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Evaluation of Urumiyeh (Iran) City Park in Terms of Noise Analysis and Sound Landscape

Urumiyeh (İran) Kent Parkı Gürültü Analizi ve Ses Peyzajı Açısından Değerlendirilmesi

Nazli ESMAEİLİ HESAR[1]

Serkan ÖZER[1]

Elif ÖNAL[1]

[1]: Atatürk University. Architecture and Design Faculty. Landscape Architecture Department, Erzurum, Türkiye

ABSTRACT

This study was conducted to evaluate how sound affects the soundscape character of Urumiyeh City Park in Urumiyeh, Iran, as a design and planning element. The study includes determining the sound status of the park and determining to what extent the noise factor, if any, can affect the soundscape. In the study method, first, the existing sound sources of the park were determined in the field. Then, for noise measurements, the study area was divided by 50 m equal intervals and 80 stations were determined. Measurements were made at these stations in three different time periods, Tuesday, Friday, and Saturday, in the afternoon, mid-afternoon and evening, for two months. As a result of the measurements, it has been determined that it exceeds 45 dB(A), which is given as the acceptable noise value for parks by WHO, in the entire park, and it exceeds it to a great extent, approximately 42 dB(A) at some measurement stations. In the evaluation of the obtained sound data, 10 different noise maps were made using the Kriging method on the ArcGis10.6. program. Finally, suggestions were made by discussing how to highlight the desired sounds in the park to reduce the noise that bothers people in Urumiyeh City Park, using concave elements and walls to reflect positive sounds and taking other necessary measures.

Keywords: Noise pollution, Noise map, Soundscape, Precautions, Urumiyeh City Park

ÖZ

Bu çalışma, İran'ın Urumiyeh kentinde sesin bir tasarım ve planlama unsuru olarak, Urumiyeh Kent Parkı'ndaki ses peyzajı karakterini nasıl etkilediğini değerlendirmek için yapılmıştır. Parkın ses durumunun belirlenmesi ve gürültü faktörü varsa ses peyzajını ne derece etkileyebileceğinin belirlenmesi çalışma esasını içermektedir. Çalışma yönteminde ilk olarak parkın mevcut ses kaynaklarının alanda tespiti yapılmıştır. Sonrasında gürültü ölçümleri için çalışma alanı 50 m. eşit aralıklarla kareleme yapılarak bölünmüş ve oluşan 80 istasyon belirlenmiştir. Bu istasyonlarda ses ölçüm cihazı ile iki ay boyunca, Salı, Cuma ve Cumartesi günleri ile bu günlerde öğlen, ikindi ve akşam olmak üzere üç farklı zaman diliminde ölçüm yapılmıştır. Ölçümler sonucunda parkın tümünde WHO tarafından parklar için kabul edilebilir gürültü değeri olarak verilen 45 dB(A)'i geçtiği bazı ölçüm istasyonlarında yaklaşık 42 dB(A) gibi çok büyük oranda aştığı tespit edilmiştir. Elde edilen ses verilerinin değerlendirmesinde hesaplamalar ArcGis10.6. programı üzerinde Kriging yöntemi kullanılarak 10 ayrı gürültü haritası yapılmıştır. Son olarak Urumiyeh Kent Parkı'nda kullanıcıları rahatsız eden gürültüyü azaltmak için parkta arzu edilen seslerin ön plana çıkartılması, olumlu seslerin yansıtılması için ise iç bükey eleman ve duvarlar kullanılması, park arka fon müziklerinin fazlalaştırılması ve diğer gerekli tedbirlerin alınması üzerine tartışılarak önerilerde bulunulmuştur.

Anahtar Kelimeler: Gürültü kirliliği, Gürültü harita, Ses peyzajı, Önlemler, Urumiyeh Kent Parkı

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Corresponding author / Sorumlu Yazar: Elif ÖNAL
E-mail: elif.onal@atauni.edu.tr

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Introduction

The concept of soundscape is known by many architects and planners as all the sounds that exist in a particular space (Dixon, 2010).

Soundscape is defined as the totality of sounds in a location, emphasizing the relationship between an individual's or society's perception, understanding and interaction with the acoustic environment (Payne et al., 2009). The main issue of concern in the soundscape approach is not the unwanted sounds that disturb people but the need for people to focus on the sounds they want to hear and desire. The soundscape is an important factor in the perception of visual phenomena. It is also an important criterion in creating a sense of space (Leus, 2010). Each environment has a different soundscape. Yu and Kang (2010) stated that the perception of the soundscape character of a space by individuals is affected by many factors, both physical and social and cultural. They stated that preferences in the soundscape do not emerge only by focusing on the sound itself, but are also related to the perceived information about other relevant components of the environment. (Yu & Kang, 2010; Kaymaz & Belkayalı, 2013).

