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Archives of Acoustics Vol. **47**, No. 2, pp. 131–140 (2022), doi: 10.24425/aoa.2022.141644

Research Paper

Evaluation of Noise Pollution in Bengaluru City, India During COVID-19 Pandemic

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(*received May 15, 2021; accepted February 8, 2022*)

Most of the Indian cities and towns have been facing serious traffic noise pollution due to urbanization, substantial growth of new vehicles, inadequate road network, etc. Automotive traffic, railroads, and air traffic are the most common sources of noise pollution in cities, with vehicular traffic accounting for around 55% of overall metropolitan noise. Prolonged exposure to such loud noise causes anger, stress, mental diseases, discomfort, hypertension, concentration problems, and sleeplessness. This study aims to investigate the effects of COVID-19 societal lockdown on changes in the noise pollution levels before, during, and after the lockdown period in various industrial, commercial, residential, and silence zones in Bengaluru, India, in light of the recent imposition of COVID-19 societal lockdown. According to data acquired from the KSPCB (Karnataka State Pollution Control Board) online portal, the average noise levels before and during lockdown were determined to be in the range of 59.4 dB to 70.9 dB and 58.2 dB to 62.7 dB for different zones. During the lockdown, all commercial, industrial and educational activities were closed to limit the spread of infection, resulting in usage of private and commercial transportation declining dramatically. Reduction in the noise level was observed during the lockdown in all monitoring stations of Bengaluru, except for Indira Gandhi Institute of Child Health, where the noise level didn't decline because of a COVID emergency. Maximum reduction was observed in the commercial area (11.56%) followed by industrial areas (8.34%). The result further indicated that only the industrial area experienced an increase of 8.41% in noise level, while other areas experienced a reduction in a noise level during the early post-lockdown. During the mid and late post-lockdown periods, most locations experienced a rapid spike in the noise intensity.

Keywords: noise pollution; Bengaluru; COVID-19 pandemic.

1. Introduction

In India, most cities have been facing serious noise pollution problems due to a significant increase in the number of automobiles, expansion of the road network, industrialization, and urbanization over the last few decades (Reddy *et al.*, 1995; Vidya Sagar, Nageswara Rao, 2006; Singh *et al.*, 2013). Noise pollution, after air and water pollution, is regarded as the third most dangerous sort of pollution, according to the World Health Organization (WHO, 2005). Vehicle traffic, trains, and air traffic are the most significant sources of noise pollution in cities (Oyedepo, Saadu, 2010; Sazegar *et al.*, 2005), with automotive traffic accounting for around 55% of the total urban noise (Jamrah *et al.*, 2006; Omidvari, 2009; Martín *et al.*, 2006). Noise pollution and its accompanying health impact are becoming more prevalent, and they can result in both short- and long-term psychological and physiological illnesses (Garg *et al.*, 2017). Long-term loud noise exposure can cause impatience, stress, mental diseases, discomfort, stress, hypertension, loss of focus, insomnia, and other problems (Öhrström, 1989; Rabinowitz, 2000; WHO, 2005; Stansfeld *et al.*, 1996; Chakraborty *et al.*, 1998). According to the recent research, a 5 dB rise in roadside noise can increase the risk of hypertension by 3.4% (Kim *et al.*, 2019; Oh *et al.*, 2019; Eriksson *et al.*, 2012).

Exposure to a high level of noise can result in hormonal dysfunction and can also contribute to an increase in blood pressure, which can have a negative impact on the body's cardiovascular system (Said, El-Gohary, 2016; Münzel, Sørensen, 2017). According to several researches, those who are exposed to high levels of road traffic noise are more likely to develop hypertension (Chang *et al.*, 2011). Ashin *et al.* (2018) noted that the road traffic noise has been related to an increase in gestational diabetes mellitus, which may lead to a glucose intolerance that occurs during the beginning of pregnancy, hence affecting pregnancy.

