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Technical Note

On Suitability of Day-Night Average Sound Level Descriptor in Indian Scenario

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The paper analyzes the monthly day equivalent levels, L_{day} (06–22 h) and night equivalent levels, L_{night} (22–06 h) values observed in year 2015 and 2016 for the 70 locations whereby continuous noise monitoring is conducted under the National Ambient Noise Monitoring Network (NANMN). The study exclusively analyzes the ambient noise data acquired for 25 locations in commercial zone, 12 in industrial, 16 in residential and 17 in silence zones. The analysis of (L_{day}–L_{night}) for 70 locations under observations reveals that 10 dB night time adjustment in day-night average sound level descriptor is not appropriate in such a scenario and as such it is recommended to use day-night average sound level and day-evening-night average sound level descriptors without any 10 dB night time adjustment or 5 dB evening time adjustments. The analysis and conclusions of the present study shall be very useful for developing single value noise descriptor correlating the noise annoyance and health effects in Indian perspectives.

Keywords: National Ambient Noise Monitoring Network (NANMN); day equivalent sound level, L_{day}; night equivalent sound level, L_{night}; day-night average sound level, L_{dn}; day-evening-night average sound level, L_{den}; equivalent continuous sound level, $L_{\text{Aeq,24h}}$.

1. Introduction

Day-night average sound level, L_{dn}, has been recommended by many scientific bodies for the valuation of community noise impact as 10 dB penalty to night time is applied to account for increased human sensitivity to noise at night. Some of the limitations associated with L_{dn} metrics can be overcome by use of normalized L_{dn} metrics. Normalized L_{dn} is the basic L_{dn} value with a number of adjustments added to account for the specific character and factors of sound. Consequently, adjustments enlisted in ISO 1996-1:2003 can account for tonality, intermittent noisy events etc. (Schomer, 2005). Day-night average sound level, L_{dn}, for the assessment of overall average sound levels calculated as:

$$L_{\text{dn}} = 10\log\left[\frac{1}{24}\left(16\cdot 10^{\left(\frac{L_{\text{day}}}{10}\right)} + 8\cdot 10^{\left(\frac{L_{\text{night}}+10}{10}\right)}\right)\right]. \quad (1)$$

Equation (1) uses the standard 10 dB night time adjustment to account for the increased sensitivity of noise at night, the expectation that the night time noise will be lower than during the day and for disturbance sleep protection. The night time is between the hours of 10.00 p.m. and 7.00 a.m. and is weighted with an additional 10 dB to compensate for sleep interference and other disruptions. The L_{den} (day-evening-night sound level) is the average sound level over a 24 hour period, with a penalty of 5 dB added for the evening hours or 19:00 to 22:00, and a penalty of 10 dB added for the nighttime hours of 22:00 to 07:00. It is very similar in nature to the L_{dn}, but with the added penalty for the evening period.

