

A Review on Urban Planning in Sudan

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Abstract

More than half of the global population now resides in urban areas, increasingly concentrated in highly dense cities, marking a relatively recent phenomenon in human history that has transformed our ways of living, working, traveling, and connecting. This article provides a comprehensive overview of urbanization in Sudan, tracing its evolution from the distant past to the present and projecting future trends. It explores various aspects of this process, including an introduction to urban planning that covers historical context, contemporary practices, planning theories, technical elements, the roles of urban planners, critiques and debates surrounding urban planning, as well as the principles of participatory urban planning. Additionally, it examines the phenomenon of squatting in Sudan, including its historical context, while also addressing architecture by discussing early historical contributions, traditional styles, developments during Anglo-Egyptian rule in the 20th century, modern architecture post-independence, and contemporary architectural practices in the 21st century.

Keywords: urban planning, squatting in Sudan, architecture in Sudan, historical background, local materials buildings.

المستخلص

أكثر من نصف سكان العالم الآن يعيشون في المناطق الحضرية، مع تزايد عددهم في المدن ذات الكثافة السكانية العالية. ومع ذلك، فإن البيئات الحضرية تُعتبر ظاهرة جديدة نسبيًا في تاريخ البشرية. لقد أحدث هذا التحول تغييرات كبيرة في طرق حياتنا، وطرائق عملنا، وتقلنا، وبناء شبكاتنا. تقدم هذه المقالة نظرة شاملة عن التحضر في السودان، متتبعًا تطوره من الماضي البعيد إلى الحاضر وتقديم توقعات للاتجاهات المستقبلية. يركز الاستعراض على جوانب مختلفة من التحضر في السودان، بما في ذلك مقدمة حول التخطيط العمراني التي تشمل الخلفية التاريخية، والممارسات في القرن الحادي والعشرين، ونظريات التخطيط، والجوانب التقنية، ودور المخططين الحضريين، والانتقادات والنقاشات المتعلقة بالتخطيط العمراني، بالإضافة إلى مبادئ التخطيط العمراني التشاركي؛ كما يناقش ظاهرة السكن غير الرسمي في السودان من وجهات نظر متعددة، بما في ذلك مقدمة تاريخية عنها؛ وأخيرًا، يتناول العمارة في السودان من خلال تقديم مقدمة لأعمال العمارة، ومساهماتها في الفترات التاريخية المبكرة، والعمارة التقليدية، والأعمال المعمارية خلال الاحتلال الإنجليزي المصري في القرن العشرين، والعمارة الحديثة ما بعد الاستقلال، وأخيرًا الممارسات المعمارية المعاصرة في القرن الحادي والعشرين.

1. Overview of Urban Planning

Urban planning is a complex interplay of technical and political processes that emphasizes the development and design of land use and the built environment. It encompasses various elements, including air and water quality, as well as the infrastructure necessary for transportation, communication, and distribution that connects urban areas. Historically, urban planning employed a top-down approach, focusing on master plans that dictated the physical layout of human settlements. The primary concern during this period was public welfare, which included considerations of efficiency, sanitation, and environmental protection, alongside the socio-economic ramifications of the implemented master plans.

As the discipline matured, urban planning began to incorporate social and environmental considerations, positioning itself as a vital tool for enhancing public health and well-being while adhering to sustainability standards. The late 20th century marked a pivotal shift, as sustainable development became a primary objective, prompted by the observable detrimental economic and environmental effects of earlier planning models. Further, the early 21st century saw the influential writings of Jane Jacobs, which underscored the necessity of integrating the interests of residents, businesses, and communities into urban planning, thereby broadening the focus to encompass the experiences and needs of local populations [1], [2] and [3].

