DOI: 10.25092/baunfbed.398478 *J. BAUN Inst. Sci. Technol., 20(1), 311-319, (2018)*

Determination of environmental noise levels at central Balikesir hospitals

Atilla MUTLU*

Balıkesir University Faculty of Engineering
Department of Environmental Engineering, Cagis Campus, Balikesir

Geliş Tarihi (Recived Date): 01.12.2017
Kabul Tarihi (Accepted Date): 07.02.2018

Abstract

In this study, our goal was to determine of noise sources and emission levels from very sensitive environments, such as hospitals, at downtown of Balikesir. It was also aimed to create noise pollution maps as the first time for those full-scale hospitals in Balikesir by carrying out of this study. According to the study results, it was determined that the noise level in Balikesir State Hospital (BSH), where is located closer to the city center, was higher than the noise levels in Atatürk State Hospital (ASH). In conclusion, the predicted noise values at BSH were higher about 9% (or approximately 7dBa) than the actual measured values. The modeling process was not performed at ASH, due to noise levels of ASH did not exceed the legal limits.

Keywords: *Balikesir, CadnaA, hospitals, noise.*

Balikesir şehir merkezindeki hastanelere ait çevresel gürültü seviyelerinin belirlenmesi

Özet

Bu çalışmada, Balikesir'de bulunan hastanelerin maruz kaldığı gürültülere ait kaynak ve emisyon seviyelerinin belirlenmesi amaç edilmiştir. İl merkezinde ilk kez yapılan bu çalışma ile hassas yapılardan olan hastanelere ait gürültü kirliliği haritalarının oluşturulması amaçlanmaktadır. Ölçüm sonuçlarına göre şehir merkezine daha yakın olan Balikesir Devlet Hastanesindeki (BDH) gürültü seviyesinin Atatürk Devlet Hastanesindeki (ADH) ölçümlere göre daha yüksek olduğu tespit edilmiştir. Sonuç olarak, BDH için modellenen gürültü seviyelerinin, gerçek ölçülen değerlerden yaklaşık

*Atilla Mutlu, amutlu@balikesir.edu.tr, http://orcid.org/0000-0002-0777-0863

%9 (yaklaşık 7dbA) kadar yüksek olduğu tahmin edilmiştir. ADH'de ölçülmüş değerler yasal sınır değerleri aşmadığı için, bu yerde modelleme yapılmamıştır.

Anahtar kelimeler: *Balikesir, CAdnaA, hastaneler, gürültü.*

1. Inroduction

It is known fact that environmental noise affects human health. Full-scaled hospitals where located in the city downtown are assessed within sensitive areas by the environmental noise regulations [1]. Therefore, hospitals are one of the most sensitive spots in terms of environmental noise. During the health service hours, traffic-related noise arises on the main streets. Patients and medical staff are adversely affected psychologically, biologically and physiologically due to existing environmental noise levels. This situation affects the quality of the health care services [2], [3], [4]. For this reason, it is necessary to identify sources of environmental noise emissions in which hospitals are exposed and it is also required to prepare environmental noise distribution maps in that sensitive areas [5], [6], [7].

In a previous study, correlations between air pollution and traffic related environmental noise levels were examined. As a result of the study, it was determined that there was a positive interaction between air pollution and environmental noise levels caused by traffic [8]. In another study, the noise level of the traffic was defined as the degree of impact. The net noise level from the source and the number of repetitions that occurred during the traffic activities were considered to be the main parameters of the environmental noise impact [9]. Another study reports that tires, which are the most important component of the running mechanism of the vehicles, should be produced in relevant qualities in order to reduce potential asphalt noise [10].

In this study, which was made for the first time in Balikesir downtown, it was aimed to determine the environmental noise levels that the hospitals were exposed during the service hours. It was also intended to prepare environmental noise distribution maps for those full-scaled hospitals.

2. Materials and methods

2.1. Study area

In this study, environmental noise level measurements were made at Balikesir State Hospital (BSH) and Atatürk State Hospital (ASH) in downtown Balikesir. Balikesir State Hospital has been serving since 1954 and has a capacity of 200 beds [11]. Ataturk State Hospital, has been serving since 1965 and has a capacity of 521 bed [12]. In the scope of the study, the first stage measurements were made at the main entrance where human and traffic activities are highly intensive (see Figure 1).

