PORT SAID ENGINEERING RESEARCH JOURNAL
Faculty of Engineering – Port Said University
Volume (20) No. 2 September 2016 pp.: 10:16

Soundscape Approach for Analyzing and Evaluation Acoustic Environment in Urban Parks

Osama Mahmoud Abo Eleinen[1], Ghada Elrayies[2] and Reem Mohamed Hussein [3]

ABSTRACT

Soundscape –the acoustic equivalent of the landscape- presents better ways to analyze, evaluate and develop acoustic environment, it is a relatively new area to many. Most studies have focused on the study of sounds as a passive perception factor –how to reduce sound level- but this paper focus on the sound into an integration process between acoustics, sound sources, human satisfaction, and landscape factors.

How to apply soundscape analyzing and evaluation approach of the acoustic environment in urban outdoor spaces in Egypt for future improvement is the aim of this paper. The steps to achieve the goal could be demonstrated as follow: identifying soundscape, presenting methods of analyzing and evaluation the acoustic environment in urban outdoor spaces, creating a methodology for applying it in the pilot study on the chosen parks sites in Egypt as a final step to conclude results. The pilot study will be represented in: selecting areas after put criteria for chosen them, choosing methods for analysis and evaluation areas, Identifying areas in general information, Analyzing and evaluating areas.

Results showed that, not only sound pressure level can analyze and evaluate the acoustic environment in outdoor spaces, but also many factors should be taken into account such as urban factors, acoustic aspects, type of sounds, landscape elements, visual aspects and demographic &cultural factors, in order to provide comfortable acoustic environment for people to exercise their activities.

Keywords: Acoustic environment – Soundscape – Soundscape analysis and evaluation – Urban spaces.

1. INTRODUCTION

The soundscape is formalized by R. Murray Schafer in the late of 1960s, he noted that: Soundscape is the sonic environment. But the significant of soundscape has appeared in the last decade in the field of community noise and environmental acoustics. Truax, (2009) describes two approaches to the acoustic environment in urban outdoor spaces: 1. Noise management approach (the traditional and objective model of the acoustic environment) and 2. Soundscape approach (the subjective and listening model of the acoustic environment). He argued the integration between the two approaches. [1, 2, 3, 4]

1.1. Definition of Soundscape

Many researchers used the definition of soundscape as the relationship between sounds and landscape in the design and landscape fields.

They considered the soundscape term refers to the acoustic environment at a place like residential area, parks, squares and streets as perceived and understood by people in context.

It is the acoustic equivalent to landscape and includes all sound sources wanted as well as unwanted. [5, 6, 7]

1.2. Soundscape Concept

The concept of soundscape treats the acoustical sounds environment as a multi-dimensional branches based on the interaction between sound sources (type of the source, features of the source, sound level power and duration of the source), physical environment (physical factors, seasonal factor and topographical factors) and human being (sociological factors, psychological factors, sensational factor and cultural factors).

1.3. Soundscape Evaluation Methods

In soundscape evaluation, it is important to consider sounds (sound information, context in which it is perceived and the sound level), users (sound sensitivity of individuals, demographic factors, social and cultural factors, sound experience and characterization of users), spaces (reverberation and access attenuation in the open public spaces) and physical condition (temperature, humidity and visual aspects).

For managing our acoustic environment and applying the soundscape concept, a tool for assessing soundscape

[1] *Associate Professor at Department of Architectural Engineering and Urban Planning, Faculty of Engineering, Port Said University. E-mail: aboeinen@hotmail.com*

[2] *Lecture at Architectural Engineering and Urban Planning Department, Faculty of Engineering, Port Said University. E-mail: ghadaelrayies@ymail.com*

[3] *Demonstrator at Department of Architectural Engineering and Urban Planning, Faculty of Engineering, Port Said University. E-mail: engreemarch@gmail.com*

quality is needed. There are many techniques to assess soundscape as shown in table1.