Bengaluru, the capital of Karnataka, is known as India's "Silicon Valley." Many individuals are migrating to Bengaluru from all around India because of job prospects. As the population grows, the needs and demands grow as well. Bengaluru has a high vehicle density during business hours (Manjunatha *et al.*, 2019), which could become a major source of sound and noise. Several studies have also found that the average noise level in various cities surpasses the limitations set by India's Central Pollution Control Board (Bhosale *et al.*, 2010; Banerjee *et al.*, 2008; Vidya Sagar, Nageswara Rao, 2006; Kisku *et al.*, 2006; Jamir *et al.*, 2014). According to the TomTom (2020), Bengaluru was among the top 10 cities worldwide in terms of traffic congestion in 2020, amid the COVID-induced lockdown bringing traffic congestion to a halt.

The WHO declared the novel coronavirus (2019-nCoV) epidemic a public health emergency of international concern (PHEIC) at the end of January (WHO, 2020). Its outbreak is likely spread from Huanan Seafood Market, Wuhan, Hubei Province, China (Harekrishna, 2020). The global epidemic has spread to over 216 countries, states, and territories as of June 25, 2020, resulting in over 9,527,123 infected cases and 484,972 deaths (WHO, 2020). The Indian government began a 14-hour citizen-led voluntary social distancing campaign (Janata Curfew) on March 22, 2020 (07:00 AM–09:00 PM IST), excluding crucial services, because of a dearth of immunization in India (such as medical services, police forces). Furthermore, because the disease's spread was thought to be imminent, the Indian government imposed a mandatory lockdown with no cross-border movement both inside and outside the country (intrastate and interstate) and rigorous social isolation measures (Somani *et al.*, 2020). To control the spread of the coronavirus, all public and private services, such as transportation, educational institutions, recreational facilities, and industries, were completely shut down during that time. Life requirements such as dispensaries, pharmacies, vegetable and fruit shops, daily needs grocery stores, and petrol pumps were the only services allowed to function under the lockdown safety rules (Lokhande *et al.*, 2021). During the lockdown, the administration has initiated regular surveillance across the country, including Bengaluru city. The post-lockdown phase, on the other hand, saw all of the previously imposed limitations lifted save for the closure of educational institutions such as schools, colleges, and coaching centres. In addition, community or religious gatherings were limited, and public transit, such as buses, trains, and flights, was only half full (Government of India, 2020). COVID-19 has a negative impact on human health and the world economy, but it also helps to minimize pollution by restricting social and economic activity (Dutheil *et al.*, 2020). Global economic activities came to a stop as countries went into lockdown. Due to the lockdown, transportation is among the worst-affected sectors. Road and air travel came to a halt as people are either unable or unwilling to travel (Arora *et al.*, 2020). According to the survey, COVID-19 caused a 96% decrease in air traffic, the lowest in 75 years (Wallace, 2020). Noise pollution has decreased as a result of the COVID-19 lockdown. The Times of India, a reputable news source, reported a lower noise level (~30–40 dB) in residential areas, and (~50 dB) in crowded metro stations (Gandhiok, Ibrar, 2020). Airports, bustrain stops/stations in India handle approximately 7800 flights, 528,333 buses, 13,452 passenger trains, and 9141 freight trains per day (Phadnis, 2020), of which only a small fraction of air traffic and freight trains were running during COVID-19 lockdown, and the live monitoring of Indian Railways' dashboard, India's largest national transporter with 22 million passengers per day, showed zero passengers or mail express trains under operation on 2 February (Dutta, 2020). With the suspension of the train operation comes an instantaneous reduction in train horn frequency, which is limited to 100 and 96 dB, respectively, during the lockdown period (Singh, 2020).