(a) (b)

Figure 1. Balikesir state hospital (a) and Atatürk state hospital (b).

2.2. Study plan and data collection

Measuring procedures for environmental noise levels were selected in order to represent daily activities. Sampling points were selected to characterized overall noise levels for those hospitals. For this reason, the main entrance area of each hospital were selected in this study. Rush hours were determined as morning hours (work starts, beginning of school and patient admission) and evening hours (work off, school day). Measurements were made, on Monday and Wednesdays at the BSH with 3 days a week; only on Fridays at ASH, between 07:30 AM - 6:00 PM. These specific days and time for sampling procedures were determined based on the official permissions from the hospital administrations.

In this study, noise data was collected by using standard (Verified to the IEC61672-1 Class 2) sound level meter (CEM DT-8852). The data collecting time interval was set and also recorded as one minute during the all measurements. Since the study period was limited for 3 months by officials, any seasonal comparisons were not performed on this study.

3. Results and discussions

3.1. Results of environmental noise measurement at hospitals

The measurement results of the study and the general descriptive statistical parameters of the obtained data are presented in Table.1 and Table.2.

Table 1. Environmental noise levels of Balikesir state hospital.

Dates	Minimum	Maximum	Means	Std.Dev.
8 April	54.0	79.8	**65.9**	4.0
10 April	53.0	81.2	63.8	4.8
15 April	52.1	78.7	62.4	4.6
17 April	49.9	85.9	62.3	4.7
22 April	53.2	82.3	63.2	4.7
24 April	49.9	84.6	63.6	4.4

Table 2. (Continued).

29 April	42.5	78.4	57.7	5.4
1 May	43.2	78.7	58.2	5.9
6 May	42.5	78.0	58.5	5.5
8 May	53.5	83.1	62.8	4.2
13 May	48.4	88.6	62.2	5.9
15 May	49.6	80.8	61.6	5.0
20 May	50.7	79.5	62.4	4.5
22 May	48.5	83.0	62.3	4.7
27 May	50.9	79.3	61.9	4.7
29 May	51.0	83.5	**65.9**	5.1
3 June	53.0	82.1	63.0	4.7
5 June	42.9	78.4	59.0	5.5
10 June	48.7	83.5	62.3	4.5
12 June	49.20	80.40	61.2	5.0

As a result of the measurements that performed in BSH, a total of 21 individual measurements were conducted at the BSH's main entrance. The lowest environmental noise level during measurements was recorded as 42.5 dBA, while the highest level was recorded as 88.6 dBA in BSH. According to statistical analysis results, the morning noise levels were higher than evening noise levels in those collected 21 data sets. The results also show that mean noise levels of 8 April and 29 May exceeded the legal limits (65 dBA).

Daily environmental noise levels in ASH were also measured and the measurement results are presented in Table.2.

Table 2. Environmental noise levels of Atatürk state hospital (ASH).

Dates	**Minimum**	**Maximum**	**Means**	**Std.Dev.**
5 April	49.5	74.1	55.9	3.0
12 April	49.5	75.3	55.9	2.9
19 April	52.6	72.4	59.3	3.4
26 April	49.9	73.3	59.4	5.4
3 May	51.2	77.0	57.6	2.9
10 May	49.0	74.8	55.4	2.9
17 May	49.7	69.3	55.4	3.4
24 May	50.5	71.4	56.2	3.9
31 May	49.1	73.8	54.8	2.6
7 June	49.9	69.0	55.3	2.8
14 June	49.9	73.4	56.9	3.7

A total of 11 individual measurements were conducted at the ASH's main entrance. The lowest environmental noise level during measurements was recorded as 49 dBA, while the highest level was recorded as 77 dBA in ASH.

