An Experimental Investigation on Noise Pollution and Comparative Analysis of Three Major Different Cities of East Godavari District, Andhra Pradesh, India

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Abstract - The cacophony of urban life reverberates across the East Godavari district, where three cities—Rajahmundry, Kakinada, and Amalapuram—stand as microcosms of the global struggle against noise pollution caused by various means of transportation like public transportation, cars, and trains. This project embarks on a rigorous investigation, utilizing sound level meters to capture the ebb and flow of noise within these urban landscapes. Through targeted measurements during peak hours over 3 weeks, the study uncovers nuanced variations in noise levels due to means of transportation. Through meticulous field measurements conducted during peak morning and evening hours over a week, the study unveils the intricate interplay of urban factors shaping noise levels. Utilizing ArcGIS, spatial distribution maps were generated, illuminating noise pollution patterns. The findings underscore the urgency of addressing noise pollution's adverse effects on public health and well-being. Through interdisciplinary collaboration, this study contributes to evidence-based policymaking and urban planning, aiming to foster healthier, more equitable urban environments. Awareness dissemination and sustainable mitigation strategies emerge as imperative, leveraging the project's insights to promote enduring solutions for noise pollution mitigation in East Godavari and beyond.

Key Words: Noise pollution, Sound level meter, ArcGIS mapping, transportation hubs, spatial distributions

1.INTRODUCTION

Noise pollution is a significant environmental issue affecting millions worldwide, causing health issues and affecting the quality of life. Rapid urbanization and industrialization have intensified the problem, posing challenges for urban planners, policymakers, and public health officials. Understanding noise pollution sources, levels, and impacts is crucial for developing effective mitigation strategies and promoting sustainable urban development. This project report investigates noise pollution in Rajahmundry, Kakinada, and Amalapuram, aiming to provide insights into spatial variations and factors contributing to differences between urban environments. The study identifies potential causes such as transportation, industrial activity, construction, and urban morphology. Addressing noise pollution is crucial for public health and well-being, as chronic exposure to high noise levels can lead to adverse health outcomes This study examines noise pollution in three different cities, focusing on the interplay of social, economic, and environmental factors.

The research aims to identify best practices or methods for mitigating noise pollution and promoting healthier urban environments. The experimental methodology uses sound level meters to measure ambient noise levels at multiple locations, and data is collected over predetermined periods to capture diurnal variations The data was collected in 5 minutes in each study area for a total of 45 minutes during the peak hour of the morning (8:00-11:00 A.M) and evening time (5:00-8:00 P.M) and one week was spent in each city for collecting the data. The data is analyzed using statistical techniques to identify patterns, trends, and correlations between noise levels and potential contributing factors. The mapping process uses ArcGIS software, allowing for a better understanding of noise pollution levels. The study contributes to a deeper understanding of noise pollution and its implications for urban sustainability, aiming to inform evidence-based decision-making and policy development to create healthier, more equitable urban environments. It also raises public awareness about noise pollution and its impact and helps find sustainable ways to mitigate noise pollution that are economical and easily accessible to all people.

Objectives of the project work

- To measure the noise level in different cities of the Konaseema district which are Rajahmundry, Kakinada, and Amalapuram.
- Analyze the data and calculate the equivalent noise level using the collected data
- Mapping the noise level using ArcGIS
- Identifying hot spots of noise pollution in the study areas

2. STUDY AREA

To analyze noise pollution in three different cities, a study area is established to gather data and assess the levels of noise pollution present. This study area should encompass various types of environments within each city, including residential and commercial areas and transportation hubs such as highways, airports, and train stations. Additionally, factors such as morning and evening time should be considered when conducting the analysis. By examining noise levels across different settings and times, researchers can identify patterns, sources, and potential impacts of noise pollution in the selected cities. The study area selected is shown in the following Figure 1.

