Participatory Street-Level Noise Monitoring in the City of Chios

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Abstract
The noise at the streets of Chios was measured in November 2018 using low cost instrumentation and a student participatory experimental design. The higher noise levels detected were connected with port traffic and entairtainemed activities.
Keywords: ambient noise, low cost sound level meters, transport noise

1. Introduction

One of the most important sources of urban noise is connected with vehicular traffic and it is potentially dangerous for public health (McAlexander et al, 2015). In a public consultation held in Chios in 2012 on the promotion of green transport, the public of Chios ranked noise as a very important environmental problem associated with traffic in the city, above air pollution (Polydoropoulou et al, 2013). The use of low-cost devices for noise measurement although lagging in accuracy and precision in comparison with expensive scientific instruments, provides greater spatial coverage and sensitizes citizens by involving them in environmental monitoring. The approach is built upon the notions of participatory sensing and citizen science (Maisonneuve et al, 2009). The aim of this study was to measure the ambient noise level in the streets of Chios city using low cost sound meters, in order to identify spatial and temporal noise level variations and connections with vehicular traffic.

2. Methodology

Ambient, short term, noise level measurements were conducted in four locations in the city of Chios, on Friday 9/11/2018. The measurements were performed by thirty-eight, 3nd year students of the Department of Shipping, Transport and Trade, within the course "Transport and the Environment". Portable Sound Level Meters 407732 Model 407732 from EXTECH Instruments were used, with the following settings: The 'A' frequency weighting was selected to simulate the subjective response of the human ear. The "slow" response (1 sec) and the "low range" (35-100 dB) were chosen. The devices were shipped fully calibrated by the manufacturer. The experimental set up follows:

a. The measurements carried out every 3 hours, for a 20-minute period (e.g. from 12:00 PM to 12:20 PM, 3:00 PM to 3:20 PM etc) in each site.
b. The student, standing on the sidewalk, held the sound level meter facing the road traffic, at a height of 1.5 m above the ground, at least 1 m from the façade of the nearest building and 1,5 m from traffic and logged manually instantaneous values of the noise level every 10 seconds for a period of 20 minutes at each measuring point. This experimental setup resulted in 8 sets of 120 instantaneous noise level values at each of the 4 locations of measurement.
c. At the same time, traffic was counted at each point. Vehicles were classified as passenger cars, motorcycles, taxis, buses, vans and trucks.

The instantaneous noise level L_i (in dB) is given by the equation (1) $L_i = 10Log\left(\frac{I_i}{I_o}\right)$, where I_i (in W/m^2) is the instantaneous noise intensity and $I_o = 10^{-12}$W/m^2 is the reference intensity.

The average noise level L_{av} of n measurements is calculated by equation (2) $L_{av} = 10Log\frac{\left(\sum_i^n 10^{L_i/10}\right)}{n}$.

3. Results and Discussion

The maximum average 20-min noise level recorded was 80,6 dB at Aigaiou Avenue at 21:00 – 21:20 and the minimum value was 51,8 dB, at 3:00 – 3:20 at Kountourioti street (Table 1). Interestingly, at 3:00 am the noise levels were rather high at Aigaiou Avenue and Plastira statue. This is probably due to port traffic because between 4–5 am a big RO-RO passenger ship that connects Chios with Piraeus arrives at the port of Chios. The noisiest area on average was Aigaiou Avenue which has the greatest traffic (Table 2) and noisy entertainment activities. On the other hand, the area with the lowest

traffic values (Tsouri – Kalampoka) is not the quietest, probably because it has a high share of motorcycles (Table 2), there is a turn where vehicles decelerate and accelerate, and the road surface is not in good condition (puddles). There is a moderate correlation between noise and traffic volume (Figure 1) indicating other sources that contribute to the noise. In general, the traffic noise depends on the vehicles (engine and tyre-road surface noise), the conditions of the road surface, the traffic composition, the total traffic volume, the speed and the acceleration – deceleration of the vehicles (Subramani et al, 2012). According to WHO, for industrial, commercial, shopping and traffic areas (indoors and outdoors), L_{Aeq}=70 dB for 24 h causes hearing impairment (Berglund et al, 1999).

4. Conclusions

There are indications of quite high noise levels, even in the night, especially at the streets that connect the city with the port and its hinterland. Noise sources are vehicle traffic, entertainment activities, the arrival – departure of the ship, the speed patterns of the vehicles, the traffic composition and the condition of the road surface.

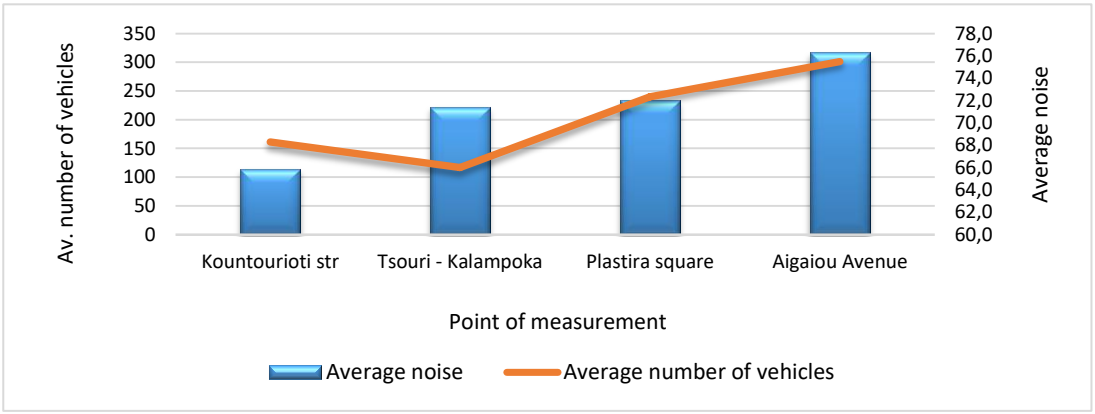

Figure 1. The average noise and the average number of vehicles at the four locations of measurement

Table 1. The noise levels with regards to time and monitoring point

NOISE (dB)	Time (hours)								
Point	**0:00**	**3:00**	**6:00**	**9:00**	**12:00**	**15:00**	**18:00**	**21:00**	**Average noise**
Kountourioti str	62,3	51,8	62,5	68,4	66,6	67,7	66,1	68,2	66,0
Tsouri - Kalampoka	67,6	62,1	64,8	71,5	73,1	73,7	72,6	74,0	71,5
Plastira Statue	65,3	69,9	72,8	74,8	75,2	70,5	71,5	68,7	72,0
Aigaiou Avenue	71,2	75,7	72,6	77,0	76,2	74,3	76,1	80,6	76,3

Table 2. The total* traffic counts with regards to monitoring point and vehicle category

Vehicle category	Kountourioti str	Tsouri - Kalampoka	Plastira Statue	Aigaiou Avenue	TOTAL	Share (%)
Passenger cars	757	462	1423	1563	4205	64
Motorcycles	467	412	324	662	1865	28
Taxis	28	24	58	36	146	2,2
Busses	4	0	22	24	50	0,8
Vans	28	37	77	93	235	3,6
Trucks	6	0	14	34	54	0,8
TOTAL	1290	935	1918	2412		

*(in 6 periods of 20 min each, during 24 h)

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