Table 1: methods to assess the soundscape in urban outdoor spaces and comparison between them. [8, 9]

Assessing soundscape in situ	Assessing soundscape in the laboratory
Definition	
Where the person listens to the soundscape in the actual location.	Where the person who assessing the soundscape stay in a room or laboratory listening to the previously recorded soundscape.
Methods	
• Soundwalks • Interviews • Scales: semantic and Likert • Categorical responses • Acoustical diary • Acoustical measures • Mixed methods	• Scales: semantic and Likert • Artificial Neural Network • Mixed methods
Advantages	
In situ, assessing soundscape provides results which show the complexities of real world situations depending on environmental information, physical, psychological and socio-cultural aspects, but it is difficult to ascertain the specific role of individual elements in the assessment.	In the laboratory, assessing soundscape provides control of which specific elements are to be considered to ascertain which have series affect in soundscape assessment and facility making relationships between experimental variables.

2. METHODOLOGY

2.1. Proposed Methodology

For analysis and evaluation the acoustic environment by using soundscape approach, you can take the following steps which shown in figure 1 as stages of work.

2.2. Area Chosen Criteria

Urban parks with green areas are very important for the quality of life of our increasingly urbanized society by its presence of nature and its components, so five local scale parks were chosen in the city of Port Said, Egypt in multi-use areas such as residential, commercial, beach areas depending on:

- General criteria:
  - Small areas to control the results and facilitate the survey and questionnaire process.
  - The site has different activities (three at least).
  - The areas have a diversity of sounds.
  - Medium density attending by users.
- Acoustics criteria:
  - Five urban areas (two have the same noise level and the others not).
  - Small areas to facilitate the measurements process.
  - Diversity of sound sources (in one site/ from site to site).

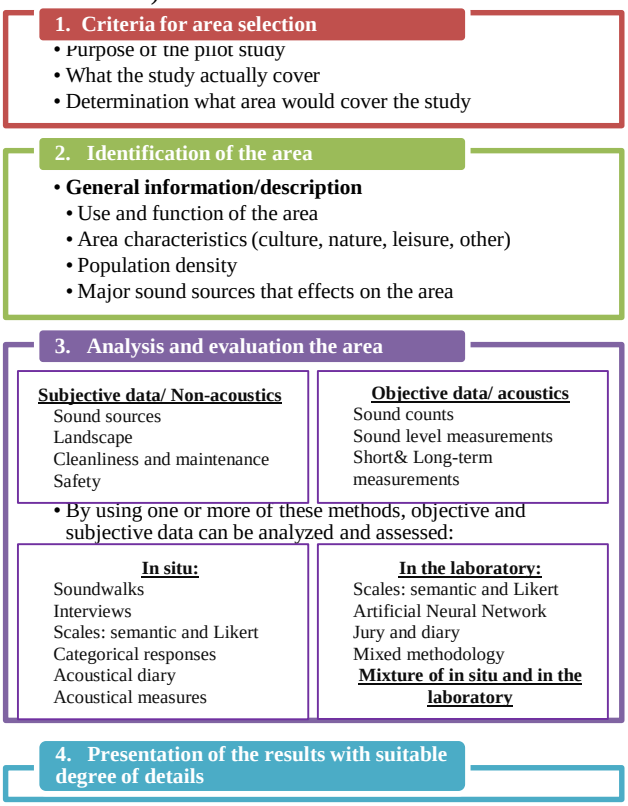


Figure 1: Proposal methodology for pilot study

2.3. Methods

2.3.1 Interviews and Scales

The questionnaire applied in the field survey is based on [10, 11, 12].

The structure of the questionnaire is as follows:

a) General questions on: reason, frequency, duration, day of week, time of day of visit;

b) Questions on soundscape: audibility of sound sources, annoyance from sound sources, pleasantness of sound sources, acoustic quality;

c) Questions on the environmental surroundings, the natural area: environmental quality, characterization of the area e.g. natural quality, safety, pleasantness;

d) Questions on personal data: male/female, age, education, job title.

Most of these questions have closed answer categories or scales ranging from 1 to 5 (so-called Lickert scale) and a few open questions were added. The questionnaire initially written in English, then translated into Arabic.

