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GIS based Assessment of Noise Environment of Imphal City, Manipur (India): A Comprehensive Study

Wazir Alam[1], Bindiya Aribam[1] and Waikhom Roshan Singh[2]

[1]Department of Forestry and Environmental Science, Manipur University, Canchipur, Imphal-795003.

[2]AEE, Manipur Pollution Control Board (MPCB), Imphal- 795001

Corresponding Author: wazir@manipuruniv.ac.in

Abstract:
Assessment of equivalent noise level was carried out within spatially distributed traffic junctions, residential colonies, commercial locations and silent zones of Imphal city for different time periods of the day. Moreover, a detail traffic noise assessment of two busy traffic junctions of the city were carried in in order to evaluate detail traffic noise scenario with respect to different traffic volume situations. The noise and geographic coordinate data from different locations of the city were further used for mapping of prediction of vulnerable noise zones of the study area using geostatistical interpolation method. The interpolated noise pollution maps revealed unsatisfactory noise environment of the city and highlight the vulnerable noise zones of the city that requires appropriate measures to control noise level.The study also highlighted and advocates the need of an appropriate initiatives for sustainably managing urban noise environment and ensuring public health safety that can be achieved by participation of various stakeholders in the form of increasing adequate of parking spaces, open spaces, effective traffic management, improvement of road conditions, construction flyovers, bye lanes and alternative roads.

Keywords: A-Weighted, Decibels, Noise Mapping, Traffic Noise Index, Noise Risk Zone

1.0 Introduction:
Noise pollution is an emerging form of urban environmental problem around the world due to its numerous severe undesirable impacts on the overall environment. Noise pollution can be defined as high decibels sound in an inappropriate place at an inappropriate time that can interfere with the quality of human life leading to range of direct and indirect health impacts (Canter, 1996). Generally, noise is a form sound energy or mechanical energy generated from a vibrating source and transmitted through a medium in a cyclic series of compressions and rarefactions per unit time called frequency. Prolonged exposure to high frequency or decibels of noise can cause undesirable impacts on human beings in the form of irritation, annoyance, damage to auditory or hearing mechanism, physiological and psychological disorders (USEPA, 1991).Since, impacts of noise are not very immediate and perceptible as other form of environmental pollutions; it's very slow and indiscernible (Garg and Maji, 2016; Wani and Jaiswal, 2010; Banerjee*et al.*, 2009; Goswami, 2009; Vijay*et al.*, 2015). The present research findings around the world have revealed that noise is becoming a major urban environmental and occupational health hazard (Garg *et al.*, 2017, 2016;Nagodawithana et al., 2015; Nasir *et al.*, 2015;Esmaeelpour*et al.*, 2014; Sivasubramanian *et al.*, 2014; Subramani *et al.*, 2012; Alam, 2011; Mehravaran*et al.*, 2011; Banerjee*et al.*, 2008a, 2008b). The impacts of noise pollution can have profound impacts on the natural wildlife and ecological system as it can disrupt ecological niches, functions of urban species in the form disturbed habitats and breeding grounds(Shannon*et al.*, 2015, Popper and Hastings, 2009; Forman and Alexander, 1998). It can also interfere with the vocal communications, territorial behaviours, mating success of both domesticated and wild species leading to their disappearance and migration (Goussous*et al.*, 2014; Parrisand Schneider, 2009, Reijnen and

Foppen,2007). The present study was carried out with an objective to assess the present noise environment of Imphal in order to highlight and advocates for the need of an appropriate urban noise environment management initiative for ensuring public health safety.

Study Area

Imphal is an emerging urban centre in the north eastern Indian region. Imphal city is considered to be the gateway to South East Asian countriesdue to its strategic location and sharing of state borders with many other important north eastern states as well as international borders with Myanmar.The population of the city is around 974,105, which is almost one-third of the state population (MPSACC, 2016). It stretches over an area of 82.89 sq. km. between the geographical coordinates24.68°to 24.93° N latitude and 93.56°to 94.17° E longitudes (Fig.1). The Imphal city is one of the fastest growing urban centers in the regionand very well connected to the neighbouring states through national and international highways (Asian highway No 1). Moreover, the city very is very well connected to the major district headquarters of the state through state highways and huge numbers of vehicles ply toand from the city every day constituting very influx of traffic. As the city is an emerging as hub for educational, medical, commercial and political activities, the traffic scenario is changing very fast due to heavy influx of population to the city from different parts of the state as well as from neighboring states.

