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Determination of the Noise Pollution on University (Education) Campuses: a Case study of Ataturk University

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Abstract
Noise pollution is among the most prominent environmental problems encountered in every aspect of daily life. The effect of noise pollution is the cause of a variety of serious health hazards. Special care should be taken to prevent noise pollution especially in areas which are sensitive to noise such as hospitals, parks, and educational institutions. One such area is the university campus; however, very little research has been conducted on this subject. In the present study, noise levels were measured on the Ataturk University campus in Erzurum, Turkey. Results of the study revealed that the average noise level was 62.70 dB(A) exceeding 55 dB(A), which is an average permitted value. A map was created to indicate the noise levels throughout the campus. This map is available for use as a reference in the planning phases of new universities. Noise mitigation should be considered in the planning phases of new university campuses.
Keywords: Barriers, Erzurum, noise map, noise pollution, University campus.

Üniversite (Eğitim) Yerleşkelerinde Gürültü Kirliliğinin Belirlenmesi: Atatürk Üniversitesi Örneğinde
Özet
Gürültü kirliliği, günümüzün en önemli çevre sorunlarından biri olup, hayatımızın her alanında karşımıza çıkmakta ve önemli sağlık sorunlarına sebep olmaktadır. Özellikle gürültüye hassas alanlar olan hastane, park ve eğitim alanları gibi yerlerde gürültü kirliliği konusunda daha dikkatli davranmalı ve tedbirler alınmalıdır. Gürültüye hassas alalardan biri olan üniversite ve eğitim yerleşkeleri gürültü kirliliği karşı fazla çalışma yapılmaması önemli bir eksikliktir. Bu amaçla Erzurum kentinde bulunan Atatürk Üniversitesi yerleşkesindeki gürültü kirliliği ölçümleri yapılmış ve gürültü seviyesi izin verilen 55 dB(A)'i geçerek, ortalama 62.70 dB(A) olduğu belirlenmiştir. Çalışmada ayrıca yerleşkenin gürültü haritası oluşturularak, özellikle yeni kurulan üniversite yerleşkelerinde gürültüye karşı alınabilecek önlemler belirtilmiştir.
Anahtar Kelimeler: Erzurum, gürültü haritası,gürültü kirliliği, önlemler, üniversite yerleşkesi.

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INTRODUCTION

The importance of noise pollution has gained much importance in recent years (Yıldırım 1993, Yılmaz and Özer 2001). While there was an increase in the price of properties close to main transportation arteries in previous years, this is no longer the case today as new developments in suburban areas become more accessible (Yılmaz and Özer 1997).

Noise pollution has become an important environmental problem in that this problem has negative impacts on public health both physically and psychologically (Aparicio-Ramon, et al. 1993, Joshi and Osada 1997, Buchta and Vos 1998, Kura et al. 1999, Ali and Tamura 2003, Stansfeld and Matheson 2003). There have been many attempts to reduce noise pollution in many countries (Arana and Garcia 1998, Onuu 2000, Zannin et al. 2002, Li et al. 2002, Morillas et. al 2002, Kumbur et al. 2003, Yılmaz and Özer 2005, Özyonar and Peker 2008, Pathak et. al. 2008, Allen et. al. 2009).

Noise pollution is among many environmental problems in close proximity to school campuses. However, with the increase in the number of motor vehicles comes an increase in noise levels. The negative relationship between learning performance and noise levels in educational centres has been determined and noise pollution has been found to

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reduce learning capabilities (Koszarny 1978, Ko 1979; Sargent et al. 1980, Green et al. 1982, Aydın 1998, Arı 1999).

The present study measures the levels of noise pollution on the Ataturk University campus and tests methods of mitigation. In addition, the principles of campus planning in order to reduce noise pollution were tested for newly founded universities in Turkey and other areas of the world.

MATERIAL AND METHODS

Material

The city of Erzurum is located in the eastern part of Turkey. It is the largest city in the Eastern Anatolian region with a population of 402,000. The city's economy is largely based on agriculture in the rural areas and winter tourism in urban areas. Harsh climatic characteristics are prevalent in the city and its elevation is 1850 to 1950 m. above sea level. Temperatures range from -37 0°C and below in the winter to 36,5°C and above in the summer (Anonymous 2011). A considerable amount of the plain on which the city is located is left for the campus of Atatürk University (Fig. 1).

