

## Full Length Research Paper

# Evaluation of noise pollution caused by vehicles in the city of Tokat, Turkey

Serkan Ozer<sup>\*</sup>, Hasan Yilmaz, Murat Yeşil and Pervin Yeşil

Ataturk University, Faculty of Agriculture, Department of Landscape Architecture, 25240, Erzurum, Turkey.

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Noise pollution and its influence on environment and life quality of human beings may be considered as a hot topic in scientific research. Since there are no sufficient studies on noise pollution in Turkey, this study was carried out to determine motorway noise levels in Tokat city centre, located at the northern part of Turkey. Noise measurements were taken in the evening to determine noise pollution all over the city as motorway transportation noise. The equivalent sound levels - Leq- were measured at 65 points, between 17 and 19 p.m. in the city. High noise levels on these streets were observed throughout the city. At fifty of sixty-five measurement points (76.9%), noise values exceeded 65 dB(A), limit value according to Turkish noise control regulation, while at fifteen points (23.1%) this value was under this value. Statistical analysis revealed that, there were significant differences in noise levels among the streets ( $P < 0.05$ ). The results showed that noise should be mentioned among the major environmental problems and studies aim at preventing it should have great priority.

**Keywords:** Tokat, noise, motorway, noise pollution, survey.

## INTRODUCTION

Noise pollution is recognized as a major problem for the quality of life in urban areas all over the world. Because of the increase in the number of cars and industrialization, noise pollution has also increased. Noise in cities, especially along main arteries, has reached up disturbing levels. Residences far from noise sources and near silent secondary roads are currently very popular. People prefer to live in places far from noisy urban areas (Yilmaz and Özer, 1998).

Many surveys addressing the problem of noise pollution in many cities throughout the world have been conducted (Li et al., 2002; Morillas et al., 2005; Zannin et al., 2002; Alberola, 2005; Lebedowska, 2005; Pucher, 2005; Tansatcha et al., 2005), and have shown the scale of discomfort that noise causes in people's lives (Butcha and Vos, 1998; Kura et al., 1999; Ali and Tamura, 2003; Marius et al., 2005). Depending on its duration and volume, the effects of noise on human health and comfort are divided into four categories; physical effects, such as hearing defects; physiological effects, such as increased blood pressure, irregularity of heart rhythms and ulcers;

psychological effects, such as disorders, sleeplessness and going to sleep late, irritability and stress; and finally effects on work performance, such as reduction of productivity and misunderstanding what is heard (Job, 1996; Evans and Hygge, 2000; Stansfeld et al., 2000; Passchier-Vermeer and Passchier, 2000; Quis, 2001; Marius, 2005).

In Turkey, noise is beginning to be considered as one of the main environmental problems (Yilmaz and Özer, 2005). With the increase in urbanisation and the number of cars, especially after 1980s, noise reached up a disturbing volume in Turkish cities. Several studies have been carried out in Turkey and the world to determine noise levels in big cities. The city of Tokat is a small city in terms of its population. This study was planned to determine the extents of noise levels in a small Anatolian city and suggest solutions.

## MATERIALS AND METHODS

### Materials

The study was conducted in June, 2005 in the city of Tokat, which is located at an elevation of 623 m and along a stream valley in the Blacksea Geographic Region of Turkey (Figure 1). The city centre is surrounded by hills with the heights of nearly 1500 m. The city represents the climatic features of both Blacksea (wet) and Middle

<sup>\*</sup>Corresponding author. E-mail: sozer2000@hotmail.com, sozer@atauni.edu.tr. Tel: + 90 (442) 2312358. Fax: + 90 (442) 2183647.