Table 2: Number of interviews in each park.

site	No. of interviews
El Montazah park, PortFoad	19
Ferial park	15
El shattee park	14
El farama park	12
El Montazah park, Port said	14

2.3.2 Acoustical measures

For the purpose of an objective assessment of the studied areas, measurements were carried out in the inner areas of the tested spaces. The measured parameters were LAeq, Lmax and Lmin. Measurements were carried out using a type TM-101 Tenmars sound level meter. The times measured were from (12 P.M to 16 P.M), and from (18 P.M to 22 P.M) in the parks which open in the evening. Over a week in the month of May 2015, measurements were performed for each of the points defined: weekends and weekdays.

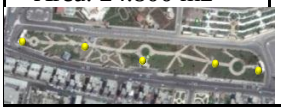
Table 3: number of points measured in each park.

site	No. of measured point
El Montazah park,PortFoad	4
Ferial park	4
El shattee park	4
El farama park	4
El Montazah park, Portsaid	5

2.4. Identification of Sites

General analysis of the five parks such as location, area, main functions and main sound sources will be presented as shown in table 4.

Table 4: basic information of the case study sites.

Sites	Main functions	Sound sources
1- El Montazah park, portfoad, port said. Area: 23.940m2 	• Open green areas and people's activity for: Relax seating, reading, and playing. • Nursery for growing plants. • Small library.	• Voices rustle of trees and winds • Birds sounds • Dogs sound • Sound from playing children • Talk sounds
2-Ferial garden, port said Area: 22.630 m2 	• Open green areas and people's activity: relax, seating, playing. • Theme park for children • Nursery for growing plants • Mosque	• Cars sounds • Water sound • Sirens from vehicles • Birds sounds • Talk sounds • trees&winds • Children playing
3-El shatee garden, port said Area: 11.330 m2 	• Open green areas & people's activity: seating, walking. • cafeteria • theme park • Photography studio	• music sounds • screaming voices • sea waves sound • People talking
4-El farma garden, port said Area: 12.079 m2 	•Open green areas & people's activity: seating, walking, relaxing. • cafeteria • music booth • area for kids playing	• vehicle sounds •music sound •children playing •water sounds from fountain • people talking
5-El Montazah Garden, port said Area: 24.800 m2 	• Open green areas • Area for kids playing • Recreational area for music	•music sound •children sounds •Vehicle sounds •talk sounds

2.5. Analysis and Evaluation

2.5.1 Subjective analysis and evaluation of the five parks

Analysis and evaluation data which extract from the interviews and the questionnaire will be presented concerning to personal data, sound and soundscape information and environmental aspects.

Table 5: number of interviews in the park, identification data and general data by the visitors.

Parks	1	2	3	4	5
	Percent (%)				
Gender					
Male	47.4	6.7	28.6	0	21.4
Female	52.6	93.3	71.4	100	78.6
Age					
15-24	36.8	13.3	35.7	66.7	0
25-44	26.4	60	50	33.3	71.4
45-64	36.8	20	14.3	0	28.6
+65	0	6.7	0	0	0
Education					
Primary	36.8	26.7	42.9	75	14.3
Bachelor	36.8	60	0	0	14.3
Degree	15.8	13.3	57.1	25	71.4
Other	10.6	0	0	0	0
Reason of come					
For my children	47	40	71.4	33.3	50
To meet people	21	26.7	50	33.3	35.7
For relaxation	21	46.7	7.1	41.7	50
To walk or run	0	6.7	7.1	25	28.6
For nature	26	20	7.1	33.3	0
Playing sport	10.5	0	0	16.7	0
Time of visited					
During morning	15.8	40	14.3	0	0
During afternoon	57.9	20	0	41.7	7.1
No specific time of the day	21	40	50	41.7	64.3
During lunch	5.3	0	0	0	0
In the evening	0	0	35.7	16.7	28.6
Time stay in it					
1/2h	42.1	0	14.3	16.7	0
1h	0	6.7	0	16.7	28.6
2h	15.8	80	50	25	42.9
>2h	42.1	13.3	35.7	41.7	28.6

Visits the park					
everyday	15.8	0	0	0	0
once per week	21	33.3	50	16.7	64.3
a few times per month	36.8	20	42.9	33.3	7.1
once per month	26.4	46.7	7.1	50	28.6

Concerning to sound and soundscape, it was found out the sound sources which divided into four categories (traffic sounds, technological sounds, human sounds and natural sounds), the level of perception on a scale from "not heard", "rarely heard", "sometimes heard", "frequently heard", and "completely heard" as shown in Figure 2, and the level of pressure or acceptance under the scale "very pleasant", "pleasant", "neutral", "unpleasant", and "annoying" as shown in Figure 3.

