

# GREEN ROOF:

## A POSSIBLE SOLUTION FOR REVIVING URBAN GREEN IN DHAKA CITY.

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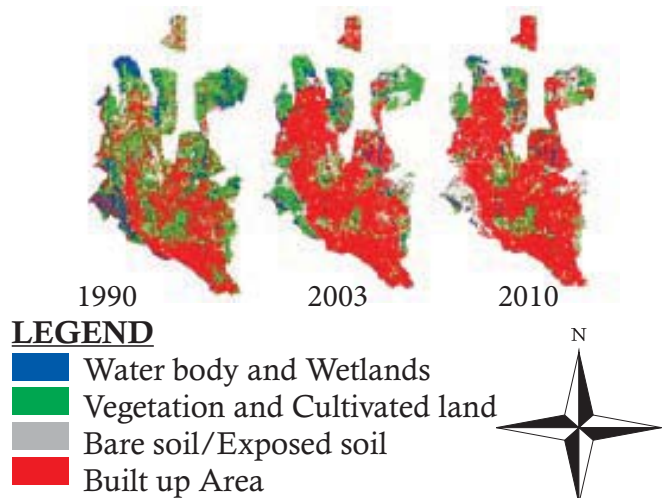
### ABSTRACT

Dhaka is one of the most rapidly urbanizing cities in the world. Due to rapid urbanization, the presence of vegetation in Dhaka has been diminishing fast. Dhaka is gradually losing its portion of green day by day. Thus, the urbanization is transforming this city into a concrete jungle. World Health Organization (WHO) recommends that there should be 9 square meter green space per city dweller for ensuring better life. Moreover, according to UNEP there should be a minimum of 25% open space (plantation and water body) in a city. Whereas the open space area is only about 14.5% in Dhaka city, according to a study in 2012 [1]. RAJUK proposed management tools like FAR (Floor Area Ratio) to control the building density and urban green; however, it is not enough to effectively regenerate the lost green parts of Dhaka city. Green roof can be a possible solution for compensating urban green of this city. The objective of this paper is to analysis the possibilities of regeneration of urban green space by green roof as well as the benefits of green roof to improve the overall city environment of Dhaka. The study methodology involved to identify the problem, develop an analysis plan, collecting data from various secondary sources, analysis the data and adjust it to the identified problem and find out probable outcomes, were the methods of this research. The advantages of green roofs in urban areas are numerous. However, green roofs demand structural standards and the waterproofing system. Despite the challenges, the green roof benefits reported here suggest that green roofs can be used effectively as a solution of reviving urban green in Dhaka city.

**Key Words:** Green roof, Urban green, Green regeneration, Urban Environment.

### 1.0 INTRODUCTION:

Dhaka, the capital city of Bangladesh, is one of the most rapidly urbanizing cities in the world. Dhaka has been losing its portions of green in an alarming way; consequently this city is going through serious ecological imbalances. According to FAO (2008) Dhaka city has 21.57% open space, of which city parks occupy 0.89%, urban forestry 0.02 %, gardens 0.90% and 12.12% belongs to agriculture. UNEP recommends a minimum of 25% open space (plantation and open space combined) within a city's total area [3]. But here in Dhaka, according to a 2012 study there is only about 14.5% open space [1].



**Fig 1.** Land cover map of Dhaka city of the years 1990, 2003 and 2010 [2].

Figure: 1 clearly shows that Dhaka has been expanding in all directions, particularly to northeast, southeast as well as southern parts.

**Table 1:** Summary of land cover classification statistics between 1990 and 2010 (area in hectares)

Land use/cover types	1990		2003		2010	
	Area	(%)	Area	(%)	Area	(%)
Water body and Wetland	1715.4	12.33	1166	8.38	799.65	5.74
Build-up	4759.9	34.20	7268.4	52.25	7970.6	57.26
Vegetation and Cultivated land	5414.6	38.91	3009.6	21.63	2232.6	16.04
Bare soil/ Exposed soil	2026.7	14.56	2467.9	17.74	2917.4	20.96

Source: Mamun et al., 2013:25 [2].

