Assessment and mapping of noise pollution using Geographic information system in Tiruchirapalli city

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Abstract
Noise pollution is one of the most common environmental hazards encountered in everyday life. The goal of this study was to assess the quantity of noise in the Ponmalai region of Tiruchirappalli city in southern India and then to use geographic information systems (GIS) to develop a visualization based on the data. The areas were classified into three categories: silent, residential and commercial. The Lutron model number SL4010 was used to measure noise. The mapping was carried out using ArcGIS version 10.3 software (Krigging). To determine the significant differences in noise levels between morning, noon and evening, a one-way Anova was used, followed by Tukey's multiple comparisons test. At each location, the vehicle intensity was also assessed. The findings revealed that the observed sound levels were above the standard limits.

Specifically, during peak hours (morning and evening), the noise level increased to an extreme. The study found that noise pollution in Ponmalai, India, is primarily due to increased vehicle movement, sound horns and public gatherings. In conclusion, recommendations include strict regulations, establishing buffer zones, creating no-honking boundaries, enforcing heavy vehicle speed restrictions, providing pro-elastic traffic roadways and implementing noise barriers in sensitive areas.

Keywords: Noise monitoring, Noise mapping, Lutron SL4010, ArcGIS 10.3 software, Krigging.

Introduction

Currently, pollution is one of the main issues affecting the environment. Among these, one of the most significant is noise pollution[18]. Another word for "noise" is "nausea," which means "sickness" in Latin. It is an unpleasant sound that makes people uncomfortable[23]. The definition of noise is an unwanted sound or possible threat to human health. Communication is released into the environment with the potential to cause harm to the ears. Excessive noise produced by humans that penetrates our surroundings and has the potential to adversely affect the balance or activity of both humans and animals is known as noise pollution. Noise pollution comes from a wide range of sources including today's society, urbanization, industrialization and other factors[16]. Noise pollution is a pervasive and invisible threat that exists on land, at sea and everywhere, despite not being physically visible.

Decibels (dB) are a unit of measurement for noise levels. The harmful consequences of noise pollution include harm to the ears, loss of proper hearing and occasionally even deafness. Furthermore, continuous interactions with loud noises cause humans to respond severely, a phenomenon known as an inflammatory response. It impacts various bodily areas including blood pressure, cardiac difficulties, lack of focus, increased respiratory rate and difficulty in concentrating. Noise pollution can lead to noise-induced hearing loss, one of the most prevalent health issues[17].

In addition to its adverse impacts on hearing loss, learning difficulties, stroke, headaches, insomnia, psychological disorders, lack of focus and hypertension, noise pollution additionally reduces the quality of life for both humans and aquatic life[27]. Unwanted sound, or noise, affects not only the daily activities of society but also the health of wildlife and humans. Even with many worldwide educational activities, the impacts of noise are still ignored and these issues remain unresolved[15].

Industrialization and transportation are the outcomes of human activity. The transportation sector is vital to the nation's economic prosperity. However, it has two opposing effects: it impacts people and the environment while also promoting economic growth. The impacts on people include sleep disturbances, elevated blood pressure and other issues[21]. Unwanted, unpleasant sounds that are a result of human activity and lower quality of life are known as noise pollution. Noise is produced when sound waves are subjected to extended periods of time which damages hearing[5].

However, noise is an unwanted sound and is regarded as an environmental danger. When exposed to high levels on a regular basis, it can harm aquatic and human health[25]. To reduce noise pollution, the World Health Organization (WHO) has attempted to educate the public, raise awareness and promote action. Environmental noise management is included in many countries' urban development regulations and environmental impact assessments. Acoustic noise can be harmful if it reaches a certain level. Fifty-five percent of the noise generated in urban areas originates from traffic.

This could directly or indirectly cause issues for people. The cause of noise pollution, sometimes referred to as sound pollution, which can be harmful to the wellness and health of individuals, is human activity. The most frequent sources of noise pollution are automobiles, aircraft, machinery, power tools, sirens and other sources of noise[11].

The environment can be contaminated in many different ways because everything is interconnected. Since pollution is essentially a tool, humans are mostly responsible for producing it. Currently, the most pressing issue is noise pollution, to which traffic noise greatly contributes due to an increase in transportation and human activity. It leads to numerous abnormalities in the human body including endocrine, cardiovascular and neural drowsiness, as well as stable or temporary functional modifications[22]. According to several studies, residential locations expose residents to higher levels of noise pollution than other areas[2]. People moving from rural to urban regions in search of better infrastructure and a better way of life are the primary factors contributing to noise pollution in cities.

According to these findings, the rate of urbanization in urban areas improved[1]. Urban areas with high sound pressure levels have negative health consequences for people. Numerous studies have examined noise pollution in urban environments[28]. Due to urbanization and the growth of the vehicle sector, noise pollution has increased over the last few years and is considered to be harmful to public health[9]. In both small and large urban areas, noise pollution has become an increasing problem. Compared to other forms of noise pollution, urban noise is more serious. India is a country that is growing and over the past thirty years, the urban population has grown.

