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Environmental Noise Pollution in the City of Tabriz, Iran

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Abstract: There are many reports on the noise pollution and its hazards from many cities around the world. The aims of these investigations were the environmental noise pollution in the populated cities in the world. This issue is not looked at as a severe problem and has not been paid much attention to in Iran. However, we intended to study noise pollution in the urban city of Tabriz—one of the crowded and prominent cities of Iran. We carried out our research at 1000 stations over the city and found that sound level was lower than 65 dB in 7.7% of stations, over 75 dB in 59.8% of stations and 37.5% in the range of 65-75 dB (in particular in the service zones and city centre) during the day.

Key words: Noise pollution, dB(A) audio sound density, $L_{Aeq,1hr}$ equivalent sound level per hour, urban-acceptable.

Introduction

Noise pollution has been considered as a severe problem. It has been studied as: Exposure effect relationships between road traffic noise annoyance in Spain by Martín et al.; and the effects of railway, aircraft and road traffic noise pollutions on children's health and cognition studied by Chinese scientist Xiaoan (2006) and Stansfeld et al. (2005). Evaluation and analysis of the environmental noise of Messia, Italy were considered by Piccolo et al. Community noise survey of Valdivia, Chile was studied by Sommerhoff et al. The measurement of train noise in northern Italy was carried out by Pronello. Noise effect of reducing traffic flow through a Spanish city was reported by Ramis et al. Environmental noise pollution in the city of Curitiba was a subject of Henrique et al. An inversion modelling method to obtain the acoustic power of the noise sources in a large factory were simulated by Guasch et al. Effect of building construction noise on residents was discussed by Fanng. Noise pollution at Calania airport was analyzed by Ignaccolo. Noise pollution associated with operation of Dar es Salam international airport was explained by Rubhera et al. Valuation of urban traffic noise and air pollution was an interesting subject discussed by Sælensminde. Finally, measurements on noise pollution in the city of Tabriz is represented in this study (no other report has been traced on this problem and no official standard has been recommended on Housing and Urban Development (HUD)). It should be noted that the rapid industrialization of Asian developing countries has pushed the need for more energy at the cost of environmental degradation.

The city of Tabriz, with more than two million inhabitants, is the capital of Azerbaijan province. The third prominent city in Iran, founded 6000 years ago, it is one of the oldest cities in the country. Tabriz along with province, occupies the North West region of Iran. For the past 2000 years, the economy of Tabriz was agriculture- and trade-based. The industrialization is somewhat recent and, along with the economical growth of the province, significant structural changes in the city are being observed. Some examples are as follows:

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A. Migration of rural inhabitants to urban areas pursuing more lucrative jobs in automobile manufactures and other industries;

B. Increasing number of circulating vehicles in urban streets; and

C. Increasing activities on planning and construction of new towers for the new inhabitants.

The increasing number of living people and vehicles has led to a new hazardous problem that has been recently introduced into the Universal curriculum: noise pollution. Noise is responsible for cochlear and general damages. Hearing loss and tinnitus are greatly depending on sound intensity and duration of exposure. Short-duration sounds of sufficient intensity (gunshot or explosion) are not considered because they are not currently encountered in our normal urban environment. Sound levels of less than 75 dB (A) are unlikely to cause permanent hearing loss, while sound levels of about 85 dB (A) with exposures of eight hours a day will produce permanent hearing loss after years. Today, popular and highly amplified music is one of the most dangerous threats for hearing organs. The intensity of noises (airport, highway) is responsible for stress and general consequences of cardiovascular disorders. Individual noise sensibility depends on several factors. Strategies to prevent damage from sound exposure include the use of individual hearing protection devices, education programmes beginning at early ages, consumer guidance, labeling the equipments with increased product noise, and hearing conservation programmes for occupational settings.

In countries with severe social problems, urban noise has not received enough attention. However, some researches have traced the problem of environmental noise in Tehran, capital city of Iran and Hamadan (Gharagozlou, 2003; Shabani et al., 2004). Nevertheless, noise pollution and its consequent influence over the environment and life quality of humans have been considered as "hot topics" in scientific research in developed countries.

The objective of the present research is to show the noise level measured in different urban zones of the city of Tabriz by a team.

Measured noise levels were classified according to the environmental legislation in effecting the city by Brüel and Kjear (1995, 1998) as also according to the HUD criterion considered by U.S. Environmental Protection Agency Office of Noise Abatement and Control and by Goldstein.

Experimental Apparatus

Noise levels were measured by means of the following equipments: Bruel & Kjaer Mediator 2238 and Bruel & Kjaer Investigator 2260. Both types are two integrating and logging sound level meters introduced by Reynolds. The measurements were carried out by a team comprising 12 operators and directed by Dr. Khosravian. The operators have made readings during the specified time on several days.

