Spatial Distribution of Noise Released from Iron and Steel Industry and their Effects on Human Health in the Lahore City, Pakistan

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Abstract: This research investigates the phenomenon of perception of people about industrial noise pollution and its effects on human health. Thirty-six (36) industries were selected for estimation of noise levels and its effects on human health. Concurrently, samples of one hundred and fifty (150) respondents were also taken from nearby residential area, using random sampling method. The key tool of data collection was well-structured questionnaires consisting of twenty-one questions. Chi-Square test was used for examination of data, which illustrated effects of industrial noise on people living in industrial zone. The noise level results indicated that the mean values were exceeding permissible environmental standard used in Pakistan. Majority of respondents (50.6 %) were conscious about the basic reason of noise pollution in study area. Eighty-two percent (82%) people have opinion that old technology was the basic cause for noise pollution. It was shocking to see the results which indicate that 99.8% people are suffering from noise related diseases. This include 81.3% with increase anger, 81.5% with ear ache, 16% with ear discharge, 79.3% with high blood pressure, 78% with depression, 77.3% temporary hearing loss, 9.3% permanent hearing loss. Only 23.3% of people conduct regular hearing test.

Keywords: Noise, pollution, spatial distribution, GIS, SPSS, Buffers.

1. INTRODUCTION

Noise is a environmental factor having direct effect on human health. Noise is generally defined as unpleasant sound which physically affects the human health. Noise effect on human health and hearing on workers as well as residents of industries has been a debating topic among researchers and scientists. Extensive and continuous exposure of noise at a higher level that is above 80 dB leads to hearing loss and some other human health issues [1]. Noise negatively effects the human beings both physiologically and psychologically. Hearing loss is the most common effect among the people of industrial area. Generally we can categorize the noise effects on ears in two groups: temporary hearing loss and permanent hearing loss [2]. Physiological effects are appearance of muscle reflexes, Blood pressure increases, heart beat accelerations, sleeping disorders. Any forms of annoyance, stress, anger and concentration disorders as well as difficulties in resting and perception are some more psychological effects of noise [3, 4].

Noise produced by iron and steel industry has harmful effect on human health particularly ears [5]. Steel plant generate noise pollution in surrounding area so this noise has auditory effects that may be permanent or temporary hearing loss and some non-auditory effects such as increasing heartbeat, tension, anxiety, fatigue and emotional imbalance [6]. Netherland government (1987) has taken some measurements to reduce hearing loss. Noise level higher than 80 dBA is considered hazardous. So employer should provide hearing protectors. If noise level is more than 90 dBA, hearing protectors must be used. There are many other symptoms such as changes in heartbeat and blood pressure, nausea, headache, insomnia and loss of hunger which are also caused by noise exposure. Long-term noise exposure can cause contraction of blood vessels in humans which may lead to heart failure [7].

Noise is major form of pollution. It can affect the communication, increased stress, disturb sleep, lack of concentration and reduced efficiency. Long time exposure in noise can caused deafness or temporary hear loss [8]. Industrial noise is badly disturbing the human organs and activities. Above 140 dB can permanently damage the ears. Noise about 90 to 110 dB can cause temporary hearing loss in employers and residents [9]. Steel plants produce huge amount of noise in plant and nearby area. Simplest method to measure the noise is linear sound pressure level (SPL) at any time, over a broad frequency band covering the whole of the audible frequency range [10]. Human ear is very complex for high intensity rates, starting from zero to 180 db. Sound pressure level of construction sites is 110 dB [11, 12]. It is estimated that about 104 million individual are at risk of noise induced hearing loss. These individual had annual $L_{EQ(24)}$ level >70 dBA in 2013. Tens of millions may be at risk of heart

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diseases and other noise related diseases [13]. Some experimental and observational studies show that noise exposure disturbs sleep, cause daytime sleepiness and lead to annoyance in individuals [14]. The particular nighttime noise can cause disturbance of sleep structure, increases the blood pressure and heartbeat rate. It also increases the stress hormone levels and oxidative stress, that may result in endothelial dysfunction and arterial hypertension [15].

