

Dhaka's Built Environment: A Comparison of Sky View Factor (SVF)

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Abstract

From a small suburban town Dhaka has emerged as a megacity in course of about four centuries. Dhaka is on the verge of a change in its urban character, vertical growth taking the place of horizontal expansion. This change has an obvious effect on the character of the built environment of the city.

This study is an attempt to explore Dhaka's built environment by investigating different areas of the city in respect of population, land use, lot size, ground coverage, site set back, building materials, building height and so on. Finally, by using the 3D map of the selected areas sky view factor (SVF) is calculated in TownScope software. It is revealed that both the population density and the characteristics of built environment vary greatly from one area to another. Furthermore, the SVF differs significantly in the selected areas of the city which can be considered as an indicator of built environment of Dhaka and should be addressed adequately to make environment-friendly city areas.

1. Introduction

Dhaka has increasingly turned to high-rise developments to accommodate an ever-growing population that has shot up from one million in 1971 to at least 12 million and rising. Dhaka city is one such case where environmental problems are associated with the accelerated rate of urbanization. Increased built density and reduction of open space, resulting from such a magnitude of urbanization affects urban environment very badly. The built environments of Dhaka city are often uncomfortable in comparison to its rural surroundings. In recent time, overheating is the major environmental concern for Dhaka. Unfortunately in Dhaka city the planning and building construction rules seldom follows the design criteria that are necessary to bring a comfortable environment.

The build environment of the study areas are investigated mostly by the field survey conducted for this research. Some characteristics of built environment such as land

use, lot size, ground coverage of buildings, site setback, building height are studied and finally the sky view factors (SVF) of the selected areas are calculated. In this study SVF is considered as an index of built environment. The sky view factor (SVF) is an important tool in urban geometry manipulation. Several researchers have identified the building geometry expressed as sky view factor (SVF) as having a complex influence on urban climate [1-2].

2. Urbanization and Urban Development in Dhaka

Dhaka flourished as a centre of administration and commerce in the Mughal period (1608-1764). Although there is evidence of pre-Mughal settlements in and around Dhaka, it is only during the Mughal period that the primacy of the city was established through trade and industry and it became the capital of Mughal Bengal. During this period an early trend in the influx of population set in and continues to this date, except with a marked decrease during the British Colonial rule (1764-1947). After independence from Pakistan in 1971, Dhaka regained its status as a capital republic.

In this way Dhaka has grown through a series of urban expansions coupled with rapid urbanization and growing population. The growth of the city has been shown in Fig. 1. Again the increase of population during 1951-2001 in the megacity is presented in Fig. 2.

Dhaka is a fast growing mega city in the world with high rate of urbanization. The city, in combination with localities forming the wider metropolitan area, is home to an estimated 12.8 million as of 2008 and the density of population is about 23,029 persons per sq. km in the capital city area [3]. The population is growing by an estimated 4.2% per annum, one of the highest rates amongst Asian cities [4]. It is one of the most densely populated cities in the world and forms the world's 9th largest agglomeration. According to Far Eastern Economic Review, Dhaka will become a home of 25 million people by the year 2025 [5].