Table 6: sound categories in the five parks that people heard.

Traffic sounds	Technological sounds	Human sounds	Natural sounds
Cars Bicycle Motorcycle	Construction noise Sirens Music Mosque Azan Machine	Talking Laughing children playing footsteps screaming	Birds Wind & leafs Water Dog sound

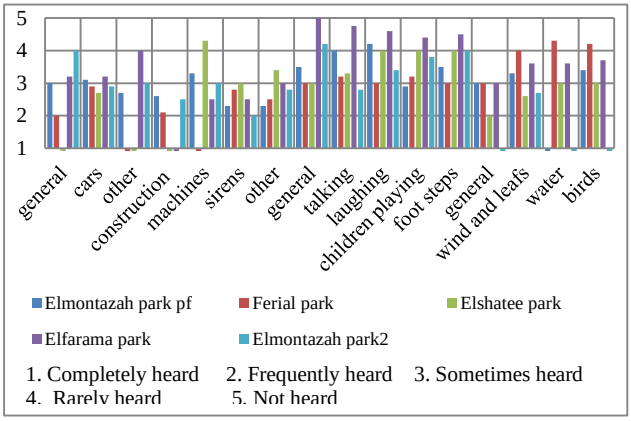


Figure 2: summary of presence/perception levels of various sources

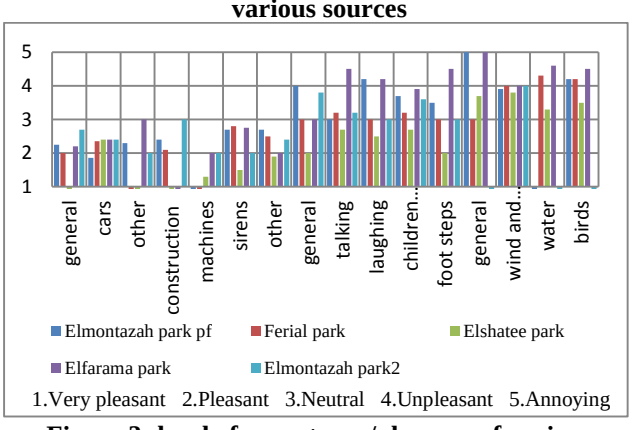


Figure 3: level of acceptance/pleasure of various sounds sources

The semantic differential test was used to examine the quality of the sound environment in general as shown in figure 4. People would judge the sounds by means of pairs of adjectives using five-pointed scale ("Pleasant, Unpleasant", "Familiar, Unknown", "Common, Characteristic", "Continuous, Discontinuous", "Relaxing, Annoying", "Calm, Noisy", "Non-chaotic, Chaotic", "Vibrant, Monotonous", "Funny, Boring", "Natural, Artificial".

