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NOISE LEVELS COMPARISON BEFORE, DURING AND AFTER LOCK-DOWN PERIODS DUE TO COVID-19 IN ITALY

Monica Carfagni[1*] **Francesco Borchi**[1] **Chiara Bartalucci**[2]
Luca Nencini[3]
[1] Department of Industrial Engineering, University of Florence, Italy
[2] Vie en.ro.se. Ingegneria s.r.l., Viale Belfiore 36 – 50144, Florence, Italy
[3] Blue Wave S.r.l., Via del Fonditore 344 – 58022, Follonica, Italy

ABSTRACT

The occurrence of the Covid-19 pandemic provided an opportunity for researchers and technicians around the world to study, qualitatively and quantitatively, the trend in noise levels during the various phases of the phenomenon.
As part of the LIFE MONZA project, co-funded by the European Union, 10 smart and innovative sensors were installed in June 2017 to measure noise levels at as many significant locations in the city of Monza (Italy).
Even following the conclusion of the project in June 2020, data acquisition continued on a regular basis by the municipality of Monza, following a training activity carried out by the University of Florence (both partners in the LIFE MONZA project together with ISPRA - Italian Institute for Environmental Protection and Research and Vie en.ro.se. Ingegneria). In 2020, an initial work was published on the comparison of noise levels measured by the sensors immediately before the start of the lock-down phase and during it. In the present study, the authors propose a comparison with the levels measured in the subsequent phase in order to understand whether the pandemic experience may have generated new acoustic scenarios or whether the overcoming of its most acute phase has brought noise levels back to pre-pandemic ones.

Keywords: *Covid-19, noise monitoring, smart sensors*

[*]***Corresponding author***: monica.carfagni@unifi.it

1. INTRODUCTION

The Covid-19 pandemic spread in Italy, and in the overall Europe, in the first months of 2020 and, after a dramatic period especially till summer of the same year in terms of lives lost (511.082 globally at the beginning of July 2020) has still left important consequences in the following years in terms of further lives lost (6.893.190 globally at the beginning of April 2023 [1]), health consequences and changed habits.
From the point of view of scientific research in the environmental field, and in acoustics specifically, there have been many studies and practical applications that have investigated and monitored the noise climate particularly during the so-called lock-down period (late February to late April 2020). In particular, the Acoustical Society of Italy (AIA) organised two main activities: 1) the collection and analysis of data measured during the emergency through surveys obtained both from fixed and mobile monitoring stations (permanent control units, acoustic climate detection stations, etc.) and from "extemporaneous" positions at the homes of the participants in absolute compliance with all the provisions in force on the Italian territory for the containment of the epidemiological emergency; 2) the design and online submission of a questionnaire aimed at evaluating people perception of the soundscape before and during the lock down phase [2]. In this framework, the Provincial Agency for the Protection of the Environment of the Autonomous Province of Trento (APPA Trento) shared the initiative to collect environmental noise levels during the emergency by COVID-19 launched by AIA, carrying out extensive monitoring over the provincial territory both to document the acoustic climate and to assess the acoustic impact of the protection measures adopted during the health emergency.

