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SHORT COMMMUNICATION

Relationship Analysis between Vegetation and Traffic Noise Pollution: A Case Study Lahore, Pakistan

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Introduction

The problem of exposure to traffic noise pollution is rapidly increasing day by day and is closely associated with the rapid industrialization and urbanization process taking place over the glob (Margaritis and Kang, 2016). Nowadays, more than 54% of the world's population lives in urban areas, a proportion that is expected to increase to 66% by the year 2050 (United Nations, 2018). The special effects of vegetation cover on propagation of sound have been the theme of much debate for a number of years (Bell et al., 2007). There is increasing evidence that this is not always true and a significant reduction of noise may be accomplished through vegetation cover if present in adequate density and depth (Peng et al., 2014). Development in urban transportation is increasing day by day. Transportation of goods from one place to another place has become very easy. Specifically, in urban areas, it is common to move people and goods from one place to another. The use of transportation in terms of vehicles makes noise. The noise of vehicles causes many problems including health issues (Monazzam et al., 2015). Noise pollution is very dangerous for human health (Selander et al., 2009). It is also very harmful to the environment. It adversely affects the quality of the environment. Noise pollution badly affects mental health. It develops aggressiveness in public. It leads to higher blood pressure. It increases the stress level. 65 dB of routine contact can cause hypertension. A level of noise above 75 dB can cause stress. It also causes heart diseases. It can cause hearing loss. The cases of noise pollution complaints are more than other environmental issues (Doygun and Gurun, 2008).

In recent years, noise pollution is highly disturbing the quality of life in cities. Traffic noise pollution has become a very serious issue. It causes health issues including mental health. It leads to annoying behavior of citizens. It affects the decisive quality of people. It completely disturbs the quality of life. Traffic is the major cause of noise pollution. Abbaspur et al. evaluated the traffic noise pollution in Karachi (city of Pakistan) where the noise pollution rate is higher in the morning and evening due to the traveling pattern of residents in this city. The traveling pattern of people defines the rate of noise pollution causing by traffic (Abbaspur et al., 2015).

Noise is usually defined as any unwanted or undesirable sound. The normal human ear and system have the outstanding capability to receive and perceive the presence of extreme and alarming noise (from transportation systems, trains, aircraft and machines etc.) in an environment that is very dangerous to the mental and physical health of the human beings on the earth surface. Noise could be a present environmental hazard of the fashionable world, originating from a good kind of sources as well as traffic, that plays a dominant role in pollution. Indeed, traffic noise has created a world crisis as a result of that, nearly the full world is crying out for facilitate. Noise is a major source of pollution. It can affect communication, increase stress, lack of concentration, and reduce efficiency. Long-time exposure to noise can cause deafness or temporary hearing loss. If the noise level is more than 90 dB, must be used, hearing protectors. 90-110 dB noise can cause temporary hear loss; above 140 dB can cause permanent hearing loss. The case study area; Lahore is the second largest metropolitan city of Pakistan in terms of population and traffic after Karachi. The total area of Lahore is 1,772 square kilometer and the road network length is more than 2,000 kilometers. The rapid growth of population and road traffic in the metropolitan city has put excessive pressure on the road network and the traffic volume on the roads and intersections has reached a saturation point (NESPARK, 2004). In Lahore city, noise pollution of traffic is very common due to low maintenance quality and vehicle horns etc. A distractive feature of the Lahore Metropolitan City's vehicle population is buses, vans, trucks, motorbike and three-wheel vehicles which are mostly driven by two-stroke engines.

Study area

The main Walton road and Mall road areas were selected as a case study area, situated in cantonment, Gulberg town, and Data Gunj Baksh town, Lahore. Lahore lies between latitude 31.58204° N and longitude 74.329376° E. Lahore is one of the largest cities of Pakistan and the provisional capital of the Punjab province. Lahore consists of an old city area fringed by newly commercial, industrial, and residential areas on the southeast that is surrounded by the suburbs in turn. At one time, the old city was

surrounded by a wall and a moat, however, these structures were replaced by parks, except in the north.

