JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

GREEN BUILDING AS A SUSTAINABLE APPROACH TO URBAN GREEN SPACE MANAGEMENT:

Case of District Three, Kabul City

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Abstract

With the increasing population, attention to urban life and the migration of rural residents to cities have daily complicated urban living and reduced its optimal efficiency. One of the challenges cities face is the shortage of urban green spaces, especially in cities that have grown rapidly and without proper planning. This has led to the conversion of green spaces into other uses such as residential, commercial, administrative, educational, and similar purposes. Kabul is among the cities experiencing rapid population growth, which has resulted in a reduction of green spaces across the city. To address this challenge, numerous solutions have been considered, one of which is green architecture (green roofs and green walls). This approach is particularly emphasized in areas with high population density and tall buildings, as open spaces and suitable land for green space development are lacking in such areas. The research method was descriptive-analytical and data collection was based on library studies and field research. This research aims to provide a better introduction to green architecture, highlight its benefits, outline its design principles, and propose a specific location as a case study for implementing green spaces using green architecture in district three of Kabul city. As a result, using the green buildings in high-density urban areas that are facing a lack of green space provides an alternative solution for creating green spaces in cities.

Keywords: Green building, green roofs, green walls, sustainable development, urban green spaces, District Three.

1. Introduction

Urban air pollution is one of the crucial factors affecting public health for city residents. Exposure to polluted air has been associated with severe health problems that lead to high mortality rates, causing an estimated 7–10 million premature deaths per year worldwide (Mannucci & Franchini, 2017).

In terms of the concept of Urban Heat Islands (UHI), many suburban and urban areas experience elevated temperatures when compared to their outlying rural surroundings. The annual mean air temperature of a densely populated city can be between 1 to 3°C warmer than the surrounding areas, and on a clear, calm night, this temperature difference can reach 12°C (Oke & Thompson, 1997).

Despite rapid urbanization and population growth, typically only 1-2% is added to the total stock of buildings annually, and therefore the focus for the maximum benefit for UHI mitigation lies with retrofitting existing buildings with vegetation applied to walls and roofs. These structures are known as green roofs and green walls. When building envelopes are covered with green roofs and green walls there is great potential to attenuate the UHI effect (Alexandria & Jonesb, 2008).

The concept of green walls refers to all systems which enable greening a vertical surface (e.g. facades, walls, blind walls, partition walls, etc.) with a selection of plant species, including all the solutions with the purpose of growing plants on, up or within the wall of a building (Newton et al, 2007).

A green roof is a roofing system that incorporate vegetation, soil and a waterproofing membrane to create a living, vegetated surface on the top of a building. Green roofs provide numerous environmental benefits, including storm water management, improved air quality and energy saving (Getter et al, 2007). Compared to traditional roof surfaces typically covered with bitumen, asphalt or steel sheeting which are directly exposed to the sun, retrofitted green roofs can attenuate housing temperature (Wilkinson & Castiglia Feitosa, 2016) and this is attributed to the reduction in thermal conductivity (Del Barrio, 1998).

However, in residential external walls exposed to the sun, and especially in tall buildings, where wall areas are much greater than roof areas, it is expected the role of green walls in mitigating extreme temperatures is significant. Thus, the combination of green roofs and green walls is expected to promote better thermal performance in residential building envelopes (Feitosa & Wilkinson, n.d.).

1. Literature Review

The first green wall suggested in 11th century, during the Viking's era. The Viking used stones timber and peat's bricks to construct their habitations. Peat is an accumulation of incompletely decayed vegetation matter; it is formed in marshes or equally environment. When the Vikings used peat's brick, grass naturally grew on this organic material; therefore, the habitation was covered with vegetation. The grass's roots helped the bricks to join in one huge brick and made the walls durable. These kinds of construction could be found in the north hemisphere wherever went the Vikings: from Canada to Norway via Island, Ireland, Sweden, and Denmark. But there is no evidence found that these early green walls were created on purpose. Natural settlement of walls by plants is happening with or without men's help. Everyone knows a building which is covered or partially covered by vegetation. In humid tropical zones, the plants from the jungle grow on any kind of buildings and covered with vegetation in Central America and South East Asia (Sadeghian, 2016).

It is in 1988 that Patrick Blanc filed a patent for the creation of a ―device to grow plants without soil on a vertical surface‖; the modern green wall was then created. On a bearing wall or support structure is placed a metal frame that supports an expanded PVC plate 10 mm thick, on which are stapled two layers of polyamide felt 3 mm thick each. A network of pipes controlled by valves provides a nutrient solution containing the dissolved minerals needed for plant growth. The felt is soaked by capillary action of the nutrient solution, which descends along the wall by gravity. Plant roots will collect the nutrients they need, and excess water is collected at the urban green space, including the greening of buildings involving both green roofs and green walls, is just one piece of the puzzle. Modern cities provide giant areas of roof and wall space, in many cases extending high above the street. Not all of this space is suitable for growing plants, but much of it is, certainly much more than has been applied in recent years (Johnston & Newton, 2004).