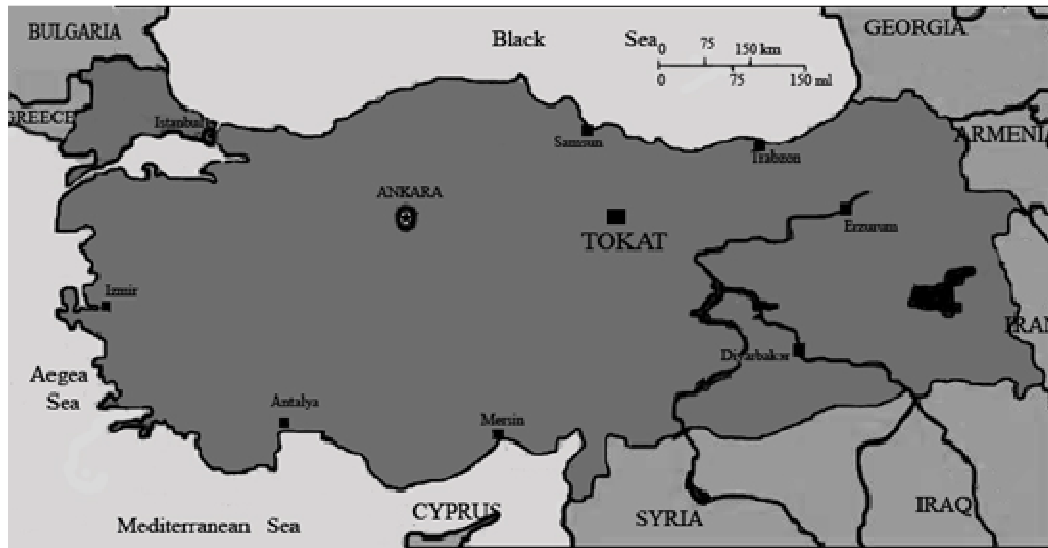


Figure 1. Location map of the city of Tokat.

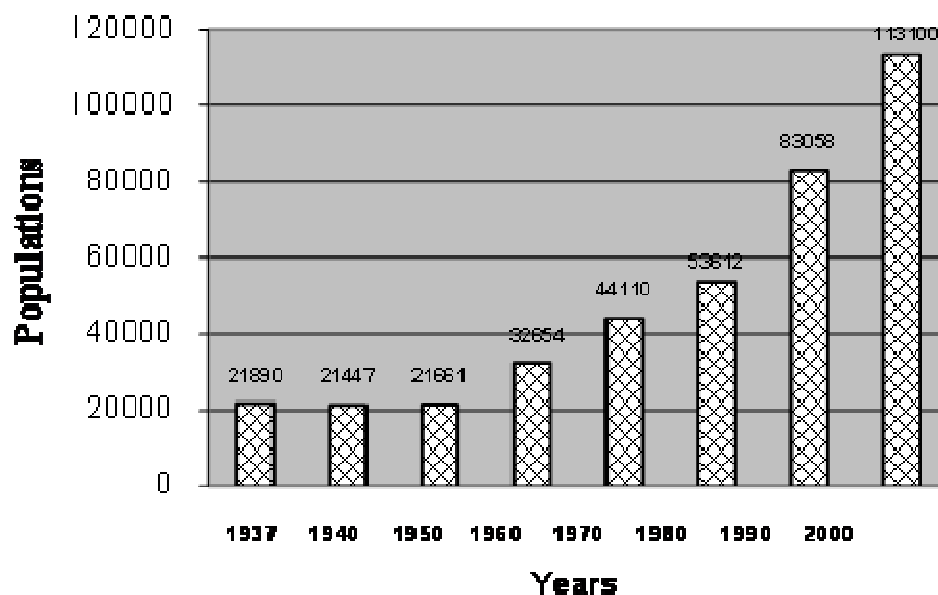


Figure 2. Population increase of the city of Tokat over years.

Anatolia (continental) Regions and mean temperature in the city is 12.3°C. According to the census in 2000, population of the city is 113,100 (Ünal, 2004). Population increase was faster especially after 1990 (Figure 2). Depending on the population increase and economic development, the number of vehicles has begun to increase since especially 1980s and in 2000s this increase became more apparent (Figure 3). Although the city had an agriculture-dependent economy, over the last few years it has become a service, industry and trade centre. The settlement form of the city is given in the Figure 4.

#### Methods

The first step of the study was to select the main streets and roads

in the city. In order to determine the measurement points, primary and secondary streets of the city were surveyed before the study. Thus, noise pollution was determined in seven main streets and vehicle number was counted on the pre-determined roads and streets and by this way, primary and secondary streets where noise problem was thought to take place were determined (Piccolo et al., 2005). In addition, vehicle number according to their types was obtained from city's traffic administration. On these streets, the most suitable 65 measurement points were selected in the light of observations and data obtained. Thirty three of 65 measurement points were on the primary streets and 22 are on the secondary streets (Figure 5). Measurements were performed on Monday, Wednesday and Friday. Noise measurements were conducted at five different points in a street. Data from 65 selected points were obtained at a height between 1.20 m and at a distance 2 - 3 m from noise