Traffic volume and quality are two of the many elements that lead to an increasing volume of noise. Because of the intensity of noise from the sirens and horns of vehicles as well as the volume of traffic[14], the impacts of environmental noise are frequently invisible and not immediately evident. It is referred to as a "neglected pollutant"[12]. Population growth has a negative effect on children during the developmental stage, inhibiting their intellectual growth and resulting in difficulties with learning, memory and concentration[24]. Additionally, a number of elements affect noise pollution such as the kinds of activities involved, the density of people and culture. Currently, sound pollution is recognized throughout the world as one of the biggest issues influencing the standard of living in metropolitan areas[8].

Moreover, noise-induced stress can exacerbate medical problems in sick people, particularly in hospitals where noise may delay healing and lengthen recovery times[3]. Noise mapping is the process of displaying sound levels in a region spatially. In locations where development plans are particularly sensitive to noise, this approach helps to present an understanding of noise distributions. This is an innovative way of determining noise levels that helps in designing methods to reduce the negative consequences of noise pollution[20]. In regard to planning, policymaking and managing noise pollution, noise mapping is considered an essential tool[6]. To establish the approximate number of people affected, maps displaying noise levels are usually used to locate locations with higher noise levels. These visualizations are then combined with population data. By utilizing these maps, plans for controlling noise and lowering levels as necessary can be made, as well as for visually representing changes over time. Several researchers around the world have carried out studies related to noise mapping[19]. A noise prediction model is required to predict and analyze the noise level along a busy roadway ahead of time during the planning and design phases, resulting in the establishment of a healthy and noise pollution-free environment.

Regression analysis has been used to create a number of models using basic variables such as vehicle speed and traffic flow[4]. A noise map displays the noisier regions and quieter regions, much like a weather map provides. To create noise contours for a region, a variety of software programs are available such as LIMA, FAA and ArcGIS[7]. When assessing traffic noise pollution, the visual representation of traffic noise distribution in noise maps is useful. The corresponding noise volume during the day and night is used in certain studies to quantify road noise pollution. This approach is suitable for the accurate assessment of compact regions[13]. The development of the transport sector, which was established to save time, is essential to our daily lives as a consequence of urbanization. However, it currently constitutes a major risk and causes the current state of circumstances by destroying the quality of life in the environment.

If preventative measures are not taken to lower the intensity of noise pollution, it will eventually cause destruction. As a result, information and prevention are needed. Furthermore, it is our duty to prevent excessive noise pollution from harming the ecosystem and to make the environment more desirable to live in. A thorough investigation of Ponmalai's traffic noise was performed for this study. Table 1 shows the permissible limit of the noise level as per Tamil Nadu Pollution Control Board (TNPCB). To easily understand the intensities visually, the measured data were mapped using ArcGIS version 10.3 (Krigging method). To understand the impacts of noise level and intensity, GIS is regarded as a useful tool. Additionally, it improves the precision and display of the city's noise level for future urban development.

Objectives

The objectives of the present study are:

1. To measure the existing noise level in the selected location of Ponmalai.
2. To analyse and compare the noise level with the standard limits prescribed by the TNPCB (Tamil Nadu Pollution Control Board) for all three zones: residential, commercial and silent.
3. The noise parameters, such as L10, L50, L90, Leq, TNI, NC and LNP, were measured and calculated and compared with the standard limits.
4. To determine the existing vehicle intensity in the study

area.

5. To create a noise map based on the noise level using ArcGIS 10.3 software via the interpolation (Krigging) method.

Table 1
Permissible Limit of the Noise Level
(Source: TNPCB)

Zones	Limit in dB (A) Leq	
	Day Time	Night Time
Commercial Zone	65	55
Residential Zone	55	45
Silent Zone	50	40

Material and Methods

Study Area: In the middle of Tamil Nadu, the districts of Namakkal, Salem, Karur, Ariyalur, Pudukkottai, Thanjavur and Dindigul surround Tiruchirappalli. Basically, it is an agricultural district that is experiencing economic growth because of the support of public sector organizations including railway workshops, BHEL, HAPP and OFT. The ready-made garment, gem cutting and manufacturing industries are well known in the district[26]. In Tamil Nadu's Tiruchirappalli district, Manapparai taluk is the town panchayat of Ponmalai. One of the four zones of Tiruchirappalli is Ponmalai. There are 56.75 square kilometers in the population area. Ponmalai is situated close to a railroad colony and workshop. According to the 2024 census, Ponmalai has 57,530 residents. The noise was measured for four months in succession. Table 2 displays the measurements which took place at fifteen different places in three zones: commercial, residential and silent zones.

The noise level measurements were taken in the study area for four months using the Lutron model number SL4010. The instrument was calibrated at every location before the measurements. At each location, readings of three sets were taken every 5 minutes and averaged to determine the equivalent sound level. The noise level measurements took place in three sessions per day: 7.00 a.m. to 10.00 a.m., 11.00 a.m. to 2.00 p.m. and 3.00 p.m. to 6.00 p.m. The noise parameters such as L10, L50, L90, overall Leq, overall morning, noon and evening values, TNI, NC and LNP were determined and are shown in table 4. The mapping was performed using the Krigging method of interpolation.

Noise Parameters: The following formulas were used to calculate the parameters such as L10, L90, Leq, TNI, NC and LNP[10]:

Equivalent Sound Level (Leq): It is a continuous noise level analytical assessment of noise intensity. It can be computed by varying the noise intensity over a number of time intervals.

