

**ASSESSMENT OF NOISE POLLUTION
IN SELECTED AREAS OF ISLAMABAD**



By

Fatima Nawaz Abbasi

Laiba Khan

Department Of Earth And Environmental Sciences

Bahria University, Islamabad PAKISTAN

2026

ASSESSMENT OF NOISE POLLUTION IN SELECTED AREAS OF ISLAMABAD



A thesis submitted to Bahria University, Islamabad in partial
fulfillment of the requirement for the degree of B.S

in Environmental Sciences

Fatima Nawaz Abbasi

Laiba Khan

Supervisor

Dr. Said Akbar Khan

Department of Earth and Environmental Sciences

Bahria University, Islamabad

2026

Bahria University
Department of Earth & Environmental Sciences
Islamabad Campus, Islamabad

Dated: 18/06/2026

Certificate

This thesis submitted by **Ms. Laiba Khan** and **Ms. Fatima Nawaz Abbasi** is accepted in the present form by Department of Earth & Environmental Sciences, Bahria University, Islamabad as the partial fulfillment of the requirement for the degree of **Bachelor of Sciences in Environmental Science**, 4 years program (Session 2022– 2026).

Committee Members	Name	Signature
Supervisor	Dr. Said Akbar Khan	
Internal Examiner	Dr. Syed Umair Ullah Jamil	
External Examiner	Dr. Abdul Shakoore	
Head of Department (E&ES)	Dr. Syed Umair Ullah Jamil	

ABSTRACT

Noise pollution is becoming one of the most important and notable environmental issues in growing urban areas where it is impacting the human population's health, well-being and quality of life. The present study was aimed to evaluate the noise pollution in certain areas of the city Islamabad, Pakistan and to check whether they meet the recommended environmental limits. Noise monitoring was carried out at various locations which includes I-9/1, I-9/2, I-9/3, I-9/4, I-10/1, I-10/2, I-10/3, I-10/4, G-9/1, G-9/2, G-9/3, G-9/4, G-13/1, G-13/2, G-13/3, G-13/4, Kashmir Highway, I.J.P. Road, Faizabad Bus Stop, and G-9 Bus Stop. Using a calibrated sound level meter, sound level measurements were recorded at various times of the day to capture the differences in sound level between residential, commercial, transportation and industrial areas. The results showed that there were significant variations in noise levels when comparing the selected sites. Heavy traffic and public transportation, frequent vehicle congestion and commercial activities are the major reasons of maximum noise levels at Faizabad Bus Stop, I.J.P. Road, and Kashmir Highway. Some moderate to high noise was heard in the industrial areas of I-9 and I-10, and relatively low noise was heard in the residential areas of G-9 and G-13. In some residential areas, however, the noise exceeded the guideline values of 55 dB recommended by the World Health Organization (WHO) for residential areas. In regard of noise pollution in transportation corridors and commercial areas, very high levels were recorded, well in excess of the permissible limits, suggesting that there is a serious environmental problem with noise pollution in these areas.

ACKNOWLEDGEMENTS

First of all, we would like to thank Allah SWT for His mercy and benefits, for giving us the strength, endurance and perseverance to successfully complete this thesis.

We are thankful to our respected supervisor Dr. Said Akbar Khan (Professor, Department of Earth and Environmental Sciences, Bahria University Islamabad) for his invaluable guidance, continuous support and encouragement during this research work. The success of this thesis is largely due to his knowledge, constructive suggestions and motivation.

Special thanks are due to all those who made it easy for us during the field surveys, noise level measurements and data collection at the different locations in Islamabad. We were very grateful to their cooperation and support to successfully complete this work.

We would like to thank our friends and classmates, for their encouragement, assistance, and support throughout our academic education.

We are also deeply grateful to Faran Ali, brother of one of the authors, for his encouragement, assistance and support during this endeavor. His willingness to work, generosity and good nature were greatly appreciated.

Finally, we would like to say our heartfelt gratitude to our dear parents Shamim Akhtar and Muhammad Khan and Naila Nawaz and Mohammad Nawaz Abbasi for their boundless love, continuous prayers, patience, sacrifices and constant support during our academic years. The support and inspiration they've given us in our lives has been a constant source of strength and motivators to achieve this feat. Thanks everyone for your support and encouragement.

TABLE OF CONTENTS

ABSTRACT.....	iv
ACKNOWLEDGEMENTS.....	v
TABLE OF CONTENTS.....	vi
LIST OF FIGURES.....	ix
LIST OF TABLES.....	x
ABBREVIATIONS.....	xi

CHAPTER 1

INTRODUCTION

1.1 Background.....	1
1.2 Global View of Noise Pollution.....	4
1.3 Noise Pollution as an Environmental Issue.....	4
1.4 Urbanization`s Effect on Noise Levels.....	5
1.5 Problem Statement.....	7
1.6 Purpose of this Study.....	8
1.7Significance of the Study.....	8
1.8 The Objective of the Research are.....	9

LITERATURE VIEW

1.9 Review of Literature.....	10
1.10 Concept of Noise Pollution.....	10
1.11 Sources of Noise Pollution.....	11
1.12 Impacts of Noise Pollution.....	12
1.13 International Studies on Noise Pollution.....	14
1.14 Studies on Noise Pollution in Pakistan.....	15

CHAPTER 2

RESEARCH METHODOLOGY

2.1. Study area.....	18
2.1.1 Point to Point Study.....	20
2.1.2 Reasons for choosing Islamabad.....	20
2.2 Sampling Design.....	21
2.3 Noise monitoring Equipment.....	22
2.4 Data Collection Procedure.....	22
2.5 Time and Duration of Monitoring.....	23
2.6 Field Observations During Monitoring.....	23
2.6.1 Traffic Noise.....	24
2.6.2 Vehicle Horns.....	24
2.6.3 Commerical Activities.....	25
2.6.4 Construction Activities.....	25
2.7 Data Analysis.....	26
2.8 Limitations of the Study.....	28

CHAPTER 3

RESULTS AND DISCUSSION

3.1 Introduction.....	29
3.2 Results of Noise Pollution in Selected Areas of Islamabad.....	30
3.2.1 Noise Levels in G-9 Sector.....	30
3.2.2 Noise Levels in G-13 Sector.....	30
3.2.3 Noise Levels in I-9 Sector.....	31
3.2.4 Noise Levels in I-10Sector.....	32
3.2.5 Noise Levels at Kashmir Highway.....	33
3.2.6 Noise Levels at I.J.P Road (Pirwadhai Bus Stop).....	33
3.2.7 Noise Levels at Faizabad Bus Stop.....	34

3.2.8 Noise Levels at Karachi Company Bus Stop.....	34
3.2.9 Sector-wise Comparison of Noise Levels.....	34
3.3 Discussion of Noise Pollution in Selected Areas of Islamabad.....	36
CONCLUSION.....	43
RECOMMENDATION.....	46
REFERENCES.....	49
ANNEXURES (A) Photographic Record of Field Survey and Noise Monitoring Activities.....	52

LIST OF FIGURES

Figure 3.1 Noise Levels Recorded at Selected Commerical Sites.....	37
Figure 3.2 Noise Levels Recorded at Selected Residential Areas.....	37
Figure 3.3 Noise Levels Recorded at Selected Roadside Areas.....	38
Figure 3.4 Comparison of Noise Levels in Commrical, Residential, and Roadside Areas in Islamabad.....	38
Figure 3.5 Study Area Map Showing the Selected Noise Monitoring Sites in Islamabad, Pakistan.....	42

LIST OF TABLES

Table 2.1: Approximate Distance Between Selected Study Sites.....	20
Table 2.2 Sampling Design and Purpose of Selected Areas.....	21
Table 2.3 Recommended Noise Levels Standards According to WHO.....	26
Table 3.1 Noise Monitoring Data for Selected Areas.....	35

ABBREVIATION

WHO	World Health Organization
NEQS	National Environmental Quality Standards
EPA	Environmental Protection Agency
Pak-EPA	Pakistan Environmental Protection Agency
Db	Decibel
SLM	Sound Level Meter
GIS	Geographic Information System
GPS	Global Positioning System
Km	Kilometer
M	Meter
°C	Degree Celsius
RH	Relative Humidity
SPL	Sound Pressure Level

CHAPTER 1

INTRODUCTION

1.1 Background

Environmental pollution is one of the most serious problems in the world that has a significant negative impact on the health of humans and environmental sustainability. The fast industrialization, urbanization, technological development, population growth and rising economic activities have significantly affected the environment all around the globe. Pollution normally can be characterized as air pollution, water pollution, soil pollution and noise pollution. Of these, the one that is frequently overlooked is noise pollution, even though it poses a threat to the well-being of the human being and his environment.

Noise pollution is the excessive and unwanted noise causing disruption of normal activities and reducing the quality of life. Noise pollution is not visible, you cannot physically touch the pollution, but it's still very real and long term. Urban noise sources are primarily related to the transportation infrastructure, industrial noise, construction noise, commercial centres and public events. Urbanization and increased transportation volume have resulted in a significant increase in noise level in cities, especially in developing countries.

Noise is any sound that is unwanted and or causes discomfort for human beings. The intensity of sounds is measured in decibels (dB) and exposure to high levels of sound for extended periods of time can cause severe physical and psychological health problems. Noise levels of more than 55 dB (55 dB during the day and 45 dB at night) can have harmful effects on human health, according to the WHO. Hearing impairment, hypertension, stress, cardiovascular diseases, fatigue, sleep disturbance, anxiety and diminished concentration are possible adverse effects of excessive noise exposure (WHO 2018).

The problem of noise pollution has worsened in developing countries caused by urbanization and industrial developments which have not adequately been planned and environmental regulations are not equally implemented. The combined

effect of traffic, industrial machinery, construction work and commercial activities are increasing environmental noise. One of the problems with noise pollution is that it is less apparent than other types of pollution, so it tends to be overlooked by policy makers and the public. It is still an important environmental and public health issue however.

Rapid urbanization and environmental issues such as noise pollution have become a serious issue in the developing countries like Pakistan. Urbanization, industrialization, traffic and lack of urban management has increased noise pollution in the major cities like Islamabad, Rawalpindi, Lahore, Karachi, Faisalabad, Multan and Peshawar to a great extent. The transportation system is considered as one of the major contributors to noise pollution in Pakistan. Excessive noise is produced by vehicles including buses, motorcycles, trucks and cars when they honk, brake, or rub tires. The lack of adequate maintenance of public transport systems contributes to the situation.

