e-ISSN No.: 2582-4228

Journal of Indian Association for Environmental Management

Journal homepage: www.http://op.niscair.res.in/index/php/JIAEM/index

Compliance of Noise Standards during COVID Pandemic in Residential and Silence Zone at NEERI Campus, Nagpur

Vijaya Laxmi[1, 2], Chaitanya Thakre[1,2], Ritesh Vijay[1*]

[1] CSIR-National Environmental Engineering Research Institute, Nagpur 440020, Maharashtra, India

[2] Academy of Scientific and Innovative Research (AcSIR), Ghaziabad 201002, India

[*] Senior Principal Scientist and Head, Wastewater Technology Division

*Corresponding Author: r_vijay@neeri.res.in

Submitted: 21 April 2022 Revised: 02 June 2022 Accepted: 20 June 2022

Abstract: **Lockdown due to COVID-19 pandemic is imposed all over the countries for the containment of corona virus disease worldwide. Hence all forms of transport (trains, flights, and automobiles), industrial activities, shopping malls, and social activities, except essential commodities and services, are restricted according to lockdown policies. Such cumbersome constraints influenced the economic circumstances of the country. At the same time, environmental conditions are enhanced temporarily, which can be considered as a silver lining. A research study is executed to quantify the consequences of lockdown on the noise pollution levels in NEERI campus, Nagpur. During the lockdown conditions, the noise monitoring was conducted at 3 locations (1 source – National Highway and 2 receptors– residential and silence zone). Further, the noise levels during lockdown conditions are compared with noise levels prevailing in pre-lockdown conditions. A significant reduction of 10 dB (A), 6.9 dB(A) and 4.3 dB(A) during the day time and 11.3 dB(A), 10 dB(A) and 3.1 dB(A) during the night time are observed at National Highway, residential zone and silence zone respectively. The study reveals that during lockdown conditions, the noise level plunged below the prescribed legal limit for the residential zone as well as for the silence zone. As an outcome of this lockdown, noise pollution has reduced immensely, the dominant reason being a decrement in the traffic volume, which also entails a reduction in honking. The study revealed that prescribed legal noise level standards are achievable, which failed to comply for many decades. In such a case, the study stipulates a new dimension of thought process to control noise pollution in urban areas, promoting sustainability with acoustical comfort. Many aspects of the current lockdown can be carried forward and reconstructed to be comprehended in the post lockdown scenarios.**

Keywords**: Noise, Noise pollution, Covid-19, pandemic, environment, traffic**

I. INTRODUCTION

The world is seriously facing humanitarian crises due to novel coronavirus (COVID-19) which causes recently identified severe acute respiratory syndrome (SARS) [1]. An outbreak that took place in Wuhan, China has been spread all over the world. Epicenter of the virus has been shifted to Europe and United States from China [2]. As on 24th April 2020, around 16 lakh people have been infected with COVID-19 and about 1 lakh people have lost their lives in the whole world [3]. Rate of advancement in numbers of new cases and deaths is alarmingly high with no sign of curtailment yet [4]. Undoubtedly this virus has pushed the world's economy to its lowest downfall which will result into increment in unemployment condition for more than 25 million peoples by the end of 2020, depending upon the recovery rate of the economy [5]. Many countries took the initiative to control the spread of COVID-19 by partial or complete lockdown after an announcement made by World Health Organization (WHO) declaring the outbreak as "pandemic" [6].