The current ambient air quality standards in respect of noise followed in India are in terms of day and night equivalent levels, L_{day} and L_{night}. It may be noted here that the day equivalent level, L_{day} and night equivalent level, L_{night} is calculated from the 24 hours noise data for each day of the year. The daytime is from 6.00 a.m. to 10.00 p.m., while the night time is considered from 10.00 p.m. to 6.00 a.m. Thus, in Indian scenario, L_{dn} is calculated considering daytime from 6.00 a.m. to 10.00 p.m. and night time from 10.00 p.m. to 6.00 a.m. (Noise Pollution Regulation and Control rules, 2000; Ministry of Environment and Forests, India). However, the requirement and procedure for monitoring the ambient noise level due to aircrafts, issued by the Ministry of Environment and Forests (MOEF) in 2008 sets the frame-work for noise monitoring at the airports. It recommends that the 16 hours day time (6:00 a.m. to 10:00 p.m.) and 8 hours night time (10:00 p.m. to 6:00 a.m.) shall be monitored and day-night average sound levels, background day-night average sound levels and event day-night average sound levels for 24 hour period shall be calculated (Requirement and Procedure for Monitoring Ambient noise levels due to Aircrafts, CPCB, 2008). There has been different noise weighting systems and descriptors recommended for aircraft noise for different time periods, cumulative methods for multiple noise events and different correction factors such as pure tone and duration correction across the globe (Xie *et al.*, 2014). However, day-night average sound levels and day-evening-night average sound levels are the common descriptors used in recent years. L_{dn} is the cornerstone of aviation noise impact analysis in United States (Wyle report, 2011). A correlation analysis of various noise metrics and indicators shows that nearly all of them are highly correlated with L_{den}. The recent studies on supplemental metric identified in characterizing community response to transportation noise is 'Community Tolerance Level (CTL)' that permits direct quantification not only of the growth of annoyance with noise exposure, but also of the aggregate effect of all non-acoustic influences on annoyance prevalence rates (Schwela, 2017; International Institute of Noise Control Engineering report, 2015; Fidell, 2017) is also based on L_{dn} for its calculation. The European Environmental Noise Directive 2002/49/EC relating to the assessment and management of environmental noise establish that the member states should create noise maps and action plans for the parts of their territory. The noise maps should present noise levels expressed in harmonized indicators: day-evening-night level, L_{den}, and night equivalent level, L_{night}. The European Position paper recommended L_{den} as the noise metrics for prediction of noise annoyance and suggests relationships for estimation of noise annoyance (% Annoyed and % Highly Annoyed) on the basis of noise exposure in dwellings in terms of L_{den}. The effect of noise annoyance, hypertension, Ischaemic Heart Disease (IHD) has been recommended in terms of acoustic indicator, L_{den}. The United States Housing and Urban Development (HUD) Noise Assessment Guidelines (NAG) recommends noise environment at a site to be acceptable if L_{dn} does not exceeds 65 dB and normally unacceptable for L_{dn} above 65 dB, but not exceeding 75 dB. L_{dn} above 75 dB is recommended to be unacceptable (HUD Noise Guidebook, 2009). Some studies in Indian context have correlated L_{dn} with % highly annoyed (Agarwal, Swami, 2009; Banerjee *et al.*, 2009) and health effects. For instance, Banerjee *et al.* (2014) suggested a threshold exposure to road traffic noise at $L_{\mathrm{den}} > 65$ dB(A) for men and $L_{\mathrm{den}} > 60$ dB(A) in women may be associated with the occurrence of hypertension.

Thus, it is observed that day-night average sound level descriptor is widely used in numerous research studies in Indian context and also in other countries. The present work ascertains the suitability of 10 dB night time adjustment to compensate for the sleep interference and other disruptions used in calculation of day-night average sound level descriptor in Indian perspectives. The difference of day equivalent sound levels and night equivalent sound levels is analyzed for the commercial, residential, silence and industrial zone sites exclusively to ascertain the severity of night noise levels in comparison to the day equivalent sound levels.

2. Materials and methods

The diversified National Ambient Noise Monitoring Network (NANMN) project has been established since year 2014 by Central pollution Control Board (CPCB), India covering 70 stations in seven major cities of the country: Bengaluru, Chennai, Delhi, Hyderabad, Kolkata, Lucknow and Mumbai. The seventy locations under study are established in seven major cities of India with each state having ten noise monitoring stations. The 70 locations cover 25 commercial sites, 16 residential sites, 17 sites in silence zone and 12 sites in industrial zone. In addition, a website application, http://www.cpcbnoise.com is developed to disseminate the data in real time to the public for generating awareness towards reducing the noise pollution in different parts of the country (Garg *et al.*, 2016a; 2017a; 2017b). Tables 1 and 2 shows the details of the seventy noise monitoring sites established in the seven cities of India by Central Pollution Control Board of India (Status of Ambient noise level in India-2015, CPCB report). The paper analyzes the monthly day and night equivalent levels for the commercial, residential, silence and industrial zone sites for 70 stations for year 2015 noise monitored data (Status of Ambient noise level in India-2015, CPCB report) and year 2016 noise monitored data (Status of Ambient noise level in India-2016, CPCB report). Thus, for instance, for 25 commercial sites under consideration, the noise monitored data of 12 months day and night equivalent levels in a year corresponds to 300 observations acquired, which can be further analyzed to ascertain the severity of night noise levels in comparison to the day equivalent noise levels. Also, the annual average day and night equivalent noise levels are analysed for understanding the severity of night noise levels in comparison to the day equivalent noise levels. The Noise Monitoring Network so established is a unique and one of the largest noise monitoring networks of its kind across the globe.

Table 1. Details of Noise Monitoring Stations installed by CPCB, India for NANMN project in Delhi, Lucknow, Kolkata, and Mumbai city of India.