According to Shahabian *et al.* (2016), the sound is an important factor in the behavior of users as an integral part of the urban landscape, in the selection of space, and in the perception of users consisting of the urban environment, in general, urban quality. In the study conducted by Shahabian *et al.* (2016), three factors affect the image created by the soundscape on people:

1- Information provided by the sound wave,

2- The source from which the sound is formed,

3- The sound level.

It is accepted that the quality of the soundscape can be characterized by perceptual parameters. These parameters can focus on sound sources that make up the soundscape, such as people, traffic or natural factors, and define the activation times, volume levels or dominance of sounds. Non-sound-related factors such as visual parameters and other external factors can affect the perception of the soundscape (Aumond et al., 2017).

The absence of overlap is effective in removing the acoustic environment from monotony, harmony caused by sound reflection, or in absorbing the sound of existing surfaces. At the same time, factors such as water, weather, humidity, and wind also support this situation (Nasirpour, 2013). In fact, this creates a sense of space for the individuals in the environment. The accumulation of very intense and unidentified sounds in places where the soundscape quality is poor leads to the loss of individual audio signals. Transparent sounds, such as walking in the snow, and animals crawling between bushes, become inaudible due to the existing sounds in the environment. In such environments, the sound perspective is lost and destroyed. Because of this, meaningful sounds are not heard, and the person's surrounding hearing capacity is reduced. This problem can progress to such a level that the person will not even hear their own speech. In such cases, most of the sounds are drowned out, turned off, or mixed with other sounds, losing the information it contains and changes (Shabirinejad, 2009). Pouya (2022) stated that soundscape quality has a great impact on other environmental attributes such as the role of the space, its readability, identity, sense of belonging, and location (Pouya, 2022).

As is known, the task of landscape architects and urban designers is to improve the quality of urban areas. To achieve this goal, the soundscape is a tool. According to Nasirpour (2013a), three factors are examined in parallel in all studies related to soundscape:

1. Reducing or disabling sounds that are too loud and unpleasant,
2. Preservation and reproduction of pleasant sounds,
3. Reproduction of the required sounds by adding sound elements that are not available in the current case.

In one study, it was stated that the noise factor in the environment affects the perceptions of the soundscape (Ferguson et al., 2024). In another study, it was stated that the main purpose of studies and evaluations on soundscape is to determine the sound or noise level and evaluate sound preferences (Yu and Kang, 2010; Yang and Kang, 2005). Noise level measurements, especially noise mapping studies, are one of the basic quantitative methods in determining acoustic comfort (Kaymaz & Belkayalı, 2013). In 2002, within the framework of the European Union (EU) "Assessment and Management of Environmental Noise Directive (2002/49/EC), it was made mandatory for all EU members to carry out noise analyzes in areas where the population is dense and where there are primary road systems (Tsai et al., 2009; Stimac, 2005). Geographic information systems in noise level measurement studies; In addition to creating a noise map, it can be used as a very effective tool in the process of more detailed planning and correct decision-making (Kaymaz et al., 2013; Tsai et al., 2009; Yamada, 2006).

This study was conducted to determine the sound status of Urimiyeh City Park, the most important park in Iran, and to determine to what extent the noise factor, if any, could affect the soundscape. With this study, first of all, the sound sources of the park were determined. Then, with the measurements made, it was determined whether there was a noise problem, where it was more and what

precautions could be taken for the areas where it was more. As a result of the study, suggestions were made to reduce unwanted sounds and increase desired sounds as studies that could be done in terms of the soundscapes of other parks and cities, specific to this park.

Material and Methods

Material

Urumiyeh is the center of Iran's Northwest Azerbaijan Province (Figure 1). The city is 18 km from Urumiyeh Lake. The city of Urumiyeh has an area of approximately 60 km^2. The city of Urumiyeh is located on the plain named after it, 50 km from the Turkish border (Figure 1).

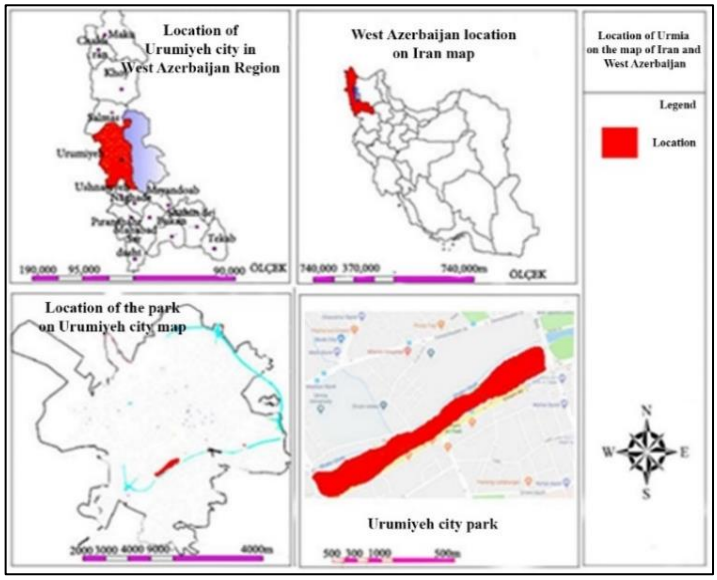

Figure 1.
The location of the city of Urumiyeh and the research area on the map (Esmaeili Hesar, 2019)