Leq = 10 Log E ((10^ (Li/10) ti)

The TNI, or Traffic Noise Index: This index is employed to determine the irritation that people experience from traffic noise. Denoting the extent of variance in traffic flow is also beneficial. The following formula was used to compute this parameter:

TNI = 4 × (L 10 - L 90) + L 90 - 30

L 10: This value can be used to statistically define the level of noise. The noise level was more than 10% during the entire measurement duration.

Table 2
Sample locations and Coordinates

Locations		Zones	Latitude	Longitude
Ponmalai Market	L1	Comm -ercial Zone	10.8217 N	78.6741 E
Ponmalai Bus Stand	L2		10.7808 N	78.715 E
Golden Rock Railway Station	L3		10.7919 N	78.7102 E
Trichy Airport	L4		10.7618 N	78.7091 E
Bharathidasan Salai	L5		10.8155 N	78.6965 E
Railway Colony	L6	Resi -dential Zone	10.7906 N	78.7112 E
Mullai Nagar	L7		10.8125 N	78.6514 E
Sundar Nagar	L8		10.7661 N	78.6845 E
K.K Nagar	L9		10.7538 N	78.6951 E
Golden Rock Quarters	L10		10.7907 N	78.7116 E
Holy Cross Girls Higher Secondary School	L11	Silent Zone	10.8295 N	78.6951 E
Railway Higher Secondary School	L12		10.7848 N	78.7185 E
Railway Hospital	L13		10.7905 N	78.7047 E
Jamal Mohamed College	L14		10.7865 N	78.6958 E
Apollo Hospital	L15		10.7806 N	78.7111 E

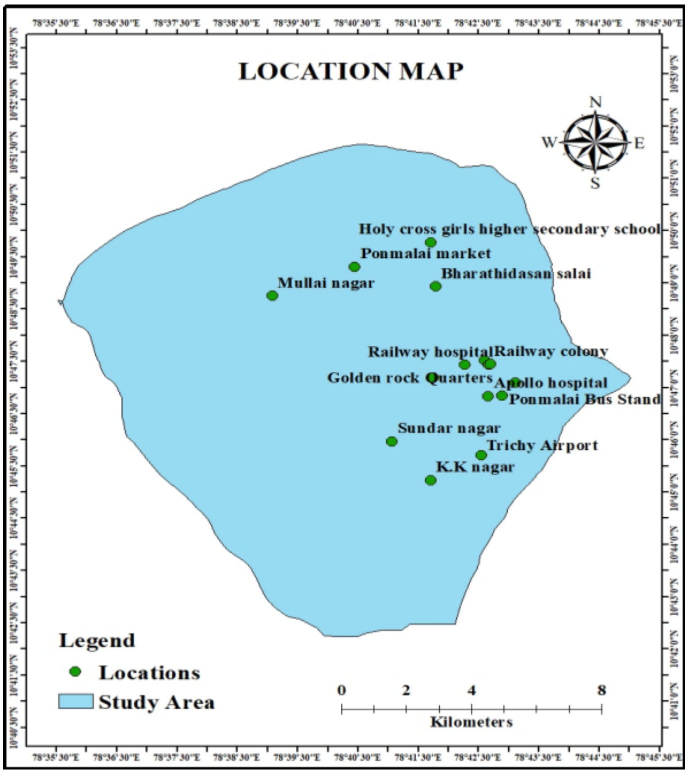


Fig. 1: Location Map

Table 3
Measured and recorded noise measurement data in dB (A) at various locations

Locations	Zones	Overall Morning (dB)	Overall Noon (dB)	Overall Evening (dB)
L1	Comm-ercial Zone	86.4	75.2	79.5
L2		82.5	76.9	81.9
L3		78.5	73.7	81.4
L4		85.3	82.2	82.5
L5		84.9	77.3	78.1
L6	Resi-dential Zone	83.5	82.5	84.4
L7		75.9	71.1	78.2
L8		80.4	76.5	81.5
L9		79.2	75.7	82.7
L10		82.9	79.5	80.4
L11	Silent Zone	79.2	74.6	82.7
L12		79.6	78.2	81.9
L13		76.5	73.7	80.5
L14		71.9	68.5	76.9
L15		82.3	74.2	79.4

L 90: It also provides a statistical analysis of the noise level. It may be computed using the following formula and represents a 90% exceedance of the noise level throughout the entire duration of the recording in a collection of noise level records over a specific time interval:

L10 = Leq + 3.0 dB (A)

L90 =.467 x Leq + 24.60 dB (A)

The formula was used to measure the mentioned parameters using the morning, noon and evening measured data. The standard limits, which appear in table 3, are compared with these computed values. Graphs and maps can be used to visually represent noise level intensities and their differences in such a way that they are easily understood.