Industrial and construction activities are another significant source of environmental noise, other than transportation. Industrial noises, such as the noise generated by factories, generators, construction equipment and machinery, have a high level of intensity and can impact the work environment and surrounding communities. Exposure to such noises can lead to occupational hearing loss and other health problems (Munzel et al., 2018).

Islamabad is witnessing rapid urbanization and congestion and noise pollution is rising in both areas. Islamabad is the capital city of Pakistan. Due to the ongoing growth in population, vehicle usage, commerce and industry, it experience greater environmental noise pollution.

The present research is aimed at the assessment of noise pollution at some selected locations of Islamabad such as I-9 Industrial Area, I-10, G-9, G-13, Faizabad, Interchange, I.J.P. Road, Kashmir Highway and some major bus stands. The zones have high traffic density, industrial activity, business activities and public transport movement and are particularly susceptible to high levels of noise pollution.

The I-9 Industrial Area is home to many factories, workshops, and industrial units that run machinery and generators throughout the day, generating intense noise. Likewise, I-10, G-9 and G-13 are high traffic and high density commercial and residential areas. Faizabad Interchange is one of the busiest transportation junctions in Islamabad-Rawalpindi where all the time there is heavy traffic which generates very high noise level.

Similarly, towards the same end, I.J.P. Road and Kashmir Highway are the significant transportation corridors which make heavy flow of traffic throughout the day. The noise generated by vehicles, horns, loudspeakers and crowd noise also make significant contributions to environmental noise at bus terminals and road side markets.

Noise pollution has serious health impacts on humans, animals and ecosystems. Animals use sound to communicate, navigate and find food. Noise from human activities affects animal behavior, migration, reproduction and habitat stability (Barber et al. 2010).

To regulate environmental pollution and create environmental standards, Government of Pakistan along with the Pakistan Environmental Protection Agency has introduced environmental laws and National Environmental Quality Standards (NEQS), which also includes noise pollution. However, enforcement of these regulations has been weak, and public awareness of the regulations is low. The results of previous study conducted in Pakistan have revealed the high noise levels in urban areas that often go beyond the permissible noise level recommended by WHO and NEQS (Khan et al., 2012).

Hence, the necessity of comprehensive research to estimate the level of environmental noise and its possible impacts on the health of humans and urban sustainability. The purpose of this study is to help in understanding and assessing the level of noise pollution in selected areas of Islamabad, its major sources, potential noises effects on health and suggest some practical measures of noise mitigation.

1.2 Global View of Noise Pollution

Increasing environmental noise pollution is a concern in many countries around the world. In the last few decades, a growing population, industrialization, transportation and rapid urbanization have dramatically increased the levels of noise in the environment (WHO, 2018). Noise pollution cannot be seen, like air and water pollution, but has a great impact on people's health and their lives. (European Environment Agency [EEA], 2020).

In the developed world, governments acknowledge environmental noise as a significant public health problem and monitor noise levels regularly, and have put in place strict regulations to limit the potential impacts of noise. (WHO, 2018). In Europe and North America, many cities have implemented noise control policies, traffic management measures and urban planning initiatives to ensure acceptable environmental noise (EEA, 2020). Yet all these measures have failed to stop the growing number of vehicles, businesses, and urban development from contributing to the problem of noise pollution (Basner et al., 2014).

In urban environments, road traffic contributes heavily to the environment's noise levels, as shown by international studies. Other significant contributors are aircraft operations, railway transport, industrial machinery and construction (WHO, 2018). It has been found that there are a lot of people around the world exposed to environmental noise levels which are more than the ones recommended by the health organizations (EEA, 2020).

1.3 Noise Pollution as an Environmental Issue

Refers to pollution of the atmosphere, water, soil, etc. Associates pollution with contaminated air, water or soil. Environmental noise can also be described as pollution as it can disrupt the ecological balance and have negative impacts on humans and wildlife (Singal, 2005). Too loud impacts the quality of the environment and can lead to a poor quality of life for people and animals.

Noise pollution is sometimes referred to as an invisible pollutant since it is not visible. After prolonged exposure to high noise levels, people may become desensitized to loud noise, which can lead to an underestimation of noise exposure risks (WHO, 2018). Exposure to unwanted sound over time can cause physical, psychological and social health issues (Basner et al., 2014).

Noise is one of the major problem in urban areas due to the high population density, high traffic volumes, industrial and commercial activities (Goines & Hagler, 2007). Environmental noise is likely to be an increasing problem as cities expand.

1.4 Urbanization's Effect on Noise Levels

The noise pollution has been one of the major factors in the rapid urbanization. With the expansion of cities, new roads, buildings, industries and transportation systems are built to accommodate the needs of the growing population, and these can create a significant amount of noise (Murphy & King, 2014).

The rising number of private vehicles has increase the issue even more. Previously quiet roads are now very busy all day. Traffic jams cause long periods of engine noise and unnecessary excessive horn use, leading to increased environmental noise (WHO, 2018). High levels of ambient noise are also produced at commercial centres, shopping districts and transportation terminals because of high levels of people and vehicles.

Urbanization in many developing cities is faster than planning and managing environments. This often leads to residential areas being situated close to highways, industrial areas and commercial centers, resulting in the residents of these areas being subjected to constant environmental noise (EEA, 2020).

Noise Pollution and its effects on human health. The impact of noise pollution on human health.

Researchers around the world have studied the link between noise and human health extensively. Research has shown that high levels of noise can have physical and psychological health effects, depending on the intensity, duration and sensitivity of exposure (Basner et al., 2014).

Hearing impairment is one of the most common effect of noise pollution. People who are exposed to loud noise on a frequent basis can experience temporary or permanent hearing loss. Certain occupations, such as those in industrial facilities, construction and the transportation industry, are at high risk (WHO, 2018).

In addition to listening issues, environmental noise can lead to stress, anxiety and mental fatigue. Exposing the body to high noise levels over prolonged periods can trigger the body's stress response system that leads the production of stress hormones, which may have an impact on emotional and physical health (Basner et al., 2014).

Another major health impact of the environment is around noise disturbance. Another major health impact of the environment is disturbance of sleep. Lifestyles of people who live near roads, airports, railway stations and active commercial zones are disturbed. The quality of sleep can impact productivity, the immune system and daily functioning (WHO, 2018).

Environmental noise and sustainable urban development concerns. Concerns related to environmental noise and sustainable urban development.

The Sustainable urban development is able to develop cities in a way that would provide healthy and comfortable living conditions for the current and future generations. Noise management is therefore an integral part of sustainable development and environmental protection (United Nations, 2015).

Too loud cities are less liveable and can have a negative effect on the health and quality of life of their citizens. Therefore, noise control measures should be taken into account within the urban planning and development processes. Appropriate zoning of land use, creation of green space, enhanced transportation

infrastructure and ongoing environmental monitoring programs can help reduce environmental noise (Murphy & King, 2014).

Planning and incorporating noise pollution management will have a positive impact on public health and environmental sustainability. Better acoustics leads to better quality of life, better wellbeing and better overall productivity of urban dwellers (United Nations, 2015).

1.5 Problem Statement

Noise pollution has emerged as serious environmental problem in Pakistan especially in fast growing urban areas like Islamabad and Rawalpindi. The population growth, growing traffic, industrial development and urbanization have greatly raised environmental noise levels in these cities. In a number of places, noise was found to be above the permissible limit set by World Health Organization and National Environmental Quality Standards (NEQS).

However, the monitoring and control of environmental noise pollution has been less focused in spite of the growing severity of the noise pollution problem. Excessive noise levels can cause hearing loss, stress, increased blood pressure, cardiovascular disease, sleep disturbances, decreased productivity and psychological issues. Children, the elderly and traffic police officers are among the vulnerable categories that pose a high risk.

High level and frequent environmental noise is observed in some areas of Islamabad and Rawalpindi such as industrial areas, highways, commercial areas and bus terminals. Unfortunately, there is a lack of scientific information on the spatial distribution of noise, noise intensity and health impacts of noise pollution in these situations. Thus, a systematic evaluation of noise pollution levels, identification of the main noise sources, assessment of their effects on health and the identification of appropriate solutions to reduce noise is needed for sustainable management of urban environmental quality.

1.6 Purpose of this Study

The primary purpose of this is to find out the noise pollution level in selected areas of Islamabad and Rawalpindi and to examine the effect of noise pollution on human health and the urban environment. This also seeks to find out the significant sources of environmental noise and suggest appropriate solutions to reduce noise and protect the environment.

1.7 Significance of the Study

The study is important as it underscores the rising problem of environmental noise pollution in Pakistan and its negative effects on human health and environmental sustainability. The results of this study could contribute to a better understanding of the magnitude of the problem of noise pollution by environmental agencies, urban planners, policymakers and government authorities and help them to make effective decisions for environmental management.

The study can also help raise awareness of citizens of the dangers of over exposure to noise and promote responsible behavior for the environment. Furthermore, the outcomes of this study can be used in future research on environmental studies on urban pollution, environmental health, and sustainable city planning.

The study also suggests some recommendations to minimize environmental noise by better traffic organization, better and routine vehicle maintenance, plantation of trees and green belts, installation of noise barriers, proper industrial zoning and the strict enforcement of environmental laws and regulations. Noise pollution has a great impact on health of humans and their lives, as on the overall livability of a city, thus its mitigation is a crucial factor in sustainable urban development in Pakistan.

Scientific Basis for Selecting the Study

The selection of the study was based on scientific principles.

The selected topic is environmental noise which has been identified as an emerging urban environmental concern given the rapid urbanization, increase in traffic, commercialization and industrial development. Although noise pollution is a serious health concern, due to its significance in the context of public health, it has not been studied as much as air and water pollution in Islamabad. Evaluation of environmental noise, as a scientific tool, can support sustainable urban planning, environmental management and policy, by providing scientific evidence.

1.8 The Objectives of the Research are

The key aims of this research are:

To record the noise levels in specific locations in Islamabad and Rawalpindi.

To compare the observed levels of noise with permissible levels from WHO and NEQS.

To know the main sources of environmental noise pollution.

To evaluate human health and well-being effects of noise.

To examine noise differences at various sites.

Educate on effective strategies and control measures in reducing urban noise pollution.