Table 1 depicts that between 1990 and 2010 urban build up areas was increased approximately by 3210 hectares, whereas vegetation and cultivated land decreased by around 3180 hectares.

Figure 1 and Table 1 illustrate that during 1990 to 2010 urban built up areas increased very rapidly. The environmental problems are increasing due to lack of proper policy and implementation. RAJUK proposed management tools like FAR (floor area ratio) to control the building density and urban green. However, it is not enough to effectively regenerate the lost parts of green of Dhaka city. It is very essential to take more initiatives in more effective ways to regenerate the urban green of Dhaka. One of the ways could be to introduce as much compatible organic matter as possible in the form of diverse vegetation on the roof tops [3].

The benefits of green roofs in urban areas are numerous. This paper tries to analyze the potentials of green roof to recover the lack of urban green of Dhaka city as green roof could be a significant tool to bring back the green.

World Health Organization (WHO) recommends there should be 9 sq. meter green space per city dweller for ensuring better life. Urban green is fast diminishing in Dhaka city resulting in a multitude of problem particularly in urban environments. As a result this city is suffering from many environmental problems, such as-

- Heat Island Effect
- Sound Pollution
- Air Pollution
- Urban Flooding/Water Logging.

The objective of this study work:

- To determine the possibilities of regeneration of green space in Dhaka city;
- To find out the benefits of green roof to improve the overall environment of Dhaka and to highlight the necessity of green roof in Dhaka city.

## 2.0 GREEN ROOF TECHNOLOGY:

### 2.1 What Is Green Roof:

Green roofs are an alternative roofing technology in which planted material is established on the roof top. Green roof is, indeed, a kind of roof which grows on the surface of plants [4]. Green roofs are also known as Eco roofs, living roofs or vegetated roofs. Dunnett and Kingsbury mentioned that the green roof is a planted roof or green roof can be defined as a roof that consists of vegetation and growing medium and sometime refers to the roof garden in some places [8].

These roofs have an effective role in urban ecological efficiency and favorable quality creation to urban life [6].

### 2.2 Types of Green Roofs.

Green roofs can be categorized into two distinguished types, these are extensive and intensive green roof.

**Table 2:** Summarized of the differences between extensive and intensive green roofs.

Intensive Green roof	Extensive green roof
☒ Require intensive maintenance	☒ Require extensive maintenance
☒ Accessible	☒ Inaccessible
☒ Require deeper substrate (min 15 cm)	☒ Require shallow substrate (only 2-15 cm)
☒ Heavy weight (saturated weight between 200 to 500 kg/m <sup>2</sup> )	☒ Low weight (saturated weight between 60-150 kg/m <sup>2</sup> )
☒ High cost	☒ Low cost

Source: Werthmann, 2007& German National Standard DIN 1055.

## 2.3 Advantages of Green Roofs:

### 2.3.1 Environmental Advantages:

#### A. Maintain Air Quality:

There is no doubt, plants have a significant role in maintaining air quality. By absorbing carbon dioxide and releasing oxygen via photosynthesis, plants recharge the atmosphere that enables all lifes, to exist. Green roofs also help to filter out dust and smog particles. Nitrates and other harmful materials are absorbed by the plants, out of the air and rainfall, and bound within the substrate.

#### B. Provides Rainwater Management:

Rain water management is another advantage of green roof in urban areas. When rain falls on bare roofs, most of it runs off into storm drains that carry it to nearby bodies of water. Heavy rains tax there runoff systems, sometimes resulting in flooding. In addition to exacerbating flooding, erosion, and sedimentation, urban runoff are also high in pollutants such as pesticides and petroleum residues, which harm wildlife habitats and contaminate drinking supplies [7]. Green roof can mitigate this problem by serving as a kind of water regeneration system. Green roofs have the potential to reduce the pollution of urban rainwater from runoff by absorbing and filtering pollutants [17].