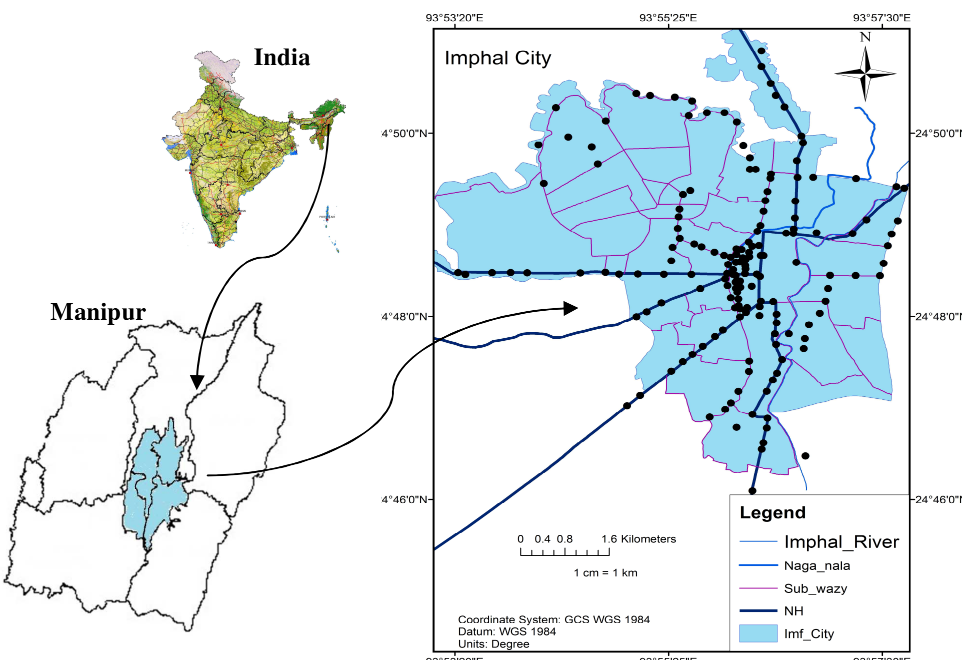


Fig. 1: Map showing location of the study area and Sampling points

2.0 Materials and Methods:

2.1 Collection of Noise Data

The measurement of noise levels were carried out using Sound Level Meter (SLM) (Make: Lutron & Model: SL-4001) within the Imphal city at different time period of the day including 51silent zone (educational institutes/hospitals) locations, 18 residential colonies, 34 commercial places and 66 traffic junctions. The details traffic noise assessments were carried out using Type-1Real Time Analyser Pulsar Sound Level Meter (SLM). The noise levels were measured at each locations keeping SLM at around1 to 1.2 m above the ground level pointing the receiver horizontally towards the source. Equivalent noise levels (L_{eq}) were recorded for consecutive months in each locations at different time period of the day i.e. morning (7- 10 am), Noon (12 noon- 2 pm) and evening (4- 6 pm). To minimize errors and get more representative valueequivalent noise levels (L_{eq}), sound levels were recorded for 45 minutes at an interval of 5 minutes at each location"A-weighted"scale. *i.e.* dB (A) which resembles human hearing response (Canter, 1996)

(a) (b)

Figure 2.The figures showing recording of noise data in the study area using
(a) Noise recoding using SL-4001 and (b) Type-1Real Time Analyser Pulsar SLM

2.2 Evaluation of Equivalent Noise Level (L_{eq}):

For any time period under consideration, the Equivalent Noise Levels (L_{eq}) represents the energy equivalent sound level or sound energy in dB (A). In actuality, the equivalent noise levels represent equivalent steady noise energy that would contain the same time-varying noise energy during the stated time period (Canter, 1996). Thus, L_{eq}can be evaluated using the following equation

$$L_{eq},T = 10 \log \left[\frac{1}{T_i} \sum_i^n 10^{\left(\frac{L_i}{10}\right)} \right], \qquad (1)$$

where, L_{eq} is the equivalent noise level observed over the total time of operation, T and T_i is the duration of measurement of i^{th} phase. Thus, $L_{eq}$is the representative noise level with same of amount of sound energy for the fluctuating noise levels for given time period, T, at an interval of T_i.