The main material of the study is the Urumiyeh urban park, which is located within the boundaries of the first district of the Urumiyeh Metropolitan Municipality. Urumiyeh urban park has an area of 60 decares. In the northern part of the research area, there is the Sehircay River, which continues parallel to the park. Across the river are the Urumiyeh University campus, a residential area, and an administrative institution. To the east of the park is Molavi street, to the west is Edalet street and the reserve area, to the south is Imama Ali boulevard, and to the north is the shopping center and residential area (Figure 2).

There is also an exhibition area at the main entrance of Urumiyeh park, where 30 different types of trees, 41 different shrubs, and especially 100 different types of tulips are exhibited. A flower festival is held in April, and a grape festival is held in September every year in the park. In addition, the park is highly preferred for activities such as walking and exercise athletes (Figure 3). Since the park is in the city center, there are many important roads surrounding it.

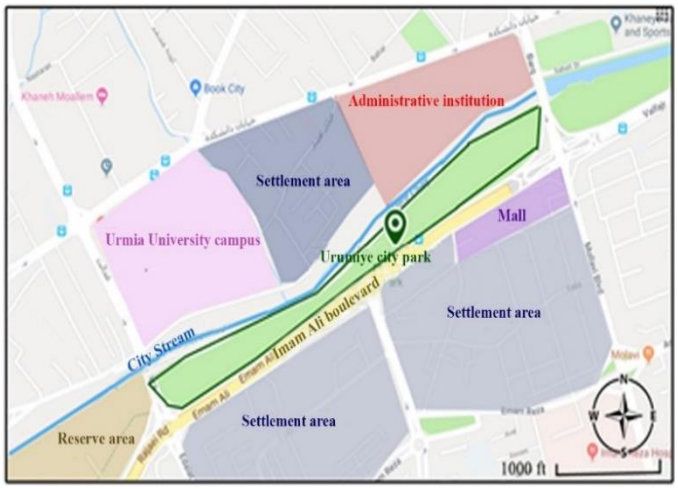

Figure 2.
Location of Urumiyeh City Park

Figure 3.
A General View from the Park Location (Urumiyeh parks and gardens directorate site (Anonymous, 2019)

Method

The study method consists of 5 stages. In the first stage, studies on noise measurements and soundscape were examined. In the next stage, the existing sound sources of the park in terms of soundscape were surveyed in the field. The existing sound sources of the park in terms of soundscape (traffic, construction and similar anthropogenic sounds, the presence and conditions of soundscape elements such as bird sounds, water sounds) were defined with a silent walk in the park. The definition of sounds was made within the framework of the general findings stated in the literature (Benfield et al., 2010, Abbott et al., 2016, Buxton et al. 2017, Franco et al., 2017, Ferraro et al., 2020, Kogan et al., 2021, Ferguson et al., 2024). In the third stage, the places to be measured in the park were determined with a grid system. In order to determine the noise level in the Urumiyeh city park, the St-8851 brand sound measurement device (sonometer) with ±1 accuracy received by the Urumiyeh Park and Gardens Directorate was used. The

study area was divided by squaring at equal intervals of 50 m. As a result of the division, measurements were made from a height of about 1.50 m above the ground with a sound measuring device at 80 stations (Figure 4). Measurements were made in rainless and windless weather in November and December 2022 (Ozer, 1998; Kaymaz and Belkayalı, 2013). The measurements were made on an average of 40 times over 4 minutes at each measurement site for two months during the weekdays and weekends, from 14:00 to 15:00 p.m. to 17:00 to 18:00 p.m. and from 7:30 p.m. to 8:30 p.m., when people use the park more, and noise is louder.