Many countries have developed their own green building standards, such as BREEAM (Building Research Establishment's Environmental Assessment Method) in the UK, CASBEE (Comprehensive Assessment System for Building Environmental Efficiency) in Japan, EcoProfile in Norway, and LEED (Leadership in Energy and Environmental Design) in the USA (Ali & Al Nsairat, 2009). Those initiatives brought significant energy saving benefit. For instance, studies have shown that on average buildings with a LEED label were 25–30% more energy efficient than conventional buildings (Kats, 2003).

2. Benefits of Green Buildings

Plants in a city can provide quantitative benefits, in the form of financial returns, as well as qualitative environmental, social and aesthetic benefits. Although the benefits are discussed separately, they are actually inseparable and should be appreciated in the built environment (Loh, 2008).

3.1. Economics Benefits

All economic benefits are associated with the environmental benefits of the green walls. The ability of the vegetative surfaces to retain storm water and water runoff from the roofs can help in reducing extend of the storm water drainage infrastructure. Plants introduced around buildings can improve construction integrity by decreasing the weathering effect. The use of green walls can reduce the climatic stress on building facades and prolong the service and practical life of buildings, additionally, it will reduce the cost on the painting materials (Johnston & Newton, 1996). Energy saving is another significant economic contribution brought by greenery in the cities. Studies have been done where the energy used for cooling in a building can be vastly reduced. Greenery can also add value to the property. Landscaping is often used to improve the aesthetic value of the urban area. Vegetation can provide visual contrast and relief from the highly built-up city environment (Dwyer et al, 1994).

3.2. Environmental Benefits

Plants can offer cooling benefits in the city through two mechanisms, direct shading and evaporate transpiration. The green walls used plants which provide shading to the building. It is very straightforward and is very much depends on the density of the plants in the green walls. As a result, not only the shaded building, but the ambience also will experience a relatively low temperature. The temperature reduction will not only affect the building, but also to the urban environment. Vegetation can improve the air quality by filtering out airborne particles in their leaves and branches as well as by absorbing gaseous pollutants through photosynthesis (Loh, 2008). Plants also release oxygen to the atmosphere through its unique photosynthesis, which troubles carbon dioxide and water to create sugar and oxygen. This attains not only oxygen generation, but also carbon dioxide reduction. Plants roots also play a role in filtering the impurities in the water before it enters a groundwater aquifer. Impurities, such as nitrogen and phosphorus, will bond together with some type of soil. Plants can reduce the amount of these impurities in the soil by taking up nitrogen and phosphorus to be used in the plant growth (Johnston & Newton, 1996). Plants can be used as sound barrier as they can reduce the noise perceived by the receiver. In the case of green walls, plants in the green walls will absorb the frequencies of the sound. Thus, reducing the noise pollution in the urban area (Dunnet & Kingsbury, 2004). Storm water in the urban area is traditionally routed off impervious surfaces and transported in drainage pipe systems to an adjacent receiving water body. Flooding may occur when the drainage is unable of storing and distributing the storm water from the land. A degraded aquatic ecosystem is usually associated with the discharge of the storm water. Green wall is actually a mulching technique as it covers the waterproof surface of the building with plants and soil or planting medium. The green wall is able to retain water to control the water runoff from the roofs. Urban green area and plants around the buildings can be viewed as an acceptable alternative habitat for urban plants and native wildlife. The presence of wildlife may improve the ecological quality and health of the environment as well as provide additional emotional, intellectual, social and physical benefits to humans (Johnston & Newton, 1996).

3.3. Social Benefits

Plants can fulfil various functions. Plants provide places for playing, sports and recreation, meeting establishing social contacts, isolation and escape from urban life, aesthetic enjoyment, viewing buildings from a distance and so on. It has been proved that visual and physical contacts with plants can result in direct health benefits. Plants can produce medicinal effects leading to reduced stress; improve patient recovery rate and higher resistance to illness. The benefits of vertical greening include noise reduction (Van Renterghem et al, 2013). Plants can be used as sound barrier as it can reduce the noise perceived by the receiver.

2. Research Methodology

The research method used in this study is descriptive-analytical. Data collection was carried out in two forms: library and field research. In the first stage, available sources such as books, articles, theses, maps, and documents about the area under study were reviewed to gain a good understanding of the topic and to obtain the regulations related to the green buildings. After understanding the entire criteria about the green roof and green walls, efforts had done to find a suitable site to apply this strategy, and since it requires high-rise buildings or mid-rise buildings, it should be the corridors' nearby because it is allowed to construct those buildings.

Then, an optimal location in district three had been found where it has the capacity to establish the green buildings on one or two sides of the street that is deemed as the corridor, and recently broaden and constructed. As a result, the most suitable location in terms of position, area, and land use for constructing these buildings in district three was determined.

