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Soundscapes of Urban Parks in and around Bhubaneswar and Puri, Odisha, India: A Comparative Study

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ABSTRACT: Anthropogenic noise is debatably one of the most common threats to national parks' resources. Park visitors and workers generally suffer from adverse effects of noise from on- and off-road vehicles. The parks, studied here, are located in strictly urban areas, surrounded by streets with intense vehicle traffic. This study assesses the soundscape of urban parks in two cities of Odisha State, on the basis of acoustic field measurements and interviews. Noise descriptors in and around three different parks in Bhubaneswar and Puri cities have been measured and analyzed. A field experiment has been conducted with 330 participants in three parks, representing urban natural environment. The questionnaire comprised identification of the interviewee, characteristics of the user's profile in terms of his/her use of the park, and aspects of individual's perception of the soundscape and environmental quality of the park. Positive correlation has been established among the noise levels of these three parks. The present study reveals that the acoustic sound levels of all the investigated parks are more than 50 dB (A) [permissible limit, established by Central Pollution Control Board (CPCB) for green parks]. Considering the urban elements and acoustical characteristics, it can be concluded that all the parks are affected by several factors such as urban planning, land use, main traffic routes, type of public transportation, and its internal sounds.

Keywords: Green area, park, noise, annoyance

INTRODUCTION

Haphazard urban growth and transport noise have caused colossal noise-pollution problems in many areas, naturally restricting quiet conditions in many protected natural areas, wherein noise disturbance has a detrimental effect on its tranquility. Compared to built environment, parks and botanical gardens offer a considerable difference in air quality, sounds, and open spaces. Research has shown that the time spent in natural settings can improve a person's mood and sense of well-being, increasing his/her cognitive performance and sleep quality as well as soothing his/her anxiety and stress.

According to McDonald et al. (1995), out of all park visitors, only 91% of the respondents considered enjoying natural quiet sounds of nature to be an imperative reason for visiting parks. The study of Haralabidis et al. (2008) demonstrated that the noise from traffic and aircraft caused inherent physiological responses (increased blood pressure and heart rate) in sleeping humans. The soundscape consists not only of unpleasant sounds but also of all other

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examples. In urban areas, these sounds are mostly veiled by environmental noise, particularly traffic noise (Schafer, 2001; Zannin et al., 2001; Ouis, 2001; Hokao, 2004; Downing & Hobbs, 2005; Kudesia & Tiwari, 2007; Goswami, 2009, 2011; Goswami & Swain, 2011; 2012a, 2012b, 2013; 2017**;** Goswami et al., 2011, 2013a, 2013b; De et al., 2017).

According to Zannin et al. (2003), soundscape is not just an acoustical determination only, but considers human perception, as well. Thus, it is pertinent to integrate acoustical measurements with other evaluation parameters like questionnaire survey. Parks and botanical gardens are green areas, contributing significantly to the quality of life, and fulfilling three main functions, viz., esthetic, ecological, and leisure (Szeremeta & Zannin, 2009; Pereira, 2003; Nucci, 2001; Milano, 1984).

The population of the studied city of Bhubaneswar, the capital of Odisha State, was only 8170 in 1921, reaching 904,721 in 2011 census. Population growth of Bhubaneswar has increased particularly after 1991. Puri is also one of the famous holistic cities of India and the most popular tourist destination in Odisha State. Thus, the vehicular density has been increasing in last few years, in both cities and their residents are intensely irritated by the sounds from the vehicles. Now, it is time for people to get some fresh air and be free from unwanted sounds. That is why they frequently go to natural or artificial parks and the number of park visitors increases gradually. Therefore, there has been an attempt to assess the acoustic comfort of the studied parks by depicting the correlation between the parks' soundscape and their visitors (Nucci, 2001). This study assesses the soundscape of urban parks in two cities of Odisha State, based on acoustic field measurements and interviews.