India has put all its effort to slow down the spread of corona virus but still, India has more than 23 thousand confirmed cases of COVID-19 till date (24/04/2020) [7]. To stop the imminent spread of a highly contagious virus country was imposed with nationwide lockdown [8]. The first phase of lockdown was imposed from 24 March 2020 to 14 April 2020 [9]. Almost 130 crores of Indian population were made to stay inside their respective homes to obstruct the spreading infection chain [10]. The lock down restricts the movement of peoples, closing down industrial establishments, educational institutions, business etc. except vehicles falling under essential services are permitted to move [8]. Every coin has two faces, though we are facing the global pandemic crises, on the

other hand, we have got the temporary remedial effects from suffocating pollution levels in India [11]. Data shows that 71% reduction in concentration of PM 2.5 and NO_x was observed during the lockdown which implies that somehow COVID-19 scenario has a silver lining [4]. The reason for this major reduction in pollutants was huge plunge in transportation activities as almost all modes of transportation came to standstill. Due to these two different scenarios viz. pre-lockdown and ongoing lockdown, hence taking advantage of the circumstances, noise pollution levels are measured in two distinct situation of transportation mobility. Lockdown has also helped in temporary tackling of noise pollution in the country. In India since last one month, reduction in vehicular volume hence fewer honking incidents, echo of loudspeakers, buzzing of machinery and limitations on certain human activities has curtailed noise as well as air pollutant.

The increasing trend of urbanization, modernization, increment in traffic volume, increase in transportation facilities and industrialization appears as the contributing factors towards rising levels of noise pollution in the country [12,13]. Noise in the locality is the outcome of numerous human activities, vehicular noise being the major contributor [14]. Traffic noise is responsible for approximately 66% of total urban noise pollution which is deteriorating the quality of life[15]. The traffic noise mainly depends on honking, traffic composition, vehicular speed and road surface [16, 17].

According to published research, noise is directly proportional to traffic volume, implying that traffic noise grows in tandem with traffic volume [18]. Noise levels are already found to be above the permissible limits in different zones of the Nagpur city, especially on traffic junctions during pre covid sessions [19]. According to Lokhande et. al 2021 for Nagpur city, the noise level was increased by 7.6 dB and 7.1 dB in the residential and along the highways respectively during the post lockdown conditions [20]. The major impact of pandemic lockdown on the city's noise pollution level results in an 8.0 dB reduction in ambient noise level. During the lockdown conditions, the impact of road traffic noise on the high annoyance and sleep disruption was found to be lesser due to the lower number of vehicles on the road [21]. In the research study, an attempt has been made to assess noise pollution during the lockdown and pre- lockdown conditions in and around NEERI Campus area in Nagpur, Maharashtra.

Study Area

The study area extends between 21° 7' 15" to 21° 7' 30" N latitude and 79° 4' 0" to 79° 4' 15" E longitude in Nagpur City, Maharashtra, India [22]. The study area constitutes the three categories as a national highway (NEERI Gate No.1), residential area (NEERI Colony) and silence zone (NEERI office campus) around the research institute named CSIR-NEERI which is shown in Fig 1.

