

# Chapter 5

## The Increasing Demand on High-Rise Buildings and Their History

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### 1 Introduction

Large-scale urban centres have entered the twenty-first century with a paradox to discuss. As the cities touch the skies with their growing skyscrapers, they also reach out to attract and embrace as many people as possible. Aiming to become an important financial, commercial, cultural, technological, or touristic place, and therefore attract investments, they need to grow. The more the cities grow, more people are needed to make it grow. With more people, more infrastructures are necessary. In this on-going trend, tall buildings appear both as protagonists and antagonists.

On the positive side, tall buildings may claim to be environmentally friendly in the process of urban densification, as they take up minimum space (on the urban plan), help mobility due to proximity to public transportation, and maximise the potential use of building installations. On the other hand, they also raise suspicion because of characteristics such as deep plan, lack of natural ventilation, urban shadows, sealed glass facades, solar reflection, and glare. In addition, arguably the biggest dispute is overcoming the perception of being vanity icons, driven by power and greed—into a more humane view, based on sustainable habitats. Shifting values is indeed the essence and core of the urban agenda of this new millennium.

Tall buildings traditionally resonate with domination, individualism, self-centredness, and egocentricity. That is *passé*, *démodé*, and *cliché*. This new era is not one of looking solely within, but soulfully outwards. The ultimate challenge of tall buildings is one of collaboration. It's a symbiotic relationship, one of integrating the

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natural environment with the built environment in the most thoughtful and responsible manner. A genuine sustainable agenda.

## 2 Sustainability

Due to the fast deterioration of quality of life, seen in a massive scale in the slums and favelas all over the developing world, man is in a desperate quest to revert this degrading path. Like most of the issues in modern society, architecture too seems to have been stricken by the influence of the ‘globalization’ process, where local cultural identity gives way to the language of ignorance and law of the strongest. Importing the architectural ideas and concepts of foreign countries, whose geography, environment, and climate are totally different from that of origin, has led to improper, often catastrophic, architectural solutions and typologies, especially in developing countries. Furthermore, any interesting lessons of what were once the most sensible ways of building, according to culture and climate, are still being ignored and forgotten.

When money and resources are abundant, how, where, and when one builds is frequently overlooked. It is important, not to say essential, that one makes the most benefit of its living environment, in an intelligent and sustainable manner. The appropriateness of one solution for one community is not necessarily appropriate for another. There are a variety of problems in big urban centres; therefore, there should be a variety of solutions. Ideas should be abundant and appropriate to each context, and knowledge never ignored, always feeding back to past experiences and ancestors. Consequently cultural values, tradition, and historic memory, all that makes people and cities diverse, interesting, and unique, will be preserved.

As we move through a new century and a new millennium with an absurd increase in population, increase in hunger, and more astonishingly an increase in social differences, sustainable development is no longer an option but a requirement. It should no longer be theoretical, but practical. In the 1987 United Nations Conference entitled ‘Our Common Future’, it was defined that “Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” Architecture plays a major role in making this development possible.

The urban centres are one of the most important works produced by humanity, and undoubtedly the one that has caused most environmental damage. Deforestation, heat island effect, and climatic changes are examples that blame the rapid growth of the industrialised city. The exaggerated use of natural resources and energy has also been a major concern. In most big cities, around one third (33 %) of the final consumption is related to the buildings.

Sustainability in developing countries, which hold 75 % of the world’s population, is a bigger challenge. They have only “17 % of the world’s gross national product, 5 % of science and technology, 15 % of energy consumption, 30 % of the

food grains, 11 % of the education spending, and 6 % of the health expenditure” (Rice and Rasmusson 1992).

According to last Revision of the official United Nations population estimates and projections about 54 % of the world’s population currently lives in urban areas, and this proportion is expected to increase to 66 % by 2050. Projections also show that urbanization combined with the overall growth of the world’s population could add another 2.5 billion people to urban populations by 2050, a total of 9.8 billion people, with close to 90 % of the increase concentrated in Asia and Africa.