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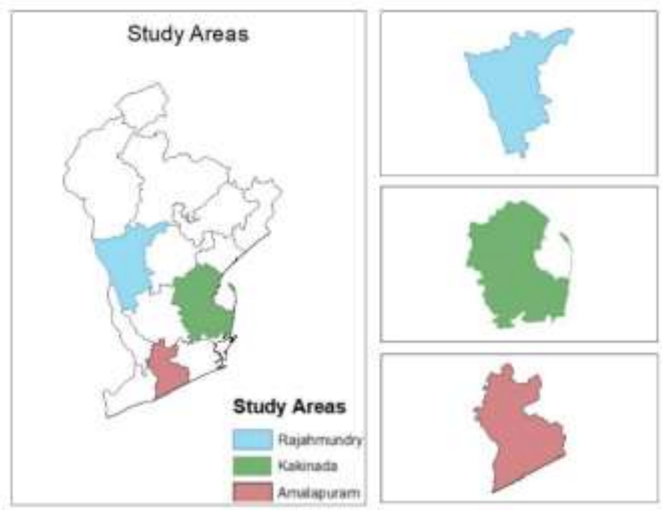

Fig. 1: Study areas

3.METHODOLOGY

This study includes the collection of noise level data from the selected cities in peak hours of the day for several days by measuring with sound level meter. Calculation of equivalent noise levels. Mapping of noise levels in the study areas using GIS techniques like Kriging or Inverse Distance Weighted (IDW) method.

The methodology adopted in this research work is shown in the following Figure 2

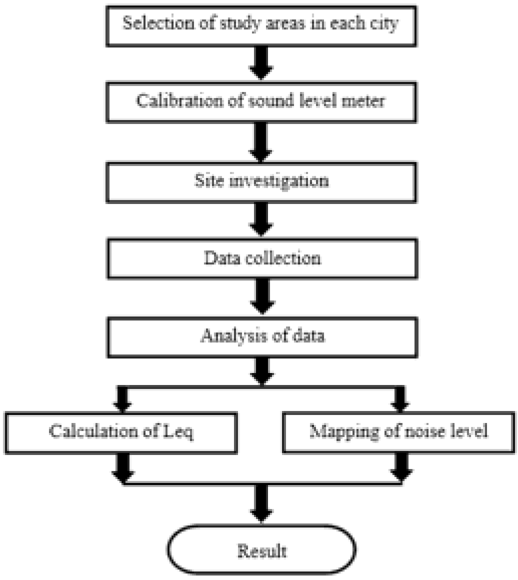

Fig. 2: Methodology adopted in this work

4. Data Collection

Noise levels were measured using a sound level meter at peak hours of the study areas About Device (Sound level meter)

HTC SL-13A is a sound level meter. It is a stable, safe, self-reliable, and high-performance sound level meter. This sound level meter measures the noise level in the A-weighted class measurement. The A-weighted measurement of sound level is the nearest to reflect how noise is perceived by the human ear. This device can record the sound range of 30dB to 130dB with an accuracy of ±1.5dB. Its frequency response is 31.5Hz to 8kHz. The sound level meter

used in this study is shown in the Fig.3 below..

Fig. 3: Sound level meter

Calibration of the sound level meter is crucial to ensure accurate and reliable measurements. Proper calibration ensures that the instrument accurately reflects the true levels of environmental noise, minimizing errors in data collection and analysis. We tested the device by measuring the sound level in a silent room with very little noise. It should show a value below 10 dB. If not, then the device must be taken to the calibration center. Also, it is recommended to take the sound level meter for calibration each year and before using the device for any form of work. Different types of devices are being used for measuring sound levels like dosimeters, octave band analyzers, sound level meters, and software-based noise level mapping tools. Site selection is pivotal in capturing the diversity of noise sources and exposure levels within the study area.

