The Urban Filter

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Abstract

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Dhaka, the capital of Bangladesh, is one of the most densely populated metropolises in the world. Surrounded by two major rivers on three sides, Dhaka started to flourish by the river Buriganga in the early 17th century. Due to rapid urbanization propagated by the economic growth since the Liberation War in 1971, Bangladesh as well as Dhaka has been facing serious environmental, social and urban problems like heavy pollution, shortage of livable space, inadequacy of clean air and water. To cope with the uncontrolled influx of migrants from outside the city, the continued tendency is to convert the open spaces into buildings in the form of high-rises.

This thesis is an exploration of reimagination of the high-rise building type in Dhaka from an environmental and socio-economic aspect. The hope is that, the proposed design of the mixed-use high-rise building in the Dhaka city will lead to the genesis of a new typology of tall buildings pertaining to a sustainable tomorrow.

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And finally--

To my parents, my little brother, my husband and my best friend Nazratan- thank you for teaching me to be humble; to be a hard-working person and never taking life for granted. I am indebted to you for my life. I love you all!

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Beauty is sweet to us, because she dances to the same fleeting tune with our lives. Knowledge is precious to us, because we shall never have time to complete it. All is done and finished in the eternal Heaven. But earth's flowers of illusion are kept eternally fresh by death.

— Rabindranath Tagore, The Gardener, 1913

THE URBAN FILTER

REIMAGINING DHAKA CITY THROUGH A NEW SOCIAL, ENVIRONMENTAL AND SUSTAINABLE PERSPECTIVE

Fig 1: aerial view of Dhaka

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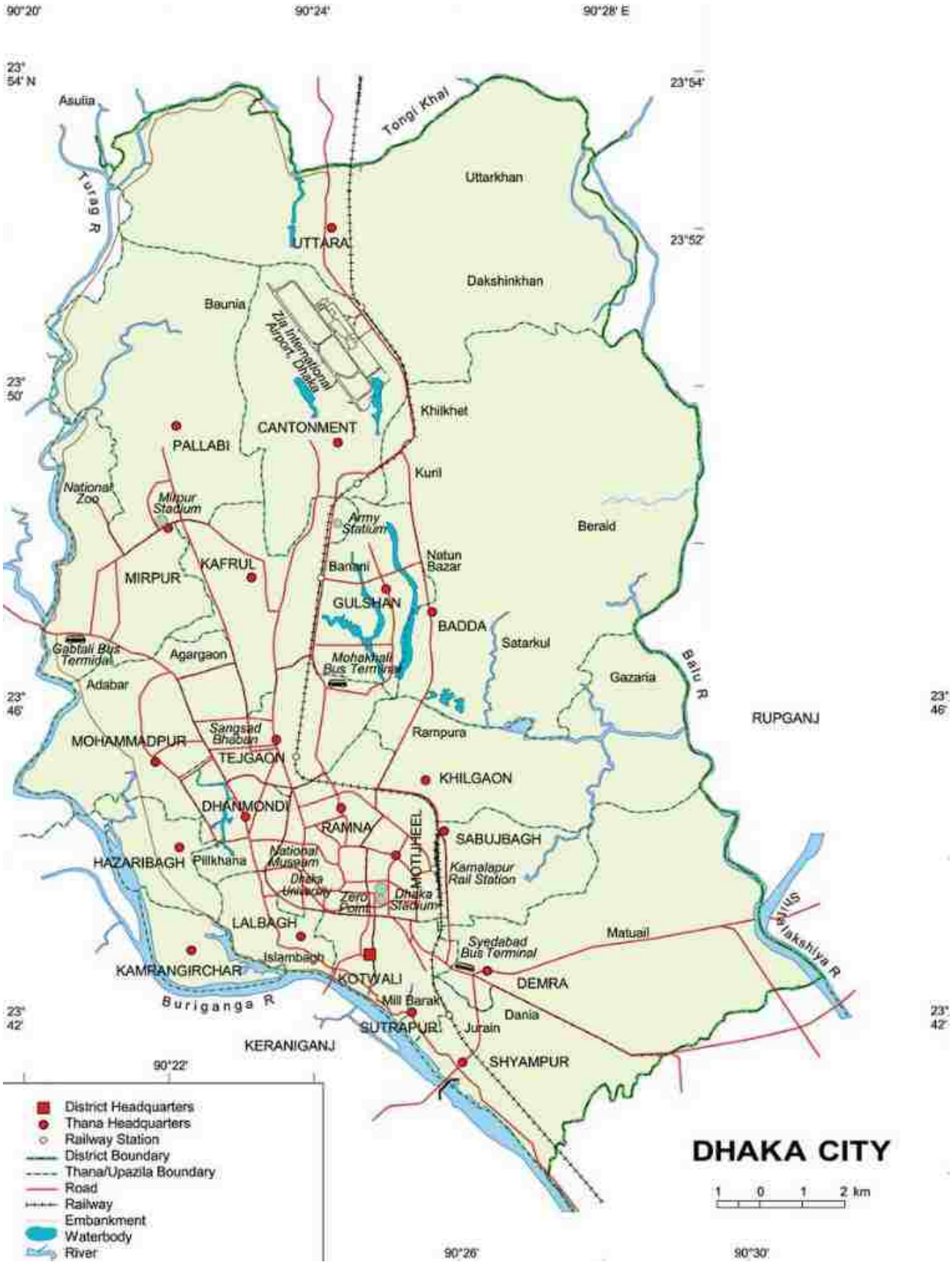


fig 2: Map of Dhaka City

PREFACE

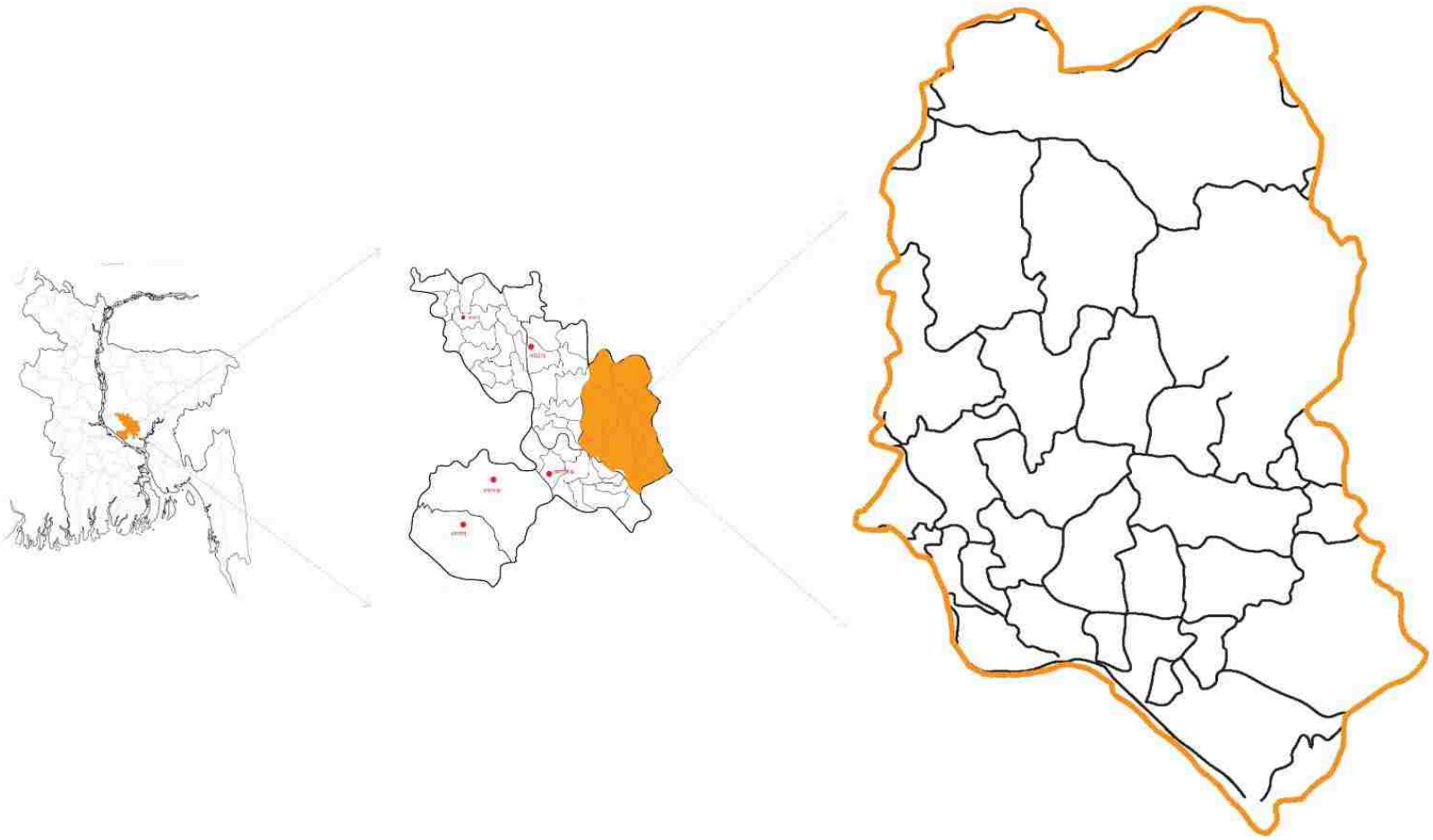
The trend of urbanization in Bangladesh characterizes the growth of Dhaka as typical "dependent urbanization" in third-world countries. It is observed that the number of tall buildings has increased very quickly, especially in the last two decades. However, sufficient improvements in the infrastructure to provide services to these buildings have not occurred. The result is the unplanned and uncontrolled growth of these high-rises which have complicated the situation in a city already overburdened in almost all respects.[1]

In recent years, Dhaka, the capital of Bangladesh has faced massive urbanization due to high economic growth. As the population of this South-Asian mega-city has grown, its physical infrastructure has also grown with similar alacrity. Dhaka is the 5th densest city in the world, with more than 45,000 people living in every square kilometer (Figure 3). Some of the major reasons for this uncontrolled urban sprawl are continuous migration, inefficient urban governance and the absence of a visionary master plan. The situation has been further worsened by Real Estate development companies. Most of the large corporates have capitalized on the need for space to live in Dhaka city by filling up nearly every corner of every residential and commercial neighborhood contributing to the current overcrowded situation. According to the Real Estate and Housing Association of Bangladesh (REHAB), there are 1,151 development companies in Bangladesh in 2016, most of which are based in Dhaka city. [2]

Considering the gradual deterioration of living conditions, the city is bound to run into a state of dysfunction unless response of an urgent nature is undertaken. Ironically, Bangladesh remains one of the only countries of the World that does not have an Energy Code. [3] As a result, Real Estate developers are not obliged to follow any sustainable building practices.

Since Dhaka is bounded on three sides by its rivers, the continuing trend is to build upward to meet the needs of the increasing population. Dhaka is an ever-changing city where the trajectory of growth can be phased as almost wild or extreme urbanization. This transformation is engineered by land-owners, developers, financiers, policy-makers and policy-breakers, and compounded at the micro level by migrants and small-time entrepreneurs.

In the extreme tropical and sub-tropical climate, there is a pressing need for more sustainable approaches to high rise buildings. This thesis proposes the integration of sustainable features into the design of a multi-use high-rise building for Dhaka city.



GENERAL INFORMATION:

NAME: DHAKA
COORDINATES: 23°42'N 90°22'E
ESTABLISHMENT: 1608, 1947 (CITY STATUS), 1971 (CAPITAL)
METROPOLITAN AREA (DISTRICT): 118.3 SQ. MILES (306.38 SQ.KM.)
GREATER METRO AREA (DIVISION): 834.4 SQ. MILES (2161.17 SQ. KM.)
POPULATION: 15.1 MILLION
CLIMATE: TROPICAL WET & DRY CLIMATE
AVG. TEMP. : 45 DEGREE F - 108 DEGREE F (7.2 DEGREE C - 42.2 DEGREE C)
MAIN RIVERS: BUIRGANGA, SHITOLOKKHA

Fig 3: location of Dhaka city in regional map

CHAPTER 1: BACKGROUND

i. HISTORICAL CONTEXT

The city of Dhaka has had a fairly humble beginning. Although the urban settlement can be dated back to 7th century CE, some of the most prominent developments have been from last 400 years. After the Sena dynasty, Dhaka was successively ruled by the Turkic and Afghan governors descending from the Delhi Sultanate before the arrival of the Mughals in 1608. Dhaka was the capital of Sub-a-Bangla from 1612 A.D. to 1717 A.D. [4] During the rule of the Mughals, the British East India Company was permitted to establish its base at Calcutta (Kolkata). The British gained strength in the region as the Mughal empire weakened. Under Governor General Charles Cornwallis (1786–93), a permanent settlement system was established in the territory—now called the Bengal Presidency—whereby property rights were granted in perpetuity to local *zamindars* (landlords). The British ruled this region for 150 years until the independence of India in 1947.

During the Mughal period, Dhaka became an important metropolis and capital of Bengal because of its administrative, commercial, and infrastructural importance. The city began to extend westward up to Sarai Begampur and northward to Badshahi Bagh.[5] Under Shaista Khan (1662–1679), the city expanded in size to over 12 miles in length and 8 miles in breadth and served as a home to nearly 1,000,000 people. [6] Local roads were filled with pedestrians, and river and canals were the important traffic conduit of the city. Therefore, landing platforms at the river bank, locally known as *ghats*, were a significant feature of Mughal City. A magnificent view of the Mughal buildings was observed from the

river because the river front was the most dominant part of Mughal City that can be approached through the river route.

The city was divided into a number of neighborhoods, which were a cluster of houses webbed with intricate narrow lanes.[7] These narrow lanes were paved with bricks in 1677–1679. [8] Two principal roads can be found: one that ran parallel to the river from Victoria Park to the western fringe of the city, and another that extended from Victoria Park to Tejgaon.[9] The intersections of narrow lanes formed wide and irregular nodes that acted as a civic space at the local level. The sense of enclosure of these spaces was very intimate in scale.

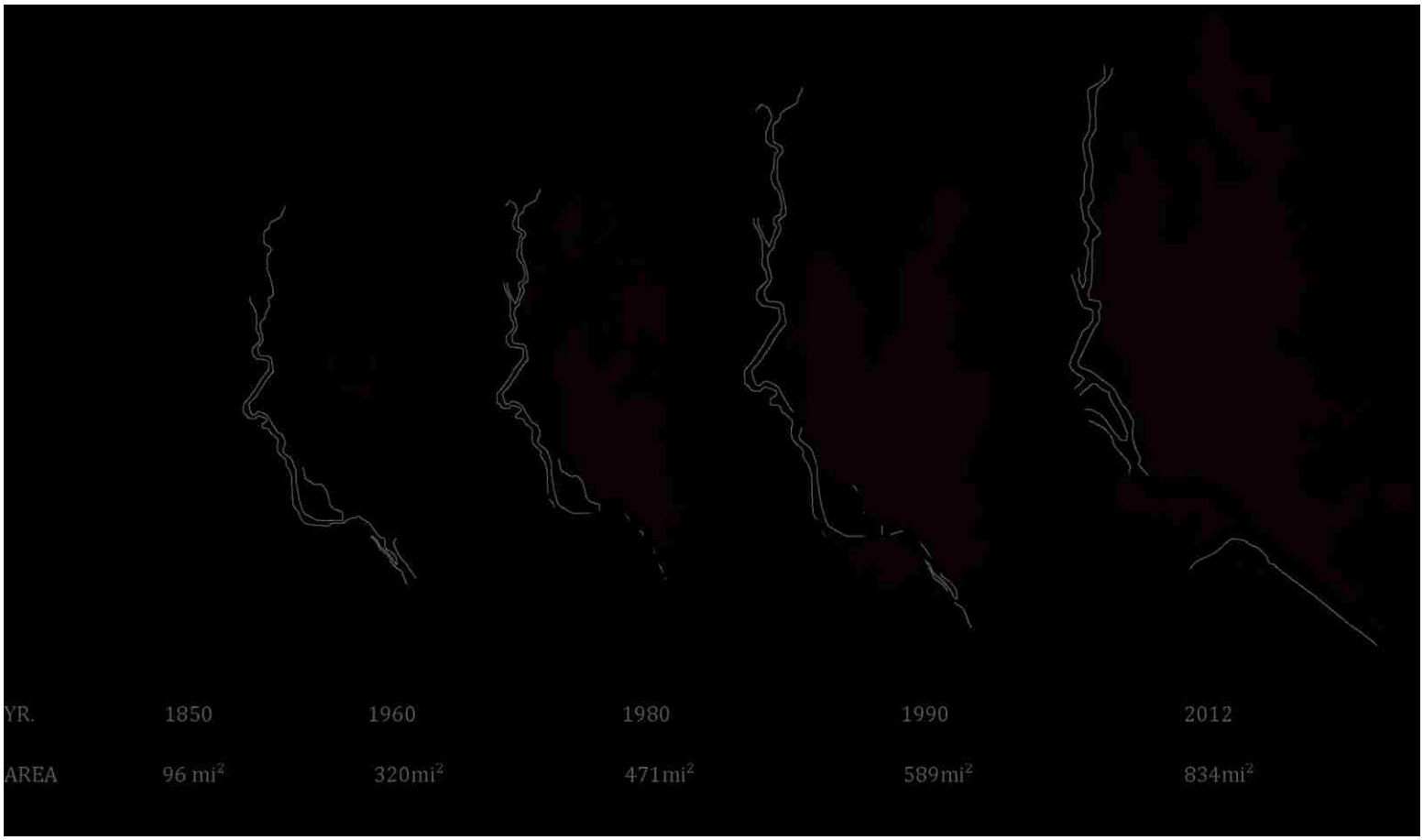


fig 4: urban growth of Dhaka city

The functional zones of Mughal Dhaka was divided into- Residential zones, Service zones, Central business districts and recreational zones (figure 4). The central business districts primarily consisted of market areas that served both the elite society and the middle-class people. The recreational spaces were mostly garden houses of the Mughal elites for gatherings, receptions and festivities. Some reminiscent examples can still be seen in a few older building complexes around the city today.