In 1990, there were ten ‘mega-cities’ with ten million inhabitants or more, which were home to 153 million people, or slightly less than 7 % of the global urban population at that time. This has increased to 28 mega-cities worldwide in 2014, home to 453 million people or about 12 % of the world’s urban dwellers. Of these 28 mega-cities, 16 are located in Asia, 4 in Latin America, 3 in Africa and Europe, and 2 in Northern America. By 2030, the world is projected to have 41 mega-cities with ten million inhabitants or more.

The first thing to be aware is that natural resources are limited, especially in a world of fast increasing population. Manmade fuels and electricity are costly, inaccessible to poorer nations. Energy systems cannot cope with the exaggerated demands. The more we use today, the less future generations can also rely on them. This opposes any logical idea of sustainability. Generally, design is not taught in most places in the context of its social and ecological impact. Mackenzie (1991) in his approach to green design suggests the approach of “eco-efficiency, which means the delivery of the maximum benefit to the user, with the minimum use of resources and the least possible environment damage.”

There is today a vast body of knowledge on how to design buildings, including skyscrapers, in a sustainable and affordable way, through the use of bioclimatic, low energy strategies. There are even (a few) examples of low-energy (more sustainable) skyscrapers that could be followed, such as Norman Foster’s Commerzbank building in Frankfurt, Ken Yeang’s Bioclimatic skyscrapers, or, on a smaller scale, the more recent wooden London’s Stadthaus, the Forte Building in Melbourne, or Michael Greene’s ‘Plyscrapper’ in Vancouver. Unfortunately, this knowledge is not being put to practice, being replaced by ‘status’ driven typologies—deep plan buildings, with all-glazed facades, which are highly energy consuming and naturally damaging to the environment. For example, about one-sixth of all electricity generated in the United States is used for air conditioning in buildings—as a result of poor design and unrealistic comfort standards. That is about 40 billion dollars (Fig. 5.1).

### 3 Brief Historical Overview of Tall Buildings

In different periods of the history of architecture, man has incessantly challenged heights in construction, being limited only by its technological capacity. Naturally, what could be called as a tall building has changed dramatically over the years. Verticality has always been a symbol of superiority and power. In medieval times, San



**Fig. 5.1** A ‘glass tower’, recently built in Cascais, Portugal. Unfortunately, Glass Architecture is today fashionable, symbolizing economic status. It leads to excessive energy consumption (e.g., due to air conditioning), poor comfort levels, and damage to the environment. It is in flagrant contradiction with a truly sustainable design practice

Gimignano in Italy was considered the Manhattan of its era. Cathedrals lashed up in the sky during the Gothic age in a symbolic attempt to bridge the mundane life on earth with heaven. The vast interiors reminded the religious community of their smallness in relation to the Almighty, and at the same time imposed respect towards the Holy.

Literature has it that the term ‘skyscraper’ was used to classify tall buildings by the end of the nineteenth century, and beginning of the twentieth. In modern times, it is widely accepted that in the 1920s and 1930s the tall building typology was already an architectural force. The United States is considered the birthplace of high-rise buildings in our contemporary society. The American cities of New York and Chicago began competing for the world’s tallest building. Buildings in Chicago like the Tribune Tower (1925) at 141 m were promptly beaten by buildings in New York such as the Chrysler Building (1930) at 319 m and the Empire State Building (1932) at 381 m high. Engineering seemed to have no constraints, and technology was pushed to its limits. “This was a period of fascination with the tall building, its iconic forces and its dazzling views from unimaginable heights. Buildings of that time are still recognized today as some of the most spectacular and grandiose worldwide—the Empire State Building representing one of the last

models of the art-nouveau and art-deco periods, the so-called ‘golden age of the skyscrapers’” (Gonçalves 2010).

In Europe, leading the modernist concept of ‘form follows function’ and ‘less is more’, Mies Van der Rohe proposed ‘glass’ skyscrapers for Berlin, responding to the need for modern office buildings. Another building designed by Mies and Philip Johnson in 1958, the Seagram Building in New York City, became an icon of the International Style. The Seagram Building is a clear expression of functionality in line with construction rationalization in tall buildings, making it lighter and cheaper than any other at the time. During the same period, Walter Gropius also contributed with innovations, proposing designs for the first residential buildings in the European continent. Le Corbusier was another modernist involved in new aspirations for tall buildings, proposing in 1923 the idea of the City of Towers, where he idealises the future city dependant on high-rise buildings, housing 4000 people each. Other utopian designs appeared around that time. Russians had some proposals, but probably the most far-fetched example came from Frank Lloyd Wright in 1956, with his 1600 m high design for a building in Illinois.

