

EMERGING GREEN SPACES IN NORTH OF DHAKA: SUITABILITY ANALYSIS IN A DENSE URBAN SETTLEMENT

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ABSTRACT

Dhaka, the capital of Bangladesh, is acute of green spaces. The uncontrolled urban sprawl is encroaching the lands in the city. The Southern part of Dhaka, the oldest part, offers few large urban green spaces for cultural activity, recreation etc. But there is serious deficiency of neighbourhood and regional urban green open or public gathering space in Northern Dhaka, except the diplomatic zone. Hence, this paper aims to identify the potential lands that can be converted into urban green space by using spatial suitability analysis and GIS. Two aspects have been chosen for desired environmental quality: existing criteria and green indices. The suitability factors are as such: size, accessibility, buffer, Historic-cultural value, existing land use, density, flooding, and water body. These suitability factors are classified into four sets- high, moderate, low and no suitability. The findings assist to synthesize the appropriate land to be adapted as public open space in North of Dhaka. Ultimately, it will help to form a base for generating a greener city in the future.

Keywords: Dhaka, Urban green spaces, Suitability Analysis

1. INTRODUCTION

Dhaka, the capital city of Bangladesh, is in acute shortage of public spaces or urban green spaces. The city is has been expanding to the north since the Mughal period, but it has a limited scope to create new green spaces. According to the UN report (2014), Dhaka is the eleventh most populous megacity in the world with 17 million people. The increasing population has put an immense pressure to the urban settlement of Dhaka and the green spaces are engulfed day by day to meet the urban sprawl (Nilufer, 1999).

A minimum of 25% open space (plantation and water body combined) of a city, is required to endure a sustainable environment, declared by UNEP. In Dhaka, open space area is only about 14.5% (Byomkesh, Nakagoshi, & Dewan, 2012). In another study by Nilufer (1999), shows that, the total amount of open space in Dhaka includes- roads, footpaths, parks, play fields, tracts, lakes, ponds etc. which is about 17-18% of the city area. According to Nilufer (1999), the total land of Dhaka City Corporation (DCC) area and its population ratio, is only 0.12 acres per thousand of population. With fewer parks and open spaces, the city is facing gradual encroachment of the open spaces both by private and public bodies. Figure 1 shows, how in 28 years the majority of urban lands, that were previously agricultural land, vegetation, water bodies or low-lying areas were converted due to the increasing demand for urban land. This process put an immense pressure on natural resources in Greater Dhaka (Dewan & Yamaguchi, 2009). These unplanned land use changes has an adverse effect on the present lifestyle and the flooding events, unbearable air pollution, flash flood, water pollution, loss of biodiversity etc. are taking places as a result.

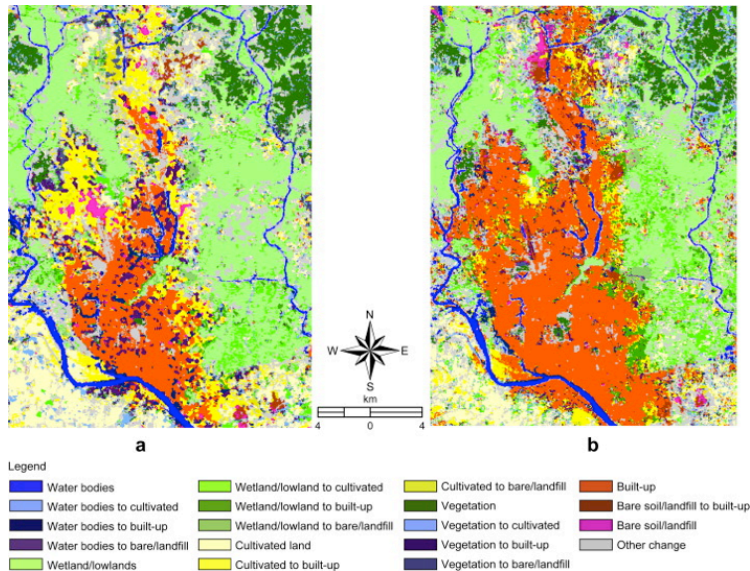


Figure 1. Major land use conversion of Dhaka, (a) 1975–1992 (b) 1992–2003. (Dewan & Yamaguchi, 2009)

The study conducted by Nilufer (1999), identifies that the precious open spaces of Dhaka are highly used and there also remains a great demand of more open spaces in our urban life. In spite of growing densification of built-up areas in newer parts of Dhaka, a number of medium and large scale open spaces are scattered in the city. The stock of public open spaces under DCC control is approximately 190 acres and under PWD is 302 acres. These two authorities cover 0.768 sq. miles of area, which is only 1.4% of Dhaka's land.