During the British period (1765–1947), the old Mughal town did not expand, but it underwent some forms of renewal. The medieval Dhaka transformed into a modern city with metal roads, open spaces, and piped water supply.[10] (figure 5). Some roads within the old city were widened, and new buildings were erected for administrative and educational purpose. The Old Fort was turned into a jail. However, most of the residential quarters were within the historic core; the river front and the area near Victoria Park was a prized location

Fig 5: Dhaka City across Buriganga River- a painting by Frederick William Alexander de Fabeck in 1861

for high-class residents. During this period, Dhaka was characterized by tree-lined streets with large canopies. Dhaka was known as the "garden city" throughout that time. (figure 6) (figure 7) (figure 8) After the partition of British-India in 1947, Dhaka served as the capital of then East Pakistan. After the liberation in 1971, Dhaka became the capital of Bangladesh. Dhaka continued to expand further to the North. [11]

fig 6

fig 7

fig 8

Fig 6,7,8: historical images of Old Dhaka with tree-lined streets and homesteads with large courtyards

1800-1960 1960-2018

Fig 9: collage showing chronological changes in Dhaka's ground plane and the skyline being congested with buildings

ii. PRESENT CONTEXT

Ever since the division of India-Pakistan in 1947, the city has been losing its livable characteristics, especially in residential neighborhoods as more and more areas are being transformed into mixed use or retail areas. Previously used water routes are being encroached on or narrowed down to give way for more crowded living conditions including informal settlements throughout the city. Although there have been efforts to create a clear master plan for the city; these efforts have been unable to impact the unchecked organic growth of the city in any way. Over time and with changes in transportation technology and

Fig 10: what was once a prominent river bank, has now become launch terminals

economic stability of the nation, people have moved away from the river for primary modes of traveling, thus looking away from the once thriving river scape. (figure 10) (figure 11)

Fig 11: the present state of the once prominent river-bank

Socio-cultural dynamics in the area resulted in the formation of a spontaneous neighborhood, known as *para mahalla*, which acts as the basic spatial unit of the organic pattern in the urban web. [12] Dhaka is now characterized by several neighborhoods that are interconnected with each other to form connections among major nodes. These neighborhoods were laid out primarily in grid patterns pre-liberation war by the-then Government. One example could be the Dhanmondi area. The Construction and Building Department of East Pakistan divided up 500 acres of horticulture and agricultural land in 1950 into plots and distributed them to politically important personnel. In 1995, DMDP (Dhaka Metropolitan Development Plan) by the Government of Bangladesh, approved

the area to have commercial zones but restricted the construction to commercial services only related to the needs of the residents' daily and weekly needs.[13] (figure 11)

fig 11: Dhanmondi Residential Area Map, DMDP (1950)


fig 12: Dhanmondi, present condition

Today, more than half the plots are used for commercial purposes. (figure 12) This, coupled with little to no parking space and lack of public transit create heavy traffic congestion making commute much longer than intended (Figure 13). The transformation of such areas is not yet over. Even now, current six story buildings are being torn down to erect ten-story towers. [13] This is one of the predominant problems in Dhaka city, these apartment buildings are coming up in all kinds of locations- from mixed middle-class neighborhoods to upper class areas, to even the commercial district. [14]

Fig 13: cars parked illegally pertaining to massive traffic congestion

This is more prominent in the business districts and in commercial areas where there is a dense concentration of high rise commercial buildings. Most of these buildings are not compliant with the parameters of sustainable design practice. These tall towers are typically characterized by being giant glass boxes (figure 14) with conditioned indoor spaces that completely ignore the climatic conditions by heavily altering the micro-climate of the area and consuming vast amounts of energy, (figure 15) built quickly to meet market demand. They often fail to meet the already limited building safety regulations. Often these buildings are constructed having no relationship with the surrounding context. Therefore, they become isolated objects relative to the neighboring buildings. (figure 16)

Fig 14: even in the sub-tropical humid climate, high rises mimic the western trend where the buildings are enwrapped for solar gain and thermal comfort

Fig 15: air conditioners and air cooler added on later to the high rises because of the artificially conditioned interior spaces

Fig 16: no defined entry, hence no relationship with the surrounding context

CHAPTER 2: URBAN DHAKA

i. CITY IN PARTS: RESIDENCE, NEIGHBORHOOD, COMMUNITY, CITY

To understand the demographic, economic and general growth pattern of the city of Dhaka as well as Bangladesh from the beginning of the twentieth century, it is important to acknowledge the different parts that make up a city. The first master plan of this city was issued in 1959, projected for the next 20 years, prepared by a British consulting firm, under the leadership of DIT (Dhaka Improvement Trust). The plan included Greater Dhaka which consisted of central Dhaka and other municipalities as well as intermittent rural areas along the fringe of the district of 320 q. miles. (figure 17)

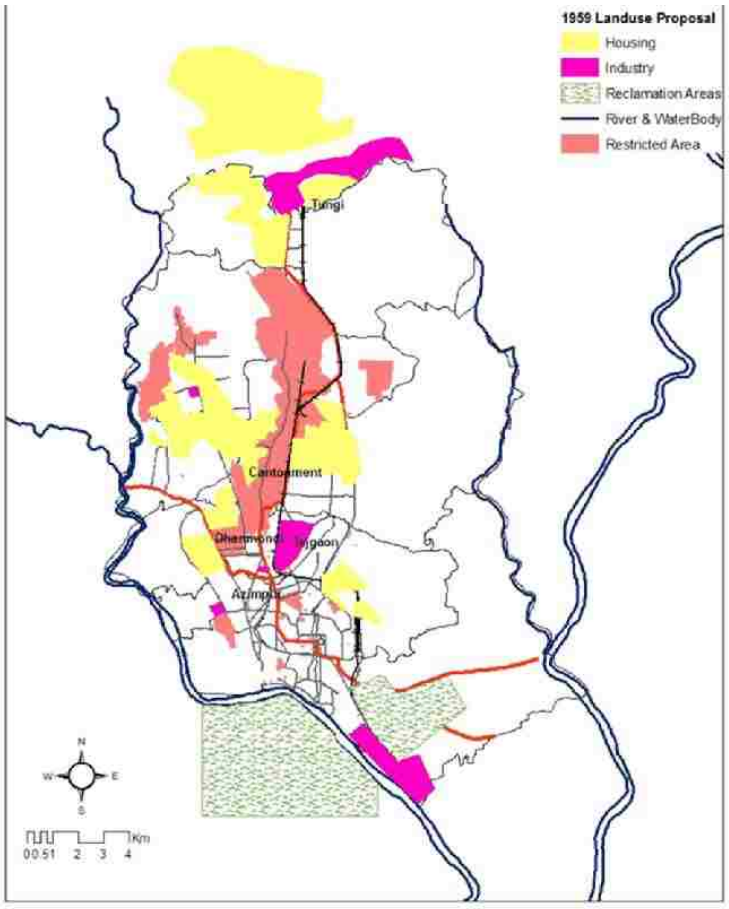


Fig 17: major land use proposal in Dhaka Master plan, 1959

This proved to be unhelpful as the population projection was highly inaccurate because of political upheaval for 1971's Liberation War. The 1959 master plan basically followed the principle of segregated and discrete land use planning for all new development. Although there were strict laws about non-residential use of land in residential areas, this was not followed thoroughly due political and socio-economic changes. Due to the rapid population growth throughout this period, formal and informal employment opportunities that were created, which led the way to creation and expansion of slums and squatter settlements Until today, the density of these slums has been as high as 2,000 people per acre. The residential land use also got altered by commercial land developers through gentrification of old city areas as well conversion of agricultural land into urban residential subdivision, skewing the master plan once. [15]

The next master plan was during the 1990s, until which Dhaka remained vastly without any planning initiative. In 1995, a master plan named "Dhaka Metropolitan Development Plan" had been drawn up with joint funding from the Government of Bangladesh and UNDP/UNCHS (HABITAT), by a Consortium of international firms-Mott Mac Donald Ltd. and Culpin Planning Ltd. in association with a local firms, Engineering and Planning Consultants Ltd., Consociates Ltd. and Development Administration Group. [16]

This plan consisted of three components: An Urban Area Plan, (figure 18), a Structure Plan, (figure 19) and a Detailed Area plan. The target population of this plan was 15 million; however, the city had already crossed the 15 million mark three years earlier. Inability of the development authority to meet the development demand has resulted in numerous informal

and spontaneous settlements in Dhaka city. Evidently, Dhaka city represents mixed characteristic of formal and informal development. Independent and individual landowners develop informal settlements, while the formal development is carried out in a similar fashion by formal public and private sectors.

In addition to developing individual apartment buildings, some large-scale developers also build housing complexes with high rise apartment buildings of 15-20 stories. [17]

Some parts of the master plans were successful. For instance, the idea of a polynuclear CBD (Central Business District) resulted in de-concentration of traffic. With this rapid and incontrollable growth of Dhaka city, multitude of neighborhoods of Dhaka have become important fragments of Dhaka city livelihood, these are formally known as Upazilas or Sub-districts. (figure 20) Defined by their characteristics, neighborhoods within these sub-districts have been dubbed either high class, middle class or low class. With every neighborhood, the residential components have been key for measuring the livability of that certain sub-district.

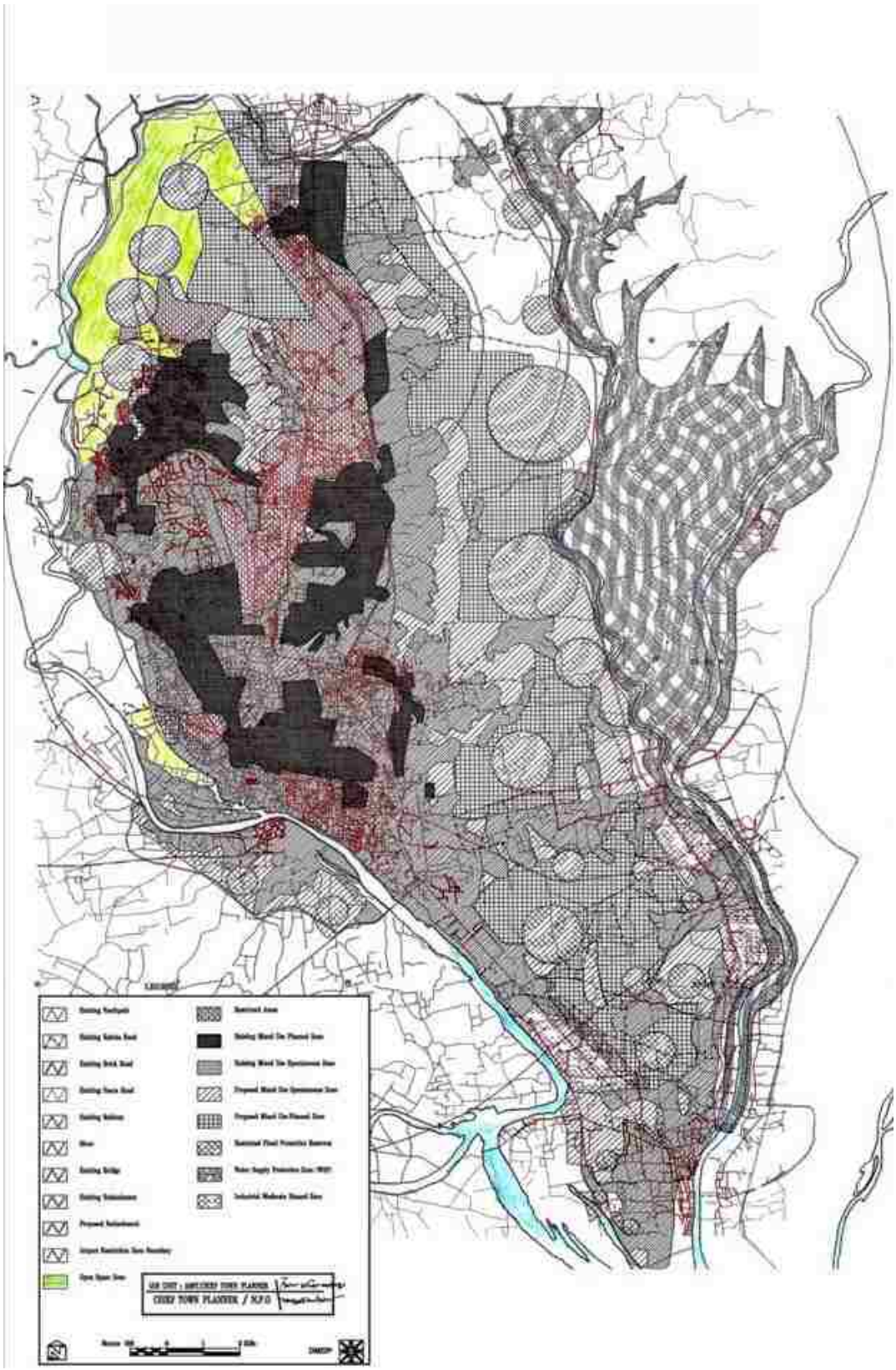


Fig 18: DMDP Urban Area Plan (1995-2005)

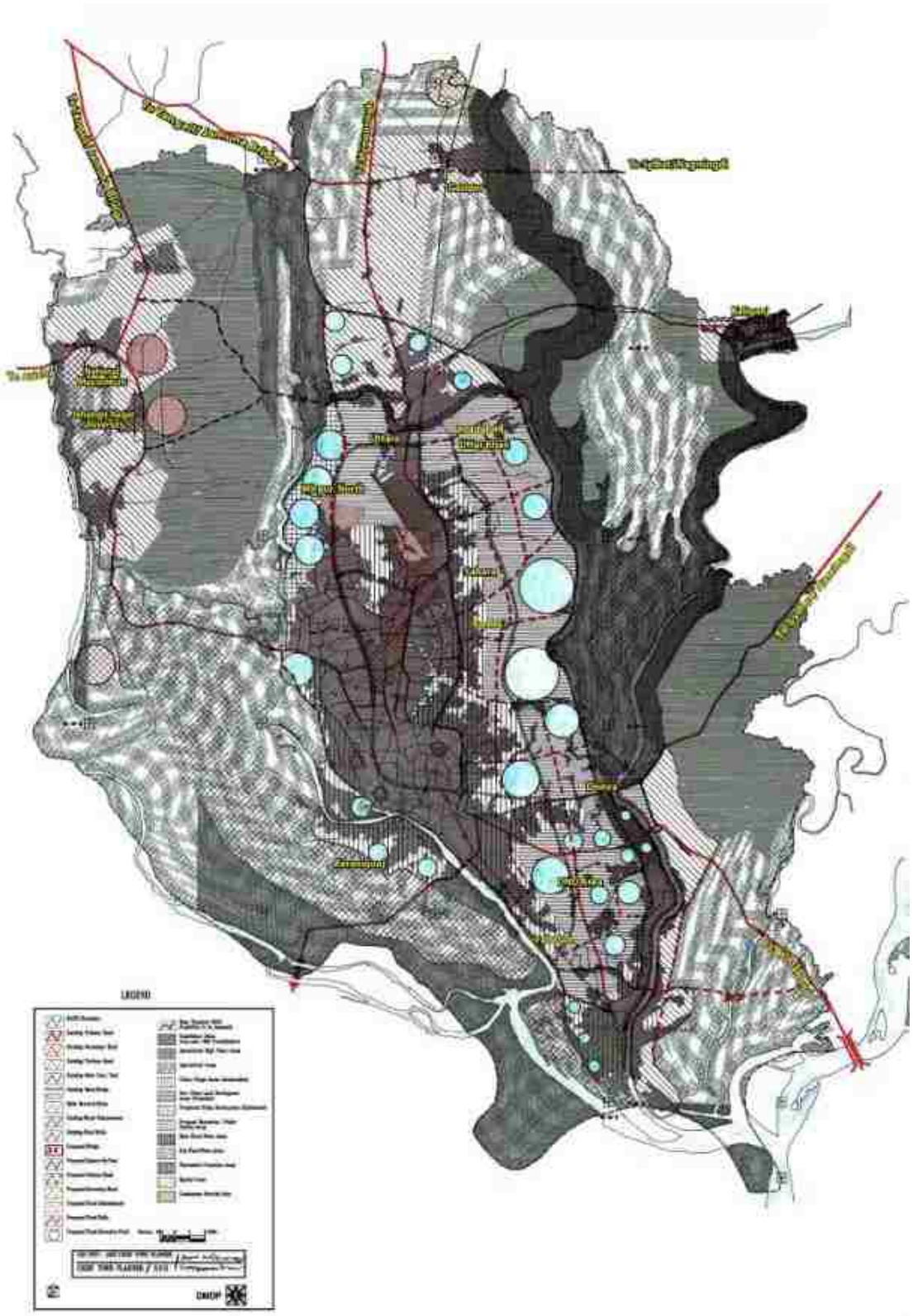


Fig 19: DMDP structure Plan (1995-2005)