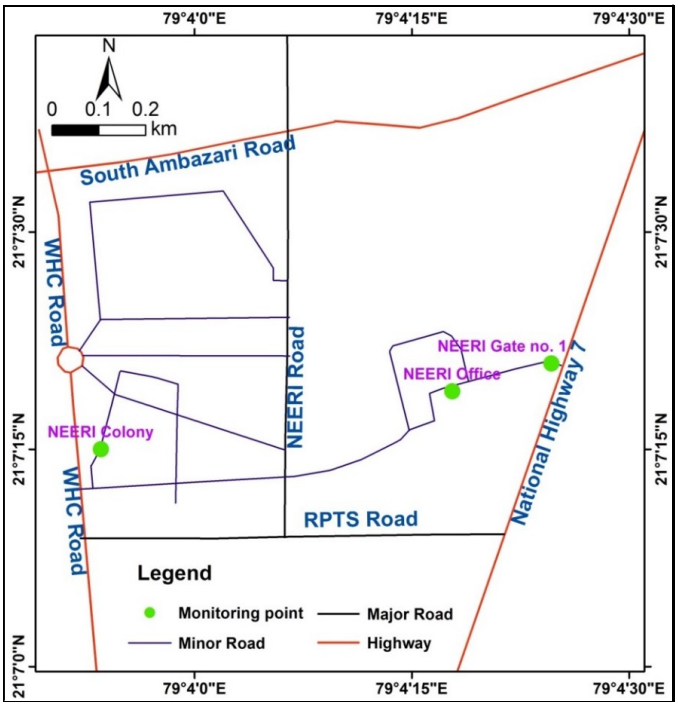

Fig 1: Study area and noise monitoring locations

II. METHODOLOGY

Data Collection

Noise monitoring was conducted at 3 locations on January 24, 2020, and April 24, 2020, as the pre-lockdown condition and during lockdown conditions respectively. Noise measurement was carried out through calibrated sound level meter with 'A' weighing on fast response on data logging set at 1s interval [23]. The sound level meter was installed at 3 locations falling along national highway (source), residential area (receptor) and silence zone (receptor). The sound meter was placed in front of CSIR-NEERI main entrance (Gate no. 1) along NH-7 which falls under the national highway category. For residential zone monitoring, the sound meter was placed inside NEERI colony, Laxmi nagar. One sound meter was placed in CSIR-NEERI office campus which is considered under silence zone. Continuous monitoring was performed for 24 hours during daytime (06:00 hrs. To 22:00 hrs.) and night time (22:00 hrs. To 06:00 hrs.) as specified in Noise Pollution Rules at respective locations [24]. Field picture of installed sound levels meter along NH-7 is shown in Fig 2.

Data Analysis

After the collection of noise data, different noise metrics were evaluated to represent the noise environment at respective categories. L_{eq}, L_{max}, L_{min}, and L_{90} were calculated for 24 hours (day and night time) at each location during both pre-lockdown and lockdown conditions, which are shown in Table 1. L_{eq} is the most common noise indicator which represents total acoustic energy over a particular time slot. L_{min} and L_{max} are the minimum and maximum sound levels in a particular monitoring period respectively. L_{90} is sound levels which fall at 90% of particular monitoring period and also called background noise [25]. L_{eq} was calculated on an hourly

basis and compared between lockdown and pre-lockdown condition, which is shown by graphically in Fig 3 to Fig 5.

Pre-lockdown During lockdown

Fig 2: Sound Level Meter Installed at NEERI Gate No. 1 (National Highway) during Lockdown and Pre-lockdown

Distribution of Equivalent Noise Level

For explicit analysis of the noise scenario, the noise equivalent level (L_{eq}) were analyzed with the interval of 1 minute for the respective monitoring locations. Since the monitoring was conducted for 24 hours (1440 minutes), per minute calculation of L_{eq} revealed 1440 readings. During monitoring, the daytime was considered to be from 0600-2200 i.e., 16 hours, and the remaining 2200-0600 i.e., 8 hours at night time. Hence 960 L_{eq}'s for daytime and 480 L_{eq}'s for night time defines precisely the variation of noise level throughout the day when comparing the lockdown and pre lockdown conditions at monitoring locations.

III. RESULTS AND DISCUSSION

During pre-lockdown conditions, L_{eq} was recorded to be 73 dB (A) and 67.7 dB (A) for morning and night time, with the peak value of 93.3 dB (A) and 90.9 dB (A) respectively along national highway (NEERI Gate no. 1) as tabulated in Table 1. Comparing the pre-lockdown and during lockdown conditions, L_{eq} was reduced from 73 to 63 dB (A) and 67.7 to 56.4 dB (A) during day and night time in lockdown condition. A significant difference in noise level for two different scenarios i.e. pre lockdown and during lockdown can be observed in Fig 3. This momentous reduction in noise level is due to reduction in traffic volume on particular National highway as traffic volume on respective highway is almost 4500-5500 per hour during peak hours on working days [26].

A 3 dB increase in sound level implies doubling of sound energy. Hence the reduction in L_{eq} of both the sessions by 10-11.3 dB (A) brings downs the sound energy by a larger margin. Reduction of L_{min} from 51.8 to 40.6 dB (A) and 43.1 to 38.8 dB (A) in morning and night time respectively conveys that apart from vehicular noise other noises also exist due to different activities in the vicinity. L_{90} also termed as background noise also falls from 64.4 to 49.9 dB (A) and 50.9 to 43.9 dB (A) during day and night time respectively.