3.2. Modeling and mapping of environmental noise levels

Nowadays, the first step to be taken for the environmental noise problem is to determine the current noise level and create noise level maps [13]. Noise maps are considered as a

way of numerically and visually expressing distributions of environmental noise from related sources [14]. In this method, the changes in the potential noise levels from physical factors in the environment are illustrated and also animated on a map. Noise mapping is done by including several preliminary information such as detailed map, road information and population density. Thus, the modeling program also needs certain information such as traffic (route) plans, vehicle numbers, vehicle speeds, vehicle types, road features as inputs are transferred to the noise map program in computer [15]. Vehicle numbers were determined by counting in real time at the intersection of each roads around the hospital. Also, vehicle speeds were gathered from the program by selecting type of the vehicles. The environmental noise levels, for a specific area, obtained from the noise maps are compared to the official limit values that are found in the legislation [16]. The current regulation, Environmental Noise Assessment and Management, states that the weighed noise limits in day time must not exceed 65 dBA for sensitive places such as hospitals [1].

In the second part of the study, environmental noise measurements were conducted at BSH (Balikesir State Hospital), where local traffic activities are more intense, to ensure the validity of the modeling results. In order to determine noise levels that the BSH may be exposed, a total of 15 measurement points are selected around the hospital (Figure. 2).

Figure 2. Measurement points at BSH (Balikesir state hospital).

A software named CadnaA (Computer Aided Noise Abatement, DataKustik, 2016) was used to visually express the change in environmental noise levels in study area [17]. In this program, the number of vehicles (normal and heavy vehicles) passing through the near streets, the coordinates of the hospital, all the transportation lines of the hospital area, the technical specifications (one way / two way, lane width) of the roads are used as input parameters. Also, details of receptors to figure out environmental noise levels of hospital has been exposed are indicated on the map. The modeled environmental noise distributions for BSH are presented in Figure 3.

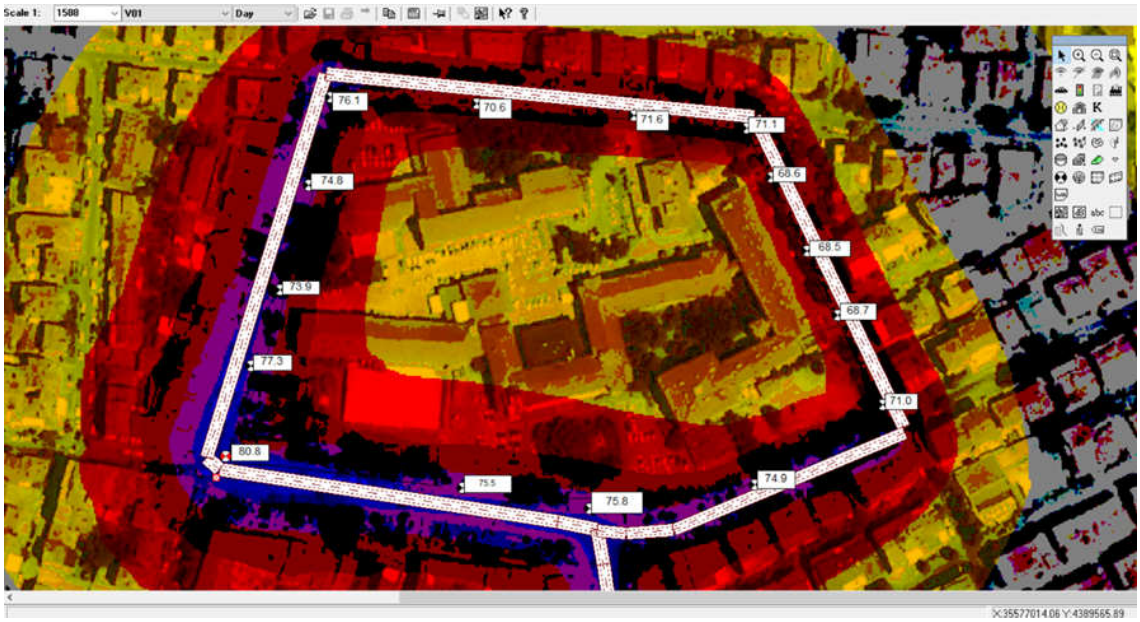

Figure 3. Environmental noise map of BSH.

After mapping, measurements were made at precisely specified receptor points in the model to investigate the validity of the predicted environmental noise levels. For this process, on-site measurements were held regularly on Mondays, Wednesdays and Fridays as three times a week. The overall results of the measurements are presented in Table 3.

Table 3. Environmental noise levels of Balikesir state hospital (BSH).