Fig 20: Dhaka city neighborhoods

A study had been undertaken in 2015 using different variables for satisfaction to ensure the sustainability of the particular neighborhood. Some of the features would be management and maintenance, recreational facilities, ambient environment, open space condition etc. The six neighborhoods that were held in consideration were Mirpur, Mohammadpur, Uttara, Ramna, Tejgaon, Dhanmondi. The study revealed many results including the following:

This showed that 65% of the participants were satisfied with living in Uttara but only 17% of the respondents were happy living in Mohammadpur. Mohammadpur was developed around 1950, therefore, like many other older neighborhoods, it was only planned according to the assumptions of the first master plan. (figure 21) On the contrary, Uttara is residential suburb area which was mostly designed to cope with the living situation of the excess population of Dhaka city.[18] (figure 22)

Fig 21: Present condition of Mohammadpur, Dhaka

Fig 22: Uttara, Dhaka

It can be incurred from this study that high satisfaction within a neighborhood contributes to strong sense of community while low satisfaction influences their decision to move elsewhere. This finding is supported by two other factors- neighbors and community facilities found in that particular area. Therefore, socio-physical features of the neighborhood influences life satisfaction and sustainability more than individual dwellings of Dhaka city.

ii. CIVIC CONUNDRUMS

a. POPULATION EXPLOSION

Due to drastic changes in the climate, there have been many climate refugees in the past few decades in Dhaka. Each year, about 500,000 people move to the Capital from coastal and rural areas—roughly the entire population of Washington, DC. [19]

These people comprise of the 40 percent of the entire population. Compared to the national average of 2.1 percent, the annual population growth rate in Dhaka is 4.2 percent, which is one of the highest among Asian countries and in the World. With more than 45,000 people living per kilometer, the density of the population of Dhaka is 75 percent higher than that of Hong Kong's. [20] At this rate, the estimated population by 2025 will be close to 25 million. [21]

Fig 23: Dhaka city population explosion

According to the International Organization of Migration, some 70 percent of slum dwellers in Dhaka moved to Dhaka after experiencing some kind of environmental hardship. Usually they find jobs in the city and never move back to their original home, increasing the number of total population of Dhaka. (figure 23)

b. ABSENCE OF GREEN IN A GARDEN CITY

Green spaces in Greater Dhaka are rapidly disappearing over the course of time even though they provide a number of natural, economic and social benefits. The disappearance of green spaces was primarily attributed to a rapid increase in the urban population, mainly driven by rural–urban migration. As a result, the landscape became highly fragmented and less connected. A substantial reduction of green patches is also leading to deterioration of the ecological condition of the landscape. The drastic reduction of green spaces in Greater Dhaka has been attributed to a lack of policy, low political motivation, and poor management. In order to ensure sustainability of green spaces and proper functioning of the city's ecosystem, there is an urgent need for strategic green space planning. [22]

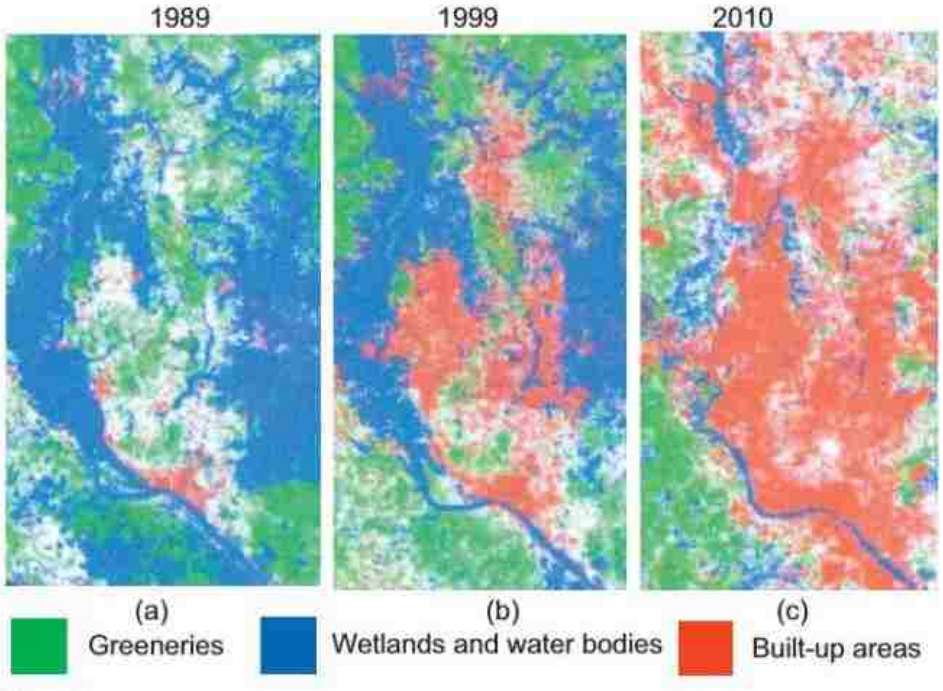


Fig 24: map showing decreasing rate of green spaces in Dhaka city during three different periods- (a) green spaces in 1989, (b) green spaces in 1999, (c) green spaces in 2010

Although it is suggested that there should be 25% space in a city that is open, for Dhaka, the number is much lower. Old part of Dhaka city has 5% and new Dhaka has only 12% land that is green and open (DMDP 1995). For Dhaka central region (DCR), the percentage is as low as 0.95% (DMDP 2016-2035) (figure 25)

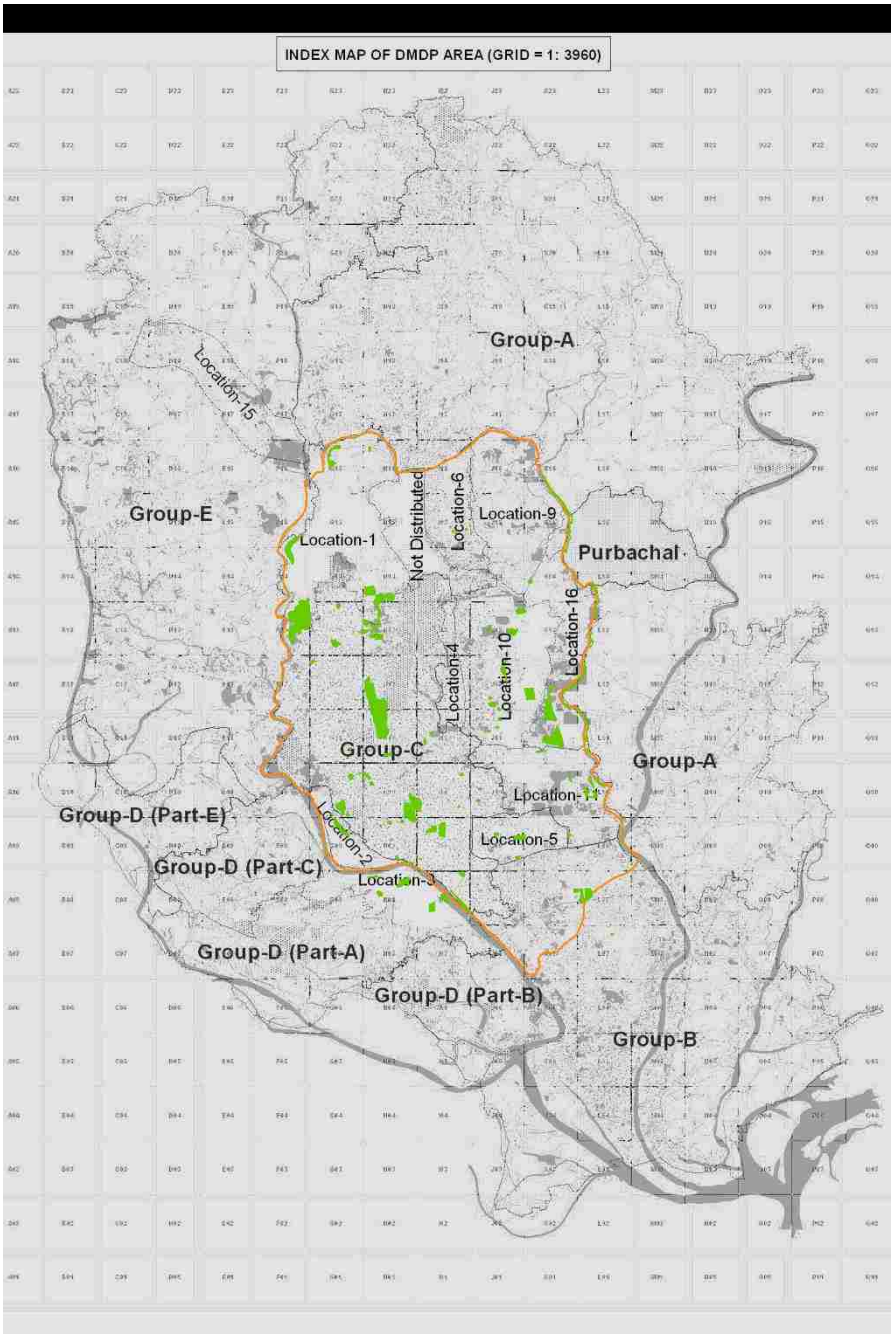


Fig 25: Dhaka's green area gradually decreasing

c. AIR POLLUTION

Dhaka, the capital of Bangladesh, has been ranked one of the highest in the US Air Quality Index (AQI), for having the worst level of air pollution in the world. According to data available from a smartphone application named AirVisual, which shows the user real-time air pollution index of any city across the globe, Dhaka can be found at the top of the chart almost all the time, signifying high level of air pollution. The number is usually around the higher limit during winter months. (figure 26) (figure 27)

The reason could be an unusual number of cars paired with thousands of brick kilns

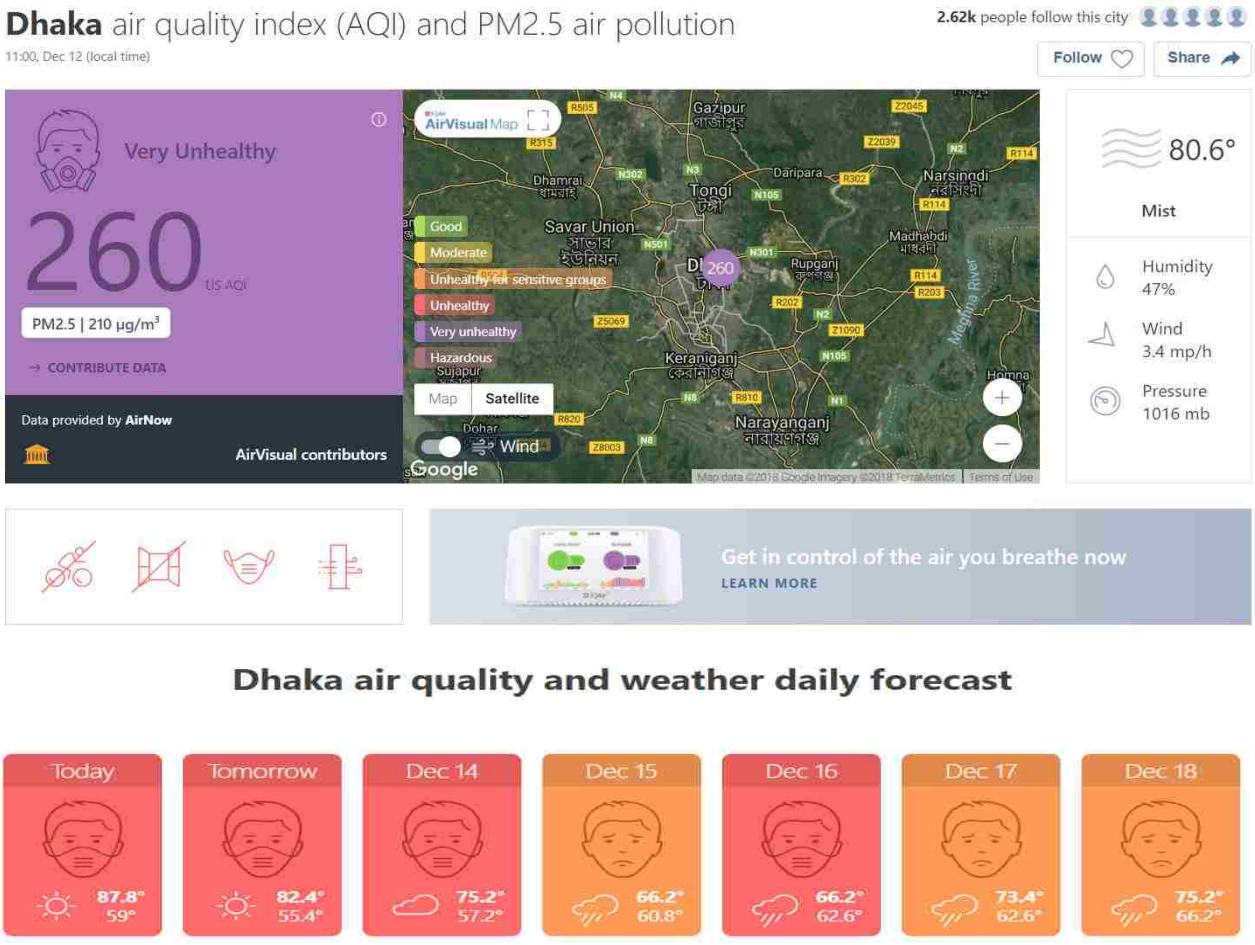


fig 26: Dhaka's AQI (Air Quality Index) dangerously high; as opposed to Seattle, which was 26 on the same day, fig 27: Dhaka's AQI for next seven days

setting up production in and around the city. The kiln operations alone—while representing just 1% of the country's GDP—generate nearly 60% of the particulate pollution in Dhaka, according to Bangladesh's Department of Environment (DOE). Many of these kiln operations—including some 530 sites producing more than 2 billion bricks annually in northern Dhaka—are so called fixed-chimney kilns, which use inefficient technology with little to no pollution controls. [23](figure 28) An AQI value over 300 represents hazardous air quality and below 50 the air quality is good. The index is based on the five criteria pollutants regulated under the Clean Air Act--ground-level ozone, particulate matter, carbon monoxide, sulfur dioxide, and nitrogen dioxide. [24]

fig 28: brick kilns attributing to Dhaka's heavy air pollution

iii. GROWTH OF TALL BUILDINGS:

Dhaka is one of the fastest growing mega cities of the World. The total area of the metropolis is about 120 sq. miles, which is home to 18.237 million people as of 2016. [25] Each day, thousands of people migrate to this financial and industrial center from all over the country. According to Bangladesh Sample Vital Statistics (BSVS), some 90 out of 1,000 people moved to urban areas. (source: Bangladesh Bureau of Statistics, BBS) This has been going on even before the Liberation War. During the 1960s Dhaka was experiencing rapid population growth (about 6% annually). [26] Since then, its population has grown more than 10 times. [27] After becoming a newly independent country following the War, Bangladesh found itself in a completely new political and economic situation which was crucial to changing the urban scene. With considerable expansion of Dhaka city, the population rose from 0.56 million in 1961 to 1.56 in 1974. (source: Bangladesh Bureau of Statistics) In fact, Dhaka is one of the only cities in the World that has experienced a steady growth in population of about 6.9% from 1947 to 2000. [28]

fig 29: Hotel Purbani, located in the Motijheel CBD area in Dhaka

To accommodate the administrative and commercial demands of a newly urbanized Dhaka, the first push for growing upward was felt. In the mid twentieth century the first "tall" building was Hotel Purbani, constructed in the Dilkusha Commercial area (Figure 29). [29]

Due to the tedious and expensive construction process as well as the political instability, about 11 high rise buildings made it into the sky line of Dhaka by 1981, most of which were commercial. The 9-story Parliament building was also constructed around the same time. [30] (Figure 30)

fig 30: National Parliament Building of Bangladesh, Dhaka

These early tall buildings were mostly 9 to 11 stories in height. During the 1990s, some high-rise buildings that were constructed reached 15 to 20 stories. Although the country's tallest building to date, the 37-story City Center Tower was constructed in 2012, the majority in Dhaka city today are 15 to 24 stories. With increasingly less space in its central urban core, Dhaka would benefit highly from an even taller building that better responds to its social and environmental context.

In the next couple of decades, buildings have multiplied 10 times in number and now there are over 300 tall buildings in Dhaka city alone, with more being approved for construction every day. As the culture of living in apartments became more popular, developers realized the benefits developing high-rise buildings for commercial use with offices, shopping malls and other mixed-uses etc. Except for residential towers, this constitutes the majority of the high-rise buildings in Dhaka city. According to the map, the majority of these and other tall buildings are distributed around the oldest central business district (CBD) area, Motijheel. Other clusters include one in Banani and and the Tejgaon commercial area. A cluster of residential high-rises have also been developed around these areas. Due to the height limitation in residential areas, many high-rises have also been developed on the fringe of these areas, in a more scattered manner.

iv. PRESENT CONDITION OF HIGH RISE BUILDINGS: LACK OF ENVIRONMENTAL CONSIDERATIONS:

The population growth since 1971 has resulted in large-scale developments on urban and building development level. The upcoming buildings in these new developments will pose a high energy demand and a necessity to address that. None of the existing key plans, policies and regulations address this issue explicitly and the country still does not have any building energy code. Additionally, very few studies exist regarding the energy impact of current urban developments, energy consumption of buildings in general, or building-energy conservation strategies in Dhaka. This suggests an urgent need for substantial research on this topic. [32]

This situation is amplified in the case of tall structures since they consume more energy in general. Office buildings in particular are often enwrapped with glazing having fully conditioned interior spaces that do not address the outside environment, negatively impacting climatic conditions. The reflective walls of tall buildings absorb the heat and release it back into the surrounding area, raising the overall temperature of the microclimate. Dense blocks of tall structures create urban canyons which impact wind speed and air quality. Tall buildings especially have an unsustainable and inefficient energy consumption pattern (Figure 31).

fig 31: high-rise buildings along major streets having no setbacks

Existing building laws focus mainly on the density of development and not the energy consequence of urban practices. There are no regulations for the envelope, materials or energy performance of a building. As a result, Real Estate developers and builders in general do not follow sustainable design principles like providing systems for passive controls and dedicated energy regulation systems in buildings. Instead, occupants rely on air conditioning and artificial lighting during day time.