2.3 Assessment of TNI, NC and NRZ

In order to estimates the degree of variation in a traffic noise, *Traffic Noise Index* (TNI) was assessed to represents the measure of annoyancebehaviour of human exposed to vehicular generated noise (Banerjee*et. al*, 2009). The TNI is estimated using the following formula

$$\text{TNI} = 4(L_{10} - L_{90}) + (L_{90} - 30)\,\text{dB(A)}, \quad (2)$$

where, $L_{10}$is peak noise levels and $L_{90}$is background noise levels representing the percentile noise levels exceeding for 10% and 90% of the sampling time, respectively. *Noise Climate* (NC) (Prachiti, et. al, 2014) is the range over which the sound levels are fluctuating in an interval of time. It is estimated by the following relation

$$\text{NC} = (L_{10} - L_{90})\,\text{dB(A)} \qquad (3)$$

The*Noise Risk Zone (NRZ)* isrepresentation of noise levels in percentage within various noise ranges in order to categorize noise pollution level as safe (<66 dBA), tolerable (66-71 dBA), low risk (71-76 dBA), moderate risk (76-81 dBA) high risk (81-86 dBA) and extremely high risk (>86 dBA) (Banerjee *et al*., 2009).

2.4 Noise Mapping

In order to highlight the vulnerable noise pollution zones of the Imphal city, noise prediction maps were prepared using ArcGIS 10.1 geostatistical mapping tools. The geostatistical tool employ interpolation techniques that can be effectively used for the purposes of noise mapping for better visual presentations of high noise level zones (Alam, 2011; Banerjee et al. 2009; Mohammadi, 2009; Yilmazo and Hocanli, 2006). The interpolation techniques usually make use of krigging; inverse distance weighting etc. to assess the acoustic behaviour over a geographical area based on the measured noise levels of the points-locations that are spatially distributed. For the preparation of vulnerable noise zone maps of Imphal city, inverse distance weighting (IDW) interpolation technique were used for generating noise colour contour based on acoustic/equivalent noise levels behaviour of uniformly distributed point locations in the study area. For this purpose, a georeferenced map for Imphal city was used for plotting the geographical coordinates of noise recorded points. After plotting the points, noise contours were generated using Inverse Distance Weighted (IDW) using the interpolation techniques of ArcGIS 10.1. After interpolation noise ranges were designated with colour code and same is reflected in the map in the form of vulnerable zones in the form of colour contours.

3.0 Results and Discussion:

3.1 Overall Noise Scenario of Imphal City

Overall noise environment of Imphal city were assessed using 169 point-locations covering all the zones i.e. residential colonies, educational institutions, hospitals and nursing homes, commercial locations, traffic junctions during different times periods of the day i.e. morning, noon and evening. The basic noise characteristics and statistical parameters of equivalent noise level (L_{eq}) of different zones are presented in Table1. The major observations is that theequivalent noise levels in all most all the zones except few locations of residential colonies were found to be exceeding the permissible limits prescribed by Central Pollution Control Board (CPCB, 2001) during different time period of the day. The major concerned is that L_{eq}were found to exceed the CPCB permissible limits by many fold in silent zones (near schools, colleges, hospitals, nursing homes, government offices), as most of these locations are either located near roadside or in the vicinity of commercial zones. Moreover, higher L_{eq} were recorded in the most of the commercial places and traffic junctions due to congested, narrow and poor roads conditions and plying of heavy vehicles. The some of the major observations for increasing L_{eq}in these zones can be attributed to lack of sufficient parking spaces for all types of vehicles, insufficientpedestals spaces, absence of alternative routes such as subways, flyovers, over bridges, poor road condition and lack of proper traffic managements initiatives. Thus, the escalating noise levels in most of the traffic junctions and commercial locations beyond noise pollution level i.e. 80 dB(A), contributing greatly deterioration ofnoise environment of the city.