According to a survey of the literature, noise levels were dramatically lowered during the COVID-19 pandemic because all industrial and commercial activities were shut down, resulting in less automobile, rail, and air traffic. Noise levels were reduced by 2 to 6 dBA during the COVID-19 lockdown period in Dublin, Ireland, Spain, and London (Asensio *et al.*, 2020; Aletta *et al.*, 2020; Basu *et al.*, 2021). Girona, a town in the northeast Spain, reported a large reduction in noise levels in the nightlife districts during the same time period, while commercial and traffic-heavy areas saw moderate-to-low reductions. The reduction in ambient noise in the port of Koper (Slovenia) was documented in a study (Čurović *et al.*, 2021) and reduced public dissatisfaction due to airplane noise at dwellings near the International Airport of Lima (Peru) are two additional notable achievements (Montano, Gushiken, 2020). Mishra *et al.* (2021) discovered that the effect of road traffic noise on the risk of high annoyance and sleep disturbances was lower during lockdown than during the pre-lockdown and unlock phases, and the risk of sleep disturbances in the residential area was reduced from 37.76% during the pre-lockdown phase to 14.72% during the lockdown phase in Kanpur. Mimani and Singh (2021) reported noise variation in only two noise stations of Bengaluru namely, Peenya Industrial Area and Domlur Residential Area during the lockdown period. However, the noise variation of all ten noise monitoring stations of Bengaluru city was published in the online portal of the Karnataka state pollution control board. Therefore, the primary objective of this paper is to study the impact of complete lockdown on the noise pollution of Bengaluru city by comparing noise levels during the pre-lockdown, lockdown, and different phases of post-lockdown in the year 2020 and to evaluate the present trend of noise in Bengaluru city.

2. Location of the study

The research was conducted in Bengaluru, the capital of Karnataka, which is located in the southern India on the Deccan Plateau at an elevation of nearly 900 meters (3000 feet) above the sea level and has a good climate all year. It has an area of 741 km^2 and is located at 12.97°N and 77.56°(286 sq mi). In the present scenario, the noise level of Bengaluru is monitored by 10 Continuous Noise Monitoring Stations located throughout the city (Fig. 1).