Due to the recent, rapid wave of growth, Dhaka city also has experienced many other problems. Unplanned development around the city has resulted in unregulated built conditions. Buildings often overlook required setbacks, increasing footprint and adding to congestion and environmental pollution. There is a tendency to increase tenancy in the building after completion which is not accounted for in the original design. This practice results in over-consumption of energy such as water, gas and electricity, posing detrimental effects on the environment.

v. CASE STUDIES:

a. Cityscape Tower in Dhaka, Bangladesh:

The flagship project of Cityscape International Ltd. is the Cityscape Tower (Figure 13), which is the first LEED (Leadership in Energy and Environmental Design) Platinum Certified building in Bangladesh. The edifice stands over 11000 sft of land, the tower is 13 stories tall, utilizing about 50% of the total area as outdoor spaces. (figure 32)

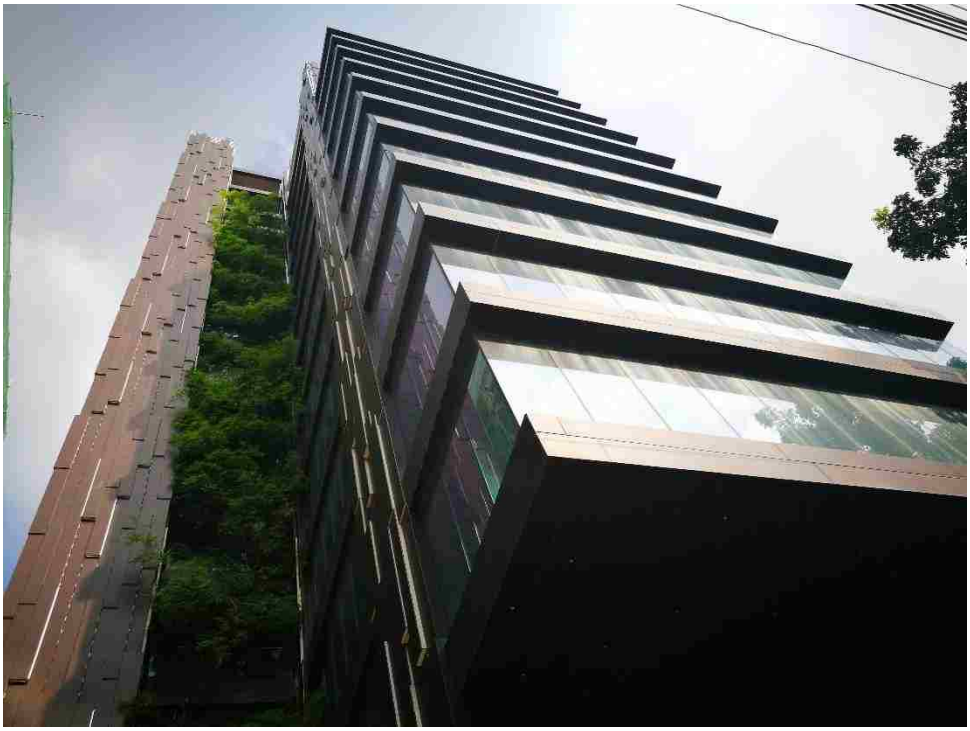


fig 32: City Scape Tower, Dhaka

The building is compliant with features of energy efficiency by using CO and CO2 with sensors for ensuring better indoor air quality, on-site water treatment and recycling plant and rain water harvesting, roof solar panels and a water fountain which is integrated into the landscape of the building. The building's renewable energy system is also smart in the context of Bangladeshi buildings since it runs on 44% less energy than other buildings in the area and is

able to save 60% more water, something that becomes scarce during warm seasons in Bangladesh.

b. MBF TOWER:

This tower is a development of the "places in the sky" idea. The site is oriented roughly north-south. The MBF Tower replaces an earlier demolished multi-story apartment block by another architect, construction of which was halted when the foundations were found to be faulty. The new project consisted of a podium for offices and a banking hall, with 68 luxury apartments in the tower block. (figure 33) [32]

fig 33: the Menara MBF tower located at the heart of Penang, in Georgetown in Malaysia

Menara MBF Tower is a mixed development of a 28-story apartment and shop-office located on the ground floor. The lower floors consist of four story office and upper floors consists of apartment units. Each residential floor has four apartments separated from the access walkways by air gaps. These increase opportunities for all-around cross ventilation to each apartment unit. The lower apartment units are extended towards the front of the building, creating an internalized atrium facing the swimming-pool deck.

The upper parts of the tower have large, two-story sky-courts for ventilation and planting, and to provide terraces. Lift lobbies are naturally ventilated, with bridges as walkways to the apartments. Stepped planter boxes are located on the buildings main façade.

c. NZEB (NET ZERO ENERGY BUILDING) AT CEPT UNIVERSITY IN AHMEDABAD, INDIA:

CEPT University's NZEB is a Living Laboratory which is a great example energy efficient

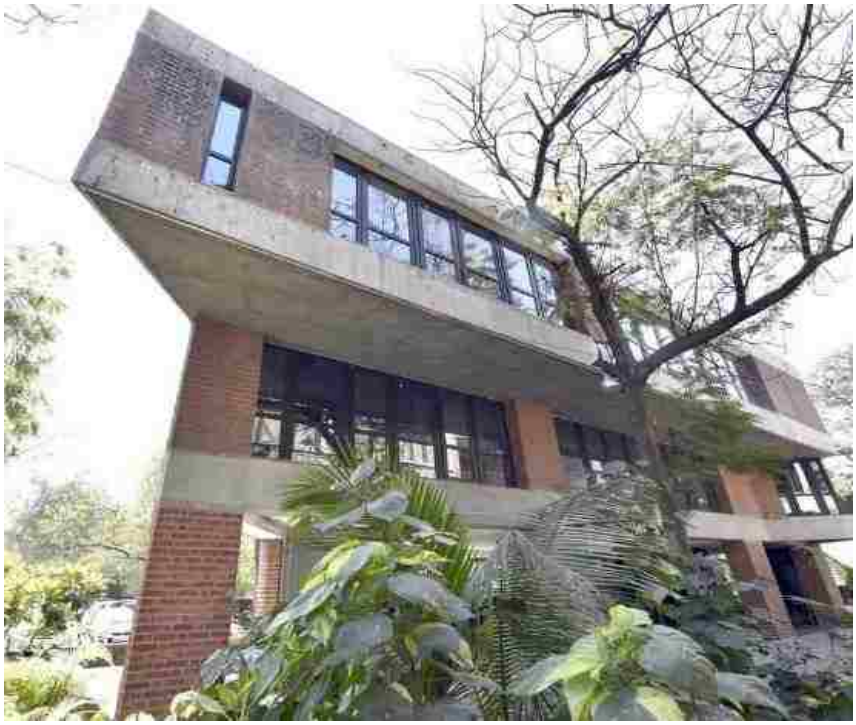


Fig 34: NZEB at CEPT

building. In 2015-16, the laboratory sent 15% surplus energy into the electricity grid. It uses hybrid ventilation and cooling system combining natural ventilation with radiant cooling to maximize the use of fresh air for passive cooling (figure 34). This helps to offset peak temperature discomfort. The building design contains sophisticated and flexible control systems that can support continuous research experiments on building monitoring and performance optimization. 50% of the roof area is covered with solar panels for on-site power generation equivalent to 70 KWh/m^2/yr. [33]

d. BD BACATA: THE WORLD'S FIRST CROWDFUNDED SKYSCRAPER:

fig 35: the first crowd funded tower in Bogota, Colombia

At 66 stories tall, the mixed-use residential/commercial building, BD Bacatá will be the tallest skyscraper in Colombia, with a colossal price tag to match. (figure 35) However, instead of

relying on one developer to finance the $240 million project, a group known as Fidi Global has pushed a different model for the skyscraper: to have Colombians fund the building themselves. a company called Prodigy Network raised almost the entire budget for the skyscraper through a crowdfunding campaign that ultimately netted about 3,800 investors. The 2009 campaign's rules stipulated that anyone could buy shares in the building, which cost roughly $20,000 per share, according to Co.Exist (but could be paid over two years). By the time the building was under construction in 2013, Prodigy had raised more than $170 million using investments from individuals. After completion, this would be the tallest tower in Bogota that helped solve the economic crisis to a great extent. [34]

CHAPTER 3: METHODOLOGY

i. CLIMATE RESPONSIVE DESIGN STRATEGIES OF VERNACULAR ARCHITECTURE OF BANGLADESH:

a. TRADITIONAL/RURAL ARCHITECTURE:

The climate responsive architecture or the vernacular architecture of Bangladesh is mainly based on two principles- ventilation and sun-control. Due to hot Summer months and cooler Winter, it is imperative to keep the cross ventilation active and the warmth trapped in

fig 36: traditional mud houses of Rural Bangladesh

respective seasons. The traditional architectures have changed very little over time since the basic principles have stayed the same for centuries. A traditional rural "Bengali House" in its basic form is a cluster of small huts arranges around a central courtyard. Some of the other contributing factors for placement of these huts may also be religious and cultural norms,

social codes, customs, and available resources. These houses are placed on plinths made of rammed earth (figure 36 and Figure 37). The walls are made of reed, formed in square or rectangular panels made of bamboo while the roof is thatched or sometimes have corrugated iron sheet for roofing. [35]

Figure 37: The concept of a central courtyard in Rural Bangladeshi houses

b. CONTEMPORARY ARCHITECTURE:

In more contemporary and urban approaches like the Sher-e-Bangla Nagar Parliament Members Club adjacent to the National Parliament Building of Dhaka, Louis I Kahn paid close attention to utilize natural forces to gain maximum internal thermal comfort (Figure 38).

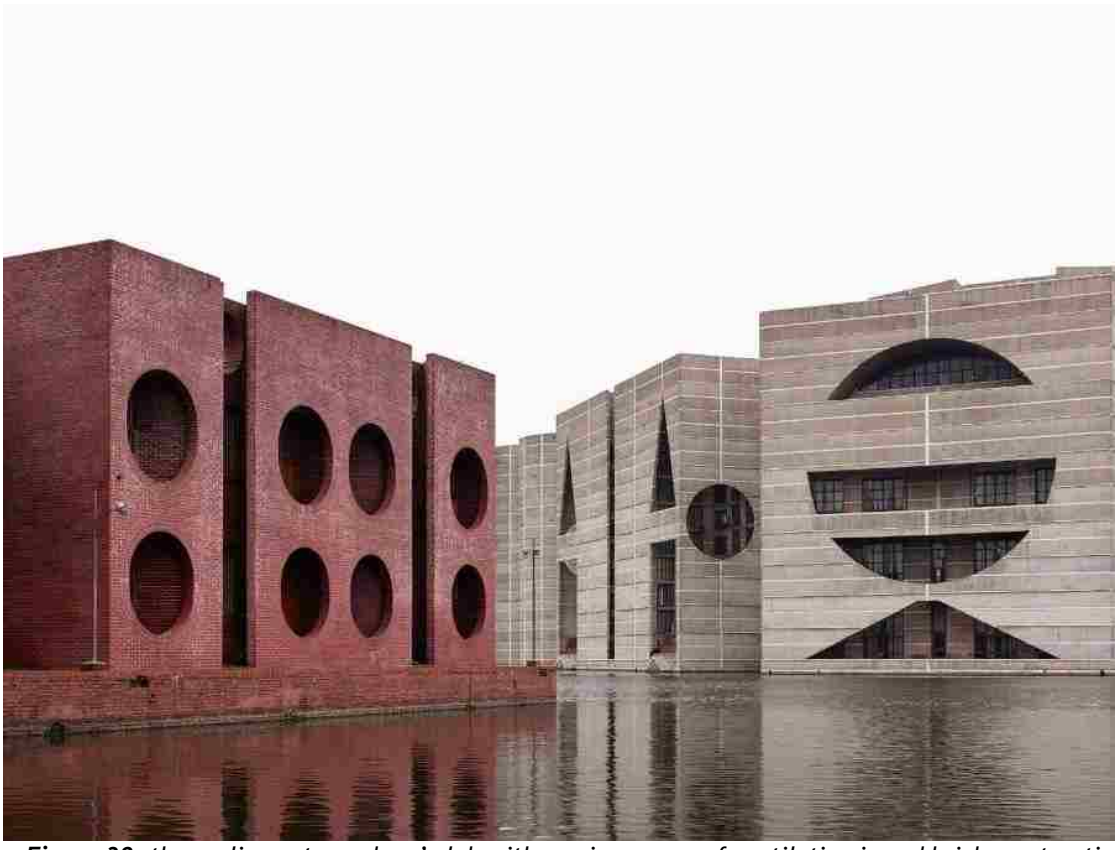


Figure 38: *the parliament members' club with passive means of ventilation in red brick constructions*

The concept of blocking out the Sun on the eastern and western facades by usage of smaller apertures like lavatory or kitchen windows while creating wide operable glass doors on north and south sides for cross ventilation is simple yet very effective for indoor comfort. [36]

In more recent examples, the twelve story Comfort Reverie Residence (Figure 39) is a building that was attempted as an expression of tropical vertical living. The hot humid Summer calls for breathing facades. Fins are added to the openings on the East and the West to channel the direction of air, as well as shading against the hot blazing Summer Sun. The playful arrangement on the West facade gives the building an interesting expression with chancing perspective from the busy road and a unique lighting experience in the interior. [37]

Figure 39: Using vertical fins for passive ventilation in warmer months of the year in Dhaka Bangladesh

ii. BIOCLIMATIC SKYSCRAPER IN THE CONTEXT OF DHAKA CITY:

In the bioclimatic design approach, the low-energy imperative is achieved through passive means (such as through shaping the built-configuration, placement of the building components, and selection of materials), rather than through the use of electro-mechanical devices and systems. While these electro-mechanical devices and systems might subsequently be added to the building's MandE and facade systems to further enhance the low-energy performance, these should be regarded as secondary to design by low-energy passive means. [38]

Figure 40: Menara Mesiniaga, a bioclimatic high rise building by Ken Yeang, Malaysia

The "Bioclimatic Skyscraper" (figure 40) is a term synonymous with Architect Ken Yeang, who has demonstrated the salient attributes of an ecological skyscraper successfully through his works. A bioclimatic skyscraper would pay close attention to the environmental impacts of a super tall building. Bioclimatic skyscraper seeks climate responsive approach for year-round comfort, using entirely passive energy means where possible to reduce energy consumption. The bioclimatic approach also has the potential of being an ecologically benign approach if other sustainable design factors such as the selection of materials and ambient energy sources are also taken into consideration. While designing a bioclimatic skyscraper, it is imperative to be sensitive about the components that make up a tall building. For instance, taking into account the climatic conditions of the area, economics, culture, building program, site constraints, wind-load, daylighting, materials, lowering the energy costs and overall sustainability of the high-rise building. Such a tall building can prove to be an asset

for the community and have far-reaching benefits. It might be the gateway to a sustainable city.

Average annual rainfall in Dhaka is around 2,200 millimeters, (figure 41) 80% of which occurs during the monsoon months (May to September), most of which makes it is way to the storm drains while Dhaka suffers serious water shortage during dryer months. A high-rise building can create solutions for both those issues. Designed carefully, it could become a rain water collector as well as free up large spaces on the ground plane for greenery to flourish. Dhaka was once a garden city; in this way the building could be seen as a pavilion in the garden. Small pockets of underutilized spaces can become recreational and gathering spots. [39]

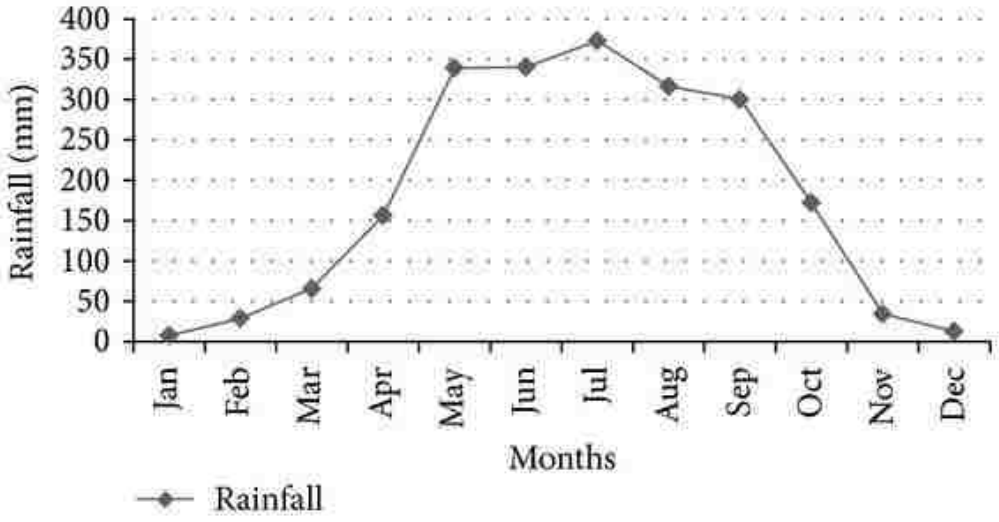


fig 41: annual rainfall in Dhaka

iii. THINKING VERTICALLY-- RE-THINKING SUSTAINABLE FEATURES OF DHAKA IN THE FORM OF A HIGH-RISE BUILDING:

In the current context of the urban life of Dhaka city, the skyscraper could be thought of as miniature versions of a city in the sky. For surrounding neighborhoods, with respect to the specific site context, it could also become a vertical neighborhood. A vertical neighborhood is viable for Dhaka as Dhaka is almost out of ground floor plane area. Since a vertical high-rise could help free up space to be used as larger green enclaves, aviaries, retention ponds, play areas, community spaces, open air exhibition spaces etc., thus, it makes every sense to think about designing a skyscraper that will bridge the gap and bring the community together.