2. MATERIAL, METHODS AND ANALYSIS

2.1. Selection of Study Area

This study was carried out in the towns situated in northeast of Lahore. These towns are famous for heavy industry and biggest steel industrial area. Therefore, this area is considered a highly noisy place. The sampling sites were located between 74˚23'24" to 74˚34'23" E longitude and 31˚35'24" to 31˚36'17"N latitude (Figure **1**).

2.2. Noise Measurement

A questionnaire carrying twenty-one questions was designed for statistical analysis of the responses about the research topic. Total one hundred and fifty questionnaires were filled during the daytime. In the questionnaires, major focus was to get information about the industrial noise and its effects on human health in the study area. Noise was measured by sound level meter. Instrument can measure noise range from 35 to 130 dB. Noise data was collected by using dB, model number SL-5826 Sound level meter from all the selected sampling industries in study area.

2.3. GIS Analysis

Spatial pattern of noise distribution produced from iron and steel industry was estimated through analysis in GIS. Inverse distance weight method was used to estimate the planar distribution of pollutants. Buffer was used on industrial noise map. High value region and low value region were highlighted by hotspot analysis of noise.

2.4. SPSS Analysis

Data analysis was executed by using statistical packages social sciences (SPSS) software 20. Hierarchal cluster analysis was used to show the pattern of noise produced by iron and steel industry.

2.5. Chi -Square Test

Chi-square test was used to find out the association between independent variable (pollutants and noise) and dependent variables (diseases). Independent variable noise level is ordinal nature data and dependent variable effects on human health have a nominal level of data. So in this case to find out the relationship between these two variables Chi -square is the most suitable test.

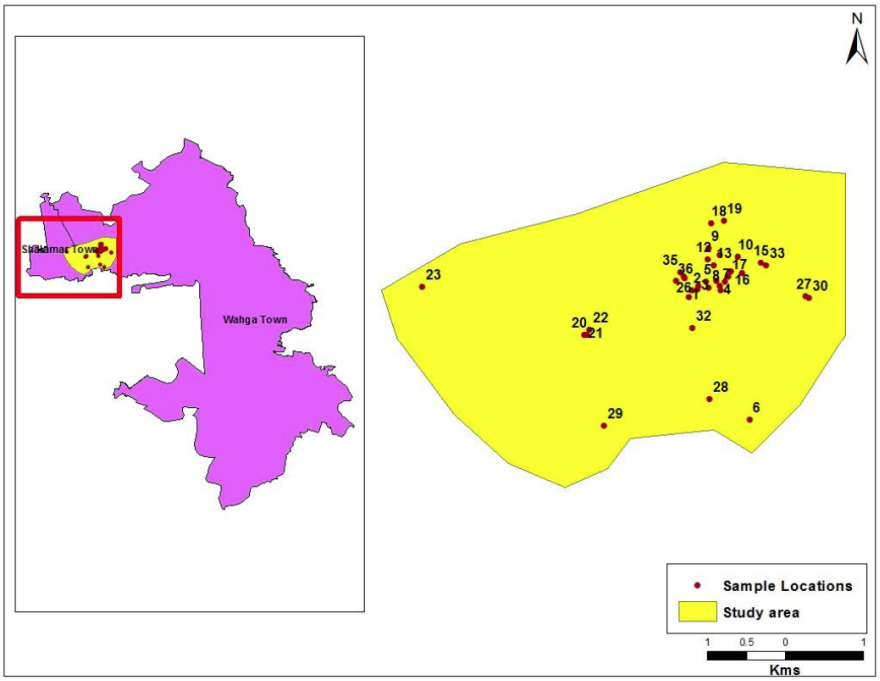

Figure 1: Sample locations of study area.

2.6. Formulation of Hypothesis

H_0: There is no association b/w variables.

H_1: There is association b/w variables.