3.2 Noise Risk Zone (NRZ)

The assessment of noise risk zone (Table 2) was carried out in order to identify the different vulnerable noise zones of the city categorically as *Safe, Tolerable, Low risk, Moderate risk, highly risk* and *extremely risk* (Banerjee *et al*., 2009). About 30% of the locations of silent zone are found to be within the moderate and high risk zone category and rest falls under safe to low risk category. Residential colonies are found under low risk zone category due to less traffic mobility. But commercial places and traffic junctions of the city are in the grasp of high to extremely risk zones category. Almost similar noise risk zone scenarios were observed in all the time period of the day i.e. morning, noon and evening indicating unsuitable noise environment of Imphal city.

Table1: Equivalent Noise Level (L_{eq}) parameters for four zones during different time of day

Noise Zones	Time	Equivalent Noise Level Parameters, dB(A)			
		Mean	SD	L_{eq}(Min)	L_{eq}(Max)
Silent Zones	07.00-10.00 am	72.7	6.6	56.8	83.0
	12.00-2.00 pm	73.2	6.6	56.1	85.8
	04.00-6.00 pm	73.6	6.5	57.4	84.2
Residential Zones	07.00-9.00 am	62.8	6.6	54.6	78.9
	12.00-2.00 pm	62.5	6.6	52.7	76.7
	04.00-6.00 pm	65.7	6.2	54.9	75.4
Commercial Zones	07.00-10.00 am	77.4	5.5	71.9	92.6
	12.00-2.00 pm	78.1	3.6	75.0	85.9
	04.00-6.00 pm	78.6	5.2	72.2	95.8
Traffic Zones	07.00-10.00 am	86.4	6.4	72.9	99.4
	12.00-2.00 pm	85.0	4.8	75.9	97.9
	04.00-6.00 pm	82.1	7.3	64.8	103.0

Table 2: Table showing the NRZ distribution in different Zones of Imphal City

Noise Zones	Time	Percentage(%) of Noise Risk Zones (NRZ)					
		Intensity of Noise in dB (A)					
		Safe (< 66)	Tolerable (66 – 71)	Low Risk (71 – 76)	Moderate Risk (76 – 81)	High Risk (81- 86)	Extremely High Risk (> 86)
Silent Zone	Morning (7-10 am)	15.7	25.5	29.4	27.5	2	Nil
	Noon (12-2 pm)	11.8	25.5	33.3	23.5	5.9	Nil
	Evening (4-6 pm)	15.7	13.7	31.4	35.3	3.9	Nil
Residential Zone	Morning (7-10am)	22.2	77.8	Nil	Nil	Nil	Nil
	Noon (12-2 pm)	72.2	22.2	5.6	Nil	Nil	Nil
	Evening (4-6 pm)	50	27.8	22.2	Nil	Nil	Nil
Commercial Zone	Morning (7-10am)	Nil	2.9	35.3	26.5	26.5	8.8
	Noon (12-2 pm)	Nil	Nil	Nil	11.8	50	38.2
	Evening (4-6 pm)	Nil	Nil	29.4	32.4	26.5	11.8
Traffic Zone	Morning (7-10am)	Nil	Nil	Nil	Nil	33.3	66.7
	Noon (12-2 pm)	Nil	Nil	Nil	13.3	13.3	73.3
	Evening (4-6 pm)	Nil	Nil	6.7	40	6.7	46.7

3.3 Traffic Noise Assessment

Traffic noise assessments were carried out using Type-1Real (Time Analyser Pulsar Sound Level Meter (SLM) investigating the traffic noise scenario of two highly congested traffic locations *i.e*. Kangla Western Gate and Singjamei Bazar of the city. Various noise levels (L_1, L_5, L_{10}, L_{50}, L_{90}, L_{95}, L_{99} *and Leq*) were recorded for two consecutive days i.e., weekday and holidays for different time period of the day *i.e*. during morning (10.00 a.m. to10.30 a.m.), noon (1.00 p.m. to 1.30 p.m.) and afternoon (4.00 p.m. to 4.30 p.m.). The total numbers of vehicles were counted during the noise assessment period to comprehend contribution of percentage of vehicles contributing the traffic noise, traffic volume, equivalent noise levels (L_{eq}), mean, standard deviations (SD), Traffic Noise Index (TNI) and Noise Climates (NC) of the study area (Table 3). It was observed that the major contributors of escalating levels of traffic noise in these two particular junctions of the city are primarily due to three wheelers (auto) and heavy vehicles (trucks) that run on diesel engines and produces lots of engine noise. The noise assessment data revealed that the equivalent noise levels are higher during the weekdays as compared to the holidays, due to less plying of traffic and lesser influx of commercial vehicles.