The southern part, the older part of the city offers more large public spaces which is more culturally active and historically significant, like – Ramna Park (established during British period in 1908), Sohrawardi Uddayan in 1972 (Mughal Garden during 1825 (Habib, 2010), later became race course during British period), Osmani Udyan, Dhaka university open areas, Shahid Minar, Majar of Three Leaders (beside Sohrawardi Uddayan), Dhanmondi lake - “Sadly, with Dhaka’s rapidly growing population, unless they can be replicated, their value will be diminished by over-utilization and these valuable assets permanently impoverished” (Nilufar, 1999). But the northern part of the city has North and South Plaza of National Assembly Building, (which is restricted of public entrance) and Chandrima Uddayan are only large scale urban green spaces available for public gathering (see Figure 2).

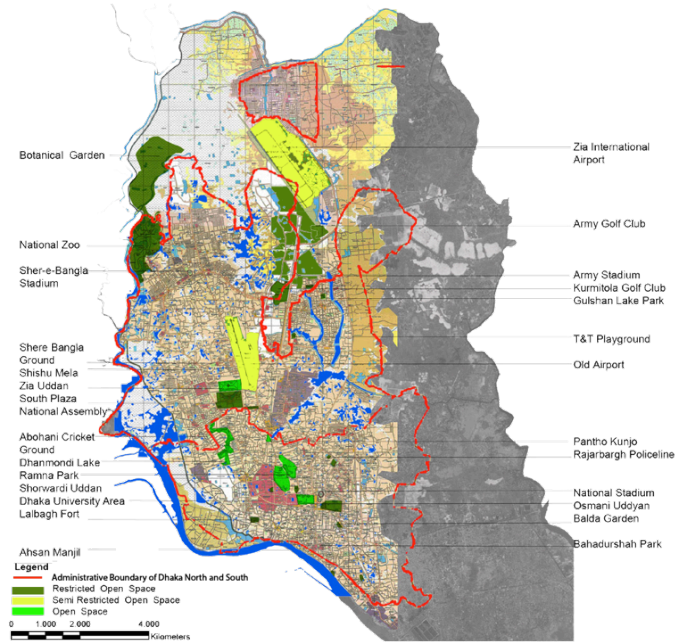


Figure 2. Major existing open spaces of Dhaka city. Source: (Habib, 2010)

Due to these issues, this research aims to identify the potential lands which exist in use as parks, liner green space like lake brims, but absence of landscape quality, inadequate accessibility and vacant/ preserved lands which are under different authorities other than PWD (Public Works Department) and Rajuk, can increase the liveable quality of the city. This paper also aims to point out the potential lands that can be converted into urban green spaces for the wellbeing of the city and make it a liveable and sustainable city for the future.

2. METHODOLOGY

Figure 3 describes the overall methodology used in this study. The Landuse Suitability Analysis (LSA) was used as the main method and supported by the spatial analysis functions of GIS through steps including: identification and collection of spatial data, maps, scoring, weighting and, data integration and GIS analysis, and output evaluation. In LSA, determining the suitability scores for each factor is a compulsory step, and in this study they were regulated from 1 to 4 where a higher score indicates an area more suitable for developing urban green open spaces. Once combined, the resulting map

provides a visual tool useful in understanding which areas of Dhaka have superior probability to convert into quality green space and which have lower levels of access.

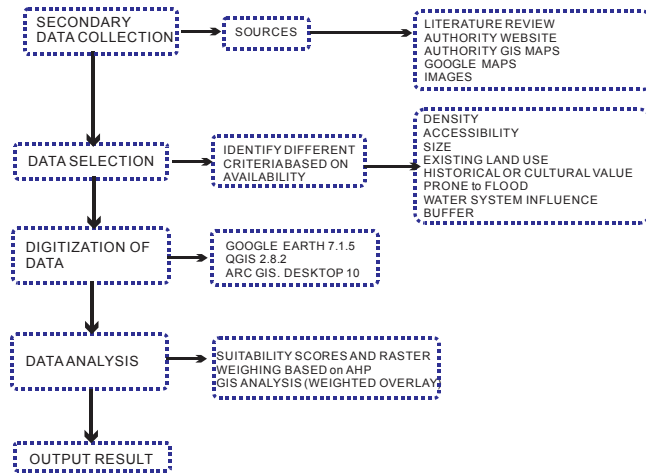


Figure 3. Methodological flowchart indicating the land suitability analysis for urban green space development in North of Dhaka