TABLE 1
Noise Monitoring Data during Lockdown and Pre-lockdown Condition

Monitoring points	Session	Noise during pre-lockdown dB(A)				Noise during lockdown condition dB(A)			
		L_{eq}	L_{max}	L_{min}	L_{90}	L_{eq}	L_{max}	L_{min}	L_{90}
NEERI Gate no. 1	Day	73.0	93.3	51.8	64.4	63.0	89.2	40.6	49.9
	Night	67.7	90.9	43.1	50.9	56.4	80.7	38.8	43.9
NEERI Colony	Day	57.4	85.3	45.5	49.2	50.5	79.5	34.8	41.4
	Night	55.9	79.1	44.4	46.4	45.9	74.5	37.4	39.6
NEERI Office	Day	54.6	73.3	38.7	45.2	50.3	70.3	38.1	42.9
	Night	47.7	62.4	36.6	40.8	44.6	61.5	36.4	40.7

The prescribed limits as per Noise Pollution (Regulation and Control) Amendment Rules, 2017 in residential areas are 55 dB (A) and 45 dB (A) during daytime and night time respectively. During the pre-lockdown condition, L_{eq} was recorded 57.4 dB (A) and 55.9 dB (A) for day and night time respectively in NEERI colony. Recorded noise levels were beyond permissible noise standard. L_{eq} was observed to be 50.5 dB (A) and 45.9 dB (A) for day and night time respectively during lockdown condition. Recorded noise levels were below the prescribed noise standard during lockdown condition due to decrement in anthropogenic activities outside the building premises. L_{eq} of every hour is shown in Fig 4, during the lockdown period, the L_{eq} value ranges from 43.5 to 55.1 dB (A) whereas it ranges from 46.4 to 62.7 dB (A) in pre-lockdown. There is a difference of around 7 dB (A) when comparing in both the conditions at NEERI colony.

L_{eq} was recorded 54.6 dB (A) and 47.7 dB (A) for day and night time respectively, during the pre-lockdown condition in NEERI office. Comparing the pre-lockdown and during lockdown conditions, L_{eq} was reduced from 54.6 dB (A) to 50.3 dB (A) during the daytime in lockdown condition which

obey the prescribed standard as per Noise Pollution (Regulation and Control) Amendment Rules, 2017 for silence zone (50 dB(A) for daytime and 40 dB (A) for night time). Reduction in L_{eq} was 3.1 dB (A) during night time in lockdown condition in NEERI office.

Fluctuating L_{eq} of every hour is shown in Fig 5; there was not much difference between the two phases in case of NEERI office. This may be attributed to the fact that there is not much effect of traffic on this location as it is at a significant distance from the road as shown in Fig 1. But the reduction in L_{eq} of 24 hour (day and night) is due to the fact that office premises were closed and the entrance of officials was minimized due to lockdown conditions.

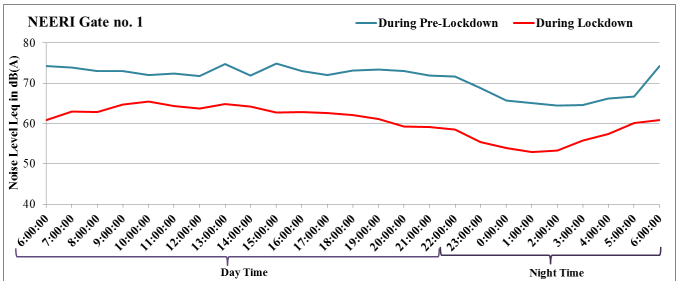

Fig 3: Comparison of Noise level during Lockdown and Pre-lockdown at NEERI Gate No. 1 (National Highway)