With the population and economic growth, Dhaka is set to become considerably wealthier which will lead to a large number of commute and a greater reliance on motorized vehicles. Already, 42% of the trips made every day are made in motorized vehicles, and the number of private cars is estimated to have grown between 5-10% a year over the last five years. These trends are bound to continue. [40]

Therefore, the main proposition would be to re-integrate the sustainable features of Dhaka city in the form of a high rise building, to create a unique design strategy that can be then implemented into the entire city as a pioneering example, to open up vast amounts of ground floor plane and connecting the detached green spaces within the immediately adjacent neighborhood through building vertically, to explore possible technological adaptations in the building to combat energy loss in terms of materials and systems, to re-associate with

surrounding context to better service the community, activation of the ground floor plane, establishment of viable indoor-outdoor relationship in each building so that it is not an isolated object-- rather a living mechanism.

iv. SITE SELECTION:

The site is located in Motijheel area. (figure 42) It is one of the oldest and most prominent vicinities in present Dhaka and bears a variety of historical as well as contemporary buildings. The immediate site is surrounded by a predominantly residential neighborhood, but like every other neighborhood in Dhaka, this too has schools, offices and retails within a half kilometer radius. Another important marker is the Kamlapur Railway Station, one of the oldest and busiest railway junctions which is in close proximity to the site. The site is also within a five-minute walking distance to the most prominent commercial area in Dhaka. This area consists of traditional and contemporary high-rise buildings; therefore, this would help getting rid of the notion of the building being the only tall structure within close proximity. As per F.A.R. guidelines, the height limit is guided by the immediate primary road which is more than 92.5', creating opportunities for designing with more freedom.

Currently the site houses a makeshift car garage, which is up for demolition in some time. (figure 43) One of the biggest site forces are the surrounding buildings which are of equally deplorable condition, as well as green spaces and a swamp which have the potential of being major elements within the design if approached carefully. The surrounding streets are narrow (about 15-20') and are accessible by rickshaw (vehicle with three wheels), cng autorickshaw, and cars. (figure 44)

SITE INFORMATION:

LOCATION- MOTIJHEEL

AREA- 86,015 FT. (1.97 ACRES)

M.G.C.- 50.00%

WIDTH OF ADJACENT RD- 95 FT. (28.5 M)

F.A.R.- 6.5 (RESIDENTIAL)

N.A.(COMMERCIAL)

Fig 42 (top): site surrounding

Fig 43 (bottom): location of the actual site with focus area shown (in dark gray)

Fig 44: site surrounding images

(in order of number)- approach road, view from across the road to the site, Shapla Chottor (iconic node), main vehicular entry to the site, surrounding building in dilapidated condition, view to the approach road from across the street, main road network, main road network adjacent to the site, looking from the site to the other side of the street

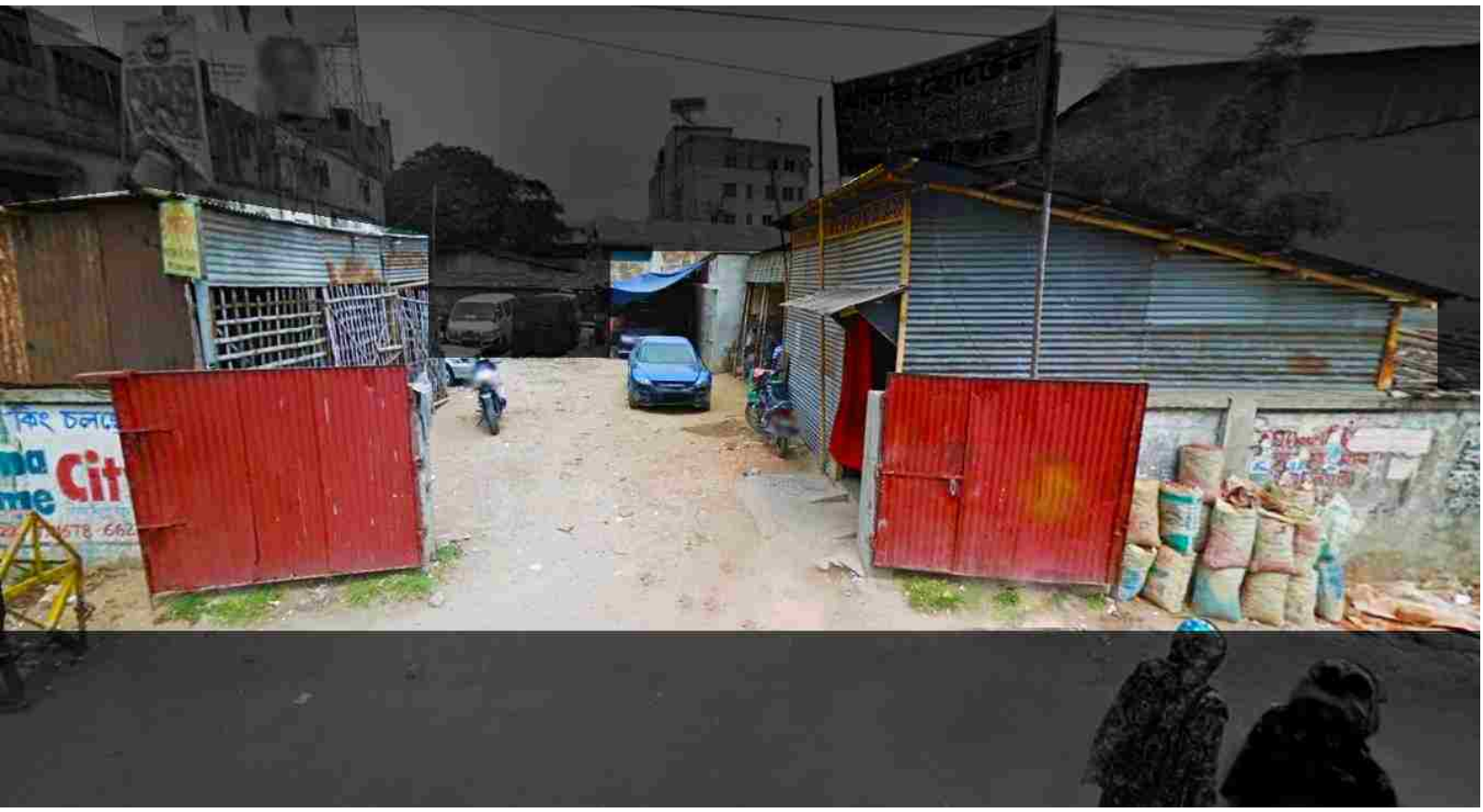


Fig 45 (top): site surrounding images

Fig 46 (bottom): approach road

Fig 47 (top and bottom): site surrounding

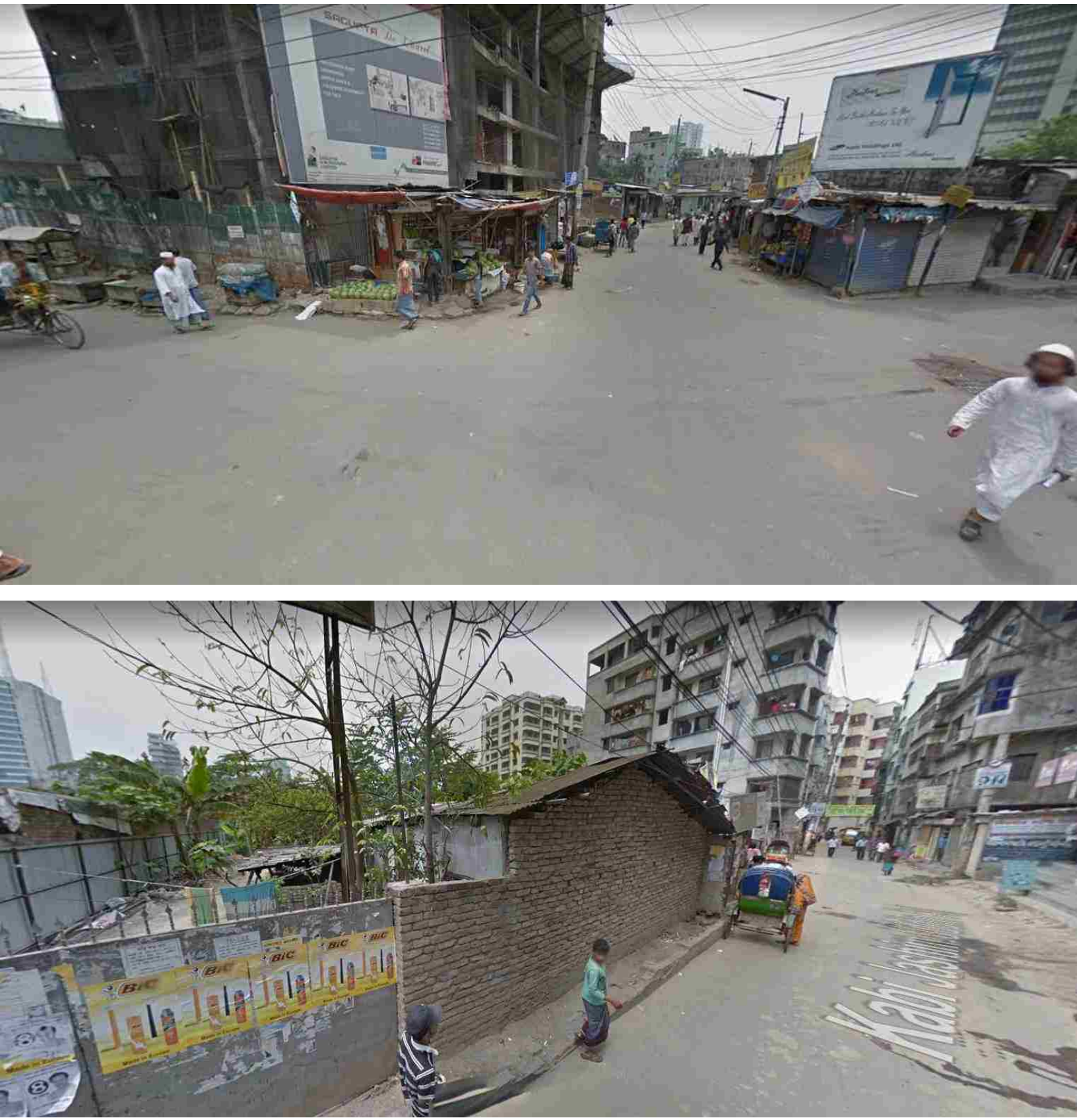


fig 48 (top and bottom): site surrounding

CHAPTER 4: DESIGN PROCESS

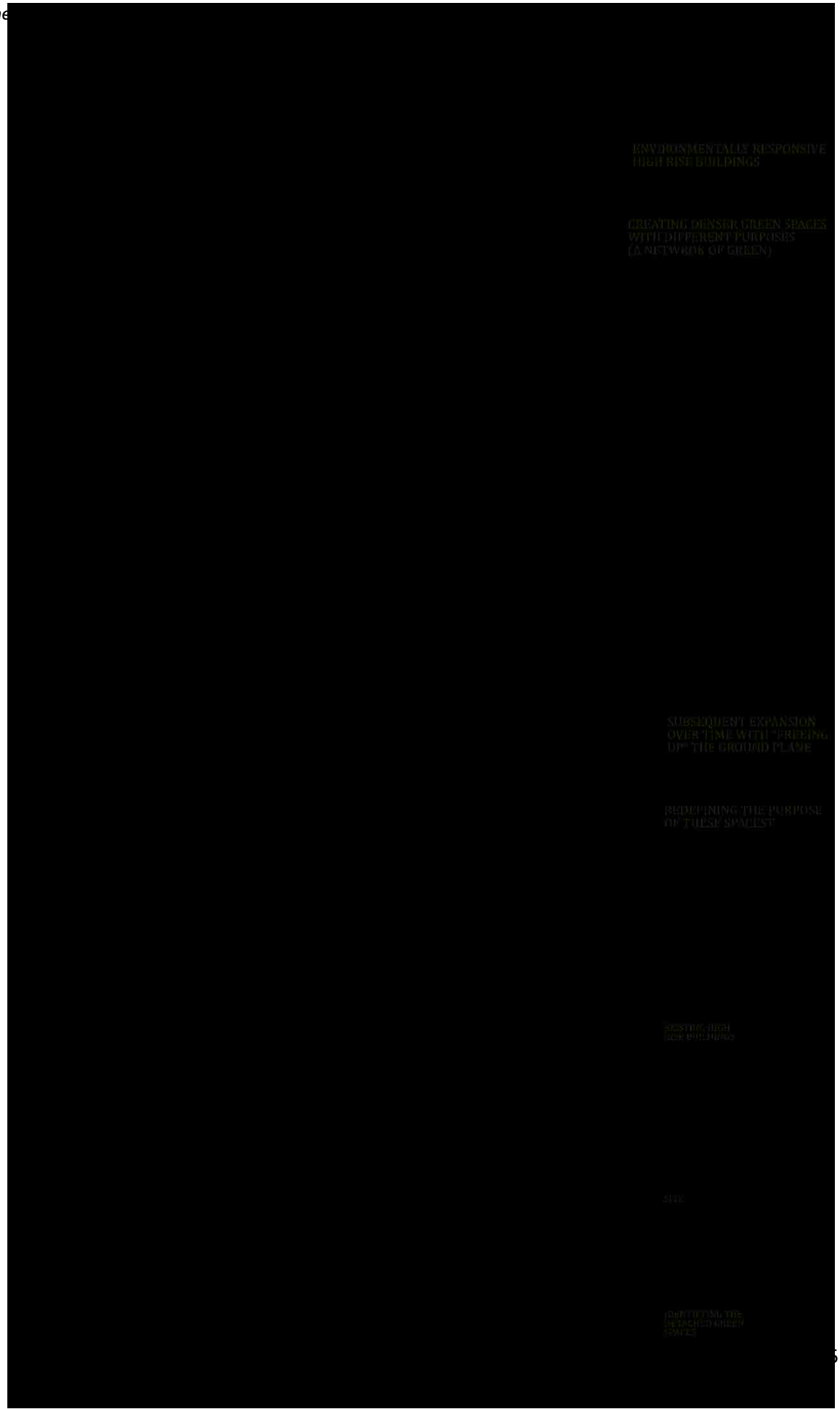
i. THE NEIGHBORHOOD

The first portion of the design process is related to the larger urban context, as this thesis is about the investigation of interpolation of building and the neighborhood. (figure 49) The goal is to connect the detached green spaces by freeing up more ground space. This creates a continuous realm of green which can then be designed as nodes, promenades, or just a tree lined walkway, which would not only reduce the amount of pollutants in the air but would also bring a sense of comfort among the bystanders. (figure 50)

Therefore, the overarching idea is to take and then give back- take the built spaces, and then to give them back as little lungs, breathing spaces for the dwellers, expand them over time whilst simultaneously creating environmentally responsive taller buildings, freeing up more ground space and inspiring vertical neighborhood living.

