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Evaluation and Analysis of the Environmental Noise of Arak, Iran

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Abstract: The results of a study on the environmental noise pollution of the city of Arak, Iran are presented. A preliminary classification of the territory into the five acoustically homogeneous urban areas classes where noise standards have been provided by Iranian regulation was adopted for the investigation. On the basis of the resultant acoustic zoning 18 sites were selected for an experimental survey. This last has been carried out by extensive measurements of the main indices for noise pollution (Leq, L_1, L_{10}, L_{50}, L_{90}). Results indicate that: (a) main roads of Arak are overloaded by traffic flow during day-time period and that in all the examined sites daily average sound levels due to road traffic exceeded environmental standards by about 10 dBA; (b) environmental noise exhibits a certain degree of spatial variance resulting primarily from the peculiar geo-morphological structure of the town and from the transport infrastructure and (c) more than 30% of residents should be highly disturbed by road traffic noise.

Key words: Road traffic noise, sound levels, noise annoyance

INTRODUCTION

Noise pollution is by now globally recognized as a major problem which affects the quality of life in urban areas. Noise effects include impacts on mental and physical health as well as interfere with indices of human comfort and emotions such as effects on sleep, conversation, frequency of induced state of annoyance, hearing loss, cardiovascular problems, as well as steady mind-set to support tasks performance (Ouis, 2001; Kryter, 1982; Langdon, 1976). Then, assessing the problem and programming actions for controlling its adverse effects have become issues of immediate concern for community as evidenced by the large number of anti-noise laws, ordinances and regulations decreed by many governments (Noise Abatement and Control, 1971; Environmental Protection Agency, 1978). Noise pollution and its consequent influence over the environment and the quality of life is now a human beings may be considered a hot topic in scientific research. Many surveys assessing the problem of noise pollution in cities around the world have been conducted (Maschke, 1999; Sadan *et al*., 1986, 1998; Job, 1988; Stansfeld *et al*., 1993; Aparicio-Ramon *et al*., 1993; Shaw, 1996; Belojevi and Jakovlevi, 1997; Yoshida and Osada, 1997; Arana and Garcia, 1998; Babisch *et al*., 1999; Schultz, 1978). In some surveys such as in Maschke (1999) noise impact was treated as a stress inductor and in consequence the role of noise as a risk factor for human health was evaluated. Maschke (1999) indicated that the induced stress by noise has a psychological consequence.

The city of Arak is one of the most important industrial cities in the country. Along with the economical growth of Arak, significant structural changes in the city have been observed. Some example can be cited:

- Increasing rural to urban migration in search of more lucrative jobs in industries
- Increasing vehicles fleet in urban streets
- Increasing activities in civil construction in order to build new homes for the new inhabitants. In countries with severe social problems such as Iran, urban noise has not been receiving enough attention. The primary goal of the present study was to evaluate the environmental noise pollution in the urban part of the city of Arak. The study has evolved as a first step an acoustic classification of the territory five acoustically homogeneous areas as set up by Iranian legislation. Subsequently, 18 sampling sites were selected to adequately represent each area resulted from the acoustic zoning for an experimental measurement campaign. A comparison was then performed between measured noise levels and permissible limits set by Iranian noise standards.

MATERIALS AND METHODS

Survey area Arak is a medium-sized ancient town of markazi (Iran). The recent population of Arak is about 500 thousands inhabitants with population growth rate 3%. The urban centre, where most of the commercial activities

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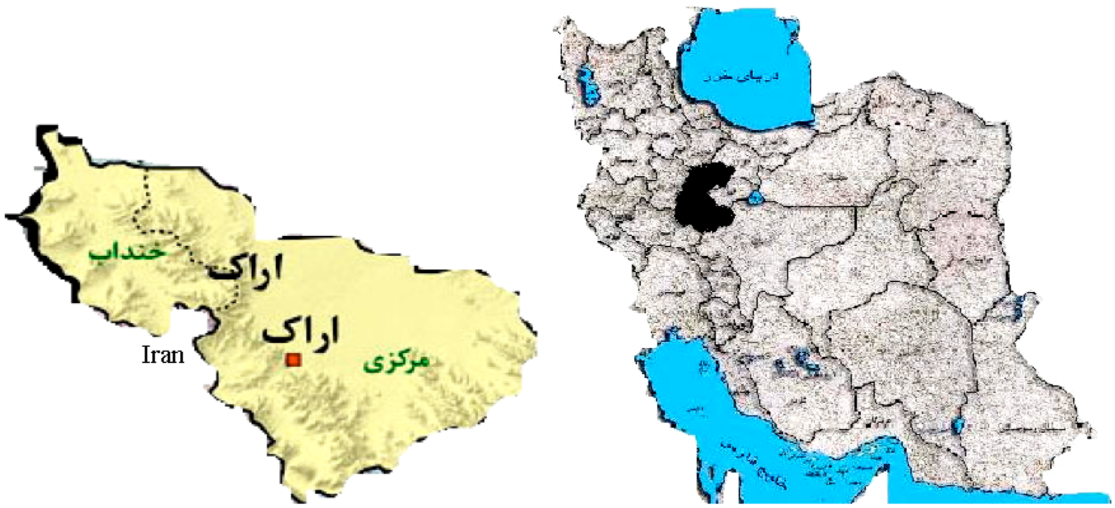