LITERATURE REVIEW

1.9 Review of Literature

In many places in the world, noise pollution is having a detrimental effect on the built environment, particularly in cities where population, industries and transportation systems grow rapidly. As the cities grow and activities develop, the noise in the environment is also increasing. It has been explained that exposure to high and prolonged sound can cause a detrimental impact on both humans health and the environment. Exposure to noise over a longer period could lead to hearing disorders, stress, sleep disturbance, high blood pressure, heart diseases, anxiety and lack of concentration (WHO, 2018). Due to these negative impacts, noise pollution has become an important health and environmental issue and a key public health concern.

A primary source of environmental noise pollution is human activities. The cities are characterized by continuous noise emissions due to traffic, industrial machinery, construction, commerce and public assemblies. Developing countries are more affected due to low level of environmental policies, poor urban planning, congestion on the roads and growth in population. Noise has become a part of urban life in fast growing cities and is impacting the way urbanites live and successfully live.

Pakistan is also facing serious problems related to environmental noise pollution. The cities like Islamabad, Rawalpindi, Karachi, Lahore, Faisalabad and Peshawar are getting louder due to rising traffic, industrialization, construction, and business activities. Noise pollution impacts on people's daily lives but is not so given attention on the par of air and water pollution.

1.10 Concept of Noise Pollution

Noise pollution means unwanted and disturbing noise that is causing discomfort and has an impact on humans and environment. When sound levels are

excessive and begin to cause some sort of harm, sound turns into noise. The loudness or strength of sound is measured in decibels (dB). The World Health Organization (WHO) found that noise above 55 dB during the day and 45 dB at night can have worst impact human health (WHO, 2018).

Noise pollution is invisible and has potentially serious and long-lasting effects, unlike other kinds of pollution. Environmental noise is a significant environmental problem in the world because of the rapid pace of urbanization, industrialization and greater transportation. Too much noise in crowded urban areas disrupts normal life, lowers comfort levels and impacts the health and wellbeing of people.

1.11 Sources of Noise Pollution

Human activities are the primary sources of environmental noise pollution, particularly in urban areas where industries, transportation systems and commercial activities are growing at an increasing pace day by day. Urban residents are still exposed to the noise of vehicles, factories, construction activities, markets and public events throughout the day. The problem has become worse due to the rapid urbanization and growing economic activities. In developing countries such as Pakistan, the environmental noise has been enhanced due to poor road conditions, weak environmental monitoring systems, overcrowded roads, poor city planning etc.

The transportation sector is one of the largest contributors to the noise pollution in the environment. Buses, cars, motorcycles, trucks and trains make loud noises from their engines, horns, brakes and exhaust systems. The problem is even worse with the traffic jams as vehicles are stuck on the roads for extended periods and horns are being sounded at all times. Heavy vehicles, particularly those with high power like trucks and buses, tend to be noisier than small vehicles due to their engine size and lack of maintenance. In Pakistan, the studies revealed a significant amount of traffic jams and unnecessary honking as the prime causes of

environmental noise pollution in cities like Islamabad, Rawalpindi, and Karachi (Khan et al., 2012).

Another major source of environmental noise pollution is industrial activities. Various factories, workshops, generators, turbines, heavy machinery operate continuously and emit high volumes of sound. Employees who are exposed to the noise of a workplace for extended periods may experience stress, fatigue, and other occupational health issues, in addition to experiencing hearing issues. Machinery is running around the clock in certain areas, like I-9 Industrial Area, resulting in constant environmental noise. During a power outage, many urban areas also suffer from the additional issue of using generators.

The building site also plays a significant role in noise emissions into the environment. Road and building, including housing societies, have heavy equipment like bulldozers, drilling machines, cranes and concrete mixers. These machines create a lot of noise which can cause disruptions to neighboring residents and employees. Building work at night has a negative impact on sleep quality, and can cause stress to residents in the immediate area.

Environmental noise pollution is also a problem in urban areas, made by commercial and social activities. In markets, shopping centers, bus terminals, railway stations, and densely populated places, the noise of people, traffic, loudspeakers and business activities still prevail. Loudspeakers are used during marriage ceremonies, political meetings, religious gatherings, and celebrations in Pakistan, where the loud sound produce excessive environmental noise. As a result of low law enforcement and lack of awareness, commercial noise pollution has become widespread in the city environment.

1.12 Impacts of Noise Pollution

Environmental noise is a nuisance which affects the health, social life and the quality of the environment. Excessive noise has a physical, mental and emotional impact and this impact is cumulative. The effects of noise pollution vary with

intensity of sound, length of exposure, and sensitivity of the individual to noise. Children, elderly persons, industrial workers and hospital patients are more susceptible to negative impacts of environmental noise pollution.

Hearing loss is one such very frequently reported effect of noise pollution. Loud sound can cause temporary or permanent hearing loss after prolonged exposure to high levels of sound. High risk occupations include factory, construction and traffic-related work, where people are exposed to high noise levels for long periods. Too much sound can also lead to tinnitus, which is the sound that people hear in their ears when there is no real sound. Research indicates that environmental noise also has a negative impact on blood pressure, stress, headache and cardiovascular diseases (Munzel et al., 2018).

Noise pollution also has a negative impact on mental health and emotional well-being. Noise can cause stress, anxiety, irritation, frustration and depression to people in the environment. When the noise is continuous it helps to distract from concentration and diminishes mental peace. Environmental noise may create learning difficulties, lack of concentration and lower academic performance for students studying near highways or near industrial areas. Employees in noisy environments can also suffer from stress and loss of productivity at work.

Another significant consequence of environmental noise pollution is sleep disturbance. Sleeping patterns can be disrupted by traffic, industrial machinery, loudspeakers and commercial activity particularly at night. Lack of sleep can cause a person to feel fatigued, weak, stressed, and not as productive during the day. Long-term sleep problems may also increase the risk of heart diseases and mental health disorders.

Noise pollution in the environment can also cause communication difficulties. When people are in noisy environments, they may struggle to hear what others say and have to shout or repeat what they have said often. This can cause the frustration and discomfort in workplaces, schools, hospitals, and public spaces.

Noise does not just impact humans, it also has a negative impact on wildlife and ecosystems. Animals communicate through sound, to locate food, for reproduction and protection. Human-made noise like overuse of cars and machinery disrupts these natural activities and can lead to animals leaving their habitats. Studies have shown that birds exposed to urban traffic and industrial noise may change their communication and migration patterns (Barber et al., 2010).

1.13 International Studies on Noise Pollution

Due to its impacts on human health and environmental sustainability, many countries around the world have undertaken studies on the issue of environmental noise pollution. It was found that in New York City transportation systems were the dominant source of environmental noise pollution. The environmental noise level reached unsafe levels recommended by WHO, due to traffic, construction work, subway systems and vehicle horns. Residents living close to roads mentioned stress, sleep loss, and health of the heart. Researchers recommended improved traffic management and urban planning to minimize noise in the environment.

Research conducted in London revealed that traffic and aircraft noise had a negative impact on people's health and well-being. The risk of hypertension, heart disease and mental stress was raised due to long-term exposure to transportation noise. The researchers suggested reducing the exposure to the environment by using sound barriers, green belts, and environmental regulations in the residential areas.

A study done in India revealed that high environmental noise levels were observed in urban areas due to traffic, industrial activities and dense commercial areas. It was noted that urban dwellers suffered hearing impairment, stress and sleep disturbance due to high environmental noise. They pointed to the importance of good traffic regulation and the use of unnecessary horns.

In the same way, Chinese studies found that strong economic development and urbanization were the factors that made major city areas more polluted with environmental noise. Industrial equipment, vehicles and buildings were recognized

as significant sources of noise in urban areas. Chinese scientists called for proper monitoring of the environment and better urban planning for the control of environmental noise.

1.14 Studies on Noise Pollution in Pakistan

Environmental noise pollution is reported to be high in urban areas in different studies performed in Pakistan. The level of environmental noise in large urban areas has significantly increased due to the rapid population growth, high level of urbanization, industrialization and high traffic levels. The majority of the researchers found that the noise level in the cities of Pakistan is higher than the level recommended by WHO and National Environmental Quality Standards (NEQS).

The study conducted in Karachi revealed traffic congestion as the prime source of environmental noise pollution. The noise levels on busy roads, railway stations, bus terminals and commercial markets were very high particularly during rush hours. Heavy traffic, unnecessary horn use and poor road conditions were significant factors to environmental noise pollution, researchers found. Neighbours of the busy roads suffered from headaches, stress, disrupted sleep and hearing difficulties.

The environmental noise pollution studies conducted in Lahore revealed high noise pollution in commercial centres, industrial areas and transportation corridors. The main sources of environmental noise were identified as factories, generators, traffic movement and construction activities. Those who were exposed to high noise reported hearing issues, stress and sleep disruption. Scientists reiterated the importance of the law over the environment and the planning of cities.

In Islamabad, the roads were found to have high level of traffic noise, especially during the day hours in the form of Murree Road, Kashmir Highway, and I.J.P. Road etc. Highly affected areas were schools, hospitals and commercial

areas near roadside locations. People living close to highways often had headaches, stress, trouble sleeping and trouble focusing.

Research then conducted in I-9 Industrial Area further revealed that the factories, generators and industrial machinery was creating an environment so noisy that was detrimental to the workers and the community. Electricity generators during the power shortage were reported to add to the environmental noise pollution in urban settings.

The environmental noise scientists and environmentalists have proposed some methods to minimize urban noise pollution. Among the proven ways to reduce transportation noise, proper traffic management is one of them. The improvement of the road infrastructure, the streamlining of traffic flow, the enhancement of public transport services as well as the widening of roads can lead to a decrease in traffic congestion and environmental noise.

Another key aspect of transportation noise control is to maintain the vehicles. Environmental noise levels are greatly raised by damaged silencers, poorly maintained engines and by the unnecessary use of the horn. Vehicle fitness standards and limits on pressure horns can help abate urban noise. The increase in electric vehicles could also help reduce the environmental noise level in the future.

Environmental noise management is also closely related to urban planning. Industrial areas should be separated from residential areas so that residents will not be exposed to the noise of industry. Planting trees and green belts along roads will help to absorb noise and provide a natural sound barrier. The placement of sound barriers next to highways, railway stations and industrial areas can also minimize environmental noise.