3. Definition and Explanation of green architecture

Green architecture is the methods and principles of designing buildings and related systems that focus on protecting the environment and reducing the negative effects of buildings on the natural environment. The main goal of green architecture is to create sustainable, energetic and environmentally friendly buildings. This design style aims to minimize energy consumption, reduce pollutants and greenhouse gas emissions, and improve the quality of the internal environment of buildings by using new technologies and optimal use of natural resources. By following these principles, buildings can be designed and built that continuously help to improve the environment (Davoodi & Zanjirei, 2025).

5.1. Green Roofs

A green roof is one of the modern approaches in architecture and urban planning, rooted in the concepts of sustainable development. It can be used to increase green space per capita, improve environmental quality, and promote sustainable urban development. A green roof refers to a lightweight system composed of prefabricated layers that, together with the building’s roof, form an integrated system and enable plant growth in a specific growing medium (Deputy of Strategic Planning and Supervision of the Islamic Republic of Iran, Winter 2010. Regulations for the design of urban green spaces).

Figure 1: Green roofs

The layers that make up a green roof typically consist, from top to bottom, Vegetation, Growth substrate, filter fabric, drainage element, protection layer, root barrier, insulation layer, water proofing membrane, and roof deck.

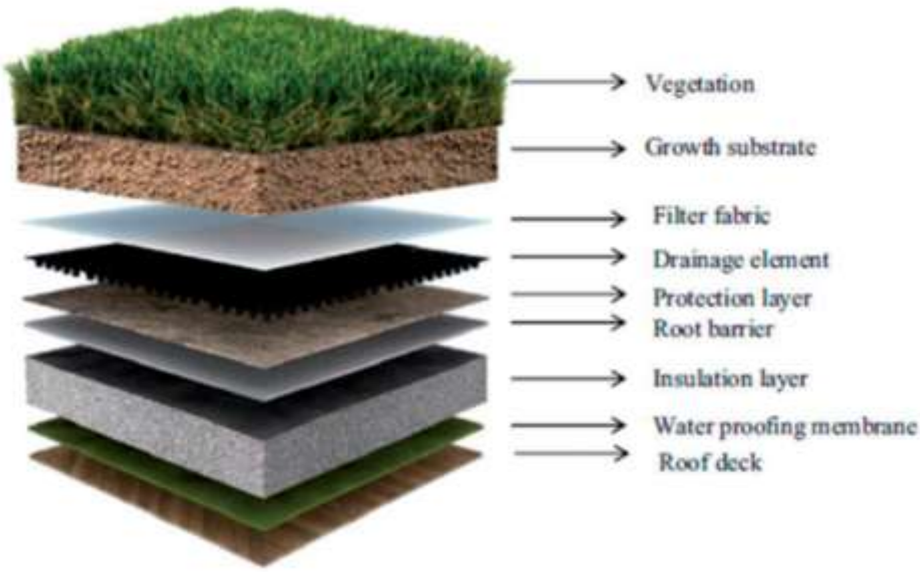

Figure 2: Schematics of different green roof components (Vijayaraghavan, 2016, p. 744).

Green roofs are divided into three types based on the depth of the planting layer, the type of vegetation, and the amount of required infrastructure:

5.1.1. Extensive Green Roof

This type requires minimal infrastructure, maintenance, and consequently, lower costs. It has a planting layer depth of about 5 to 15 centimeters, making it lightweight and imposing limited load on the building. Due to its low weight, extensive green roofs usually do not require structural modifications and are more suitable for installation on existing buildings. Depending on the depth of the planting layer, this type of green roof increases the roof's weight by 70 to 170 kilograms when saturated with water. Extensive green roofs can be applied on both flat and sloped roofs up to a 30% slope. The only limitation of extensive green roofs is the type of vegetation, as they are limited to plants with shallow roots. Wildflowers, turf grasses, sedum species, mosses, and other low-maintenance, drought-tolerant plants are suitable for this type. Extensive green roofs are generally not functional for active use, but their environmental benefits can be utilized.

5.1.2. Intensive Green Roof

Another type is the intensive or concentrated green roof, which has a thicker planting layer and therefore no limitations on the choice of vegetation. On intensive green roofs, it is possible to plant various species, including shrubs and trees that can be planted in the ground. The planting layer in intensive roofs ranges from 20 to 60 centimeters. These roofs require maintenance, irrigation, and care similar to ground-level green spaces. Due to their heavier weight, they must either be installed on buildings with higher load-bearing capacity or on buildings whose structures can be reinforced to support the additional load. When saturated with water, intensive green roofs add about 290 to 970 kilograms to the roof's weight. The best option for this type of green roof is to construct it on new buildings and account for the additional roof load in the initial structural design and calculations.

5.1.3. Semi-Intensive Green Roof

The third type is actually a combination of the extensive and intensive green roofs. Recently, prefabricated models have entered the market that can be installed on any roof or balcony without the need for infrastructure. These prefabricated units come with a variety of pre-planted vegetation, ranging from small plants to trees and shrubs (Deputy of Strategic Planning and Supervision of the Islamic Republic of Iran, Winter 2010. Regulations for the design of urban green spaces).