Noise Climate: The noise environment determines where variations occur. This is determined by calculating the noise climate (NC), which is computed as follows:

NC = (L10-L90) dB (A)

Noise Pollution Level (LNP): The measurement design takes both sound and frequency stability into consideration. The following formula was used to compute this parameter:

$$LNP = L50 + (L10-L90)^2/60 + (L10-L90)$$

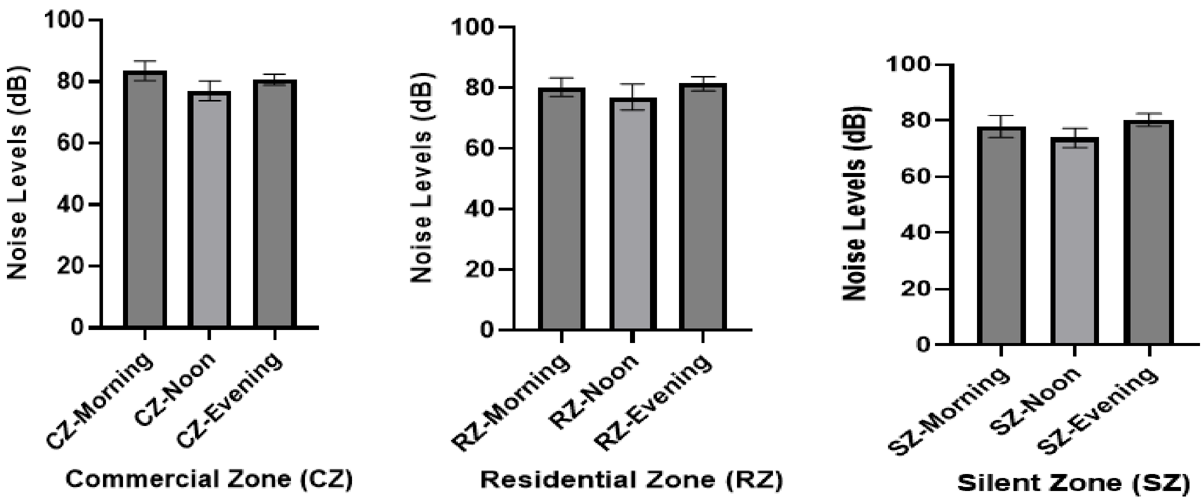
Noise Map: Mapping provides visual information about the acoustic level and is a useful tool for analysing areas affected by loud noises. In this research, noise maps are created by using the measured overall noise level data from various locations in different zones of Ponmalai in Tiruchirappalli city. Simultaneously, the latitude and longitude were measured with the help of GPS and these results were plotted in ArcGIS 10.3 software. The interpolation (Krigging) method was used for the generation of the map.

Results and Discussion

The measured and calculated noise level characteristics including overall morning, noon and evening values as well as L10, L50, L90, Leq, TNI, NC and LNP, are discussed here. A graph was plotted between the noise level on the Y-axis and numerous parameters in each location on the X-axis. The analysis revealed that in every zone, the noise intensity was greater than that during peak hours (morning and evening).

Table 4
Levels of noise parameters in dB (A) at various locations

Locations	Zones	Leq (dB)	L10 (dB)	L50 (dB)	L90 (dB)	TNI (dB)	NC (dB)	LNP (dB)
L1	Commercial Zone	87.4	90.4	79.8	65.4	123.4	25	115.2
L2		85.8	88.8	76.3	64.6	119.4	24.2	110
L3		83.6	86.6	72.9	63.6	109.7	23	104.7
L4		88.3	91.3	79.2	65.8	125.8	25.5	115.5
L5		86.3	89.3	77.4	64.9	120.5	24.4	111.7
L6	Residential Zone	88.2	91.2	80.3	65.7	125.7	25.5	116.5
L7		80.7	83.7	73.8	62.2	106.2	21.5	103
L8		84.7	86.7	77.6	64.1	116.5	22.6	108.3
L9		84.8	87.8	78.4	64.2	116.6	23.6	111.2
L10		85.9	88.9	76.4	64.7	119.5	24.2	110.1
L11	Silent Zone	83.7	87.7	78.6	63.6	114	24.1	112.3
L12		84.9	87.9	77.7	64.2	117	23.7	110.7
L13		82.5	85.5	76.4	63.1	110.7	22.4	107.1
L14		78.5	81.5	72.4	61.2	100.4	20.3	99.5
L15		84.2	87.2	75.9	63.9	115.1	23.3	108.2



**p<0.05 Vs CZ-Morning *p<0.05 Vs SZ-Noon

Fig. 2: Noise levels among various zones during the morning, noon and evening

Statistical Analysis: After assessment of the normal distribution using the Kolmogorov-Smirnov test and Shapiro-Wilk test, the data were analyzed using one-way analysis of variance (Anova) followed by Tukey's multiple comparisons test as a post-hoc test for comparison between various groups. A *p* value of less than 0.05 was considered statistically significant and the p value is of two-tailed. Figure 2 represents noise levels among various zones during the morning, noon and evening. Data were expressed as mean ± SD. Data were analyzed using one-way Anova followed by Tukey's multiple comparisons test. A *p* value of less than 0.05 was considered statistically significant.

Figure 3 represents noise levels during the morning, noon and evening at various zones. Data were expressed as mean ± SD. Data were analyzed using one-way Anova followed by Tukey's multiple comparisons test. A p value of less than 0.05 was considered statistically significant. No statistically significant differences were noted during the morning, noon and evening in various zones.

Comparison of noise levels with standard limits in each zone: Figure 4 represents the noise level in a commercial zone. The standard limit for the commercial zone is 65 dB (A). According to the results of the analysis, the overall morning, noon, evening, Leq, TNI, NC and LNP exceeded the standard limits. The ranges of Leq, TNI, NC and Lnp were 83.6 to 88.3 dB (A), 109.7 to 123.4 dB (A), 23 to 25.5 dB (A) and 104.7 to 115.5 dB (A) respectively. Normally, commercial zones have higher noise levels in all sessions. Especially in the evening, the closing time of schools, colleges and workplaces and the emerging time of evening shops make for a public gathering and high traffic flow. The amount of noise in the morning session ranged from 78.5 to 86.4 dB (A). During the noon period, the noise intensity is between 73.7 and 82.2 dB (A). During the evening session, the noise intensity was between 78.1 and 82.5 dB (A).