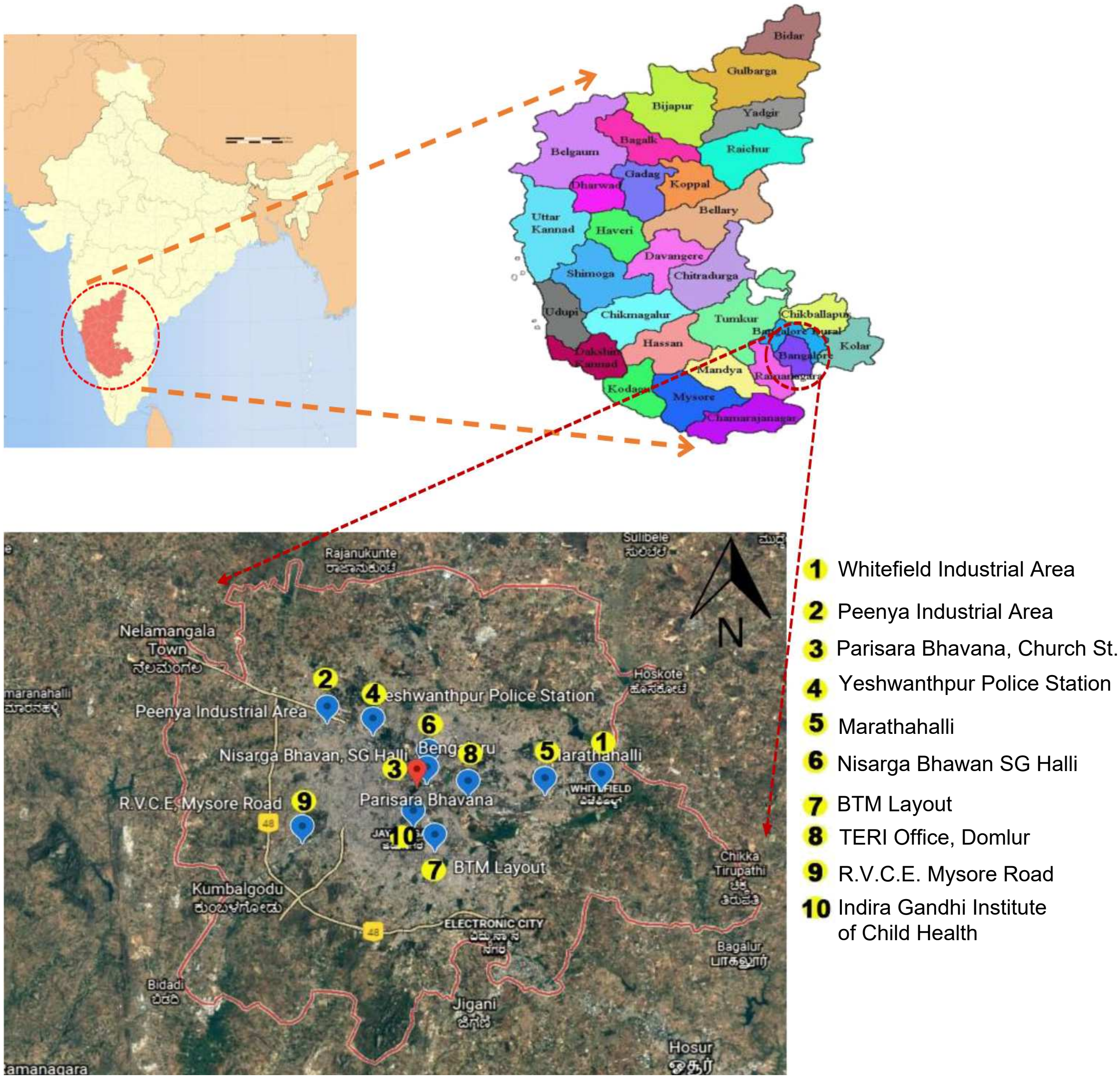

Fig. 1. Map showing the study area along with monitoring stations (source: Google Earth "Map data ©2022 Google, Maxar Technologies").

3. Material and methods

3.1. Data collection and analysis

The Monitoring Stations under National Ambient Noise Monitoring Network (NANMN) was established in Bengaluru city to optimize the nature and impact of lockdown on noise pollution in the ten strategic locations as given in Figs 1 and 2. Industrial, commercial, residential, and silent zones are the four categories in which these sites are classified. The industrial areas include Whitefield Industrial Area and Peenya Industrial Area. The commercial areas include KSPCB Office, Parisara Bhavana in Church Street, Yeshwanthpur Police Station, and an eastern suburb, i.e. Marathahalli. The residential areas include Nisarga Bhawan, SG Halli, BTM Layout, and The Energy and Resources Institute (TERI) Office in Domlur. While Indira Gandhi Institute of Child Health, near National Institute of Mental Health and Neuro Science (NIMHANS) and RV College of Engineering (RVCE), Mysore Road are silence zones by being a hospital and an educational institution, respectively.

Geonica Earth Sciences, Spain (Geonica, n.d.) manufactured and deployed the Noise Monitoring System (NMS), which measures real-time noise and can simply manage a large number of stations. NMSs are designed for use in all climates and are suited for outdoor usage with compact, custom-built enclosures. The NMS, which may be mounted on a mast, includes a waterproof cabinet with a noise level analyzer and a battery, a communication device for sending data to a receiving station, a backplate, and an external microphone (for measuring sound). The NMS comes with

Fig. 2. Aerial photographs of selected NANMN locations
(source: Google Earth “Map data ©2022 Google, Maxar Technologies”).

one battery, but if there is no acceptable local power source or the main power is disrupted, two extra batteries can be added. When the NMS is connected to an external AC or DC source, the batteries are charged. The NMS can be powered by a number of different sources, including solar panels connected via the DC supply input. Data retrieval with both automatic and manual operations, as well as data storage in a SQL database, were completed to allow users to do data analysis and processing. Longitude, latitude, and height can be tracked and saved in the NMS along with noise measures using a normal commercial GPS receiver and antenna unit.

Data from the NMS is sent over GPRS to the main server (Central Receiving Station). The central receiving station receives data through GPRS from all distant stations, analyses the noise data, and generates various reports (National Ambient Noise Monitoring Network [NANMN], 2016).

The noise monitoring and measurements were performed in calm climatic conditions for precise and accurate readings. The data obtained from the site, accuweather.com, revealed that the weather conditions were mostly similar for all measurements in COVID-19 phases in Bengaluru city. As noise pollution is linked to health problems, just ten sites are insufficient to represent the city's entire noise situation. So, in order to consolidate the study, there should be a demand to increase the number of noise monitoring stations at other locations, including other noisy and crowded areas of Bengaluru city, such as Banashankari, the city's busiest locality with "Banashankari Amma Temple", and Koramangala, which is dotted with opulent shopping malls.