Urban planning seeks to address how individuals engage in living, working, and recreation within specific areas, thus facilitating orderly development in urban, suburban, and rural contexts. While its core focus is on the planning of communities and settlements, urban planners also oversee the efficient transport of goods, resources, people, and waste, alongside the distribution of essential services like water and electricity. They strive to foster inclusion and opportunity for diverse populations, stimulate economic growth, promote public health, and preserve ecologically significant areas that contribute to the reduction of carbon dioxide emissions. Additionally, urban planners play a crucial role in safeguarding heritage structures and the built environment. Given that contemporary urban planning teams typically comprise highly educated professionals within city governments, recent discussions have highlighted the importance of involving more community members in the planning process [4], [5] and [6].

Urban planning is inherently interdisciplinary, drawing from fields such as civil engineering, architecture, human geography, politics, social science, and design. Urban planners engage in research and analysis, strategic thinking, policy formulation, public consultation, and implementation. Although urban planning is closely related to urban design, the former has emerged as a distinct professional discipline, encompassing various subfields, including land use planning, zoning, economic development, environmental planning, and transportation planning. Successful urban planning projects require a comprehensive understanding of zoning laws and regulations, as well as the ability to manage both large-scale master plans for undeveloped sites (Greenfield projects) and smaller-scale interventions and refurbishments of existing structures and public spaces. Notable figures such as Pierre Charles L'Enfant in Washington, D.C., Daniel Burnham in Chicago, Lucio Costa in Brasília, and Georges-Eugène Haussmann in Paris designed cities from inception, while Robert Moses and Le Corbusier focused on refurbishing and transforming urban neighborhoods in alignment with their distinctive visions for urban living [2], [7], [8], [9] and [10].

1.1 Historical Context

Evidence of urban planning and intentionally designed communities can be traced back to the civilizations of Mesopotamia, the Indus Valley, Minoan culture, and ancient Egypt during the third millennium BCE. Archaeologists exploring the ruins of cities from these regions have uncovered paved streets meticulously arranged in a grid pattern, with intersections at right angles. The concept of a systematically planned urban area evolved as various civilizations embraced this approach. By the 8th century BCE, Greek city-states prominently adopted orthogonal (grid-like) layouts. Hippodamus of Miletus (498–408 BCE), an ancient Greek architect and urban planner, is regarded

as the father of European urban planning, lending his name to the Hippodamian plan—a pioneering grid layout for cities [11], [12] and [13].

The ancient Romans, drawing inspiration from the Greeks, employed orthogonal planning in their urban designs. Roman city planning prioritized military defense and public utility, and as the Roman Empire expanded, these principles of urban organization spread across its territories. However, as the Empire began to wane, many of these planning innovations gradually fell by the wayside. Yet, remnants of Roman city layouts persisted in numerous European towns. From the 9th to the 14th centuries, urban growth in Europe often followed an organic and sometimes chaotic pattern. Nevertheless, with the advent of the Renaissance, cities experienced significant expansion through carefully planned extensions.

Beginning in the 15th century, documentation of urban design, along with the profiles of those involved in the planning process, became more prevalent. This era saw the emergence of theoretical treatises on architecture and urban planning that explored fundamental questions about designing urban spaces to meet the varying needs of their inhabitants, complete with descriptions and illustrations of towns and cities.

During the Enlightenment, several European rulers sought to ambitiously transform their capital cities. Notably, during the Second French Empire, Baron Georges-Eugène Haussmann, under the guidance of Napoleon III, orchestrated a significant redesign of Paris, giving rise to a more modern capital characterized by broad, straight boulevards [14] and [15].

At the dawn of the 20th century, planning and architecture underwent a significant paradigm shift. The burgeoning industrial cities of the 19th century experienced rapid growth, revealing the harsh realities of urban life for the working poor, which increasingly became a pressing public concern. The laissez-faire economic policies that dominated the Victorian era began to wane, making way for a New Liberalism that advocated for intervention on behalf of the disadvantaged. By around 1900, theorists were crafting urban planning models aimed at alleviating the adverse impacts of industrialization, striving to provide citizens, particularly factory workers, with healthier living environments. Consequently, the ensuing century was characterized by a central planning approach to urban development, though this did not necessarily correspond to an enhancement in the overall quality of urban life.