#### C. Improves Noise Protection:

Planted areas are natural sound insulators and absorb more sound than hard surfaces. A green roof with a 12cm (4.8in) substrate layer can reduce sound by 40 decibels while a 20cm (8 in) layer can reduce by 46-50 decibels [16]. This is very effective for buildings near airports, factories and noisy places.

#### D. Reduce 'Heat Island' Effects:

One of the most potential benefits of Green roofs is the reduction of the urban heat-island effect [9]. Green roofs can help to moderate the climate of urban areas. Urban areas are as much as 5o C warmer than the surrounding suburbs [3] because most of the land area is covered by materials, such as asphalt and concrete, which have a low reflective power. These surfaces absorb and retain heat energy from the sun, rather than reflecting

it. As a result, these hard surfaces get hotter and remain hotter than outlying areas, where green surfaces reflect more sunlight. An extensive network of roof garden in an urban area could reduce the temperature by several degrees by covering heat retaining spaces with more reflective green cover. Moreover, by increasing the evaporation of moisture it helps to cool down the air and can decrease the temperature of the roof surface by as much as 4° C [10].

#### E. Enhance Aesthetics:

From the aesthetic standpoint, roof gardens clearly help to improve the environment. However, adding such green space can do more than simply improve the appearance of the space. Green roof dramatically increases the aesthetic appeal of urban roof surface. Moreover, attractive roof garden often helps to increase the value of apartment complexes and office buildings. Architectural features such as waterfalls, swimming pools, aquaculture in addition to plantation provides recreational spaces [3]. Living roofs provide aesthetic and psychological benefits for people in urban areas. Even when green roofs are only accessible as visual relief, the benefits may include relaxation and restoration [24], which can improve human health.

#### F. Provides natural biodiverse habitats:

Green roofs compensate the green spaces, which we are lost for building development. Furthermore, they provide natural habitats for wildlife and bring nature back into the city. Green roofs are commonly inhabited by various insects, including beetles, ants, bugs, flies, bees, spiders, and leafhoppers [11]. Green roofs have also been used by nesting birds and native avian communities [12].

### 2.3.2 Social advantages:

#### A. Peaceful island within the urban jungle:

Green roof located above ground level, is like a peaceful island within the urban jungle. A feeling of isolation from the traffic, noise, dust can be sensed in green roofs above ground level. One of the most significant qualities in almost all green roofs is their quietness. Street sounds seem to rebound off building walls and bypass the roof level [15].

### B. Promote community within a city:

Though green roofs give a sense of isolation from the urban environment, they can also promote community within a city. Green roofs associated with office buildings provide a place for employees to mingle in a more relaxed setting.

### C. Maintain a connection with nature:

Green roofs can also enable city dwellers to maintain a connection with nature that might not otherwise be possible. Urban areas are as congested and unattractive as they have always been. Indeed cities are so crowded with buildings, streets and parking lots. Green roofs can bring a patch of nature back into even the most over-developed urban space.

### 2.3.3 Economic Advantages:

#### A. Enhances the worth of the structure:

The most obvious advantage of a green roof is a valuable amenity that enhances the worth of the structure it occupies. The building owner can charge higher rates for rental space because the roof is an attraction.

#### B. Reduces energy costs:

Another benefit of green roof is lower energy costs. They can reduce the energy required for the maintenance of interior climates [13], because vegetation and growing plant media intercept and dissipate solar radiation [20]. The green roof on the build-form can contribute to lower energy costs, as the green roof does provide some additional insulation for the roof.

#### C. Protect waterproofing materials:

Green roofs can also help to protect water proofing materials from degradation caused by rapid temperature changes and the effects of ultraviolet light. Such membranes are consequently more easily damaged by the expansion and contraction caused by widely fluctuating roof temperatures. Temperature stabilization of the waterproofing membranes by green-roof coverage may extend their useful life by more than 20 years (USEPA 2000); some green roofs in Berlin have lasted 90 years without needing major repairs [25].