Based on a graphical examination of all three sessions (morning, noon and evening), the noise level was high as recorded in L1 (Ponmalai Market), L3 (Golden Rock Railway Station) and L4 (Airport). Location L1 (Ponmalai Market) is one of the busiest market centers. All essential commodity trade actions take place in this region. This market also has a way to reach the Golden Rock Railway Station. Location L3 (Golden Rock Railway Station) is busier due to the sounds of vehicles gathering, trains honking, announcements and trucks collecting goods from the goods train. Location L4 (Airport) is one of the busiest locations in the city. Markets and educational institutions are also located near the airport.

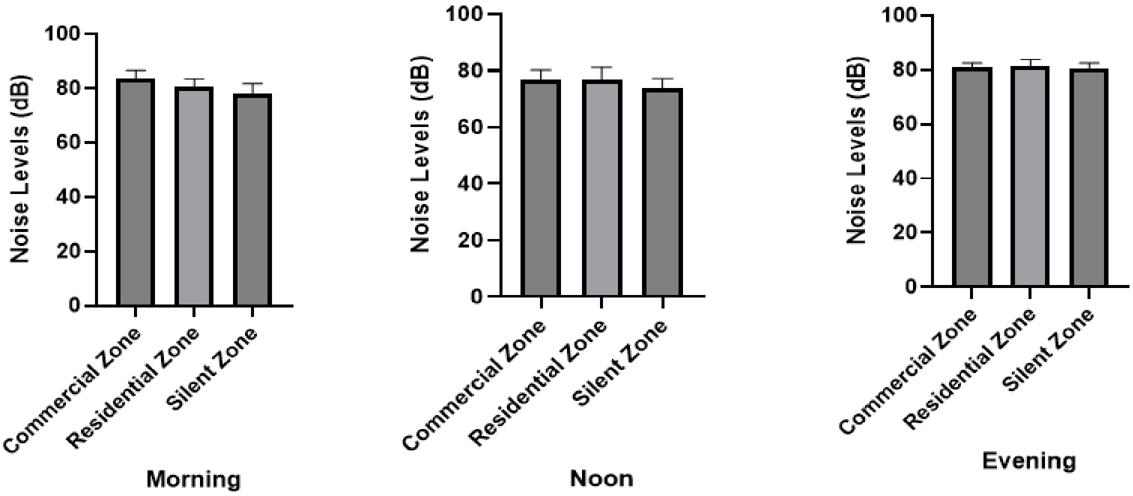


Fig. 3: Noise levels during the morning, noon and evening at various zones

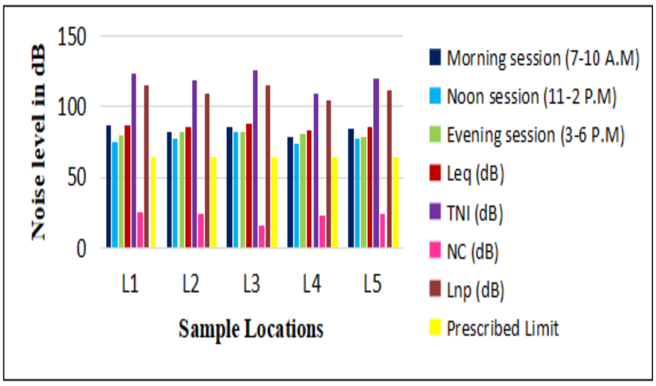


Fig. 4: Commercial Zone

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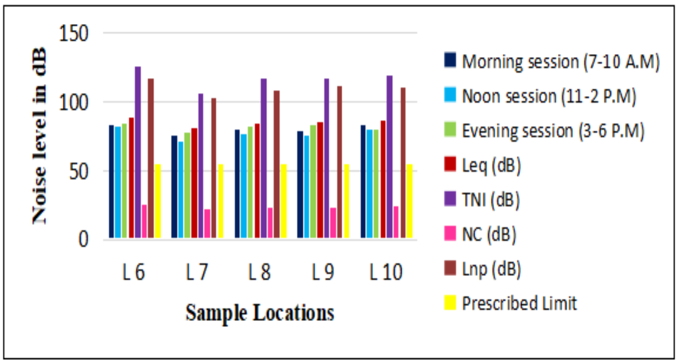