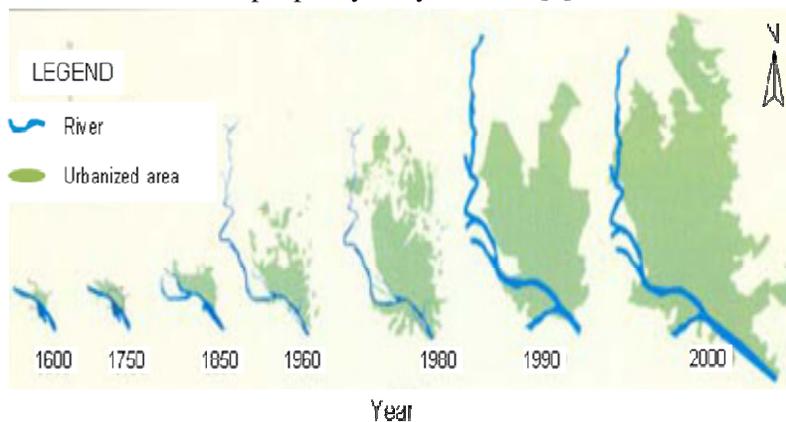


Figure. 1: Growth of Dhaka city from 1600-2000

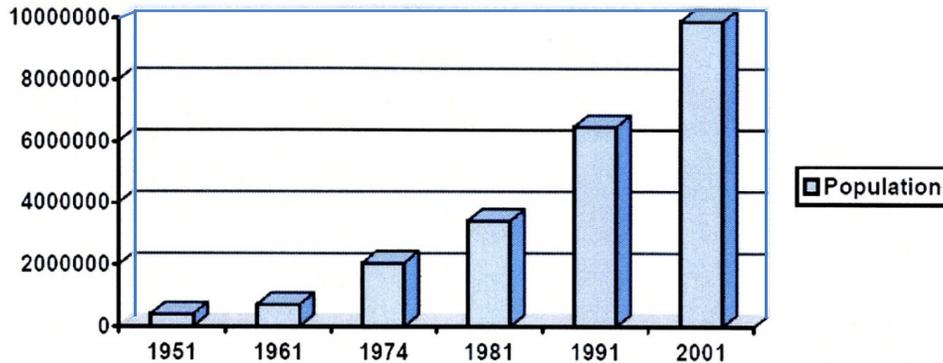


Figure. 2: Population growth in Megacity Dhaka during 1951-2001 [6]

It is apparent from existing patterns of urban development that one of the major environmental challenges for the city is to address the issues of high density living. The present problems of housing and transportation would have to be effectively addressed along with the needs for leisure spaces. At present existing open spaces are diminishing to make a way for the buildings and roads; and such patterns of growth are having adverse effects on the urban environment. To cope up with ever-increasing pressure Dhaka has started going upwards, an inevitable and common phenomenon in all modern cities with dense population and little scope for horizontal expansion due to topographical reasons. Allowing more building height is a means through which the demands for high density development are met.

3. Methodology

The methodology of this study can be described by the following two steps:

i. Field Survey

In this research the approach to the problem is primarily through the reconnaissance survey with which the study areas are selected. The next stage of the research is field survey. The field survey on the build environment centered around three specific areas in the city, having distinct characteristics related to build environment. The outdoor areas were observed and selected following a reconnaissance survey done in March 2008. The designated areas are termed as Study Area and thus the three selected areas are termed as Study Area I, Study Area II and Study Area III. Finally, a detailed survey was conducted to collect data on build environment during March 25 - April 20, 2008. Through this survey data was collected on site planning, building layout, building height and shape, width of roads and pedestrian ways, building materials and so on.

ii. Calculation of sky view factor (SVF)

The sky view factor (SVF) is a dimensionless parameter denoting the quantity of visible sky at a certain location. SVF approaches unity in perfectly flat and open land, while locations with obstructions such as buildings and trees cause SVF to be proportionally less. In this study it is expressed in percentage. The SVF of the study areas are calculated using the 3D building maps which are drawn by VectorWorks software. By using these maps SVF at the selected points (as shown in Figs. 4-6) is calculated for all the areas using TownScope software.