Results and Discussion

The city of Tabriz is divided into urban zones, as shown in Figure 1. Each zone has a particular noise emission density limit according to the municipal law number 8583 from 1995 legislation, which legislates urban noise and public comfort (Brüel and Kjear, 1995, 1998). From this Act, the allowed limits for each zone in particular area are as listed in Table 1.

In the present study the measurements were carried out during the afternoon in 1000 locations over all zones listed in Table 1, during working days and under ideal meteorological conditions i.e., no wind and no rain. Duration of each measurement in individual site was one hour and every reading was repeated three times.

To obtain rational distribution of the measurement sites per zone, the city was divided into locations with 2500 inhabitants, as demonstrated in Table 2. A non-regular grid was used to distribute the measurement points throughout the city (Table 2). The proximity to roads and building facades was avoided. Figure 1 shows the distribution of the measured sites per zone over the city of Tabriz.

The measurements distribution arrangement was as follows: First measurement was carried out while people were leaving home between 07:00 am and 08:00 am. Second reading was taken in the period of returning home from work between 12:00 and 01:00 pm. Having lunch at home is still a current characteristic in many Iranian cities. The third measurement was performed when people were returning home after a working day between 07:00 pm and 08:00 pm. The three L_{Aeq} measurements were averaged for each site to find a single $L_{Aeq,1hr}$ (value of the distribution of the measured equivalent sound level). $L_{Aeq,1hr}$ values from all measurement locations can be seen in Table 3. Table 4 shows the zone distribution of the measured equivalent sound level. The mean value in different zones is calculated and given in Table 5. The $L_{Aeq,1hr.}$ is approximately 75 dB(A), which is clearly unacceptable according to HUD of USA.

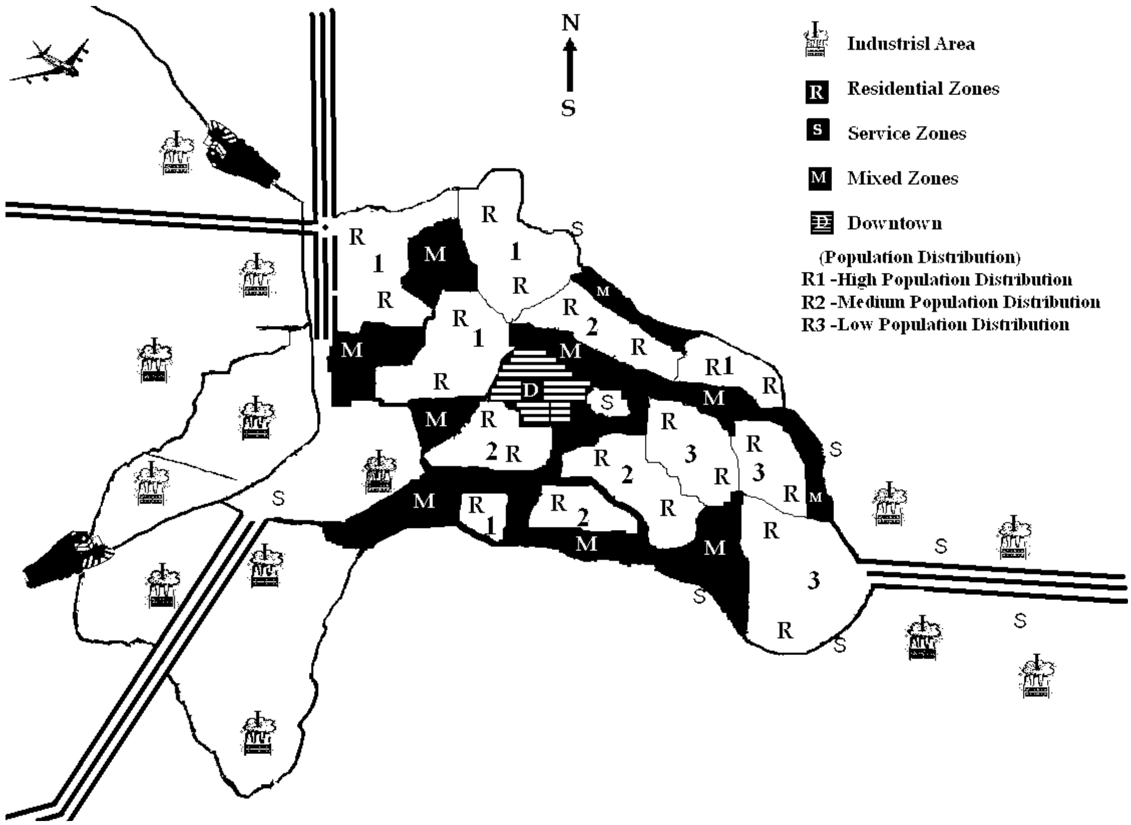

Figure 1: The city of Tabriz in 2004, divided into urban zones and the distribution of the measured points over the city.