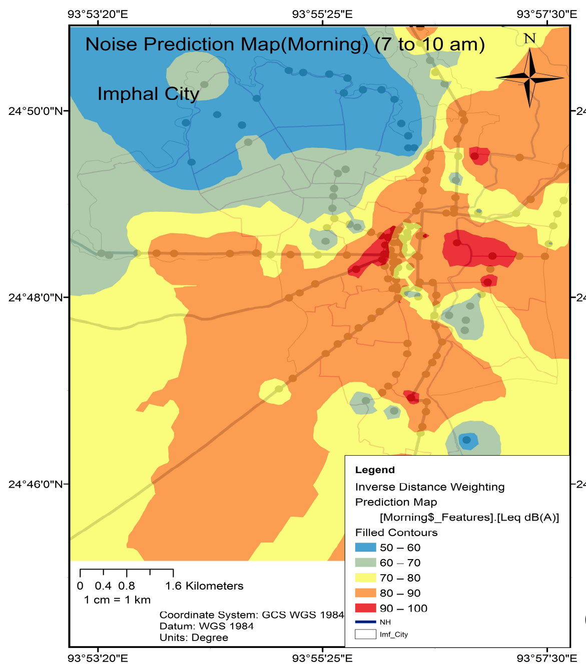
Table 3: Table showing the traffic volume characteristics, basic statistics and TNI and NC of Equivalent Noise Levels (L_{eq}) of two traffic junctions of the Imphal city

Place	Day	Time	Total Traffic Vol.	% of 2-wheeler	% of 3- wheeler	% of 4-wheeler	% of Heavy Vehicle	Equivalent Noise Levels (L_{eq})	Mean	SD	TNI	NC
Kangla gate	Holiday	10.0-10.30 am	1584	41.3	10.4	45.8	2.5	74.9	72.2	8.3	94.7	15.9
		1.00 - 1.30 pm	1358	39.1	13.6	44.9	2.4	74.4	70.5	6.8	75.0	9.9
		4.00 - 4.30 pm	1242	40.3	11.3	46.5	1.9	72.8	70.7	7.2	72.5	9.4
	Week day	10.0 - 10.30am	1930	45.5	10.6	42.8	1.1	78.3	75.4	7.6	81.6	10.6
		1.00 - 1.30 pm	1811	40.8	12.0	45.8	1.4	75.5	74.3	7.2	77.6	9.8
		4.00- 4.30 pm	2136	40.6	14.0	43.1	2.3	78.4	74.9	7.6	81.3	10.6
Singjamei Bazar	Holiday	10.0- 10.30 am	1462	41.4	14.1	42.8	1.8	80.7	77.6	7.9	81.3	9.8
		1.00- 1.30 pm	1396	45.0	12.5	40.4	2.1	77.9	75.3	8	82.3	10.7
		4.00- 4.30 pm	1598	40.7	17.8	39.4	2.1	80.4	76.9	8.1	83.9	10.8
	Week day	10 - 10.30 am	2238	50.0	11.7	37.0	1.3	81.9	77.9	7.3	81.0	9.7
		1.00 - 1.30 pm	1931	43.1	16.0	39.2	1.8	80.7	77.5	8.1	83.6	10.6
		4.00- 4.30 pm	2279	50.7	10.7	37.5	1.2	82.2	77.3	8.1	83.6	10.6