By strategically selecting sites representing various land uses and population densities, the project can provide a holistic understanding of noise pollution patterns and their implications. First, we selected the major cities that are highly developed and with high population density like Rajahmundry, Kakinada, and Amalapuram. Then, we selected our sites by defining the objective of our project, selecting areas near transportation hubs and the diversity in demography, geography, and economy. For more accurate mapping, we selected four study areas in each city. The selected study areas in each city are: 1. Amalapuram: Bus station, Clock tower, Mummidivaram gate, and red bridge

2. Kakinada: Bus station, train station, Masjid center and Bhanugudi junction

3. Rajahmundry: Bus station, Kotipalli bus stand, Thyagraj Street, and train station We selected these study areas after considering the following points:

Identifying the objective of the project

Considering noise sources

Diversity in demography, geography, economy, culture etc.

Prioritizing the study areas

During the data collection phase, meticulous attention to detail is essential. Standardized protocols should be followed to collect noise level readings at predetermined intervals, ensuring consistency and comparability across different sites and periods. After completion of the site selection process, we visited the site with the sound level meter for data collection. The data collection was taken during the peak time of morning i.e., 8-11 A.M and evening i.e., 5-8 P.M. In each study location, we spent 45 minutes collecting 9 readings of noise level with an equal interval of 5 minutes for each reading which means we collected 18 readings of noise level in one study area during morning and evening. A similar approach was followed for each city for a total of 9 days while collecting the data. For each city, 3 days were spent on the data collection process. Each reading was noted down carefully in a paper with the necessary format filled in. According to the location of our study area, we scheduled our data collection time within the peak hours.The below table shows the selected city, study areas, and schedule.

Table 1: Selected study areas and schedule of data collection.

S.N.	City		Study area	Time	Time
		S. N		Morning(8-11 A.M)	Evening(5-8 P.M)
1	Amalapuram	1	Bus station	8.00-8:45	7:15-8:00
		2	Clock tower	8:45-9:30	6:30-7:15
		3	Mummidivaram Gate	9:30-10:15	5:45-6:30
		4	Red bridge	10:15-11	5:00-5:45
2	Rajahmundry	1	Train station	8:00-8:45	5:00-5:45
		2	APSRTC bus stan	10:15-11	7:15-8:00
		3	Kotipalli bus stand	8:45-9:30	6:30-7:15
		4	Tyagaraja nagar	9:30-10:15	5:45-6:30
3	Kakinada	1	Bus station	8:00-8:45	7:15-8:00
		2	Train station	8:45-9:30	6:30-7:15
		3	Bhanugudi junction	9:30-10:15	5:45-6:30
		4	Masjid centre	10:15-11	5:00-5:45

Fig. 4: Measuring the noise in the field

Table. 2: Noise levels at Amalapuram Bus stand

S. N		Latitude	Longitude	Sound level
Morning data	1	16.5801089	81.997831	72.9
	2	16.579605	81.998382	87.23
	3	16.579529	81.998378	90.87
	4	16.579511	81.998386	88.9
	5	16.579327	81.998399	91.9
	6	16.579566	81.998358	89.7
	7	16.579751	81.993366	87.4
	8	16.579973	81.997574	92.5
	9	16.579556	81.998356	91.6
Evening data	1	16.579566	81.998358	88.6
	2	16.577499	81.993366	86.3
	3	16.579973	81.9975747	91.4
	4	16.579556	81.998358	90.5
	5	16.5801089	81.9978308	71.8
	6	16.579605	81.998382	86.22
	7	16.579529	81.998378	89.86
	8	16.579511	81.998386	87.8
	9	16.579327	81.998399	90.8

Calculation of equivalent noise level (*Leq*)

The equivalent noise level (*Leq*) is calculated as,

$$L_{eq} = 10log_{10}\sum_{i=1}^{n}\left[t_i \times 10^{\frac{L_i}{10}}\right]$$

Where, Leq= Equivalent noise level

ti = time duration of ith sample

Li= Noise level of any ith sample

n = Number of samples

5.Mapping of Noise levels using GIS

The study utilized maps from Google Earth and Earth Explorer, with image processing conducted through ERDAS. Noise data was inputted into MS Excel, and the file was saved in CSV (Ms-DOS) format, which can be directly imported into ArcGIS, followed by mapping in ArcGIS. Geoprocessing settings were configured within ArcGIS to align output coordinates with the map layer, ensuring seamless integration and analysis. The output surface raster location and semi-variogram model were defined, and the interpolation by IDW (Inverse Direct Weight) and Kriging processes were executed to ensure accuracy and customize the output