5.2. Green Walls

Green walls refer to vegetated surfaces that are installed vertically on buildings or other urban structures. These walls contribute to the enhancement of building quality, as they function as both sound and thermal insulators. In fact, some believe that green walls can reduce a building’s heating energy needs by up to 50%. In addition to their aesthetic value, green walls can also play a significant role in reducing visual pollution in cities.

Beyond meeting architectural aesthetic needs, green walls also respond to essential functions such as: providing natural insulation for buildings (thermal, moisture, and sound), utilizing dead roof spaces to create pleasant environments, introducing visually appealing surfaces on building facades, integrating artificial structures with nature, helping to reduce atmospheric pollution, and increasing the oxygen level in the air, among other benefits.

Moreover, designing buildings with green roofs leads to greater sustainability and effective management of storm water and rainfall. Green surfaces on building facades can also create suitable habitats for various living creatures such as birds, reptiles, and small organisms. In fact, the soil bed and vegetation cover serve as ideal habitats for many living beings, and their presence can offer a range of functions. In such conditions, besides visual beauty, some of these creatures can feed on harmful insects — a familiar example being the presence of geckos on wall plants, which help reduce insect populations significantly by preying on them (Deputy of Strategic Planning and Supervision of the Islamic Republic of Iran, Winter 2010. Regulations for the design of urban green spaces).

The layers that make up a green wall typically consist, from out to in, drainage, plant, 2 geo-texile (felt) layers, irrigation pipe, waterproof, PVC panel, and steel structure.

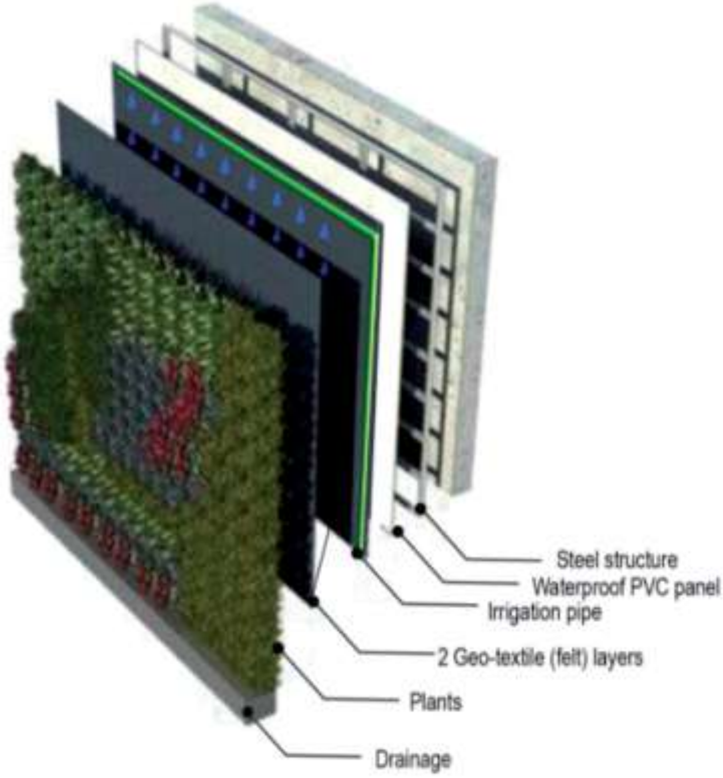

Figure 3: Schematics of different green wall components (http:perperwww.denory-gw.com).

Figure 4: Green walls

6. Study area

6.1. District Three of Kabul City

This district forms the western part of old Kabul city. The foothills of the mountains to the northeast define the district, separating it from District Two. District Three has a total area of 9.22 square kilometers, of which 82% is planned and the remainder is unplanned. A significant portion of this district is occupied by the Kabul University campus, and the Kabul Zoo is located in its southeastern part. The approximate population of District Three is 95,400, and the area is divided into 12 neighborhoods, with each neighborhood containing between 800 to 1,250 households (Nahia Action Plane(SNAP), Kabul 3th district, 2017).