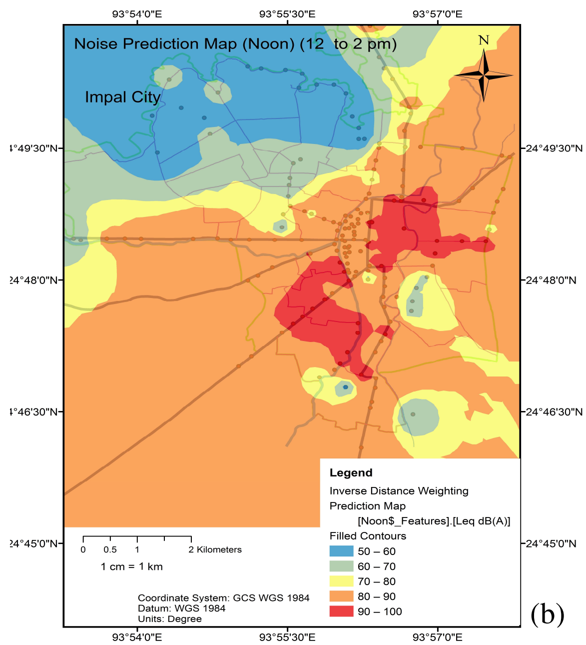
The higher values traffic noise variation or index (TNI) indicate overall fluctuation of noise over time and more disorderliness of traffic behaviour in the traffic junctions of the city. The traffic noise annoyance or noise climate (NC) of the junctions signify noisier environment conditions that results due to less variations between background (L_{90}) and peak noise (L_{10}) levels. The higher values of equivalent noise levels (L_{eq}), higher TNI and consistent NC in these traffic junctions indicates higher background noises due to continuous noise sources. The continuous and higher noise climate (NC) may cause serious noise pollutions induced health problems on the dwellers or people residing in the vicinity of traffic junctions of traffic points of the city. The higher TNI values of the study area highlights disorderliness of traffic behaviour of the Imphal city due to poor traffic management initiatives.

3.4 Noise Mapping

Noise prediction maps were prepared using ArcGIS 10.1 geostatistical tool in order to identify and highlight the noise pollution vulnerable zonesof Imphal city during the different time periods of the day. Predicted noise maps and colour contours were generated by the ArcGIS 10.1 software using the geostatistical interpolation techniques *i.e.* inverse distance weighting (IDW) interpolation technique for generating the predicted vulnerable noise zone maps based on the acoustic behaviour of the study area. The IDW interpolation techniques make use of measured noise levels of point-locations to evaluate noise levels of surrounding area or in the vicinity between two nearest point. The vulnerable noise prediction maps are prepared for the different times zones i.e. morning, noon and afternoon are presented in Fig, 2(a), 2(b) and 2(c) respectively. The predicted map shows that few locations within the city mainly comprising of commercial zones, traffic junctions and roadside residential colonies are in the grip of higher noise levels i.e. more than 80 dB(A). From the figures [Fig 2(a), 2(b), 2(c)], it is distinct that the morning and noon are having higher coverage of noise pollution levels than the afternoon (i.e. 4 to 6 pm).



(a)



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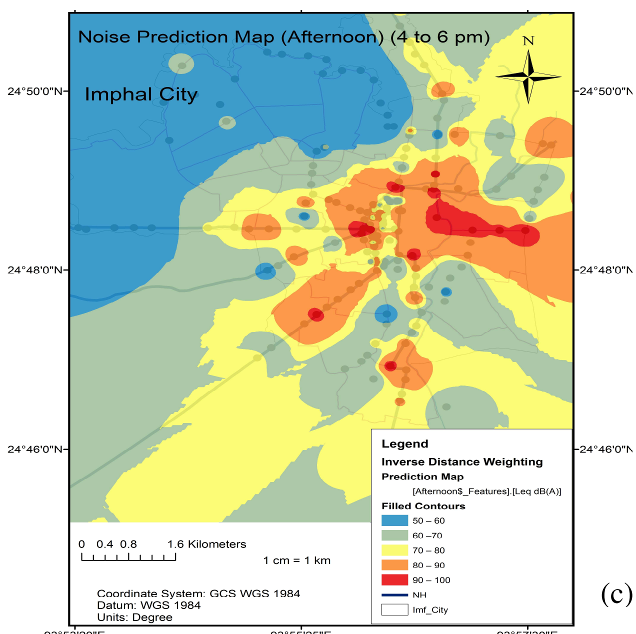

(c)

Figure 3: The Figure showing the predicted vulnerable noise environment zones of Imphal city during (a) morning hours (i.e. 7 to 10 am) (b) Noon (12 to 2 pm) and (c) Evening (7 to 10 prepared using geostatistical interpolation (IDW) methods