The fluctuation in the mean concentration of noise levels was studied in five phases in the year 2020 from the pre-lockdown phase (1st March to 23rd March) to lockdown period (24th March to 15th May) and early post-lockdown (1st June to 31st July), mid post-lockdown (1st August to 30th September), and late post-lockdown (1st October to 30th November) to evaluate the present trend of noise in Bengaluru city.

3.2. Equivalent sound pressure level (L_{eq})

Equivalent sound pressure level (L_{eq}) is the statistical value of sound pressure level that can be equated to any fluctuating noise level (NANMN, 2016). It is formulated to describe the time-varying nature of transportation noise into equal steady-state noise levels, which for a defined period contains the same acoustic energy as the time-varying noise (Cohn, McVoy, 1982):

$$L_{eq} = 10 \log \sum_{i=1}^{i=n} (10) \frac{L_i}{10} x t_i / t_t, \tag{1}$$

where L_{eq} is equivalent continuous equal energy level, n is number of sound samples, L_i is the noise level of any i-th sample, t_i is time duration of the i-th sample, t_t is total time period of the event.

L_{eq} is also described as a steady noise level that expands the same amount of energy over time as fluctuating levels do. A sound level meter with a "flat" response monitors sound pressure levels and reflects the strength of low-frequency noises with the same emphasis as higher-frequency sounds. Therefore, the sound meter is equipped with a frequency-weighting filter. The human ear does not respond equally to all frequencies, with low and high frequencies being less efficient than medium range frequencies. To obtain a sound level that covers a wide range of frequencies and conforms approximately to the response of the human ear, a frequency weighting filter is used. The sound level obtained as a result is A-weighted sound. Therefore, we measure sound level as L_{eq} [dBA] (NANMN, 2016).

4. Results and discussion

For a better understanding of the changes in noise level as a result of nationwide lockdown in India, the corresponding noise level data were further classified into five categories (according to pre-lockdown, lockdown, and different periods of post-lockdown). Data processed between the 25th of March and the 31st of May 2020 (India's nationwide lockdown declaration) can be classified as "lockdown", while data processed prior to the 25th of March 2020 is classified as "pre-lockdown", and data processed after the 31st of May 2020 is classified as "post-lockdown." In this study, the post-lockdown period is divided into 3 parts, i.e. early post-lockdown (June – July 2020), mid post-lockdown (August – September 2020), and late post-lockdown (October – November 2020), respectively. Table 1 shows an overview of L_{eq}'s statistical features throughout the different periods of shutdown. The L_{eq} sound levels for all zones during pre-lockdown are in the 52.6–76.7 dB range, and then the range slightly decreased during lockdown (51.9–67.5 dB). The L_{eq} sound levels were slightly increased during different phases of post-lockdown for all zones.

The equivalent continuous noise level data of ten locations were averaged over L_{eq} during the daytime, and its noise variation was observed during different phases of lockdown as presented in Fig. 3. During the pre-lockdown period the average noise level was observed more than the prescribed limit set by the Central Pollution Control Board (CPCB) of India for all zones except the industrial zone. During the lockdown period, the average noise level of the commercial zone was reduced drastically and the L_{eq} value was under permissible limit whereas the L_{eq} value of industrial, residential, and silence zones was slightly decreased. The noise level in all three phases of post-lockdown was more than the prescribed limit in the residential and silence zones, whereas in the industrial and commercial

Table 1. Statistical summary of L_{eq} [dB] during different phases of lockdown.