Suitability Analysis is defined as the most appropriate spatial analysis for land uses, identified by land use suitability analysis based on specific requirements, preferences, and predictor of some activity. (Malczewski, 2004). Generally a myriad of data set can be used for the suitability analysis of urban green spaces based on ecological, economic and social demands. In this study, the first type of Urban Green space of Dhaka city is “Urban Green Parks”, has been chosen as the desired prototype to acquire land for development. The following table explains the typical physical attributes of ‘Urban green Park’ classified by Nilufer (1999). But further liner green besides lake or wetlands has also been enlisted in this study, due to shortage of huge portion of land (see Figure 4)

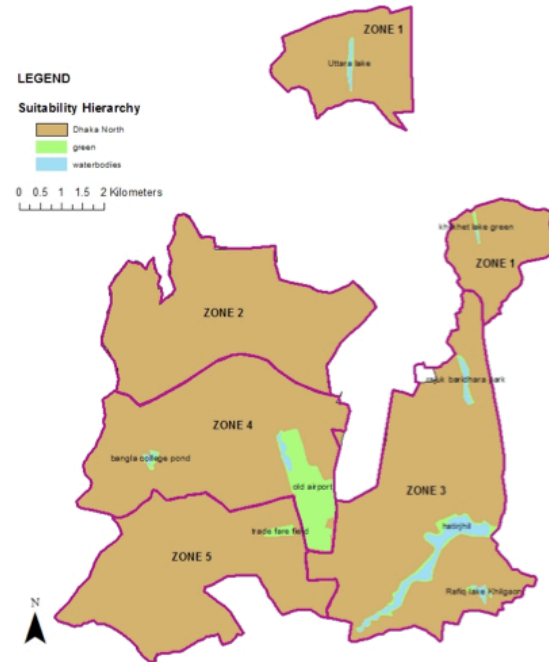


Figure 4. Proposed lands for urban green space in North of Dhaka

The suitability factors accessibility, Historic-cultural value, flooding and water body are taken into consideration other than size, buffer or distance from locality, existing land use and density.

- **Size:** Size is a prime factor for the urban green space in Northern Dhaka. So that it can accommodate the cultural festivals like Pohela Boishakh, National events like Independence day, Fairs etc. all the part and parcel of Bengali life style. It is also vital for the ecology and to enhance a sustainable city for living.

- **Accessibility:** Using space syntax analysis Khan (2014) showed that the use of parks can be augmented by making their accessibility better i.e. by providing entrances from other adjacent roads of parks in Dhaka city. Ease of access of any system of public space depends on the number of alternative access roads. More favourable are major roads, as they ensures more easy accessibility. A large space like Botanical Garden of Dhaka is underutilised, because the road network doesn't offer a clear approach.
- **Land Use:** Land use includes how people use and manage the land (Wikipedia, 2015). The economy is interrelated to land-use. The mixed use offers- commercial, residential, institutional uses existing in a particular area that can bring an array of users from different socio-cultural background. Otherwise a specific area can be comprised of dedicated commercial, residential, institutional, industrial users.
- **Density:** Population size is an important factor to be considered. Different countries around the world has their own standard of green space ratio per 10,000 people. Even it may vary from city to city within a country, for instance – in US, Boston offers 7.9 acres per 1000 population, whereas New York offers 4.7 acre per 100. (Harnik, Donahue, & Weiswerda, 2012). Densely populated Dhaka is unable to meet this bear minimum ratio. In zone 2 and 4 there is a serious lack of large or even neighbourhood scale urban green space, but it has the highest population density among 5 zones. Therefore, it will help to decide which land is more vital.
- **Historical and Cultural values:** History and cultural values is another social factor which will include value to the urban green spaces. Uy & Nakagoshi (2008), Manlun (2003) selected this criteria to preserve the site for future generations and by using the space. In the current study, few selected sites have significant historical value - liberation war genocide field or first establishment of an airport in Dhaka city.
- **Water System influence:** In the densely populated area, it is difficult to find vacant lands, so the existing lakes and lake side have been also included as potential green space. Because Dhanmondi Lake development in Dhaka South city corporation is a successful example of urban space of 15 acre which consist of the soft and hard scape excluding waterbody area. And it will also help to terminate encroachment of wetlands caused by urban sprawl and may play a major means of flood and stormwater runoff mitigation. In Vietnam, the Hanoi masterplan includes green spaces beside water bodies as valuable landscapes in lieu of strategic planning (Uy & Nakagoshi, 2008).
- **Flood:** Flood is a form of natural hydro-meteorological phenomenon

and very common in Dhaka due to heavy rain, dense settlement and poor drainage network. Sarker & Sivertun (2011) studied various factors of flood and produced a foold prediction mapping of the city, which is used as reference of areas vaulnareable to flood risk.