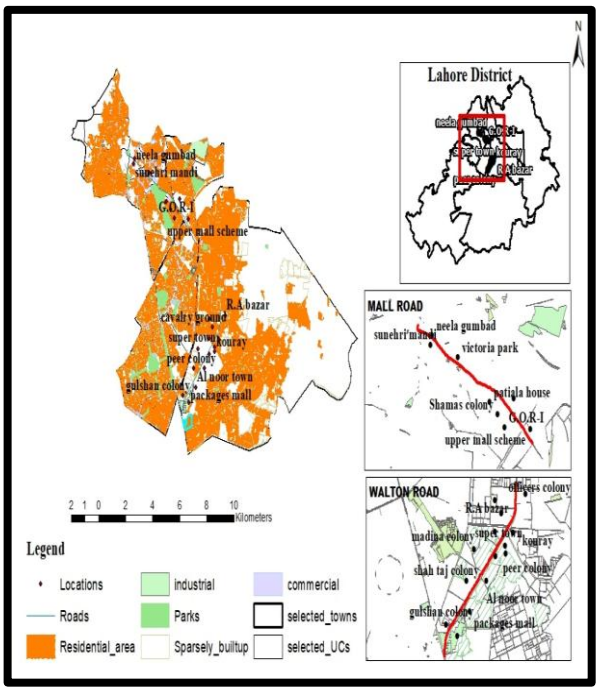


Fig. 1 Depicting the case study area; Walton and Mall Road

The study area Walton road which lies at latitude 31°27'46.52" N and longitude 74°20'56.80" E and Mall road which lies at latitude 31°32'28.50" N and longitude 74°21'4.06" E. These areas are significant in their culture and commercial areas along with important roads providing access to CBD from the inner cities of Lahore. These areas are located near Ferozepur Road, Bedian Road, Jail Road, and Lahore Zoo. Mall road is located in Gulberg town and Data Gunj Baksh town while Walton road is located in cantonment. Walton road lies in UC 152.

Material and Methods

Data and its sources

Primary data were collected through the field survey at Walton and Mall Road, Lahore. Total 10 locations on both roads were selected with the help of a random sampling technique. GPS navigation device was used as a tool for an assortment of primary data collection. Coordinates of 10 locations were taken with the help of GPS. To conduct the present study the primary data on the noise level was collected by using a sound level meter (JTS-1357) as well as a mobile application Sound meter and several vehicles were also calculated. To cover the objective, ten sample sites were selected from both Walton road and Mall road. Data were collected in the morning and evening on the same sample sites to draw the comparison of noise levels during different time intervals with that of traffic flows. Data were collected in April 2019 at 10:00 am to 12:00 pm and 4:00 pm to 6:00 pm for morning and evening respectively. Data is collected on weekends i.e. Saturday and Sunday. Field data collected is shown in table 1.

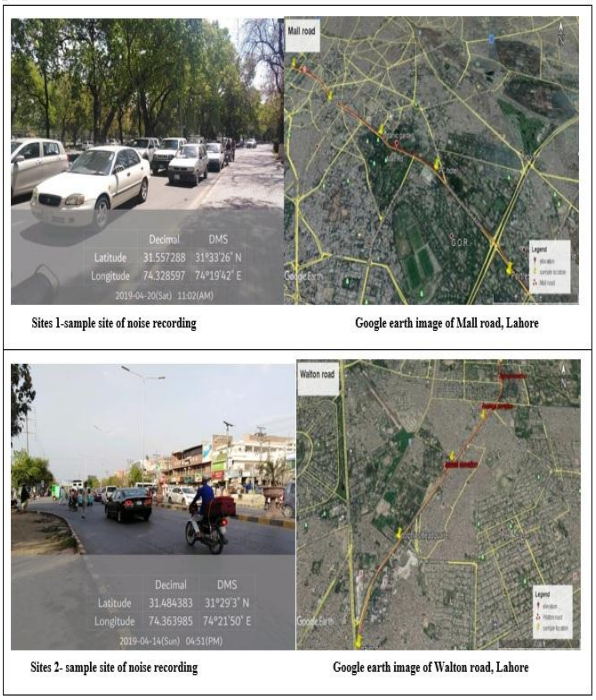


Fig. 2 Sample point locations of Mall and Walton Road, Lahore

Relationships between noise pollution and vegetation cover of the surrounding environment were also identified using descriptive statistics and deriving NDVI (Normalized Difference Vegetation Index) values for selected sample points.