6. RESULT

After analysis of all the collected data, it was found that among the selected three cities Rajahmundry had the highest noise level and those areas near the train station and bus station had the highest noise level. Then, Kakinada had the highest noise level but some unexpected noise level was found in some areas like in Bhanugudi junction. Although there was a huge traffic flow, it had a lower noise level than what we expected. Amalapuram had the lowest noise level among 3 cities but that doesn't mean it is safe. It also had a high noise level near the bus station and the areas near the Red Bridge. We have found that controlled traffic flow, strict traffic rules, and usage of traffic lights and crosswalks help a lot in mitigating as we have seen this help lower the noise level in Kakinada city.

Here, below are the pie chart and table of data showing the equivalent noise level of each study area on a single day:

Table.3 Equivalent Noise levels at Amalapuram

Amalapuram	Equivalent noise level	
	Morning(Leq)	Evening(Leq)
Bus stand	89.9031	88.8211
Mummidivaram Gate	89.2107	83.2271
Red Bridge	81.1109	76.9562
Clock tower	75.9622	82.3006

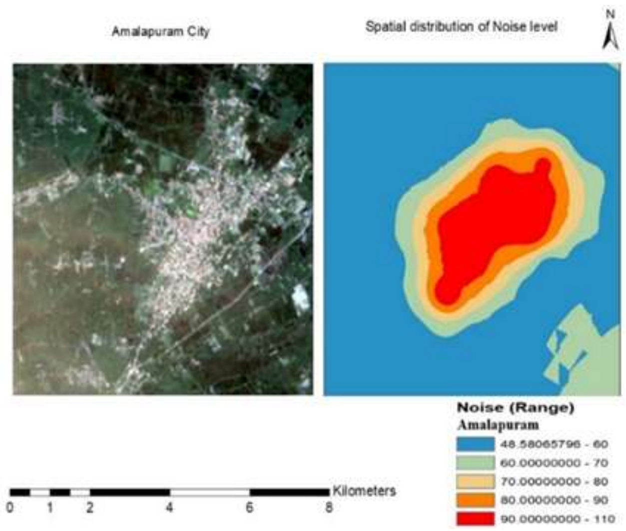

Fig.5 Spatial distribution of Noise in Amalapuram

Table.4 Equivalent Noise levels at Kakinada

Kakinada	Equivalent noise level	
	Morning(Leq)	Evening(Leq)
Bus station	81.3806	94.3855
train station	63.0887	65.9847
Bhanugudi junction	77.9569	77.5388
Masjid center	79.9661	81.7804