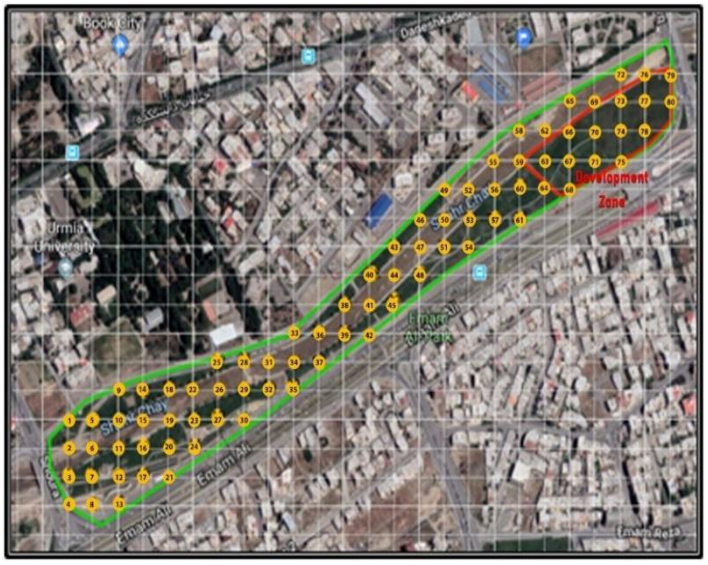

Figure 4.
Sound level measurement points in Urumiyeh City park

The obtained data was calculated with the formula equivalent noise level (Leq) (1). Leq is defined as the level of a sound with the same total energy as the sound in question, at a fixed level, in a given time interval. In other words, it is a noise scale in dBA, which gives the average value of sound energy or sound pressures that continue over a given period of time. dBA is a unit of sound evaluation that particularly emphasizes the medium and high frequencies to which the human ear is most sensitive. Therefore, it is calculated with the formula equivalent sound level (Demir, 2013).

$$Leq = 10 \log\left(\frac{1}{n}\right) \sum_{i=1}^{n} 10^{\left(\frac{Li}{10}\right)} \quad (1)$$

Leq: Equivalent noise level (dBA), n=Number of noise measurements, Li= Noise level in measurement

In the fourth stage, a 1/500 scale map taken from Google Earth was used to prepare a noise map of Urumiyeh city park. The main indicators of the sound map are the sound levels obtained by measurements. Along with the calculations, a noise map was obtained using the Kriging method on the ArcGIS10.6.1 program. In the creation of models, estimates were made using the Inverse Distance Weighing (IDW) and Inverse Distance Weighted Interpolation Method with Geographic Information Systems (GIS) (Baskan, 2004; Taylan and Damcayırı, 2016).

At the conclusion stage, it was stated whether there is a noise problem in the park, where there is more noise, and what measures can be taken to create a qualified soundscape for these places. Proposals have been made for the design of soundscapes for other parks and cities.

Table 1.
Sound sources of Urumiyeh city park

	Desired Sounds	Undesired Sounds
Artificial sounds	Vehicle, construction, and aircraft sounds	Azan sound and music sound broadcast from speakers, ornamental pool
Human sounds	The sounds of people talking, the sounds of walking, the sounds of peddlers, the sounds of bicycle drivers, boaters, and the sounds heard from children's playgrounds.	
Natural Sounds	The sound of the wind	The sound of birds, the sound of water (Sehircay River), the sound of walking through the leaves in autumn

Results

Examination of the Current State of the Park in Terms of Soundscape

The park is heavily used because it is located in an important place in the city. Various activities are carried out in the park. The traffic density on Imam Ali Boulevard, where there are important public buildings and shopping centers, is a source of noise in this part of the park. In terms of quiet walking and sound landscape in the park, Table 1 was created with the data obtained after the examinations by focusing on the existing sound sources and what is being heard in the park. Due to the fact that the park is located on the edge of the stream, the sound of water flow is constantly heard all over the park, especially at low elevations close to the water. Therefore, it significantly blocks the noise and traffic noise prevailing in the area. From the hoppers installed on the lighting elements, the sound of music is heard, as well as bird sounds as a pleasant natural sound. An intense noise is heard from the children's playgrounds located in the area.

