

## Environmental Noise Pollution Level at Birjand City Using Statistical and GIS Techniques

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### Introduction

Noise pollution is one of the environmental pollution that threatens public health to the survival of organisms. Urban traffic causes noise pollution as a major factor of air pollution. This is one of the problems of urban citizens. This is also a growing problem that has a potential impact on public health, which is mainly resulted from transport vehicles in the cities and the residential environments.

In most developed and developing countries, the problems of noise pollution have been considered through legislative measures to reduce or eliminate it. The effects of noise pollution on human being do not arise direct or immediate in human body. Physiological and psychological effects of the pollution on humans are usually appeared gradually and have long-term direct impact on the human nervous system, general health and may hearing loss.

In the past, it was thought that the major noise pollution can just be caused by traffic congestion in large cities, thus, most studies about the problem have been conducted in metropolitan cities. While evidence showed that the cities like Yazd with low number of motorcycles has high level of noise pollution. Studies that have been conducted in various parts of Tehran metropolis can express excessive amounts of noise exceeding standard levels in different regions so that most citizens have expressed annoying. Assessment of the noise pollution of Mashhad city showed the highest level of noise in the morning on Bahar Street and in the afternoon and night times in Kohsangi Street. Most of the street traffic noises at all times were reported on Nakhrisi Street. Evaluation of noise pollution in Zanjan City also showed that this pollution in residential and commercial areas was exceeded the threshold limit and there are significant difference among the morning, afternoon and evening times. Noise pollution monitoring results for Yasuj City also indicated that the most crowded stations at all hours of the day and night noise levels is exceeded the standards. Equivalent sound level measured at 13 different stations in Kerman also approved that the levels of noise pollution in most of the stations are higher than the threshold limit. Studies in the most countries outside of Iran suggest that the noise level is far beyond standards limit which can be attributed to the development of urban poor and inefficient management and cultural issues.

Traffic of vehicles is one of the factors that may give rise to noise pollution in the society. Considering the high levels of noise pollution can have a significant effect on public health. The record shows that most of the noise pollution from traffic has been done in major cities such as Tehran, and there is no enough research in the city of Birjand. On the other hand, the increasing physical expansion of the city and establishment of industrial center in the city and also progressive and significant increase of vehicles and other sources of noise pollution make conduction of this research necessary. This study aimed at evaluating the comparative study of noise pollution levels in Birjand city in morning, noon and night times has been carried out using statistical techniques and GIS.

### Material and Methods

In this study, the Casellacel, model Cel450 noise pollution meter was used in accordance with international standards. Primarily through field visits and interviews with the people and authorities, the noise pollution sources were identified. 43 points were selected. They were particularly on squares, intersections and crossroads. The specified locations were identified on the map and with help of maps and GPS to find the desired location and raw collect the data. In this study, the standard time of 30 min to measure the noise levels were considered. To do these measurements, the sample times at intervals of 8 to 10:30, 11 to 12:30, 20:30 to 18 are selected. According to World Health Organization standards, Sound Level Meter was placed 3.5 m from the wall and 0.5

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m from streets and station locations were selected close to standard conditions. Sound level meter was calibrated before each measurement with frequency of 1 kHz for 114 dB. In order to obtain more than 95% of CI, 774 samples were measured. As, 3 times in each station throughout the winter and spring seasons were selected in the three periods, 8 to 10:30 am, 11 to 12:30pm noon and, 18 to 20:30 pm night, due to the traffic level. The collected data were stored in Excel and then using the SPSS application for statistical analysis techniques such as frequency and correlation coefficient. ILWIS Academic 3.2 Software was applied to draw the geographical distribution of noise and traffic of the city in three different periods in the morning, noon and night.

## Results and Discussion

The results showed that in the morning period the stations 7, 8, 15, 18, 20 to 37, 39 and 43 and in the afternoon period the stations 1,4, 6, 7, 11, 13, 15, 16, 18, 20, 21, 23- 39, 42 and 43 and also in the evening period the stations 2,4, 6, 7, 8, 9, 12, 15, 16, 17, 18, 20, 30, 32 - 39, 42 and 43 have equivalent sound level more than 70 dB. According to the results, almost in all of the stations noise pollution level were more than 70 dB at the night period. It revealed that sources of noise pollution in this period are more and also in the morning is more than noon. This is resulted from the distribution of vehicles numbers. A survey conducted in the holy city of Mashhad showed that the majority of the stations along with increasing the number of vehicles had the highest level of noise pollution at night.

