Status of ambient noise in a chromite mining complex: An assessment and analysis

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Abstract: Systematic monitoring of ambient air quality in respect of noise has been carried out in and around a chromite mining complex to estimate the degree of association of all the areas under study. The objectives of the study are to estimate the noise levels at different category of areas of the ambient air that has been due to the development of a mining complex. Monitoring of noise levels has been carried out during the summer 2008 and the winter 2009 and all the category of areas have been represented in the study design. The monitoring data has been used to perform the t-test and the test reveals that the equivalent noise levels (L_{eq}) levels of all the stations differ with the test value at 5% level of significance. Analysis of Variance (ANOVA) reveals that the L_{eq} levels are not identical with respect to the category of areas and also the time of day ($p<0.01$). The Chi-square test reveals that the degree of association between Industrial area and L_{eq} is 0.821, for the Commercial area, Residential area and Sensitive area are 0.602, 0.692 and 0.257, respectively. Since, the value 0.821 is the maximum for the ambient air quality and is exhibited for the Industrial area, a strong association exists between the noise levels and Industrial area, the most affected location.

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1. Introduction

The noise levels in the ambient are mainly associated with factors viz., traffic density **(Ali, 2004; Banerjee et al., 2009; Don and Rees, 1985; Ishiyama and Hashimoto, 2000; Johnson and Saunders, 1968; Moses et al., 2000; Murthy, 2001)**, setting up of new Industrial facilities **(Madhu, 1999; Mathew, 1966)**, Commercial areas **(Burgess, 1977; Pandya and Shrivastava, 1999)**, presence of intrusive noise sources **(Oyedepo and Saadu, 2010)** and many more **(Omidvari and Nouri, 2009; Pal and Saxena, 2000)**. Besides, meteorological parameters also do play an important role in controlling the ambient noise quality **(Tanaka and Shiraishi, 2008; Thorsson et al., 2004)**. **Mohammad (2009)** investigated that the degree of annoying effect due to noise is felt more during morning than in the evening to the people living along the roadside. **Pal and Saxena (2000)** have also found that the association of noise levels differ significantly with respect to the type of areas and mainly attributed to various activities of the mining complexes. There are other factors which are also equally responsible to change the quality of noise levels in the ambient **(Lui et al., 2006; Pulikesi et al., 2006)**. But, the main sources of noise are permanent or temporary sources; point, area or line sources and static or dynamic sources. Noise propagates in the form of sound energy **(Scheiblechner, 1947)** to the far field **(Kerketta et al., 2009)** and thus, change in the noise quality influences the neighbourhood. Therefore, the present work aimed at to evaluate the status of ambient air quality in respect of noise in a chromite mining complex with the following objectives:

i) To test if the equivalent noise levels for Industrial, Commercial, Residential and Sensitive areas conform to the prescribed standards of **NPR (2000)**.
ii) To test if there exists a significant difference of noise levels for different categories of areas viz., Industrial, Commercial, Residential and Sensitive areas located near to a chromite mining complex with respect to the time of day.
iii) To test the independence of the ambient air quality (Industrial, Commercial, Residential and Sensitive areas) with respect to noise levels.
iv) If there exists the dependence relation then to determine the degree of association between the attributes.

2. Material and Methods

2.1 Study Area

The mine site, the Sukinda valley is located in Jajpur district in the state of Orissa, India. The mining complex under study produces chromite ore of both friable and lumpy varieties with facilities of Chrome Ore Beneficiation (COB) plant in the mining lease area. The study area is 130 km away from Bhubaneswar, the state capital of Orissa, 65 km away from National Highway-5 and 52 km from JK Road, the nearest railway station. The locations under study represent different categories of areas viz., Industrial, Commercial, Residential and Sensitive and relatively close to the mining complex.

2.2 Noise Measurements

Digital Sound Level Meter (Model: 4226) of M & K, Denmark (Bruel & Kjaer) make was used during the period of noise survey. The sound level meter was placed at 1.2 to 1.5 m above the ground surface, minimum 7 m away from the point source and free from any obstacles or any reflecting objects. Measurement was carried out in clear sky weather and sustained wind to avoid background noise level difference of more than 10 dBA **(Heimann, 2003)**.

2.3 Noise Parameters

The noise levels have been quantified in terms of L_{90} and L_{eq} which are defined as below:

L_{90} : Minimum noise level exceeding 90% of monitoring time and is also known as background noise.

L_{eq} : The equivalent noise level over a particular monitoring time.