Zone	Pre-lockdown			Lockdown			Early post-lockdown			Mid post-lockdown			Late post-lockdown		
	L_{eq}	L_{min}	L_{max}	L_{eq}	L_{min}	L_{max}	L_{eq}	L_{min}	L_{max}	L_{eq}	L_{min}	L_{max}	L_{eq}	L_{min}	L_{max}
Industrial															
I	65.2	43.7	78.3	59.3	44.4	75.8	63.5	54.2	77.3	63.4	56.5	77.5	62.2	41.5	94
II	61.9	45.4	77.1	57.1	40.9	82.1	62.8	47.6	79.2	63.1	46.5	78.4	62.7	44.5	90.7
Commercial															
I	65.3	41.3	77.1	58.3	41.9	75.5	62	50.3	75.3	64.9	54.1	76.3	61.5	49.9	80.6
II	70.9	47.5	77.1	65	48.1	84.5	67.8	52.7	83.2	69.3	62.4	83.8	69.5	59.6	92.6
III	76.7	43.1	100	65	46.9	95	49.7	43.2	71	54.8	19.1	87.1	58.7	3.4	104
Residential															
I	52.6	41.1	91.1	52.4	35.8	98.2	59.3	44.1	91.6	57.8	38.2	97.6	72.1	45.6	132.7
II	64.4	44.8	86.8	63.1	47.1	94.2	47.8	38.1	69.6	48.7	38.9	94.1	38.8	19.2	81.1
III	61.4	38.2	77.1	59.1	37.8	82.3	61.9	48	79.7	62.3	50.1	78.7	58.5	42.7	88.8
Silence															
I	56.2	40.7	83	51.9	42.5	81.7	55.1	47.5	88	66.9	50.5	87.8	68.7	46.8	95.2
II	66.9	36.8	101	67.5	35.4	110	59.4	33.4	91.2	58.6	38.1	90.8	59.6	20.9	104.1

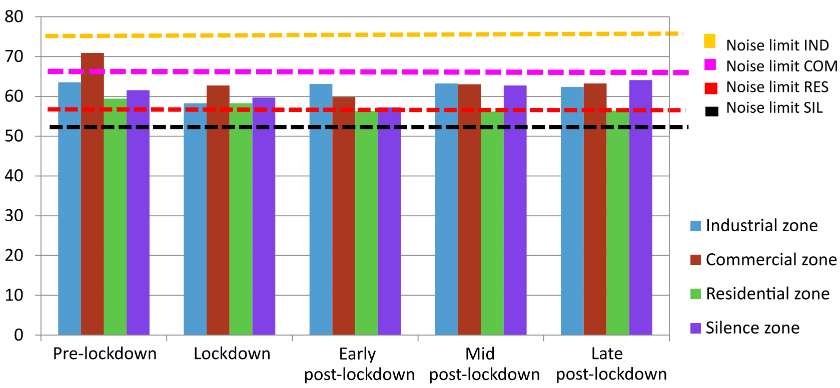

Fig. 3. Noise variation in L_{eq} [dB] observed during different phases of lockdown.

areas noise levels were under a permissible limit following a similar trend as observed during the lockdown period. Similar findings were observed by Lokhande *et al.* (2021a), Mishra *et al.* (2021), and Mimani and Singh (2021).

The Student's *t*-test was used to compare the mean noise level observed between the pre-lockdown and lockdown, lockdown and early post-lockdown, early post-lockdown and mid post-lockdown, and mid post-lockdown and late post-lockdown. The results revealed that the noise levels did not vary significantly at any of the lockdown phases in 2020.

Figure 4 represents the average percentage change in L_{eq} values of Bengaluru from the pre-lockdown to post-lockdown phases. The results revealed that an average maximum reduction of 11.5% was found in the commercial areas followed by industrial areas whereas the minimum reduction (2.02%) was observed in the residential areas from the pre-lockdown to lockdown. This can undoubtedly be linked to a significant reduction in traffic, stringent restrictions on individual movement, and business closures, the effects of which could be seen in the residential and quiet zones (Mishra *et al.*, 2021). One of the most significant causes of noise in Indian cities was the movement

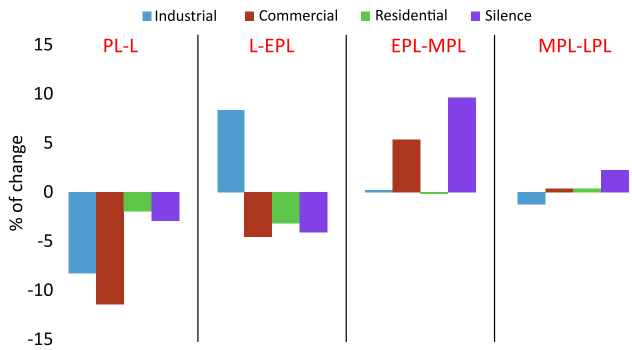

Fig. 4. Average % change in L_{eq} values of Bengaluru from the pre-lockdown to post-lockdown in the year 2020. Comparison of the percentage change during post-lockdown, lockdown, and pre-lockdown periods in the year 2019 and 2020.