In the city of Turin data from the noise monitoring network, managed by the City and Arpa Piemonte, were analysed to obtain a first quantitative evaluation of the acoustic effects induced by the restrictions in urban areas. The LYS (Locate Your Sound) project [3] in Italy (about 4000 recordings at the beginning of July 2020) invited citizens to spontaneously collect and record the soundscape during lock down near theirs places of life.
Acoucité developed a questionnaire oriented towards assessing population feelings about the changes in the noise environment since lock down [4]. In London the UCL Acoustics Group carried out an online experiment assessing some recordings achieved in the pre- and during lock down soundscapes.
In the USA, the N.Y.U. project, called SONYC, recorded audio clips from one of 16 microphones that have been monitoring patterns in noise pollution in the city for more than three years, in research funded by the National Science Foundation.
According to all the mentioned studies, it turned out that during the most severe phase of the spread of the pandemic noise levels in urban areas significantly decreased and that the soundscape was mainly characterized by natural and human sounds.
However, an interesting question is whether noise levels during the current settling phase, at a time when no restrictions have been in place for months now, have returned to similar levels as in 2019, or whether the pandemic-related experience has actually affected changing people's habits under the same boundary conditions, such as promoting the use of more sustainable means of travel in the city.
In this regard, there are still not many studies available, and those produced mostly focus on the comparison of the acoustic scenario immediately before the spread of the Covid-19 pandemic and the lock-down period.
Only a few studies also include the period just after the lock-down one referring to the months during which a return to “normality” is envisaged.
In fact, as stated in [5], [6], according to data collected by monitoring units distributed throughout the city of Barcelona, the progressive release of the restrictions reactivated city activity, and lead to a progressive restoration of noise levels until they reached values comparable to those of previous years once the confinement was over. However, the recovery of noise activity is still not complete, although it is unclear whether this could be related to the noise abatement strategies that the city has been implementing in recent years, to the fact that the full normality was not reached after the end of the lockdown, or to the fact that habits could be definitively changed.
In Milan [7], the monitoring network of 24 monitoring units was located in a pilot area within the ring road, which is mainly dominated by traffic noise. Since the greatest severity of the confinement, activity has gradually recovered, with the previous year’s numbers having been reached again by the beginning of June 2020.
The National Ambient Noise Monitoring Network (NANMN) installed across seven major Indian showed that the daytime and night-time reductions during the confinement ranged from approximately 4 to 14 dB(A) compared to mean pre-lockdown levels while when the lockdown restrictions began to relax, the noise levels started to increase almost linearly, reaching the pre-pandemic ones [8].
The results regarding environment noise from the Interlight S.L. company in Cordoba [9] showed a significant decrease caused by lockdown and a rapid posterior growth resulting from the de-escalation, increasing even further than before lockdown and despite the reduction in mobility. These results could be caused by the population’s perception of the use of public transport as a risk to their health, resulting in using individual vehicles, such as cars, or even due to the opening of bars and commercial activity.

The objective of this paper is to update a study previously published in 2020 [10], analyzing the levels measured by the smart noise sensor system installed in the city of Monza as part of the European LIFE MONZA project, extending the analysis previously covering the years 2019 and 2020 to the same months of 2021 and 2022.

2. THE LIFE MONZA PROJECT AND SMART SENSORS FOR NOISE MONITORING

The methodological approach for the reduction of noise pollution in the urban contexts can be mainly advised in the reduction of noise at the source, traffic control, careful planning of the urban and regional development, building's shelter against the noise, compensation's and incentivation interventions for the exposed people, controls activity and restaining of the noise's sources, scientific research and health education.
A practical solution including several of the above-mentioned approaches is the institution of a Low Emission Zone (LEZ), as a frequent and consolidated

action in the administrative practice of European cities. However, in adopting this measure the impacts and benefits concerning air quality are widely analysed, while the effects related to noise pollution have not been comprehensively addressed yet.
The LIFE MONZA project (Methodologies fOrNoise low emission Zones introduction and management - LIFE15 ENV / IT / 000586), co-funded by the European Commission, started in September 2016 and was concluded in June 2020 [11]. The main objective of the project, coordinated by ISPRA in partnership with the Municipality of Monza, the University of Florence and Vie en.ro.se. Ingegneria s.rl., was to develop and test a methodology, easily replicable and applicable in different contexts for the identification and management of the "Noise Low Emission Zone", an urban area subjected to traffic restrictions.
In practice, impacts and benefits of the noise LEZ implementation concerning the issues of noise pollution have been analysed and tested in the pilot area of the Municipality of Monza where a new low noise asphalt has been laid, measures to better manage traffic flows have been applied and also activities for the active involvement od citizens (e.g. questionnaires, pedibus, app) have been carried out.
One of the most significative aspects of the LIFE MONZA project was the design and test of a new smart noise monitoring system which began to collect noise levels in the area on June 2017 and, at the end of the LIFE MONZA project, was given for free to the city that, according to the project's proposal would take care of it by using it for monitoring activities in the three years after the project conclusion, but that actually continued the data collection activity also after.