Level of Significance

$\alpha = 0.05$

Test Statistical

$$x^2 = \frac{\varepsilon(fo - fe)2}{fe}$$

3. RESULTS AND DISCUSSION

3.1 Diseases Caused by Noise of Industry (Cross Tabulation)

No	Hypothesis	Significance
1	Industrial Noise Pollution reducing the efficiency of work, increase anger, interference in communication and lack of concentration.	0.000
2	Industrial Noise Pollution causes Earache, Headache, Ear discharge and high blood pressure in human.	0.000
3	Industrial Noise Pollution causes Tiredness, Depression, Hypotension and Insomnia (Sleeplessness).	0.000
4	Industrial Noise Pollution causes Temporary Hearing Loss in Human.	0.000

Source: Primary data computed by cross tabulation.

In the first point of cross tabulation, the p-value is 0.000 that is less than α-value 0.05 so, an alternative hypothesis H_1 accepted rather than null hypothesis H_0. Industrial noise pollution reduced the efficiency of work, increase anger, interference in communication and lack of concentration of people in who are living near the iron and steel industry. The significance value is 0.000 which shows the strong association between variables.

The second point of table signposts the p-value is 0.000. The p-value is less than alpha value so, H_1 accepted and H_0 rejected. This point describe as residents of iron and steel industry are suffering from different diseases such as earache, severe headache, ear discharge and high blood pressure that caused by industrial noise pollution. The p-value shows that there is strong association between these diseases and industrial noise.

The second last point of table signifies the p-value that is 0.000 that is less than α-value that is 0.05. Less value of p indicates the acceptance of alternative hypothesis. Further elaboration of point is industrial noise caused tiredness, depression, hypertension and insomnia or sleeplessness in people who are living near iron and steel plants. Its significance value 0.000 shows the strong association between variables.

The last point of table marks the significance value is 0.000 and α-value is 0.05 because p-value is less than α-value so, it can be accept the alternative hypothesis which means noise that coming from iron and steel industry caused temporary hearing loss in residents of study area. The significance value 0.000 shows that there is strong association between temporary hearing loss and industrial noise.

3.2. Spatial Pattern of Noise (dB) Pollution

Spatial patterns of noise in study area are generated through GIS analysis. In Figure **2**, light color shows the lower range of noise and dark color shows the higher range of noise in study area. Malik Hafiz re-rolling steel mill, Ashfaq steel mill, Haji Ilyas steel mill, Mashallah re-rolling steel mill, Subhan foundry steel mill, Ghulzar re-rolling steel mill, Rana Safdar steel mill, Tariq steel furnace steel mill, Madina steel mill, Abid re-rolling steel mill, Asad steel mill, Mushtaq steel re-rolling mill, Haji sharif steel mill, Waseem brother steel re-rolling mill and Karamat re-rolling steel mill were released highest industrial noise level about 97-100 dBs. These industries were found in Shadi pura, Bhani road, and Darogha wala ring road. Industries TM steel mill, Arif steel re-rolling mill, Ammar re-rolling steel mill nad Faridia steel mill of shalamar town were producing 78 to 85 dBs of noise. Hardly one or two industries (Faridia steel mill and Arif steel mill) were producing 75 dB noises in study area. Noise related diseases such as headache, high blood pressure, earache, temporary hearing loss, hypertension and depression frequently were observed throughout in study area.

3.3. Buffer Analysis of Noise (dB)

For Buffer analysis, Buffers were created according to the intensity of sound produced by industries. Figure **3**, yellow buffers show the 150 meters radius where the noise ranges between about 90 to 100 dBs. The area surrounded by each buffer shows that the people living within this zone suffer from the noise related diseases. Shadi pura, Ring road and Bhani road have closest iron and steel factories in study area and absence of green belt throughout the area makes it more noisier. Therefore, high noise ranges were observed in these area and people are immensely suffering from