Fig 49: linking green spaces and making them accessible to the public

Fig 50: the


ENVIRONMENTALLY RESPONSIVE HIGH RISE BUILDINGS
CREATING DENSER GREEN SPACES WITH DIFFERENT PURPOSES (A NETWORK OF GREEN)
SUBSEQUENT EXPANSION OVER TIME WITH "FREEING UP" THE GROUND PLANE
REDEFINING THE PURPOSE OF THESE SPACES?
RESTORING HIGH RISE BUILDINGS
AHE
CONNECTING THE DETACHED GREEN SPACES

a. NEIGHBORHOOD BACKGROUND STUDY

To get an idea of the fabric of the neighborhood, some context analysis was done:

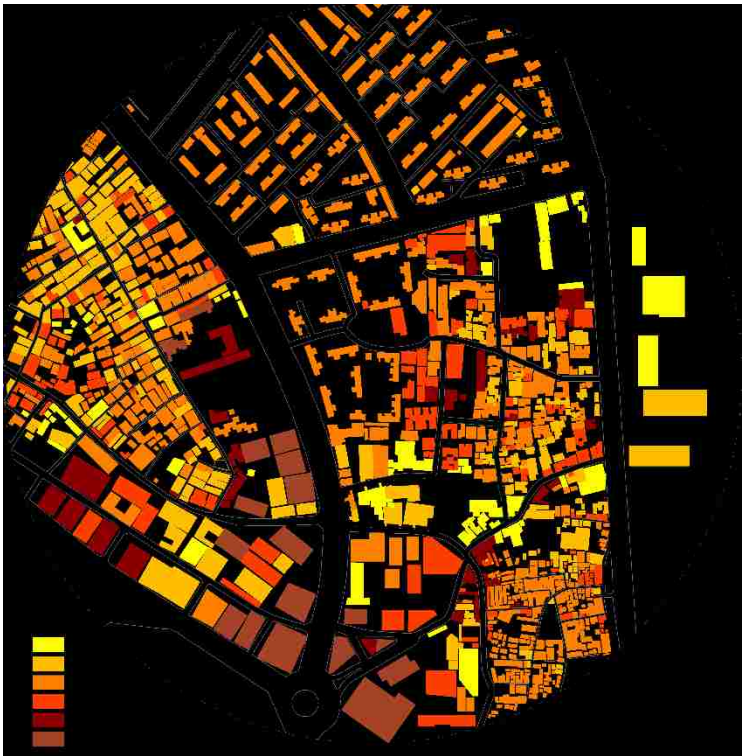


Fig 51: building story

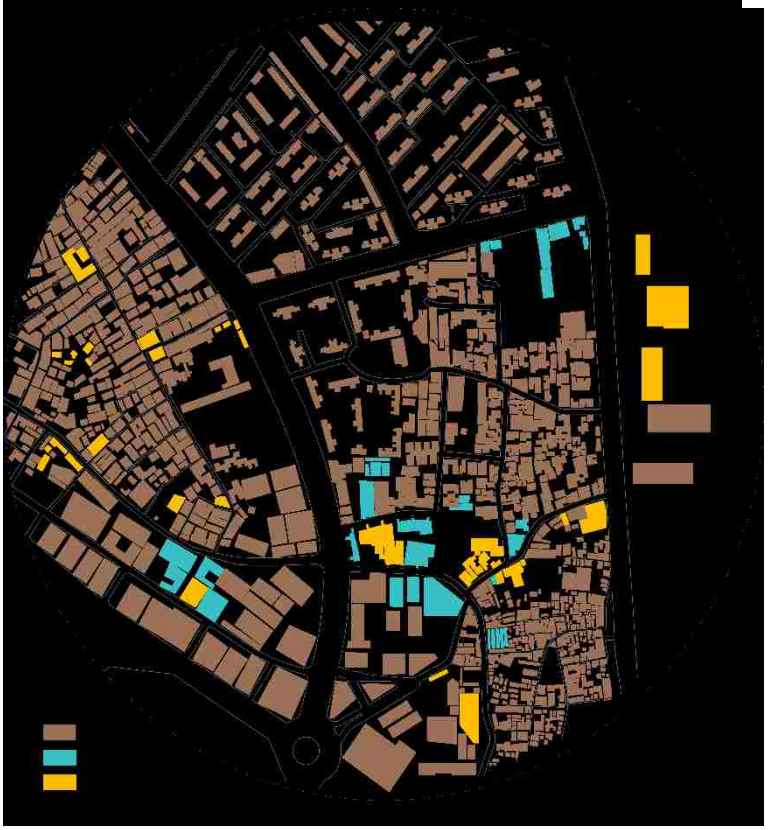


Fig 52: building condition

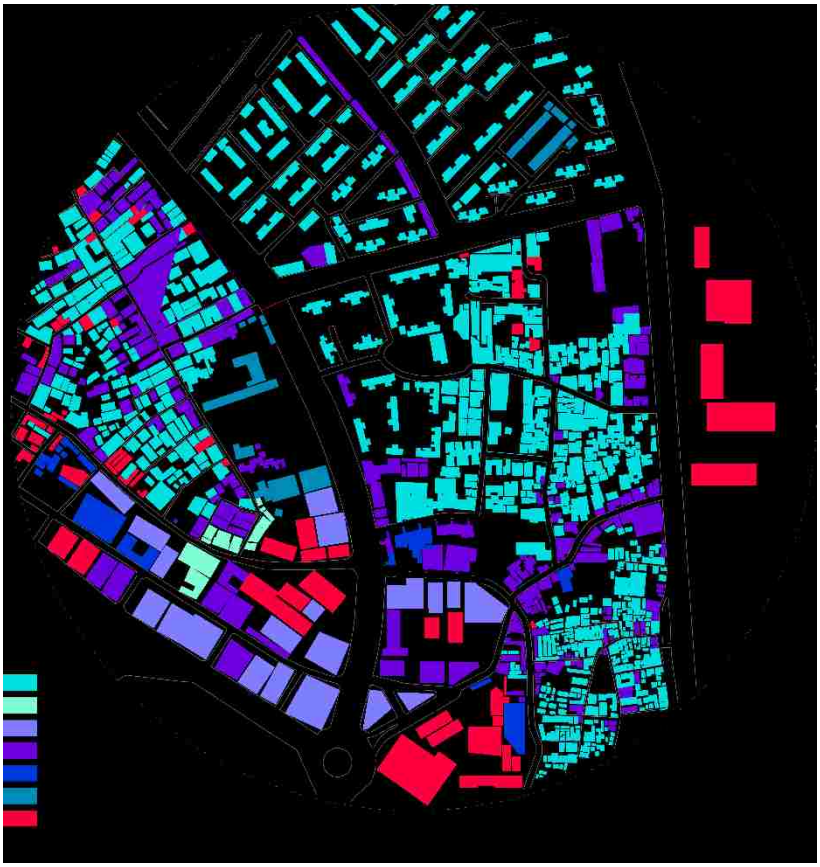


Fig 53: building function

Fig 54: traffic pattern

Fig 55: types of green spaces

b. FINDINGS: THE LATTICE

The previous studies yielded into the assumption that the neighborhood is primarily consisted of 6 story buildings, as well as some buildings that are in alarming condition. Some buildings encroach on the continuous green paths; therefore, it would be helpful to replace those buildings with green spaces. Those structures would then be built as levels/ living accommodations in the high-rise building. (figure 56-figure 62)

1

Fig 56: In an attempt to make the larger open spaces accessible from the adjacent roads, a number of buildings that are in bad condition were identified. These are then replaced and rebuilt within the high-rise providing equity for the tenants of those constructions.

2

Fig 58: The now new & older open spaces are placed on the above map as guiding points for creating a continuous path that will be the network of green spaces through this particular neighborhood.

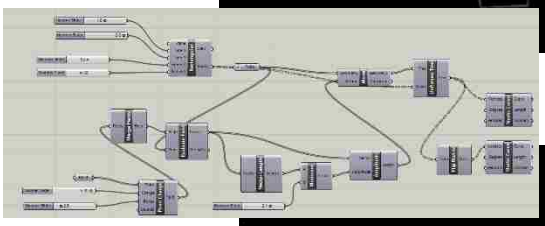
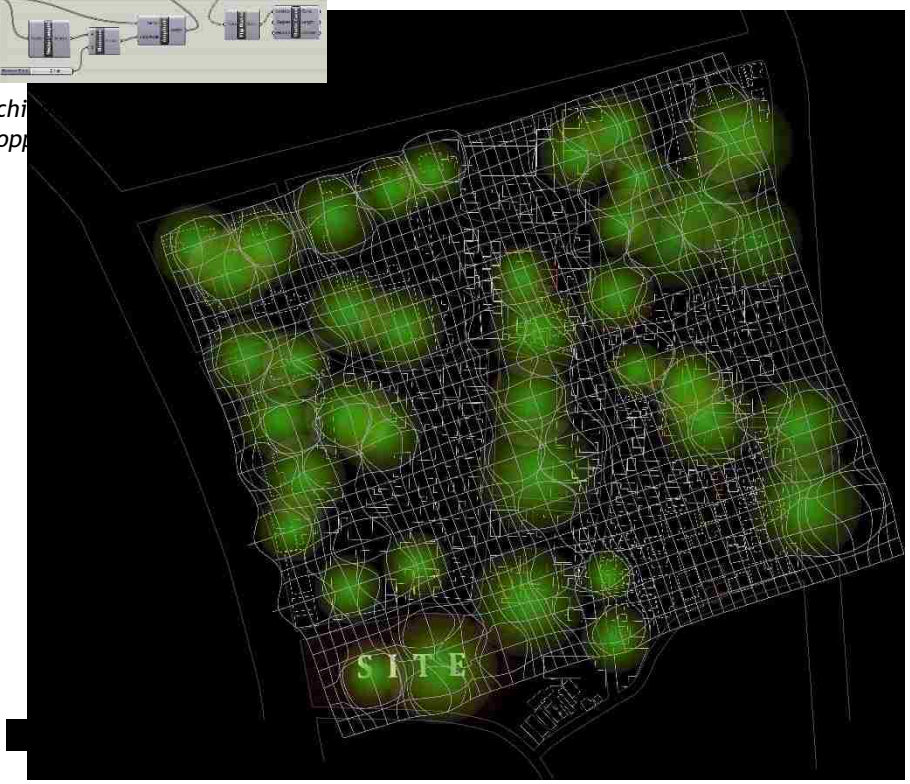
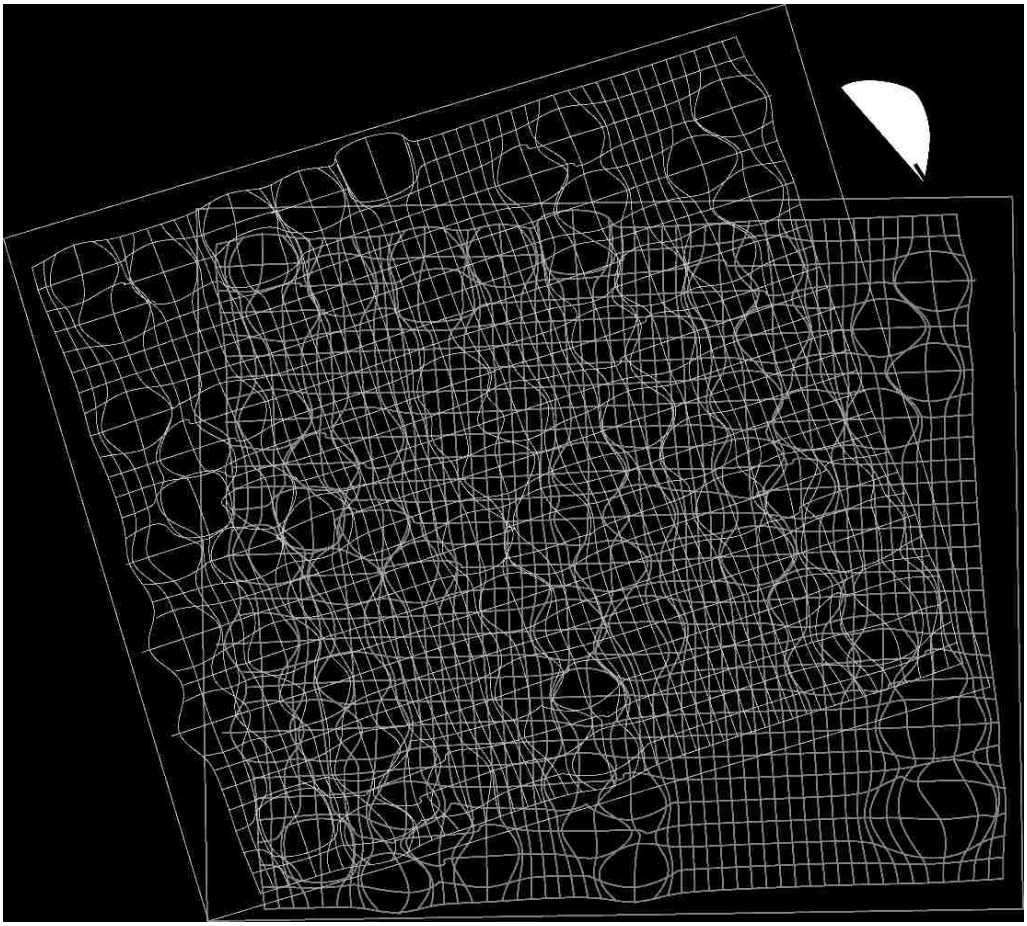


Fig 57: grid pinchi
a grid in grasshopp



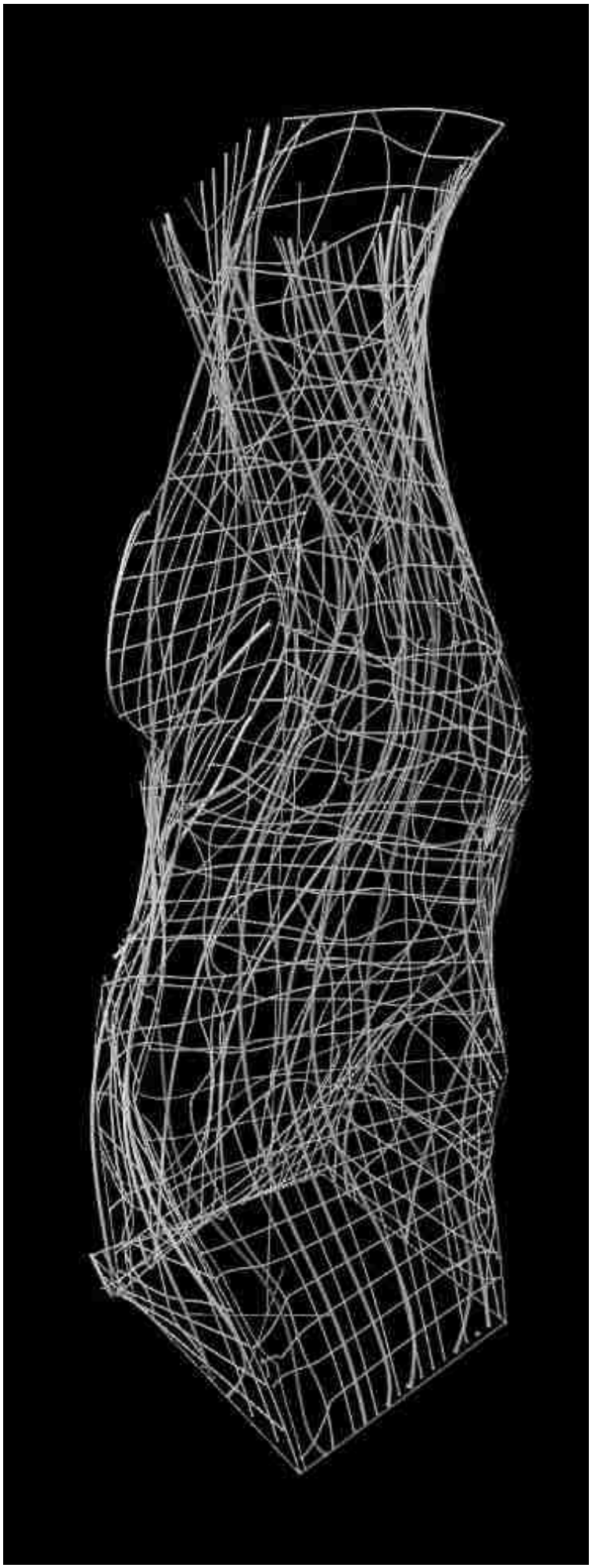
3

Fig 59: finding a logical pattern on the horizontal plane through a grid & the distortion as the places where the existing green is. This could possibly be applied in the design of the building complex so that it serves the neighborhood rather than just be an isolated



4

Fig 60: The lattice is distorted in the places where the existing & newer urban greenery is located.



5

Fig 61: Building skin, the lattice, which is a perforated mesh, scaled to the height of the building.

ii. HIGH-RISE CONCEPT

Conceptually, in terms of the greenery, the public and private spaces are connected vertically by the lattice which works as the skin of the entire building, not only giving it some structural stability but also acting as the receptacles carrying the green from one level to other, in this case from the apartment levels to the public gardens. (figure 63) the gardens change throughout the season, while purifying the air, acting as large filters for a polluted city.

