Environmental perception during rapid population growth and urbanization: a case study of Dhaka city

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Abstract Dhaka city in Bangladesh has been passing through a hasty process of urbanization and population growth since the last few decades. Rapid growth of population, unplanned urbanization and industrialization in the periphery has generated pressure to the changes in land use pattern, which has also caused huge urban expansion. This expansion process is engulfing cultivated land, vegetation, wetlands and water bodies without considering their environmental impacts. This study argues that these changes and their scale of environmental impacts or sufferings are not equally distributed among the dwellers in Dhaka city. It seeks to explore variations of environmental qualities on the basis of people's perceptions. The study finds that the dwellers in the city perceive their neighborhood environment differently, which may affect environmental qualities of the area and their sustainable management as well. Therefore, it is imperative to consider spatial variations and inequalities of environmental opportunities or sufferings in urban planning of Dhaka city.

Keywords Dhaka city · Urban environment · Environmental qualities · Perception · Satisfaction index

1 Introduction

Cities are already home to more than half of the world's population (Cohen 2006). Still, this trend of growth of urban population is quite fast, particularly in the developing

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countries (Rana 2011; Li et al. 2010). The UN (United Nations) forecasts that today's urban population of 3.2 billion will rise to nearly 5 billion by 2030, when three out of five people will be living in cities (Lewis 2007). Brockerhoff (2000) notes that a majority of the population of less-developed countries will be living in urban areas by 2020, and which will be dramatic in Asia and Africa (IRIN 2006). For example, Bangladesh is experiencing huge urban population growth (13.5 million in 1981, 22.9 million in 1990, 37.3 in 2000, and 46.4 in 2005) in recent decades (Chowdhury and Amin 2006). Particularly, Dhaka has been a habitat of more than twelve millions people. The four major cities of Bangladesh (Dhaka, Chittagong, Khulna and Rajshahi) hold nearly 60 % of the total urban population, while Dhaka alone holds 35 % (BBS 2001). Islam (2001) notes that the average annual population growth rate of Dhaka is 7 % during the last three decades, thus it takes a decade to be double. Burkart et al. (2008) state that the population was 1.5 million in 1975 and it reached to 12.4 million after 30 years. These characteristics actually indicate that Dhaka is one of the fastest growing megacities in the World (Burkart et al. 2008; World Bank 2007; Islam et al. 1997).

The impacts of rapid urbanization and uncontrollable growth of population are not only noticeable in case of land use changes but also it generates deterioration of environmental quality in the wake of mismanagement of urban services (Akbar et al. 2007; Islam 2005). Hossain (1992) notes the serious problems of environmental degradation stemming from urbanization in terms of land use changes, inadequacy in settlements, lacking in water and sanitation facilities, and degradation of community ambient environment. Du et al. (2010) also explores that disordered land use changes during urban expansion cause loss of wetlands in and around the city, which has direct and indirect impacts to inadequacy of water. A recent study by Moniruzzaman and Rana (2009) found that the wetlands in Dhaka city are gradually shrinking for rapid urban expansion on the one hand and the new areas of waterlogging are increasing on the other hand. There are studies that also find relationships between wetland reduction and expansion of urban built-up areas for rapid urbanization in Dhaka (Sultana et al. 2009; Islam 2006; Reza and Alam 2002). These researches particularly focus on the issues of land use change and its ecological impacts in the city.

There are researches that also pay attention to urban dwellers' perception on neighborhood environment and quality of life. A focus has been given to define what factors actually distinguish or influence how people perceive their quality of life. For example, Petrosillo et al. (2007a, b) note that socioeconomic status, cultural ties and past experiences determine the level of perception on environmental quality. This indicates that the issue of perceiving environmental quality is very subjective and may be associated with people's status and experiences. In addition, the success of environmental management also links with the people's awareness and their perceptions (Daily 1997; Petrosillo et al. 2007a, b). In the same line, Pendleton et al. (2001) state that on the one hand, environmental quality can affect people's behavior, and people have capacity to enhance or deteriorate environmental quality through behavior and values on the other. Thus, only available environmental services may not quantify the quality of environment, unless and until the human behavior to environment and management process is changed. Therefore, it is essential to know what shapes environmental quality as well as the environmental perceptions for designing a better urban environmental management plan (Aretano et al. 2013; Petrosillo et al. 2007a, b). However, these researches particularly accentuate on the issue of considering social characteristics into planning and decision making process.