The following equation is used to evaluate L_{90} and L_{eq} **(Irwin and Graf, 1939)**:

$$L_{av} = 10 \log_{10} \sum 10^{Li/10} \quad \dots \quad (1)$$

Where

L_{av} = average noise level, dBA

L_i = the ith sound pressure level, dBA

i = 1, 2, 3, ……, N

N = number of readings for each parameter

2.4 Ambient Noise

Systematic ambient noise monitoring was carried out at all the stations for two different seasons i.e. summer 2008 and winter 2009 for one week between 07.00-22.00 hours. As exhibited in Table 1, the stations are located along the main road of the Sukinda valley and also inside the colony of a chromite mining complex. All the locations have been selected to represent the Industrial, Commercial, Residential and Sensitive areas. Between two consecutive readings, a time gap of 60 second was followed in summer and 15 second in winter.

To meet the research objectives, the data so obtained are analyzed through SPSS (16.0) package under Window–XP environment. Generalized Linear Model ANOVA, Chi-square test and t-test have been used as statistical tools to meet the desired objectives. While doing the Chi-square test, the noise levels have been divided by taking the value of L_{90} (background noise) as the splitting point.

Table 1: Details of noise monitoring stations and t-test of ambient noise

a. Monitoring season: Summer 2008

Sl. No.	Station Code	Location	Area Category	Time of day, hours	L_{90}	L_{eq}	p
1.	A1	STP[a]	Industrial	07.00-22.00	52.78	53.31	<0.01
2.	A2	STP	Industrial	08.00-20.00	52.94	53.65	<0.01
3.	A3	Workshop	Industrial	10.00-19.30	59.67	60.76	<0.01
4.	A4	Workshop	Industrial	08.00-21.45	70.64	72.29	<0.05
5.	B1	GM Office	Commercial	08.00-21.45	60.03	61.96	<0.01
6.	B2	Airfield	Commercial	09.00-20.00	77.30	78.65	<0.01
7.	B3	GM Office	Commercial	10.00-20.00	59.16	60.41	<0.01
8.	C1	Main Gate	Residential	07.00-22.00	59.96	60.62	<0.01
9.	C2	Main Gate	Residential	08.00-20.00	62.25	62.99	<0.01
10.	C3	Main Gate	Residential	09.00-20.00	70.91	72.73	<0.01
11.	C4	ATM[b]	Residential	09.00-20.00	57.09	58.39	<0.01
12.	D1	Hospital	Sensitive	07.00-18.00	58.78	59.46	<0.01
13.	D2	Hospital	Sensitive	08.20-20.00	60.27	61.26	<0.01

NB: [a] Sewerage Treatment plant, [b] Automatic Teller Machine

b. Monitoring season: Winter 2009

Sl. No.	Station Code	Location	Area Category	Time of day, hours	L_{90}	L_{eq}	p
1.	A5	STP	Industrial	09.00-18.00	64.13	64.67	<0.01
2.	B4	GM Office	Commercial	09.00-18.00	56.79	58.33	<0.01
3.	B5	Airfield	Commercial	10.00-18.00	69.92	71.29	<0.01
4.	C5	Main Gate	Residential	09.00-18.00	55.81	57.91	<0.01
5.	C6	ATM	Residential	09.00-18.00	72.07	72.86	<0.01
6.	D3	Hospital	Sensitive	09.00-17.00	66.01	67.02	<0.01

3. Results

As exhibited in Table 1, t-test was performed taking the test values as 75 dBA, 65 dBA, 55 dBA and 50 dBA **(NPR, 2000)** for Industrial, Commercial, Residential and Sensitive areas, respectively by assuming the hypothesis as:

H_0: L_{eq} levels of all categories of areas do not differ with the test values.

H_1: L_{eq} levels of all categories of areas differ with the test values.

The hypothesis is rejected at 5% level of significance as $p<0.05$.

As exhibited in Table 2 (a), ANOVA was performed for the noise levels at different Industrial areas assuming the following hypothesis:

H_0: L_{eq} levels are identical with the Industrial areas and also the time of day.

H_1: L_{eq} levels are not identical with the Industrial areas and also the time of day.

Since, $p<0.01$, the hypothesis is rejected at 1% level of significance and thus, the L_{eq} levels are not identical with respect to the Industrial areas and also with the time of day.