2.1 The smart noise sensors

The low-cost smart sensors technical specifications were defined addressing the aim of a long-term monitoring of acoustic parameters. These are expected to be useful to understand the variability of acoustic climate in the pilot area with mainly reference to the overall A-weighted continuous equivalent sound pressure level.
According to the previous general requirements and to the outcome of the state of the art analysis described in [12], several specifications of the monitoring units are defined.
During the project, ten monitoring stations have been installed in the pilot area of Libertà district (Fig. 1).
In particular, three microphones (hb101, hb152 and T0014) have been installed along the Viale Libertà, the main urban street of the pilot area. The other microphones have been uniformly distributed along other streets belonging to the pilot area.
Concerning the verification procedures, the low-cost sensors challenge consists in maintaining the network performance during long term periods of outdoor operation.

The periodic check of the system is designed and performed to understand if the measurement accuracy is maintained in time or if one or more sensors need to be repaired or replaced [10]. After the preliminary check procedures were applied, the long-term on-site verification procedure has been applied both in the ante and in the post-operam periods to verify the noise monitoring system performances.
The long-term on-site checks have been scheduled every four/six months at least for two years during the noise monitoring period in the pilot area (1 year in the ante-operam scenario and 1 year in the post-operam scenario).
Regarding sensors' stability during the COVID-19 period all sensors proved to be stable according to calibration checks performed before and after the lock down period.
Regarding the reliability of smart noise monitoring systems, a first important result consisted in the verification of a good alignment between noise measurements carried out with class I sound level meter and the low-cost network, with average differences below 1 dB.
Further results on comparing the measured results by traditional sound level meter and noise sensors obtained in the frame of the LIFE MONZA project are available on reports published on the project website [13].

2.2 Data collection and monitoring after the project's conclusion

After the conclusion of the project, the operation and maintenance of the sensor system was carried out by the municipality of Monza at its own expense and was expected to be continued in the period following the three years since the conclusion of the project.
From June 2020, in fact, calibration of the smart monitoring system was carried out at least once a year.
The last microphones' substitution was carried out in 2021.

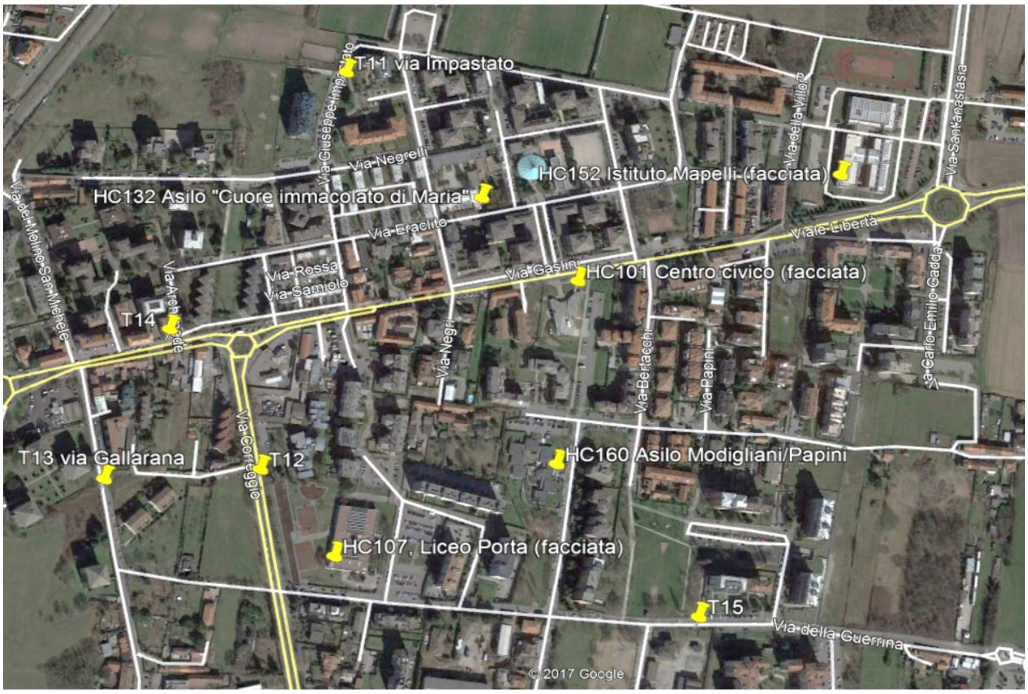

Figure 1. Libertà district of the city of Monza and smart sensors positioning.