Drawing upon the findings of the existing literatures, this study pays attention to spatial variations of environmental qualities based on people's perceptions. It argues that consideration of spatial variations of environmental sufferings or benefits need to be

incorporated into decision making process for better environmental management that may offer equal environmental opportunities for all urban dwellers. This paper experiments spatial variations of environmental sufferings as perceived by the respondents in the selected areas in Dhaka city, Bangladesh.

2 Objectives of the study

The main objective of this study is to assess relationships between major urban environmental sufferings in Dhaka city that possibly shapes environmental perception of the dwellers as well as affect the decision making process. The specific objectives are as following:

- To determine major environmental sufferings in Dhaka city based on people's perception on the existing urban environmental qualities; and
- To explore spatial variations of the perceived urban environmental qualities based on environmental sufferings in the city.

3 Methodology

Investigation of spatial variations of urban environmental problems in Dhaka City was based on factual and perceptual data. The factual data were collected from various secondary sources, and the perceptual data were collected through questionnaire survey method. Major environmental problems were identified on the basis of the perception of the respondents, which were further assessed for the sake of evaluating environmental qualities.

As can be seen in the Fig. 1, this study considers Dhaka city as the study area. The city is located almost in the middle of the country. It was considered to be studied not only for its political identity as capital of Bangladesh, but also it represents an interesting case of rapid urbanization, huge land use changes and remarkable degradation of environment. However, the land use map of the study areas (shown in Fig. 2) was divided into 11 grids, which were denoted as A, B, C, D, E, F, G, H, I, J and K (Table 1). To do the selection of the study areas, the Location Quotient (LQ) formula (The term first used in European Union and later by Mack and Jacobson 1996) was used, which is as following:The formula for computing Location Quotient is:

$$\text{LQ} = \frac{e_i/e}{E_i/E}$$

where e_i, local area in Grid-A; e, total local area; E_i, reference area of the study area; E, reference area of the study Total reference area of the study area.