Table 1 Data Collected through GPS Field Survey

Data	Date	Time
Noise/ Traffic flow	31/3/19	10:00 am-12:00 pm
		4:00 pm- 6:00 pm
	6/4/19	10:00 am-12:00 pm
		4:00 pm- 6:00 pm
	7/4/19	10:00 am-12:00 pm
		4:00 pm- 6:00 pm
	14/4/19	10:00 am-12:00 pm
		4:00 pm- 6:00 pm
	20/4/19	10:00 am-12:00 pm
		4:00 pm- 6:00 pm
	21/4/19	10:00 am-12:00 pm
		4:00 pm- 6:00 pm
	27/4/19	10:00 am-12:00 pm
		4:00 pm- 6:00 pm

Normalized difference vegetation (NDVI)

In this study, one satellite image for the year 2019 of Landsat-8 OLI-TIRs is acquired with the Path: 149 and Row: 38. The acquired Landsat satellite image has been first pre-processed as radiometric and geometrically corrected for the image enhancement

and then extracted by mask according to the boundary of the selected case study area of Lahore through GIS and RS techniques. Then, analysis of the NDVI (Normalized Difference Vegetation Index) was performed to identify the percentage ratio of green cover in the selected case study area. Spatial analysis of NDVI has been executed with the following equation:

$$\text{NDVI} = \frac{(\text{NIR} - \text{RED})}{(\text{NIR} + \text{RED})}$$

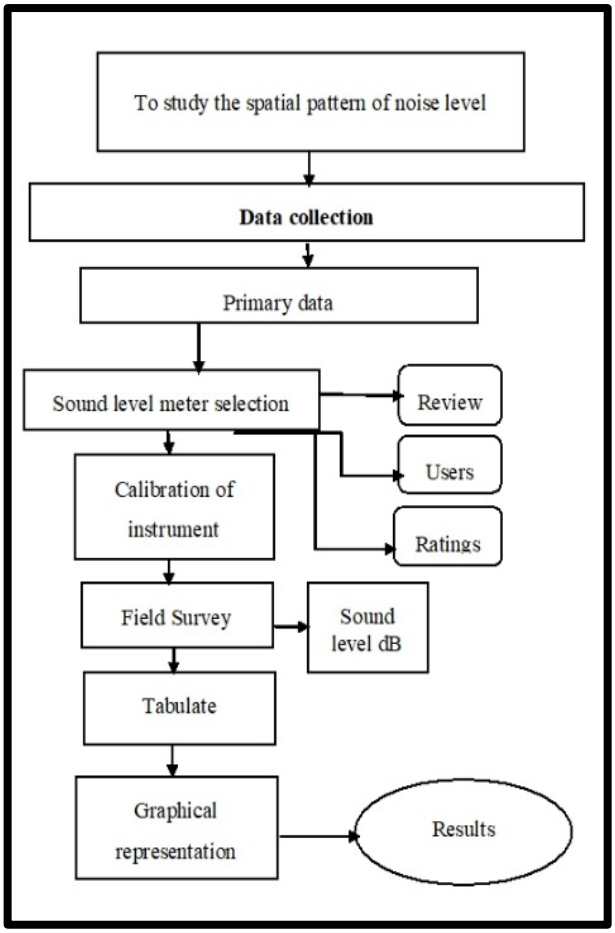


Fig. 3 Flow chart of the research methodology

Scatter plot and correlation

Scatter plots have been generated to show the correlation of the number of vehicles per hour and noise level. Later, vegetation cover and noise level have also been assessed using scatter plots and exhibiting its correlation.

Results and Discussion

Traffic flows at walton and mall road

Ten observations point for traffic measurement has been taken at both Walton road and mall road. The highest traffic flow was found at Walton road Qainchi Bridge, from where heavy traffic operates all times of the day. One of the obvious reasons for the high noise level at this location is that the Qainchi point is the busiest interaction of Feroz Pur road, model Town, and Walton road. Among 10 traffic measurement locations at both Walton road and mall road, daily maximum average traffic flow per hour was found at Walton road on Qainchi Bridge. Figure 4 shows the highest concentration of traffic flow was found at Qainchi Bridge which is 241 traffic counts per hour as compared to others. The second highest traffic flow was found at Dolphin Headquarter which is 240 vehicle flow/hr. The lowest concentration of traffic flow was found at R.A Bazar which is 161 vehicle flow/hr.