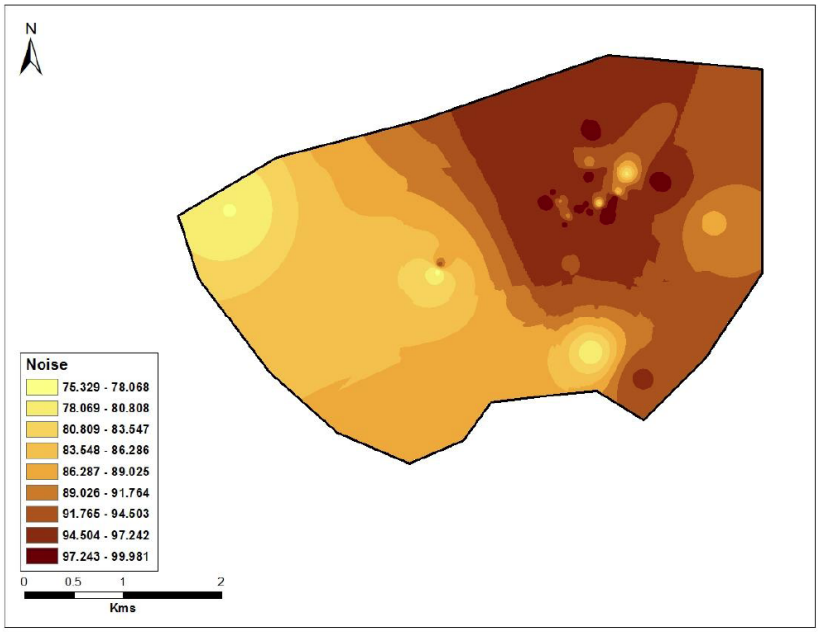

Figure 2: Spatial Pattern of noise in study area.

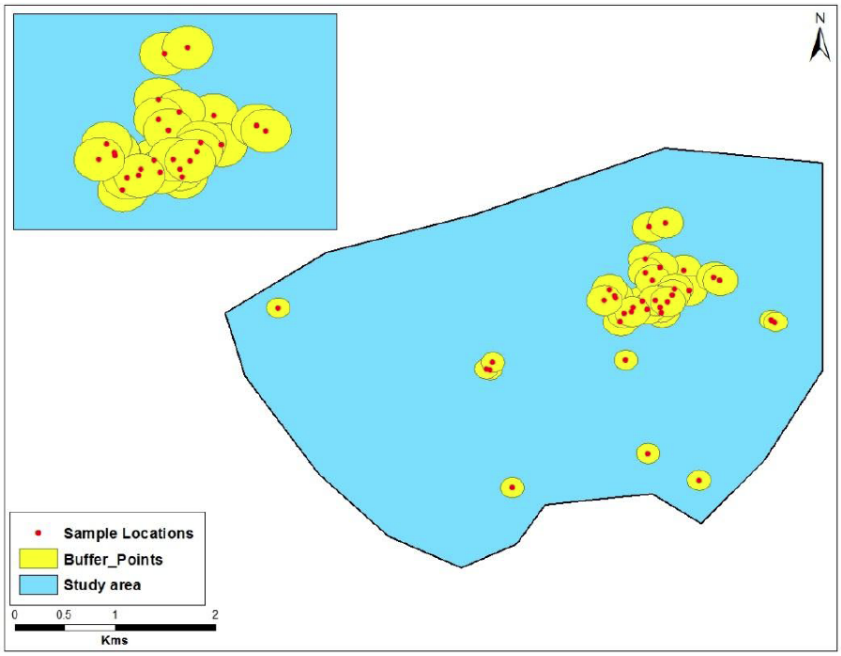

Figure 3: Buffer analysis of Noise (dB) in study area.

headache, earache, ear discharge, hypertension, high blood pressure and temporary hearing loss. Small yellow buffers show the low intensity of noise, range 75 to 89 dBs with the radius of 100 meters. Due to less concentration of iron and steel industry in remaining part of study area, noise range was not so high however sleeplessness, tiredness, interfere with communication, lack of concentration, headache, earache, hypertension and increase anger are also observed there.