4. About the Study Areas

For this study three areas are selected from the city with different land uses and physical characteristics. These are (i) planned residential area, (ii) central business district (CBD) and (iii) unplanned mixed use area which are located in Dhanmondi, Motijheel and Siddeswari area, respectively. These areas can be regarded as the representatives of the city areas. In this research Dhanmondi, Motijheel and Siddeswari area are termed as Study Area I, Study Area II and Study Area III, correspondingly. Figure 3 shows the location of the study areas in Dhaka city. The study areas Dhanmondi, Motijheel and Siddeswari with the buildings are shown in Figs. 4, 5 and 6, respectively. This study focused on the outdoor space between the rows of buildings along the road. Figures 7, 8 and 9 show the typical views of the existing canyons of Study Area I, Study Area II, and Study Area III, respectively. The characteristic features of these areas are discussed here:

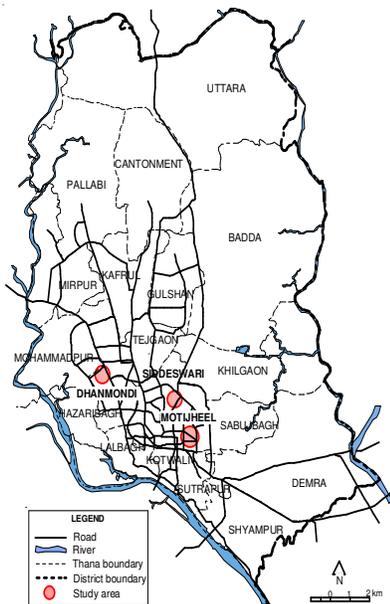


Fig. 3: The study areas in Dhaka city

Study Area I - Dhanmondi Area

This area is located in Dhanmondi *thana* in ward no. 49 of Dhaka city. Dhanmondi was initially developed as a low-density posh residential area for high-income and higher-middle income groups in early 1950's. In 2001 the density of population was 40533/sq. km in Dhanmondi *thana*. Dhanmondi is one of the first planned residential communities in Dhaka. About 1000 highly serviced plots were developed on an area of 473 acres. This area is located 5 km away from the city center. The plots were lavishly set and sized by 14400 sq.ft (1337.8 sq.m). Three types of streets (30 meter, 15 meter and 10-15 meter) with sidewalks are provided in Dhanmondi. The design principle for creating the plots was grid iron pattern of road network with rectangular plots. Up to 2006 the height limitation of building was 6-storied in this area. Initially one residential building was constructed at a suitable position in each plot with large open space surrounding the building with sufficient setbacks on all the sides. But the scene of this area has started to change rapidly with the rapid increase of population in Dhaka city. Moreover due to rapid increase of land value in the city the big plots are mostly being sub- divided into a number of small plots. As a result the density of the area has increased due to subdivision of plots and construction of multistoried buildings. Gradual invasion of non- residential uses has drastically affected the quality and changed the character of this area.