It is interesting to notice that although air conditioning already existed by then, the buildings from the first half of the twentieth century relied on natural ventilation for cooling. Its internal environment was dependent on its relation to the external environment. Therefore the benefits of daylight, passive cooling, and acoustic comfort were based on the interaction of the building design and its fabric with the exterior.

The post-war period saw the spreading of the International Style, where tall buildings increased the size of their (deep) plans, leading to the excessive use of artificial lighting and air conditioning. The extensive repetition and banalisation of the design guidelines from the International Style in the United States and elsewhere resulted in a building model of poor contextual relationships with urban culture, climate, and urban design. This was a rupture of designing with the climate, and the beginning of a vicious cycle of buildings was totally dependent on artificial energy sources for lighting and cooling.

During the 1960s and 1970s, the industrial business in the United States was booming, which led to another race for the world’s tallest building. This was a statement of power and wealth. One of the two main buildings, which resulted from this period, was the World Trade Centre in New York in 1972, with 417 m, and which was eventually destroyed in a terrorist attack on September 11th 2001. The other iconic building of this period is the Sears Tower, built in 1973, 442 m high.

Soon after, in 1973, there was an economic turnaround and a world energetic problem with the oil crisis that halted the skyscraper race. For the first time, people’s attention was directed to the fragility of our natural resources and our deep need of its preservation. The rational use of fossil fuels and the environmental quality in spaces in tall buildings were beginning to be discussed. The profound dependency on air conditioning also brought an increase in health problems, and awareness of the sick building syndrome (SBS), caused by its poor air quality. Consequently, the 1980s saw the first moves to a more environmentally friendly design for tall buildings, and the publication of the Brundtland Report (1987), addressing the issues and

concepts of sustainability. This report was eventually followed by a green agenda, officially known as Agenda 21, resulting from the UN summit in Rio, in 1992.

The 1990s saw a spread of the phenomenon of globalization and the economic pressures resulting from it. New financial centres were booming around the planet, especially in big urban cities of developing countries like Taipei, Singapore, Shanghai, Beijing, and Dubai. This led to a great demand for office and commercial buildings, rapidly transforming the urban grid of already densified cities. The capitalist transformation and consequent economic development forced a vertical building boom in places of Southeast Asia and the Middle East. The most representative building of this period is the Petronas Tower, built in the capital city of Malaysia, Kuala Lumpur, in 1997. Its 452 m beat the Sears Tower as the tallest building on the planet, until then.

In a different direction, tall buildings in Europe were being discussed in the light of environmental awareness. High-rise buildings with sustainable concepts were appearing, such as Norman Foster's headquarters of the Commerzbank in Frankfurt in 1998. Its design included passive strategies for cooling, daylighting, and heating. Sky gardens and a central atrium were also incorporated. It is said that for over 80 % of the year the building is naturally ventilated. The Commerzbank is acknowledged as the first and one of the most important environmental tall buildings in Europe. The recognition of the importance of sustainability and environmentally responsible buildings led to the introduction of rating systems such as BREEAM, which assesses how 'green' is a building.

Since the late 1990s and throughout this young twenty-first century, there has been another, yet much greater, race for the world's tallest building. Countries like Dubai and Abu Dhabi have with incredible speed completely transformed their natural environment into a sea of tall glass buildings, totally disconnected to their climate and completely unaware of their energetic cost and environmental damage. This trend is not stopping so soon, as there is a new 'generation' of buildings planned, and others already being built, over the next decade.

There is no doubt that tall buildings play a significant role in today's society. It expresses wealth, power, status, economic capacity, and technological accomplishment. Nevertheless, concerns regarding environmental performance, public welfare, and sustainable development are not a choice anymore, but a necessity.