Table 2: ANOVA of HEMMs (Dependent variable: Equivalent noise levels)

a. Industrial Areas

Sl. No.	Station Code	L_{eq}, dBA Time of day			Tests of between-Subjects effects		
		Morning	Afternoon	Evening	Sources of interaction	F	p
1.	A1	55.01	56.27	48.88	Time of day	279.20	<0.01*
2.	A2	54.66	51.76	54.48	Location	2218.00	<0.01*
3.	A3	58.47	61.97	61.75	* The equivalent noise levels are not identical with respect to time of day and different Industrial areas.		
4.	A4	76.06	75.77	65.84			
5.	A5	67.15	65.15	61.71			

b. Commercial Area

Sl. No.	Station Code	L_{eq}, dBA Time of day			Tests of between-Subjects effects		
		Morning	Afternoon	Evening	Sources of interaction	F	p
1.	B1	64.42	63.81	57.53	Time of day	41.00	<0.01*
2.	B2	76.64	78.88	80.42	Location	3248.00	<0.01*
3.	B3	60.70	63.45	57.05	* The equivalent noise levels are not identical with respect to time of day and different Commercial areas.		
4.	B4	61.35	55.52	55.91			
5.	B5	69.63	71.23	73.06			

c. Residential Areas

Sl. No.	Station Code	L_{eq}, dBA Time of day			Tests of between-Subjects effects		
		Morning	Afternoon	Evening	Sources of interaction	F	p
1.	C1	62.256	60.840	61.89	Time of day	117.52	<0.01*
2.	C2	48.71	59.90	69.41	Location	760.83	<0.01*
3.	C3	61.12	61.44	59.62	* The equivalent noise levels are not identical with respect to time of day and different Residential areas.		
4.	C4	73.23	71.44	73.93			
5.	C5	58.63	55.99	60.55			
6.	C6	69.62	74.02	75.48			

d. Sensitive Areas

Sl. No.	Station Code	L_{eq}, dBA Time of day			Tests of between-Subjects effects		
		Morning	Afternoon	Evening	Sources of interaction	F	p
1.	D1	59.28	62.01	57.74	Time of day	60.60	<0.01*
					Location	1954.00	<0.01*
2.	D2	63.16	59.56	61.08	* The equivalent noise levels are not identical with respect to time of day and Sensitive areas.		
3.	D3	67.17	66.93	66.76			

As exhibited in Table 2 (b), ANOVA was performed for the noise levels at different Commercial areas assuming the following hypothesis:

H_0: L_{eq} levels are identical with the Commercial areas and also the time of day.

H_1: L_{eq} levels are not identical with the Commercial areas and also the time of day.

Since, $p<0.01$, the hypothesis is rejected at 1% level of significance and thus, the L_{eq} levels are not identical with respect to the Commercial areas and also with the time of day.

As exhibited in Table 2 (c), ANOVA was performed for the noise levels at different Residential areas assuming the following hypothesis:

H_0: L_{eq} levels are identical with the Residential areas and also the time of day.

H_1: L_{eq} levels are not identical with the Residential areas and also the time of day.

Since, $p<0.01$, the hypothesis is rejected at 1% level of significance and thus, the L_{eq} levels are not identical with respect to the Residential areas and also with the time of day.

Similarly, as exhibited in Table 2 (d), ANOVA was performed for the noise levels at Sensitive areas assuming the following hypothesis:

H_0: L_{eq} levels are identical with the Sensitive areas and also the time of day.

H_1: L_{eq} levels are not identical with the Sensitive areas and also the time of day.

Since, $p<0.01$, the hypothesis is rejected at 1% level of significance and thus, the L_{eq} levels are not identical with respect to the Sensitive area and also with the time of day.

Table 3: Cross-classification of background noise level (%) of ambient noise levels

a. Chi-Square Test for the Industrial Area

Sl. No.	Station Code	Percentage of Occurance – Time of day: Morning $\le L_{90}$	Morning $>L_{90}$	Afternoon $\le L_{90}$	Afternoon $>L_{90}$	Evening $\le L_{90}$	Evening $>L_{90}$	Chi-Square Test statistics: χ^{2a}	p	V^b
1.	**A1**	03.28	29.51	00.00	32.79	29.51	04.92	41.16	<0.01	**0.821**
2.	A2	06.12	26.53	30.61	2.04	12.24	22.45	19.96	<0.01	0.638
3.	A4	08.00	24.00	10.00	22.00	26.00	10.00	09.22	<0.01	0.429
4.	A5	03.80	37.69	06.79	24.28	14.44	13.00	167.9	<0.01	0.311
5.	A3	13.51	18.92	10.81	21.62	08.11	27.03	00.99	NS	0.164