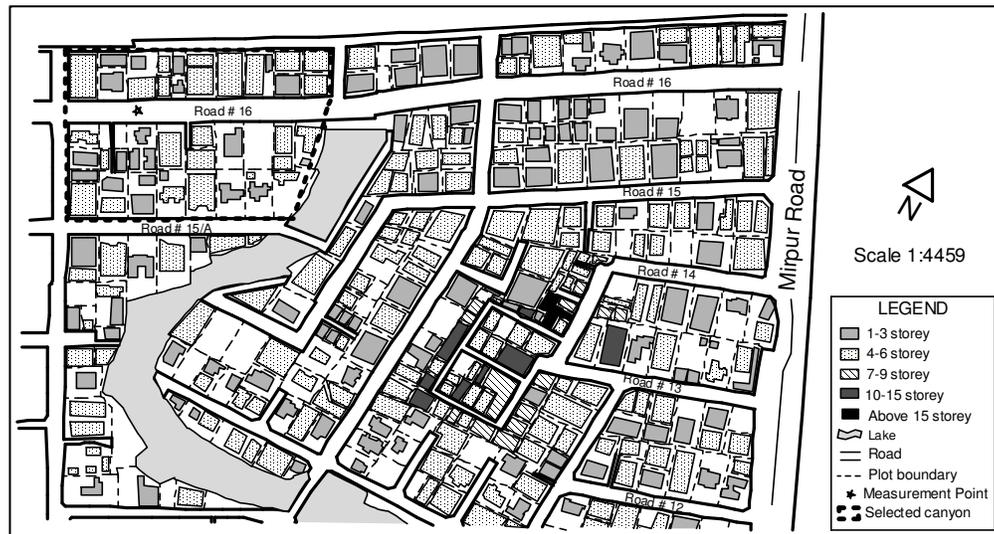


Fig. 4: Map of Study Area I (Part of Dhanmondi residential area), Dhaka

Study Area II - Motijheel Area

This area is located in ward no. 32 of Motijheel *thana* in Dhaka city. This area is the principal commercial district of Dhaka city. It is a planned area developed in 1960's.

The area is situated in the southern part of the city, which is characterized by relatively high built density and consequently a high population density of 54470 peoples/sq.km in Motijheel *thana* as per 2001. This area was planned with grid iron pattern road network and rectangular plots having roads on two sides of the plots. The two main streets are 36 m and 24 m wide. As the heart of the city the main offices of many financial institutions including the central bank of Bangladesh (Bangladesh Bank), other government and private banks, insurance companies, the Dhaka Stock Exchange, the power and water development board, the city development office (RAJUK) and other government and private offices are located here. The ground coverage is very high and most of the high-rise buildings of the city are located in this area.

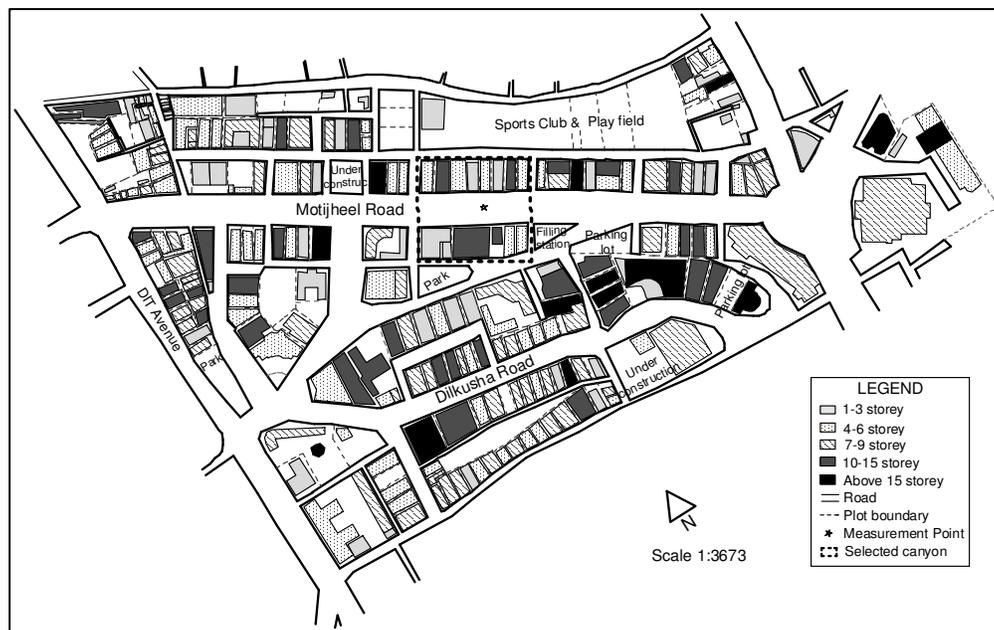


Fig. 5: Map of Study Area II (Part of Motijheel commercial area), Dhaka

Study area III - Siddeswari area

This area is located in ward no. 53 of Ramna *thana* in Dhaka city. In the beginning, low density and large plots made up due to the unplanned nature of Siddeswari and lack of urban services. The area was covered with extensive vegetation and water bodies, which have been gradually destroyed. The unplanned nature of development of Siddeswari continued and after the independence of Bangladesh in 1971, this community experienced rapid population increase. Post-independence period resulted in high density development with numerous high-rises and medium-rises replacing the low-rises. Land in Siddeswari is being intensively used due to its proximity to the city center. More than 85 percent of a plot is presently being

developed for medium and high-rises, ignoring the setback rules promulgated by the city development authority. The facade of buildings is placed right up to the street line and the streetscape is dominated by them. The existing streets are very narrow (4m to 6m) and congested without any sidewalks for pedestrian. The spaces left between buildings are also not adequate to allow for daylight and airflow properly.