## **4 Greenery and High-Rise Buildings**

Recently, there has been a spate of interest in how to combine the stressing demands of modern life and society with a healthy natural environment. Applied researchers have become increasingly interested in how to benefit the most out of natural elements and resources such as sun, wind, and vegetation. The possibility that man can benefit from natural cooling and evapotranspiration from vegetation instead of artificial air conditioning, humidifiers, or any other energy-consuming device has generated interest in the development of passive cooling environments.

Two negative aspects of great urban societies are the overheating of a city, a process commonly known as the heat island effect, and pollution. The main reasons for these major threats are firstly the highly successful economic strategy of the wealthiest nations, backed as it is by technological innovation. Secondly is the accelerated rate in which the world's population is growing. The bigger the city, the bigger these problems are. Vegetation in its various forms has been said and known as being able to diminish these negative aspects. Greenery has long been known for its cooling effects and improving unfavourable microclimatic conditions around buildings, and consequently ameliorating the quality of life of its users.

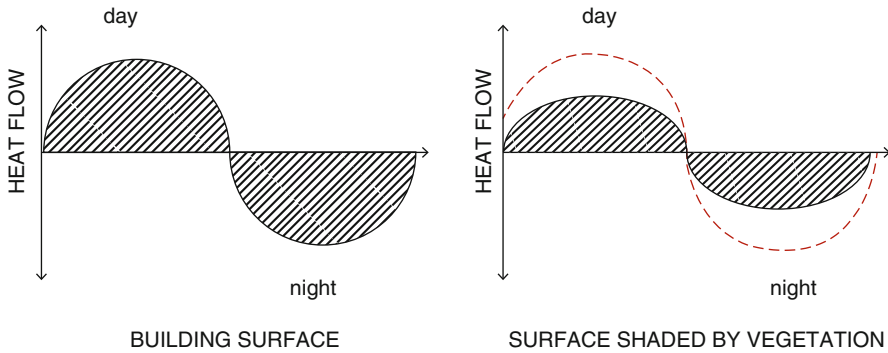
To create comfortable indoor and outdoor living environments, or to reduce cooling loads, solar control is the most basic construction method of building in the low latitudes. Nevertheless, "it is widely admitted that plants around buildings alter the adverse microclimates and make the thermal environment more pleasant and liveable. Planting for solar control or wind protection is a good practical example" (Hoyano 1988).

Nevertheless, architecture is the form of art with most impact on people and their perceptions. "Architecture reflects, materializes and eternalizes ideas and images of ideal life. Buildings and towns enable us to structure, understand and remember the shapeless flow of reality and, ultimately, to recognise and remember who we are" (Pallasmaa 1996). Our living environment "strengthens the existential experience, one's sense of being in the world, essentially giving rise to a strengthened experience of self" (Pallasmaa 1996). The closer we bring nature to our habitats, the better use we can make of it, gaining in physiological and psychological aspects.

Trees and landscape are not only scenery, but linked with physical, biological, and cultural features. They include the entire community of all living and lifeless things, and depend on the relationships and forces of both the biotic and abiotic world. Man being an inseparable part of this system is in a position to modify it, to exclude, introduce, or change natural and unnatural elements in his surroundings. The quality of interference will define the extension and quality of sustainability.

To minimize the impact of external factors, especially wind, high-rise buildings are mostly built with sealed facades, neglecting any possibility of cooling through natural ventilation. The relentless use of central and mechanical air conditioning leads to an excessive and even unnecessary use of energy. Sometimes, a natural and comfortable external temperature of 26 °C is transformed into an unpleasant 18 °C due to air conditioning. Bigger problems such as overloading energy peaks and sick building syndrome come into question. "A vicious circle is created because waste heat from air-conditioning units to cool buildings dries up the city temperature which then requires larger cooling load for the buildings" (Takakura et al. 2000). Sick building syndrome is manifested as diffuse reactions to airborne compounds, aerosols, and other particulates, commonly found in poorly maintained air conditioners. Some reactions can be itchy eyes, dry mucous membranes, abnormal fatigue, headache, or other psychosomatic reactions (Ryd 1991).