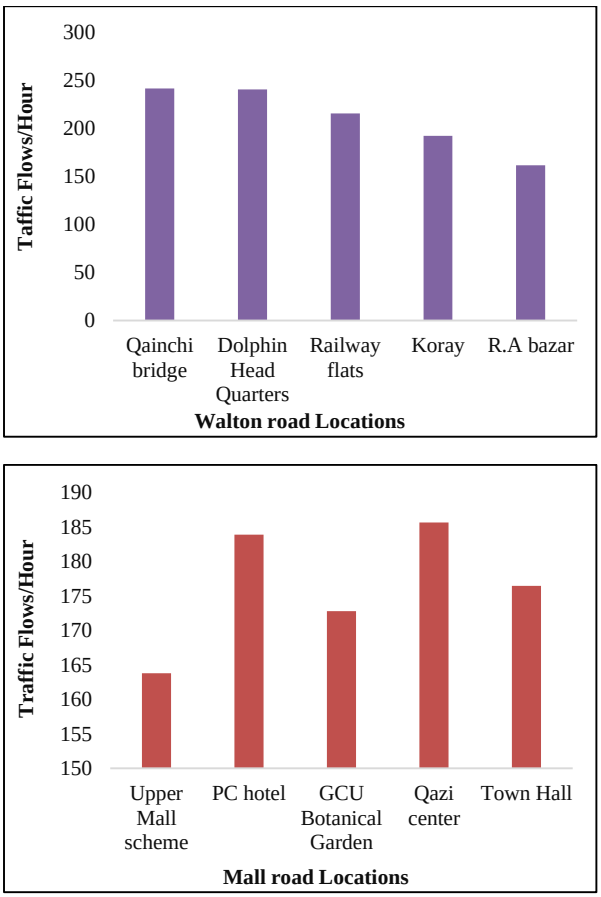


Fig. 4 Traffic flow per hour at Walton and Mall Road, Lahore

Mall road was found to be a less noise polluted site as compared to Walton road. From the result of a survey conducted during 8 days of data collection, the results show the less concentration of noise level at Mall road as compare to Walton road. Figure 4 shows the highest concentration of traffic flow was at Qazi center which is 186 traffic counts per hour as compared to others. The second highest traffic flow was found at PC hotel which is 184 traffic flow/hr the lowest concentration of traffic flow was found at the upper mall scheme (Fortress bridge) which is 163 vehicle flow/hr.

Noise Fluctuations at Walton and Mall Road

Figure 5 shows the high concentration of noise level in R.A Bazar. R.A Bazar was emitting the high value of

noise level (76.06 dB) as compared to others. The second highest consternation of noise level was Koray. The observed average noise level was 76.06 dB. However maximum and minimum noise level is 86.68 and 49.29 respectively. It showed that 100% of noise measurement locations are exposed to the higher noise level. Even though the daily average minimum noise level at all locations is more than 45 dB, which reflects the aggravated problem of noise on the roadsides of Lahore city. The highest maximum noise level 89 dB was found near Qainchi Bridge, from where traffic passes all time of the day and night.

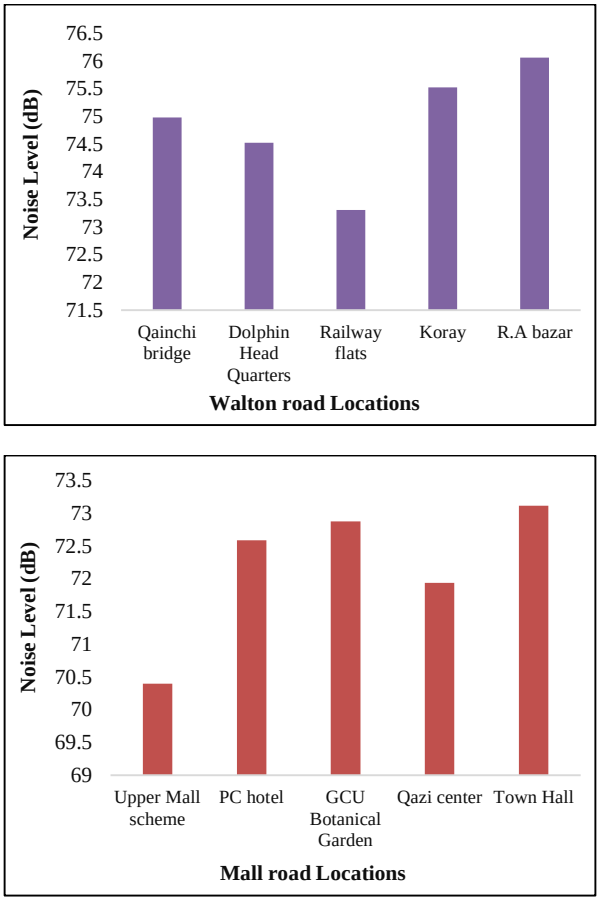


Fig. 5 Traffic Noise Fluctuation in Walton and Mall Road, Lahore

Figure 5 shows the high concentration of noise level in Mall road. The Townhall was emitting a high value of noise level (73.11 dB) as compared to others. However, the maximum and minimum noise levels are 85.42 and 45.69 respectively. It showed that 100% of noise measurement locations are exposed to the higher noise level. Even though the daily average minimum noise level at all locations is more than 45 dB, which reflects an aggravated problem of noise on the roadsides of Lahore city. Upper Mall scheme and Qazi center were emitting less concentration of noise level as compared to other location of the mall road.