Measurement Points	**Minimum**	**Maximum**	**Means**	**Std. Dev.**
Point1	47.0	111	68.7	6.4
Point2	49.9	114.9	68.2	6.6
Point3	48.7	98.9	67.4	6.7
Point4	51	84.6	66.7	5.2
Point5	44.3	84.3	68.3	5.7
Point6	49.6	105.1	66.6	5.8
Point7	50.9	88.4	65.2	5.1
Point8	48.2	89.9	65.6	5.2
Point9	51.2	98.2	64.8	6.4
Point10	50.3	89.9	66.2	5.3
Point11	49.1	102.1	64.1	5.7
Point12	52.2	90.6	66.1	5.1
Point13	51.1	94.5	66.4	6.2
Point14	51.8	92.4	68.0	5.3
Point15	48.5	101.2	67.7	5.7

In the last part of the study, the modeled and also the measured environmental noise levels were compared and the results are presented in Figure 4. Generally, it is determined that the modeled values were higher than the measured values by about 9% (in other words about 7dB) in BSH. The difference might occur due to sensitivity of on-site measurements that may reflects more realistic (or valid) results if they compared with modeled results. According to modeling results, the highest modeled noise levels were predicted at the south-west corner location of the BSH. The highest modeled environmental noise level for BSH was estimated as 80.8 dBA. The south-west corner location has more traffic density than the other sampling point due to number of vehicles that passed and also traffic lights that causes noises during start and stops. The modeling process was not performed at ASH, because environmental noise levels in the Atatürk hospital did not exceed the legal limits.

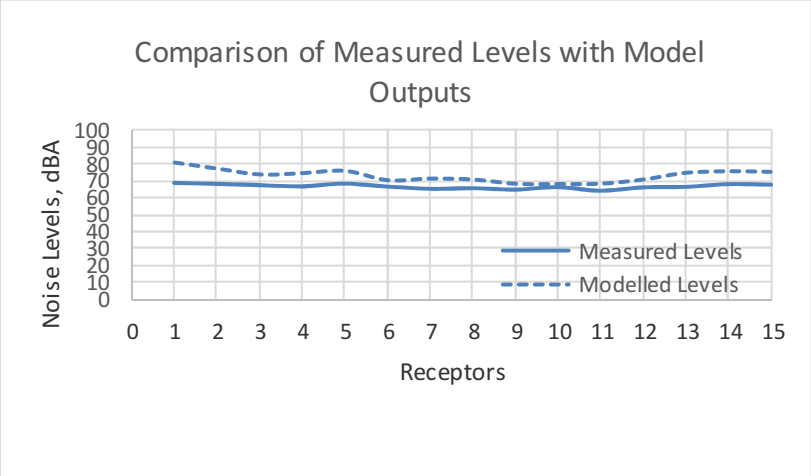

Figure 4. Measured and modeled environmental noise levels of BSH.

In a similar study in Greece stated that environmental noise levels were measured as 52.6 (± 8.2 dBA) and 59 (± 2.2 dBA), respectively, in two different hospitals [18]. It might be concluded that the measured noise levels at BSH (Balikesir State Hospital) were about 10% higher than those measured hospitals in Greece. This difference may be occurred that due to the fact that our hospital had more traffic density.

4. Conclusions

The following results were obtained as a result of the studies that carried out in full-scale hospitals in downtown Balikesir City;

- ✓ The equivalent environmental noise levels in BSH (Balikesir State Hospital) where is located in Downtown were found to be statistically higher than ASH (Atatürk State Hospital) which is located on the West side of the Downtown. The difference might occur due to highly heavy traffic activities around the BSH.
- ✓ The equivalent environmental noise levels of BSH were found to be higher in morning time than in other time periods for that hospital. In mornings, some traffic activities around the hospital may be reorganized by local officials, For instances, giving permission to enter hospital area only public transportation vehicles rather than private and commercial vehicles, by lessening stop and go

processes of the vehicles via eliminating traffic lights, by making one-way routes around the hospital area.