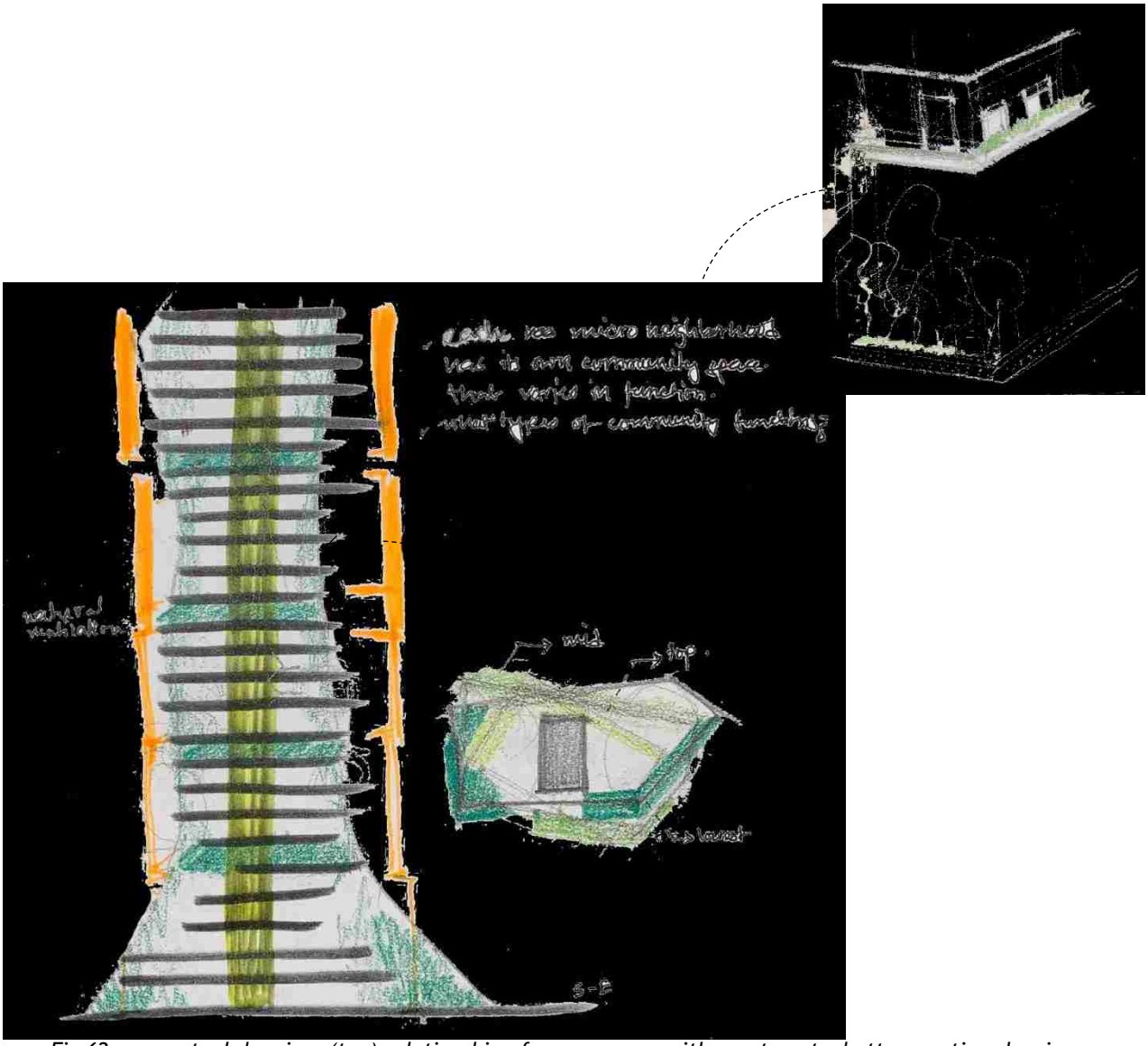


Fig 62: conceptual drawings (top) relationship of green spaces with apartments, bottom section showing public garden sandwiched between private apartment spaces,

iii. THE BUILDING:

To realize the impact of a tall building on such a site, environmental studies were done to ensure that the ground floor plane was getting sufficient sunlight (figure 65) as well as no singular surface got extreme sun exposure. (figure 64) The ground floor plan is designed according to the shadow range study results. (figure 66) Trees and appropriate landscape is done where the result shows lighter hues.

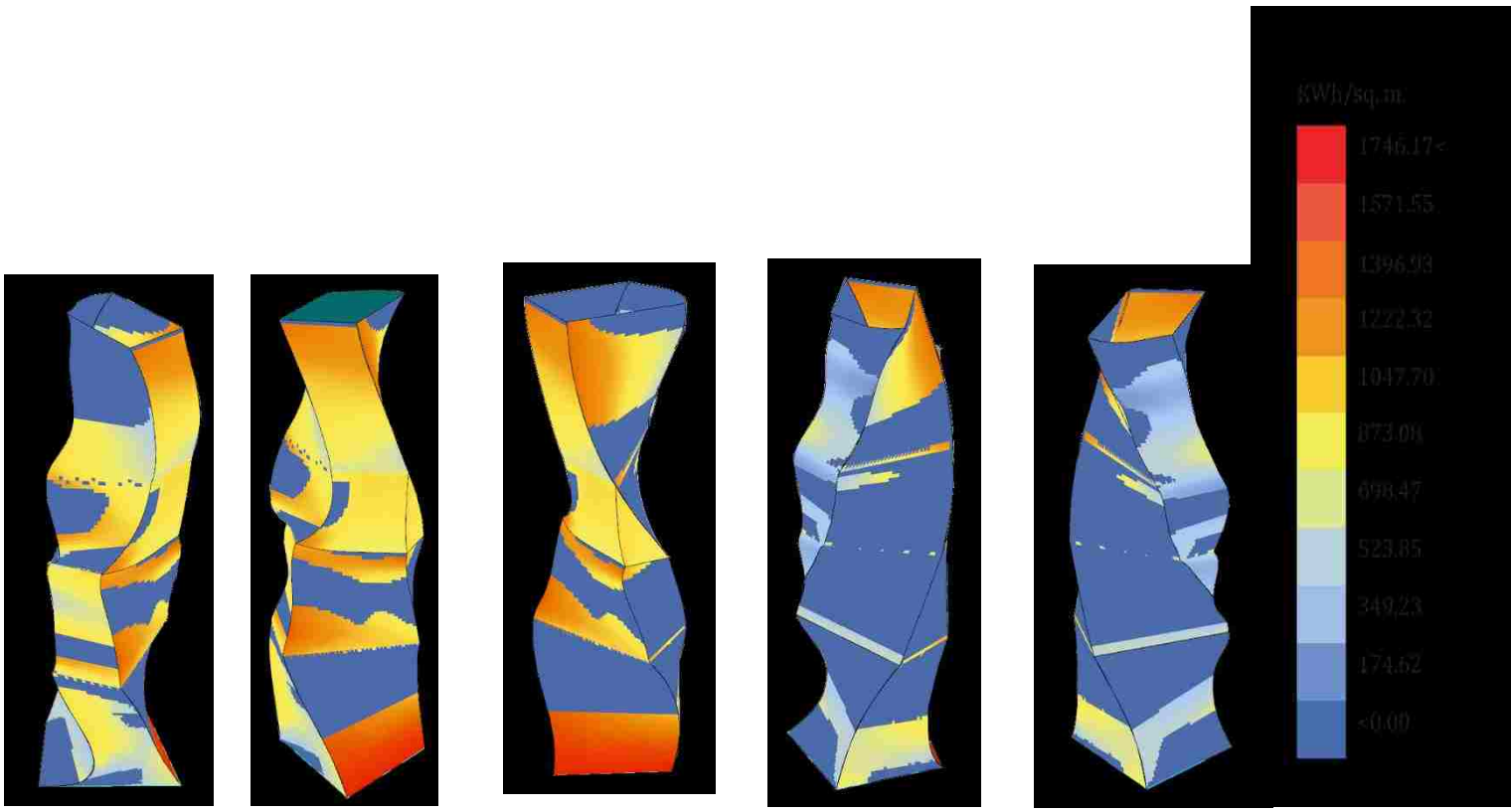


Fig 63: solar insolation study

SHADOW RANGE STUDY OF GROUND FLOOR

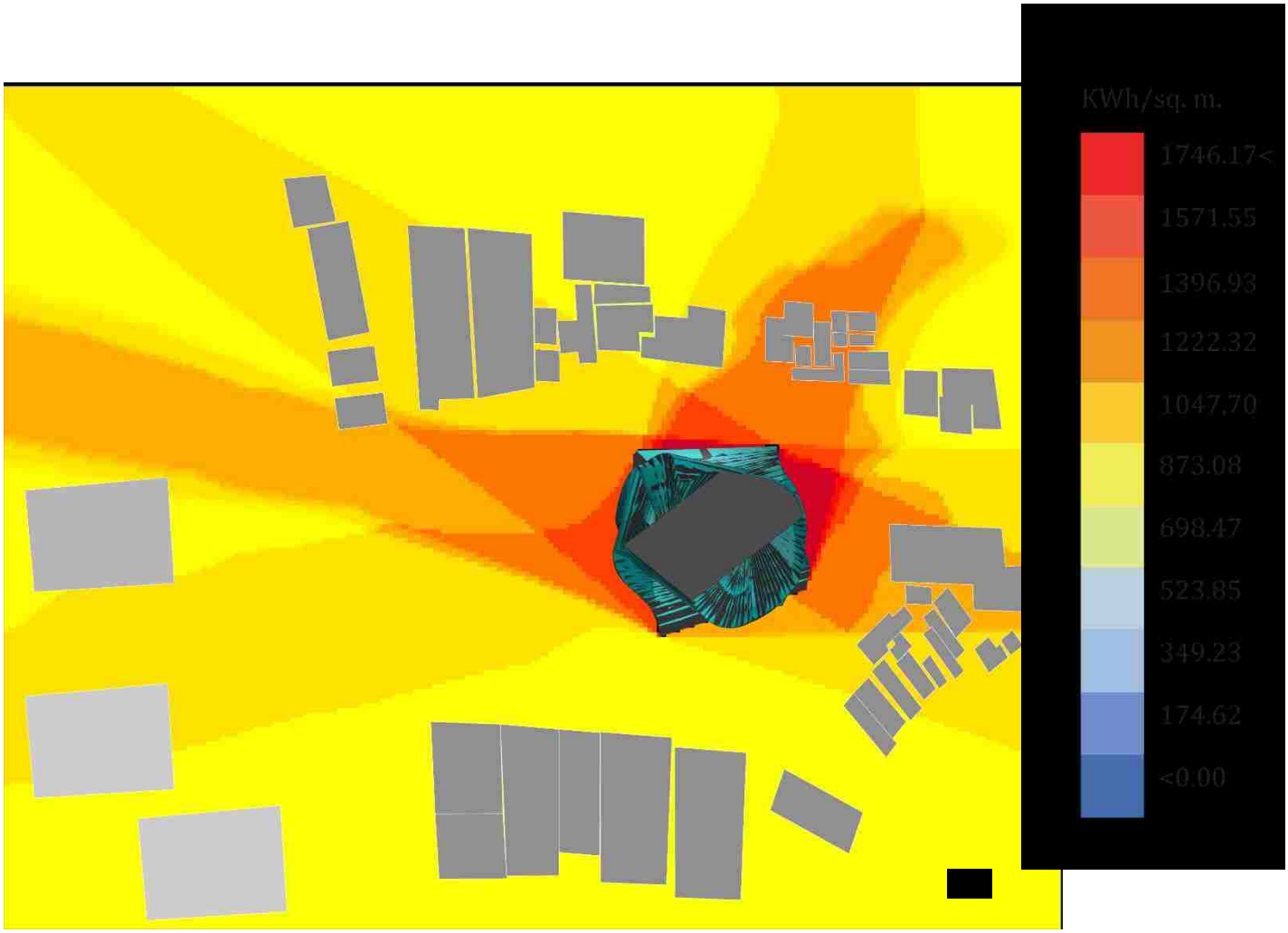


Fig 64: shadow range study for around the year solar gain on ground plane

GROUND FLOOR PLAN

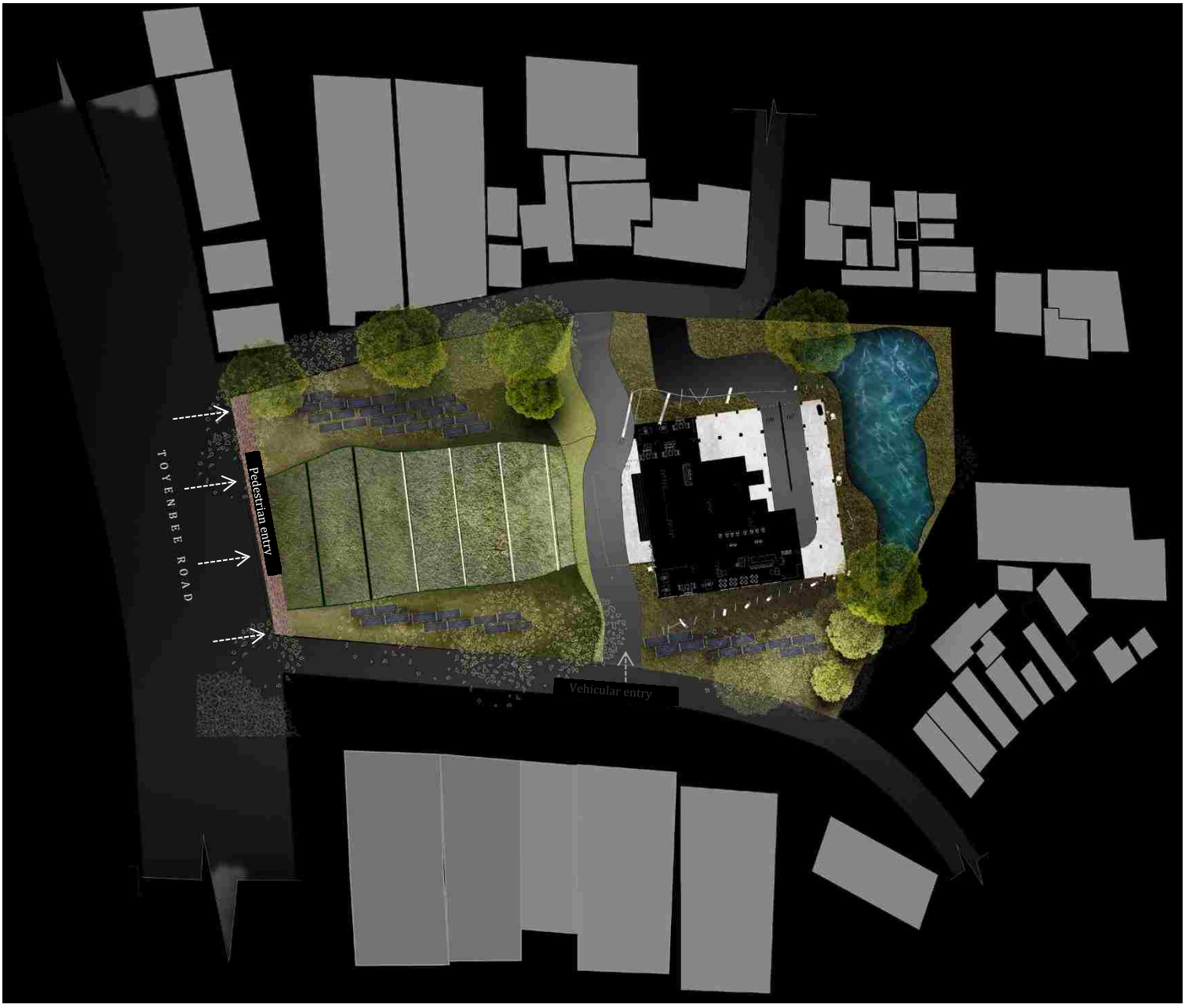
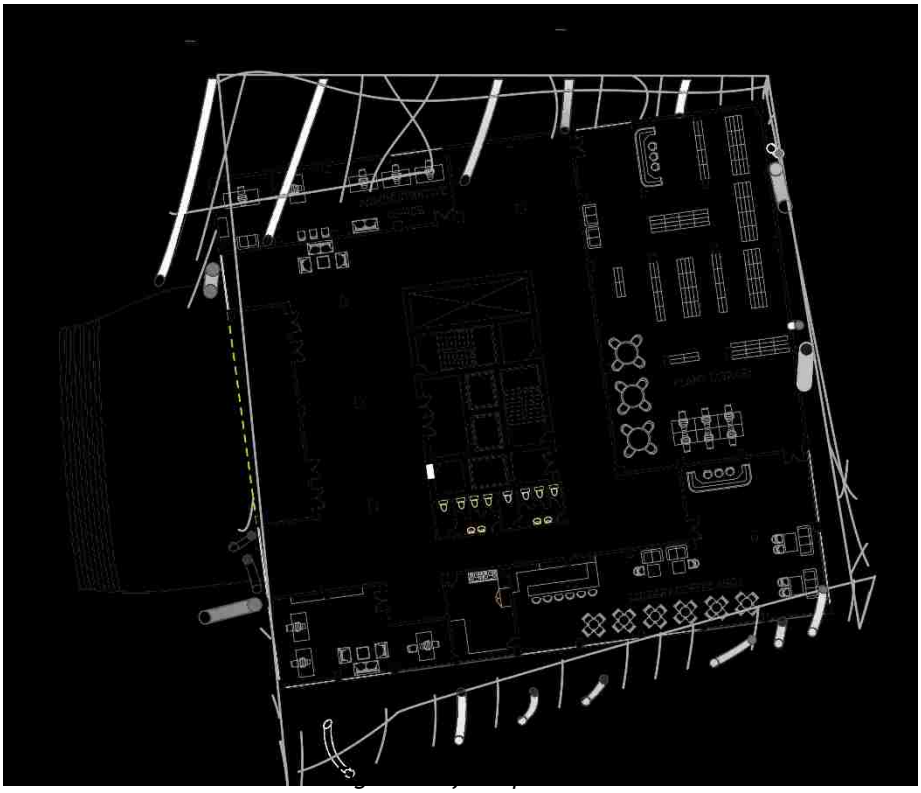


Fig 65: ground floor plan generated following the shadow range study

Fig 66: activity on ground floor on a typical weekday

Fig 67: vehicular entry

The ground plane remains active throughout the day, the ramp slowly leads up to the inside of the building on the 2nd floor level. The ground plane is meant to be flexible in functionality; the shaded canopies can be places where people relax to being hang out places with street vendors, or food trucks. On Fridays, the ground level can become a bustling farmers market, serving the surrounding neighborhoods.