Table 1: Limits for urban noise (dB(A))

Zone	*Day 07:00 am Limit 07:00 pm*	*Rest 07:00 pm Limit 10:00 pm*	*Night 10:00 pm Limit 07:00 am*
Residential	55	50	45
R1+R2+R3	60	55	55
Mixed	65	60	55
Services	70	60	60
Downtown	70	60	60
Industrial			

Source: Bruel and Kjear, 1998

Table 2: Distribution of sites of the measurements

Zone	*Number of locations*	*Percentage (%)*
Residential	500	50.0
Mixed	75	7.5
Services	200	20.0
Downtown	97	9.7
Industrial	128	12.8

Table 3: Distribution of the measured $L_{Aeq,1hr}$ values in 1000 different sites in the city of Tabriz

$L_{Aeq.}$dB(A)	*Number of sites*	*Percentage (%)*
$L_{Aeq.}$ ≤50	10	1.0
$L_{Aeq,r}$≤55 50<	35	3.5
$L_{Aeq,}$ ≤60 55<	12	1.2
$L_{Aeq,}$ ≤65 60<	20	2.0
$L_{Aeq,}$ ≤70 65<	165	16.5
$L_{Aeq,}$ ≤75 70<	356	35.6
$L_{Aeq,}$ ≤80 75<	270	27.0
$L_{Aeq,}$ ≤85 80<	130	13.0
$L_{Aeq,}$ ≤90 85<	2	.2
$L_{Aeq, r}$>90	0	0

Table 4: Distribution of the measured $L_{Aeq,2hr}$ values per zone

$L_{Aeq,2hr}$ dB(A)	*Locations residential*	*%*	*Locations mixed*	*%*	*Locations services*	*%*	*Locations downtown*	*%*	*Locations industrial*	*%*	*Total*
Local legislation [dB(A)]	55		60		65		70		70		
Local legislation [dB(A)] acceptable	65										
$L_{Aeq,2hr} \leq 50$	9	90	1	10	-	-	-	-	-	-	10
$L_{Aeq,2hr} \leq 55$ 50<	30	85.7	4	11.5	1	2.8	-	-	-	-	35
$L_{Aeq,2hr} \leq 60$ 55<	10	83.3	-	-	-	-	1	8.35	1	8.35	12
$L_{Aeq,2hr} \leq 65$ 60<	10	50	2	10	3	15	5	25			20
$L_{Aeq,2hr} \leq 70$ 65<	100	60.6	20	12.1	30	18.2	10	6.1	5		165
$L_{Aeq,2hr} \leq 75$ 70<	200	56.2	20	5.6	55	15.5	35		46		356
$L_{Aeq,2hr} \leq 80$ 75<	100	37	80	29.6	5	1.9	40	14.8	45	16.7	270
$L_{Aeq,2hr} \leq 85$ 80<	41	31.5	48	37	6	4.6	6	4.6	29	22.3	130
$L_{Aeq,} \leq 90$ 85<							-	-	2	100	2
Locations per zone	500		175		100		97		128		1000

Table 5: The mean value in different zones

$L_{Aeq,2hr}$ dB(A)	*Locations residential*	*$L_{Aeq,2hr}$*	*Locations mixed*	*$L_{Aeq,2hr}$*	*Locations services*	*$L_{Aeq,2hr}$*	*Locations downtown*	*$L_{Aeq,2hr}$*	*Locations industrial*	*$L_{Aeq,2hr}$*	*Total*
Local legislation [dB(A)]	55		60		65		70		70		
Local legislation [dB(A)] acceptable	65										
$L_{Aeq,2hr} \leq 50$	9	450	1	50	-		-		-		10
$L_{Aeq,2hr} \leq 55$ 50<	30	1650	4	220	1	55	-		-		35
$L_{Aeq,2hr} \leq 60$ 55<	10	600	-		-		1	60	1	60	12
$L_{Aeq,2hr} \leq 65$ 60<	10	650	2	130	3	195	5	325			20
$L_{Aeq,2hr} \leq 70$ 65<	100	7000	20	1400	30	2100	10	700	5	350	165
$L_{Aeq,2hr} \leq 75$ 70<	200	15000	20	1500	55	4125	35	2625	46	3450	356
$L_{Aeq,2hr} \leq 80$ 75<	100	8000	80	6400	5	400	40	3200	45	3600	270
$L_{Aeq,2hr} \leq 85$ 80<	41	3485	48	4080	6	510	6	510	29	2465	130
$L_{Aeq,} \leq 90$ 85<							-		2	180	2
Locations per zone	500	36835	175	13780	100	7385	97	7420	128	10105	1000
Mean $L_{Aeq,1hr}$ values per zone		73.67		78.74		73.85		76.49		78.94	

Residential: 73.67 dB(A); Mixed: 78.74 dB(A); Services: 73.85 dB(A); Downtown: 76.49 dB(A); Industrial 78.94 dB(A).