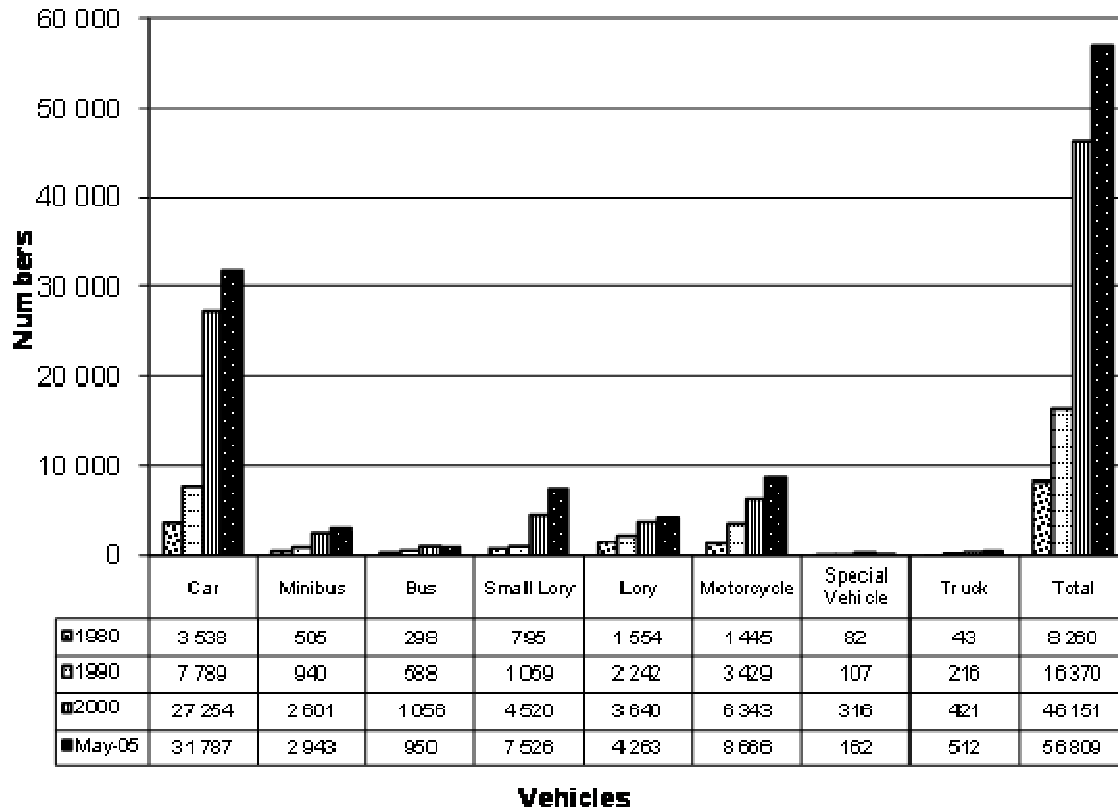


Figure 3. Increase in the number of vehicles in the city of Tokat over years.

sources as defined by the previous studie of Ramis et al. (2003), <http://poweracoustics.com> (2009), Piccolo et al. (2005) and Jamrah et al. (2005). Measurements were carried out through a sonometer, Anologue Cel 254 K2. Erroneous situations tried to be prevented by calibrating sonometre. At each measurement points, totally 50 noise values were recorded in five seconds by taking one noise value in every six seconds. Because the obtained raw data was given according to the limit value of Turkish noise control regulation, Leq and sound ranges are wide in traffic noise, values were converted into Leq. Measurements were performed considering noise control regulation in Turkey and WHO and international standards used in previous studies (NCI, 1986; ISO, 1996; WHO, 1999; Gaja et al., 2003). Leq represents the equivalent energy sound level of a steady-state and invariable sound. It includes both intensity and length of all sounds occurring during a given period (Piccolo et al., 2005). Measurements were done out when the effects on the noise sources of variable factors were at minimum. All the data were obtained on weekdays and under suitable meteorological conditions, that is, in the absent of wind and rain. Because the transportation distances in the city were short, the noise measurement intervals were also short. For this reason, values were obtained between 17:00 and 19:00 p.m. when the traffic density is higher than that at other hours.