of individual and commercial transportation (Mishra *et al.*, 2010) which is also one of the reasons behind the drastic decrease of noise pollution in commercial areas during the lockdown period. Similar observations were reported by Mishra *et al.* (2021), and Mimani and Singh (2021). Thus, the reduction of the number of vehicles on roads has immensely helped in lowering noise pollution. Results also showed that, due to the lockdown, the average reduction in noise level at both sites of the industrial areas, i.e. Whitefield Industrial Area and Peenya Industrial Area, was 8.3% which might be due to the closure of industrial activities as industrial machinery and processes are composed of various noise sources such as rotors, stators, gears, fans, vibrating panels, turbulent fluid flow, impact processes, electrical machines, internal combustion engines, and so on (Gerges *et al.*, 2001). Moreover, during the lockdown, most industrial regions were closed, with only a few units engaged in vital item deliveries remaining operating. Furthermore, because many units were shut down, noise pollution in industrial regions was reduced (Peeyush, 2020). Noise pollution from large industrial sources, such as stone quarries, has dropped dramatically in the months since COVID-19 was lifted (Mandal, Pal, 2020; Derryberry *et al.*, 2020). Changes in the sound levels also show a decrease in sound during the lockdown, followed by an increase after the lockdown phase (Mishra *et al.*, 2021).

However, in the early post-lockdown phases (1st June – 31st July), the average noise level was increased by 8.41% in the industrial areas compared to the lockdown phase. This could have been caused by the movement of heavy vehicles through the narrow roads (e.g. Kundalahalli Main Road, Hoodi Main Road, and Nelamangala Majestic Service Road) as at this period more industrial units were open.

The result revealed that the average noise level was increased by 9.6% in the silence zone, 5.3% in the commercial zone and slightly increased in the industrial areas during the mid post-lockdown phase (1st August – 30th September) compared to the early post-lockdown phase except in the residential areas. The average L_{eq} value was declined in the residential areas during mid lockdown phase which might be due to the closure of educational institutions including schools, colleges, coaching centres etc., as well as the restrictions placed on community/religious events. Furthermore, public transit, such as buses and railroads, was only partially functional (Lokhande *et al.*, 2021a). In the silence zone the increase in the average percentage of L_{eq} was observed, as these zones are surrounded by hospitals. While maintaining social distance standards, commercial and industrial establishments such as industries, retail malls (Royal Meenakshi Mall, Ascendas Park Square Mall, Phoenix Market City, etc.), cinema halls (Urvashi theatre, Cinepolis Multiplex, etc.) were progressively reopened so the increase of 5.35% and 0.15% was observed in these areas.

During the late post-lockdown period, the average percentage of L_{eq} was slightly increased in all zones except the industrial areas which might be due to containment measures adopted by the Karnataka State government as the local increase in infections was reported. Similar findings were observed by Mimani and Singh (2021) in Guindy, an industrial area in Chennai.

ANOVA of overall average percentage change in different phases of the year 2020 shows that the noise level did not differ significantly at all study sites.

Figure 5 represents the comparison of noise data of ten different locations during the years 2019 and 2020. From this figure, we can observe that the sound levels in all zones were reduced significantly during the lockdown period in the year 2020 as people were following the strict lockdown guidelines. However, as noise terminals in these areas are located in the vicinity of a major highway or near a traffic intersection point facing the road, there was a marginal increase in noise level in the industrial area during the lockdown to early post-lockdown period, i.e. 8.4% in the year 2020, as compared to the corresponding year of 2019, where all zones percentage increase in the noise level was observed, as noise terminals in these areas are located in the vicinity of a major highway or near a traffic intersection point facing the road. During the early post-lockdown and mid post-lockdown percentage decrease in noise level was observed in all areas in the year 2019, as Bengaluru citizens were strictly following noise guidelines. But in 2020, a sharp increase of percentage in noise level was observed in the industrial area (0.15%), commercial area (5.35%), and silence area (9.61%), whereas in the residential area, a decrease of 0.17% of noise was observed. This could be possible because educational places and businesses followed the "work from home" concept and also there was a reduction in traffic. Then during the mid post-lockdown and late post-lockdown period, the percentage increase in the noise level was observed in all areas in both years, however, in 2020, a decrease of 1.26% was observed in the industrial area.