The location quotient (LQ) is an index for comparing an area's share of a particular activity with the area's share of some basic or aggregate phenomenon. Table 1 shows the details of land use categories of the study area. It also helps to determine the areas, where land use changes are taking place at a large scale. It was found that the grid D, E and J have larger location quotient values (Table 1). These areas, basically, were chosen for fieldworks (Table 2). The basic demographic and socioeconomic data were collected from the latest reports of Bangladesh Bureau of Statistics.
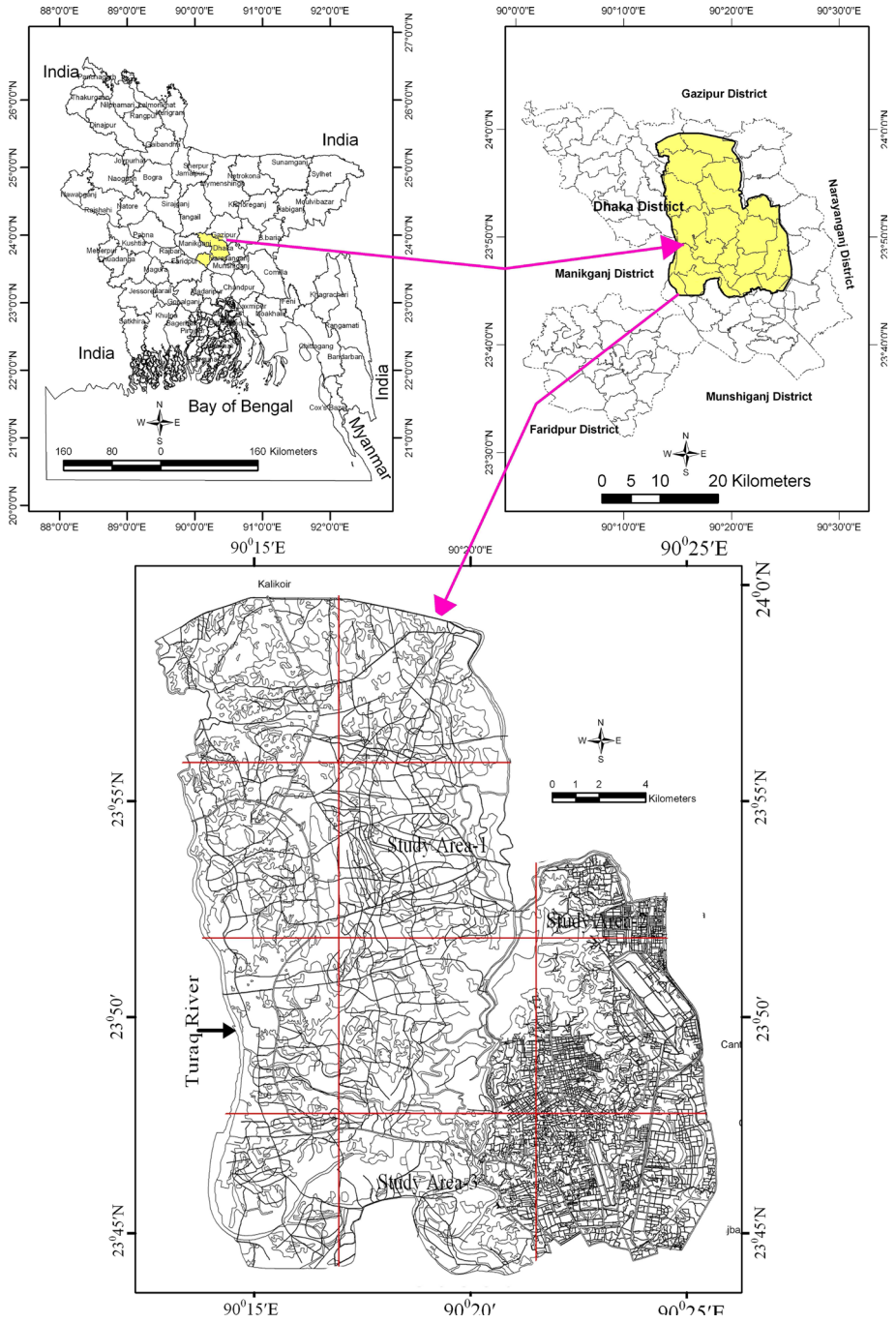
Fig. 1 Location of study areas. *Source* Modified after Islam (2011)
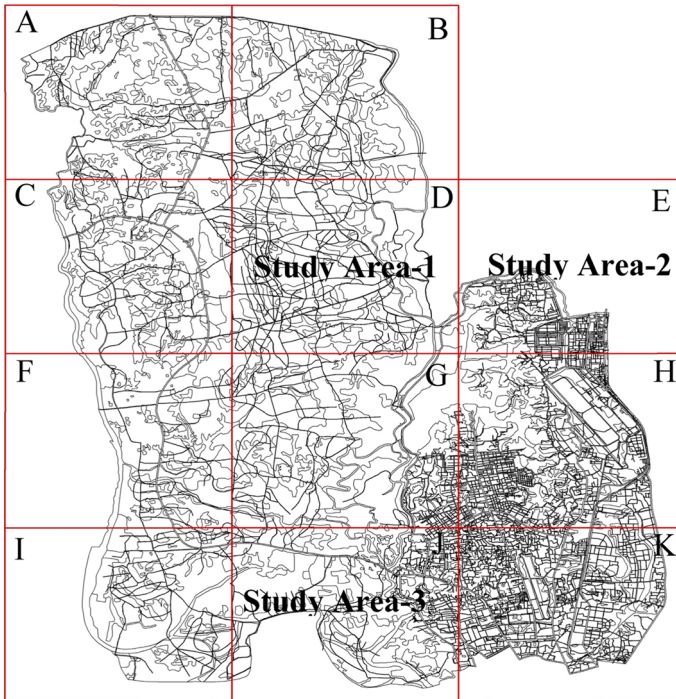
Fig. 2 Selected study areas