Name of location	City	Area characteristics	Latitude	Longitude
Dilshad Garden	Delhi	Silence	28°40′ 53.76″ N	77°19′ 6.2″E
Civil Lines		Commercial	28°40′ 55.97″N	77°13′ 25.75″E
CPCB HQ.		Commercial	28°39′ 20.99″N	77°17′ 39.91″E
R. K. Puram		Residential	28°33′ 46.23″N	77°11′ 12.4″E
DTU, Bawana		Silence	28°44′ 44.49″N	77°5′ 1.56″E
Anand Vihar		Commercial	28°38′ 51.22″N	77°18′ 57.02″E
ITO		Commercial	28°37′ 41.21″N	77°14′ 27.22″E
Mandir Marg		Silence	28°38′ 11.41″N	77°12′ 2.36″E
NSIT Dwarka		Silence	28°36′ 14.46″N	77°2′ 28.78″E
Punjabi Bagh		Residential	28°40′ 12.83″N	77°7′ 54.14″E
Gomti Nagar	Lucknow	Silence	26°52′ 58.02″N	80°59′ 58.02″E
Chinhat		Industrial	26°54′ 17.09″N	81°03′ 13.08″E
Hazrat Ganj		Commercial	26°51′ 0.66″N	80°56′ 51.59″E
IT College		Silence	26°52′ 22.47″N	80°56′ 30.28″E
Indira Nagar		Residential	26°53′ 25.08″N	80°59′ 57.29″E
CSS Airport		Commercial	26°45′ 55.41″N	80°53′ 10.91″E
PGI Hospital		Silence	26°45′ 17.68″N	80°55′ 59.53″E
RSC Aliganj		Commercial	26°53′ 21.89″N	80°56′ 24.43″E
Talkatora Industrial Area		Industrial	26°50′ 2.44″N	80°53′ 30.25″E
Vibhuti Khand		Residential	26°52′ 6.75″N	81°00′ 12.54″E
Kasba Gole Park	Kolkata	Industrial	22°31′ 1.2″N	88°24′ 15.8″E
Birati N		Residential	22°40′ 13.99″N	88°26′ 1.74″E
New Market		Commercial	22°33′ 41.4″N	88°21′ 10.4″E
R G Kar		Silence	22°36′ 16.18″N	88°22′ 43.20″E
Patauli		Residential	22°28′ 21.07″N	88°23′ 29.71″E
Tollygunge		Commercial	22°29′ 56.48″N	88°20′ 43.79″E
SSKM Hospital		Silence	22°32′ 19.58″N	88°20′ 35.29″E
Bag Bazar		Residential	22°36′ 4.61″N	88°22′ 1.01″E
WBPCB HQ		Commercial	22°33′ 42.67″N	88°24′ 32.46″E
Tartala		Industrial	22°30′ 56″N	88°18′ 19.2″E
AS HP	Mumbai	Silence	19°1′ 15.83″N	72°51′ 33.24″E
M&M Kandivali		Industrial	19°12′ 3.87″N	72°52′ 12.14″E
Bandra		Commercial	19°3′ 20.77″N	72°49′ 49.41″E
Ambassador Hotel		Commercial	18°56′ 0.67″N	72°49’ 29.61″E
MPCB HQ.		Commercial	19°6′ 42.73″N	73°0′ 43.80″E
L&T Powai		Industrial	19°7′ 18.31″N	72°53′ 34.27″E
Thane MCQ		Commercial	19°0′ 57.38″N	72°51′ 29.24″E
Pepsico Chembur		Residential	19°2′ 52.89″N	72°54′ 37.12″E
Vashi Hospital		Silence	19°4′ 45.49″N	73°0′ 0.12″E
Andheri		Industrial	19°6′ 44.49″N	72°51′ 20.71″E

The present work thus analyses the monthly (L_{day}–L_{night}) values observed in dB for the 70 sites spread across the seven major cities of India for year 2015 and 2016 with following objectives:

- Analyse the difference of day and night equivalent levels, L_{day} and L_{night} levels to ascertain the severity of night noise levels in comparison to the day ambient noise levels for commercial, residential, silence and industrial zones sites.
- Ascertain whether 10 dB night time adjustment is appropriate or not.
- Recommend a suitable single value noise descriptor as followed in European continent also in Indian scenario for correlating the noise annoy-

Table 2. Details of Noise Monitoring Stations installed by CPCB, India for NANMN project in Hyderabad, Bengaluru, and Chennai city of India.