As the 20th century unfolded, urban planning began to gain recognition as a distinct profession. The Town and Country Planning Association was established in 1899, and the University of Liverpool introduced the first academic course on urban planning in Great Britain in 1909. Throughout the 1920s, modernist principles and a call for uniformity began to permeate urban planning, a trend that persisted until the 1970s. In 1933, Le Corbusier unveiled his vision of the Radiant City, proposing a vertical urban structure as a remedy for pollution and overcrowding. However, many planners soon came to associate the modernist ideals with increasing crime rates and various social issues.

By the latter half of the 20th century, a notable shift occurred as urban planners began to embrace individualism and diversity within urban centers, [3], [16], [17] and [18].

1.2 Practices of the Twenty-First Century

Urban planners investigating the escalating congestion in urban environments have begun to tackle the externalities, specifically, the adverse effects resulting from increased demand linked to expanded highway systems in Western nations like the United States. According to a prediction made by the United Nations Department of Economic and Social Affairs in 2018, an additional 2.5 billion people are expected to inhabit urban areas by 2050, driven by global migration trends. In response, contemporary planning theories have embraced innovative concepts such as Blue Zones and Innovation Districts. These frameworks aim to integrate distinctive geographic areas within cities, facilitating novel business development and prioritizing infrastructures that enhance residents' quality of life and potentially extend their lifespans.

Moreover, planning practices have been adapted to incorporate policy changes designed to combat the anthropocentric impacts of global climate change. For instance, London has implemented a

congestion charge for vehicles seeking access to already congested areas of the city. Today's urban centers are increasingly emphasizing the importance of public transit and cycling by enacting similar policies [19].

1.3 Theories of Planning

Planning theory encompasses a comprehensive set of scientific concepts, definitions, behavioral relationships, and foundational assumptions that collectively shape the field of urban planning. Currently, eight primary procedural theories dominate the landscape of planning procedures: the rational-comprehensive approach, the incremental approach, the transactive approach, the communicative approach, the advocacy approach, the equity approach, the radical approach, and the humanist or phenomenological approach.

In addition to these procedural theories, there are several significant conceptual frameworks in planning. Notable among these is Ebenezer Howard's "Three Magnets" theory, which he proposed as a vision for the future of British settlements, alongside his innovative Garden Cities concept. Other influential models include the Concentric Zone Model, commonly referred to as the Burgess Model, developed by sociologist Ernest Burgess, the Radburn superbloc design that promotes pedestrian accessibility, the Sector Model, and the Multiple Nuclei Model, among others [20] and [21].

1.4 Technical Considerations in Urban Planning

The technical dimensions of urban planning encompass the implementation of scientific and technical methodologies, considerations, and characteristics that contribute to effective land use, urban design, management of natural resources, transportation systems, and infrastructure development. Urban planning employs a range of techniques, including forecasting population growth, zoning land divisions, conducting geographic mapping and analysis, assessing public park spaces, evaluating water supply systems, identifying transportation trends, analyzing food supply requirements, allocating healthcare and social services, and assessing the implications of land use decisions.

To foresee urban development and gauge the impact of various interventions, planners utilize diverse models. These models facilitate the identification of relationships and patterns within demographic, geographic, and economic datasets. They can address immediate concerns such as urban mobility, as well as long-term challenges related to land use and growth. A notable example of such a model is the Geographic Information System (GIS), which is instrumental in constructing representations of existing urban plans and projecting potential future effects on society, the economy, and the environment.

Additionally, building codes and regulations play a crucial role in urban planning by dictating how cities are constructed and utilized at the individual level. Methods of enforcement encompass government zoning (i.e., designated government-held areas), planning permissions, building codes, as well as private easements and restrictive covenants [1], [22], [23] and [24].