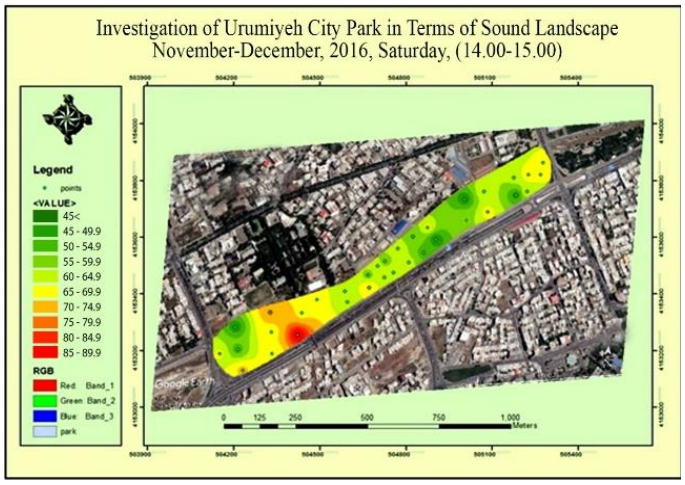

Figure 5.
Saturday Noon Sound Assessment Map

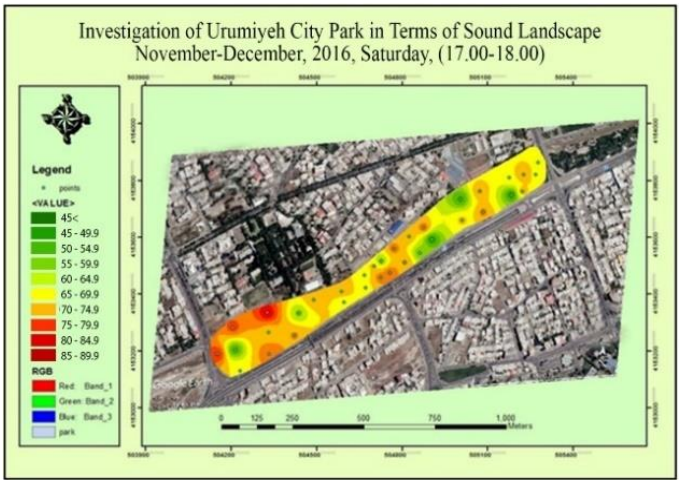

Figure 6.
Saturday Afternoon Sound Assessment Map

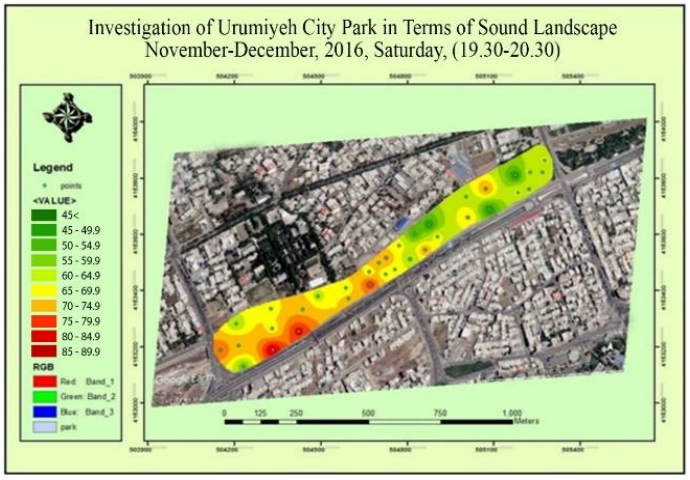

Figure 7.
Saturday Evening Sound Assessment Map

Determination of the Sound Level of Urumiyeh City Park

In order to create the sound map of Urumiyeh city park, measurements were made for 3 days, Tuesday, Friday, and Saturday. Measurements were made for two months during the hours when people used the park more and when the noise was the highest. By evaluating the results, the high noise places were determined, and 10 maps were created, including the afternoon, mid-afternoon, evening, and general average noise maps of the park on Tuesday, Friday, and Saturday.

Sound Measurement Assessment on Saturday

Measurements were made in the park on Saturday in 3-time intervals: afternoon (14.00-15.00), mid-afternoon (17.00-18.00), and evening (19.30-20.30). According to these measurements, the average sound level in the park on Saturday afternoon was found to be 67.94 dB(A) (Figure 5). The sound level was determined to be 60.9 dB(A) in the mid-afternoon on the same day (Figure 6) and 68.38 dB(A) in the evening (Figure 7). On Saturday, the evening hours were the highest in the departments. At the measuring stations, the highest is again on Saturday at 24 pm. the station has an output of 84.39 dB(A). In the evening, the noise was much higher than usual, especially noticeable at stations 17, 21, and 24. The concentration of parking users due to the cooling of the air in the evening, the sounds of vehicles entering and exiting the parking lot, and the excess of vehicles passing through the main road (Imam Ali Boulevard), as well as at other times of the day, were instrumental in increasing the noise level. It is also due to the fact that there are intensive activity opportunities in this part of the park and that users gather more in this part of the park. The lowest value was in the afternoon with 50.30 dB(A) at the 59th station.

Sound Measurement Assessment on Tuesday

The average sound level was found to be 63.28 dB(A) on Tuesday afternoon (Figure 8). The average sound level was 67.37 dB(A) in the mid-afternoon (Figure 9) and 68.87 dB(A) in the evening (Figure 10). On Tuesday, the evening hours were the highest again in the day sections. In the evening, the highest sound level is 84.09 dB(A) at the 17th station. In general, the areas where the noise is high are the 8th, 17th, 23rd, 24th, and 27th stations, which are the areas where Imam Ali Boulevard is located and where there are activities, as in other times. The lowest noise level was measured in the afternoon at station 69 with a value of 49.60 dB(A).

Sound Measurement Assessment on Friday

In the measurements made on Friday, the average value in the afternoon was determined to be 56.7 dB(A) (Figure 11). In the mid-afternoon measurement, the sound level increased to 62.19 dB(A) (Figure 12), and in the evening, it increased to 71.66 dB(A), which is the highest value (Figure 13). As on other days, it was determined that the sound level was high in the evening. The lowest value of 48.54 dB(A) was measured at station 69 in the afternoon. On

Friday afternoon, the noise value was lower than at this time on other days. The reason for this is that Friday is known as a public holiday on the weekend in the Islamic Republic of Iran. Because of this, mid-afternoon hours are considered the calmest and least traffic-free day of the week, as the temperature is too high and the public has rest hours. The highest was measured at the 17th station with 87.49 dB(A) in the evening. The reason for this is that people prefer the park in the evening hours when the weather is cooler on weekends and the density of visitors increases. Accordingly, there is an increase in traffic on Imam Ali Boulevard.