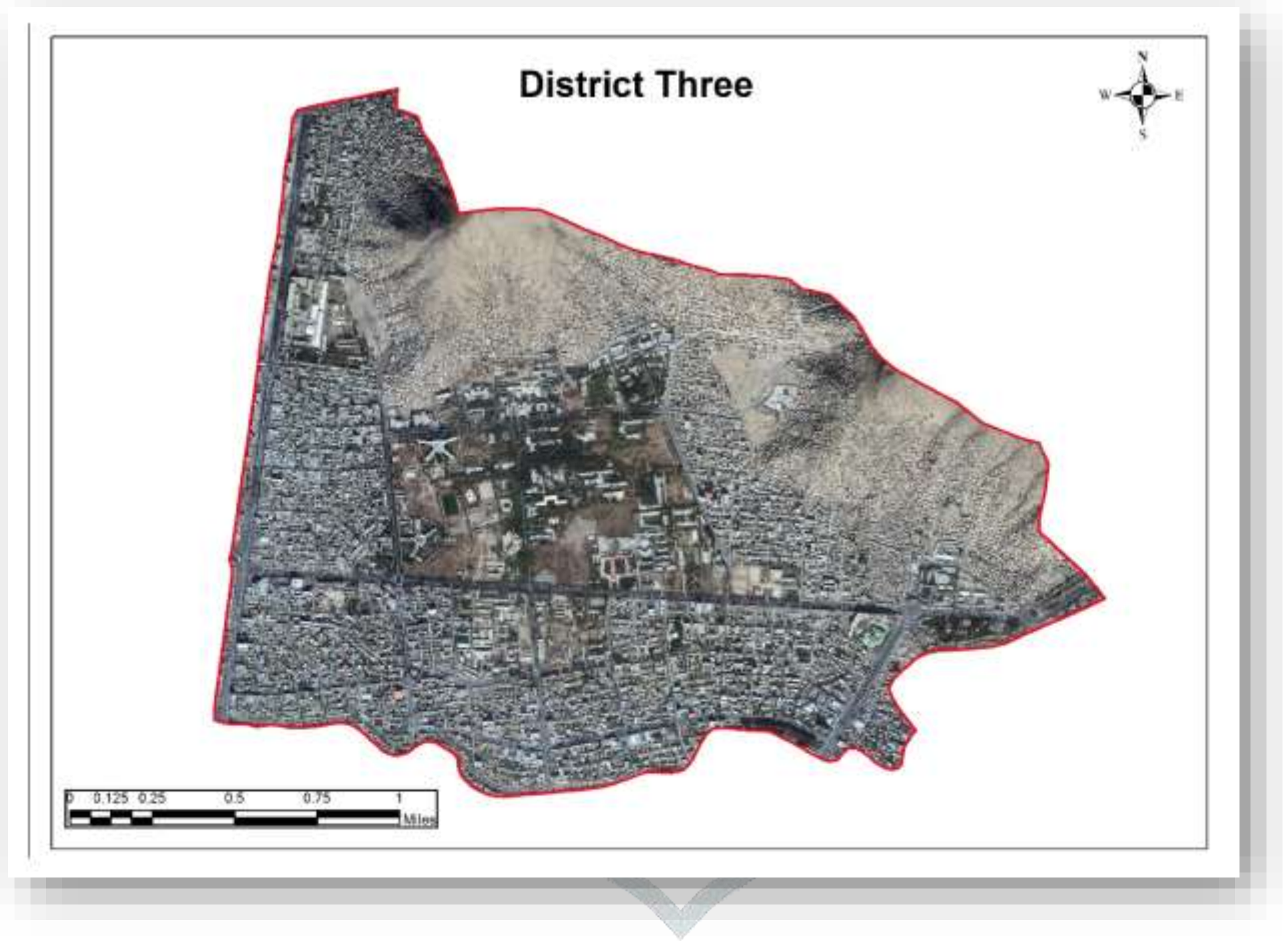

Figure 5: Kabul City, District three

6.2. Land Use and Population Density in 3th District of Kabul

The predominant land uses in this district are governmental and residential. Additionally, commercial and mixed-use areas can be noted, which have contributed to a staggering population increase. Most of the buildings and land uses in this district fall under the middle-income housing category. Besides the mentioned uses, other land uses such as recreational, religious, educational, etc., are also present (Nahia Action Plane(SNAP), Kabul 3th district, 2017).