MATERIAL AND METHODS

The studied city of Bhubaneswar is located at 20°15' North Latitude and 85°52' East Longitude, while Puri is located at 19°48' North Latitude and 85°51' East Longitude. The former is the capital of Odisha State and the later, one of the imperative holy tourist places of India, situated on the coast of the Bay of Bengal, 60 km off Bhubaneswar. Noise descriptors in and around different selected parks of Bhubaneswar and Puri were measured and analyzed. The criterion for parks selection was mainly based on the fact that the studied parks were located in the areas of great urban density, surrounded by streets with heavy vehicle traffic (Zannin et al., 2006). Table 1 gives the other basic information about the studied parks. The measurements were taken on the foot paths of these parks (Zannin et al., 2006). Thus, the locations and number of measurement points cover the whole area of the parks, corresponding to the sites frequently visited by the parks' visitors.

All the measurements were taken on week days, i.e., Monday to Friday, between 5:00 and 7:00 p.m. Noise levels were measured by following standard procedure, using calibrated sound level (dB) meter (Model HD2110L) in September 2015 for three parks (Gandhi Park and IG Park of Bhubaneswar and Gandhi park of Puri) (Mohapatra & Goswami, 2012a, b; Swain & Goswami, 2012, 2013a, 2013b; 2014a, 2014b; Swain et al., 2012a, 2012b, 2012c; 2013; 2014; Pradhan et al., 2012a, b). There were sixty measurements within one-hour duration (i.e. at one-minute interval) only in the evening (5:00- 7:00 p.m.).

The noise levels of different selected sites of three investigated parks were predicted along with their equivalent noise levels (L_{eq}). The value of L_{eq} was calculated in dB (A) by using Robinson formula (1971) as below:

$$L_{eq} = L_{50} + (L_{10}-L_{90})^2 / 56$$

For the present study the different percentile noise levels used were:

L_{10}: The level, exceeded within 10% of the measuring time in dB(A).

L_{50}: The level, exceeded within 50% of the measuring time in dB(A).

L_{90}: The level, exceeded within 90% of the measuring time in dB(A).

A total of 330 visitors of these three parks were interviewed randomly by three trained interviewers to reveal their perception of the soundscape and environmental quality of these parks without informing them about the purpose of this study. The questionnaire was prepared based on a methodology tested and validated for the study of sound perception in public spaces (Pereira, 2003; Zannin et al.; 2006; Szeremeta & Zannin, 2009). Some of the imperative questions of the questionnaire are enumerated hereunder.

- What are the most pleasurable and most unpleasant facets of the park's soundscape?
- While spending time in the park, could you please categorize different types of sound heard?
- Does the park soundscape give you any trouble?

In these questions, the word ‘sound' was used instead of ‘noise' in order to avoid inducing any particular response (Szeremeta & Zannin, 2009; Zannin et al., 2006; Lynch et al., 2011, Raimbault & Dubois, 2005).

RESULTS AND DISCUSSION

In the present study noise monitoring confined the two parks of Bhubaneswar such as Gandhi Park (established in 1998 with an area 27 acre and 6km away from the city center), Indira Gandhi (IG) Park (established in 1984 with an area of 10.7 acre and located in the heart of the city), and the Gandhi Park of Puri (established in 2002 with an area of 6 acre and 10km away from the city center) (Table 1). Here in these parks, the noise was not due to transportation only but various other activities were responsible for it, also. Noise levels were measured in 72 points of six different sites, namely the Entrance, Site-1, Site-2, Site-3, Site-4, and Site-5 of these three parks (Fig.1), presented in Tables 2 and 3. In each park, the maximum noise level was found at the entrance point, as it faced the road side directly and there was some space for parking the cars and for vendors to sell their goods. However, inside the park premises, the L_{eq} value was almost the same in all sites. According to CPCB, the maximum permissible limit for the park during day time is 50 dB (A). In IG Park of Bhubaneswar, at sites 2 and 4, the equivalent noise levels were 60.1 and 60.5 dB respectively (Table 2). These two sites were close to the road and prone to traffic noise. The maximum and minimum noise levels were higher in Bhubaneswar's parks than that of Puri. At the entrance, the L_{eq} value was 64.6 dB both in IG Park (Bhubaneswar) and Gandhi Park (Puri), but it was 65 dB in Gandhi Park in Bhubaneswar (Table 2). Generally, the mean noise level was low in Puri Gandhi Park than the two studied parks of Bhubaneswar. The minimum noise level was 46.6 dB in IG Park, Bhubaneswar; 51.7 dB in Gandhi Park, Puri; and 52.2 dB in Gandhi Park, Bhubaneswar (Table 2).