Atatürk University is among the first established universities in Turkey, founded in 1957 in close proximity to the city centre. The university plays a large role in the social and economic life of the city. The total number of the students registered at the university is 33,540 and among them 30,000 live on campus. There are 14 faculties, 4 vocational schools, 6 graduate schools, and 14 research centres at Ataturk University (Fig. 2). The total surface area of the university is 8 million m^2 of which 4.3 m^2 is open green space. There is a dormitory complex with the capacity for seven thousand students and public houses for university staff.

Methods

Within the scope of the study period, noise measurements were conducted at 12 different sites along the main axes where faculties are located, where there is dense motor vehicle traffic flow, and at one site on a street with relatively less traffic. In the selection of the measurement sites, two principles were considered. The first principal was the selection of the sites close to the service buildings for educational purposes; the second was to select the sites where the movement of vehicles changes, such as bus stops or traffic lights.. The 13 selected sites were: 1) Nursery Faculty, 2) Science Faculty, 3) Theology Faculty 4) Sports Facilities 5) University Market, 6) Administration Building, 7) Engineering Faculty, 8) Education Faculty, 9) Chemistry Faculty, 10) Entrance from Yenişehir, 11) Entrance from Dadaşkent, 12) Monument, and 13) the Agriculture Faculty.

Noise measurements were carried out three times per day, in the morning, noon, and evening during periods when there was no precipitation and less traffic. Morning measurements were taken between 08:00 and 09:00, afternoon measurements were taken between 12:00 to 13:00, and evening measurements were taken between 16:00 to 17:00. Noise levels were measured using a , Cell 254 K2 model device, 1.2 m above the ground and 3 m away from the noise source (Ramis et al. 2003, Jamrah et al. 2005). In every measurement a total of 40 values were measured in four minutes (Yılmaz and Özer 2005). The noise values obtained were converted into Leq units. A variance analysis and the Duncan multiple comparison tests were applied to the data (Anonymous 1999).

A spatial distribution map of noise levels on campus was constructed using the ArcGIS 9.1 software which contains the interpolation technique "Inverse Distance Weighted". The IDW technique provides the ability to adjust the values according to the distance of the location from the noise sources. After selecting the measurement sites and considering the maximum distance between them and the radius type variable, the surface distribution map of noise levels was drawn based on these measurement values.

RESULTS

The campus of Atatürk University is very close to the city centre and therefore has high levels of traffic an average of 971 vehicles enter the campus each hour. The noise levels measured at 13 different sites revealed that average noise levels were above the permitted value of 55 dB(A) (Anonymous 2014) . The mean noise levels measured at all sites was 62.70 dB(A), exceeded the permitted value by 7.7 dB(A). The mean values of the morning, noon, and evening measurements are similar, measuring 62.65 dB(A), 62.51 dB(A), and 62.95 dB(A), respectively (Fig. 3).

The mean noise levels for each point were compared and the maximum mean noise level was discovered to be at the fourth site (near the sport facilities) with 67.97 dB(A). This site is near the main campus axis and there is no traffic calming

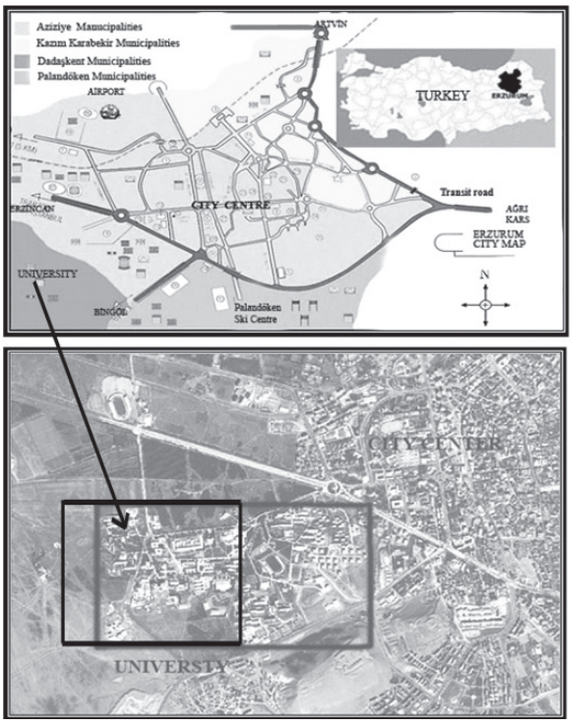

Fig. 1. Location of Erzurum Turkey and the Erzurum city plan.