Name of location	City	Area characteristics	Latitude	Longitude
Abids	Hyderabad	Commercial	17°23′ 27.42″N	78°28′ 25.59″E
Tarnaka		Residential	17°25′ 43.57″N	78°32′ 15.83″E
Jeedimetla		Industrial	17°30′ 44.12″N	78°28′ 10.43″E
Gaddapothram		Industrial	17°36′ 4.1″N	78°22′ 19.8″E
Jubilee Hills		Residential	17°26′ 22.08″N	78°23′ 58.28″E
Gachibowli		Silence	17°27′ 36.1″N	78°20′ 3.3″E
Punjagutta		Commercial	17°25′ 27.77″N	78°27′ 3.74″E
Paradise		Commercial	17°26′ 36.7″N	78°29′ 15.9″E
Zoo Park		Silence	17°22′ 8.44″N	78°28′ 17.42″E
Kukatpalli		Commercial	17°29′ 45.3″N	78°23′ 39″E
BTM	Bengaluru	Residential	12°54′ 30.36″N	77°35′ 10.96″E
Yeshwantpur		Commercial	13°1′ 5.04″N	77°33′ 28.13″E
Marathahalli		Commercial	12°54′ 45.45″N	77°34′ 34.58″E
R.V.C.E		Silence	12°55′ 23.15″N	77°29′ 58.5″E
Nisarga Bhawan		Residential	12°59′ 0.54″N	77°35′ 40.15″E
Whitefield		Industrial	12°58′ 38.47″N	77°45′ 5.18″E
Parisar Bhawan		Commercial	12°58′ 32.18″N	77°36′ 12.38″E
Dolmur		Residential	12°57′ 48.86″N	77°38′ 17.78″E
Peeniya		Industrial	13°1′ 4.28″N	77°30′ 11.45″E
Nihmans		Silence	12°56′ 15.27″N	77°35′ 32.95″E
Eye Hospital	Chennai	Silence	13°6′ 16.13″N	80°17′ 3.35″E
Pallikarnai		Commercial	12°56′ 14.67"N	80°12′ 55.27″E
Guindy		Industrial	13°0′ 42.79″N	80°13′ 9.46″E
Velachery		Residential	12°58′ 35.09″N	80°13′ 15.27″E
Perambur		Commercial	13°6′ 43.46″N	80°14′ 16.85″E
Washermanpet		Commercial	13°7′ 53.84″N	80°16′ 43.95″E
T. Nagar		Commercial	13°2′ 24.34″N	80°13′ 57.44″E
Anna Nagar		Silence	13°5′ 21.45″N	80°13′ 23.93″E
Triplicane		Residential	13°3′ 17.91″N	80°16′ 28.44″E
Sowcarpet		Residential	13°5′ 42.4″N	80°16′ 32.2″E

ance and for developing exposure-effect relationship and correlating with health aspects such as hypertension, Coronary Heart Disease etc.

However, the analysis of ambient noise levels, comparison with the recommended ambient noise standards of India and understanding the noise scenario (Garg *et al.*, 2017a; 2017b) in each city and site is beyond the scope of present work. Also, these details are comprehensively discussed for each site in CPCB reports on status of ambient noise levels for the two years. The present study concentrates on the above mentioned objectives as there has been no recommended single value noise descriptor correlating the noise annoyance and for developing exposure-effect relationship and correlating with health aspects such as hypertension, Coronary Heart Disease etc. in Indian perspectives.

3. Results and discussion

Figures 1 and 2 shows the frequency distribution of monthly (L_{day}–L_{night}) values observed in dB for the overall 70 sites spread across the seven major cities of India for the year 2015 and 2016. Table 3 analyzes the frequency distribution of difference (L_{day}–L_{night}) values observed in dB exclusively for the commercial, residential, silence and industrial zone sites for year 2015 and 2016. The analysis of (L_{day}–L_{night}) for the 25 commercial sites, 17 sites lying in silence zone, 16 sites lying in residential zone and 12 sites lying in industrial zone shows that majority of the differences between the monthly (L_{day}–L_{night}) values lie between 0 to 10 dB. Figure 3 shows the frequency distribution of monthly (L_{day}–L_{night}) values for the commercial, residential, silence and industrial zone sites for the year