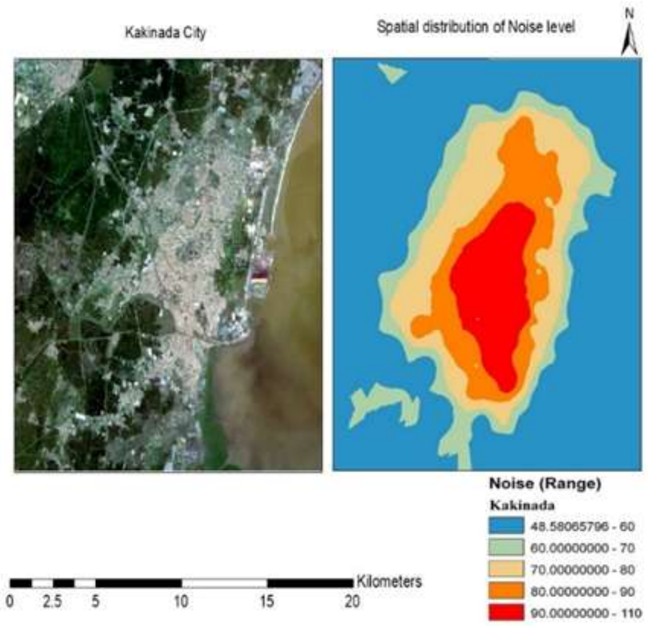

Fig.6 Spatial distribution of Noise in Kakinada

Table.5 Equivalent Noise levels at Rajahmundry

Rajahmundry	Equivalent noise level	
	Morning(Leq)	Evening(Leq)
Apsrtc bus station	77.774	74.9207
Kotipalli bus stand	77.5456	78.4314
Train station	81.0273	87.1576
Thayagraj street	82.1249	81.7316

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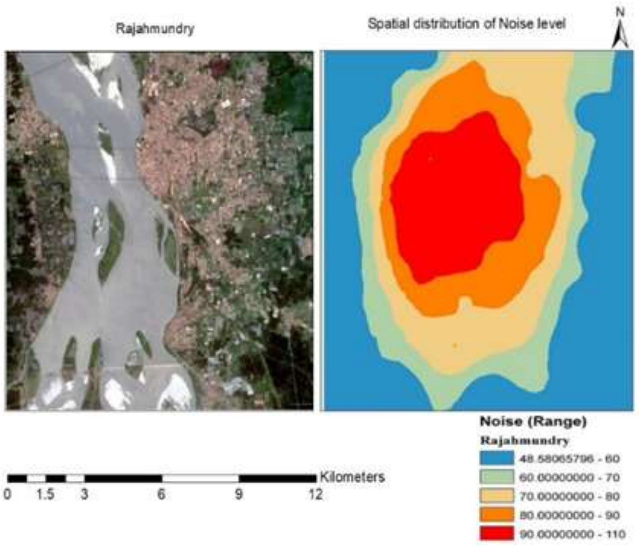

Fig.7 Spatial distribution of Noise in Rajahmundry

7.DISCUSSION

Mitigation strategies involve identifying transportation modes and activities contributing significantly to noise pollution, allowing for targeted interventions. Implementing sound insulation measures, such as strict policies and traffic lights at junctions with high traffic flow, along with introducing noise barriers, can help alleviate the adverse effects of noise pollution near transportation hubs. Utilizing data from this project and other online sources can guide the placement of infrastructure, ensuring that schools, hospitals, and residential areas are developed in locations with lower noise levels, while industries are situated away from residential zones and near established industrial areas. High noise pollution levels near transportation hubs have implications for public health and quality of life, necessitating public

health interventions like community noise monitoring programs and awareness campaigns to address associated health risks. Furthermore, promoting sustainable transportation practices, such as electric vehicle usage and expanding public transportation networks, not only reduces noise pollution near transportation hubs but also mitigates environmental impacts like air pollution and carbon emissions. We can adopt different mitigation strategies for reducing the noise levels that are suitable according to the environment of the places. We can make the roads wider in Amalapuram with traffic lights in different areas and strict rules and regulations.

8. CONCLUSIONS

The study aimed to assess the noise levels in three cities of East Godavari district: Rajahmundry, Kakinada, and Amalapuram. Using sound level meters, measurements were taken in four selected study areas near transportation hubs during peak morning and evening hours over one week in each city. Data on noise levels, longitude, and latitude were recorded and entered into an Excel file. Equivalent noise levels were calculated, and spatial distribution maps were created using ArcGIS interpolation. Rajahmundry exhibited the highest noise levels, particularly near the train and bus stations. Kakinada also showed high noise levels, with unexpected readings at Bhanugudi junction. Despite heavy traffic flow, noise levels were lower than anticipated. Amalapuram had the lowest noise levels overall but still experienced elevated levels near the bus station and Red Bridge areas. The findings emphasize the need for targeted noise mitigation strategies in these urban centers to address areas of high noise pollution and safeguard public health and well-being.

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