- **Distance or Buffer:** As it is aimed to propose urban green proto type of “Urban green parks”. Of which accessibility radius of 1.2 km is acceptable. The proximity analysis by Etingoff (2014) determined access to green space outside of the immediate area. In this study, the outer ring of each zone has been buffered to 1.2 km, and then it is identified which land falls in the strategic location to be covered by maxmum number of zones.

The proposed lands have been drawn in polygon in Google Earth 7.1.5 and saved as .kml file. Then these .kml file has been converted to shapefiles using QGIS Desktop 2.8.2 and projected in ArcGIS 10 by using WGS_1984_UTM_Zone_46N projected co-ordinate system for Bangladesh.

In LSA, determining the suitability scores for each factor is a compulsory step, and in this study they were regulated from 1 to 4 of scale (see Table 1). Here a higher score indicates an area more suitable for developing urban green space. In the Size map, for instance, greater than 120 acre in size spaces receive the score 4 (highest suitability), < 120 but ≥ 40 acre in size score 3 (moderate suitability), < 40 but ≥ 30 acre in size achieves 2 (low suitability) and smaller than 30 acre in size score 1 (no suitability).

Analytical Hierarchical Process is a mathematically multi-criteria decision making process. Pairwise comparison method can exchange subjective measurements of comparative importance into a linear set of weights that is developed by Prof. Thomas L. Saaty (1980) known as Analytical Hierarchical Process (AHP). An online AHP calculate created by Goepel (2014), has been used to obtain AHP of nine degree and pairwise comparison matrix for both factors and sub category and define each criteria's relative importance by weighted score. It precisely influence the result, and is complicated by interacting of factors with each other (Uy & Nakagoshi, 2008, c.f. Banai-Kashani, 1989).

Consistency ratio (CR) for the above weights have been tried to maintain under 10% and this consistency is acceptable. Because, it is less than 0.10 which means the subjective judgments need not to be revised.

Finally the weight have been normalised and the spatial analysis tool has been used in ArcGIS 10 to overlay the previously rasterised maps to obtain the final composite map.

Table: 1. Suitability classes and scores

Factor	Suitability class	Class description	Score
Density	High	699,910 / sqkm	4
	Moderate	48,828 -47,028 / sqkm	3
	Low	43,198 /sqkm	2
	No	33,024/ sq km	1
Accessibility	High	Bounded by four Major Rd.	4
	Moderate	Bounded by one Major rd. two secondary rd.	3
	Low	Bounded by two secondary rd.	2
	No	Bounded by Alley	1
Size	High	≥ 120 acre	4
	Moderate	< 120 but ≥ 40acre	3
	Low	< 40 but ≥ 30 acre	2
	No	30 acre <	1
Existing land use	High	Mixed use	4
	Moderate	Institutional	3
	Low	Commercial	2
	No	Residential	1
Historical or cultural value	High	Historic site	4
	Moderate	Culturally active site	3
	Low	Tourist area	2
	No	Other areas with potential of high historic value	1
Flood prone	High	Low risk	4
	Moderate	Moderate risk	3
	Low	High Risk	2
	No	Very high Risk	1
Water system influence	High	Besides waterbody or lake	4
	Moderate	Water within site	3
	Low	Distance to main reservoir, lake is < 10 m	2
	No	No waterbody within 50 m or vicinity of site	1
Buffer of 1.2 Km radius	High	Covers 4 or all zones	4
	Moderate	Covers 3 zones	3
	Low	Covers 2 zones	2
	No	Cover the only zone it belongs to	1