Fig. 1: Geographical location of Arak in Iran

Table 1: Noise exposure limits set by Iranian legislation

	Permissible limit for the equivalent continuous sound level-Leq dB(A)	
Type of area	Day (07:00-22:00)	Night (22:00-07:00)
Residential	55	45
Commercial-residential	60	50
Commercial	65	55
Industrial-residential	70	60
Industrial	75	65

and public utilities are located, is characterized by a square-meshed road network with low buildings and narrow roads (Fig. 1).

Eighteen sampling points were selected along the roads of the urban centre to ensure adequate representation of all the five acoustically homogeneous areas of the territory resulted from the acoustic zoning (Table 1). Noise was measured 1 m away from the facades of buildings and 1.5 m above ground using a Class 1 2231 B and K integrating sound level meter together with a 4230 B and K calibrator.

Dynamic range: Eighty dB adjustable to give full scale readings from 80 to 140 dB in 10 dB steps.

Exchange rate: Three dB - in addition 4 or 5 dB can be selected.

Threshold level: Can be set in the range 0-100 dB.

The acoustic survey was carried out in the working days excluding anomalous local circumstances like markets, fairs or festivities. Measurements were taken for all the sites in the daytime period which runs from 07:00 am to 22:00 pm by Iranian legislation. At each location and for each interval-time the A-weighted continuous equivalent sound level Leq and the statistical levels L_1, L_{10}, L_{50} and L_{90} were measured. At the each site, 10 days measurement was conducted.

RESULTS AND DISCUSSION

Noise levels time variation: An example of the measured acoustic data is reported in Fig. 2 where the time variation of the A-weighted sound level Leq and of the statistical levels L_1, L_{10}, L_{50} and L_{90} is plotted for the case of site 5. In Table 2, the daily average values for all the investigated sites are also listed.

Mean noise: In all sampling locations the daytime average sound level, Ld, exceeds the maximum permissible limit set by legislation. The overall mean value of Ld is 75 dB(A) with a standard deviation of 2.4 dB(A) while the overall mean value of the exceeding difference is 15 dB(A) with a standard deviation of 3.2 dB(A). In Fig. 3, the average Ld values per acoustic zone are shown together with the exceeding extent.

Peak noise: Statistical levels L_1 and L_{10} are obviously very high being determined by the transit of single vehicles which behaves as simple point sources. In daytime the mean values of L_1 and L_{10} for area A are 80.5 and 75 dB(A), respectively.

All the 18 site measurement results are included. A linear relationship between L_{10} and Leq is observed: experimental points are fitted by the linear law L_{10} = 0.93Leq + 2.9 with a correlation coefficient R^2 = 0.96

Table 2: Average values for noise levels

Site	L_1dB(A)	L_{10}dB(A)	L_{50}dB(A)	L_{90}dB(A)	L_ddB(A)	Mean	STD
1	79.5	76.1	68.0	64.4	74.3	70.8	4.4
2	80.1	75.2	65.4	61.2	76.0	71.4	4.4
3	81.3	75.6	68.2	63.8	77.1	73.2	4.2
4	80.7	74.2	65.3	62.7	75.2	72.2	4.3
5	81.2	73.4	66.4	64.9	74.6	71.0	4.5
6	78.3	72.1	64.2	61.5	73.4	70.2	4.9
7	77.8	70.6	63.0	62.9	70.0	69.7	4.5
8	77.7	72.4	62.7	60.2	72.6	69.1	4.6
9	78.2	69.2	61.4	55.3	71.5	68.8	4.1
10	79.8	76.3	67.0	64.3	73.1	69.4	3.9
11	82.2	78.4	69.9	67.6	78.1	71.4	4.0
12	80.4	74.6	67.1	65.0	75.2	69.5	3.4
13	81.1	75.3	66.2	64.3	76.8	69.8	3.2
14	80.4	75.2	65.6	59.1	74.2	70.3	3.1
15	84.3	79.2	70.9	66.8	78.0	73.4	3.5
16	82.2	77.4	68.4	65.5	77.2	74.2	4.1
17	81.6	76.5	69.0	66.3	78.3	75.3	3.6
18	83.4	79.1	70.6	65.7	78.6	75.6	3.7