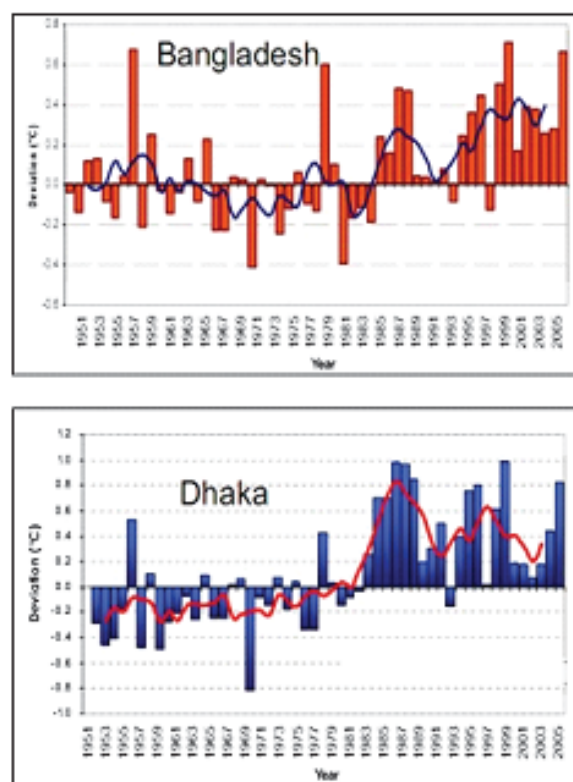
## 3.0 PRESENT SITUATION OF DHAKA CITY AND THE PROSPECT OF GREEN ROOF AS A SOLUTION:

Dhaka is going through serious types of hazards in which the environmental problems are most noticeable. Because of rapidly decreasing urban green for last few decades, Dhaka city is facing the most difficult time ever and the situation is getting worse day by day. The green roofs can mitigate most of the problems like heat island effect, sound pollution, air pollution, urban flooding/water logging from excessive rainfall and so on. The green roofs can alleviate these problems which are caused to a great extent by decreasing 'Urban Green'.

### 3.1 Heat Island Effect:

People, who lives in Dhaka, definitely have the same feeling that the temperature of Dhaka city has been increasing for last few decades as urban green has been replaced with hard surfaces like asphalt road, concrete building structures.

The green areas are one of the permanent effect variables of urban heat island [21]. Dhaka city is becoming a heat island day by day due to insufficient of green spaces.



**Fig 3:** Trend of temperature change in Bangladesh and Dhaka [21].

Fig 3 depicts that in overall Bangladesh, after 1979 temperature below the base year temperature for some years. But for Dhaka temperature never came back to the base year temperature. It is also observable that the increase in temperature is higher in Dhaka than in Bangladesh [21]. During the summer the temperature becomes more unbearable and the situation will be getting worse in the near future if effective initiatives are not taken immediately.

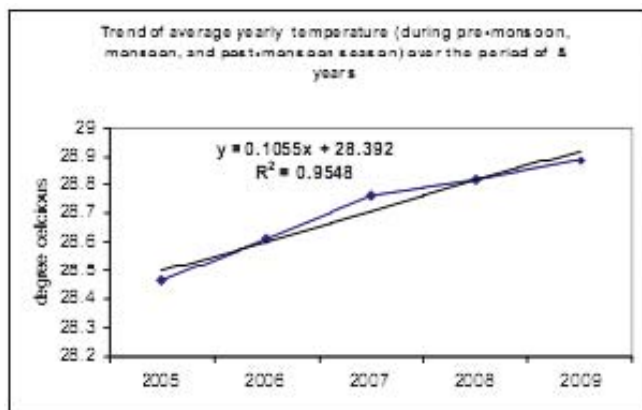


Fig 4. a: Trend of average temperature for Dhaka [21].