4.0 Conclusion:

The overall noiseenvironment of the Imphal city is not satisfactory as most of the locations are already in the grip of escalating noise pollution levels that exceeds the noise standards prescribed by Central Pollution Board and Noise Pollution (Regulation and Control) Rules, 2000. The noise environment of residential zones were found well within the noise pollution standards (i.e. 80 dB(A)), but noise levels of most of the silent zones, commercial locations and traffic junctions were found to be in high and extremely high risk category. The traffic noise index and noise climate of traffic junctions of the city indicates more fluctuating and disorderliness of traffic scenario with less variation between background and peak noise levels. The escalating noise levels in the city is mainly due to heavy traffic inflow, improper traffic management, lack of parking spaces, absence of alternatives roads, flyovers, over bridges, pedestal, insufficient greeneries along the road side, lack of open spaces and poor road conditions. Moreover, the age and condition of vehicles, uses of electronic horns and attitudes of plyers are also some of the contributing factors. In order to minimize the nuisance of noise pollution, a proper city planning and traffic managementinitiativesare immediately required along with strict enforcement of noise pollution control rules and regulation. Demarcation of noise sensitive zones or 'no horn zone'; broadening the roadsand subways;demarcation ofcycling lanes and pedestal or footpaths;construction of flyovers and over bridges in busy traffic junctions;well-planned parking spaces in commercial zones; increasing greeneries and open spaces along roadside; construction of noise barriers around residential colonies and silent zones; replacing old and out-dated vehicles and more importantly creating mass awareness among the people are some of the suggested traffic noise management initiatives that can adopted to ensure sustainable urban environment and public health security of the dwellers of Imphal city.

5.0 Acknowledgement:

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References:

1) Alam, W. (2011): GIS based Assessment of Noise Pollution in Guwahati City of Assam, India. *Int. J. of Environ. Sci.*, 2(2): 743-751.
2) Banerjee, D. (2014): Association Between Transportation Noise and Cardiovascular Disease: A Meta Analysis of Cross-sectional Studies Amongst Adult Populations from 1980 to 2010. *Indian J. Public Health,* 58:84–91.
3) Banerjee, D., Chakraborty, S.K. and Gangopadhyay, A. (2008a): Evaluation and Analysis of Road Traffic Noise in Asansol: An Industrial Town of Eastern India. *Int. J. of Environ. Res. and Public Health*, 3(3): 165-171.
4) Banerjee, D., Chakraborty, S.K., Bhattacharyya, S. and Gangopadhyay, A. (2008b): Attitudinal Response Towards a Road Traffic Noise in the Industrial Town of Asansol, India. *Environ. Pollu. Monit. and Assmnt.*, 151(1-4): 37-44.
5) Banerjee, D., Chakraborty, S.K., Bhattacharyya, S. and Gangopadhyay, A. (2009): Appraisal and Mapping the Spatial-Temporary Distribution of Urban Road Traffic Noise. *Int. J. Environ. Sci. and Technol.*, 16(2): 325-335.
6) Canter, L.W., (1996): *Environmental Impact Assessment*. McGraw Hill Inc, New York.
7) CPCB, (2001): *Noise Pollution Regulation in India*, Central Pollution Control Board New Delhi.
8) Esmaeelpour, M.R.M., Sekhavatjou, M.S. and Chabi Ahwazi, Z., (2014): Designing a Traffic Noise Prediction Model for Highways in Iranian Megacities (Case Study: Ahvaz City). *J. Environ. Res.*, (2): 427-434.
9) Forman, R.T.T. and Alexander, L.E. (1998): Roads and their Major Ecological Effects. *Ann. Rev. Ecology Sys.*, 29: 207- 231.
10) Garg, N. and Maji, S. (2016): A Retrospective View of Noise Pollution Control Policy in India: Status Proposed revisions and Control Measures.*Curr. Sci. J.*, 111(1):29–38.