3. EXPERIMENTAL RESULTS

The data for the first six months of the years 2019 and 2020 are those already used in the previous research [10], while those for the same period of the years 2021 and 2022 were made available by the municipality of Monza and processed with the same procedure allowing to elaborate data collected, and obtaining average weekly values in terms of Lnight and Lden parameters.

3.1 Data comparison from 2019 to 2022

In Fig. 2-17 trends of noise levels collected by sensors hb101, hb107, hb132, hb152, hb160, T0012, T0013, T0014 are reported. Sensor T0015 has been excluded from the analysis due to lack of data for the 2021 reference period while sensor T0011 has been excluded from the current analysis since it had not been included even in the previous analysis due to lack of collected data especially in the reference period for 2019 and 2020.

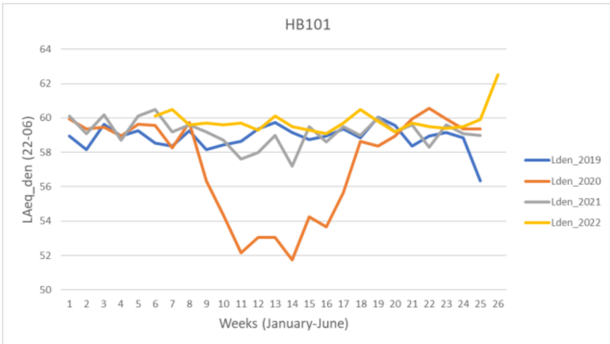

Figure 2. Sensor hb101 – Lden comparison across the four years.

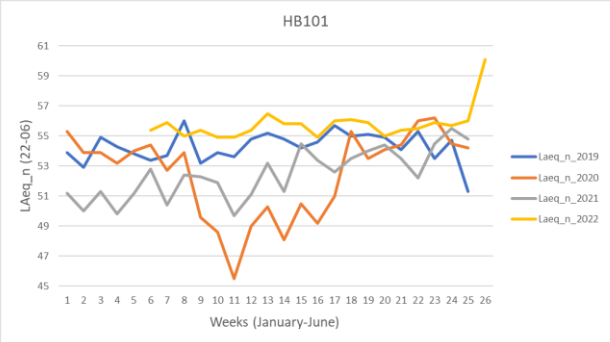

Figure 3. Sensor hb101 – Lnight comparison across the four years.

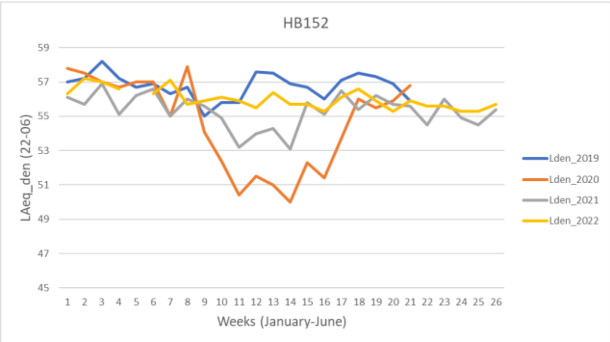

Figure 4. Sensor hb152 – Lden comparison across the four years.

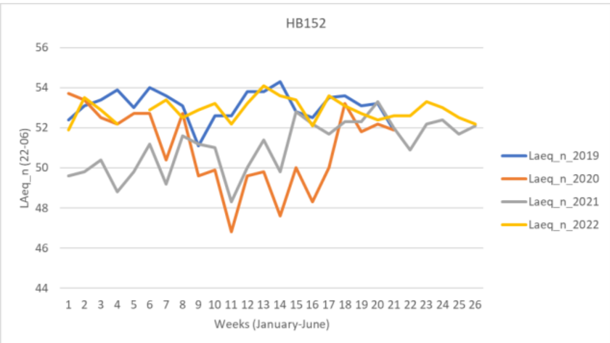

Figure 5. Sensor hb152 – Lnight comparison across the four years.