Table 1 Average location quotient value in the study area grid A to K

Grids	Land use categories								Total	Average
	BU	BL	AL	VG	WB	WL	TC	OT		
A	1.08	0.85	0.15	7.28	0.56	0.38	0.60	–	10.90	1.56
B	0.68	–	0.73	4.39	0.53	1.44	0.75	2.63	11.15	1.59
C	0.97	2.06	0.46	4.66	0.29	0.80	0.42	0.74	11.14	1.39
D	0.64	0.75	0.52	6.88	0.75	0.45	0.61	3.13	13.73	**1.71**
E	0.91	1.10	0.96	1.07	0.55	1.17	2.45	1.38	9.59	**1.99**
F	1.16	0.25	0.90	3.29	0.49	0.11	1.50	1.23	8.93	1.12
G	0.16	1.11	1.16	2.16	0.37	3.20	1.35	–	9.50	1.35
H	0.81	1.10	1.12	0.15	0.37	1.25	4.01	–	8.81	1.10
I	0.75	0.92	0.54	3.85	0.62	1.96	1.12	0.77	10.53	1.32
J	0.37	0.93	0.65	0.78	0.93	3.70	1.13	4.65	13.14	**1.64**
K	0.92	1.78	0.62	0.37	1.56	1.21	3.78	–	10.24	1.28

Bold values indicate that the areas with highest average location quotient value are selected for questionnaire survey

BU built up, *BL* bare soil/landfill, *AL* agricultural land, *VG* vegetation, *WB* water bodies, *WL* wet/lowland, *TC* transport and communication, and *OT* Others

Table 2 Selected study areas

Names of the area	Ward number/Union Parishad (Shown in Fig. 2)
Area-01	Ashulia Union; A part of Yearpur and Birulia Union
Area-02	Uttora (a part of DCC ward-01) and Harirampur Union
Area-03	Ward- 09, 10; and a part of ward- 08, 11, 12, 43, 46, and Amin Bazar Union, and a part of Kaundia, Banagram, Bhakurta, and Tetuljhora Union.

Source Modified after Islam (2011)

Questionnaire survey technique was used to determine the level of satisfaction on environmental qualities of the study areas. A questionnaire[1] was framed including eight major environmental variables (Table 3). In addition, the response of the respondents was categorized based on 6-point scale (Highly Satisfaction, Satisfied, Acceptable, dissatisfied, highly dissatisfied, and no response).

However, the questionnaire survey was administered in the three selected areas, which were Ashulia (study area-1), Uttora (study area-2) and Amin Bazar (study area-3). Figure 2 shows the selected study areas. A total of 397 interviews were conducted through questionnaire survey. The respondents were purposively selected, albeit the most interested and suitable one was chosen for collecting data. It can also be noted here that the head (both male and female) of a household was chosen for interviews.

To determine citizen's level of satisfaction, a satisfaction index (Yeh and Tan 1975) was used

$$\text{Satisfaction index, Is} = (f_s - f_d)/n$$

here f_s, number of satisfied respondents; f_d, number of dissatisfied respondents; n, total number of respondents

The assessment of spatial variations of environmental qualities has been done on the basis of satisfaction index (Table 4). Environmental sufferings were determined through negative index of satisfaction, which was considered to assess the spatial variations.

4 Results and discussion

4.1 Major urban environmental sufferings in Dhaka city

The quality of environment largely depends on the availability and quality of the essential infrastructural and utility services, like sanitation, sewerage system, drainage, supply of safe drinking water, garbage disposal system, electricity and gas or fuel for cooking. Moreover, urban environmental qualities are associated with the deterioration of the ambient environment and the insufficient public infrastructure and services to meet the demands imposed by rapidly growing population and huge urban expansion. Respondents were asked to identify the sufferings related to environmental degradation in their local areas. Table 5 shows the opinions of the respondents. It highlights that flash flood and drainage congestion (67 %), water pollution (68 %), air pollution (79 %), water and sanitation (63 %), garbage disposal system (73 %), traffic congestion (79 %) and open space/recreation facilities (36 %) are the major environmental problems in the study areas.

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[1] A similar questionnaire was also used in a Ph.D. research (Islam 2011).

Table 3 Major urban environmental variables

Major environmental variables	
1. Water supply	5. Drainage condition
2. Sanitation facilities	6. Cleaning and maintenance
3. Garbage disposal	7. Recreation facilities
4. Sewerage system	8. Traffic management

Source Modified after Islam (2011)

Table 4 Index for spatial variation of urban environmental degradation in Dhaka city

Index value (Is)	Meaning
Is = −100 %	Highly dissatisfied
−100 to −50 %	Severely degraded/vulnerable
−50 to −25 %	Moderately degraded/vulnerable
−25 to −1 %	Mildly degraded/vulnerable
Is = + 100 %	Highly satisfied
+ Value	Not degradation/vulnerability

Source Modified after Islam (2011)