1.5 Urban Planning Professionals

An urban planner is a specialist in the field of urban planning, dedicated to optimizing land use and infrastructure within communities. These professionals devise strategies for the development and management of urban and suburban areas, taking into account the compatibility of land uses along with economic, environmental, and social trends. When crafting plans for various community types (i.e. commercial, residential, agricultural, natural, or recreational), urban planners must address a comprehensive array of factors, including sustainability, current pollution levels in air and soil, potential pollution sources, transportation dynamics such as congestion, crime rates, property values, economic development, social equity, zoning regulations, and relevant legislation.

The significance of urban planners is increasingly recognized in the 21st century as modern society grapples with challenges such as population growth, climate change, and unsustainable development. In this context, urban planners may be regarded as "green collar" professionals.

Research indicates that urban planners around the globe operate within diverse planning cultures, tailored to their specific cities and communities. Nevertheless, experts have identified a core set of

skills, competencies, and foundational knowledge that are consistent among urban planners, transcending national and regional boundaries [25], [26], [27], [28], [29], [30] and [31].

1.6 Critiques and Ongoing Discussions

The neoclassical school of economics posits that planning is superfluous, or even detrimental, as market efficiency naturally facilitates optimal land use. A related perspective within pluralist political thought contends that government intervention in the competitive landscape of interest groups which is responsible for determining land usage is unwarranted. In contrast, proponents of urban planning assert that planners should enhance urban environments similarly to how engineers and architects improve residential spaces, tailoring them to better accommodate the needs and preferences of their inhabitants.

The prevailing consensus-building model of planning, which aims to integrate diverse community preferences, has faced criticism for reinforcing existing power dynamics rather than challenging them. In light of this, the concept of agonism has been put forward as an alternative framework for urban planning decision-making [32] and [33].

Another significant debate in the realm of urban planning revolves around the inclusivity of the decision-making process. Predominantly, urban planning adopts a top-down approach, often overlooking the input of local residents affected by these decisions. Sherry Arnstein, who developed the widely referenced Ladder of Citizen Participation, has provided a tool for urban planners and local governments to assess their level of inclusiveness or exclusiveness in planning efforts. City council meetings, which are open to public attendance and encourage citizen feedback, represent a key avenue for engagement between city officials and residents. Furthermore, certain federal mandates require citizen participation in government-funded infrastructure projects.

Many urban planners and agencies depend on community input to inform their policies and zoning plans. The effectiveness of such engagement can be gauged by the extent to which community members' voices are acknowledged and acted upon [6] and [34].

1.7 Engaging in Collaborative Urban Planning

Participatory planning in the United States took root during the 1960s and 1970s. Concurrently, this approach began to influence the development sector, sharing similar characteristics and objectives. Numerous influential urban planners and activists have played pivotal roles in advancing and shaping participatory planning movements. Among them, Jane Jacobs stands out for her substantial contributions, which have had a profound impact across the nation. Additionally, there has been a recent trend toward involving youth in urban planning education, enriching the discourse and practice of community engagement [35] and [36].

2. Squatting in Sudan

2.1 Overview of Squatting in Sudan

Squatting in Sudan is characterized by the unauthorized occupation and development of land within urban boundaries for residential purposes, violating urban planning and land-use regulations. These informal settlements began to emerge in Khartoum in the 1920s, experiencing significant growth during the 1960s. By the 1980s, the government-initiated efforts to dismantle these settlements in Khartoum while attempting to regularize them in other areas. As of 2015, it was estimated that Khartoum had approximately 200,000 squatters, with additional significant populations in Nyala (180,000), Kassala (60,000), Port Sudan (70,000), and Wad Medani (170,000) [37].

2.2 Historical Background of Squatting in Sudan

The emergence of informal squatter settlements in Khartoum can be traced back to the arrival of migrants from rural areas in the 1920s. By the early 1960s, this migration had intensified, resulting in an estimated 50,000 squatters, [37].