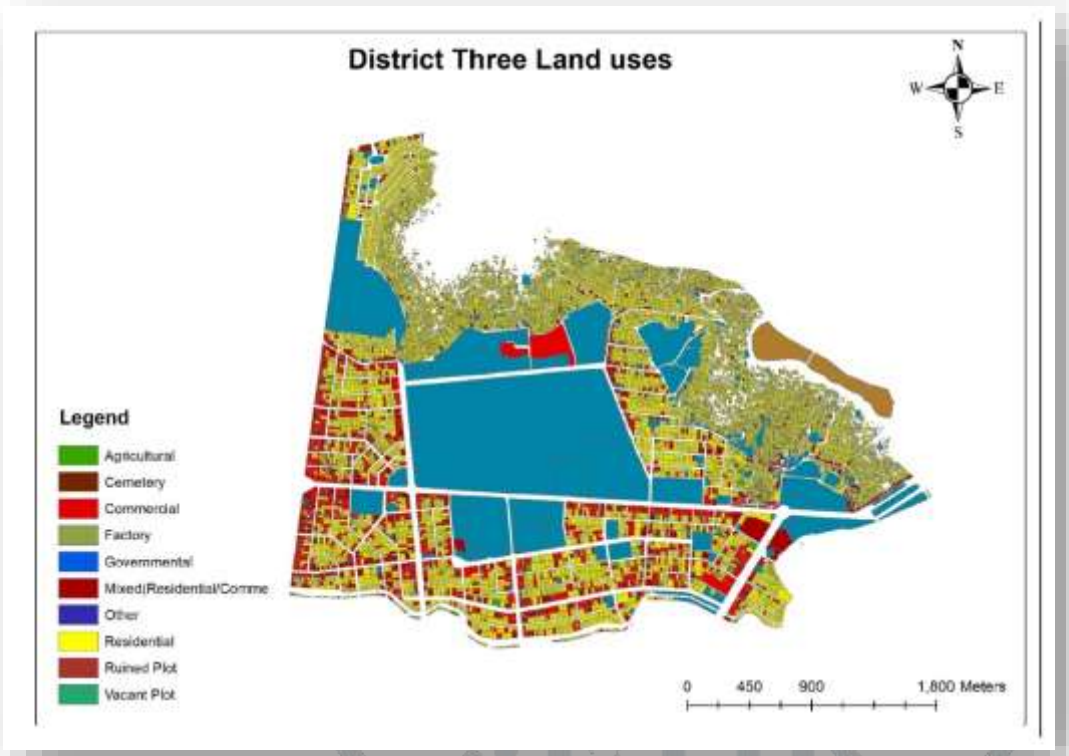

Figure 6: Land use, District three

The population density in district three is considered based on the figures within the framework of Kabul's urban design(KUDF), with a minimum population of 0-19 people and a maximum population of 265-373 people per section.

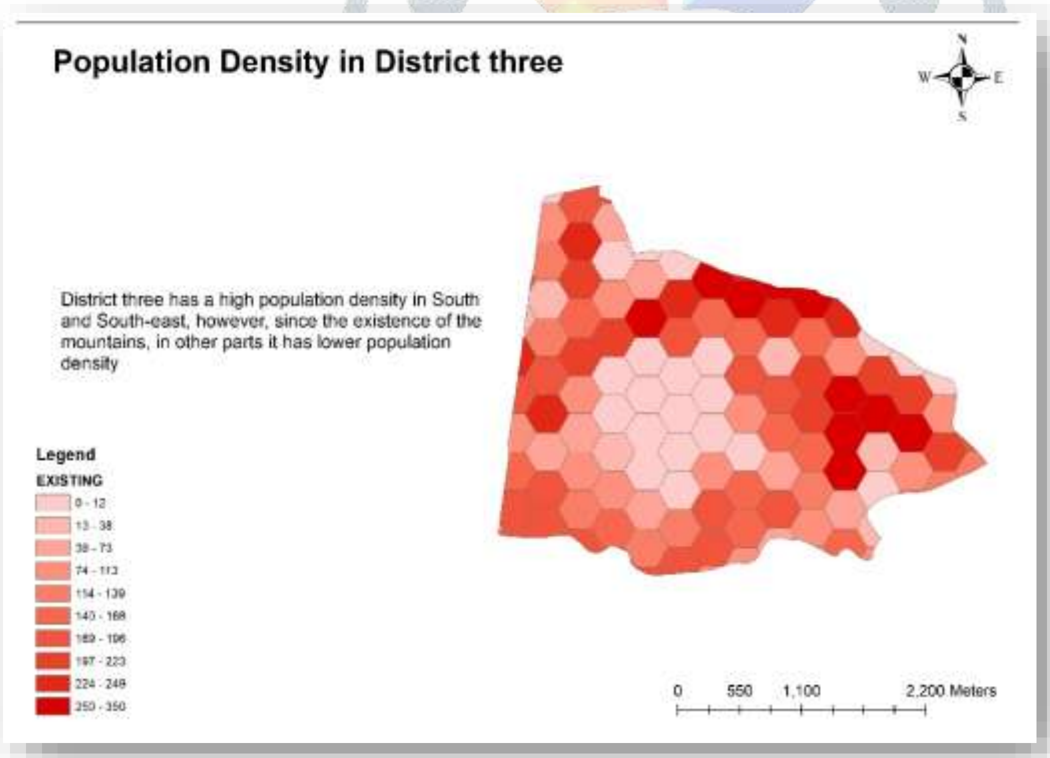

Figure 7: Population density, District three

6.3. Green Spaces in District three of Kabul

District Three of Kabul city has a total of six parks of varying sizes located in different areas. Three of these are neighborhood parks, and the other three are community parks, with a combined area of approximately 49,000 square meters.

Table 1: Kabul Municipality, Department of greening, GIS office

No	Name	District	Area/m^2
1	Nowruz Park	3th district	15742.8
2	Chamcha Mast green space	3th district	10112.7
3	Sarai Ghazni	3th district	3013.2
4	University's street green space	3th district	1367.3
5	Dehbory Park	3th district	13641.8
6	Karte-e-Mamorin Park	3th district	5122.3

Figure 8: Green spaces, District three

Given this area and a population of 95,400, the green space per capita in District Three is about 0.513 square meters, whereas the urban green space standard in Afghanistan should be at least nine square meters per person. Therefore, District Three suffers from a severe shortage of urban green spaces. Since the district is small and almost all its land is occupied by various uses, green architecture is one of the best alternatives and solutions for achieving sustainable development goals.