Fig. 5: Residential Zone

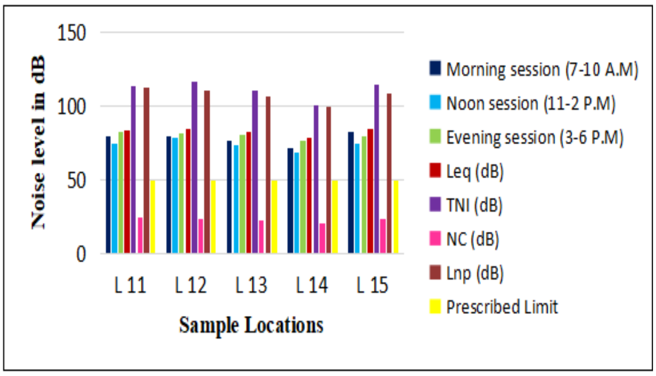

Fig. 6: Silent Zone

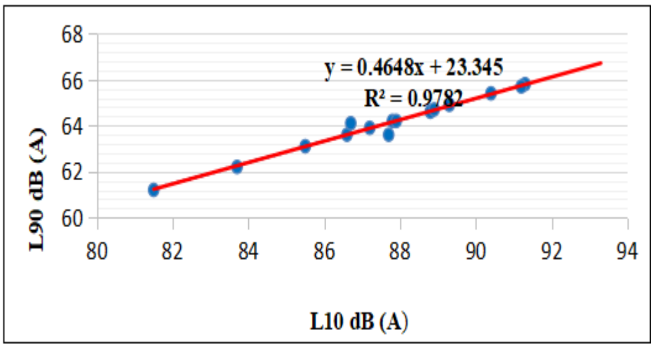

Fig. 7: Relationships between L10 dB (A) and L90 dB (A) at the sample locations

Figure 5 represents the noise level in a residential zone. The standard limit for the residential zone is 55 dB (A). From the graph results, the overall morning, noon, evening, Leq, TNI, NC and LNP exceeded. The ranges of Leq, TNI, NC and Lnp were 80.7 to 88.2 dB (A), 106.2 to 125.7 dB (A), 21.5 to 25.5 dB (A) and 103 to 116.5 dB (A) respectively. During the morning session, the noise intensity was between 75.9 and 83.5 dB (A). During the noon period, the noise intensity was between 71.1 and 82.5 dB (A). During the evening session, the noise intensity was between 78.2 and 84.4 dB (A). Locations L6 (railway colony) and L10 (golden rock quarters) have extremely high noise levels. Location L6 (railway colony) is having extremely high level because it is located near the railway hospital and railway station. It creates discomfort during the train's arrival and departure, the horn sounds are very loud. Additionally, during a goods train, it may create extreme noise. These factors also create some noise pollution in that area. Therefore, the traffic flow is always high at location 6. Location L10 (Golden Rock Quarters) is near the school, so the noise level was always high in this area. Figure 6 represents the average level of noise parameters for the study area of the silent zone. The Leq, TNI, NC and LNP all exceeded the standard limits at each location. The ranges of Leq, TNI, NC and Lnp were 78.5 to 84.9 dB (A), 100.4 to 115.1 dB (A), 20.3 to 24.1 dB (A) and 99.5 to 112.3 dB (A) respectively. The prescribed limit for the silent zone is 50 dB (A). Most of the time, the noise level reaches its peak during peak hours (morning and evening). Due to the opening and closing of schools, people go to their workplaces or engage in their work activities. Therefore, the peak time was the noisiest among all zones.

Among all locations, there was a slight decrease at noontime due to on-going sessions in schools, offices and workplaces, so noise levels decreased. During the morning session, the noise intensity was between 71.9 and 82.3 dB (A). During the noon period, the noise intensity was between 68.5 and 78.2 dB (A). During an evening session, the noise intensity was between 76.9 and 82.7 dB (A). According to the graphical analysis of all three sessions (morning, noon and evening), the noise level was high at L13 (Railway Hospital), which is located near the Ponmalai market and Railway Station. Due to the crowd, the noise level is always high in that area.

Railway quarters are closer to the hospital, so noise levels are always higher. Location L15 (Apollo Hospital) is situated in a congested region close to commercial areas while location L14 (Jamal Mohamed College) is situated along a roadside, indicating that the college is at a higher level. Additionally, the calculated values for Leq, TNI, NC and LNP were greater than allowed.

Figure 7 illustrates the relationship between the L10 dB (A) and L90 dB (A) noise levels at the sample locations. The x-axis represents the L10 dB (A) noise level of the sample sites while the y-axis shows the L90 dB (A) noise level. This graph indicates the 0.9782 coefficient of correlation between the L10 dB (A) and L90 dB (A) noise levels, showing a strong relationship between the two. The L90 dB (A) noise level increases in combination with an increase in the L10 dB (A) noise level.

Figure 8 illustrates the relationship between the TNI dB (A) and NC dB (A) noise levels at the sample locations. The x-axis represents the sample sites' TNI dB (A) noise level, while the y-axis represents their NC dB (A) noise level. The figure indicates the strong association between TNI dB (A) and NC dB (A), with a correlation coefficient of 0.9124. The NC dB (A) noise level increases in coordination with the TNI dB (A) noise level.

Traffic Volume Survey: Table 5 shows the contributions of light and heavy vehicles at fifteen locations. These traffic volume analyses took place for four months. In each location, the vehicle volume contribution measurements took place for one hour. These measurements were taken by the traffic counter app on cell phone. An illustration of the contribution from light vehicles (two-wheelers) is shown in figure 9. An illustration of the heavy vehicle contribution is shown in figure 10. The phone was positioned 1.2 meters above the ground's surface. In commercial zones, vehicles contribute greatly to L3 (Golden Rock Railway Station) and L4 (Airport).