In the late 1980s, under the leadership of Sadig Elmahdi, the government initiated a campaign to demolish these settlements. The authorities regarded displaced individuals and squatters with suspicion, particularly in the aftermath of a failed insurrection led by the Nuba and other South

Sudanese groups in 1985, [38]. Following the Sudanese army coup in 1989, which overthrew the democratic regime of Elmahdi, the Revolutionary Command Council of National Salvation which is a military government led by Omar Elbashir intensified its focus on dismantling squatter communities. In 1990, the introduction of Decree 941 (Approval of Some Procedures to Contain Squatter Settlement) and an amendment to the Civil Transactions Act authorized the eviction of squatters [39]. These evictions were often accompanied by violence, as evidenced by protests in October 1994 in Omdurman, where at least eleven individuals lost their lives. Significantly, these actions were executed without judicial orders or prior notice. Minister of Engineering Affairs, Dr. Bannaga, was quoted as saying, "We do not specify the date because if we do, they'll organize themselves and mount an organized opposition." International condemnation ensued, with the United States and other global donors denouncing the plans for forced resettlement [40] and [41].

In Kosti, approximately 72,000 squatters were evicted, while in Eldamazin, about 23,000 were displaced. A 1992 assessment by the United States Agency for International Development and the United Nations Children's Fund estimated that around 400,000 people had been forcibly removed to camps devoid of basic sanitation and market facilities. The newly established Al Salaam camp alone housed over 80,000 individuals. While the Angola informal settlement was demolished, many of its 50,000 residents returned and rebuilt their makeshift homes [42], [43] and [44].

In contrast, other cities in Sudan, such as Nyala and Port Sudan, undertook processes to regularize squatter settlements, a procedure that can take several years. By 1995, squatters comprised approximately 40 percent of Greater Khartoum's population, totaling 1.9 million, which included 800,000 displaced by conflict in the south and 350,000 displaced by drought in the west. That same year, the government announced that it had demolished 90 percent of informal settlements and had forcibly relocated many individuals to camps. In a startling display of retribution, six squatters were hanged in 2010 as punishment for their involvement in the deaths of thirteen police officers during an eviction in Soba Aradi, Khartoum, five years earlier [45] and [46].

As of 2015, government analysis indicated the presence of approximately 200,000 squatters in Khartoum, along with 180,000 in Nyala, 60,000 in Kassala, 70,000 in Port Sudan, and 170,000 in Wad Medani. Squatter settlements were characterized by the unauthorized acquisition and construction of land within city limits, violating Urban Planning and Land laws as well as building regulations, [37].

3. Architecture in Sudan

3.1 Overview

The architectural landscape of the Democratic Republic of Sudan is a reflection of the country's rich geographical, ethnic, tribal, and cultural diversity, as well as its historical evolution. The various lifestyles and material culture evident within its human settlements along with their architecture and economic activities have been shaped by differing regional and environmental conditions. Throughout its extensive documented history, Sudan has served as a canvas for diverse and evolving forms of human civilization, all of which have been influenced significantly by foreign cultures.

The origins of known architectural structures and urbanization in Sudan can be traced back to the eighth millennium BCE. The cultural exchanges with its northern neighbor, Ancient Egypt, instigated long periods of mutual influence, resulting in both Egyptian and distinctly Nubian settlements adorned with temples and pyramids that flourished in the Kingdom of Kush, particularly in its final capital, Merowe. From approximately 500 CE to around 1500 CE, vibrant Christian kingdoms thrived in Upper Nubia and further south along the Nile. These kingdoms fostered the development of significant cities featuring monasteries, palaces, fortifications, and cathedrals, which displayed Coptic and Byzantine cultural influences from Egypt and the Eastern Mediterranean, [47].