barrier on the road, therefore, vehicle speeds are generally increased at this point. This point is

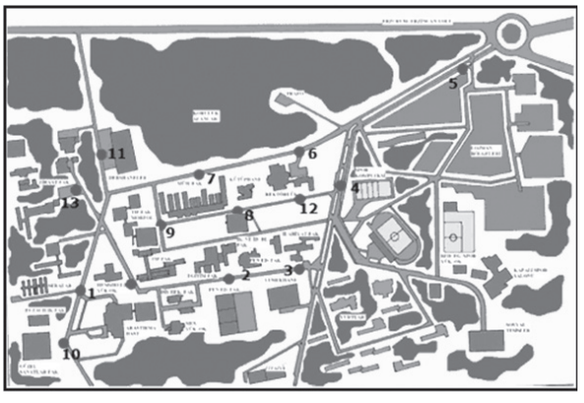

Fig. 2. Ataturk University Campus plan and measurement sites.

followed by the first measurement site, the Nursery Faculty, with 67.03 dB(A). This measurement site is one of the main stops for public transportation vehicles. Minimum mean noise levels were measured at the site near the Agriculture Faculty with 53.61 dB(A). This point is further away from the main axis than the other sites. However, even at this remote point the maximum permitted value was very closely approached. Values at all the sites

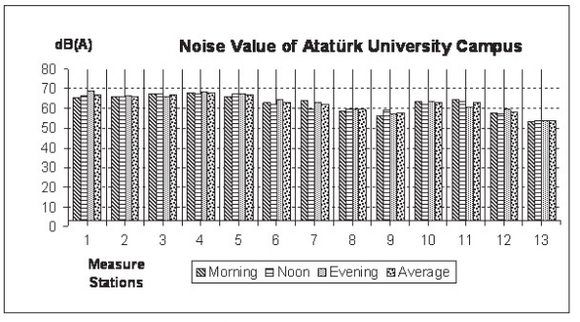

Fig. 3. Noise values of Atatürk University Campus.

except for the last mentioned site were above the permitted noise levels.

The experiment design was a complete randomized design with replication. The data was subjected to the analysis of variance using the SPSS statistical package. According to the statistical analysis, the differences of values at the 1st, 3rd, 5th, 6th, 7th, 10th, and 11th sites were not statistically significant ($p<0,05$) with a means of 67.03^{ab}, 67.13^{ab}, 66.93^{ab}, 63.19^{c}, 62.09^{c}, 63.05^{c}, and 62.83^{c}, respectively (Table 1).

A noise map of the University campus was drawn considering the mean values obtained from the three measurement times. From the map, it can be determined that the site represented by number 13 is affected by the least noise level and only this area is below the permitted value. The sites with the values above 65 dB (A) are shown in five different and isolated parts on the map. The prevalent range of noise values on the map of the campus is 55 - 65 dB (A) (Fig. 4).

DISCUSSION

This study revealed that there is significant noise pollution on the Ataturk University campus. From the map (Figure 4) representing the distribution of noise levels, it is clear that only a very small area of campus has acceptable noise levels. The reason for this unfavourable condition may be that vehicular traffic density is high including a large numbers of buses. Restrictions placed on the number and type of vehicles allowed should be suggested. Vehicles running on electricity could replace these types of vehicles to reduce the noise levels. Another measure may be that the vehicles entering the area should be diverted to large auto parks and should not be parked in close proximity to the educational areas.

Another measure of reducing noise levels on campus may be to reorganize places where traffic calming barriers currently exists and to add new

Table 1. Statistic analysis of noise measurement sites.