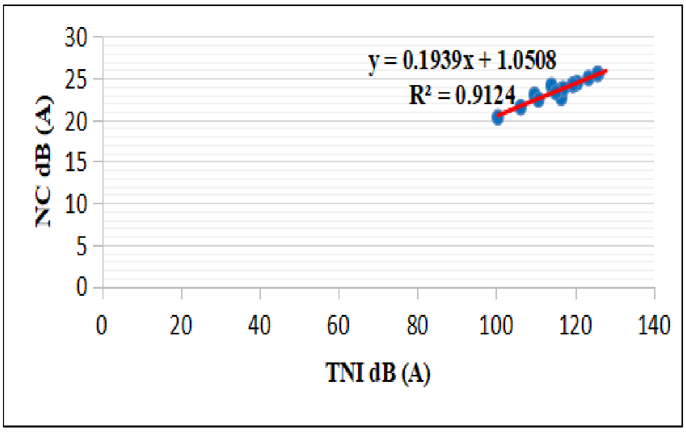

Fig. 8: Relationships between the TNI dB (A) and NC dB (A) at the sample locations

Table 5
Contribution of light and heavy vehicles

Locations	Light Vehicles	Heavy Vehicles
L1	728	649
L2	316	269
L3	1248	714
L4	1469	956
L5	572	114
L6	500	310
L7	106	80
L8	76	24
L9	95	57
L10	468	275
L11	259	39
L12	300	104
L13	650	405
L14	900	310
L15	1036	639

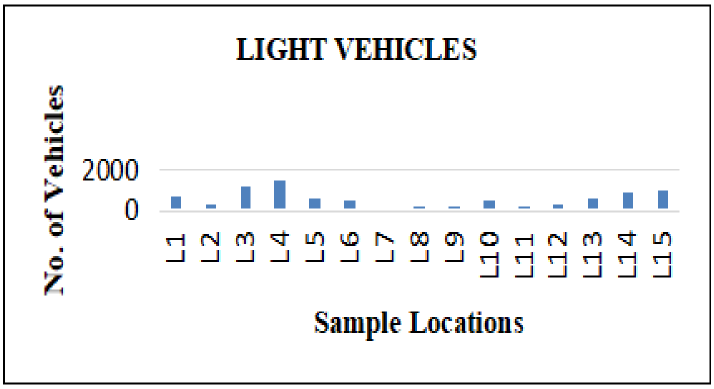

Fig. 9: Contribution of Two-Wheelers

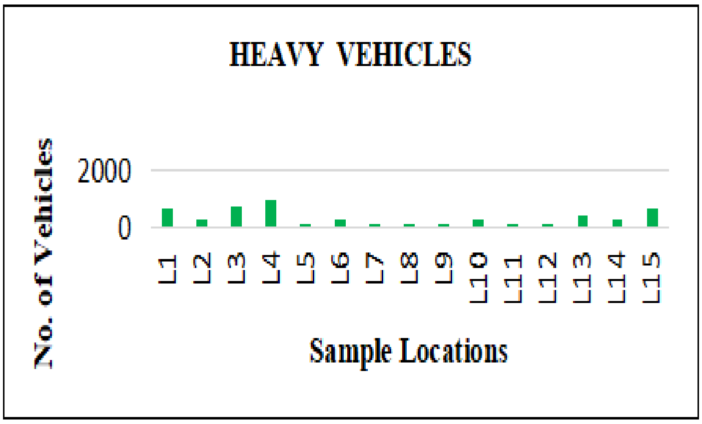

Fig. 10: Contribution of Heavy Vehicles

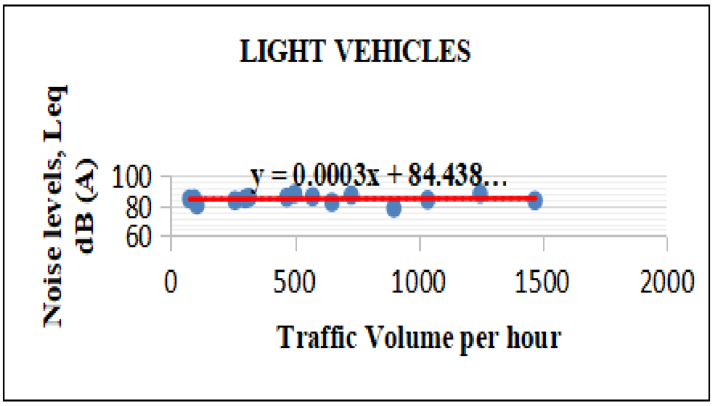

Fig. 11: Relationship between the volume of traffic and noise level dB (A)

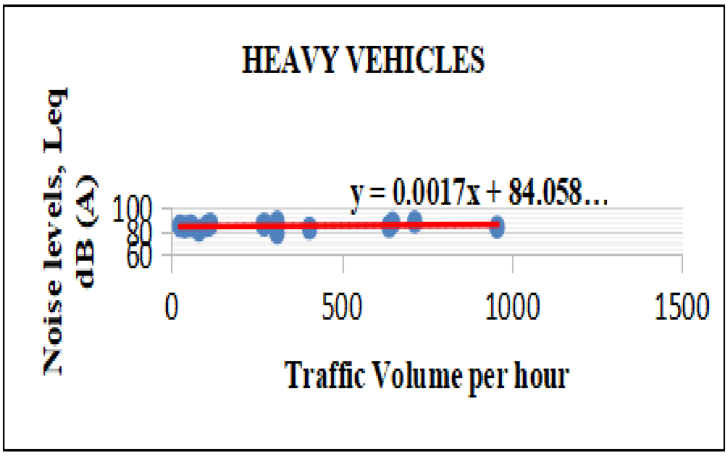

Fig. 12: Relationship between the volume of traffic and noise level dB (A)