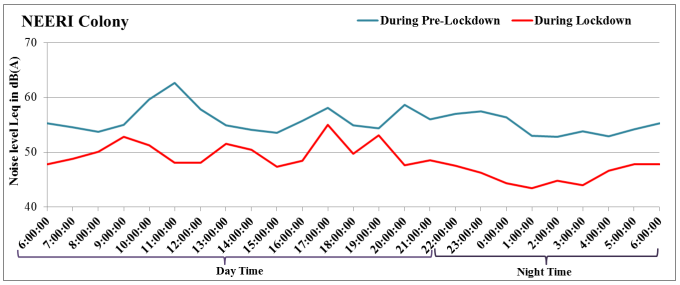

Fig 4: Comparison of Noise level during Lockdown and Pre-lockdown at NEERI Colony (Residential area)

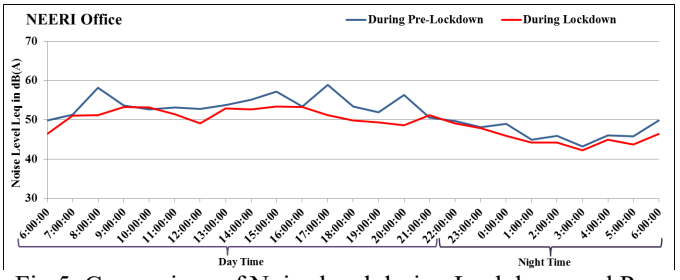

Fig 5: Comparison of Noise level during Lockdown and Pre-lockdown at NEERI Office (Silence zone)

Distribution of Equivalent Noise Level

As mentioned earlier, L_{eq} was calculated with the interval of one minute during the whole monitoring period of 24 hours. For location NEERI Gate No.1 as shown in Fig.1, the distribution of equivalent noise level is shown in Fig.6. In the pre-lockdown period, during the daytime, not a single L_{eq} was observed to be below 60 dB (A). This may be due to the reason that this monitoring location is placed near a busy highway that has a high traffic volume during daytime. The most dominating range was 70-75 dB (A) with a maximum percentage of 48.8%. 4 instances were observed where the L_{eq} level surpassed the colossal noise level of 85 dB (A). During night time, the range 65-70 dB (A) dominated the session with 34.6%. Unlike the daytime session, 22.5% of L_{eq} readings were observed to be below 60 dB (A) for the night session. Hence L_{eq} is lower for night time as compared to daytime as shown in Table 1. Noise range of 65-70 dB (A) and 70-75 dB A) dominated with a share of 35.8% and 36% respectively in 24-hour noise equivalent distribution for pre- lockdown session as shown in Fig. 6.

For the same location during lockdown session, 60-65 dB(A) was prevailing with a huge share of 59.6% i.e. 572 minutes L_{eq} out of 960 belonged in the respective range. No instances were observed in the range of 75-85+ dB(A). Only 17.1% of L_{eq} crossed the noise level of 65 dB(A) during daytime. During the night time, the noise level range dominating the session was observed to be 55-60 dB(A) with 27.3%. The noise ranging between 45-60 dB(A) collectively summed up with a share of 77.1% of the night session. It was observed that for 47 instances the noise level was below 45 dB(A). No noise equivalent level above 70 dB(A) was observed during the night session. Noise range of 60-65 dB(A) dominated with a share of 43.4% in 24-hour noise equivalent distribution for lockdown session as shown in Fig. 6.

For NEERI colony monitoring location befalling under the residential zone, the distribution of noise equivalent level is shown in Fig. 7. For the pre-lockdown daytime session, the most dominant noise level range was observed to be 50-55 dB(A), with a huge share of 67.9%. 25.2% of noise equivalent level surpassed the legal limit of residential zone i.e. 55 dB(A) legalized for a daytime session. For the pre-lockdown night time session, a noise range of 50-55 dB(A) prevails with a share of 72.9%. No noise equivalent level was observed below the range of 45 dB(A) during the night session. For 24-hour noise equivalent distribution during pre-lockdown, 1002 instants are observed for the noise range of 50-55 dB(A).