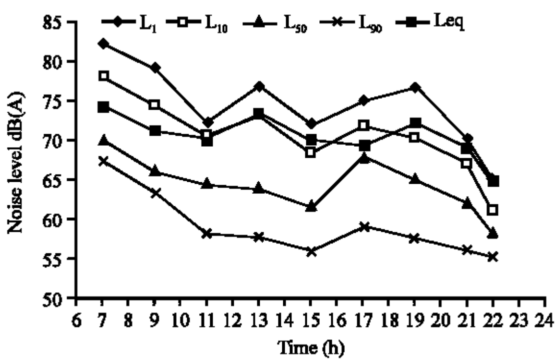

Fig. 2: Hourly noise levels relative to sampling location 5

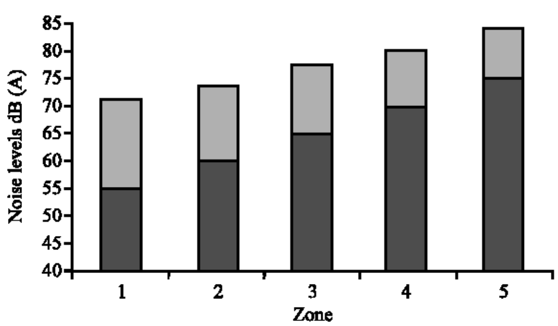

Fig. 3: Average Ld values per acoustic zone. Light grey areas indicate the exceeding extent over the permissible limits

(Commission of the European Communities, 2000). This result suggests that reliable prediction of L_{10} can be made once Leq is known (Fig. 4).

Background noise: Statistical levels L_{90} are very close and can be considered as the background noise levels. In this case noise is due to the whole stream of cars which behaves as a line source of sound.

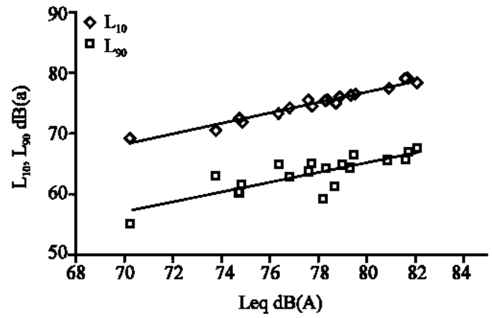

Fig. 4: Correlation between the percentile level L_{10} and Leq

The mean values of L_{90} for area A is 63.4 dB(A). The correlation between L_{90} and Leq is not as good as than that found between L_{10} and Leq as shown in Fig. 4 where the linear law $L_{90} = 0.8 \bullet Leq + 1.6$ fits measured data with a correlation coefficient $R^2 = 0.64$. It has been pointed out (Commission of the European Communities, 2000) that the increased data scattering observed at low percentile levels would reflect the high randomness of noise level fluctuations in the outdoor environment or the scattering of the noise climates. On the other hand, data at the lower noise levels are expected to inherently contain high degree of scatter as a result of the sensitivity of Leq levels to noise from other sources and from short duration noisy events.

CONCLUSIONS

The urban noise survey presented in this study has revealed that even in a medium size city such as Arak, environmental noise levels due to road traffic are notably higher than the limits set by Iranian noise standards and policy to protect public health. In the overall monitoring sites noise daily average sound levels Ld resulted higher than 71 dB(A) and clearly correlated with traffic flow conditions which are nearly saturated in most of the urban roads. Obviously, the identification of the worst affected areas requires the employment of noise mapping that, cause the relatively small number of measurement points, has not been possible to draw up in the present study. Anyway, available data have allowed to point out that an unsuitable and acoustically incompatible location of important facilities can give rise to marked spatial variations in the city noise, with the existence of areas characterized by sound level distributions obeying to different statistics. Since the most penalized areas cannot be easily redeveloped by the introduction of facility pertinent zones suitable to the urban characteristics of the specific areas, it is necessary to think of recovery plans.

This phase should come after the drafting of a noise map, actually in progress. At this point we can only affirm that, as the heavy traffic constitutes the main source of noise pollution, a desirable mitigation action would be that to find a new location for the landing-places far from residential areas to decongest the urban centre from the heavy traffic.

This action would give rise to the double benefit effect to reduce the number of vehicles and to reduce the maximum noise levels being prohibited the noisest vehicles.

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