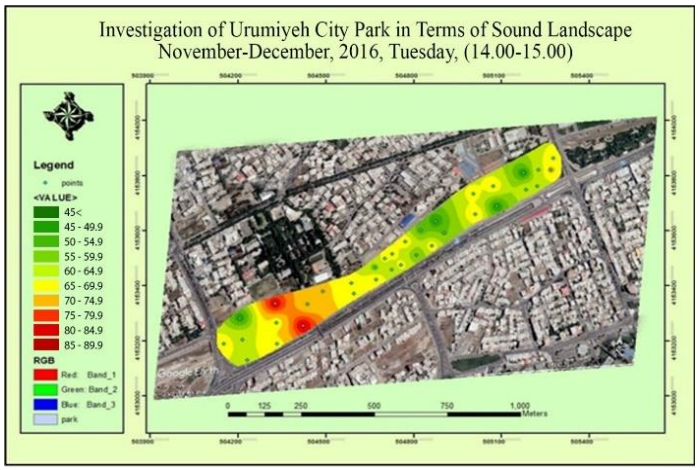

Figure 8.
Tuesday Noon Sound Assessment Map

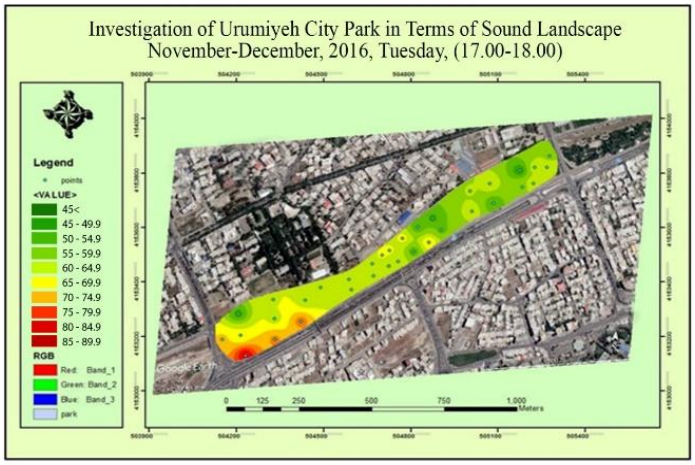

Figure 9.
Tuesday Afternoon Sound Assessment Map

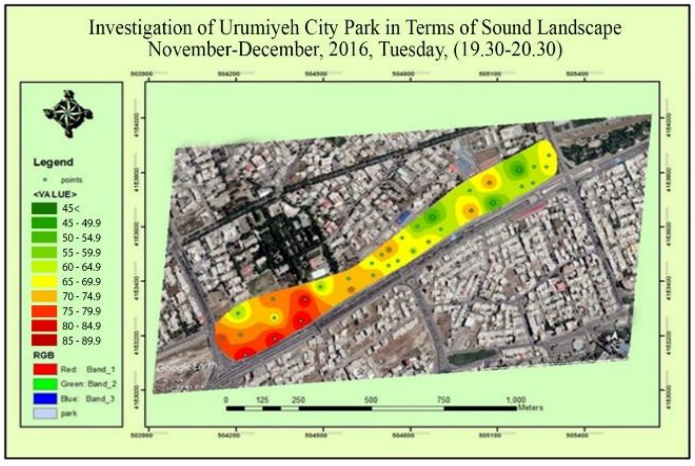

Figure 10.
Tuesday Evening Sound Assessment Map

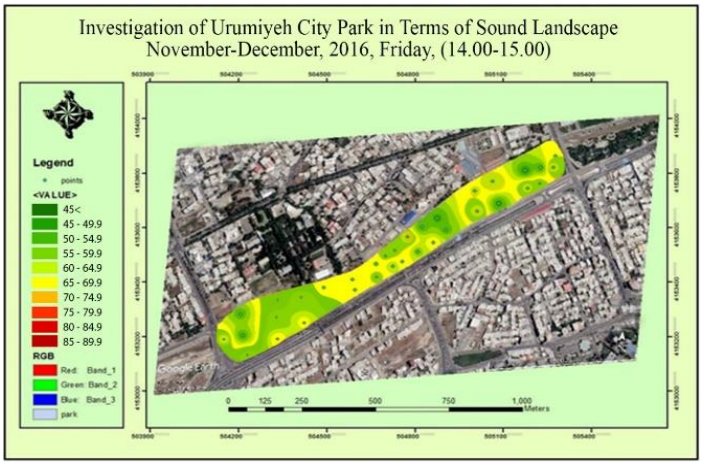

Figure 11.
Friday Noon Sound Assessment Map

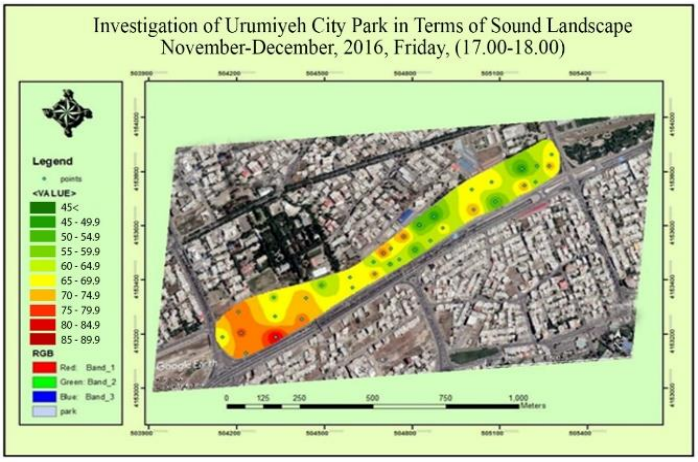

Figure 12.
Friday Afternoon Sound Assessment Map

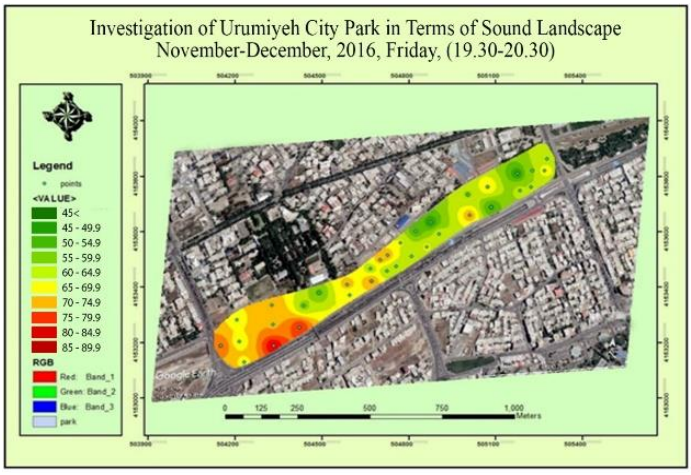

Figure 13.
Friday Evening Sound Assessment Map

General Assessment of the Sound Condition of Urumiyeh City Park

When the averages of the measurements made in Urumiyeh City Park are examined, it is seen that the park is generally under high noise pressure (Figure 14). The regions in the northeastern part, which are seen in green and yellow, partially have a slightly lower volume level. In the southwestern part of the map, the main entrance area with red and its shades is seen as the area where the sound level is high. The sound level increased more in the evening than at other times