Surveying Tables 3, 4 and 5, we can notice that in 45 locations, representing 4.5% out of the total number of locations considered in our study, the equivalent sound levels ($L_{Aeq,1hr}$) have a maximum value of 55 dB(A), meaning that they are in accordance with the city urban legislation. Table 4 shows that these locations are almost all in the residential zone and represent 19.5% of total 500 locations of this zone. Mixed and services zones also have some measurement sites in accordance with the local legislation: five sites in the former (0.5% out of the measured locations) and 11 sites in the latter (1.1% out of the measured locations).

The US Department of Housing and Urban Development (HUD) recommends the following noise levels for residential areas, measured outdoors by U.S. Environmental Protection Agency Office of Noise Abatement and Control:

$L_{Aeq} \leq 49$ dB(A) clearly acceptable

$49 < L_{Aeq} \leq 62$ dB(A) normally acceptable

$62 < L_{Aeq} \leq 76$ dB(A) normally unacceptable

$L_{Aeq} > 76$ dB(A) clearly unacceptable

By considering the above criteria, all locations mentioned above can be classified as normally acceptable. Looking at Table 4, it is clear that the measured $L_{Aeq,1hr}$ in 16 locations belonging to the residential zone ranged between 55 and 60 dB(A). These values do not satisfy the low number 8583 from 1995 legislation which states a 55 dB(A) limit for this zone, but according to the HUD criteria they are still classified as normally accepted.

Table 4 shows that a few locations, (9.8%), in the mixed zone satisfy the limits shown in Table 1 which states the maximum value of sound emission density should be 60 dB(A) at day time. The mixed zone includes residential areas with strong commercial activity. By applying the HUD criteria to this case, it is revealed that 68.57% out of the 75 locations in this zone range from $65 < L_{Aeq,1hr} \leq 80$ dB(A), being considered as normally unacceptable. In 80 locations the $L_{Aeq,1hr}$ exceeded 76 dB(A), being classified as clearly unacceptable. Table 4 also shows that in the service zone only four locations satisfy the criteria of Table 1. So, all 99 locations measured in this zone, exceed the day limit of 65 dB (A), as the sound levels range from $65 < L_{Aeq,1hr} \leq 80$.

Table 5 shows the average sound levels for all measurements per zone. It is noticeable that, all values exceed the limits specified by the environmental legislation for the city of Tabriz according to Table 1. It is also obvious that the average value for all measurements made in residential zones is classified as normally unacceptable according to the HUD criteria.

During the realization of this study, it was observed that traffic noise was the major source of environmental noise pollution. This finding of social survey shows that in addition to air pollution, traffic noise was the major source of annoyance for the citizens. In his paper, Maschke wrote that the sound level category of 66-70 dB(A) is to be regarded as the threshold of health impairments. According to Maschke, from the point of view of preventive medicine, an equivalent sound pressure level of 65 dB (A) should be considered as the limiting value of exposure to traffic noise during the day. From Table 3, one can find out that in 933 locations, which represents 93.3% of the total locations, the values of the equivalent sound levels range $65 < L_{Aeq,2hr} \leq 90$. Thus, it is understandable, that the major part of the population, i.e. 93.3%, is daily exposed to sound emission levels greater than 65 dB(A) which is considered by preventive medicine as the critical value one can be exposed to (Maschke). Table 3 also shows that 75.8% of the population is exposed to noise levels greater than 70 dB(A), considered as the threshold of health impairments.

Conclusions

The city of Tabriz, one of the most populated cities of Iran which is considered as a model of urban development in the Middle East, is environmentally noise polluted. About 93.3% of the locations measured in this study showed equivalent sound levels over 65 dB(A) during the day, the limit for preventive medicine. Over forty percent (40.2%) of the locations measured showed extremely high values of equivalent sound levels, namely over 75 dB (A) during the day. A widely accepted scientific fact is that living in “black acoustics” (Maschke, 1999; G. Be lojevia and B. Jakovlevia, 1997), in which the equivalent sound level is higher than 65 dB (A), put the urban population in a high risk category for numerous noise subjective effects, including psychological, sleep, and behavioural disorders.

Among all things that can be done to relieve the environmental noise pollution problem in the city of Tabriz, the most effective one is to promote awareness of the population about the risks of daily exposure to high noise levels. Noise relief is less of a scientific problem but primarily a policy problem, and this is not yet understood in Tabriz as well as in Tehran, the capital city of Iran.

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