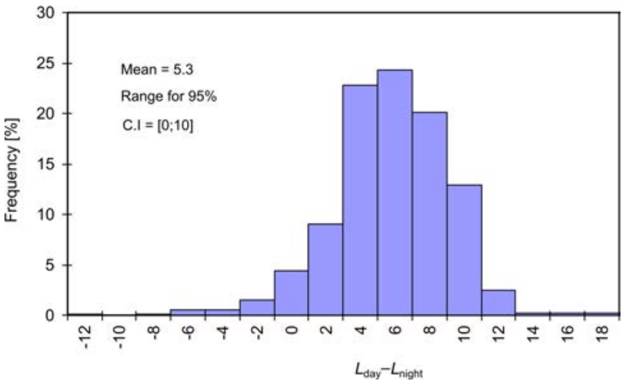

Fig. 1. Frequency distribution of monthly (L_{day}–L_{night}) values observed in dB for the 70 sites spread across the seven major cities of India for year 2015.

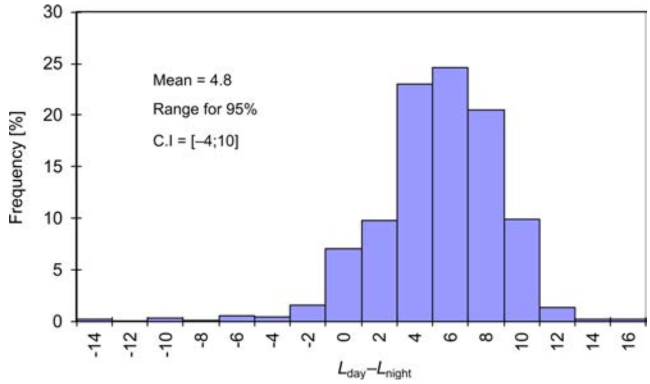

Fig. 2. Frequency distribution of monthly (L_{day}–L_{night}) value observed in dB for the 70 sites spread across the seven major cities of India for year 2016.

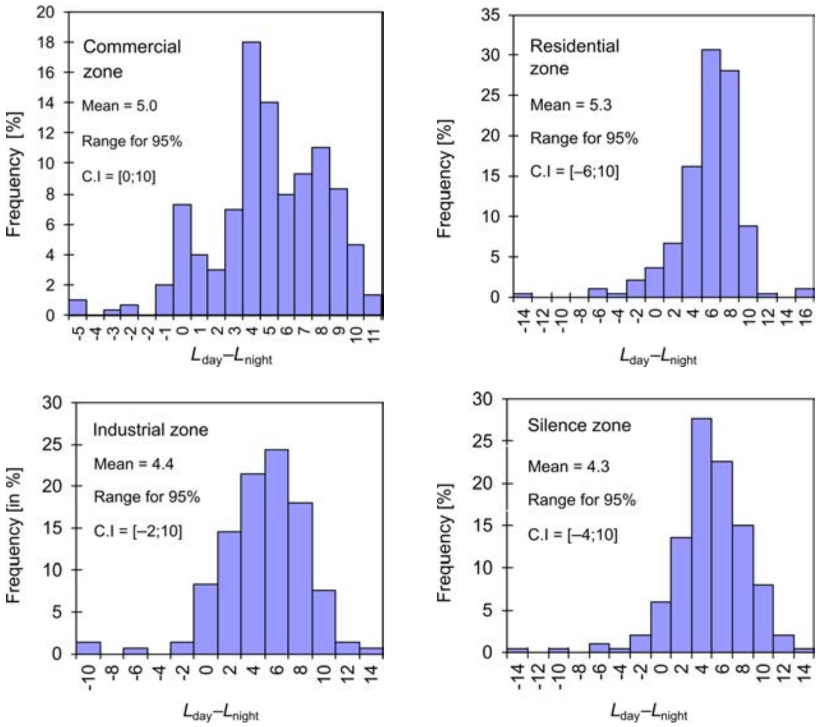

Fig. 3. Zone wise frequency distribution of monthly (L_{day}–L_{night}) values observed in dB for the seven major cities of India for year 2016.

Table 3. Frequency distribution of difference monthly (L_{day}–L_{night}) values observed in dB for the 70 sites spread across the seven major cities of India for year 2015 and 2016.