during the sections of the day where the measurement was made. The highest value of 71.66 dB(A) was measured on Friday evening. This was followed by a value of 68.38 dB(A) on Saturday evening. The lowest values were in the afternoon. The lowest value was 50.67 dB(A) on Friday, followed by 60.90 dB(A) on Saturday. Considering these values, even the Friday afternoon value, which is the lowest, exceeds the allowable limit by more than 5 dB(A). In the evening, it has been determined that it exceeds the allowable value between 23-26 dB(A).

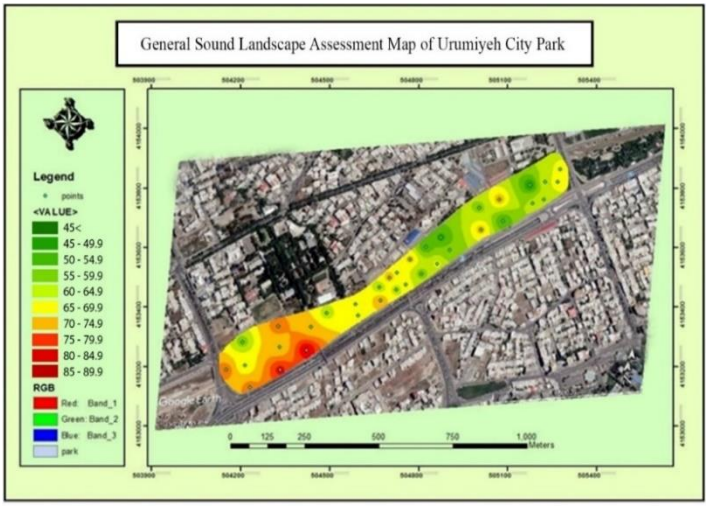

Figure 14.
General Soundscape Assessment Map of Urumiyeh City Park

Considering the station measurements in the park, the 17th and 24th stations were found to be the highest in terms of noise. This is followed by stations 21, 23, and 27. These areas are the main entrance and activity areas of the park. Places where the volume is low have come to the fore as 49th and 69th stations, which are not actively used and are far from the entrance zone, where there is little activation activity.