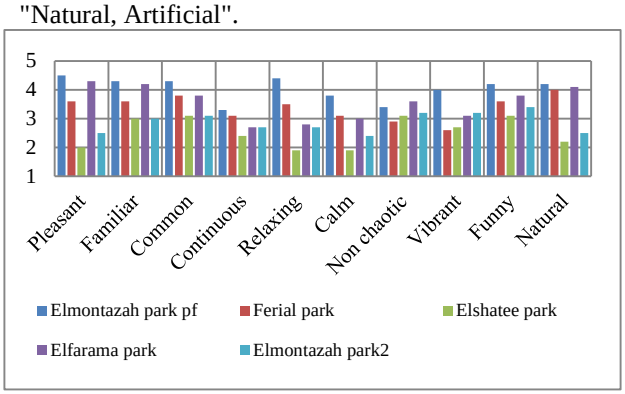


Figure 4: sound environment description

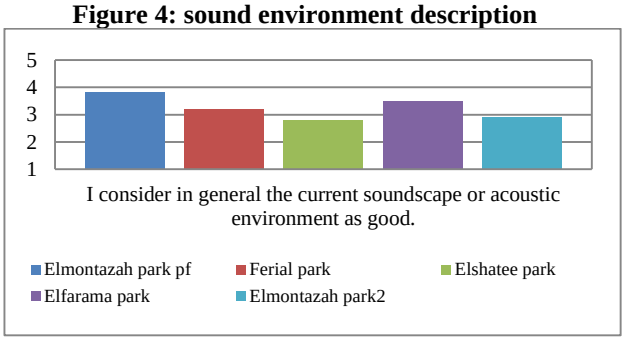


Figure 5: Quality of soundscape

Concerning to the environmental aspects in the park, a semantic weighting scale was used with five pointed entries: "very good", "good", "fair", "bad" and "very bad" and the results is shown in Figure 6.

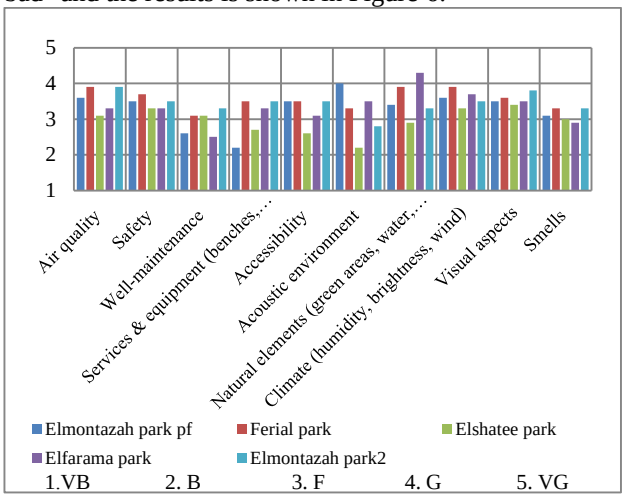


Figure 6: acceptance of environmental conditions in the site

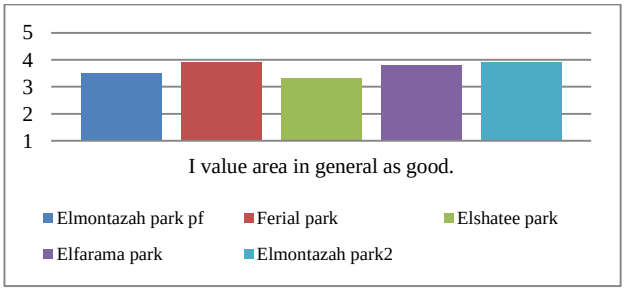


Figure 7: Quality of environment

2.5.2 Objective analysis and evaluation of the five parks

Objective measurements were carried out in the inner areas and the parameters were LAeq, Lmax and Lmin. Measurements were performed for each of the points defined: weekends and weekdays.

Table 7: equivalent sound levels in the five parks, port said: maximum A-weighted level (LAmax), equivalent sound level (LAeq) and minimum A-weighted level (LAmin).

	P	LAeq week day	LAeq week end	L_{Amax}	L_{Aeq}	L_{Amin}
El Montazah park, PF	1	51.1	53.2	68.3	52.2	48
	2	54.6	59	63.2	56.4	47
	3	50.6	58.3	67.7	53.7	46.8
	4	49.7	50.5	60.9	50	46.3
Ferial park	1	52.8	55.9	63.5	54.4	51.8
	2	53.3	54.2	56.5	53.7	49
	3	55.4	56.7	69.6	56	50
	4	52.8	52.9	58.6	52.8	47.8
El shattee park	1	70.4	70.7	74	70.5	66.5
	2	68.5	67.5	74.2	68	64.9
	3	71.4	72.3	73.3	71.9	67.7
	4	75.5	76.4	76.3	75.9	71.8
El farama park	1	58.9	71.1	72	65	64.5
	2	64.1	70.3	74.2	67.2	64.5
	3	65	60.7	69.3	62.9	61.1
	4	61.1	62.8	68.6	61.9	60.2
El Montazah park	1	58	68.6	67.8	63.3	46.9
	2	56.7	68.2	68	62.5	45.9
	3	58.5	71.6	72	65.1	48
	4	54.2	70.9	68.1	62.6	59.1
	5	61.6	71.5	68.8	66.6	59.7