Variation of monthly (L_{day}–L_{night}) values	Commercial zone [%]		Residential zone [%]		Silence zone [%]		Industrial zone [%]		Overall, 70 sites [%]	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
$-15 < (L_{\text{day}}–L_{\text{night}}) \leq -10$ dB	0.0	0.0	0.5	0.5	0.0	1.0	0.0	1.4	0.1	0.6
$-10 < (L_{\text{day}}–L_{\text{night}}) \leq -5$ dB	1.0	1.0	1.6	1.0	1.5	1.5	0.0	0.7	1.1	1.1
$-5 < (L_{\text{day}}–L_{\text{night}}) \leq 0$ dB	6.0	10.3	4.7	6.3	7.6	8.0	6.9	9.7	6.2	8.8
$0 < (L_{\text{day}}–L_{\text{night}}) \leq 5$ dB	37.8	46.0	40.5	37.2	53.5	55.3	45.8	51.4	43.5	47.1
$5 < (L_{\text{day}}–L_{\text{night}}) \leq 10$ dB	52.2	41.3	50.0	53.9	35.9	31.7	42.4	34.7	46.0	40.8
$10 < (L_{\text{day}}–L_{\text{night}}) \leq 15$ dB	3.0	1.3	2.6	1.0	1.5	2.5	4.9	2.1	2.9	1.7

2016. It can be observed that only a small proportion of these observations (≤2.5% for year 2016; ≤4.9% for year 2015) show a difference between 10 to 15 dB. For instance, the analysis of (L_{day}–L_{night}) for the 17 sites lying in silence zone shows that 89.4% of observations show a difference between 0 to 10 dB in year 2015 and 87.0% of observations show a difference between 0 to 10 dB in year 2016. Only 1.5% of the observations in year 2015 and 2.5% of observations in year 2016 shows a difference between 10 to 15 dB.The analysis of (L_{day}–L_{night}) for the overall 70 sites shows that 89.5% of observations show a difference between 0 to 10 dB in year 2015 and 87.9% of observations show a difference between 0 to 10 dB in year 2016. Only 2.9% of the observations in year 2015 and 1.7% of observations in year 2016 shows a difference between 10 to 15 dB for all the 70 sites.

Table 4 shows the statistical analysis for monthly (L_{day}–L_{night}) values observed in dB for the 70 sites. It can be observed that, the difference of day and night equivalent levels lies between −4 to 10 dB for 95% confidence level and −6 to 14 dB for 99% confidence level. It can be also observed that night noise levels are within 5 dB(A) as compared to the day equivalent levels for the maximum number of sites lying in silence zone. Table 5 shows the frequency distribution of difference of annual average (L_{day}–L_{night}) values observed in dB for the 70 sites spread across the seven major cities of India, whereby it is observed again that majority of annual average (L_{day}–L_{night}) values lie between 0 to 10 dB.

These observations thus suggests that the day equivalent sound levels are comparable to the night equivalent sound levels in all the seventy sites and thus the probability of difference greater than 10 dB(A) between the day equivalent sound level and night equivalent sound level is less than 3%. Thus, it can be concluded that 10 dB night time adjustment in day-night average sound level is not appropriate in such a scenario. These observations also suggest that 5 dB evening time correction in day-evening-night average sound level descriptor is not justified. Thus, the 24-hours equivalent continuous sound level, $L_{\text{Aeq,24h}}$, would rather be more suitable as it is a common way of expressing day-night average sound level without 10 dB night adjustment (Garg *et al.*, 2015). In Indian scenario, the ambient noise standards are recommended for day equivalent sound levels and night equivalent sound levels. However, for correlating the noise annoyance, one single noise descriptor would be rather more rational as followed in European continent (Schultz, 1978; Miedema, Vos, 1998; Miedema, Oudshoorn, 2001; EU's Future Noise Policy, WG2-Dose/Effect, 2002; Garg *et al.*, 2015). A recent study on proposed amendments in the ambient noise standards of India proposed $L_{\text{Aeq,24h}}$ of 70 dB(A) for industrial zone; 65 dB(A) $L_{\text{Aeq,24h}}$ for commercial area and mixed residential and commercial zones; 60 dB(A)

Table 4. Statistical analysis for monthly (L_{day}–L_{night}) values observed in dB for the 70 sites spread across the seven major cities of India for year 2015 and 2016.