Direct solar radiation impacting on walls and windows is the primary source of heat gain, but two other factors are also important: heat from ambient air, and



**Fig. 5.2** Effects of vegetation on a surface (after Oke 1990)

indirect, long wave radiation from the immediate surroundings. All three of these factors can be moderated by vegetation growing close to a building's surface. The greenery works like a second skin to roofs and walls, acting as insulation. Figure 5.2 describes the effect.

Rooftops with vegetation can also decrease the heat flux through the rooftop slab. In urbanized areas during the summer, the vegetation system can be successfully applied to reduce the thermal load on buildings and to moderate hotter and drier climates. Studies by Harazono et al. (1990) indicate that the absolute humidity in the surrounding air increased and the air temperature in the room below decreased with the rooftop vegetation in summer. Investigations show that changes in plant activities cause seasonal variations in the effects of vegetation. During the summer for example, the transpiration of plants is more vigorous and plants and deciduous trees have leaves, which interrupt solar radiation and then shade building surfaces. Harazono states: "If we were able to grow plants and trees on unused surfaces without the need for any additional reinforcement, for example, rooftops or other open spaces, then we could obtain a more beautiful neighbourhood, a moderate microclimate, and a decrement in the thermal load on the air-conditioning of buildings."

Vegetation also interferes directly with air quality. The pollutants can be diluted or transformed into harmless substance before reaching their targets, which can be plant, animal, human being, or inanimate structure. Vegetation can act as an effective sink for airborne pollutants. They may intercept or absorb pollutants, which are then combined with plant tissue and are effectively removed from their pathway. Carbon dioxide is an essential part of the food making process of plants, photosynthesis. They absorb this pollution and it is then assimilated as carbon within the vegetation, with the by-product oxygen released into the atmosphere. Carbon dioxide is absorbed by the leaf surface through stomata. Once the pollutants are absorbed, they are diffused into intercellular spaces or dissipated by water films.

The inherent characteristics of vegetation such as evapotranspiration, dust retention, and shading indicate the enormous potential of working with the urban fabric and ameliorating the environmental performance of tall buildings. Ken Yeang, an architect from Malaysia, has embraced the idea of bioclimatic skyscrapers, linking different



forms of greenery to his tall building designs. For the past three decades, he has taken the challenge of designing ‘green’ buildings, integrating the building with its natural environment, mainly in the tropics. The use of vegetation as a building element and fabric has allowed a very distinct architecture. Although there is not much data on the building’s environmental performance, there is no doubt of its impact on public awareness towards an ecological approach. On the contrary of being a limitation, the environmental agenda allows for creative possibilities, inventiveness, and opportunities for sustainable expression, along with responsible ethics.

## 5 Conclusions

Growing cities are facing a troubling scenario. Population is rising at worrying speed, road networks expanding, suburbs spreading incessantly, increasing numbers of vehicles and pollution, great areas being abused, harming plants and man’s life. The environment and human pride is being destroyed, leaving the city in a shameful state of landscape decomposition. The rural society has been overwhelmed by the urban, obfuscating cultural values and confusing collective instincts. Huxley described the uncontrollable urban colonisation as chaotic 30 years ago, and since then it has not gone any better: “Man is at last pressing hard on his spatial environment. There is little leeway left for his colonisation of new areas of the world surface. He is pressing hard on his resources, notably non-renewable resources. In fact, we are well on our way to ruining our material habitat. But we are beginning to ruin our spiritual, cultural and emotional habitat also. We are spreading great masses of human habitation over the face of the land, neither cities nor suburbs nor towns nor villages, just a vast mass of urban sprawl or sub utopia. And to escape this, people are spilling out farther and farther into the wilder parts and so destroying them. And we are making our cities so big as to be monstrous, so big that they are becoming impossible to live in.” The survival of the urban areas depends on the city and nature being a single design.

With the impossibility to continue to spread outwards, tall buildings can be part of the solution and literally rise to the occasion. A responsible, sustainable, and creative design, one which relates to its natural environment, will be the stepping stone for a new paradigm in city planning.

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