Table 3 presents the noise levels (peak noise, L_{50}, and background noise level) observed in the different parks, explicitly showing that the noise levels were higher in the parks of Bhubaneswar than in the one in Puri. Correlation coefficient was established between the parks of two urban areas. The correlation coefficient between the noise levels of Puri and Bhubaneswar parks was 0.37.

Table 4 shows People’s responses to the pleasant sounds. Most of the interviewees considered the landscape responsible for pleasant sounds, yet in Gandhi Park of Bhubaneswar, 67 respondents (77.01%) did not find any unpleasant sounds in the park, while this was 78.9% in Gandhi Park of Puri and 70.42% in IG Park of

Bhubaneswar (Table 5). According to 23 respondents, inadequate lighting facilities at some places of IG Park led to mysterious activities by some young visitors, in turn resulting in noise pollution. They suggested that in the absence of light at night, some visitors shouted in the park, which was annoying. But this problem was negligible in other two parks. Table 6 shows the number of interviews in each park, along with identification data and the forms of usage by the park's visitors. Different sound types identified in the park were traffic noise, chattering of people, the sound of birds, and other natural sounds (wind, water, trees, etc.). These were the principal sounds to render the studied areas' soundscape. Table 7 offers Absolute Frequency (AF) and percentage of references to the types of sounds in different parks. Visitors' perception of each park revealed that the most frequently identified sound in Gandhi (Bhubaneswar and Puri) and IG Parks was bird song, mentioned by 29.9%, 22.2%, and 21.13% of the interviewees, respectively. This was followed by traffic noise which was mentioned by 26.43%, 15.6%, and 27.46% of the interviewees, and human sounds, present in 18.39%, 21.1%, and 24.65% of the responses, respectively. These data demonstrate that even in public parks, traffic noise is easily perceived, adding up to 16.05% of all sounds mentioned in these parks.

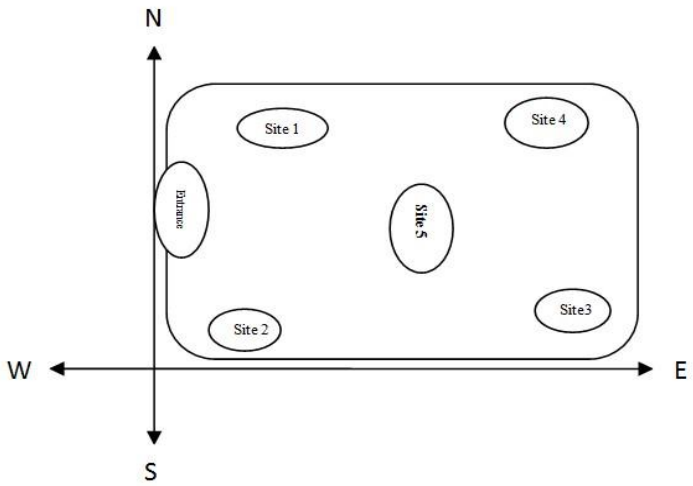

Fig.1. General Sketch of three parks depicting the six different noise monitoring sites

Table1. Area, distance from the city center, and the foundation year of the parks

Urban parks	Year of foundation	Area	Distance from the center (km)
Gandhi park (Bhubaneswar)	1998	27 Acre	6 km
IG park (Bhubaneswar)	1984	10.7 Acre	0 km
Gandhi park (Puri)	2002	6 Acre	10 km

Table 2. Sound levels (maximum, minimum, mean, and equivalent noise levels) measured in each park

Sites	Gandhi park (Bhubaneswar)				IG Park (Bhubaneswar)				Gandhi park (Puri)			
	Lmax	Lmin	Mean ± SD	Leq	Lmax	Lmin	Mean ± SD	Leq	Lmax	Lmin	Mean ± SD	Leq
Entrance	79.3	55.3	63.5 ± 4.9	65	81.4	55.2	63.6 ± 4.3	64.6	73.3	52.5	63.1± 4.5	64.6
Site-1	63.8	52.7	58.1 ± 2.7	59.2	62	50.5	57 ± 2.2	57.5	62.4	52.1	57.9 ± 2.7	57.9
Site-2	61.1	53.1	57.3 ± 1.8	57.8	64.8	55.6	59.7 ± 2.0	60.1	62.6	52.4	57.2 ± 2.1	57.2
Site-3	69.3	53.8	58.9 ± 3.2	60.1	64.6	53.2	58.7 ± 2.2	59.4	62.4	52.1	58.1 ± 2.3	58.1
Site-4	70	54.6	59.4 ± 3.3	59.6	67.8	54.6	60.2 ± 2.4	60.5	63.3	51.7	57.7 ± 1.9	57.7
Site-5	59.8	52.2	56.7 ± 1.7	57.3	60.7	46.6	55.4 ± 2.3	56	60.1	52.2	56.8 ± 1.7	57