Therefore, in District three of Kabul City, the most suitable locations for green buildings are the economic corridors. These areas predominantly feature medium-rise and high-rise residential buildings, making them ideal candidates for meeting green building standards such as energy efficiency, sustainable materials, and green infrastructure. Moreover, since these zones are mixed-use (commercial-residential), green buildings can significantly enhance the aesthetic appeal and functionality of the area while also reducing noise pollution—a critical issue in densely populated urban centers.

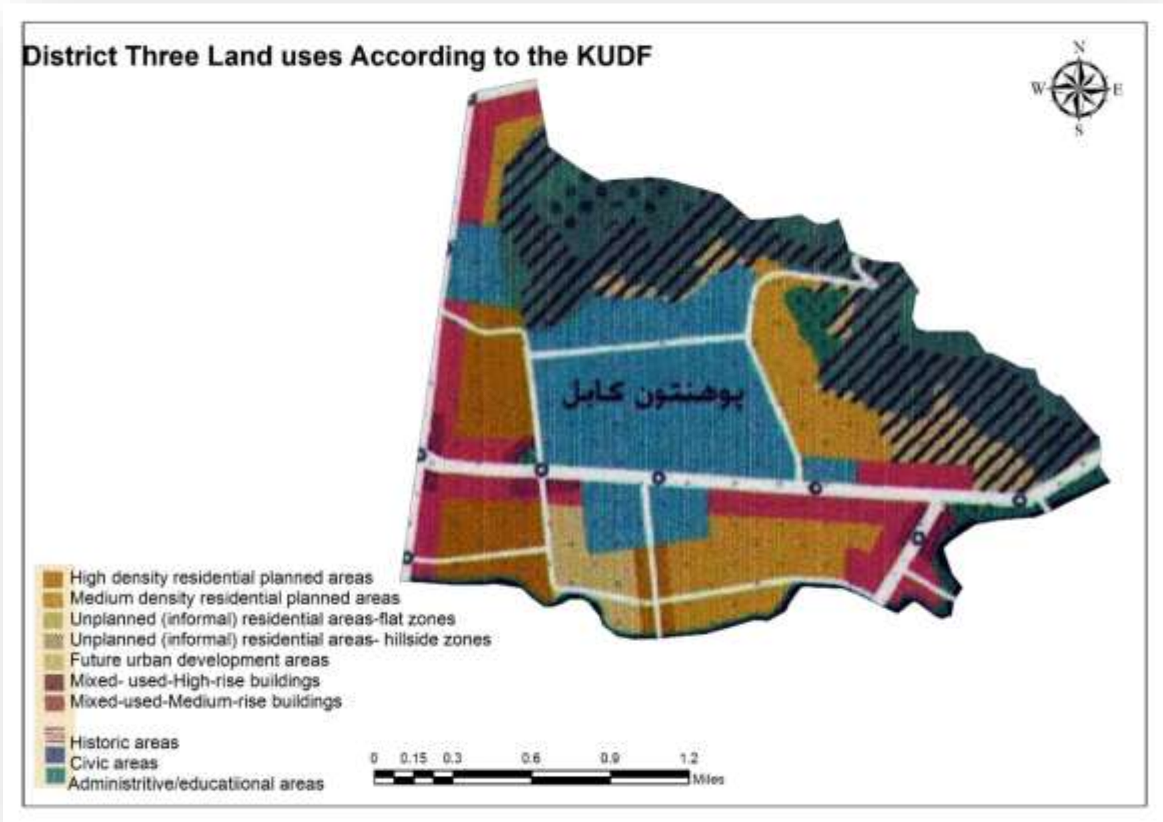

Figure 9: KUDF, Land use, District three,

In District three, Kot-e-Sangi is recognized as the Central Business District (CBD). The Kabul Urban Development Framework (KUDF) has also designated this zone for mixed-use high-rise and medium-rise developments, making it a prime location for green building initiatives. Recently, buildings on the northern side of the road were demolished for road expansion, creating an opportunity for new, sustainable constructions in their place.

Figure 10: District three, The ruined area (Authors)

Therefore, according to the data and the existing condition of the site, a suitable area selected for building green buildings.