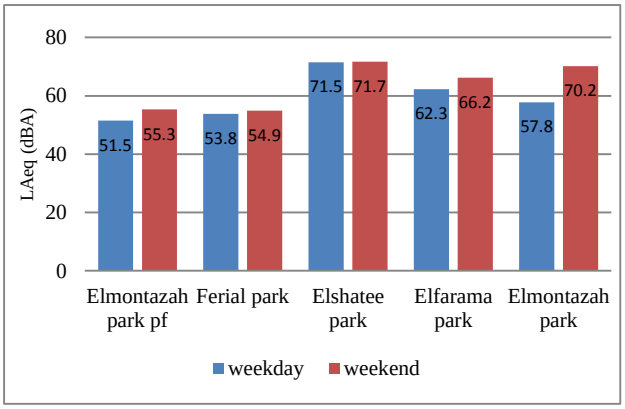


Figure 8: equivalent sound level in weekdays and weekends

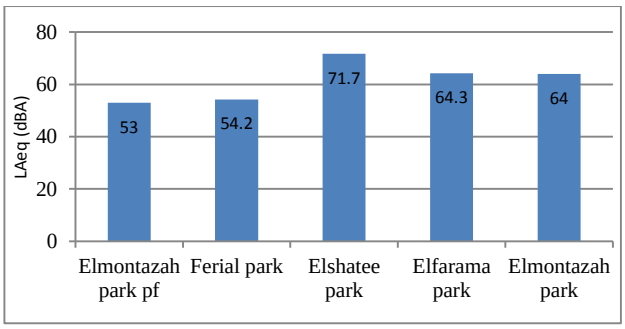


Figure 9: equivalent sound pressure levels along one week

3. RESULTS

The results show overall data obtained from the subjective and objective analysis and assessment of soundscape in the five parks as shown in table 8.

Table 8: results.

Questionnaire results		
Parks	**El Montazah park, PF**	**Ferial park**
% Users consider sound and soundscape atmosphere as:	84%Pleasant 88%Calm 66%Non-chaotic 86%Vibrant 90%Natural	80%Pleasant 70%Calm 62%Non-chaotic 76%Vibrant 72%Natural
% satisfaction with the soundscape:	78%	64%
Sound sources (dominant):	Birds, children playing, Wind and leafs (pleasant), Cars (sometimes heard, unpleasant).	Wind and leafs (pleasant), Human sounds (neutral), Cars (unpleasant), water (when the fountain switch on).
% users perceived the environmental elements as:	70%Visual 72%Air quality 70%Safety 52%Maintenance 70%Accessibility 44%Services	72%Visual 78%Air quality 74%Safety 62%Maintenance 70%Accessibility 70%Services
% satisfaction with the place:	70%	78%
Measurements results		
LAeq (One-week measurements)	53 dB (A)	54.2 dB (A)

Follow Table 8: results.

Questionnaire results		
El shattee park	**El farama park**	**El Montazah park**
44%Pleasant 38%Calm 48%Non-chaotic 62%Vibrant 40%Natural	82%Pleasant 55%Calm 54%Non-chaotic 76%Vibrant 86%Natural	50%Pleasant 54%Calm 54%Non-chaotic 62%Vibrant 50%Natural
52%	72%	58%
Machine (annoying), music (unpleasant), human sound &screaming (neutral).	Children playing (pleasant), water sound, wind& leaf (pleasant), car (unpleasant).	Car (unpleasant), human sounds (neutral), wind& leaf (pleasant).
68%Visual 62%Air quality 66%Safety 62%Maintenance 52%Accessibility 54%Services	70%Visual 66%Air quality 66%Safety 50%Maintenance 62%Accessibility 66%Services	76%Visual 78%Air quality 70%Safety 66%Maintenance 70%Accessibility 70%Services
66%	76%	78%
Measurements results		
71.7 dB (A)	64.3 dB (A)	64 dB (A)