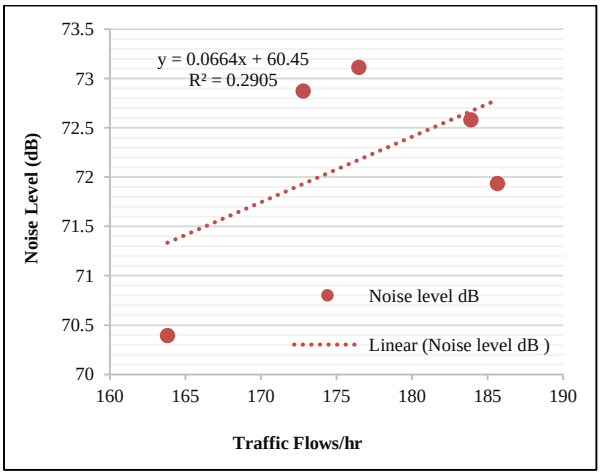
Correlation of Traffic Flows and Noise Levels

Figure 6a shows that with every 1 decibel of noise level increase the -0.018 traffic flow decreases. There is a negative relation between traffic flow and noise level of Walton road and it is concluded that as the noise level increases the traffic flow decrease at Walton road.

Table 2 Traffic flow/ hr and noise level (dB) at Walton Road, Lahore

Traffic flow/hr	Noise level dB
242	74.98
241	74.52
215	73.31
192	75.52
162	76.06
Traffic flow/ hr. and noise level (dB) on Mall road, Lahore	
164	70.3958
184	72.583
173	72.875
186	71.935
177	73.1145

Figure 6b shows that with every 0.064 traffic flow increase the 1 decibel of noise level will also increase. There is a positive relation between Traffic flow and noise level of Mall road and it is concluded that as traffic flow increase the noise level also increase at Mall road.



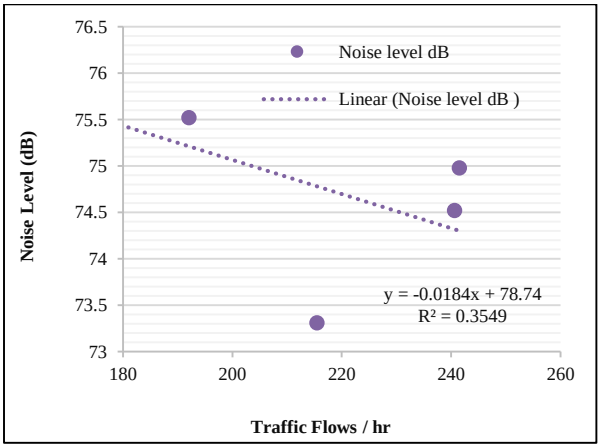


Fig. 6 Traffic Flow and noise correlation: a) Walton Road; b) Mall Road

Impact of Vegetation on Noise Pollution

Indices are being applied to check out the vegetation cover. The threshold value of the normalized difference vegetation index is from -1 to +1. Figure 7 shows the NDVI (normalized vegetation index), which highlights the vegetation of an area. The Figure 7 showing more vegetation in the Mall road than Walton Road, Lahore.

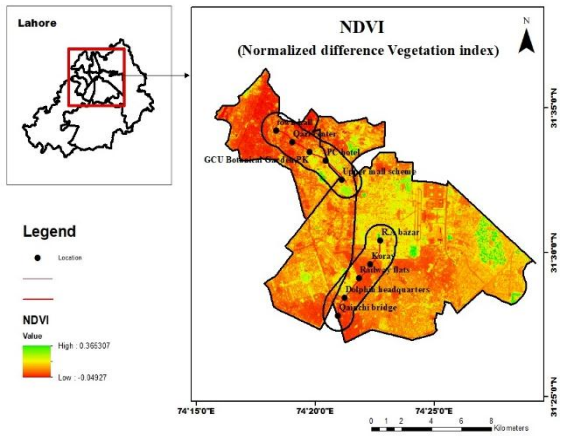


Fig. 7 NDVI at Walton and Mall Road, Lahore

There is an inverse relationship between noise level and vegetation. Qainchi Bridge the vegetation cover is 4 hectare and the noise level are 74.98 while at Koray the vegetation cover is 3 hectare and the noise level are 75.52 dB.