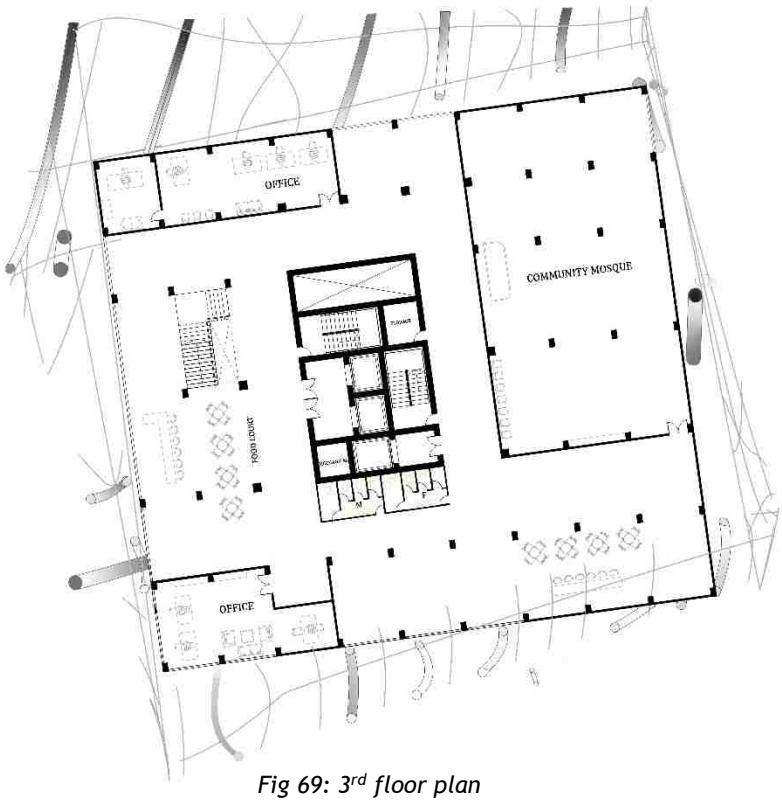


Fig 69: 3rd floor plan

The vehicular entry is tucked away behind the grass ramp, to encourage pedestrian movement along the site.

Vertical garden on level 4, is accessible to the public, housing tropical & subtropical plants in an outdoor environment. This space changes throughout the year, since plants in the tropical region vary very much through seasons. This garden could also be an exhibit of rare and almost extinct flora and fauna, which might help raise awareness among visitors.

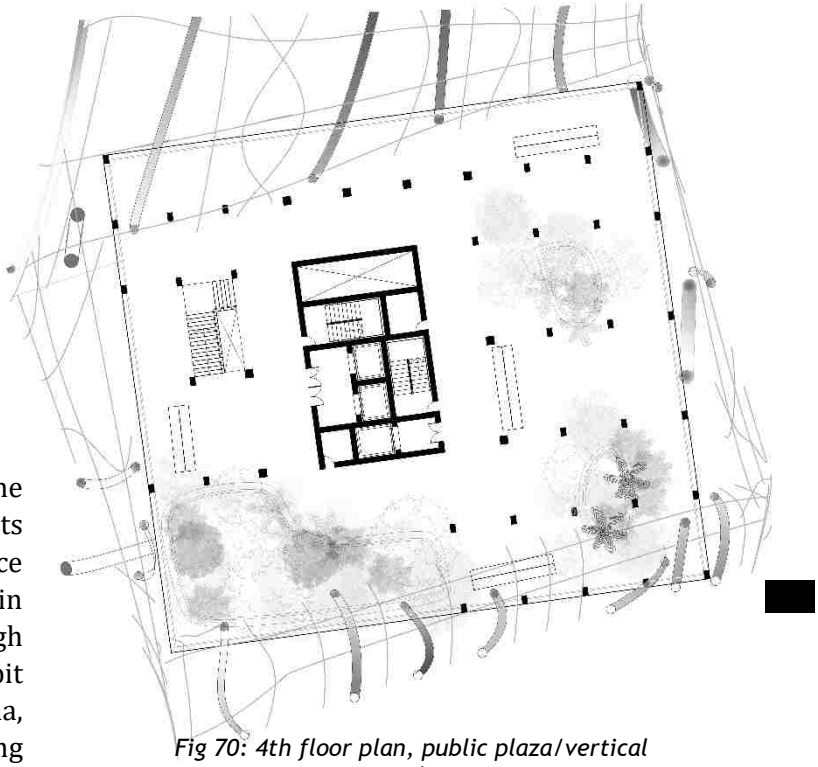


Fig 70: 4th floor plan, public plaza/vertical garden

Fig 71: public plaza/vertical garden

Similar play of nature, but on a higher level, this is on level 14; therefore, this might be a great opportunity for more varieties of plants to be showcased, again, changing through the seasons, being affected by the outside climate, just like they would out in the open.

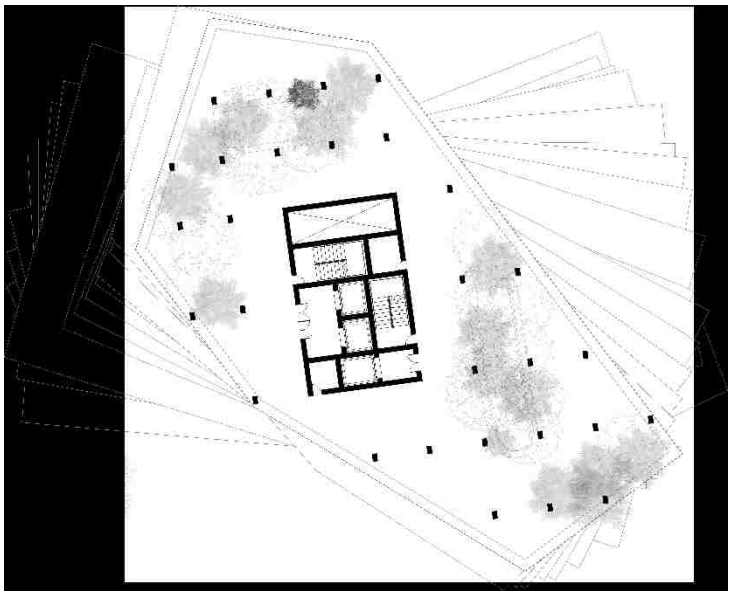


Fig 72: typical public vertical garden plan

Fig 73: public vertical garden

Fig 74: typical apartment complex plan

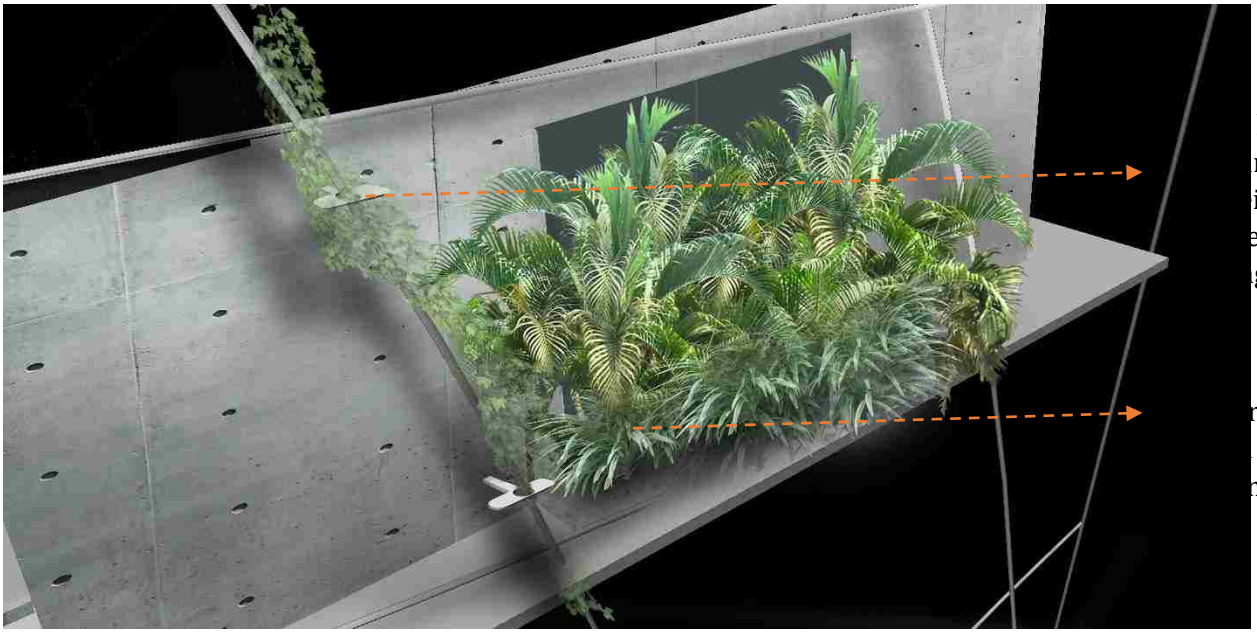


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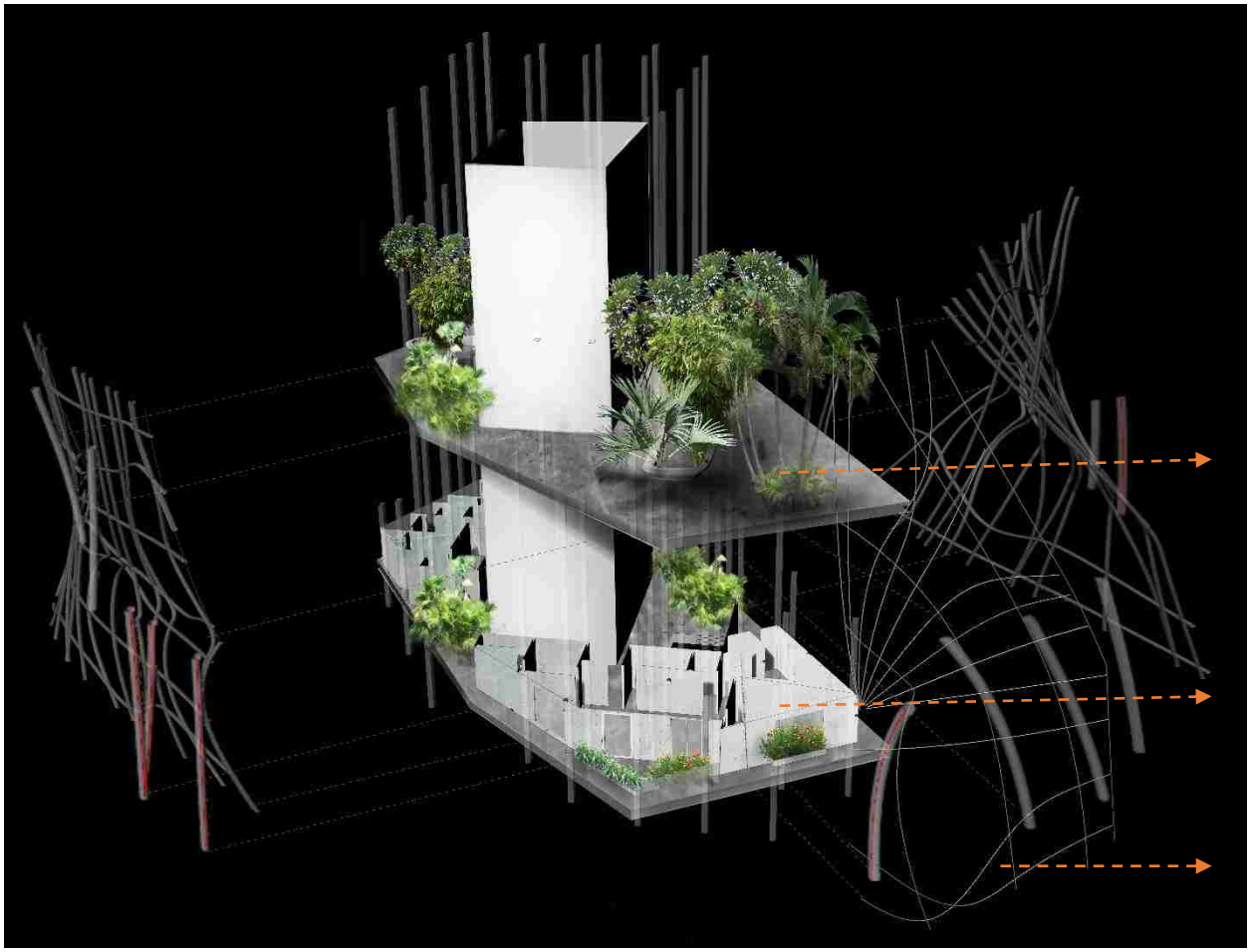
Fig 75: private apartment gardens



Public vertical garden

Apartment

lattice

Fig 77: longitudinal section through site

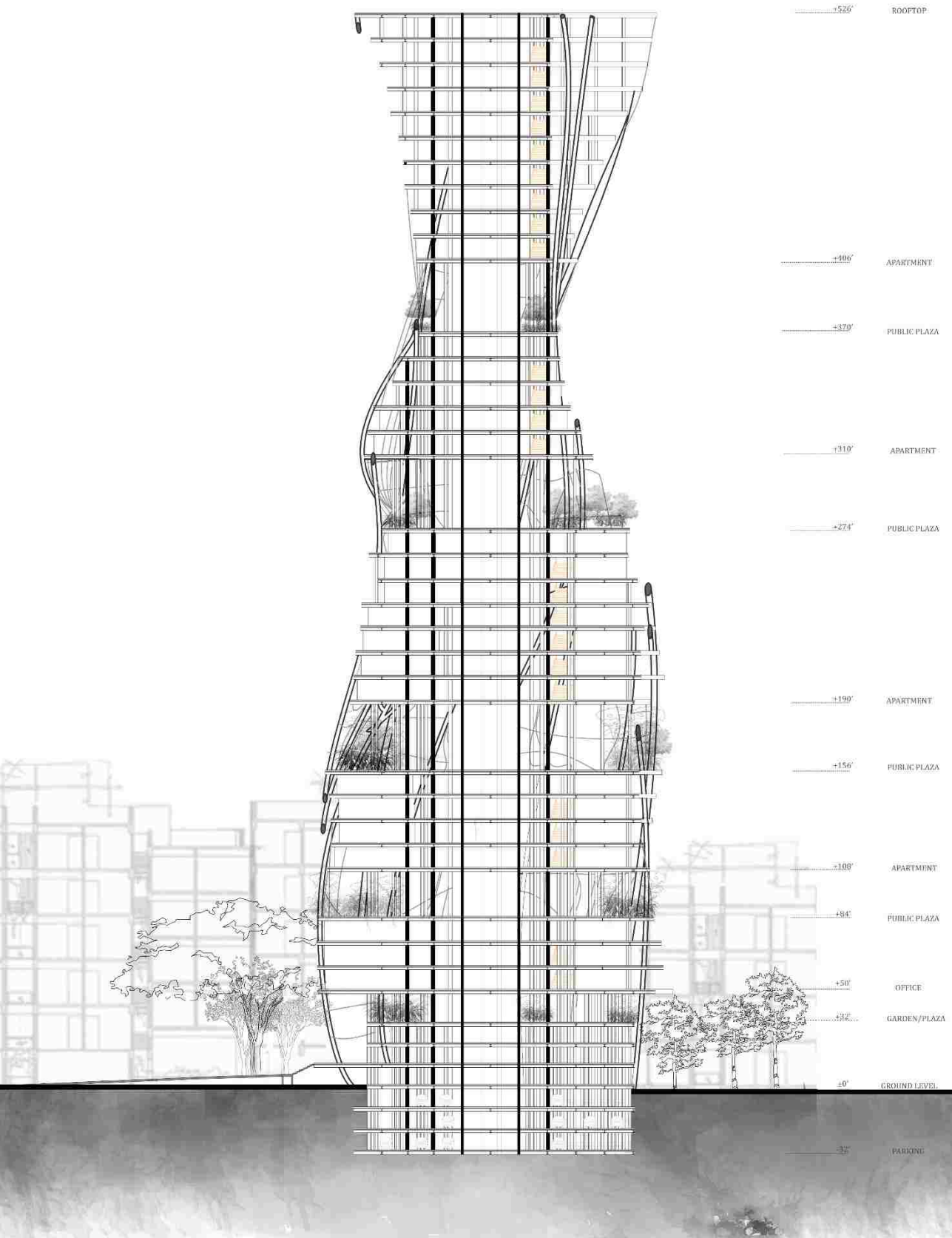


Fig 78: view during sunset

Fig 79: future image where other neighborhoods are applying the same strategy

CHAPTER 5: CONCLUSION

Due to the economic growth, Bangladesh is moving at a rapid pace, changing the way people think and act with development. Dhaka, being the confluence and the most important socio-economic hub within this scenario, has the potential for accommodating a new idea for making drastic changes in the dwellers' day to day lives. Dhaka city is suffering from lack of breathing spaces, a vertical garden intertwined with living spaces gives the perfect opportunity for not only the tenants, but also people from all over the city to come and rekindle the relationship with nature. This project has the potential of being applied in different scenarios with similar environmental constraints. Not only does it break away from the traditional ideas of a high-rise buildings, it also challenges the entire idea of a massive

structure and its purpose in a complex urban fabric. The push for creating unconditioned spaces in such high elevation gives the opportunity of facing away from mechanical jargon. Also, this gives the people living and visiting this complex to take ownership for sustaining a delicate yet healthy and stable environment. The small pockets of gardens that change throughout the year on the building provide benefits for cleaner, purified air, taking care of the indoor environment, creating different kinds of microclimates pertaining to the biodiversity and the ecology of that small region. The plants help keep the pollutants at a low level, while providing people with an oasis in a city that is losing touch with nature. Zooming out, this large edifice actually becomes a part of the neighborhood, as it rises from the blueprint of the surrounding neighborhood. This helps free up the ground level, giving way to a more walkable, thus more tolerable and livable city. With time, the network of green, if established, would help change the definition of active public spaces as those spaces then can inspire the people living in the city to be more responsible about the nature. This entire scheme, will hopefully pave the way to a truly sustainable Dhaka city, one where the streets would be lined with tropical trees, and help save the future of Dhaka.

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LIST OF FIGURES

UNLESS OTHERWISE MENTIONED, ALL IMAGES ARE BY THE AUTHOR

LIST OF FIGURES (CONTINUED)

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LIST OF FIGURES (CONTINUED)

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