Public awareness in controlling environmental noise pollution is also important. Excessive noise exposure, like many other issues, is not widely understood by many people as a risk to health and environment. Education on responsible behavior and environmental protection can be achieved via awareness campaigns in schools, TV, social media and community programs.

Moreover, environmental laws and National Environmental Quality Standards (NEQS) should be more effectively implemented by government and environmental agencies. By making environmental law more effective and enforcing it regularly, environmental noise pollution can be minimized and urban life can be enhanced.

CHAPTER 2

RESEARCH METHODOLOGY

2.1 Study Area

The present study was carried out in various urban sectors of urban centres and in busy traffic zones in Islamabad, Pakistan to determine the extent of ambient noise pollution in residential, commercial and roadside areas. Islamabad is the administrative capital of Pakistan and is one of its fastest growing cities. As the population grows, city roads are being extended, traffic jams are growing, commercial activities are expanding, and there is a growing public transport system, the problem of noise pollution has become widespread in various parts of the city. The impact of environmental noise on human health, comfort, communication and daily life activities makes it one of the key environmental issues in urban areas.

Islamabad is situated on the Potohar Plateau in the northern part of Pakistan. The city has ample traffic flow on its major roads like Kashmir highway, I.J.P Road and Faizabad interchange. Islamabad has also grown into the vibrant commercial and residential areas of many neighbourhoods. The noise of buses, trucks, motorcycles, public transport stations, roadside markets, construction work and vehicle horns play a important role in the noise of a city.

Short and long-term exposure to environmental noise exceeding the permissible limits can lead to health problems including stress, headache, difficulty concentrating, hearing difficulties, hypertension, sleep disturbance, cardiovascular diseases, etc. (WHO, 2018). The other studies carried out in Pakistan also revealed that the urban traffic and commercial activities are the primary sources of environmental noise pollution in urban areas of the metropolitan cities (Khan et al., 2018).

In this research, various sites of Islamabad were chosen such as:

- G-9/1, G-9/2, G-9/3, G-9/4, G-13/1, G-13/2, G-13/3, G-13/4, I-9/1, I-9/2, I-9/3,

I-9/4, I-10/1, I-10/2, I-10/3, I-10/4, Karachi Company Bus Stop, Faizabad Bus Stop, I.J.P Road Pirwadhai Bus Stop, Kashmir Highway.

The sites were chosen as they reflect various land use patterns found in Islamabad such as busy roadsides, residential colonies, markets, transport routes, and commercial centres, as well as bus stops. The chosen areas are high traffic areas and areas of public activity during the day.

Three different monitoring points were selected from each study area:

Roadside area, Residential area, Commercial area

These three locations were chosen to make a comparison of the noise levels in urban environments. Roadside areas were chosen to monitor traffic noise, residential areas to assess the noise's effect on local residents and commercial areas to investigate the effect of the markets and public movement on the environmental noise.

The climate and environmental conditions in Islamabad are described below. The climate and environmental conditions of Islamabad are given below.

Humid subtropical climate with hot summer and cool winter. The noise levels are higher during the day, particularly during peak traffic times, as a result of vehicle and pedestrian traffic. The city experiences heavy traffic during working hours and during office hours, particularly on the main roads such as Kashmir Highway and I.J.P Road.

Environmental conditions of Islamabad also play role in the transmission and level of noise. The road surfaces, which are open with low amounts of vegetation, exhibit low noise intensity, whereas areas of trees and green belts exhibit slightly lower noise intensity. The daytime hours at commercial markets and transport terminals are typically busier with more sound than residential colonies.

Urbanization and population growth have also been a factor in the deterioration of the environment in Islamabad. Where once the area had peaceful residential land, it is now being developed as business centres, and as a result of

this traffic and noise has grown. The same observations were also made by Ali and Malik (2011) who concluded that urban development and transport operations are the main factors contributing to the pollution of the environment in Islamabad.

2.1.1 Point to Point Study

The study sites were selected throughout Islamabad and were representative of different land-use types. The distance between the monitoring locations was approximately 2 km - 18 km, providing a wide spatial sampling of the residential, commercial, industrial and roadside environments.

Table 2.1: Approximate Distance Between Selected Study Sites

Location	Approx. Distance
G-9 to G-13	8 km
G-9 to I-9	5 km
I-9 to I-10	3 km
I-10 to Faizabad	8 km
Faizabad to Kashmir Highway	8 km
Karachi company to G-9	2 km

2.1.2 The reason for choosing Islamabad

Islamabad was chosen as it is one of the rapidly growing urban cities of Pakistan characterized by the growing volume of traffic, heavy industrial and commercial activities. The city has a variety of land use categories such as residential areas, industrial areas, commercial markets and major transportation facilities, which makes the city a good choice to evaluate urban noise pollution.

2.2 Sampling Design

The study sites were selected using purposive sampling technique. The sites were chosen according to traffic volumes, commercial activities, public travel and population density. Sampling points were chosen in such a way that they represented the major urban environments of Islamabad.

Noise levels were measured in the roadside, residential and commercial areas in each selected site. Monitoring was conducted at peak traffic times in the day-time, when traffic and human activity are still high. Careful readings were taken to note the differences in environmental noise in various sectors.

Table 2.2: Sampling Design and Purpose of Selected Areas

The sampling design consisted of:

Area Type	Purpose
Roadside	To monitor traffic-related noise
Residential Area	To research the effects of noise on the community
Market/Public Activity Noise	To assess the noise levels of surrounding commercial activity

The selected areas were both moderate and highly congested to have a fairly good comparison and understanding of the environment noise level in Islamabad.

2.3 Noise Monitoring Equipment

A portable digital sound level meter (noise meter) was used for measuring environmental noise levels during the study. The instrument is used to measure the intensity of the sound in decibels (dB), the standard unit to measure noise.

The instrument was checked properly to obtain accurate readings before taking readings. The noise meter was recorded about 1.5 meters above the ground level. Care was taken to avoid obstacles and interference during data collection.

The sound level meter was chosen due to its capacity of measuring the environmental sound in a quick and reliable manner. It is noted that the same instruments had been used for the past few years in conducting previous environmental noise studies in the urban areas of Pakistan (Shahid et al., 2015).

2.4 Data Collection Procedure

Data collection was done through direct field visit to the selected areas in Islamabad. The noise readings were collected at each selected point at daytime when traffic and business activities were at their peak.

The digital noise meter was used at each monitoring point to take three measurements. Average reading was taken to minimize any possible reading error and enhance the reliability of the results

In field observations, the following sources of noise were found:

- Vehicle horns
- Heavy traffic movement
- Public transport buses
- Motorcycles and rickshaws
- Commercial market activities
- Construction work

- Crowded public areas

Monitoring was also conducted and field notes were taken to document traffic and environmental observations.

The following data were gathered:

1. Sound in the road environments
2. Sounds in residential areas.
3. Levels of noise in commercial areas.

The sound level measurements were made in decibels (dB).

2.5 Time and Duration of Monitoring

Noise monitoring was conducted at times when traffic and people in the public areas were expected to be at their highest. The majority of readings were recorded at mornings and afternoon timings as these were the periods of maximum movement of vehicles and people.

The sound meter was left to stabilize each time at each location before taking the reading. To increase accuracy three readings were used at each point and the average value calculated. The monitoring took place in normal environment to prevent any extraordinary changes in sound levels.

The length of time spent monitoring at each location was about 10 to 15 minutes. Traffic flow and traffic movement, and nearby activities, were also closely monitored during this period.

2.6 Field Observations During Monitoring

In the field survey, various environmental factors and public activities were noted that help to raise environmental noise levels.

Persistent heavy traffic, needless honking of horns and public transportation system usage were observed in commercial and roadside areas. Bus stops and transport terminals were also busy during the monitoring period.

The noise levels were relatively low in residential areas; however, areas near main roads had moderate to high noise levels as a result of traffic movement in the vicinity.

Other sources of sound were observed in some areas as follows:

- Construction activities
- Road repair work
- Loudspeakers in markets
- Generator usage
- Heavy transport vehicles

The major causes of environmental noise in the study areas were understood based on these observations.

2.6.1 Traffic Noise

Nearly all study areas were disturbed by traffic noise as the predominant source of environmental noise. High noise levels were generated on a regular basis by cars, buses, trucks, motorcycles and public transport.

2.6.2 Vehicle Horns

Another significant source of noise from the vehicles was the frequent use of horns by their drivers. Unnecessary horn use during heavily trafficked road and business traffic areas resulted in a marked increase in the noise of the environment.

2.6.3 Commercial Activities

Environmental noise levels included markets, shops, street vendors and public gatherings. The higher the commercial sound intensity was found in areas with busy markets.

2.6.4 Construction Activities

Loud sound levels were also generated during construction activities, drilling machines, generator activities and during road repair.

The health effects of noise pollution. The impacts of noise pollution on health.

There are a number of bad effects of environmental noise pollution on humans.

High sound levels have a negative impact on physical and mental health, according to WHO guidelines.

In the field visits the local people voiced their complaints as:

- Headache
- Sleep disturbance
- Stress and irritation
- Lack of concentration
- Hearing discomfort

Long-term exposure to environmental noise has also been found to have a negative impact on hypertension, anxiety, cardiovascular diseases, and hearing loss (WHO, 2018).

Some groups, such as children, the elderly, students and patients are more susceptible to the negative impacts of environmental noise.

The specification applies the same system of quality assurance as the WHO standards.

Noise measurements were made in several study zones and the measured noise in most of these areas were higher than the recommended limits set by the World Health Organization.

Table 2.3: Recommended Noise Levels Standards According to WHO

Following WHO recommendations:

Area Type	Recommended Limit
Residential Area	55 dB
Commercial Area	65 dB
Traffic/Roadside Area	70 dB

A number of sampling sites along the road and in commercial premises had levels higher than these limits. The sound levels were found to be very high at some locations like Karachi Company Bus Stop, Faizabad, I.J.P Road and Kashmir Highway.

2.7 Data Analysis

The data collected were tabulated and compared with different locations. The average levels of the three noise types (roadside noise, residential noise, and commercial noise) were examined on their own.

The results showed that

Noises levels were generally higher in roadside areas. Moderate to high sound intensities were observed in commercial areas.

Roadside zones generally showed higher sound levels than did residential areas, but there were instances where the sound levels exceeded allowable limits.

The main causes for high environmental noise were traffic congestion, public transport mobility, the density of markets, and urbanization.