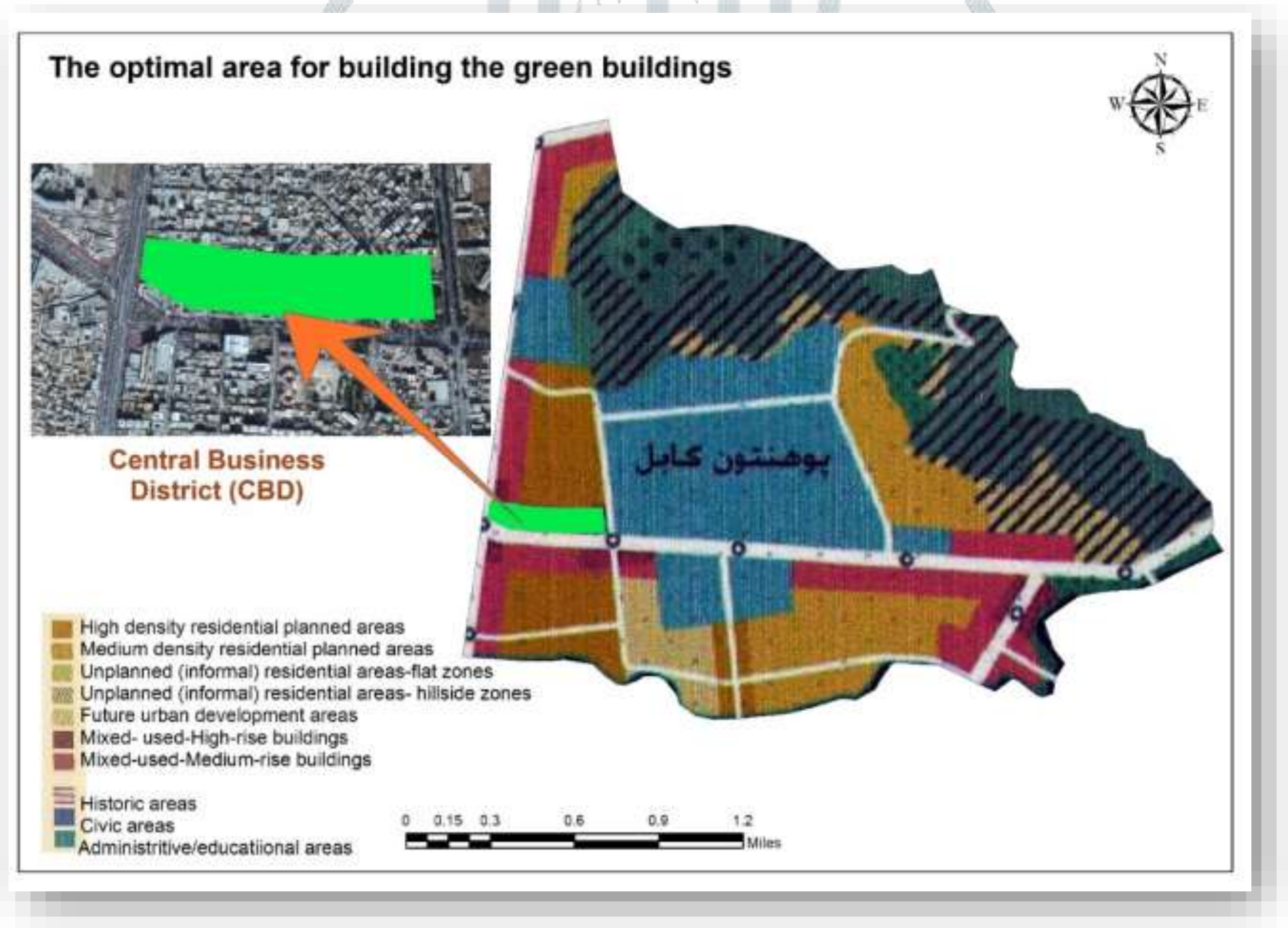

Figure 11: District three, The optimal area for green buildings

The selected area covers a large expanse, but further studies are required to pinpoint the exact locations for green buildings. A detailed technical assessment must be conducted to determine the engineering standards, dimensions, and feasibility of such projects.

4. Conclusion

Green architecture stands as one of the most significant and valuable innovations in today's world, particularly as cities face relentless urbanization pressures. Rural migration and uncontrolled urban expansion have led to deforestation, loss of green spaces, and their replacement with impervious surfaces—key contributors to the Urban Heat Island (UHI) effect. This phenomenon exacerbates energy consumption, air pollution, and public health risks, undermining the resilience and sustainability of cities.

In areas where land is still available, creating parks and green infrastructure can mitigate these challenges. However, in densely built urban zones especially those with limited space due to geographical constraints establishing traditional green spaces becomes economically and logistically unfeasible, as it often requires demolition and costly land acquisition.

This is where green buildings emerge as a transformative solution. In District three of Kabul City, specifically in the Kot-e-Sangi area—a bustling commercial hub—recent redevelopment of its economic corridor has opened opportunities for mixed-use (commercial-residential) constructions. Given that these buildings are newly planned, integrating green building principles such as energy efficient designs, rooftop gardens, vertical greenery, and sustainable materials can address the deficit of urban green spaces while promoting sustainable development.

Thus, in space-constrained, high density regions like District three, green buildings are not just an alternative but a necessity for equitable and low carbon urban growth. Their implementation can set a precedent for Kabul's broader transition toward a climate responsive and sustainable urban future.

Conflicts of interest

All authors declare that they have no conflicts of interest to disclose.

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