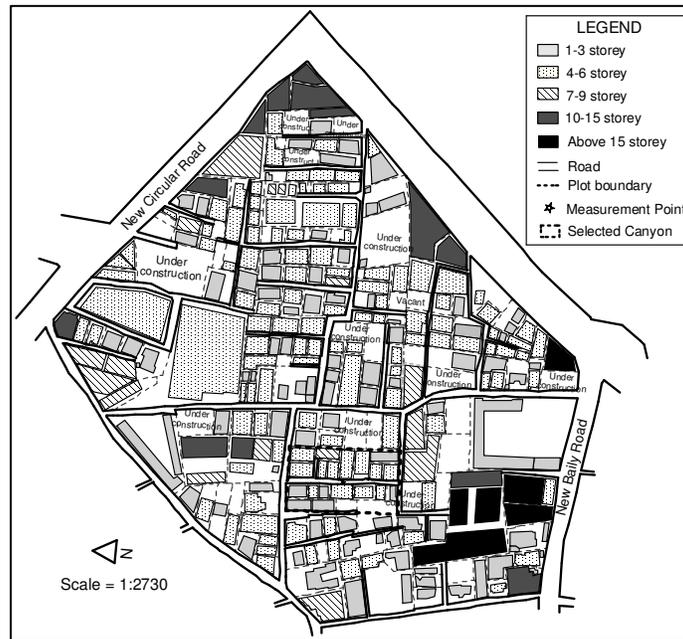


Fig. 6: Map of Study Area III (Part of Siddeswari area), Dhaka



Fig. 7: View of Study Area I (Dhanmondi)



Fig. 8: View of Study Area II (Motijheel)

5. Characteristics of the Study Areas

Some important characteristics of the built environment of the study areas including population are discussed below:

5.1 Population

As in Dhaka city the density of population is at the alarming stage, the study areas are not an exception. The population data exactly for the part of study areas is not available. Thus the population data on *thana* and ward level collected from the census report [7] are used here. From those an understanding about the population density on the specific study areas can be made. It is found that the density of population has increased largely from 1991 to 2001 (Fig. 10). It became almost double (two times) in case of Dhanmondi thana where it was increased from 20691 persons/km² in 1991 to 40533 persons/km² in 2001. The density of population in Motijheel thana is high (54470 persons/km² in 2001) and it is 33370 persons/km² as of 2001 in Ramna thana where study area III (Siddeswari area) is situated.

Moreover the density of population in the ward level is also shown in Table 1. Study Area I, Study Area II and Study Area III are sited in ward no. 49, 32 and 53, respectively. It shows that although the density of population decreased in this level still it is high. In ward no. 32 where the Study Area II is located the density of population is the highest (40102/km²) among these three areas.



Figure. 9: View of Study Area III (Siddeswari)