Outline the negative effects on the environment caused by noise pollution. Discuss the adverse effects of noise pollution on the environment.

The impact of environmental noise pollution is not only on humans but also on the environment. People living in urban areas may be affected by high sound intensity, as it could impact communication, productivity, learning ability and comfort level.

Continuous traffic noise may make learning and concentrating difficult in educational institutions and residential colonies in close proximity to busy roads. Road noise can also cause disturbance at hospitals and healthcare centers that are close to the road.

Noise pollution can also cause disruption of birds and animals' communication and natural behavior. Urban noise can diminish environmental quality, and induce stress in living organisms.

It is observed that with the rise of urbanization and transportation activities, environmental noise is also rising in developing countries (Yousaf et al., 2021).

Health and environmental risks and the measures taken to reduce noise pollution. Health and environmental risks and measures taken to prevent noise pollution.

Use of various measures can be adopted to minimize noise pollution in urban environment.

2.8 Limitations of the Study

During the study, there were some restrictions:

- Noise readings were taken during daytime only.
- Readings may be slightly affected by weather conditions and temporary traffic conditions.
- Local variations in sound levels were noted at some locations as a result of traffic volume variations.
- Due to limited time and resources, continued long-term monitoring was not possible.

However, due to these constraints the data gathered did give a good idea of the noise levels in the selected areas of Islamabad.

CHAPTER 3

RESULTS AND DISCUSSION

3.1 Introduction

The results of noise pollution monitoring at the selected areas of noise pollution and major traffic areas of Islamabad have been presented in this chapter. The noise was measured at roadside, residential and commercial locations to evaluate the current noise levels at various areas of the city. The values recorded were analyzed to find out noise 'hot spots' and to compare noise level between sectors. The results were further discussed with reference to possible noise sources and their potential environmental impacts.

The findings of Noise Pollution in selected areas of Islamabad are presented below:

The areas of Islamabad selected for noise monitoring were different sectors of Islamabad, namely G-9, G-13, I-9, I-10, Kashmir Highway, I.J.P Road (Pirwadhai Bus Stop), Faizabad Bus Stop and Karachi Company Bus Stop. Noise levels were measured at roadside, residential and commercial sites to assess the current noise situation.

The results recorded reflected very large differences among the selected sites. Roadside noise levels were between 64 dB and 78 dB, residential noise levels were between 61 dB and 97 dB and commercial noise levels were between 64.3 dB and 86 dB.

3.2 Results of Noise Pollution in Selected Areas of Islamabad

3.2.1 Noise Levels in G-9 Sector

The G-9 is one of the busiest sectors of Islamabad due to the commercial activities, traffic movement, markets, and public transportation. Environmental noise was present in different sub-sectors of the G-9 in different amounts.

The road side noise level was measured as 66.5 dB and the residential and commercial area were measured as 62 dB and 64.5 dB respectively in G-9/1. Higher noise level was observed in the road side area due to the movement of vehicles and activities in the markets.

In G-9/2, the ambient noise level was measured at 71.7 dB at the roadside because of the traffic and people's activities. The residential area had an average level of 62.4 dB and the commercial area 64.3 dB.

The commercial noise level was relatively high for G-9/3. The roadside area had 66.4 dB while the commercial area had 71 dB due to the many markets and activities that took place in the area.

The recorded residential noise was 68 dB for G-9/4, slightly higher than other neighbouring residential sites. This rise could be related to traffic volumes and commercial activity in the vicinity.

3.2.2 Noise Levels in G-13 Sector

G-13 is one of the growing residential area of Islamabad which has experienced rapid population growth and traffic congestion in recent years. This is a relatively quieter area than commercial areas such as G-9 and I-9, but environmental noise in the area has been growing on account of the number of vehicles, roadside activities and nearby commercial markets.

The roadside noise level was found to be 67 dB, the residential area noise level was 61 dB, and the noise level in the commercial area was 65 dB in G-13/1.

The sound level in the road side area was comparatively high due to the presence of vehicle activities and nearby market activities.

The road side area measured 68 dB, residential area measured 62 dB and commercial area measured 66 dB in G-13/2. During monitoring moderate traffic was observed and there were some local businesses.

Other than this, environmental noise was clearly measurable for G-13/3. In the roadside area, it was 69 dB, in residential area 63 dB and in commercial area 67 dB. Public movement and transport activities were the main contributors to environmental sound in this area.

The roadside area measured 70 dB, the residential area measured 64 dB and the commercial area measured 68 dB in G-13/4. This was slightly higher than other sub-sector of G-13 because of the increase in traffic movement and commercial development.

In general, the level of environmental noise was moderate in the G-13 sector. The residential areas were relatively calm when compared to the roadside and commercial areas but some exceeded the recommended WHO permissible limits. The main causes of an increase of environmental noise in this sector are the increasing degree of urbanization, the increased number of vehicles and commercial expansion.

3.2.3 Noise Levels in I-9 Sector

There are no restrictions on noise levels in I-9 Sector.

I-9 is an industry and commercial zone, where significant traffic flow occurs throughout the day. Industrial noise, road traffic and congestion in the vicinity of the road caused high levels of noise in several areas of I-9.

In I-9/1, noise measured at the roadside was 72 dB, and 69 dB was observed in commercial areas. Heavy vehicles and transport traffic regularly pass through the area.

The roadside area was 74 dB and the commercial area was 71 dB. The sound levels were raised by continuous traffic flow and by commercial shops.

High roadside and commercial noise values were also observed on I-9/3 and I-9/4. The main sources of environmental noise were found to be heavy vehicles, workshops and public transport.

The noise levels in I-10 Sector is 2.9 of 10. Noise levels in I-10 Sector is 2.9 out of a 10.

The I-10 sector is made up of residential colonies, commercial markets and transport routes. I-10 sectors had noise levels from 70 dB to 74 dB at the roadside.

Residential noise levels were moderate at I-10/1 and I-10/2, and high at the commercial sites, likely because of market noise and public activities.

Commercial noise and noise on the roadside was comparatively high in I-10/3 and I-10/4 as these are still busy during the day.

3.2.4 Noise Levels in I-10 Sector

I-10 Sector is an area of Islamabad that has a high density of residents and businesses, and is a busy place for traffic and public activity, especially during the day. The environmental noise level was moderate to high for different sub-sectors of I-10 due to transport activities, road congestion, commercial markets and adjacent workshop areas.

The noise level on the roadside was measured at 70 dB, and residential and commercial areas measured 63 dB and 68 dB respectively. Higher sound levels were measured in the road side area due to the continuous traffic flow and the people living close to the road side.

The noise level for I-10/2 was found to be 72 dB at the roadway and 64 dB and 69 dB in residential and commercial areas respectively. During monitoring, congestion and movement of motorcycles and public transport vehicles were frequently witnessed.

The roadside areas had a 73 dB rating, the residential areas had a 65 dB rating and the commercial areas had a 71 dB rating for I-10/3. Roadside and commercial traffic was a major factor in the rise in environmental noise in this area.

I-10/4 measured 74 dB along the roadside, and 66 dB and 72 dB in residential and commercial areas respectively. This area was still active in the daytime due to market activity, transport movements and public activity.

In general, the environmental noise levels were observed to be rising in the I-10 sector particularly in the roadside and commercial areas. The main sources of sound pollution were heavy traffic flow, transport movement and increasing urban activities in this sector.

3.2.5 Noise Levels at Kashmir Highway

Among the monitored locations, the highest noise level recorded on the road was on the Kashmir Highway (78 dB). The road is one of the busiest of transportation in Islamabad and is used all day. The measured residential/commercial noise at this location was about 74 dB, which is a high noise exposure level.

3.2.6 Noise Levels at I.J.P Road (Pirwadhai Bus Stop)

I.J.P Road (Pirwadhai Bus Stop) was the busiest road with the highest noise level throughout the study. The residential noise level was 97 dB and was the loudest noise level at any of the sampling sites. There was also some relatively high

roadside and commercial noise. This is due to the higher noise levels that are caused by the high traffic volume, transport facilities, loading and de-loading operations and nearby commercial establishments.

3.2.7 Noise Levels at Faizabad Bus Stop

Another hotspot found was at a bus stop in Faizabad. Noise level on the road was 76 dB and in the residential area was 85 dB. The sector is also a significant transport hub where Islamabad and Rawalpindi are connected and a large volume of vehicles traverse the area throughout the day.

3.2.8 Noise Levels at Karachi Company Bus Stop

The commercial noise level was found to be highest at Karachi Company Bus Stop (86 dB). The noise levels at the houses were high (76 dB), and the roadside noise levels were relatively high. The area is also busy during the day with commercial and shopping center operations and public transportation.

3.2.9 Sector-wise Comparison of Noise Levels

The highest analysis of the selected sectors showed that the overall noise levels of I-9 and I-10 were greater than the overall noise levels of G-9 and G-13. The high concentrations found in these areas may be due to industrial, commercial and high traffic activities. On the other hand, G-13's noise levels were comparatively low as the area is primarily a residential area with limited industrial and commercial activities.

The highest noise levels were present at I.J.P Road Pirwadhahi Bus Stop, Faizabad Bus Stop, Karachi Company Bus Stop, Kashmir Highway while comparatively lesser in G-13 and G-9.

TABLE 3.1 Noise Monitoring Data for Selected Area

AREA	Roadside (dB)	Residential (dB)	Commerical (dB)
G-9/1	66.5	62	64.5
G-9/2	71.7	62.4	64.3
G-9/3	66.4	61	71
G-9/4	64	68	66
Karachi Company Bus Stop	70.2	76	86
I-9/1	72	65	69
I-9/2	74	66	71
I-9/3	73	67	72
I-9/4	75	68	73
I-10/1	70	63	68
I-10/2	72	64	69
I-10/3	73	65	71
I-10/4	74	66	72
G-13/1	67	61	65
G-13/2	68	62	66
G-13/3	69	63	67
G-13/4	70	64	68
Faizabad Bus Stop	76	85	71
I.J.P.Road Pirwadhahi Bus Stop	72	97	70
Kashmir Highway	78	69	74

3.3 Discussion of Noise Pollution in Selected Areas of Islamabad

Based on the results of the present study, it is inferred that noise pollution has evolved as a serious environmental problem in Islamabad. The majority of the noise levels recorded were above the WHO (2018) guideline of 55 dB for residential areas. The following factors seem to have influenced the high level of environmental noise in the study area: rapid urbanization, growing traffic flow, commercial expansion, industrial development and continuous operation of public transport systems. This has been also reported in other countries worldwide, with urban development and the use of transport systems as the main sources of environmental noise (WHO, 2018; Goines and Hagler, 2007).