On the urban planning part:

We can see two parks have relatively large similarity regarding the surrounding streets namely: Elmontaza park and Elfarama park (The two parks are surrounding by streets from the four sides, one of these streets at least is the main street with high traffic density). When measurements were taken in the two sites, the results showed that the equivalent sound pressure levels in the two parks were the same approximately and recorded 64 dB, but when interviews were taken place and visitors evaluated the acoustic environment or the soundscape, the results showed that, one park – Elfarama park- was good and the sounds were congruent with the place with (72% percentage), and the other park -Elmontaza park- was not good and the sounds which they heard weren't congruent with the place with (58% percentage).

We can see also that, the park which surrounded by built-up area such as Emontaza,portfoad park which surrounded by homes, villas and towers and no streets beside it, recorded sound pressure level 53dB and this level was the least sound levels between the five parks. Also, the park which surrounded by local streets –Ferial park- recorded sound level (54dB) less than the parks which surrounded by main streets.

On the design part (area design & surrounding environment):

It can be seen that, the parks which have an area for the theme park or large games for children and youth, recorded high sound pressure level such as Elshatee park which recorded 71.6dB. The parks that have a zone for children playing games (small games for kids or children) recorded less sound pressure levels such as Elfarama park recorded 64.3dB, Elmontaza park 64dB and Ferial park 54.2dB. The park which has no games zone for children recorded the least sound pressure level (Elmontaza, Portfoad Park 53dB).

It's noted that all zones which made for people to relax, didn't achieve the purpose of this goal as the levels of sound exceeded the permissible levels for comfort.

Some people described the environment as good for its natural elements, visual aspects or climate (Elfarama park) and others described it good as its services, well-maintenance or acoustic environment (ELmontaza, portfoad park).

We can note that, in spite of the good results in Elshatee park elements such as visual aspects, climate, safety, air quality and well-maintenance, the park recorded the least value in the environmental assessment (66%). The results showed that, the main element which made the evaluation not good was the acoustic aspects so; the soundscape is an important element in the evaluation of the urban areas like parks.

Not only the acoustic aspects are important as Elmontaza, Portfoad Park had recorded the highest value in the evaluation of the soundscape but not the highest value in the environmental assessment in general. The services & equipment and well maintenance recorded below values in the park.

On the acoustic environment/ soundscape part:

People loved natural sounds and most visitors loved human sounds especially children playing but they didn't love traffic or mechanical sounds. This is clear from the results in analyzing and evaluation the parks such as:

- In the parks which visitors heard natural sounds or human sounds higher than traffic sounds, the soundscape had been described as very good (Elmontaza, portfoad park 78% and Elfarama park 72%), but in the parks which people heard traffic sounds higher than the other sounds, people described the soundscape with values less than the previous values (Elmontaza park 58% not good).
- Also, it is noted that, in the parks where fountains exist (water sound) when it switched on, people described the soundscape as good to very good (Elfarama park and Ferial park).
- Adjectives were described on how people feeling regarding the soundscape or the acoustic environment. People described good adjectives in the parks where natural sounds existed (pleasant, calm, natural), and described other adjectives in the parks where human sounds existed (funny, vibrant), but they described bad adjectives when they heard traffic sounds or mechanical sounds (unpleasant, noisy, annoying, chaotic, artificial).

It can be seen that, all equivalent sound levels in the five parks exceeded the allowable levels in Egyptian and world lows with different values, but we can see the perception of the visitors was different in cases with the measurements and other cases agreed with it such as:

Table 9: comparison between objective and subjective results in two parks.