Most of the street width is between 20-40 m with an average 28.67m. Only in 2 stations the streets are more than 50 m wide. Since the traffic is distributed irregularly in the city, in most cases, widening of the roads is not based on traffic volume. Consequently, there is no significant relationship between street width and the amount of traffic which is the main cause of noise pollution in the city. The research that has been done in the Bushehr City also find no significant relationship between the width of the street and traffic volume.

As Table 1 show, there is no significant difference between the widths of the streets and no other measured parameters.

**Table 1. Pearson correlation coefficient between mean noise pollution level, traffic and street width**

	Noise level in morning	Noise level in noon	Noise level in night	Traffic in morning	Traffic in noon	Traffic in night	Street width
Noise level in morning	1						
Noise level in noon	0.618**	1					
Noise level in night	0.503**	0.453**	1				
Traffic in noon	0.279	0.325*	0.512**	1			
Traffic in noon	0.300	0.350*	0.514**	0.988**	1		
Traffic in night	0.263	0.291	0.518**	0.994**	0.969*	1	
Street width	-0.103	0.022	0.266	0.250	0.207	0.265	1

The width of the street is not affected by noise pollution level. It may be due to speed of cars on the more deserted streets which causing the amount of noise increases rapidly. The mean level of noise pollution in the morning time shows not significantly correlated with traffic volume. The mean level of noise pollution at various time intervals was significant at 1% level. This means that in most areas with high levels of noise pollution during the morning or noon, at night, the same process is followed. The strongest correlations were found between the different measured parameters with the traffic in time morning, noon and night. The results of this study this can be concluded that the traffic volume has a direct effect on the noise pollution levels. There is direct relationship between the number of vehicles, vehicle types and levels of noise pollution, a more significant role in this regard for motorcycles.

According to the Iranian standard, the noise limits in the open air during the day are as following: residential areas (55dB), commercial- residential (60dB), commercial (65dB), industrial-residential (70dB) and industrial areas (75dB), considering the noise threshold limit for residential areas is 55 dB. Noise pollution levels for many different areas, including residential and commercial, is exceeded from limited values. For example, in terms of commercial- residential areas only station No. 5 (intersection of 15 Khordad Street and Tohid Street), have a mean contamination level of 30.58 dB which is acceptable in the period of morning while other stations are beyond the standard level.

In terms of commercial in the morning period, Station No. 5 for the Noon period, Station No. 17 (intersection of Tohid Street and Mosa Sadr Street) and Station No. 12 (Sajad Shahr- Imam Sadeqh Square) for the night

period, Station No. 1 (Madrass Street- Jamaran square), Station No.40 (Adel Street- 19th Alley) and Station No. 41 (Adel Street- 10th Alley) in the morning were in the standard level. Results of other investigators also represent the noise level exceeded standards in different regions in different towns.

With the growing trend of modernization and population increase traffic noise pollution is avoidable. In the near future noise pollution levels in the city at all hours of the day will exceed the standard values, as serious danger to public health. Therefore, it is important to take the appropriate measure to reduce and control these pollutants. Methods to deal with noise pollution in cities can be named such as; urban land suitable site selection in a comprehensive and detailed designs, manufactures standard and vehicles standard, restrictions on movement of vehicles and motorcycles, speed limits, traffic improvement and expansion of public transport. As well as building of acoustic walls around roads, using sound-absorbing materials in residential and commercial buildings and application of green space on the edge of residential areas and roads will reduce noise pollution in the city. The appropriate number of noise measurement stations, land use and acoustic zoning maps of the city is integral to any planning for the city.

### **Conclusion**

Noise pollution is one of the most important environmental problems of today society and is considered as a potential danger to human health. In this study, 43 sites were selected to evaluate and measure the noise level. Statistical analysis revealed that there is no significant relationship between the width of the streets and traffic volume and noise level. The results of the present study was that the traffic volume and noise levels mapping alignment for three different periods in the morning, noon and night were plotted using GIS. This indicates direct effect of the traffic volume at noise pollution level. The level of noise pollution of Birjand in different stations was compared with standard level of noise in Iran. This revealed that almost all of the residential stations have exceeded the values of standard and puts public health at risk, Therefore, the appropriate measures must be taken to reduce and control these pollutants.

Using urban land suitable site selection in comprehensive and detailed designs, manufactures standard and low-volume vehicles, cars and motorcycles restrictions on traffic, speed limits, traffic culture and expansion and encourage of public transportation are the suggestions to deal with noise pollution in cities. The construction of sound walls around roads and application of sound absorbing materials in residential and commercial buildings and also use of green space on the sidelines of residential houses or roads can help reduce the pollution. Presence of a good number of noise measuring stations is a prerequisite for any plan in the city.

**Keywords:** Birjand City, GIS maps, noise pollution, statistical analysis.