Table 5 Major environmental sufferings in Dhaka City

Major environmental problems	No. of dissatisfied respondents (out of total 397 respondents)	Percentage
Air pollution	314	79.09
Traffic congestion	312	78.59
Garbage disposal system	289	72.80
Water pollution	268	67.51
Flash flood and drainage congestion	267	67.25
Water and sanitation	251	63.21
Open space/recreation facilities	142	35.77

Source Modified after Islam (2011)

4.2 Perception on urban environmental qualities

A perception-measuring scale was used to determine level of satisfaction of the respondents regarding eight environmental variables. A prestructured list of variables was used based on the types of environmental opportunities and sufferings the dwellers in Dhaka city generally perceive. The satisfaction scale was categorized as highly satisfied, satisfied, acceptable, dissatisfied, highly dissatisfied and no response. The category 'acceptable' refers to the answer when respondents take a neutral position. This answer indicates that the respondents may not clearly understand the questions or they were a bit pleased with environment. In addition, few of them also decline to answer. However, Table 6 shows that the respondents are comparatively satisfied with recreational facilities and cleaning and management system. It does not mean that they are completely satisfied with the facilities; rather these facilities might be better than other variables. On the contrary, a majority of the respondents reply that the traffic management, water and sanitation facilities are worse than other services. Table 6 also specifically indicates that more than 9 % of respondents

are highly satisfied with cleaning and maintenance facilities in the study areas, even though 18 % of them were in favor of recreational facilities. On the contrary, more than 20 % of the respondents were highly dissatisfied with sanitation facilities, sewerage and drainage system.

Thus, the satisfaction scale shows that the majority of the respondents were dissatisfied with the existing environmental services in the study areas. Despite the facts, many of the respondents were comparatively satisfied with several services, even though the services are still insufficient. The next section further tries to rank satisfaction of the respondents using 'satisfaction index'. The index value and their meaning are given in the methodology section.

4.3 Ranking urban environmental sufferings

Table 7 shows the ranks of the urban environmental sufferings based on satisfactory index. It is notable here that the total number of satisfied respondents and the total number of dissatisfied respondents were considered for this calculation. It was found that traffic management and water supply situations in the study areas are severely vulnerable in the wake of huge urbanization and land use changes. In addition, drainage, garbage disposal and sanitation facilities in the areas are moderately vulnerable. And, cleaning and maintenance falls into the category of mild vulnerable index.

4.4 Spatial variations of urban environmental qualities

Eight environmental variables were considered to experiment the spatial variations of environmental perceptions of the respondents. It was found that majority of the respondents is dissatisfied about the quality of environment in the city. Moreover, their responses to environmental dissatisfaction were found to be variable in the study areas. Table 8 shows these variations among the three selected areas. Based on severity of the environmental problems (as it is ranked in the Table 8), the area-03 (Amin Bazar) is much more vulnerable than others. The data in the table 8 also indicate that the area-02 (Uttora) has comparatively better environmental quality, even though the respondents have reported

Table 6 Perception (level of satisfaction) on urban environmental qualities

Variables	Highly Satisfied		Satisfied		Acceptable		Dissatisfied		Highly dissatisfied		No response	
	F	P	F	P	F	P	F	P	F	P	F	P
Water supply	9	2.27	44	11.08	61	15.37	266	67.0	10	2.52	7	1.76
Sanitation facilities	8	2.02	32	8.06	52	13.10	175	44.08	92	23.17	38	9.57
Garbage disposal	2	0.50	34	8.56	45	11.34	189	47.61	64	16.12	63	15.87
Sewerage system	4	1.00	60	15.11	69	17.38	136	34.26	91	22.92	37	9.32
Drainage condition	5	1.26	41	10.33	49	12.34	203	51.13	81	20.40	18	4.53
Cleaning and maintenance	37	9.31	62	15.62	65	16.37	137	34.51	77	19.39	19	4.79
Recreation facilities	11	2.77	72	18.14	92	23.17	137	34.51	84	21.16	13	3.27
Traffic management	1	0.25	37	9.32	49	12.34	261	65.74	38	9.57	11	2.77

Source Modified after Islam (2011)

F frequency, *P* percentage (*N* = 397 for the three samples area)