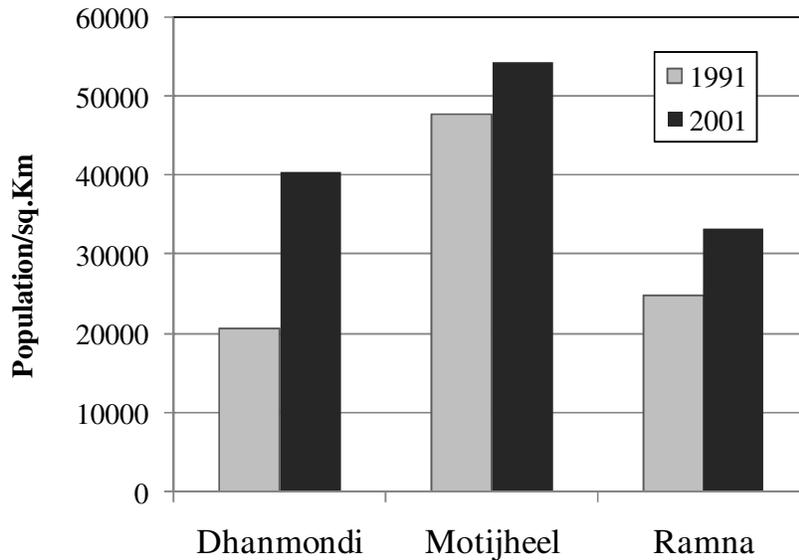


Figure. 10: Population density in ward no. 49, 32 and 53 in 2001

Table 1: Population density in Dhanmondi, Motijheel and Ramna *thana* in 2001

Ward	Area (in km ²)	Population	Density (per km ²)
49 (Dhanmondi)	2.9	46017	15867.93
32 (Motijheel)	1.014	40664	40102.56
53 (Ramna)	1.6268	45774	28137.45

5.2 Land use

As the detail land use survey is not conducted for this study, the land use map of 2003 prepared by Dhaka City Corporation is used here. The distribution of different land uses in Study Area I and III are shown in Fig. 11. The study area I and III is predominantly residential. Among the other land uses in study area I, commercial occupies 13% and mixed uses are 9%. In study area III, mixed uses occupy 14% and commercial occupies 10% land use. Whereas the other uses are insignificant. Study area II is the fully commercial area as it is the central business district (CBD) of Dhaka city. In this case the other uses are negligible.

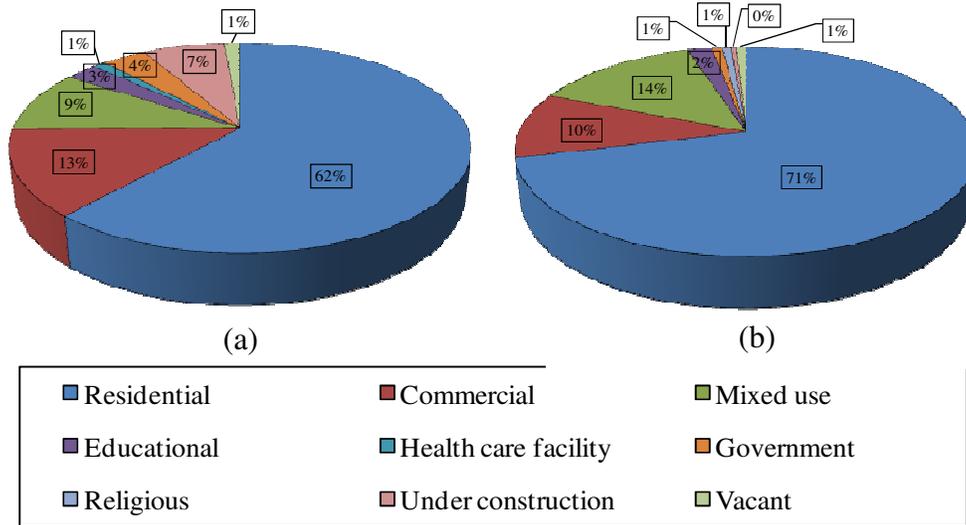


Figure. 11: Distribution of land uses in (a) Study area I and (b) Study area III

5.3 Lot size

The size of lot is delineated from the maps collected from Dhaka City Corporation (DCC). Fig. 12 shows the distribution of various lot sizes in the study areas. In case of Study Area I, the lot size is large and about 30.6% plots are 1000-1500 m² and 25% are 600-800 m². In Study Area II 34.1% of lots are 400 to 600 m². The small sized lots (100-400m²) are the most prevalent in Study Area III. About 47% lots are 200-400 m² and 22% are 100-200 m².