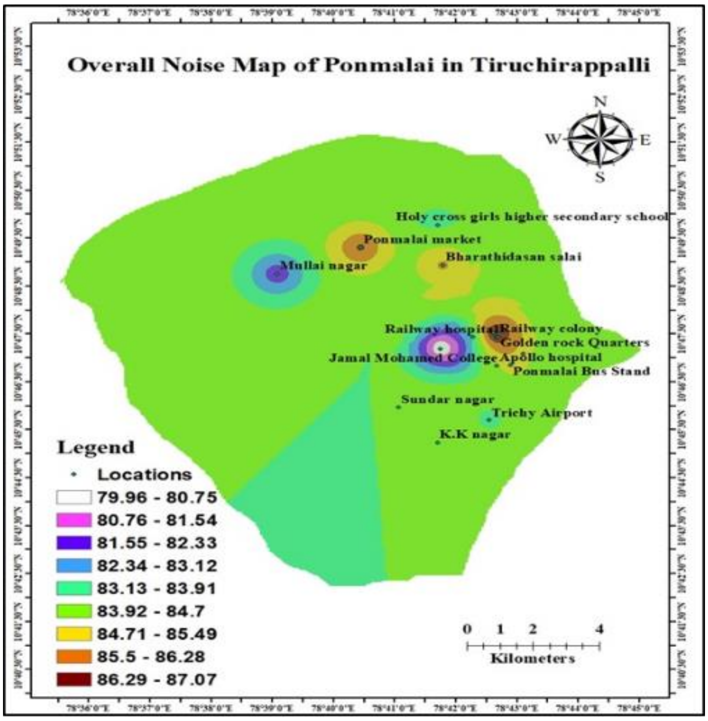

Fig. 13: Overall Noise Map

In residential zones, the vehicle contributions are high in L6 (railway colony) and L10 (golden rock quarters) and in silent zones, the vehicle contributions are high in L13 (railway hospital), L14 (Jamal Mohamed College) and L15 (Apollo Hospital). A greater light vehicle contribution occurs in locations L3 (Golden Rock Railway Station), L4 (Airport), L14 (Jamal Mohamed College) and L15 (Apollo Hospital)—nearly 1000 and above. A greater heavy vehicle contribution occurs in locations such as L1, L3, L4 and L15 which are nearly 700 and above respectively. The traffic counter app recorded the volume of traffic in each area for a duration of one hour. These assessments of traffic volume were conducted for four months.

Figure 11 illustrates the significant association between traffic volume and noise intensity. The x-axis represents the traffic volume per hour while the y-axis represents the noise level in dB (A). The correlation coefficient between traffic volume and noise level, r xy, is 0.0029 in the figure, demonstrating a strong relationship between the two variables. This illustrates that as the volume of traffic increases, the noise intensity also increases. Figure 12 illustrates the significant association between traffic volume and noise intensity, indicated by the correlation coefficient r xy of 0.0356. This reveals that as the traffic volume increases, so does the noise intensity. This correlation results from slow-moving automobiles on roads interfering with fast-moving vehicles, which in turn increases congestion.

Figure 13 represents the overall noise map. The different colours on the map indicate the different levels of noise at each location. This noise map was created based on the measured Leq data. From the noise map analysis, the results show that noise levels reach their peak during peak times due to higher-level public gatherings, the opening and closing of schools, colleges and workplaces and so on. The sound level ranged from 78.5 dB (A) to 88.3 dB (A). The highest level occurs at Golden Rock Railway Station and ranges from 88.3 dB (A).

Conclusion

The overall noise level in Ponmalai at Tiruchirappalli city of southern region of India was studied experimentally. Mostly, it reaches its peak level at peak time in all three zones. However, the commercial zone experiences greater sound levels. Some locations in the residential zone situated within or near the locations showed higher noise levels at both peak and off-peak times. Additionally, the noise parameters Leq, TNI, NC and LNP exceeded the level of tolerance. Therefore, it can be concluded that the major reason for noise pollution in these locations might be associated with increased vehicle movement, sound horns and high public gatherings.

Hence, the following recommendations should be taken into consideration:

(i) Implement strict regulations prohibiting the honking of vehicular sirens in peaceful areas.

(ii) All types of loud vehicles should be prohibited in silent zones.

(iii) A buffer zone against noise should be established in sensitive areas.

(iv) The boundaries separating silent and residential areas must be created as no-honking areas.

(v) Make appropriate land-use plans and follow them.

(vi) Heavy vehicle speed restrictions should be strictly enforced in residential zones.

(vii) Pro-elastic traffic roadways such as rubberized tar roads, should be provided to reduce noise.
(vii) Modifications to vehicle silencers should be strictly regulated.
(viii) Cars should not honk in sensitive places such as hospitals, schools, colleges, or other educational or health organizations and
(ix) Hospitals and educational institutions should have noise barriers such as belts and curtain plants.

The baseline data provided by this study will be useful in the planning and creation of action plans for the city's future growth.

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