NB: [a] Chi-square constant, [b] Cramer's V

b. Chi-Square Test for the Commercial Area

Sl. No.	Station Code	Percentage of Occurance – Time of day: Morning $\le L_{90}$	Morning $>L_{90}$	Afternoon $\le L_{90}$	Afternoon $>L_{90}$	Evening $\le L_{90}$	Evening $>L_{90}$	Chi-Square Test statistics: χ^2	p	V
1.	**B1**	00.00	34.69	10.20	22.45	22.45	10.20	17.74	<0.01	**0.602**
2.	B3	12.50	22.50	07.50	25.00	27.50	05.00	11.07	<0.01	0.526
3.	B4	14.05	27.40	19.36	11.62	13.24	14.34	101.14	<0.01	0.242
4.	B5	17.96	14.76	17.07	18.30	11.09	20.82	40.13	<0.01	0.165
5.	B2	15.79	17.29	11.65	21.80	10.53	22.93	05.53	<0.10	0.144

c. Chi-Square Test for the Residential Area

Sl. No.	Station Code	Percentage of Occurance – Time of day: Morning $\le L_{90}$	Morning $>L_{90}$	Afternoon $\le L_{90}$	Afternoon $>L_{90}$	Evening $\le L_{90}$	Evening $>L_{90}$	Chi-Square Test statistics: χ^2	p	V
1.	**C2**	33.73	07.26	09.66	22.07	00.11	27.16	837.5	<0.01	**0.692**
2.	C1	02.08	31.25	25.00	08.33	25.00	08.33	20.20	<0.01	0.649
3.	C3	09.84	24.59	03.28	22.95	18.03	21.31	05.07	<0.10	0.288
4.	C5	10.33	22.51	18.82	14.76	09.59	23.99	17.43	<0.01	0.254
5.	C4	18.06	23.17	20.53	10.70	10.18	17.37	96.51	<0.01	0.236
6.	C6	18.88	14.69	12.59	20.28	12.94	20.63	08.21	<0.05	0.169

d. Chi-Square Test for the Sensitive Area

Sl. No.	Station Code	Percentage of Occurance – Time of day: Morning $\le L_{90}$	Morning $>L_{90}$	Afternoon $\le L_{90}$	Afternoon $>L_{90}$	Evening $\le L_{90}$	Evening $>L_{90}$	Chi-Square Test statistics: χ^2	p	V
1.	**D2**	22.45	10.20	30.61	2.04	26.53	08.16	03.23	NS	**0.257**
2.	D1	09.43	33.96	03.77	20.75	20.75	11.32	01.87	NS	0.206
3.	D3	19.24	29.44	12.49	21.40	07.90	09.52	05.15	<0.10	0.059

In Table 1, the time of monitoring of noise levels presented and also the values of L_{90} and L_{eq} of Industrial, Commercial, Residential and Sensitive areas have been presented. The value of L_{90} (Background noise) does not exceed 75 dBA, the prescribed limits of **NPR (2000)** during summer and winter and also L_{eq} for the Industrial area. The station A1 (STP) is found to be the quietest whereas the station A4 (Workshop) is the noisiest. Monitoring results at the Commercial areas reveal that the value of L_{90} exceeds 65 dBA for the stations B2 and B5 (both are Airfield) during summer and winter. Similarly, L_{eq} for the stations B2 and B5 exceeds the prescribed limits for the day time. The stations B4 (the GM Office) is found to be the quietest and the station B5 (airfield) is the noisiest. The Residential areas also show that L_{90} value is more than 55 dBA, the stipulated standards and also L_{eq}. The station C5 (ATM) is the quietest among all the Residential stations. Similarly, the Sensitive areas indicate that both L_{90} and L_{eq} levels are more than 50 dBA, at all the stations. The noise level at the hospital (D2) is found to be the quietest during summer 2008.

As depicted in Table 2 (a) to (d), the ANOVA reveals that the noise levels are dependent with the different category of areas located in and around the chromite mining complex at 1% level of significance ($p<0.01$) and also with the time of day($p<0.01$).

As exhibited in Table 3 (a), the Chi-square test of independence reveals that for all the time of day, the Industrial areas and the equivalent noise levels are dependent at 1% level of significance ($p<0.01$) and the degree of association is 0.821 (Cramer's V). Table 3 (b) shows that the degree of association exists between the noise levels and the Commercial areas at 10% level of significance ($p<0.10$) and the maximum degree of association is 0.602. In case of Residential areas, association exists with the noise levels at 10% level of significance ($p<0.10$) and the maximum degree of association is 0.692. Similarly, the noise levels and the Sensitive areas are also associated at 10% level of significance ($p<0.10$) and the maximum degree of association is 0.257.