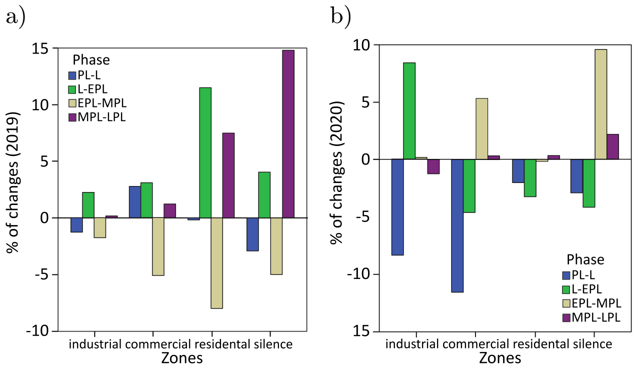

Fig. 5. Comparison of noise during pre-lockdown, lockdown, and post-lockdown period during 2019 (a) and 2020 (b).

5. Conclusions and recommendations

Based on the data collected by the National Ambient Noise Monitoring Network, this paper outlines the influence of lockdown in India on the noise levels, as well as the magnitude of variations in the noise levels in the industrial, commercial, residential, and quiet zones of Bengaluru city (NANMN, 2016). The study's main goal was to look at how noise levels changed during different stages of lockdown. At all ten noise monitoring locations (i.e. the early post-lockdown, mid post-lockdown, and late post-lockdown), the results showed a significant reduction in noise levels during the lockdown phase compared to the pre-lockdown and post-lockdown phases, which could be due to a ban on industrial activities, air and road transportation, and service sector companies during the lockdown and a partial resumption of these activities after the lockdown amidst the pandemic. Another cause could be that Bengaluru is experiencing severe traffic noise pollution as a result of urbanization and a significant increase in the number of vehicles, as well as an inadequate road network. During the lockdown, a reduction in the noise level was observed in all monitoring stations of Bengaluru, except for the Indira Gandhi Institute of Child Health. Because this quiet zone monitoring station is bordered by hospitals and medical institutions, continuous exposure to excessive noise can have a severe impact on healthcare safety and quality, as well as cause hospital patients to heal and recover more slowly. However, when the lockdown constraints were lifted from the early post-lockdown period to the late post-lockdown period, the noise levels in the commercial, residential, and silence zones increased, following a similar trend to the pre-lockdown period. Also, during lockdown stages, all four zones, namely industrial, commercial, residential, and silence, had a reduction in noise levels, which were significantly lower than the same period in 2019.

The findings of this study also show that stringent traffic reduction strategies such as a no-honking policy, for short trips, substituting active modes like cycling and walking for motorized private transportation, parking management, and restricting access for the noisiest vehicles can minimize noise pollution, improve road safety, give recreational value to all users, and promote community health (Mishra *et al.*, 2021). Furthermore, as the city has grown rapidly, the noise level mapping is a vital tool for obtaining a visual map of the sound contours of a specific area for the management and control of environmental noise (Manwar *et al.*, 2017). Because the noise level in the silent zone has increased, traffic officials and departments responsible for noise reduction should take immediate action to limit noise pollution near the hospitals. As a result, a city-wide noise monitoring network should be created at the local and regional levels, and a noise reduction strategy should be developed based on the data collected by these monitoring stations. Furthermore, more research may be required to address the long-term effects of noise pollution and provide an overall sustainable transport infrastructure.

Acknowledgments

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The authors are thankful to members of the Environmental Biology Laboratory, Department of Zoology, Patna University. This research did not receive any funding.

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