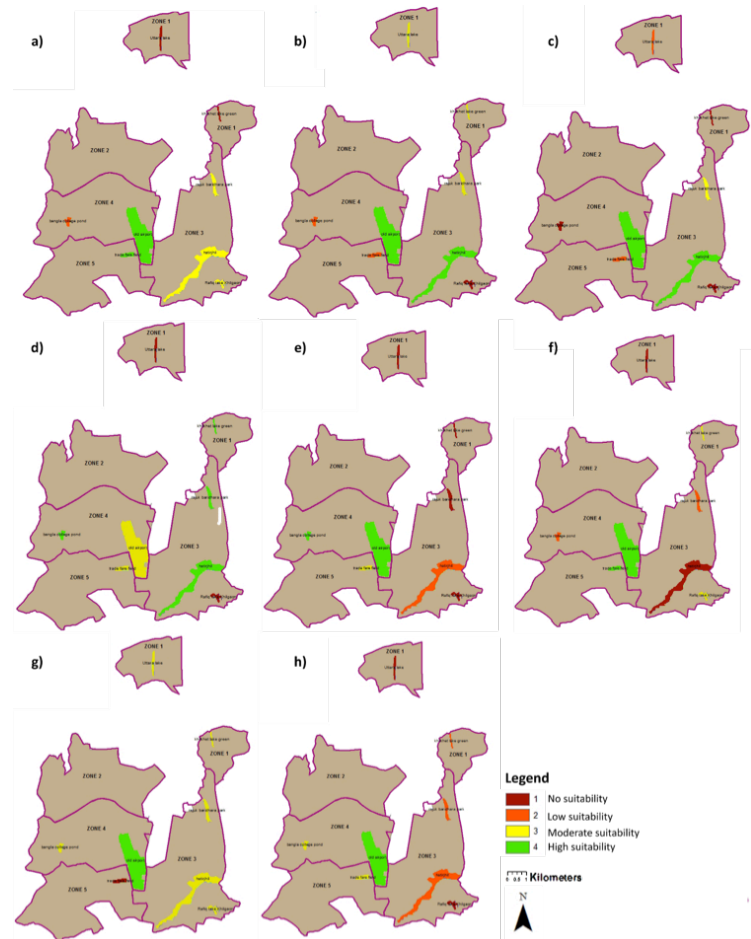
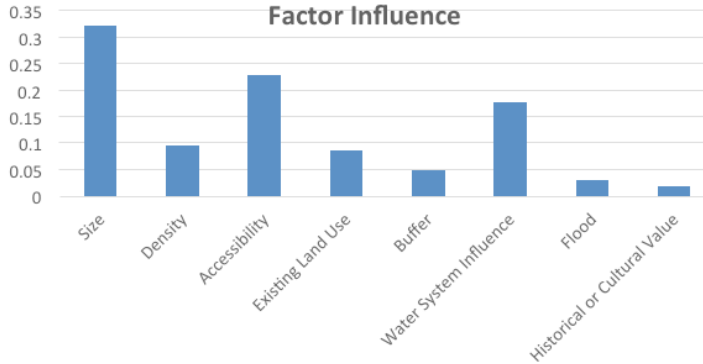


Figure 5. Suitability scores for a) density, b) accessibility, c) size, d) existing land use, e) historical and cultural value, f) flood prone g) water system influence h) buffer

Chart 1. Factor influence of categories



3. RESULT

The final overlay of all the maps has produced the desired map and the most suitable land for conversion has been identified (see Figure 7).

Suitability Analysis of Proposed Urban Green Spaces in North of Dhaka

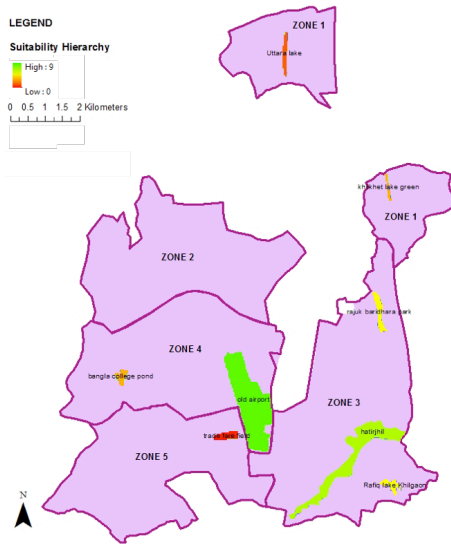


Figure 7. Composite map of proposed lands with highest suitability

4. CONCLUSION

The research has led to identify the most appropriate vacant land of North of Dhaka which can serve to most of the people surrounded by maximum zones, except zone 1. In terms of landscape architecture, the Old Airport can contribute to increase the green space ratio after development of the site and diverse flora and fauna habitat can be introduced in the heart of the city. The establishment of an urban park in the congested area of North dhaka will not only increase the land value in terms of aesthetics and landscape but it will also help to take steps to build sustainable city. It will also help to develop economy and new users. The habitants of North dhaka will not have to travel down to south for any urban gathering if this land is established as an urban green space at the heart of the city.

But further reaserch is necessary for better understanding and social criteria like users should be included for more accurate outcome of results. For more intense results, if funding and time available, more land should be identified to develop community parks and greenbelts surrounding the city. Previously Nilufer (1999) suggested to convert the Old Airport into urban green spaces and resemble it's potential with the Central Park of New York. This heuristic research will certainly create a new horizons in the field of landscape architecture in Bangladesh. To develop a more sustainable city we must understand the growing needs and pressing problems of the current lands. Multi criteria suitability analysis is surely an important tool, only used by the planners in Bangladesh. But it's the first time it has been used to identify lands for landscape planning purpose.

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