Statistical evaluation was done on the results of the noise measurements. A variance analysis procedure was applied to the data through SPSS software programme. Duncan Multiple Range Test was used to compare the significance of the differences between the mean values.

A noise map of the city was created after the evaluation of the data and the results of the study were transferred in to the map. Noise map showed totally four different classifications considering

the values lower than 55 dB(A), which are not seen as problematic; 55-65 dB(A), which are permitted values; 65-75 dB(A), which are higher values and 75 dB(A), which is the highest value. The obtained noise values were grouped and similar groups were combined. From this map, by determining the reasons for noise in the area where it was high, measures to be taken against noise were proposed.

## RESULTS

Evaluations on noise Measurement were based on limit value of 65 dB(A) in noise control regulation in Turkey and international standards used in previous studies (EPA, 1978; NCI, 1986; ISO, 1996; EUC, 1986) and it was found that allowed limit values were exceeded at 50 of 65 measurement points. In the city, excessive noise levels were found on especially primary streets (Figure 4). Among 65 measurement points, 31 were on primary streets and the rest on main (1<sup>st</sup> road) roads. Noise values were beyond the 65 dB(A) limit value on 30 measurement points on primary streets and 20 on secondary streets. The highest noise value (81.6 dB(A)) was determined on the 2<sup>nd</sup> Street while the lowest (49.1 dB(A)) was on the road next to suburban area.

Noise exceeded the 65 dB(A) allowed limit values in six of seven primary streets in the city. On most of these streets, noise level was over Leq = 70 dB(A). These were

