires, because it is forbidden to talk to people anywhere (closed or even open spaces) yet.

Sharing to Peruvian authorities the information on healthy environmental sound levels that the authors had registered is still in debt because the actual governmental priorities are to put under control the COVID-19 outbreak, so when the time it comes, the authors would communicate their findings about the soundscape which took place in this Lima district (as a private research with no external funding), in order to develop some possible environmental and health policies about the impact of aircraft noise in this residential neighborhood.

Finally, a suggestion to make is 'Car-free Sundays,' because it has been objectively demonstrated with sound measurements of this survey that the soundscape on Sundays is really healthy due to a restraint on circulation in streets; then, establishing a vehicle circulation restriction on Sundays morning after the pandemic is overcome should be an environmental policy not only for Lima City but also (why not) a worldwide policy.

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References

1. WHO (2021) «Global data-Peru», World Health Organization, available at: https://covid19.who.int/region/amro/country/pe, (accessed July 28, 2021).

2. Statista (2021) «Coronavirus (COVID-19) deaths worldwide per one million population as of July 28, 2021, by country», Global No.1 Business Data Platform, available at: https://www.statista.com/statistics/1104709/coronavirus-deaths-worldwide-per-million-inhabitants/, (accessed July 28, 2021).

3. Čurović, Jeramb, Murovec, Novaković, Rupnik, Prezelj (2021), «Impact of COVID-19 on environmental noise emitted from the port», Elsevier. Science of the Total Environment 756-144147, available at: https://doi.org/10.1016/j.scitotenv.2020.144147

4. Steele, D.; Guastavino, C. (2021), «Quieted City Sounds during the COVID-19 Pandemic in Montreal», Int. J. Environ. Res. Public Health 2021, 18, 5877, available at: https://doi.org/10.3390/ijerph18115877

5. Montano, W.A.; Gushiken, E.I. (2021), «COVID-19 and soundscape changes due to the lockdown. The case of Lima, Peru», AKUSTIKA 49, 2021. – pp. 48-55, available at: http://doi.org/10.36336/akustika20213946

6. Bartalucci, C.; Bellomini, R.; Luzzi, S.; Pulella, P.; Torelli G. (2021) «A survey on the soundscape perception before and during the COVID-19 pandemic in Italy», De Gruyter. Noise Mapp. 2021; 8:65–88, available at: https://doi.org/10.1515/noise-2021-0005

7. Rumpler, R.; Venkataraman, S.; Göransson, P. (2021) «An observation of the impact of CoViD-19 recommendation measures monitored through urban noise levels in central Stockholm, Sweden», Elsevier. Sustainable Cities and Society 63 (2020) 102469, available at: https://doi.org/10.1016/j.scs.2020.102469

8. Lecocq, T. et al. (2020) «Global quieting of high-frequency seismic noise due to COVID-19 pandemic lockdown measures», Science 11 Sep 2020, Vol. 369, Issue 6509, pp. 1338-1343, available at: https://doi.org/10.1126/science.abd2438

9. Sakagami, K. (2020) «A note on the acoustic environment in a usually quiet residential area after the 'state of emergency' declaration due to COVID-19 pandemic in Japan was lifted: Supplementary survey results in post-emergency situations», De Gruyter. Noise Map. 7(1), 192–198, available at: https://doi.org/10.1515/noise-2020-0016

10. Asensio, C., Aumond, P., Can, A., Gasc, L., Lercher, P., Wunderli, J.-M., Lavandier, C., de Arcas, G., Ribeiro, C., Muñoz, P., Licitra, G. (2020), «A taxonomy proposal for the assessment of the changes in soundscape resulting from the Covid-19 lockdown», Int. J. Environ. Res. Public Health 17(12), 4205, available at: https://doi:10.3390/ijerph17124205

11. Murray, S. (2015) «Meteorological effects change sound propagation», Doors to arrival. Research, analysis and comments on the FAA's SoCal NextGen metroplex project and environmental assessment, available at: http://doorstoarrival.com/meteorological-effects-change-sound-propagation/, (accessed July 21, 2021).

12. CESVA (2021) «TA120 Noise measuring sensor for Smart Solutions», CESVA instruments SLU, available at: https://www.cesva.com/en/products/sensors-terminals/TA120/, (accessed July 21, 2021).

13. ISO (2016) «ISO 1996-1 Acoustics. Description, measurement and assessment of environmental noise - Part 1: Basic quantities and assessment procedures», ISO. Geneva, Switzerland.

14. IEC (2013) « IEC 61672-1:2013. Electroacoustics - Sound level meters - Part 1: Specifications», IEC. Geneva, Switzerland.

15. EU (2002) «Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise», EUR-Lex Official Journal. Brussels, Europe, available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32002L0049 (accessed July 21, 2021).

16. Schafer, M.R. (1977) «The Soundscape: Our sonic environment and the tuning of the world», Rochester, Vt. Destiny books, available at: https://quote.ucsd.edu/sed/files/2014/01/schafer_1.pdf.

17. ISO (2014) «ISO 12913-1:2014 Acoustics – Soundscape – Part 1: Definition and conceptual framework», ISO. Geneva, Switzerland.

18. Rey-Gozalo G, Barrigón-Morillas JM (2016) «Analysis of Sampling Methodologies for Noise Pollution Assessment and the Impact on the Population», International journal of environmental research and public health, available at: https://openi.nlm.nih.gov/detailedresult?img=PMC4881115_ijerph-13-00490-g003&query=&req=4, (accessed July 21, 2021).

19. Alsina-Pagès, R.A.; Bergadà, P.; Martínez-Suquía, C. (2021) «Changes in the soundscape of Girona during the COVID lockdown», JASA 149(3416), available at: https://doi.org/10.1121/10.0004986