For the lockdown session, during the daytime, the dominant category was observed to be 45-50 dB(A) with a share of 54.5% as shown in Fig. 7. Only 5.9% of the noise equivalent level was observed to be surpassing the legal daytime noise level limit of 55 dB(A), while 94.1% were below the standard noise limit. During the daytime, none of the noise equivalent levels was observed below 40 dB(A). During the lockdown session, 2.9% and 7.1% share of noise equivalent levels were observed to be below 40 dB(A), during day and night sessions respectively. The L_{eq} range of 40-45 dB(A) was observed to be dominant, with a share percentage of 51% during the night session. For the night session, the standard noise limit for the residential zone is 45 dB(A), and the 41.9% noise equivalent level were observed surpassing the standard limit.

For the NEERI office campus, the monitoring location is considered to be a silence zone according to Noise Pollution (Regulation and Control) Amendment Rules, 2017. The distribution of noise equivalent level is shown in Fig. 8. The

permissible noise limit for a silence zone is 50 dB(A) and 40 dB(A) for day and night time respectively. During the day session for pre lockdown session, the dominant noise range was observed to be 50-55 dB(A) with a share percentage of 58.1%. Only 8.5% of L_{eq} were observed to be surpassing the noise level of 55 dB(A). During the night session, the noise level ranged 45-50 dB(A) was prevailing with 52.7% i.e. 253 instants out of 480. For the day session, 33.3% L_{eq} values were observed to be below 50 dB(A) whereas for the night session only 5.8% of L_{eq} values were observed to be below 40 dB(A).

During lockdown conditions, the noise range of 45-50 dB(A) was dominant with a share percentage of 57.4% and 62.5% for day and night sessions respectively. For the daytime session, 42.2% of L_{eq}'s were observed to be above the legal noise level standardized for daytime in a silence zone. During the night session, a major share of 19.8% was observed for the noise level less than 40 dB(A), which was only 5.8% during the pre-lockdown condition. As shown in Fig. 8, the major noise reduction can be observed during the day session, where the share of noise range 45-50 dB(A) increased from 23.9% during the pre-lockdown period to 57.4% during lockdown conditions.

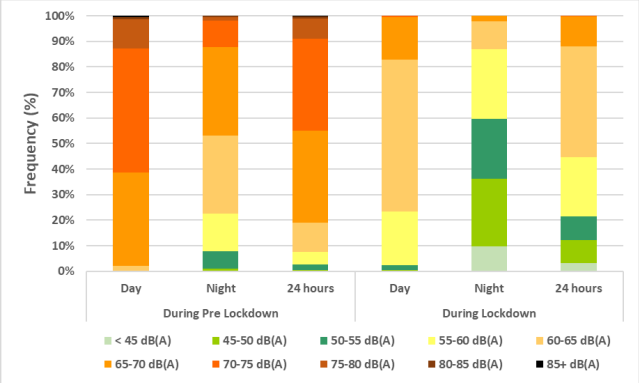

Fig. 6 Noise equivalent distribution at NEERI Gate No.1 (National Highway)

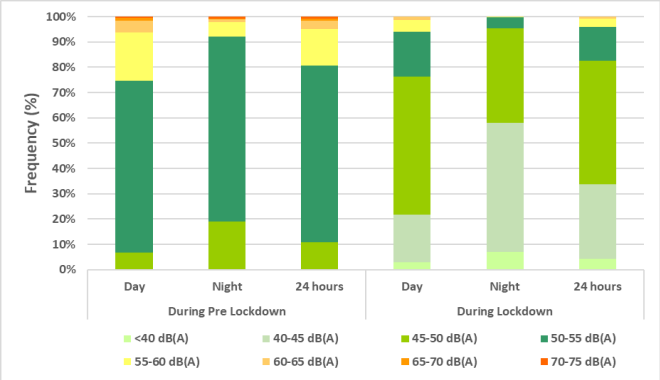

Fig. 7 Noise equivalent distribution at NEERI Colony (Residential zone)