The station A3 (Workshop) is independent with the noise levels at 1% level of significance. The station D2 (Hospital) does not show any significant relation at 10% level of significance and also the station D1. It is found that the noise levels remain below L_{90} (Background Noise) during most of the times at all these stations and therefore, it may be inferred that the noise levels is not significant in respect of its background noise level ($p<0.10$).

4. Discussions

The t-test shows that the L_{eq} levels differ with their respective test values at 5% level of significance. The ANOVA exhibits that the L_{eq} levels are not identical with respect to Industrial, Commercial, Residential and Sensitive areas and also the time of monitoring i.e. morning, afternoon and evening ($p<0.01$).

As exhibited in Table 3 (a), the Chi-square test of independence reveals that the Industrial areas show association with noise levels during the time of the day at 1% level of significance ($p<0.01$) and the maximum degree of association is 0.821 (Cramer's V) for station A1, the STP. The L_{eq} is found to be within the prescribed standards of **NPR (2000)**. **Pal and Saxena (2000)** found that the noise levels at different Industrial category of areas are dependent with time of day. The study also reveals that there exists high degree of relation between the Industrial locations such as Regional Repair Workshop, Heavy Repair Shop, Dakra Mine Unit Workshop, KT Mine Workshop and KHD Mine Workshop and noise levels vary from 73.5-81.2 dBA. This is attributed to the presence of the mining complex near to the Industrial areas. **Rabeiy et al. (2004)** investigated that the noise levels in the workshop in El-Gadida mine are higher than the administrative norm of Turkey and also agreed that it is mainly associated with its location near to the mining area. **Sensogut and Cinar (2007)** found that the noise levels are in the range of 102-103 dBA from the maintenance workshop of a colliery. **Oyedepo and Saadu (2010)** surveyed that the noise levels at Passenger Hall Loading Park (Garage) are between 71-81 dBA. The high noise levels are associated with playing of record players within this park and also use of loudspeakers to call the passengers into the Commercial vehicles.

As exhibited in Table 3 (b), the Chi-square test of independence reveals that the Commercial areas are associated with noise levels during the day of monitoring at 10% level of significance ($p<0.10$) and the maximum degree of association is 0.602 (Cramer's V) for station B1, GM Office. **Oyedepo and Saadu (2010)** found that the noise levels in the Commercial areas in the range of 65-84 dBA and are associated with the noise from vehicle horn, engine, traffic volume and presence of intrusive noise sources. **Mohammad (2009)** investigated that 52% of subjects believed to bother the noise in the morning and is more irritating. **Pal and Saxena (2000)** found that the noise levels at the junction points of national highways are influenced by heavy traffic density of 0.2519 and 0.4478 in case of the state highways.

As exhibited in Table 3 (c), the Chi-square test reveals that the noise levels vary with the Residential areas during the day of monitoring at 10% level of significance ($p<0.10$) and the maximum degree of association is 0.692 (Cramer's V) for station C2, Main Gate. As this station is the entry point of all the employees and is also located adjacent to the main road leading to NH-5, the traffic density fluctuates throughout the day and also the noise levels. Similarly, the variation of noise levels during the day of monitoring is also due to plying of different HEMMs through this station.

Similarly, as exhibited in Table 3 (d), the Chi-square test reveals that the noise levels vary with the Sensitive area during the day of monitoring and the maximum degree of association is 0.257 (Cramer's V) for station D2, the Hospital in summer season. However, association exists between noise levels and the hospital, the Sensitive area and is significant in summer at 10% level of significance.

The Chi-square test reveals that the maximum degree of association between Industrial area and L_{eq} is 0.821, the values for the Commercial areas, Residential areas and Sensitive areas are 0.602, 0.692 and 0.257, respectively. Since, the value 0.821 is the maximum for the ambient air quality and is exhibited for the Industrial areas, it can be inferred that there is a strong association between the noise levels and the Industrial areas. Hence, it can be concluded that the Industrial area is the most affected area due to operation of the chromite mining complex.