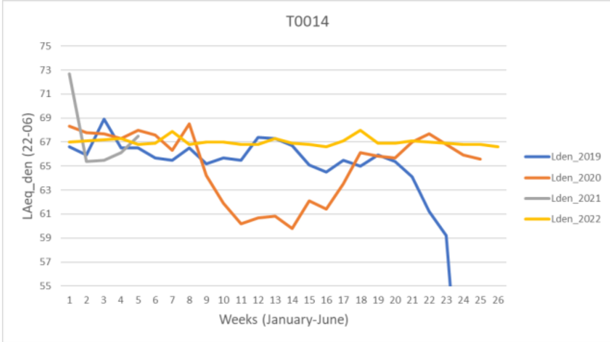

Figure 6. Sensor T0014 – Lden comparison across the four years.

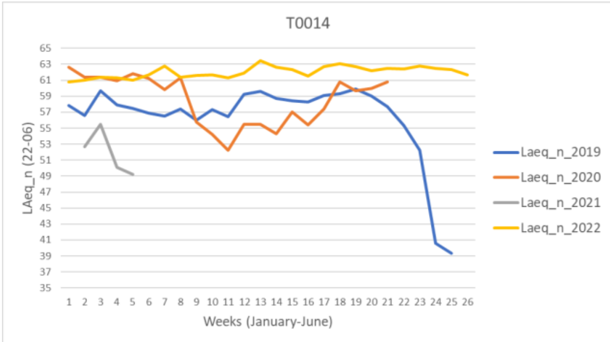

Figure 7. Sensor T0014 – Lnight comparison across the four years.

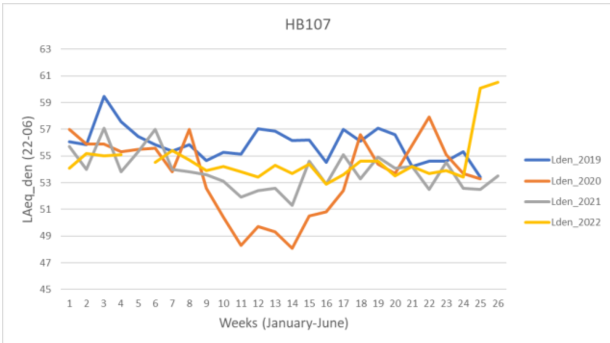

Figure 8. Sensor hb107 – Lden comparison across the four years.

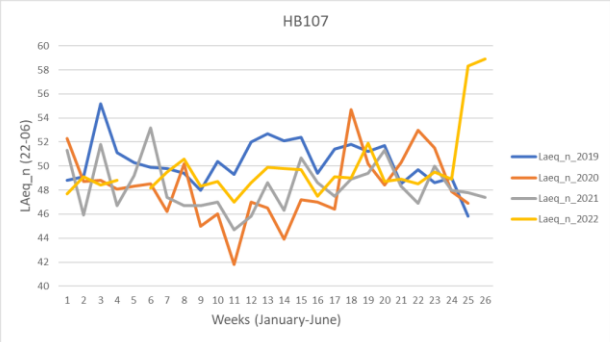

Figure 9. Sensor hb107 – Lnight comparison across the four years.

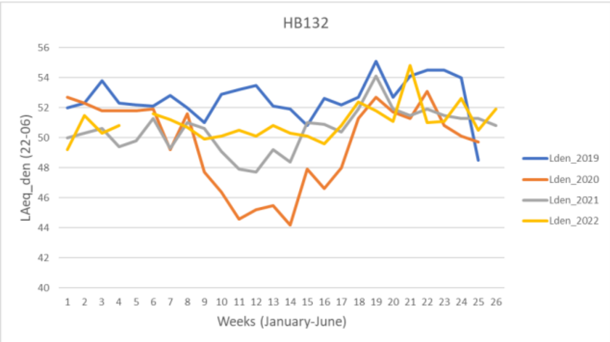

Figure 10. Sensor hb132 – Lden comparison across the four years.

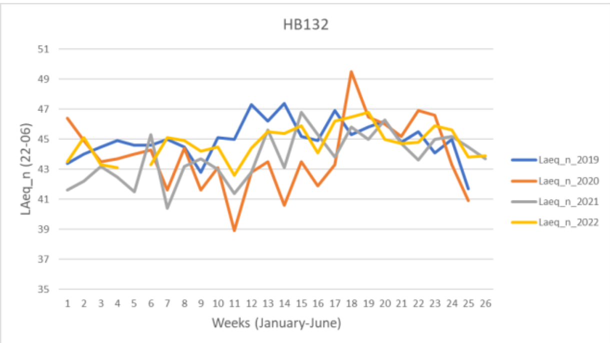

Figure 11. Sensor hb132 – Lnight comparison across the four years.