Table 3 Vegetation effects on noise at Walton Road

Location	Noise Level dB	Vegetation (hectare)
Qainchi bridge	74.98	04
Dolphin-head Quarters	74.52	9.6
Railway flats	73.31	09
Koray	75.52	03
R.A Bazar	76.06	09
Vegetation effects on noise at Mall road		
Upper Mall scheme	70.39	17.3
PC Hotel	72.58	10.6
GCU-Botanical Garden	72.87	8
Qazi centre	771.93	3.9
Town Hall	773.11	3

Figure 8a shows that with every 0.01 square kilometer decrease in Vegetation will increase 0.1 decibels in noise level on Walton road. There is a positive relation between vegetation and noise level and it is concluded that a decrease in vegetation will increase noise level at Walton road. There is also inverse relation between noise level and vegetation at Mall Road i.e. at Town Hall, the vegetation cover is 3 hectares and the noise level is 73.11 while at Qazi center the vegetation cover is 3.9 hectares and the noise level is 71.93. Figure 8b shows that with every 0.83 square kilometer decrease in vegetation will increase 0.1 decibels in noise level on Mall road. There is a positive relation between vegetation and noise level and it is concluded that a decrease in vegetation will increase noise level at Mall road.

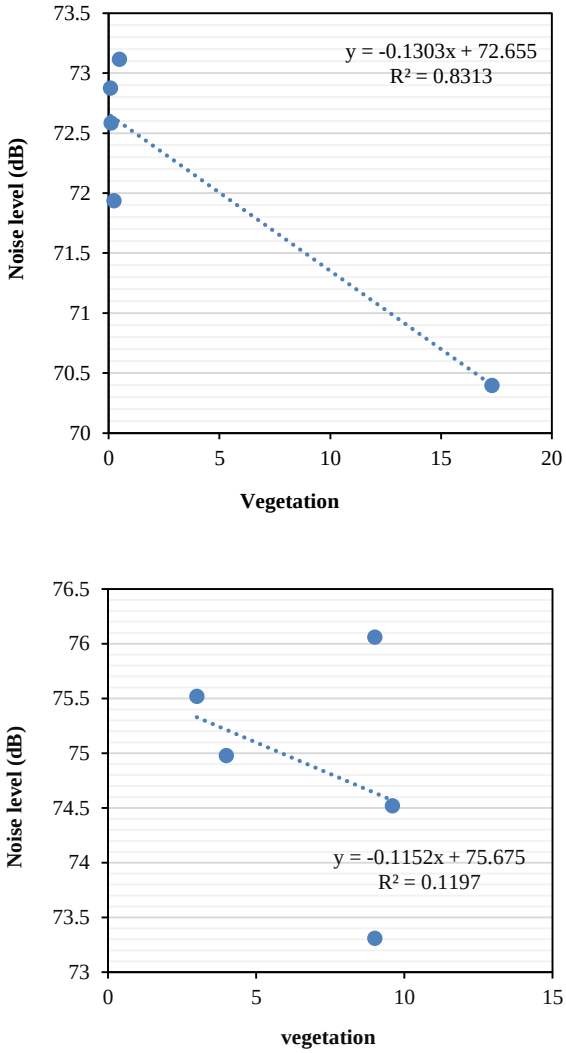


Fig. 8 Vegetation and noise correlation: a) Walton road; b) Mall road

Conclusion

The selected sample sites of Walton road are the major locations, where higher production of noise levels and traffic are found. The daily maximum level of noise was 89 dB recorded. The most noise polluted site was found to be Walton road as compared to the Mall road. From the result of a survey conducted during 8 days of data collection, the results show that the high concentration of noise level was at all sample locations of Walton road. R.A Bazar was creating the average high value of noise level (76.06 dB) as compared to others locations on Walton road and Mall road. From Walton, road-heavy traffic operates at all times of the day. One of the obvious reasons for the high noise

level at Walton road is that the Qainchi point is the busiest interaction of Feroz Pur road, model Town, and Walton road. There is a positive relationship between traffic noise level and traffic flow of both roads. Finally, it has been recognizing that this study's findings on the spatial distribution of noise level. However, there is a strong relationship between noise level and traffic flow on both roads.

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