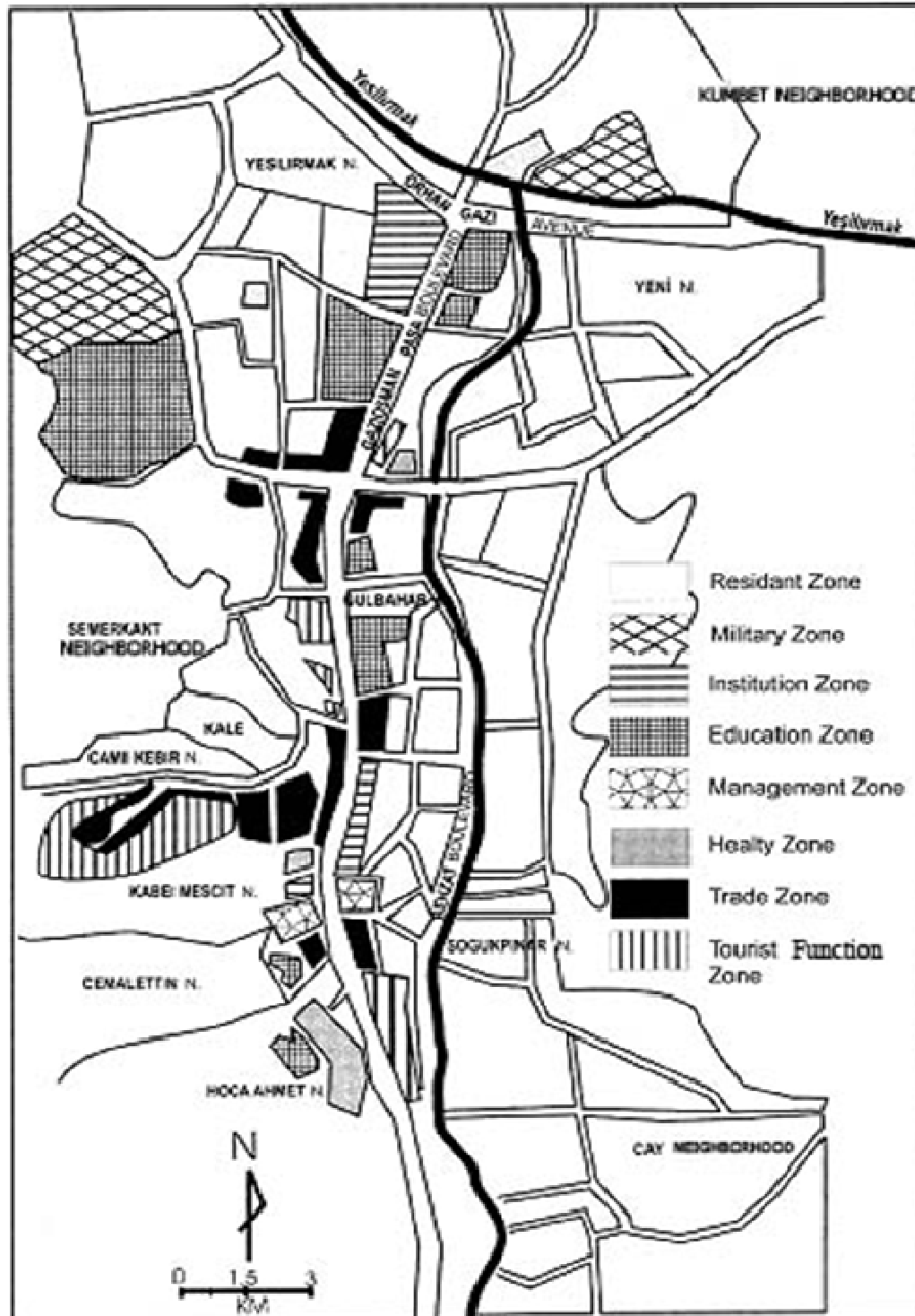


Figure 4. Settling form of the city of Tokat.

the 1<sup>st</sup>, 2<sup>nd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 7<sup>th</sup> streets, important parts of the city. The highest noise values were recorded on the 1<sup>st</sup> street with 77.1 dB(A). On only one of these seven streets, 6<sup>th</sup> street, the noise level was below the limit value of 65 dB(A) with 60.6 dB(A). Differences between

noise levels of streets were found to be statistically significant ( $P < 0.01$ ). While allowed limit value of 65 dB(A) was exceeded at 50 (76.9%) of 65 selected measurement points, at 15(23.1%) of them, values were found to be in the allowed range (Table 1).