Discussion

Studies aimed at improving, increasing the quality of life of those living in urban areas and achieving a sustainable quality are of increasing importance every day (Kaymaz and Belkayali, 2013). City parks are at the beginning of the places where you go to relax and be away from the noise in cities. For this reason, city parks occupy an important place in improving the quality of life. However, parks remain under the noise pressure of the city. Some of the city parks where people prefer to get away from the noise, relax and rest have begun to lose these features.

Iran's Urumiyeh City Park is also under pressure from noise pollution. The park is located in a place where there are important public institutions and organizations of the city, as well as shopping centers. In particular, Imam Ali Boulevard, which is around the park, has heavy traffic. The lack of the presence of shrubs and trees in the part of the park where this road is located, which will prevent noise, often leads to a high level of noise in the park. In addition, the most important other elements that increase the noise of the park are the activity areas located in the entrance area of the park and the density of both vehicles and pedestrians at the main entrance to the park. The broadcasting of music in the park, the sounds of vendors, and the sounds in the children's playground are especially affecting the entrance area as an unwanted sound source in the park.

Tuesday, Friday and Saturday measurements showed that Friday's sound level was calmer (63.51 dB(A)) compared to other days. The fact that Fridays are holidays and people prefer not to go out until the evening because of the heat can be counted as the reason for the low output. As is known, the World Health Organization (WHO) has determined that the desired level in parks is 45 dB(A) (Zhang & Kang, 2007). However, the fact that even the lowest Friday value in Urumiyeh City Park exceeds the permissible value in parks by about 18 dB(A) indicates that the sound level has become quite uncomfortable. During the day, afternoons were observed as the time with the lowest sound level compared to other times. The fact that traffic is less in the afternoon and users do not prefer to come to the park due to the heat is one of the reasons why the values are low. The Tuesday afternoon value, which is the lowest day part, exceeds the allowable value by 11 dB(A).

The day of the highest volume level was on Tuesday (66.51 dB(A)). The fact that there is overtime on Tuesdays and the presence of official institutions around the park can be counted as the main reason for the high noise level. In the day sections, the evening times were the time when there was the most noise. On Tuesday, the sound reached its highest noise value with a value of 71.66 dB(A) in the evening.

When the stations were examined, the 17th (87.49 dB(A)) and 24th (84.39 dB(A)) stations were observed as the places where the sound was highest on Friday evening. These are followed by the 21st, 23rd, and 27th stations. These areas are the main entrance and activity areas of the park and the Southeastern area where the music broadcast is located.

Places, where the volume is low are mainly the 49th and 69th stations in the Northwest region, where the park is not actively used, away from the entrance area, and there is little activity (Figure 14).

When the sound map of the research area is examined, it is seen that the sound levels in the park exceed the desired level of 45 dB(A) in the whole area of the park when both national and international regulations are compared, and it exceeds that in some stations, day and day sections. As a matter of fact, similar results were obtained in the study conducted by Ozer (2017). Unfortunately, these results show that a significant part of city parks are not comfortable enough with noise, and precautions should be taken against noise pollution.

Conclusion and Recommendations

The fact that city parks are located in the city center provides a great advantage for people to access the parks. However, the parks in the center remain under significant traffic noise pressure. That is why the noise level in city parks is higher than in other parks. In particular, there are values that are much higher than the values allowed by the WHO. For this reason, it is necessary to be more careful in terms of noise pollution measures in the city center and in parks surrounded by traffic roads. Especially in the planning stage, large areas should be provided for the noise barrier in these areas, the soil level should be raised, and noise barriers should be made. In noise barriers, a better result can be obtained by combining trees and shrubs that are effective in preventing noise with inanimate barriers.

Although some visitors like the music broadcast to the park by the businesses in the parks in the Eastern culture, it both increases the sound level of the park and does not please the other visitors. It is an unwanted sound for people who come to the park for silence. Therefore, music broadcasting in parks should not be loud in certain areas.

In the same way, it can be ensured that the noisy activity areas in the park are collected in some areas, and the sound level of other parts is low.

Another study to be done is to bring the desired sounds to the forefront in parks. In particular, it is necessary to increase the sounds of birds and water sounds. For this, more ornamental ponds can be used. In order to increase bird sounds, it is necessary to increase bird nests in parks and to prefer fruit-bearing trees that birds like more. Again, the birds should be encouraged to come to the area by making places to feed the birds in different parts of the park.

In addition to these specified studies, the number of vehicles passing around the parks should be reduced, especially the passage of large vehicles should be restricted. Measures should be taken to reduce vehicle speeds. The traffic green wave system can provide a significant benefit in this regard. Along with such technical measures, it is possible to significantly reduce the noise level in all parks, especially in parks in urban centers, by raising drivers' awareness and being more active in the implementation of legal measures.

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