Table 7 Ranks of urban environmental sufferings

Environmental variables	Number of only satisfied respondents (fs)	Number of only dissatisfied respondents (fd)	Satisfaction index (Is) (total respondents 397) (%)	Rank
Traffic management	37	261	−56	1
Supply of water	44	266	−55	2
Drainage condition	41	203	−40	3
Garbage disposal system	34	189	−39	4
Sanitation facilities	32	175	−36	5
Cleaning and maintenance	58	137	−20	6
Sewerage system	60	136	−19	7
Recreational facilities	62	137	−18	8

Rank indicates severity of the problem

Source Modified after Islam (2011)

Table 8 Spatial variations of urban environmental problems

Variables	Area-01 Ashulia (Is)	Area-02 Uttora (Is)	Area-03 Amin Bazar (Is)
Traffic management	−53 %	−48 %	−59 %
Rank	2	3	1
Supply of water	−51 %	−48 %	−58 %
Rank	2	3	1
Drainage condition	−31 %	−30 %	−45 %
Rank	2	3	1
Garbage disposal system	−42 %	−27 %	−39 %
Rank	1	3	2
Sanitation facilities	−34 %	−34 %	−36 %
Rank	3	2	1
Cleaning and maintenance	−31 %	−13 %	−36 %
Rank	2	3	1
Sewerage system	−16 %	−13 %	−20 %
Rank	2	3	1
Recreational facilities	−16 %	−16 %	−20 %
Rank	2	3	1
Average dissatisfaction value	−34 %	−28 %	−39 %
Rank	2	3	1
Total rank	18	26	10

Rank indicates severity of the problem

Source Modified after Islam (2011)

remarkable environmental sufferings. The table also reveals that the respondents in Amin Bazar reported noteworthy dissatisfaction on most of the variables except garbage disposal system. The negative index values identify all of the three areas as moderately degraded.

To justify the results, statistical techniques were used. It was argued that the respondents in the three areas are not enjoying similar environmental opportunities or sufferings. To test the variations among three areas, Friedman's test was used. The null hypothesis was that there is no variation among the three areas; and the alternative hypothesis was that

there is variation among the three areas. The alpha value was 0.001 and the degrees of freedom was $3-1 = 2$. From the chi-square table, it was found that with an alpha level of 0.001 and 2 degrees of freedom, the critical value is 13.816. Thus, this value indicates that if the chi-square value is greater than 13.816, the null hypothesis will be rejected. Here, we find that the calculated chi square is 41.5, which is greater than 13.816. This indicates that the calculated value is greater than the tabulated value, which suggests that the null hypothesis is rejected. Therefore, we can conclude that there is a significant variation of environmental qualities (or sufferings) among the three areas.

To statistically test the variations, Wilcoxon's signed-rank test technique was also used to calculate the p value for pairwise comparisons between the study areas. It was found that all three areas differ significantly from each other: Ashulia versus Uttora ($p = 0.027$), Uttora versus Amin Bazar ($p = 0.012$), Ashulia versus Amin Bazar ($p = 0.025$). These results statistically justify that the environmental qualities of the three study areas are significantly different from each other.

5 Conclusion

The study aims to find out major environmental sufferings in Dhaka city based on people's perception on the existing urban environmental qualities. The results indicate that the dwellers in Dhaka city are suffering from various environmental problems, in which traffic mismanagement, irregular garbage disposal, and inadequacy in water and sanitation facilities are remarkable. In addition, the study also finds that environmental sufferings in the city are not equally distributed among the dwellers. It means that dwellers of different areas of the city are sufferings at different scales. This study finds that Amin Bazar is much more environmentally vulnerable than Ashulia and Uttora, despite all three areas fall in moderately degraded category based on satisfaction index. It does not mean that Ashulia and Uttora have satisfactory environmental qualities, since many dwellers in these areas responded in a negative manner. However, the overall findings of the study indicate that the environmental conditions in Dhaka city have not been reached to a satisfactory level to the dwellers. In addition, the dwellers are suffering at different scales of environmental problems, which need to be considered in the urban development plans and service delivery systems. The statistical tests of the findings also justify that the environmental qualities of the study areas are significantly different from each other. The paper also accepts that people's perception plays an important role in planning and managing environmental quality. On the contrary, a good quality of environment also affects people's behavior and values, which generally defines human perceptions. Thus, it is imperative to understand the socio-spatial variations of perception of the people which essentially affect and determine human behavior as well as sustainable activism to environment.

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