11) Garg, N., Sinha, A.K., Gandhi, V., Bhardwaj, R.M. and Akolkar, A.B. (2017): Impacts of Diwali Celebration on Environmental Noise Pollution in India. *Acoustics Australia,* 45(1): 101-117.
12) Garg, N., Sinha, A.K., Gandhi, V., Bhardwaj, R.M. and Akolkar, A.B. (2016): A Pilot Study on Establishment of Ambient Noise Monitoring Network Across the Major Cities of India. *Appl. Acoust.,* 103**:**20–29.
13) Goswami, S. (2009): Road Traffic Noise: A Case Study of Balasore Town, Orissa, India. *J. Environ. Res.*, 3(2): 309-318.
14) Goussous, J., Al-Dakhlallah, A., Jadaan, K.S. and Al-Zioud, M.A. (2014): Road Traffic Noise in Amman, Jordan: magnitude and cost investigation. *J. Traffic and Logis. Engg.,* 2(2): 104-107.
15) Mehravaran, H., Zabani, S., Bidhendi, G.R.N., Ghousi, R. and Shirazi, H.K. (2011): Noise Pollution Evaluation Method for Identification of the Critical Zones in Tehran. *J. Environ. Res.*, 5(1): 233-240.
16) Mohammadi, G.H. (2009): An investigation of Community Response to Urban Traffic Noise. Iran. *J. Environ. Health Sci. Eng.*, 6(2): 137-142.
17) MSAPCC, (2015): Manipur State Action Plan for Climate Change, Directorate of Environment, Govt. of Manipur, India.
18) Nagodawithana, N.S., Pathmeswaran, A., Pannila A.S, Wickramasinghe A.R., Sathiakumar, N. (2015): Noise-induced Hearing Loss among Traffic Policemen in the City of Colombo, Sri Lanka, *Asian J. of Water, Environ. Pollutn.,* 12(3):9–14.
19) Nasir, U.P., Brahmaiah, D. (2015): Impact of Fireworks on Ambient Air Quality: A Case Study. *Int. J. Environ. Sci. Technol.,* 12: 1379–1386.
20) Parris, K.M. and Schneider, A. (2009): Impacts of Traffic Noise and Traffic Volume on Birds of Roadside Habitats. *Ecology and Society*, 14(1): 29.
21) Popper, A.N. and Hastings, M.C. (2009): The Effects of Human Generated Sound on Fish. *Integr. Zool*., 4: 43-52.
22) Prachiti, M., Nitesh, J., Bharati, B. and Ambika, J. (2014): Study of Fluctuating Noise Levels in Palghar. *Pollutn. Resrch*., 33(2): 1-6.
23) Reijnen, R. and Foppen, R. (1997): Disturbance by Traffic of Breeding Birds: Evaluation of the Effect and Considerations in Planning and Managing Road Corridors. *Biodiv. Conser*., 6: 567-581.
24) Shannon, G., McKenna, M.F., Angeloni, L.M., Crooks, K.R., Fristrup, K.M., Brown, E., Warner, K.A., Nelson, M.D., White, C., Briggs J., McFarland, S. and Whittemyer, G. (2015): A Synthesis of Two Decades of Research Documenting the Effects of Noise on Wildlife. *Biol. Rev. Camb. Philos. Soc.,* 91:982–1005.
25) Sivasubramanian, R., Krithiga, S. K., Dhivya, S. and Keerthinarayana, S. (2014): Assessment of Traffic Noise and Annoyance Response in Madurai City. *Int. J. Adv. Tech. Engg. Sci*., 2(12): 646-653.
26) Subramani, T., Kavitha, M. and Sivaraj, K.P. (2012): Modelling of Traffic Noise Pollution, *Int.. J. Engg. Res.Apllctn.,*2(3): 3175- 3182.
27) USEPA, (1991): *Noise Abatement Program, Code of Federal Regulation*, United States Environment Protection Agency, 24-115.
28) Vijay, R., Sharma, A., Chakraborti, T. and Gupta, R. (2015): Assessment of Honking Impact on Traffic Noise in Urban Traffic Environment of Nagpur, India*. J. Environ. Health Sci. Engg*., 13(10):10.
29) Wani, K.A. and Jaiswal Y. K. (2010): Assessment of Noise Pollution in Gwalior, M.P. India. *Adv. in Biores.,*1(1):54-60.
30) Yilmazo, G. and Hocanli, Y. (2006): Mapping of Noise by Using GIS in Sanliurfa. *Enviro. Monit. Assess.*, 121(1-3):103-108.