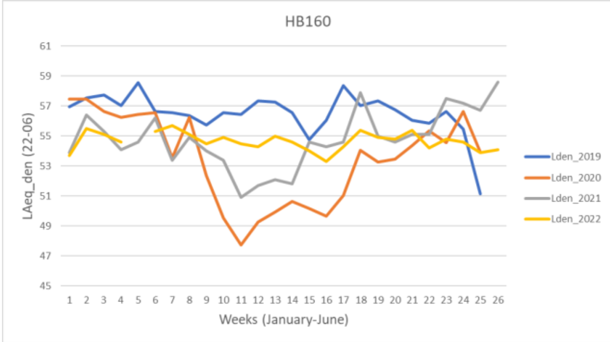

Figure 12. Sensor hb160 – Lden comparison across the four years.

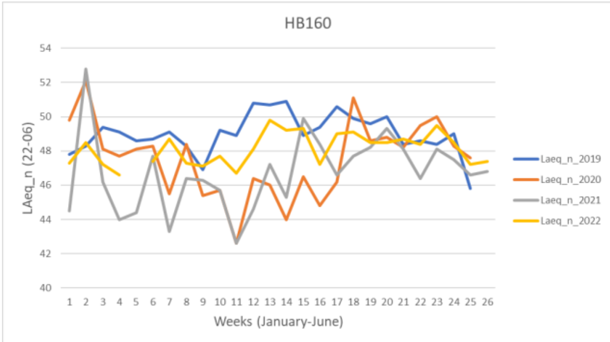

Figure 13. Sensor hb160 – Lnight comparison across the four years.

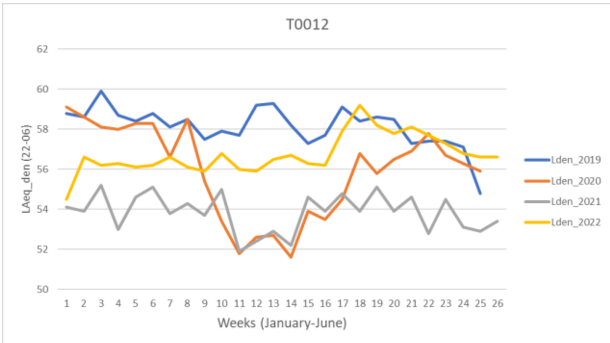

Figure 14. Sensor T0012 – Lden comparison across the four years.

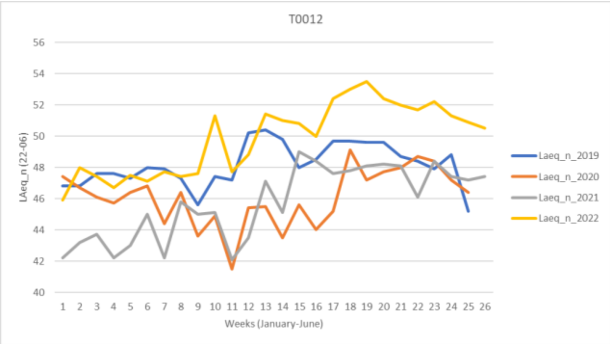

Figure 15. Sensor T0012 – Lnight comparison across the four years.

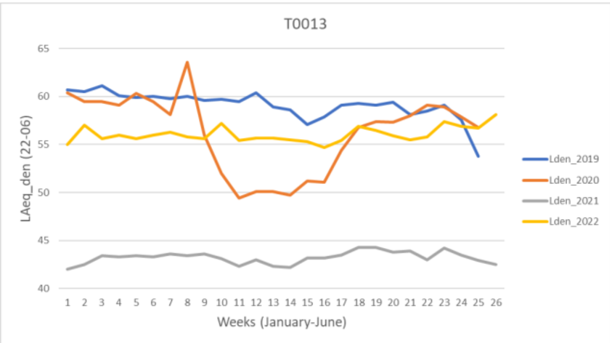

Figure 16. Sensor T0013 – Lden comparison across the four years.