Objective results levels		Subjective results on soundscape	
El farma park, port said	El Montazah park, port said	El farma park, port said	El Montazah park, port said
64.3 dB	64 dB	Good 72%	Neutral to not good 58%

Demographic and other factors:

It can be seen that, more frequented visitors on the parks were children, youth and adults, and elder people went with low rates in different proportions in the parks. We can see that, elder people went to the parks which its sound pressure level relatively little from other parks and have zones that would enable elders to relax and rest such as Elmontaza, portfad park, Ferial park and Elmontaza, portsaid park. On the other hand, we can see that, children, youth and adults go to the parks which have zones for playing games, cafeteria, theme park and manifestations of movement and activity. Adults went to Elmontaza, portfoad park, Ferial and Elmontaza, portsaid park to meet people, walk and make their children play. The youth went to Elshatee park, Elfarama, Ferial and ELmontaza, portsaid parks to go to the theme park, sitting in the cafeteria with their friends and to walk, run and make activities. Most adults' visitors in the parks were women as they went to make their children play, to relax and to meet their friends.

4. CONCLUSION

Complete soundscape approach for analyzing and evaluation the acoustic environment in urban local parks is used (easy to apply and not very coast) which contain:

- Subjective assessment (acoustic and non-acoustic)
- Objective assessment (sound measurements)

And can be concluded from results:

1) Studying site surrounded is important not only the inner area as:

- External sounds effect on the sounds that people hear on the site.
- External sounds effect on the sound level inside the parks.

2) Environmental elements affect the perception of people such as visual aspects, air quality, safety, well-maintenance, services and equipment (benches, playing areas), accessibility, acoustic environment, natural elements (green areas, water, birds..), and climate (humidity, brightness, wind).

3) Type of sound had a big effect on people's perception regarding the acoustic environment or the soundscape as:

- Natural sounds make people pleasant, relax and calm (people described the soundscape as good / very good when they heard it).
- Human sounds make people funny and vibrant.
- Traffic and mechanical sounds make people unpleasant, chaotic, noisy and annoying.

4) Demographic factors also effect on people satisfaction on acoustic environment regarding to ages categories and their needs from sounds and activities.

5) Peoples' comfort in urban parks depended on acoustic and non-acoustic factors, this means that, sound level alone don't reflect the human perception.

5. REFERENCES

(1) Dumyahn1, S. L. & Pijanowski1, B. C. 2010. Beyond Noise Mitigation: Managing Soundscapes as Common Pool Resources. Purdue University.

(2) Wang, K. 2003. The Aesthetic Principles Of Soundscape In Architectural Design. Master Of Science, Texas A&M University.

(3) Brown, L., Heutschi, K. & Andringa, T. 2009. Memorandum of Understanding For the implementation of a European Concerted Research Action designated as cost Action TD0804 Soundscape of European Cities and Landscapes. Brisbane, Australia.

(4) Brown, A. L. 2011. A Review of Progress in Soundscapes and an Approach to Soundscape Planning. Griffith University.

(5) Hedfors, P. 2003. Site Soundscapes: Landscape architecture in the light of sound. Doctoral, Swedish University of Agricultural Sciences.

(6) Iramatsu, K. 2004. Soundscape : The Concept and Its Significance in Acoustics. Kyoto University, Kyoto.

(7) Axelsson, Ö. 2012 Introducing Soundscape. AESOP 26t h Annual Congres METU, Ank ara.

(8) Kang, J. 2007. Urban Sound Environment, Taylor & Francis Group, Newyork, USA.

(9) Davies, W. J., Adams, M. D. & Bruce, N. S. 2009b. A Positive Soundscape Evaluation Tool. EURONOISE. Edinburgh, Scotland.

(10) QUADMAP 2009. Questionnaire Quiet Urban Areas. In: ENV/IT/407, L. (ed.).

(11) Semidor, G. 2005. Soundscape Approach As A Tool For Urban Design Barcelona, Bristol, Brussels and Genoa: European Commission Dg Research.

(12) Weber, M. 2012. Quiet Urban Areas: repositioning local noise policy approaches – questioning visitors on soundscape and environmental quality. Inter Noise 2012. Newyork – USA.