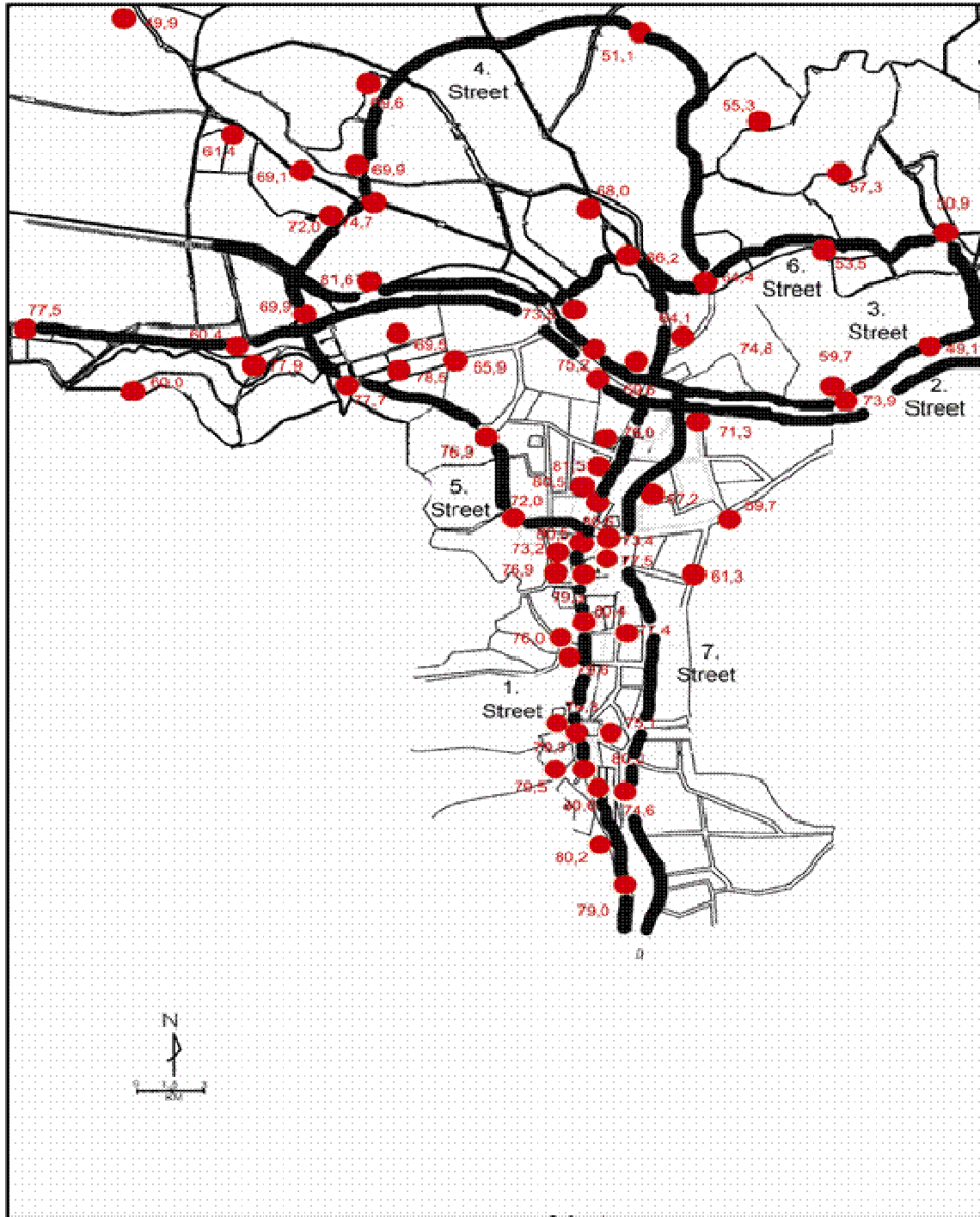


Figure 5. Noise measurement points in the city of Tokat .

Street bearing the heaviest traffic load was the 1<sup>st</sup> street. On this street, 2,248 vehicles on the average passed in an hour. Among the various vehicles passing on the street in an hour, 1,714 were automobiles, followed by minibus and bus 298 and 36 vehicles (Figure 6).

Of the noise levels obtained from the points on seven streets, values of 1<sup>st</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 7<sup>th</sup> streets were found to be statistically very significant while those of 2<sup>nd</sup>, 3<sup>rd</sup> and 6<sup>th</sup> were not significant compared to limit value. Differences between the noise levels were found to be statistically significant ( $P < 0.05$ ; Table 2).

Overall noise chart was prepared on the basis of the measurements conducted in the city (Figure 7). As can be seen from the chart, along the main streets of the city, 1210 Sci. Res. Essays

2004), Messina (Piccolo et al., 2005) noise levels exceeded the allowed values. In Turkey, measurements in Adana (Uslu, 1995), Trabzon (Demirel et al., 1997) and

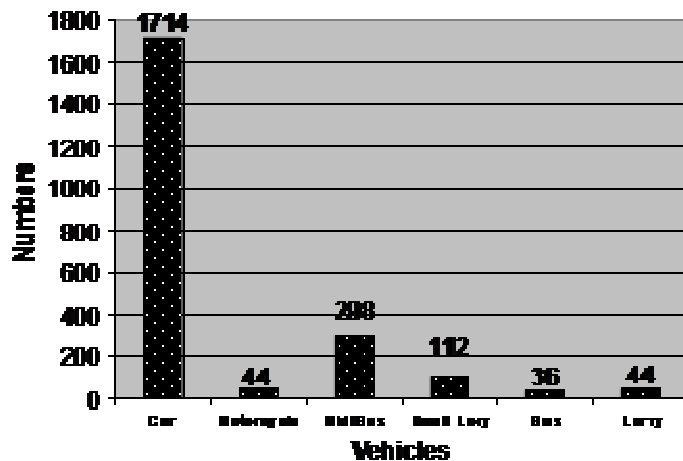
**Table 1.** Classification of the noise values at 65 points.

Noise range (Leq)	Measurement points	%
50 <	2	3.1
50 - 54	3	4.6
55 - 60	5	7.7
60 - 64	5	7.7
65 - 69	10	15.4
70 - 74	11	16.9
75 - 79	20	30.8
80 >	9	13.8
Total	65	100.0

**Table 2.** Statistical analyse of the values.

Streets	N	X Mean	± Sd	Sig.	P
Street 1	5	77.1	2.87402	.001 (a)	Xx
Street 2	5	70.86	6.58506	.117 (ab)	Ns
Street 3	5	69.64	5.21325	.117 (b)	Ns
Street 4	5	70.56	1.00648	.000 (ab)	Xx
Street 5	5	74.96	3.91254	.005 (ab)	Xx
Street 6	5	60.62	7.79083	.277 (c)	Ns
Street 7	5	74.36	4.21224	.008 (ab)	Xx

Xx: P < 0.01 Ns: P > 0.05.