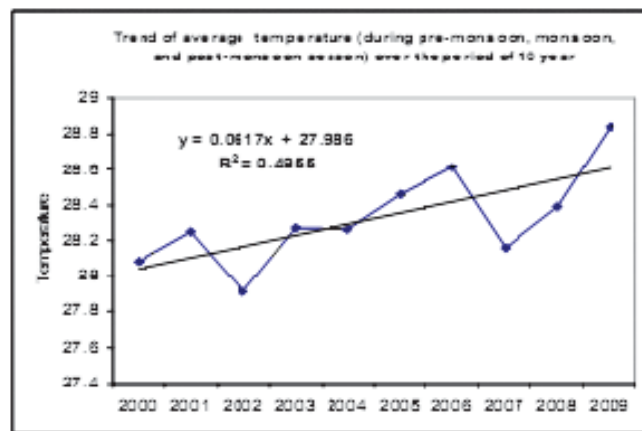


Fig 4.b: Trend of average temperatures for Dhaka [21].

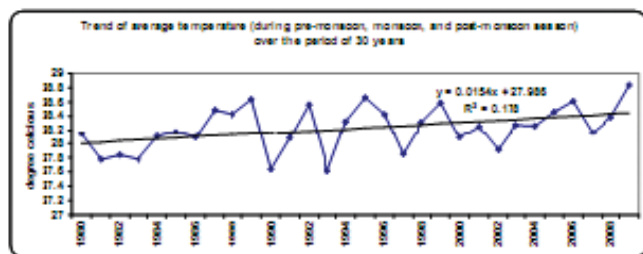


Fig 4.c: Trend of average temperature for last 5 years in Dhaka [21].

Fig. 4(a, b, c) show the trend of average temperature in Dhaka. From the figure it is seen that the temperature of Dhaka is increasing over the decade, and increase in the last decade is higher than previous decades.

Green roofs provide shade and remove heat from the air through evapotranspiration, reducing temperatures of the roof surface and the surrounding air. On hot summer days, the surface temperature of a green roof can be cooler than the air temperature, whereas the surface of a conventional rooftop can be up to 90°F (50°C) warmer.

### 3.2 Sound Pollution:

Sound pollution now-a-days is a major health threat to the people of Dhaka city. A study was conducted in the cities of Dhaka by the Department of Environment (DoE), sponsored by the World Health Organization, to measure the extent of sound pollution, types of noise, sources of noise and exposure to noise.

Table 3. Noise Quality Standards, by Zone and Time of Day.

Zone Class	Limits in dB	
	Daytime (6 am – 9 pm)	Nighttime (9 pm-6 am)
Silent zone	45	35
Residential zone	50	40
Mixed zone	60	50
Commercial zone	70	60
Industrial zone	75	70

Source: Unnayan Shamannay, People’s Report on Bangladesh Environment 2001.

Noise pollution has increased in different parts of Dhaka city. Level of noise in Dhaka city is now a major concern for the general people because it has exceeded the tolerance level (22). According to a survey by WHO of 45 locations of Dhaka city, it is clear that most of the traffic points and areas are suffering from noises exceeding the standard limits of Bangladesh.

**Table 4 :** Noise level in Commercial Areas of Dhaka

Name of Areas	1999(dB)	2002(dB)
Farmgate	90.0	81.0
Rajuk Avenue	87.8	87.8
New market	86.4	86.3
Gulshan	86.3	82.0
Motijheel	82.0	83.0
Standard Limit	70	70

Source: WHO, 2002

**Table 5:** Noise level in Residential Area of Dhaka

Name of Areas	1999(dB)	2002(dB)
Mirpur	79.4	63.0
Shakaripatti	75.5	75.6
Dhaka Cantonment	74.4	73.0
Dhanmondi	67.0	65.0
Banani	61.4	61.4
Mohammadpur	61.0	61.0
Gulshan	56.6	55.0
Standard Limit	55	55

Source: WHO, 2002

**Table 6:** Noise Level in Mixed Area of Dhaka

Name of Areas	1999(dB)	2002(dB)
Mouchak Round	92.6	80.0
English Road	90.0	90.0
Dhaka Judge's Court	83.7	83.7
Chawk Bazar	77.8	79.0
Shakaripatti	77.5	77.5
Standard Limit	60	60