Table 3. Different Noise Levels (Peak noise, L50, and background noise level) observed in different parks

Sites	Gandhi park (Bhubaneswar)			IG Park(Bhubaneswar)			Gandhi park (Puri)		
	L10	L50	L90	L10	L50	L90	L10	L50	L90
Entrance	69.1	62.6	57.3	68.3	63.3	59.6	68.5	62.2	56.9
Site-1	61.4	58.3	54.3	59.1	57.2	54.9	61.2	57.2	54.6
Site-2	59.7	57.4	55	62.4	59.5	56.8	59.2	56.8	54.5
Site-3	63.5	58.7	54.7	61.5	58.7	55.2	60.4	57.5	54.7
Site-4	64.3	58.4	55.9	63.3	59.9	57.5	60.1	57.4	55.7
Site-5	59.1	57	54.8	57.7	55.6	52.8	59.3	56.7	55.1

Table 4. Number of statements about the pleasant sounds identified in the park

Aspects	Gandhi park (Bhubaneswar)		IG park (Bhubaneswar)		Gandhi park (Puri)	
	Response	%	Response	%	Response	%
Soundscape	22	25.29	34	23.94	19	21.1
Animals	5	5.75	4	2.82	4	4.4
Air	6	6.9	4	2.82	12	13.3
Location	8	9.19	12	8.45	9	10
Landscape	46	52.87	88	61.97	46	51.1

Table 5. Number of statements about the unpleasant sounds identified in the parks

	Gandhi park (Bhubaneswar)		IG park (Bhubaneswar)		Gandhi park (Puri)	
Unpleasant aspects	Response	%	Response	%	Response	%
Soundscape	8	9.2	19	13.38	8	8.9
No unpleasant aspects	67	77.01	100	70.42	71	78.9
Lighting facility	12	13.79%	23	78.9	11	12.2

Table 6. Number of interviews in each park, identification data, and forms of usage by the park's visitors

Gender	Total number	Percent (%)
Male	187	56.67
Female	143	43.33
	Age	
Below 15 years old	25	7.58
15 to 25 years old	145	43.94
25 to 35 years old	92	27.88
35 to 45 years old	31	9.39
Above 45 years old	37	11.21
	Level of education	
Elementary	36	10.9
High school	122	36.98
Higher education	172	52.12
	Time spent in the park	
1 hour	171	51.82
2 hour	85	25.76
3 hour	44	13.33
More than 3 hour	30	9.09
	Weekly visits to the park	
Everyday	141	42.73
3 times in a week	66	20
Once in a week	123	37.27
	Type of activity engaged in the park	
Passing through	80	24.24
Physical exercise	44	13.33
Reading	45	13.64
Watching nature	65	19.7
Pleasure	42	12.73
Education	54	16.36

Table 7. Number (absolute frequency-AF) and percentage of references to the types of sounds in the parks

Question 3	Gandhi park (Bhubaneswar)		IG park (Bhubaneswar)		Gandhi park (Puri)	
Identified sounds	**AF**	**%**	**AF**	**%**	**AF**	**%**
Birds	26	29.9	30	21.13	20	22.2
Vehicle traffic	23	26.43	39	27.46	14	15.6
People	16	18.39	35	24.65	19	21.1
Sounds of nature	13	14.94	24	16.9	28	31.1
Others	9	10.34	14	9.86	9	10