Measurement stations	*Morning*	*Noon*	*Evening*	Range
1	65,54	66,67	68,9	67,03^{ab}
2	66,34	66,34	66,38	66,35^{b}
3	67,49	67,62	66,29	67,13^{ab}
4	68,10	67,31	68,49	67,97^{a}
5	66,16	67,36	67,28	66,93^{ab}
6	63,08	62,15	64,35	63,19^{c}
7	63,91	59,42	62,95	62,09^{c}
8	58,67	59,57	59,47	59,24^{d}
9	56,35	59,16	57,4	57,64^{e}
10	63,53	62,29	63,33	63,05^{c}
11	64,4	63,58	60,51	62,83^{c}
12	57,6	57,35	59,35	58,10^{de}
13	53,32	53,83	53,69	53,61^{f}
Range	62,65	62,51	62,95	62,70

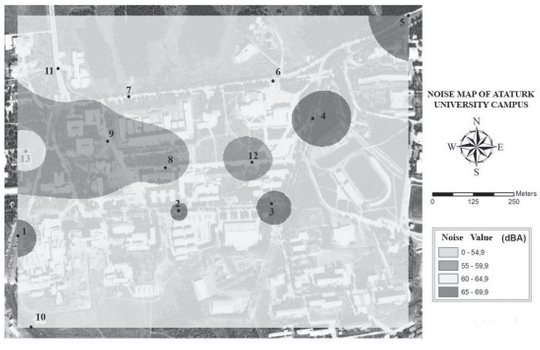

Fig. 4. Noise map of the Atatürk University Campus.

ones if required. These devices can prevent vehicles from producing excessive noise by reducing their speed. In this respect, careful examination of currently unsuitable barriers should be carried out and required measures should be taken. After passing over a barrier a driver increases speed, resulting in an increase in noise pollution. In order to reduce noise, barriers should be placed at least 100 m away from buildings.

Main access arteries of the University should be diverted to avoid educational facilities. If this is not possible, planted buffer zones with suitable noise reducing species should be planted between educational buildings and main arteries (Erdoğan and Yazgan 2007, Özer et al. 2007). Open green spaces and or beds planted in these areas should be 10 to 15 m wide and planted with a suitable combination of coniferous and broad leaved tree species. If these mitigation measures, are taken, noise levels may be reduced by a rate of 10 to 15 dB (A) (Anonymous 1974), which can considerably eliminate noise pollution.

Plants which may reduce noise levels including, *Pinus sylvestris* L. and *Picea abies* L. trees, which adapt to urban areas, can be planted for noise mitigation. As the deciduous tree, *Acer pseudoplatanus*, is known to reduce noise the most (10-12 dB(A)), can be planted with *Quercus robur* (6-8 dB(A)), *Acer negundo* (4-6 dB(A)), *Betula pendula* (4-6 dB(A)) and shrubs such as *Ribes divericatum* (6-8 dB(A)), *Syringa vulgaris* (6-8 dB(A)), *Forsythia intermedia* (4-6 dB(A)) and *Sambucus nigra* (Bernatzky 1978). In addition, the plant material used in the plant design should have branches at the ground level, a dense leaf area, and be planted so that their leaves are directed towards the noise sources (Finke 1980).

In addition, building insulation for heat conservation is essential in cities like Erzurum, where extremely cold winters are prevalent. This type of insulation can reduce not only heat loss but also reduce noise pollution in residential areas (Başar 2000).

Since the foundation of the University in 1957, noise pollution has consistently become a new and serious environmental problem on campus. In this respect, it may be suggested that the number of vehicles on the campus should be limited by more effectively controlling the vehicles entering the area, and the placement and number of traffic calming barriers should be carefully adjusted. As one of the most effective measures to be taken for the reduction of the noise level, efficient construction of buffer planting areas is suggested for the main axes hiding pedestrian walks from main arteries (Demirel 1998, Özer et al. 2007).

When planning new university campuses, noise pollution should be considered to be one of the planning factors. Noise pollution can be effectively mitigated by implementing appropriate planning measures (Güler and Çobanoğlu 1994). In addition, when selecting campus sites great care should be taken to construct campuses in areas away from city centres and noise sources.

It is vitally important that newly founded universities implement the above measures to achieve low levels of noise on campuses. Recent studies show that high levels of noise affect reading and comprehension negatively (McFarlandand and Ramstetter 1977, Atmaca and Peker 1999). It is only possible to perform prolific scientific and educational studies in a quiet and peaceful environment.

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