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References

1. Ali, S.A. Investigation of the dose-response relationship for road traffic noise in Assiut, Egypt. Appl. Acoust. 2004; **65**:1113-1120.
2. Banerjee, D., Chakraborty, S.K., Bhattacharya, S. and Gangopadhyay, A. Appraisal and Mapping the Spatial-temporal distribution of urban road traffic noise. Int. Environ. Sci. Tech. 2009; **6**(2):325-335.
3. Don, C.G. and Rees, I.G. Road traffic sound level distributions. J. Sound Vib. 1985; **100**(1):41-53.
4. Ishiyama, T. and Hashimoto, T. The impact of sound quality on annoyance caused by road traffic noise: An influence of frequency spectra on annoyance. Japan Soc. Automot. Eng. Rev. 2000; **21**:225-230.
5. Johnson, D.R. and Saunders, E.G. The evaluation of noise from freely flowing road traffic. J. Sound Vib. 1968; **7**(2):287-309.
6. Moses, A.A., Ravichandran, C., Sagila, J.C., Sangeetha, R., Srinivasan, K., Andrews, J. and Raja, R.E. Noise Pollution Assessment in Chidambaram, Erode and Thanjavur towns in Tamil Nadu. Indian J. Environ. Prot. 2000; **20**(12):881-884.
7. Murthy, U.N. A statistical model between traffic volume and noise levels in urban areas. Indian J. Environ. Prot. 2001; **21**(9):837-838.
8. Madhu, S. and Ravichandran, C. Occupational Health Hazards in Industries due to noise pollution. Indian J. Environ. Prot. 1999; **19**(7):504-507.
9. Mathews, J. Measurements of Environmental Noise in Agriculture. J. Agri. Eng. Res. 1968; **13**(2):157-167.
10. Burgess, M.A. Noise prediction for urban traffic conditions-Related to measurements in the Sydney Metropolitan area. Appl. Acoust. 1977; **10**:1-7.
11. Pandya, M. and Shrivastava, R.K. Analysis of noise levels and its health effects in Commercial areas of Jabalpur City: Part-I analysis of noise levels. Indian J. Environ. Sci. 1999; **3**(2):197-200.
12. Oyedepo, O.S. and Saadu, A.A. Evaluation and analysis of noise levels in Ilorin metropolis, Nigeria. Environ. Monit. Assess. 2010; **160**:563-577.
13. Omidvari, M. and Nouri, J. Effect of noise pollution on traffic policeman. Int. J. Environ. Res. 2009; **3**(4):645-652.
14. Pal, A.K. and Saxena, N.C. Development of noise indices for coal mining complexes, An ENVIS Monogram, 2000, Ministry of environment and Forests, India.
15. Tanaka, S. and Shiraishi, B. Wind effects on noise propagation for complicated geographical and road configurations. Appl. Acoust. 2008; **69**:1038-1043.
16. Thorsson, P.J., ӧgren, M. and Kropp, W. Noise levels on the shielded side in cities using a flat city model. Appl. Acoust. 2004; **65**:313-323.
17. Mohammad, Gh. An investigation of community response to urban traffic noise, Iran J. Environ. Health Sci. Eng. 2009; **6**:137-142.
18. Lui, W.K., Li, K.M., Ng, P.L. and Frommer, G.H. A comparative study of different numerical models for predicting train noise in high-rise cities. Appl. Acoust. 2006; **67**:432-449.
19. Pulikesi, M., Karthikeyan, P., Sai, R.L., Ramamurthi, V. and Sivanesan, S. Exceedences of Noise Level during Festival Day-Diwali, 2006. www.eco-web.com/edi/061026.html.
20. Scheiblechner, H. The Validity of the 'Energy Principle' for Noise-Induced Hearing Loss. Audiology 1947; **13**:93-111.
21. Kerketta, S., Dash, P.K. and Narayan, L.T.P. Work zone Noise levels at Aarati steel plant, Orissa and its attenuation in far field. J. Environ. Biol.2009; **30**(5):903-908.

22. NPR (200). The Noise Pollution (Regulation and Control) Rules, 2000 of Ministry of Environment and Forests, Government of India, India, 2000.
23. Heimann, D. Meteorological aspect in modeling noise propagation outdoors. Euro Noise, Naples, 2003.
24. Irwin, J.D. and Graf, E.R. Industrial Noise and Vibration Control. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1939. pp. 16.
25. Rabeiy R.E., Mohamed, M. A-K and Gomma, W.A. Study on the noise prediction in mining and Industrial plants. Ass. Univ. Bull. Environ. Res. 2004; **7**(2):77-89.
26. Sensogut, C. and Cinar, I. An empirical model for the noise propagation in open cast mines- A case study. Appl. Acoust. 2007; **68**:1026-1035.

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