Tables 8 and 9 offer the opinions, concerning the questions of aesthetic quality of the sounds, i.e. pleasant and unpleasant aspects of sounds. Majority of the respondents revealed that bird sounds as well as other natural sounds was pleasant, while traffic noise was the most unpleasant sound. Local bodies should take necessary steps to abate unpleasant sounds in public parks, ensuring best environmental quality; therefore, proper planning and coordination are necessary for implementation of soundscapes in all parks (Zannin et al., 2003). Based on the interviewees' responses and the acoustic data, it is clear that traffic noise is mostly considered as unpleasant in all parks. Table 10 shows the percentage and the absolute number of opinions referring to the level of noise in each park. In Gandhi Park of Bhubaneswar, the average sound level was 59.8 dB, 59.6 dB in IG Park, and 58.7 dB in Gandhi Park of Puri. All parks showed an influence of traffic noise on their soundscape; however, in Gandhi Park of Bhubaneswar, most of the interviewees considered the sound level of the environment as normal (72.4%) and only 12.6 % stated that they found this sound level "a little" annoying, with 9.2% and 5.8% calling it "more or less" and "very" annoying, respectively. Most of IG Park visitors considered the ambient sound level as normal (66.2%) and only 33.8% stated that they were annoyed by it. However, 16.9% visitors were bothered 'a little' about the soundscape of IG park; 9.2%, 'more or less'; and 7.7%, 'very' much. Although the average sound level of Gandhi Park in Puri was 58.7 dB, 67.8% i.e., 61 interviewees, said that the sound level of the environment was normal. Nonetheless, compared to the other two parks, annoyance of this park's visitors from the soundscape was "a little" for 15.5%, "more or less" for 10%, and "very" for 6.7% (Table-11). The data revealed that the annoyance from the sound level of an unpleasant sound (traffic noise), prevailing in the soundscape, was relatively low. Thus, the presence of pleasant sounds, natural and artificial landscape elements, and vegetation of noise attenuating plants would considerably enhance the acoustic comfort of the urban parks (Ozdemir et al., 2014; Szeremeta & Zannin, 2009; Yang & Kang, 2005; Feiber, 2004; King & Davis, 2003).

Table 8. Number of references to the pleasant sounds, identified in the parks

Identified sounds	Gandhi park (Bhubaneswar)		IG park (Bhubaneswar)		Gandhi park (Puri)	
	References	**%**	**References**	**%**	**References**	**%**
Birds	34	39.08	54	38.03	34	37.8
Vehicle traffic	13	14.94	25	17.61	14	15.6
People	24	27.59	38	26.76	28	31.1
Sounds of nature	12	13.79	21	14.78	11	12.2
Others	4	4.6	4	2.82	3	3.3

Table 9. Number of references to the unpleasant sounds, identified in the parks

Identified sounds	Gandhi park (Bhubaneswar)		IG park (Bhubaneswar)		Gandhi park (Puri)	
	References	%	References	%	References	%
Vehicle traffic	68	78.16	91	64.08	77	85.6
People	16	18.39	43	30.28	10	11.1
Others	3	3.45	8	5.64	3	3.3

Table 10. Number and percentage of references to sound levels of the parks environment

Level of ambient sound	Gandhi park (Bhubaneswar)		IG park (Bhubaneswar)		Gandhi park (Puri)	
	No.	%	No.	%	No.	%
Noticed nothing	8	9.19	14	9.86	9	10
Low	15	17.25	27	19.02	17	18.9
Normal	55	63.22	84	59.15	61	67.77
High	9	10.34	17	11.97	3	3.33
Total	87	100	142	100	90	100

Table 11. Number and percentage of references to the irksomeness in sound levels of the parks environment

Level of ambient sound	Gandhi park (Bhubaneswar)		IG park (Bhubaneswar)		Gandhi park (Puri)	
	No.	%	No.	%	No.	%
None	63	72.4	94	66.2	61	67.8
A little	11	12.6	24	16.9	14	15.5
More or less	8	9.2	13	9.2	9	10
Very	5	5.8	11	7.7	6	6.7
Total	87	100	142	100	90	100

CONCLUSION

In the present study, in all the three parks, the acoustic sound level was more than the 50 dB (A) limit, established by CPCB (2000), acceptable for green parks. These public spaces were closer to the streets, confirming the influences of vehicular noise on their soundscapes. Environment sound assessments depend not only on acoustic measurable data but on other parameters like environment, vegetation, fauna, birds, and the receiver itself. Based on urban factors and acoustical elements, it is inferred from the present study that all parks were affected by several aspects such as town planning, land use, traffic routes, vehicle density, and location of the park as well as its vegetation.

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