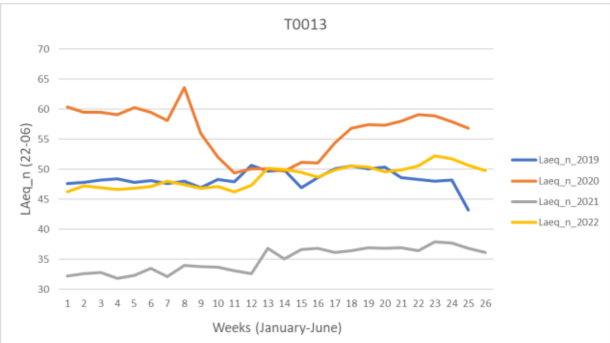

Figure 17. Sensor T0013 – Lnight comparison across the four years.

4. DISCUSSION

Analysis of the results obtained for the various sensors shows slightly different trends for them. In particular, comparing the levels measured by the sensors located along Viale Libertà (hb101, hb152, and T0014) shows that, for the hb101 and T0014 sensors, in 2022 not only are the 2019 levels reached again but the latter are also slightly exceeded; while for the hb152 sensor in 2022 there is a clear increase in noise levels compared to 2020 and 2021 without, however, reaching the 2019 levels, particularly in terms of Lden. In terms of Lnight, however, there is a higher correspondence between the values measured in 2019 and 2022. Considering the data measured by the remaining sensors placed at buildings (hb107, hb132, hb160), there is an increase in measured noise levels in 2021 compared to 2020 and a further increase in 2022 compared to 2021 although 2019 levels are not yet reached. Considering the data measured by the remaining sensors placed on poles (T0012, T0013), in the former case there is a closer alignment of the noise levels collected in 2022 to those collected in 2019 in terms of Lden, particularly in the latter part of the reporting period, while in terms of Lnight the 2022 levels reach and exceed those of 2019. For sensor T0013 there is evidence of a presumed sensor malfunction in 2021, while for 2022 the noise levels for the night period are found to be aligned with those of 2019, while in terms of Lden the 2022 levels are on average about 3 dB lower than those of 2019. Considering sensors located on buildings' facades, it is noted that there is a clear difference in terms of trends in measured noise levels, since for those located near Viale Libertà in 2022 there is an alignment of the noise levels with those measured in 2019, an indication that these sensors are affected by road traffic noise. Otherwise, noise levels measured in 2022 by sensors located near secondary are still lower than in 2019, this probably indicating a variation in citizens' habits after the pandemic or the effect of the implementation of noise reduction interventions by the Municipality. On the other hand, with regard to noise levels measured by pole-mounted sensors, uneven results are found also due to periodic malfunctions, and in this regard, further investigation is necessary to better understand the nature of these trends.

5. CONCLUSIONS

Although extensive research has been done in Europe to assess whether and how much during the lock-down period there was a decrease in noise levels and a change in the mainly perceived noise sources, there are still not many works addressing whether and how much, after the conclusion of the most acute period of the pandemic, noise levels and the main types of noise sources have recovered. In Barcelona, the progressive release of the restrictions led to a restoration of noise levels until they reached values comparable to those of previous years once the confinement was over, although some verifications are still on going. Also in Milan usual activities have gradually recovered together with related noise levels. In India, the National Ambient Noise Monitoring Network showed that the daytime and night-time reductions during the confinement ranged from approximately 4 to 14 dB(A) compared to mean pre-lockdown levels while when the lockdown restrictions began to relax, the noise levels started to increase realigning to the pre-pandemic ones. In Cordoba a significant decrease caused by lockdown occurred, followed by a rapid posterior growth, increasing even further than before lockdown. As part of the LIFE MONZA project, the installation of smart sensors for monitoring noise levels made it possible to analyze the trend of noise levels during the spread of the pandemic, giving the possibility to compare the levels measured in the months between January and June of the years 2019, 2020, 2021 and 2022 in the current publication. It is interesting to note that there tended to be a return to "normal" noise levels at Viale Libertà prior to the lock-down period, a sign of a return to "normality" at such an important connecting artery. Regarding the sensors placed in areas less affected by road traffic noise, further investigation is needed to understand whether, where current noise levels are lower than in 2019, this may actually be due to a change in citizens' habits or to occurred noise reduction interventions.

6. ACKNOWLEDGMENTS

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