The results also show that noise levels were significantly higher in roadside areas and commercial areas than in residential areas because there is continuous traffic there, vehicle horns and business activities. Peak hour traffic was a significant factor in the elevated noise levels, especially in the morning and evening. The noise levels in residential areas were generally low compared to other areas, though there were a few areas that were above the recommended WHO limits. This indicates that urban sprawl has intruded into residential areas and has placed more of its inhabitants in contact with the urban noise environment. High noise exposure over long periods of time can have a negative impact on health and wellbeing by leading to stress, sleep disturbance, decreased concentration and increased risk of cardiac issues. Additionally, noise pollution can also affect wildlife by disrupting animal communication, breeding behavior, and habitat use. This is in line with the previous studies, in which transportation and commercial activities were referred as the major contributors of urban environmental noise. Noise pollution can thus be reduced and the environment and people's health protected through effective urban planning, better traffic control, and strict enforcement of environmental noise regulations.

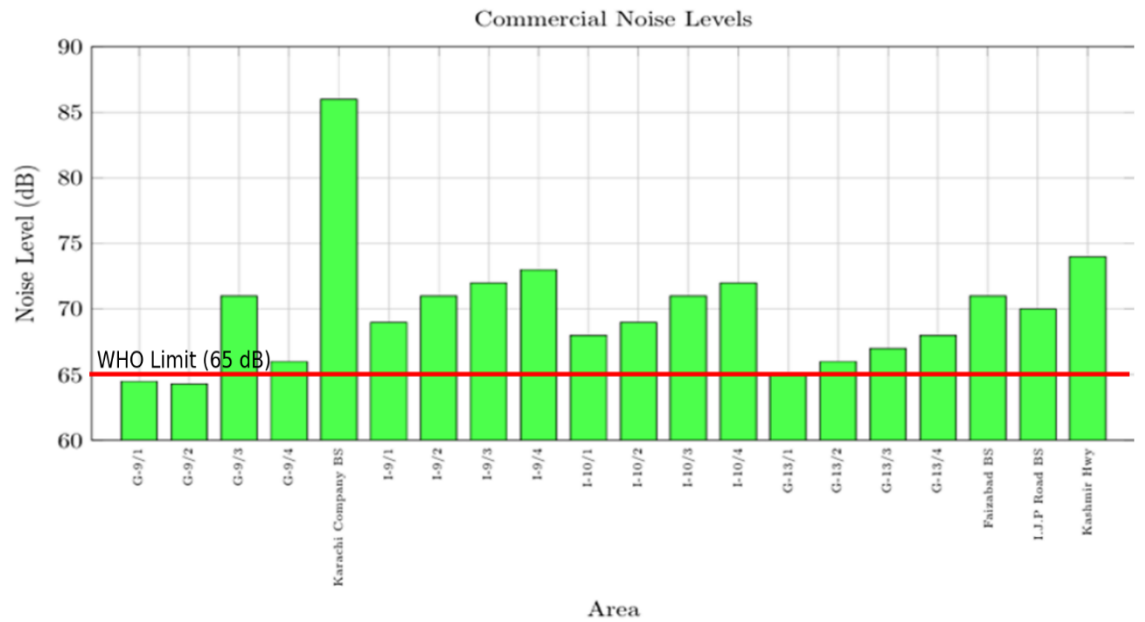


Figure 3.1: Noise Levels Recorded at Selected Commerical Sites

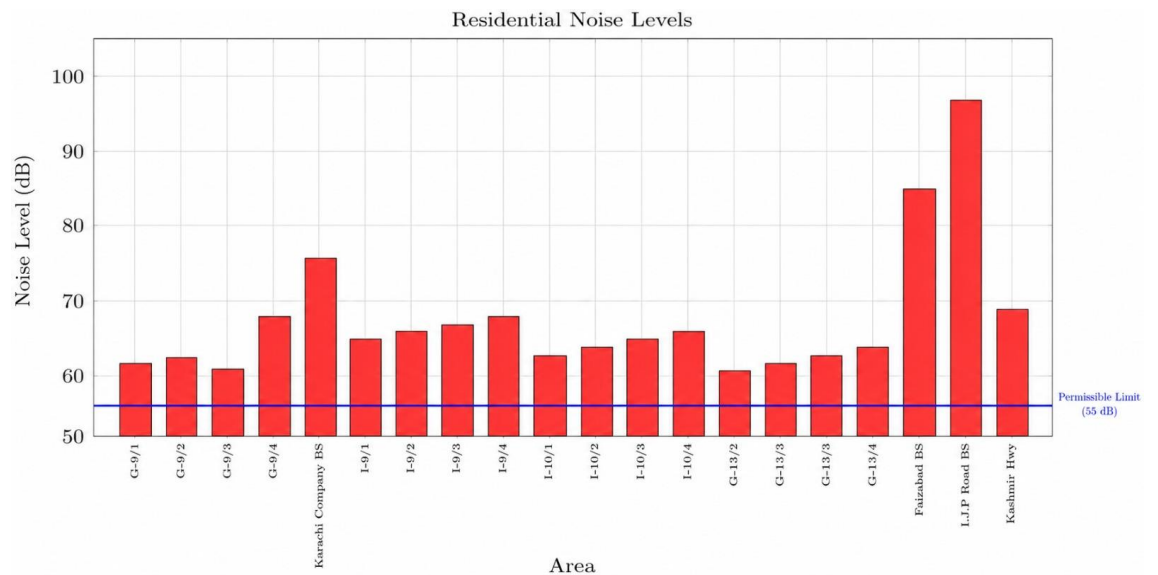


Figure 3.2: Noise Levels Recorded at Selected Residential Areas

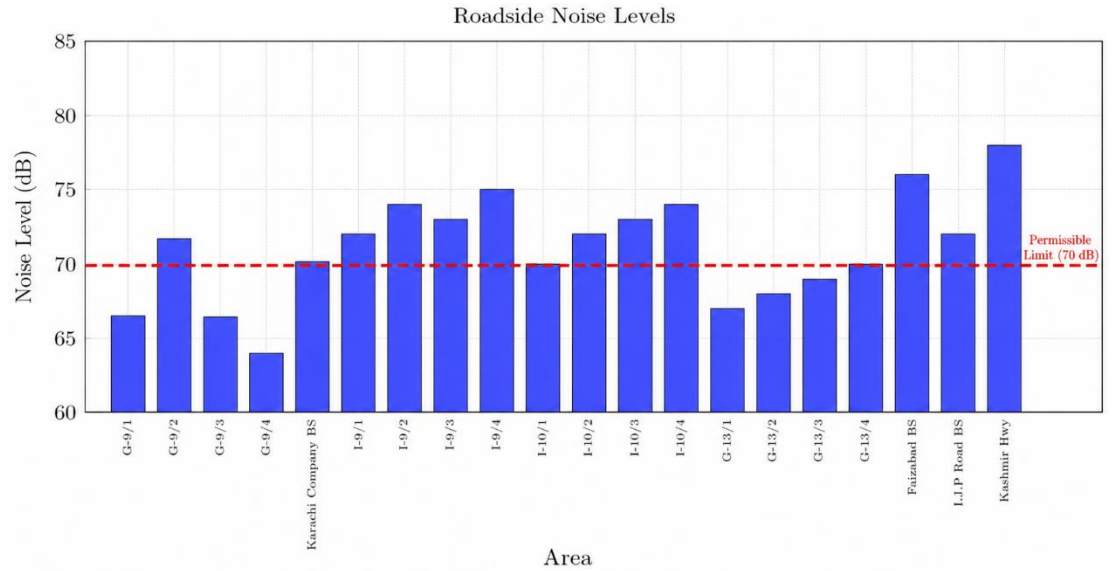


Figure 3.3: Noise Levels Recorded at Selected of Roadside Areas

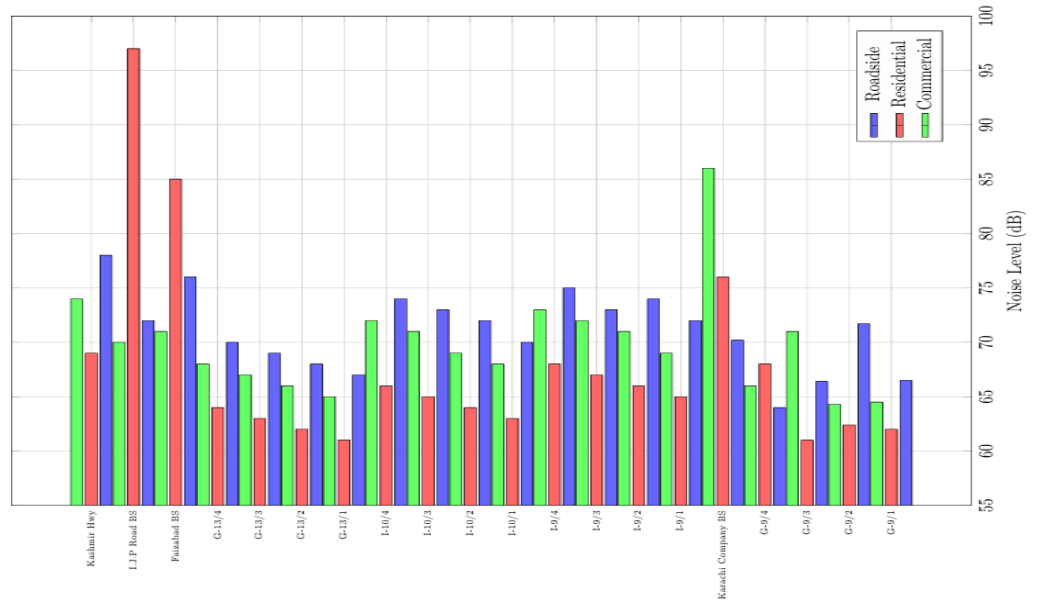


Figure 3.4: Comparison of Noise Levels in Commerical, Residential, and Roadside Areas in Islamabad

Overall, noise levels were moderate in the G-9 area in comparison to that of industrial and transport noise-dominated areas. Roadside noise levels varied from 64 dB to 71.7 dB, and high noise levels were also observed for residential and commercial areas. G-9 is mainly a residential and commercial sector, but the high traffic volumes, roadside businesses and population are causing the noise levels in the area to increase. Increased noise exposure due to traffic growth and urbanization was reported by Ohrstrom (2004) in moderate residential areas of the urban environment in Sweden.