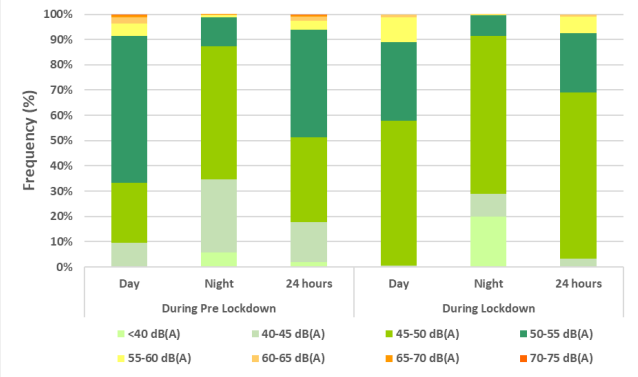

Fig. 8 Noise equivalent distribution at NEERI Office Campus (Silence zone)

IV. Conclusion

An attempt has been made to monitor noise levels and to compare with prescribed standards during the lockdown and pre-lockdown at source and receptors. The study revealed a significant reduction in noise pollution during the lockdown period due to restrictions in vehicular movement and human activities. Hence, certain aspects contributed by this pandemic in the society can be guiding van which can be altered for its incorporation in our habitat. As an outcome of this lockdown, noise pollution has reduced immensely, the crucial reason being decrement in the traffic volume, which also includes a reduction in honking incidents. The outcomes of the study summarized that prescribed legal noise level standards deployed are attainable, which were a rare instance in the past, which can also serve as blessing in disguise. After some time, the lockdown conditions will be lifted and efforts will be taken to regain the momentum of the society. Meanwhile, an endeavor must be required to maintain or at least minimize the noise level in the ambiance in post lockdown conditions. Many aspects need to be recognized as a learning lesson from the lockdown conditions and must be further enforced. In such a case, the study establishes a new dimension of thought process to control noise pollution in urban areas. The pandemic has delivered a huge opportunity for the coming future where we can amend our policies, management, and approach towards noise as a pollutant and leads towards a sustainable society. For the control of noise pollution during post pandemic situations, technological interventions in terms of speed-based honking mechanism and Noise ATM are needed to be developed to reduce the honking incidences and its detrimental effects, especially at traffic junctions and during traffic jams.

V. References

M.L. Holshue, C. DeBolt, S. Lindquist, K.H. Lofy, J. Wiesman, H. Bruce, C. Spitters, K. Ericson, S. Wilkerson, A. Tural, G. Diaz, A. Cohn, L. Fox, A. Patel, S.I. Gerber, L. Kim, S. Tong, X. Lu, S. Lindstrom, M.A. Pallansch, W.C. Weldon, H.M. Biggs, T.M. Uyeki and S.K. Pillai, 2020. First case of 2019 Novel Coronavirus in the United States. *N. Engl. J. Med.,* 382, 929–936.

G. Jing, 2020. Diary of a life in locked-down Wuhan, https://www.bbc.com/news/world-asia-china-51276656 (Date accessed: April 1, 2020)

Web 1, http://www.worldometers.info/coronavirus/

A. M. Shrestha, U. B. Shrestha, R. Sharma, S. Bhattarai, H. N. T. Tran and M. Rupakheti, 2020. Lockdown caused by COVID-19 pandemic reduces air pollution in cities worldwide,

ILO, 2020. ILO Monitor 2nd edition: COVID-19 and the world of work, Updated estimates and analysis, https://www.ilo.org/wcmsp5/groups/public/@dgreports/@dcomm/documents/briefingnote/wcms_740877.pdf (Date accessed: April 25, 2020)

S. Das, P. Ghosh, B. Sen and I. Mukhopadhyay, 2020. Critical community size for COVID-19--a model based approach to provide a rationale behind the lockdown, *arXiv preprint arXiv*., 2004,03126.