**Figure 6.** The number and the kinds of the vehicles passing on the street in an hour.

especially in the 1<sup>st</sup> and some parts of the 2<sup>nd</sup> street noise level was observed to be above 75 dB(A).

Neighbourhoods in suburban areas were found to have lower noise levels.

## DISCUSSION

There have been many studies on noise levels in recent years in various countries including Turkey. In one of these studies (Zeid et al., 2000), the noise level in Arrabba, a city in Palestine, was found to be 67 dB(A), from 20 measuring points. At 60% of these points, the level exceeded 65 dB(A). In Curitiba in Brazil, at 93% of the measurement points, the noise level was over the limit value of 65 dB(A) and it was over high noise level of 75 dB(A) at 40.3% of these points (Zannin et al., 2002). In Beijing (Li et al., 2002) and Cáceres (Morillas et al., 2002) Capital Cities (Brown and Bullen, 2003), Assiut (Ali,

Erzurum (Yılmaz and Özer, 2005) showed that noise levels reached significant values.

Similar results with the studies mentioned above were also obtained in Tokat city centre. Depending on the fast increase in the number of vehicles, noise pollution has reached important levels in the last fifteen years. On densely utilized roads, the equivalent sound pressure levels can reach up to 75 – 80 dB(A) (Yoshida et al., 1997). From the measurements, noise levels were found to exceed the limit value of Leq = 65 dB(A) and reach up to 82.8 dB(A). The noise levels above 65 dB(A) was measured on the 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> and 7<sup>th</sup> streets, which are the primary streets of the city. The only noise value under 65 dB(A) was determined in the 6<sup>th</sup> street.

High levels of noise determined on these measurement points are also true across the whole city. Except for one, at all the points on primary streets and majority of those on secondary streets noise levels were beyond 65 dB(A). From the statistical analysis, it was found that noise values exceeded permitted limit of (65 dB(A)) (NCI, 1986) in the six of seven evaluated streets and in four of them differences were highly significant (P < 0.05).

Although the roads in the city was newly constructed ones and the number of old vehicles was relatively low; Nevertheless, noise levels were found to be high, which is due to the highway road passing through the city from West to East. For this reason, a heavy traffic road is seen in the 1<sup>st</sup> street, which causes the highest noise level on this street. Because of this density, traffic flow was slow.

Majority (43.0%) of the active city population works in the service sector (Ünal, 2004). On this street, service sector of the city was collected. Public service structures susceptible to noise on the 1<sup>st</sup> street are exposed to a noise level over 70 - 75 dB(A). Disturbing conditions because of this high noise level are largely experienced by the people using the facilities such as hospital, school, park and houses along these roads. The Environmental Protection Agency (EPA) recommends that the acceptable noise level in a hospital should not exceed 40 dB(A) (Marius et al., 2005).

Planning should be done using the prepared noise map. Success should not be expected from struggle with

the noise pollution without partnership of the people.