Similarly, the selected other sectors had comparatively higher noise levels than G-13. It is largely residential and less trafficked with less commercial activity. The noise in the homes was recorded between 61 dB and 64 dB, among the lowest during the study. Even these values, however, were higher than the WHO recommended one, meaning that the environmental noise level is progressively impacting quieter residential areas, too. A study was carried out in Ankara, Turkey and it was reported that the noise levels of quiet neighbourhoods were also found to be rising due to urban development and growing road networks (Özer et al., 2009).

The I-9 always had the highest noise level among all sectors for roadside, residential, and commercial noise locations. This is due to the movement of heavy vehicles throughout the day, the presence of industrial units, warehouses, workshops, commercial centers. The findings are in line with the observations made by Murphy and King (2014) that industrial zones and mixed commercial–industrial areas are generally exposed to more environmental noise than purely residential areas. Likewise, I-10 also experienced higher noise levels, primarily because commercial establishments are permitted to grow along the route, traffic volumes are also increasing, and urban development continues.

The highest roadside noise level was recorded on Kashmir Highway (78 dB). This is one of the busiest roads of Islamabad and sees the continuous flow of vehicles like cars, buses, motorcycles and trucks. This is a high traffic zone which makes a major contribution to environmental noise pollution in the area. The same has been observed globally, as high-speed roads and main roads are identified as the main contributors of noise pollution in the urban setting. According to Goines and Hagler (2007), millions of people around the world are impacted by road traffic noises, and it is one of the most prevalent environmental pollutants in urban areas. Similarly, another study, carried out in the city of Delhi, India, reported that high traffic volumes in the city lead to noise levels varying from 75 dB to 85 dB near the roadside (Singh and Davar, 2004).

The noise level was high at Faizabad Bus Stop due to its transportation importance and link between Rawalpindi and Islamabad. Environmental noise is caused by traffic, excessive use of vehicles' horns and continuous operation of public transport vehicles. This is consistent with observations made elsewhere in the world. The transportation hubs, bus terminals, and railway stations tend to have high noise levels due to the number of vehicles and human activity that is concentrated in these areas, as stated by Basner et al., (2014). A study in Lagos, Nigeria, also identified bus terminals as one of the noisiest urban environments because of the frequent movement of vehicles and activity of passengers in the terminals (Oyedepo and Saadu, 2010).

Among all the findings of this study, the comparison of the extremely high residential noise level obtained at I.J.P Road Pirwadhahi Bus Stop (97 dB) was a remarkable result. This is much higher than recommended environmental values and represents high noise pollution. These can have negative impact on the human health and well being of people nearby if they're at high levels. Over-exposure to noise can cause sleep problems, high blood pressure, stress, cardiovascular diseases, poor performance at work, and hearing issues, according to Basner et al., (2014). The same has been observed in studies on residents of New York City,

USA, who were closer to transportation corridors had higher levels of stress and sleep disturbance from chronic exposure (Hammer et al., 2014).

The noise level at Faizabad Bus Stop (85 dB) and Karachi Company Bus Stop (76 dB) was also quite high. The surroundings of these sites include commercial markets, public transportation systems and busy roads, adding to the environmental noise. Stansfeld and Matheson (2003) found that annoyance, sleep disturbance and mental stress were more likely to be experienced by people living close to major roads and commercial centres as a result of long-term exposure to noise. In another study in London, United Kingdom, it has been reported that major transportation corridors were found to be in the most polluted areas of the city as opposed to the areas that were closer to suburban areas (Clark and Paunovic, 2018).

Generally, commercial areas had higher noise levels than residential areas due to the noise generated by business activities, the movement of customers, vehicle parking and traffic congestion. The highest commercial noise level was observed at Karachi Company Bus Stop (86 dB). Karachi Company is one of the busiest commercial centres of Islamabad which gets a lot of visitors every day. Münzel et al. (2018) observed that commercial districts and transportation centers tend to have the highest levels of environmental noise, as a result of the mix of economic activities and traffic. Higher noise levels were also observed in the commercial areas compared to residential areas in Beijing, China (Xie et al., 2011) and Madrid, Spain (Barrigón et al., 2016).

The results of this study are also coherent with the study carried out in Pakistan. Alam et al (2018) found that the most significant source of environmental noise in urban areas of Pakistan is the increase in traffic density. Noisy areas were often found to have high noise levels near roads, commercial zones and transport terminals in similar studies conducted in Lahore, Karachi and Rawalpindi.

In general, it shows that traffic, public transport services, commerce activities, industries and speedy urbanization are the prime sources of environmental noise

pollution in Islamabad. Noise levels in areas close to the highway, transport terminals, industrial and commercial areas were considerably higher than predominantly residential areas. I was able to identify the following locations as being the most noise polluted: I.J.P Road Pirwadhai Bus Stop, Faizabad Bus Stop, Karachi Company Bus Stop, Kashmir Highway and I-9 sector. However, since G-13 is a relatively residential area and has less traffic, it is relatively less affected.

The results in this study corroborate the results of national and international studies in the past, which have revealed that environmental noise pollution is increasingly emerging as a serious problem in fast-growing urban areas. Adopting various noise mitigation measures like better traffic management, stricter vehicle noise standards, urban green belts, noise barriers, and land use planning, is essential to reduce noise pollution and enhance noise quality of life (WHO, 2018; Basner et al., 2014; Münzel et al., 2018).

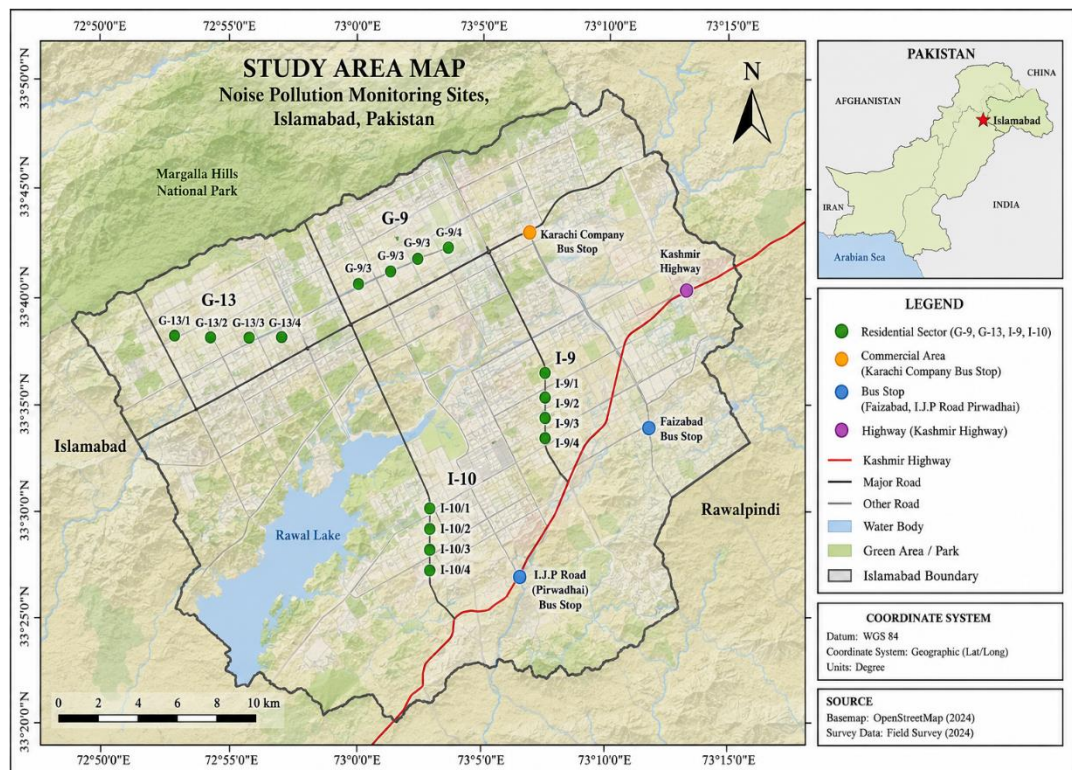


Figure 3.5: Study Area Map Showing the Selected Noise Monitoring Sites in Islamabad, Pakistan

CONCLUSIONS

- a) Through this study we measure the noise levels of selected areas of Islamabad namely G-9, G-13, I-9, I-10, Kashmir Highway, I.J.P Road (Pirwadhai Bus Stop), Faizabad Bus Stop and Karachi Company Bus Stop. To assess the overall environmental noise quality and the main noise sources in the city, noise measurements were taken from road side, residential and commercial environment.
- b) The results showed that there were significant differences in noise levels between the chosen locations. Roadside noise levels were in the range of 64 dB to 78 dB, residential levels were in the range of 61 dB to 97 dB and commercial noise levels were in the range of 64.3 dB to 86 dB. From the results it is concluded that environmental noise is a growing concern in Islamabad, especially in the regions where the movement of traffic is high, commercial activities are present and the city is developing rapidly.
- c) The Kashmir Highway had the highest noise level at the roadside of 78 dB amongst all the monitored places. This is one of the main transport hubs in Islamabad where all the time vehicles are running. The high noise levels heard at this location indicate the importance of road traffic noise to environmental noise. Likewise, Faizabad Bus Stop also experienced high noise levels throughout the roadside, as a result of the continuous movement of vehicles, heavy traffic and public transportation activities.
- d) The most important result of the study was obtained at Pirwadhai Bus Stop (I.J.P Road) where residential noise level was 97 dB. This was the highest ever observed value in the study and the values were well above the international recommended environmental standards. These high levels of noise can present significant issues for any neighbors nearby, with adverse impacts to sleep, stress, focus, and other health issues. The extremely high value at this site is due to the high traffic levels, transport facilities, commercial activity and human movement in the vicinity.