Source: WHO, 2002

**Table 7:** Noise Level in Industrial Area of Dhaka

Name of Areas	1999(dB)	2002(dB)
Inside of Nabisco, Tejgaon	89.0	85.0
Tejgaon	87.0	84.0
Hazaribagh	80.8	80.0
Standard Limit	75	75

Source: WHO, 2002

**Table 8:** Noise Level in Silent zone Area of Dhaka

Name of Areas	1999(dB)	2002(dB)
I.C.D.D.R.B Hospital	76.5	65.0
Dhaka Medical College Hospital	70.0	70.0
Kakrail Mosque	70.0	70.0

Bangladesh Sheikh Mujibur Rahman Medical University	68.9	69.0
Shaheen School	67.6	58.0
Titumir College	66.8	66.8
Temple and Church	65.5	85.3
I.P.H. Mosque	60.0	55.0
Dhakeswari Mandir at Bakshi Bazar	53.0	53.0
NIPSOM	50.0	50.0
Standard Limit	50	50

Source: WHO, 2002

Noise pollution is a serious health risk as well as it can also increase stress and blood pressure and many other problems. Green roofs reduce sound pollution by absorbing sound waves outside buildings and preventing inward transmission [8].

### 3.3 Air Pollution

The quality of air is deteriorating day by day due to insufficient green in the city as air quality and green space are interrelated. The outdoor and indoor air of Dhaka are getting polluted mainly with increased Nitrogen dioxide (NO<sub>2</sub>), Sulphur Dioxide (SO<sub>2</sub>) and Suspended particulate matter (SPM) all the year around from different sources [22]. Department of Environment (DoE) pointed out that air pollutant (SO<sub>x</sub>, NO<sub>x</sub> and CO<sub>2</sub>) levels in Dhaka city are about 4 to 5 times higher than the prescribed level of Air Quality Standard (AQS) in Bangladesh.[19] Such pollutants remain and persist with air due to lack of tree coverage. Trees can remove pollution by intercepting airborne particles [22].

So, we can say that, there is a proportional relationship between green space and air quality. If green space increases, air quality will increase and if green space decreases, then air quality will also decrease [22]. So the air pollutants can be removed by green roofs as the plants absorb the pollutant particles. It can be an effective option to mitigate air pollution as well as other environmental problems.

### 3.4 Urban Flood/Water Logging:

In recent years Dhaka has been facing extensive water logging during the monsoon. Now the situation is becoming worse that even a little rain causes a serious problem for certain city areas. According to a survey, 74 percentage of respondents have mentioned that heavy rainfall is one of the main reasons for water logging in Dhaka city [23]. One of the most significant reason behind this is, the lack of urban green in this city. When rain falls onto a green surface, most of the water soaks into the topsoil to the nearest water courses or ground water. However, when the land is covered by the hard surfaces (roads, roofs, pavements, car parking) the ground cannot absorb water, as a result the direct runoff increased to around 80% of the rainfall volume whereas it will be only 15-20% in case of green surface [23].

Green roofs can mitigate this problem of Dhaka city by serving as a kind of water regeneration system. Green roofs have the potential to reduce rainwater runoff. The soil of green roofs can hold as much as 15 to 20 percent of the rain falling on planted areas for up to two months, releasing it more slowly into a city's storm system [15]. A dramatic improvement of the quality of surroundings can be possible by a extensive network of green roofs which could greatly decrease the load on a city's storm-runoff-system as well as reduce flooding.

### 4.0 CONCLUSION

Rapid urbanization is the main reason to decrease green space in this city, which is an alarming environmental degradation. We have to somehow regenerate the green spaces in this city so that, this city could be able to recover its losses. Green roof could be a potential solution to revive urban green. Most of the rooftops of Dhaka are flat which are quite appropriate for greening [3]. In addition the weather of this region is very suitable for green roofs. If effective initiatives are taken by the governments and related authorities, the green roof concept can be implemented properly to recover the losses of urban green.

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