3.4. Hotspots Analysis of Noise Pollution

Hot spot analysis technique was applied to determine the hot spots of noise at different sample locations in study area. Figure **4** shows the outcome of GiZ scores the locations with either high or low value cluster spatially. Where there is a high negative value <-2.58 for a GiZ scores, it is a cold spot within proximity of statistically significant cluster. Similarly where there is a high positive value >2.58, it means a hotspot is

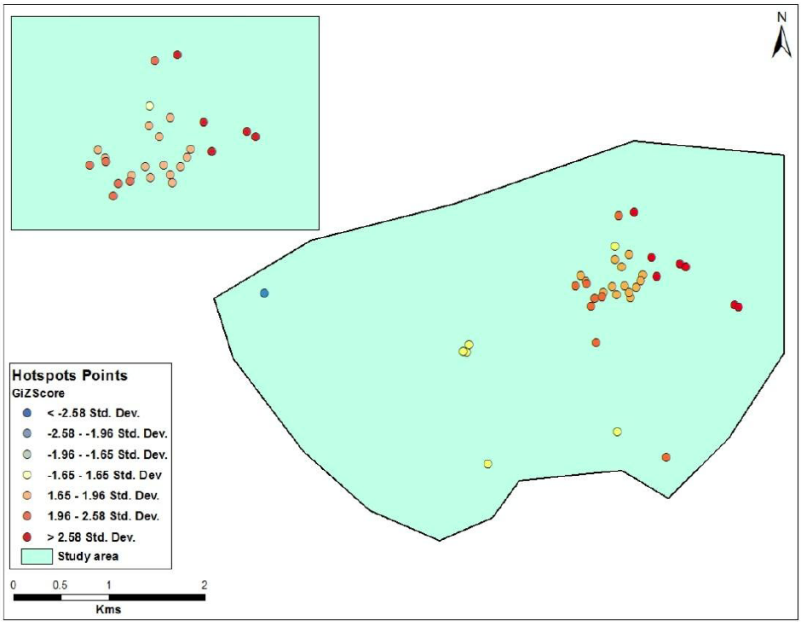

Figure 4: Hotspot of noise at different sample locations of study area.

encompassed within study area. In the key GiZ scores shows the corresponding color of study area. Maroon color shows the high GiZ scores or hotspots which were found to be located in Moman pura, Shadi pura and Darogha wala ring road named by haji sharif re-rolling steel mill, Mushtaq steel mill, Asad steel re-rolling mill, S.A steel mill, S.J steel furnace steel mill, Fine steel re-rolling steel mill, Abid steel mill, Madina steel re-rolling mill, Malik Quasar steel re-rolling mill, Tariq steel mill. Light red colors show the GiZ scores 1.65 to 2.58 which are nearly hotspot > 2.58. They were located at Darogha wala chowk, Bhani road and some areas of Ring Road. Majority of respondents (50.6 %) were conscious about the basic reason of noise pollution in study area. Eighty-two percent (82%) people have opinion that old technology was the basic cause for noise pollution.

4. CONCLUSION

This study reveals the shocking facts about industrial noise pollution and its effects on human health in study area. Strong relationship between industrial noise pollution and health issues has been found. Noise levels in study area has crossed threshold level of acceptable noise. People living and working in this area are directly affected by noise pollution. Results show that 99.8% people are suffering from noise related diseases. This includes 81.3% of increase anger, 81.5% of ear ache, 16% of ear discharge, 79.3% high blood pressure, 78% of depression, 77.3% temporary hearing loss, 9.3% permanent hearing loss. Only 23.3% of people conduct regular hearing test. Characteristically, the same percentage of diseases have been observed in almost entire study area and drops steadily as distance increased from study area. This general trend is known as “distance decay” function. Use of old noisy technology is considered main cause of nose pollution. Almost all people have general awareness with detrimental negative effects of industrial noise however, they cannot change their residences and jobs owing to financial constraints.

The respondents living in depreciated environment of industrial area complained against industrial noise pollution yearly. Some of the respondents seem unsatisfied with the implementation of existing governmental laws for industrial noise pollution, however, government need to take strategic initiatives to safeguard the people from detrimental effects of industrial nose.

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