- ✓ It was determined that the equivalent environmental noise levels in the Atatürk hospital did not exceed the legal limits.
- ✓ When the measurement results are taken into consideration, it was determined that the level of environmental noise in BSH, which is located in the downtown, was higher than the environmental noise level in ASH. The main difference might occur due to highly heavy traffic activities and more patient acceptances in the BSH.
- ✓ As a result of the environmental noise levels obtained from the noise maps, it was understood that the values modeled in BSH, in general, were as high as about 9% (in other words about 7dBA) than the actual measured environmental noise levels. The difference might occur due to sensitivity of on-site measurements that may reflects more realistic (or valid) results if they compared with modeled results.
- ✓ There is a need to carry out more extended study in order to figure out not only traffic but also the other possible noise sources around the hospitals. The future study should be conveyed for longer period to determine whether any seasonal differences are exists.

Acknowledgement

We would like to express our gratitude to the Balikesir University, the Ministry of Health and the Scientific and Technological Research Council of Turkey (TUBITAK 2209/A) for their support in order to complete this study.

References

[1] ÇGDYY, Ministry of Environment and Forestry, Environmental Noise Assessment and Management Regulation, 4 June (2010).

[2] Suksaard, T., Sukasem, P., Tabucanoo, M., Aoi, ı., Shirai, K., and Tanaka, H., Road traffic noise prediction modeling Thailand, **Applied Acoustics**, 58(2), 123-130, (1999).

[3] Pamanikabud, P. and Tharasawatpipat, C., Modeling of urban area stop-and-go traffic noise, **Journal of Transportation Enginering- Asce**, 125(2), 152-159, (1999).

[4] Kumar, K. and Jain, V.K., Autoregressive integrated moving averages (ARIMA) modelling of a traffic noise time series, **Applied Acoustics**, 58(3), 283-294, (1999).

[5] Harris, R., Cohn, L., and Knudson, S., Evaluation of the federal Highway Administration's Traffic Noise Model, **Journal of Transportation Enginering-Asce**, 126(6), 513-520, (2000).

[6] Probst, B. and Huber., Calculation and assessment of traffic noise exposure, **Sound and Vibration**, 34(7), 16-20, (2000).

[7] Baldemir, F. and Akbulut, A., Determination of Noise Level and Sources in Elazığ City Center, **F.Ü. Fen ve Mühendislik Bilimleri Dergisi**, 9(1), 1-16, (1997).

[8] Clench, J., Bartonova, A., Klaboe, R. And Kolbenstvedt, M., Oslo traffic study-part 1: an integrated approach to assess the combined effects of noise and air polution on annoyance, **Atmospheric Environment**, 34(27), 4727-4736, (2000).

[9] Sato, T., Yano, T., Björkman, M., and Rylander, R., Road traffic noise annoyance in relation to everage noise level, number of events and maximum noise level, **Journal of Sound and Vibration**, 223(5), 775- 784, (1999).
[10] Herman, L.A., Analysis of strategies to control traffic noise at the source-Implications for policy makers, **Environmental and social effects of transportation**, 1626, 41-48, (1998).
[11] Turkey Public Hospitals Authority (TKHK), [Online]. Available: http://Balikesirdh.saglik.gov.tr, (2016a)
[12] Turkey Public Hospitals Authority (TKHK), [Online]. Available: http://Balikesirataturkdh.saglik.gov.tr, (2016b)
[13] Nas, B., Road Traffic Noise Levels in Konya City Using Geographical Information Systems (GIS), **3. Coğrafi Bilgi Sistemleri Bilişim Günleri**, 6-9 October (2004).
[14] Probst, W. and Huber,B., The Sound Power Level of Cities, **Sound and Vibration**, 37 (5), 14-17, (2003).
[15] Bıçakçı, T., Environmental noise maps resulting from traffic and Cukurova University Campus sample, Master Thesis, Çukurova University, Adana, Turkey, (2003).
[16] Kurra, S., **Environmental Noise and Management**, Bahçeşehir Üniversitesi Press, İstanbul, Turkey, (2009).
[17] DataKustik,CadnaA (Computer Aided Noise Abatement), [Online]. Available: http://www.datakustik.com/en/products/cadnaa/, (2016)
[18] Tsara, V., Nena, E., Serasli, E., Christaki, P., Vasileiadis, V. and Matamis, D., Noise Levels in Greek Hospitals, **Noise and Health**, 10(41), 110-112. DOI: 10.4103/1463-1741.44350, (2008).