5.4 Ground coverage and site setback

The percentage share of different ground coverage of the buildings in the study areas are shown in Fig. 13. In Study Area I about 30% buildings occupied 30-50% ground coverage. In this area about 28% and 18% buildings occupied 50-60% and 60-70% ground coverage, respectively. Again the ground coverage is very high in Study Area II and Study Area III. In these areas the highest share of ground coverage is above 70%. In Study Area II about 50% buildings occupy more than 70% ground coverage and it is about 33% for Study Area III. The share of 60-70% ground coverage is high in Study Area II and Study Area III which are 29% and 27%, respectively.

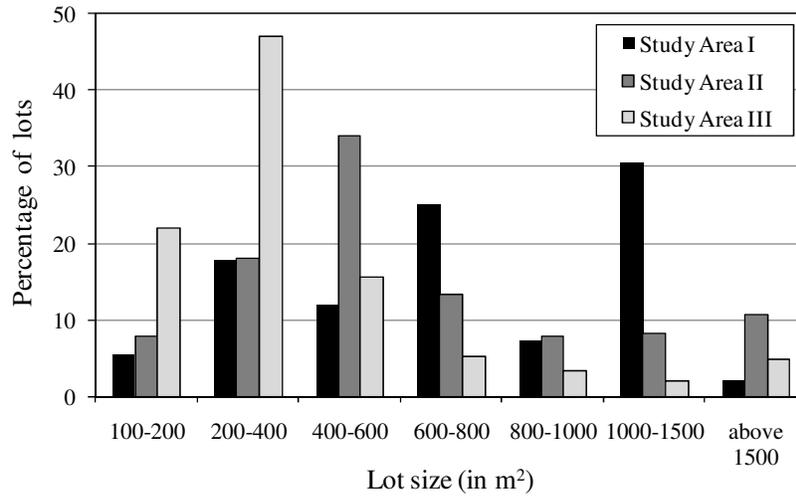


Figure. 12: Distribution of lot sizes in Study Area I, Study Area II and Study Area III

Again site setback depends on ground coverage of a lot. A plot with high ground coverage can have small site setback. The situation of site setback can be seen in Figs. 4-6. The situation of site setback is comparatively better in Study Area I than the other two areas. In Study Area II and Study Area III the ground coverage is high; therefore the site setback is small in these cases.

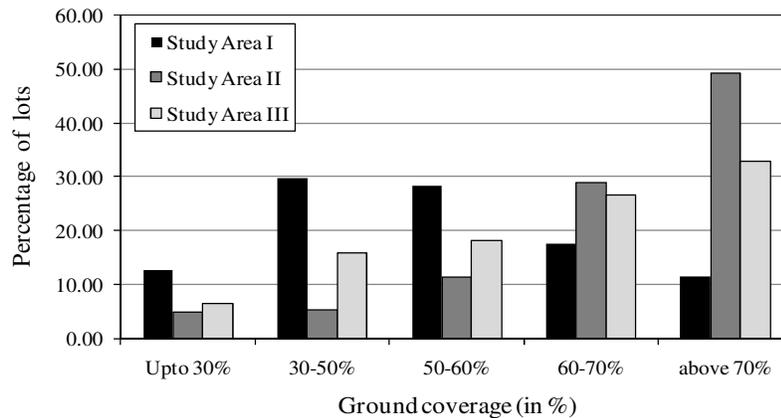


Figure. 13: Distribution of ground coverage in Study Area I, Study Area II and Study Area III

5.5 Building materials

Almost all the buildings in the study areas are concrete structures. There are some

tin-shade buildings which are not considered in this study because of the possibility of destruction or relocation of those (their transitory character). Some of the concrete buildings possess glass façade, steel and other modern building materials in some parts of those.