Parameter	Commercial zone		Residential zone		Silence zone		Industrial zone		Overall, 70 sites	
	2015	2016	2015	2016	2015	2016	2015	2016	2015	2016
Mean [dB]	5.8	5.0	5.5	5.3	4.2	4.3	5.2	4.4	5.3	4.8
No of observations	300	300	192	192	204	204	144	144	840	840
Standard Deviation [dB]	3.2	3.2	3.4	3.5	3.2	3.7	3.0	3.6	3.3	3.5
Maximum Value [dB]	12	11	15	16	12	14	13	14	17	16
Minimum Value [dB]	−7	−8	−12	−14	−7	−14	−2	−10	−12	−14
Range for 95% C.I [dB]	[−2; 10]	[0; 10]	[−4; 10]	[−6; 10]	[−2; 10]	[−4; 10]	[0; 12]	[−2; 10]	[−4; 10]	[−4; 10]
Range for 99% C.I [dB]	[−2; 12]	[−3; 11]	[−6; 16]	[−6; 16]	[−4; 12]	[−6; 14]	[0; 14]	[−10; 12]	[−4; 16]	[−6; 14]

Table 5. Frequency distribution of difference of annual average (L_{day}–L_{night}) values observed in dB for the 70 sites spread across the seven major cities of India.

Variation of difference (L_{day}–L_{night}) values	Percentage of noise monitoring stations	
	2015	2016
$-15 < (L_{\text{day}}-L_{\text{night}}) \le -10$ dB	0.0	0.0
$-10 < (L_{\text{day}}-L_{\text{night}}) \le -5$ dB	0.0	0.0
$-5 < (L_{\text{day}}-L_{\text{night}}) \le 0$ dB	0.0	20.0
$0 < (L_{\text{day}}-L_{\text{night}}) \le 5$ dB	50.7	47.1
$5 < (L_{\text{day}}-L_{\text{night}}) \le 10$ dB	49.3	30.0
$10 < (L_{\text{day}}-L_{\text{night}}) \le 15$ dB	0.0	2.9

for residential zone and 55 dB(A) for silence zone (Garg *et al.*, 2015) as ambient noise standard limits. Thus, a cumulative noise exposure metrics such as day-night average sound level without 10 dB night time adjustment i.e. $L_{\text{Aeq,24h}}$, may be considered for Indian situation for developing exposure-effect relationship (Garg *et al.*, 2012; 2016b) and correlating with health aspects (Babisch *et al.*, 2010; Banerjee *et al.*, 2014). It is also recommended that calculation of Community Tolerance Level (CTL) recommended in recent studies (Fidell *et al.*, 2011; Schomer *et al.*, 2012; Gestland *et al.*, 2015; International Institute of Noise Control Engineering report, 2015; ISO 1996-1:2016; Morinaga *et al.*, 2017) as the supplemental metrics for correlating noise annoyance may use $L_{\text{Aeq,24h}}$ instead of L_{dn} in Indian perspectives.

4. Conclusions and recommendations

The paper describes the analysis of monthly day equivalent levels, L_{day} (06–22 h) and night equivalent levels, L_{night} (22–06 h) acquired under the diversified National Ambient Noise Monitoring Network (NANMN) across the seven major cities in India for continuous noise monitoring throughout the year. The analysis of (L_{day}–L_{night}) for 70 sites in overall reveals that majority of the monthly (L_{day}–L_{night}) values lie between 0 to 10 dB. Only 2.9% of the monthly observations in year 2015 and 1.7% in year 2016 show the difference of (L_{day}–L_{night}) for 70 sites in overall between 10 to 15 dB. These observations thus suggests that the night equivalent levels are comparable to the day equivalent levels in all the seventy sites and thus the probability of difference greater than 10 dB between the day equivalent level and night equivalent level is less than 3%. It can be also observed that night noise levels are within 5 dB as compared to the day equivalent levels for the maximum number of sites lying in silence zone. Thus, it can be concluded that 10 dB night time adjustment in day-night average sound level is not appropriate in such a scenario. On the similar analogy; these observations also suggests that 5 dB evening time correction in day-evening-night average sound level descriptor is not justified in Indian context as the evening time noise levels are as severe as the day equivalent noise levels. Thus, the 24-hours equivalent continuous sound level, $L_{\text{Aeq,24h}}$, would rather be more suitable as it is a common way of expressing day-night average sound level without 10 dB night-time adjustment. It is thus recommended that for developing an exposure-effect relationships and correlating noise annoyance and correlating the noise exposure with the health aspects as recommended in WHO report (Burden of disease from environmental noise, JRC EU, 2011); the single noise descriptor, 24-hours equivalent continuous sound level, $L_{\text{Aeq,24h}}$, would rather be more suitable as compared to L_{dn} or L_{den} descriptors.

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