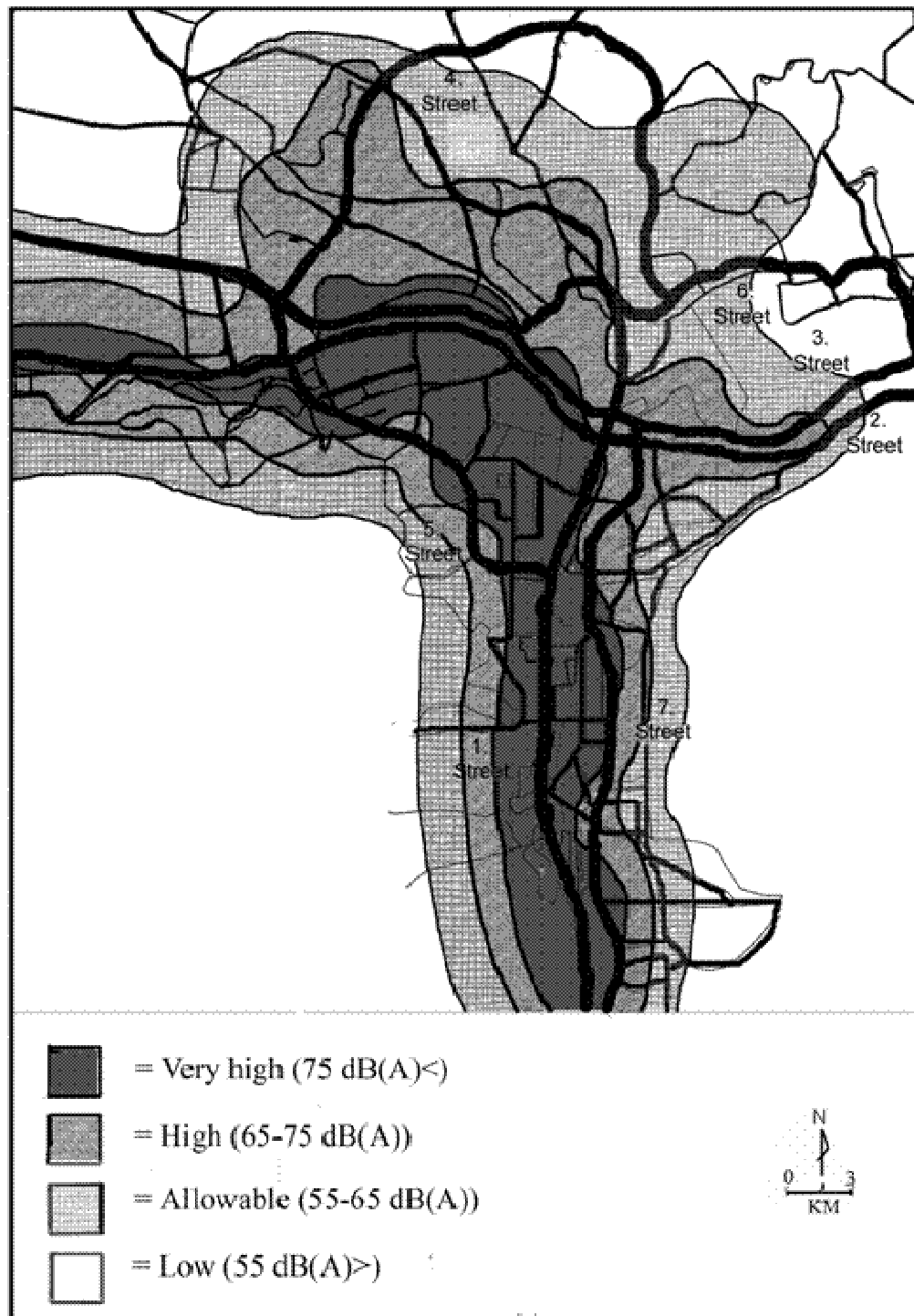


Figure 7. Noise map of Tokat city.

### Conclusion

In Turkey, more attention is now being paid to noise pollution. In most of the studies conducted on noise

pollution so far all over the world, it was found that noise pollution reached considerably high levels; thus, noise pollution is the candidate for the most important

environmental problem of the city. The outcomes of the study showed that noise values reached up to significant levels even in a small sized city with a population of 100,000. Although the city of Tokat is a small sized city, noise values were as high as those in mega and crowded cities.

cities.

City centres are the places where noise problems are very high. Similarly noise level in Tokat city was also found to be high, which is increased by a ring road passing through the city centre. This road should be out of the city and it should be surrounded by effective plant materials on noise reduction (Özer et al., 2007; Yilmaz and Özer, 1998). In addition, long and large vehicles should not pass through the city centre. Routes of public transportation vehicles should be reorganized so as not to accumulate at one point in the city. Motor bikes also cause a considerably high noise level; therefore, city people should be encouraged to use bicycles on their ways to work. In addition, suitable tyre use and the increase in the volume of noise preventive devices, suitable road covering materials, changing road elevation, increasing the public awareness can be mentioned among other noise preventive methods (Uslu, 1995).

Therefore, protections related to planning, technical, biological, legislative and educational issues should be taken in order to avoid negative effects of noise pollution on environment. Noise pollution levels should be measured continuously, and the critical levels should be kept. Indeed, the most effective noise control measure is to promote awareness of the population about the risks of daily exposure to high noise levels.

This study has revealed that even in Tokat one of the small-sized cities, noise pollution has reached serious levels, showing that the noise has become one of the major environmental problems of the country to be urgently overcome. Enforcement of more effective regulations and constraints on the noise problem seems to be promising for the cities in Turkey, which is at the stage of accession negotiations with European Union.

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