- e) Noisy commercial sites also were present. The commercial noise level was highest in Karachi Company Bus Stop (86 dB) which showed the impact of commercial markets, business activities, customer movement, and traffic congestion. The results indicated that commercial center is one of the most noise polluted centres in urban environments because of the high level of activity that occurs there on a day-to-day basis.
- f) The sector-wise comparison showed that on overall noise level I-9 and I-10 sectors had higher noise level as compared to G-9 and G-13 sectors. Environmental noise levels were high, particularly in areas of I-sector industrial units, workshops and warehouses, commercial markets and heavy vehicle movement. Areas with a mostly residential character as G-13 were comparatively quieter due to relatively low traffic density. The measured noise levels for the G-9 and G-13 areas were lower than for industrial and transportation areas, but were still higher than the recommended noise limits for residential areas.
- g) The study also showed that traffic density is the most influencing factor of environmental noise in Islamabad. Roadside, bus and transport hubs, commercial zones and locations close to roadways consistently exceeded residential areas in noise levels. Environmental noise has become very intense throughout the city due to the accelerated growth of the number of vehicles, urban expansion and commercial development. The results suggest that noise is not only a problem on the major roads and commercial areas but is also moving into the residential areas.
- h) The measured value was compared with the World Health Organization (WHO) recommended value of 55 dB for residential areas and it was found that most of the monitoring sites exceeded the recommended value. This implies that there could be a large proportion of exposed population in these regions exposed to unhealthy levels of environmental noise. These conditions can have a harmful impact on physical, mental, work, learning, and quality of life if they persist.

- i) The study summarizes that the noise pollution issue is currently a major environmental concern in Islamabad. The places that were found to be the most noise polluted were I.J.P Road (Pirwadhai Bus Stop), Faizabad Bus Stop, Karachi Company Bus Stop, Kashmir Highway and I-9 sector. The noise levels measured in these areas were considerably higher than those measured in residential areas and are areas of great concern that are in need of immediate attention from the environmental authorities and urban planners.
- j) From the results obtained, it can be concluded that the various factors that contribute to environmental noise pollution in Islamabad are the increase in traffic volume, operations of transportation, commercial activity, industrial development and rapid urbanization. To reduce the impacts of noise pollution and protect public health a range of effective measures must be put in place, including better traffic management, enforcement of vehicle noise limits, public awareness campaigns, creating green spaces, erecting noise barriers and careful urban planning. With proper mitigation measures, the noise pollution in the environment can be minimized, creating a better and sustainable urban environment for the people of Islamabad.

Recommendations

1. Improvement of Traffic Management:

The outcomes of this study revealed that the noise in high load areas like Kashmir Highway, Faizabad Bus Stop, I.J.P Road and Karachi Company is high, primarily because of the congestion and heavy traffic in these roads. Hence, traffic management systems should be enhanced to alleviate traffic congestion and facilitate smooth traffic flow. Noise levels in these highly trafficked areas can be reduced by improved traffic control.

2. Control on Unnecessary Horn Usage:

One of the biggest sources of noise pollution in urban areas is the overuse of car horns. The drivers should be encouraged to not use the horn unnecessarily, particularly in residential areas, schools, hospitals, public offices, etc. This issue can be reduced by awareness campaigns and stringent traffic management policies.

3. Regular Maintenance of Vehicles:

With poor maintenance, engines and exhausts can be noisy. The need for regular vehicle inspections and maintenance should be encouraged to ensure that vehicles are running efficiently and quietly. This can help to minimize road traffic noise.

4. Planting More Trees:

The planting of trees is underway in Green Belts and Tree Plantations. Tree planting is progressing in Green Belts and Tree Plantations.

Tree planting can help mitigate environmental noise if planted along roadsides and around residential areas. Trees are natural sound absorbers and contribute to more peaceful surroundings. Moreover, green belts help to reduce air pollution and also add to the beauty of the city.

5. Installation of noise barriers:

Noise barriers should be erected on roads and highways, especially near residential communities on roads and highways with heavy traffic. These barriers can help to lower the transmission of traffic noise and improve residents' living environment.

6. Special attention paid to highly affected areas:

The study concluded that the bus stops along I.J.P Road Pirwadhui, Faizabad Bus Stop, Karachi Company Bus Stop and Kashmir Highway are the most noise polluted bus stops. They should be targeted to be noise controlled and monitored regularly for public health protection and improvements in living conditions.

7. Adequate urban planning and zoning:

Industrial activities in close proximity to residential areas can introduce additional noise into the environment. Future urban development should promote separation of residential, commercial and industrial areas. The planning of such can assist in minimizing human noise exposure and contribute to a balanced urban environment.

8. The levels of noise are regularly monitored:

There is a need to monitor noisy pollution of Islamabad regularly in various areas. Regular monitoring will help to pinpoint areas where noise levels are rising and enable authorities to take action at an early stage to rectify any issues. Further, periodic surveillance will be useful in evaluating noise control efforts.

9. Promoting public awareness, community participation:

It is important to carry out public awareness programmes to educate individuals on the negative effects of noise pollution. A large number of people don't realize that excessive noise levels repeatedly can cause them stress, sleep loss, headaches, hearing loss and decreased concentration. Unnecessary noise in everyday life can be kept down by getting the community involved.

10. Strengthening Environmental Regulations:

Environmental protection authorities have a role to play in ensuring noise control regulations and standards are implemented. The proper implementation of environmental legislation can be used to manage excessive noise from vehicles, commercial activities and other sources. Frequent checks and sanctions for non-compliance might induce compliance.

The upgrading of sustainable transportation systems is encouraged. Sustainable transportation systems are promoted.

Public transport could be promoted to minimize the presence of private cars on the roads. The use of public transport can reduce traffic, the consumption of fuel and environmental noise. A sustainable transport mode can help to create a quieter and healthier cityscape.

REFERENCES

- Alam, M., Khan, S., & Ahmad, N. (2018). Assessment of environmental noise pollution in urban areas of Pakistan. *Pakistan Journal of Environmental Sciences*, 12(2), 45–54.
- Ali, S., & Malik, R. N. (2011). Environmental impact of urbanization and transportation on Islamabad city. *Journal of Environmental Planning and Management*, 54(7), 923–938.
- Barrigón, J. M., Gómez Escobar, V., Rey Gozalo, G., & Méndez Sierra, J. A. (2016). Assessment of environmental noise in urban areas of Madrid, Spain. *Applied Acoustics*, 102, 1–8.
- Basner, M., Babisch, W., Davis, A., Brink, M., Clark, C., Janssen, S., & Stansfeld, S. (2014). Auditory and non-auditory effects of noise on health. *The Lancet*, 383(9925), 1325–1332.
- Clark, C., & Paunovic, K. (2018). WHO environmental noise guidelines for the European Region: A systematic review on environmental noise and quality of life. *International Journal of Environmental Research and Public Health*, 15(11), 2400.
- European Environment Agency (EEA). (2020). *Environmental Noise in Europe 2020*. Copenhagen, Denmark: European Environment Agency.
- Goines, L., & Hagler, L. (2007). Noise pollution: A modern plague. *Southern*

Medical Journal, 100(3), 287–294.

Hammer, M. S., Swinburn, T. K., & Neitzel, R. L. (2014). Environmental noise pollution in the United States: Developing an effective public health response. *Environmental Health Perspectives*, 122(2), 115–119.

Khan, S., Muhammad, S., Shah, M. T., & Khan, A. (2018). Environmental pollution and urban health issues in Pakistan. *Environmental Monitoring and Assessment*, 190(4), 221–230.

Murphy, E., & King, E. A. (2014). *Environmental Noise Pollution: Noise Mapping, Public Health and Policy*. Oxford, United Kingdom: Elsevier Academic Press.

Münzel, T., Schmidt, F. P., Steven, S., Herzog, J., Daiber, A., & Sørensen, M. (2018).

Environmental noise and the cardiovascular system. *Journal of the American College of Cardiology*, 71(6), 688–697.

Ohrström, E. (2004). Longitudinal surveys on effects of changes in road traffic noise: Annoyance, activity disturbances and psycho-social well-being. *Journal of the Acoustical Society of America*, 115(2), 719–729.

Oyedepo, S. O., & Saadu, A. A. (2010). Evaluation and analysis of noise levels in urban areas of Nigeria. *Environmental Monitoring and Assessment*, 160(1–4), 563–577.

Özer, S., Yilmaz, H., Yesil, M., & Yesil, P. (2009). Evaluation of noise pollution caused by vehicles in the city of Ankara, Turkey. *African Journal of Agricultural Research*, 4(10), 942–949.

- Shahid, M., Ahmed, S., & Khan, M. (2015). Assessment of environmental noise levels in major urban centers of Pakistan. *Pakistan Journal of Scientific Research*, 67(3), 156–164.
- Singal, S. P. (2005). *Noise Pollution and Control Strategy*. New Delhi, India: Alpha Science International Ltd.
- Singh, N., & Davar, S. C. (2004). Noise pollution sources, effects and control. *Journal of Human Ecology*, 16(3), 181–187.
- Stansfeld, S. A., & Matheson, M. P. (2003). Noise pollution: Non-auditory effects on health. *British Medical Bulletin*, 68(1), 243–257.
- United Nations. (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*. New York, USA: United Nations.
- World Health Organization (WHO). (2018). *Environmental Noise Guidelines for the European Region*. Copenhagen, Denmark: WHO Regional Office for Europe.
- Xie, H., Kang, J., & Tompsett, R. (2011). The impacts of environmental noise on urban residents in Beijing, China. *Applied Acoustics*, 72(11), 917–924.
- Yousaf, M., Hussain, A., Ahmad, N., & Iqbal, M. (2021). Urbanization and environmental noise pollution in developing countries: A case study of Pakistan. *Environmental Challenges*, 5, 100247.

6% Overall Similarity

The combined total of all matches, including overlapping sources, for each database.

Match Groups

-  **62 Not Cited or Quoted 5%**
Matches with neither in-text citation nor quotation marks
-  **17 Missing Quotations 1%**
Matches that are still very similar to source material
-  **0 Missing Citation 0%**
Matches that have quotation marks, but no in-text citation
-  **0 Cited and Quoted 0%**
Matches with in-text citation present, but no quotation marks

Top Sources

- 2%  Internet sources
- 2%  Publications
- 4%  Submitted works (Student Papers)

Integrity Flags

0 Integrity Flags for Review

Our system's algorithms look deeply at a document for any inconsistencies that would set it apart from a normal submission. If we notice something strange, we flag it for you to review.

A Flag is not necessarily an indicator of a problem. However, we'd recommend you focus your attention there for further review.

ANNEXURES (A)

Photographic Record of Field Survey and Noise Monitoring Activities