5.6 Building height

The building height in the study area is investigated through field survey. The existing share of different building heights for each area is illustrated in Fig. 14. Here the buildings are categorized into 3 groups according to the number of stories: low-rise (1-3 storied), medium-rise (4-6 storied) and high-rise (above 7-storied) buildings. It is observed that about 44% building in Study Area II is high-rise while it is only 7% in Study Area I and 14% in Study Area III. The height of a one-storied building is 3 m. It can also be said that Study Area II is predominantly high-rise whereas Study Area I and Study Area III are medium-rise.

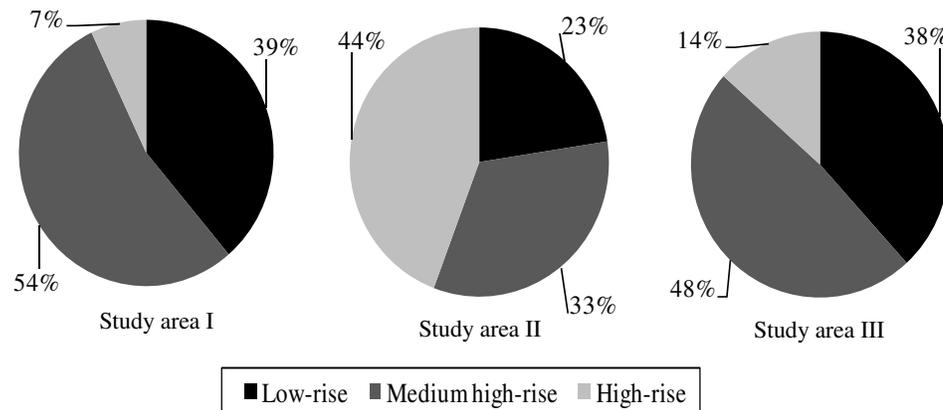


Figure. 14: Share of different building heights in Study Area I, Study Area II and Study Area III

6. Sky View Factors (SVF) of the Study Areas

Fig. 15 illustrates the sky view factors of Study Area I, Study Area II and Study Area III. It was calculated at the respective measurement points (as shown in Figs. 4 -6) in the middle of the road at 1.2 m above the ground. Indeed SVF is affected by the building shape and height and also by the width of road. Therefore the SVFs of three study areas vary greatly because of different building forms and road width. SVF is found highest in Study Area I (51.2%) and lowest in Study Area III (12.6%).

In fact, sky view factor shows the amount of visible sky at a certain location. It has immense effects on urban environment as solar radiation, air temperature, wind velocity, day lighting etc. are directly affected by SVF.

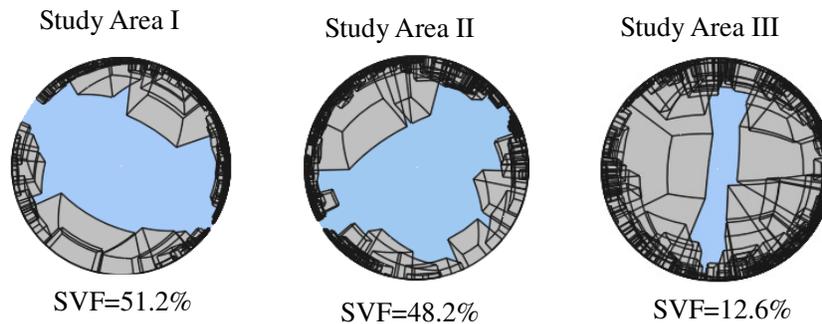


Fig. 15: Sky view factors (SVF) of the study areas

7. Conclusion

This study evaluated the built environment of Dhaka city with respect to various characteristics of it. It was revealed that SVFs vary significantly from one area to another as the building height and shape, and road width differs. As SVF has a direct influence on urban environment, therefore, the planning and building rules should address this factor adequately.

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