Ministry of Health and Family Welfare Government of India., https://www.mohfw.gov.in/

P. Pulla, 2020. Covid-19: India imposes lockdown for 21 days and cases rise.

Advisory, T. F. (1945) Government of India,

S. K. Dhaka, V. Kumar, V. Panwar, A. P. Dimri, N. Singh, P. K. Patra and M. Kajino,2020. PM 2.5 diminution and haze events over Delhi during the COVID-19 lockdown period: an interplay between the baseline pollution and meteorology, *Scientific reports*, *10*(1), 1-8.

D. Ray, S. Subramanian and Vandewalle, 2020. India's lockdown. *Centre for Economic Policy Research*.,

S. Sharma, M. Zhang, J. Gao, H. Zhang and S.H. Kota, 2020. Effect of restricted emissions during COVID-19 on air quality in India, *Science of The Total Environment*., 728, 138878.

K. Kalawapudi, T. Singh, J. Dey, R. Vijay and R. Kumar, 2020. Noise pollution in Mumbai Metropolitan Region (MMR): An emerging environmental threat, *Environmental Monitoring and Assessment.*, 192(2), 152.

R. Vijay, R. Popat, M. Pisode, A. Sharma, K. Manoj, T. Chakrabarti and R. Gupta, 2013. Evaluation and analysis of noise levels at traffic intersections of Nagpur city, India, *Journal of environmental science & engineering*., 55(2), 197-206.

V. Laxmi, J. Dey, K. Kalawapudi, R. Vijay and R. Kumar, 2019. An innovative approach of urban noise monitoring using cycle in Nagpur, India, *Environmental Science and Pollution Research*., 26, 36812-36819.

C. Thakre, V. Laxmi, R. Vijay, D.J. Killedar and R. Kumar, 2020. Traffic noise prediction model of an Indian road: an increased scenario of vehicles and honking, *Environmental Science and Pollution Research*., *27*(30), 38311-38320.

R. Vijay, A. Sharma, T. Chakrabarti and R. Gupta, 2015.Assessment of honking impact on traffic noise in urban traffic environment of Nagpur, India, *Journal of environmental health science and engineering*., 13(1), 10.

R. Vijay, T. Chakrabarti and R. Gupta, 2018. Characterization of Traffic Noise and Honking Assessment of an Indian Urban Road, *Fluctuation and Noise Letters.*, 1850031.

S. K. Lokhande, P. F. Chopkar, M. C. Jain and A. Hirani, 2021. Environmental noise assessment of Bhandara City in the adversity of COVID-19 pandemic: A crowdsourcing approach, *Noise Mapping*., 8(1), 249-259.

S. K. Lokhande, S. S. Pathak, P. A. Kokate, S. A. Dhawale and G. L. Bodhe, 2018. Assessment of heterogeneous road traffic noise in Nagpur, *Archives of Acoustics*., 43.

S. K. Lokhande, S. S. Pathak, P. A. Kokate, S. A. Dhawale and G. L. Bodhe, 2016. Evaluation and forecasting of highway traffic noise in the City of Nagpur, India, *International Journal of Earth Sciences and Engineering*., 9(4), 1529-1535.

A. Mishra, S. Das, D. Singh and A. K. Maurya, 2021. Effect of COVID-19 lockdown on noise pollution levels in an Indian city: a case study of Kanpur, *Environmental Science and Pollution Research*., 28(33), 46007-46019.

R. Vijay, C. Kori, M. Kumar, T. Chakrabarti and R. Gupta, 2014. Assessment of traffic noise on highway passing from urban agglomeration, *Fluctuation and Noise Letters*., 13(04), 1450031.

CPCB, Protocol for Ambient Level Noise Monitoring, July 2015

Noise pollution (regulation and control) Rules; 2000 http://envfor.nic.in/downloads/public-information/noise-pollution-rules-en.pdf

E. Murphy and E. King, 2014. Environmental noise pollution: Noise mapping, public health, and policy, *Newnes*.,

C. Thakre, V. Laxmi, R. Vijay, D. J. Killedar and R. Kumar, 2018. Characterization of Honking Noise in Urban Environment of Nagpur, *The Journal of Acoustical Society of India*., 45(4), 165-175.