With the increasing arrival of Arab Muslim migrants from the 7th century onward, the Christian kingdom of Makuria formalized a treaty known as the Baqt with the Muslim rulers of Egypt. This

agreement permitted Muslims to trade and travel freely, leading to the establishment of the first mosques and cemeteries in Upper Nubia, recorded from 1317 CE onwards, [48].

From around 1500 CE until the early 19th century, the Muslim Sultanates of the Funj and Darfur emerged as new kingdoms in the southern and western regions of Sudan. Prosperous cities such as Sinnar and El Fasher developed, showcasing buildings designated for local administration, personal residences, agriculture, crafts, and trade which included the controversial slave trade [49].

Khartoum, situated on the southern bank of the Blue Nile, emerged as the nucleus of the Turkish-Egyptian state. However, in 1885, it faced significant destruction at the hands of the Mahdi's followers, who subsequently established their capital in Omdurman, located across the White Nile. In the early 1900s, Khartoum underwent reconstruction spearheaded by the British administration under Lord Kitchener, adopting the standards of a modern European city. As of 2021, Greater Khartoum has evolved into a bustling metropolis with an estimated population of nearly six million people, consisting of Khartoum proper and connecting by bridges to Khartoum North (Bahry City) and Omdurman to the west.

The rural landscapes of Sudan still predominantly exhibit traditional African architectural styles, yet they have also witnessed significant transformations in settlement patterns, infrastructure, and architecture throughout the 19th and 20th centuries.

3.2 Early Historical Periods

3.2.1 Prehistoric Era

By the eighth millennium BC, the Neolithic communities had transitioned to a sedentary lifestyle within the Nile Valley, establishing fortified villages constructed from mud bricks. Here, they complemented their hunting and fishing activities in the Nile with the cultivation of grains and the herding of cattle, [50].

In eastern Sudan, the El-Butana Group emerged around 4000 BC. Although details regarding their settlement patterns remain limited, evidence from several sites that some settlements reaching nearly 10 hectares which suggests prolonged habitation. The inhabitants of the Butana Group typically resided in small, circular huts. While few cemeteries have been identified, it appears that most individuals were interred in a contracted position, [51].

3.2.2 Ancient Egyptian Settlements in Nubia

Buhen, an ancient Egyptian settlement located near modern-day Wadi Halfa in Sudan's Northern State, is renowned for its impressive fortress, believed to have been built during the reign of Senusret III around 1860 BC, during the 12th Dynasty, [52].

The fortifications of Buhen featured a three-meter-deep moat, drawbridges, bastions, buttresses, ramparts, battlements, and loopholes, as well as a catapult. Notably, the outer wall encompassed a space between two walls that was equipped with a double row of arrow loops, enabling both standing and kneeling archers to simultaneously offer fire support.

In 1962, an archaeological expedition uncovered remnants of the smelting process, indicating the presence of an ancient copper factory at the site. Additionally, Buhen housed a temple dedicated to Horus, constructed under the reign of Hatshepsut. The walls of this temple, along with architectural elements from the Semna cataract and other significant sites, were reassembled in the garden of the National Museum of Sudan prior to the inundation caused by Lake Nasser, [53] and [54].

3.2.3 The Kingdom of Kush

During the era of the Kingdom of Kush (approximately 950 BC – 350 AD), the monarchs of Kush reigned over their northern neighbor, Egypt, as pharaohs for more than a century. This period was marked by a significant Egyptian cultural influence on Nubian society. Prominent urban centers, notably the city of Naqa, emerged, featuring grand temples dedicated to ancient deities such as Amon and Apedemak. Among the notable structures in Naqa is a smaller temple known as the Roman Kiosk, which showcases a blend of indigenous Nubian and Hellenistic architectural elements, as illustrated in Figure 1 depicting the Amon Temple at Naqaa, [55].

Additional examples of ancient Nubian architecture include rock-cut temples, expansive mudbrick structures referred to as deffufa, tombs with stone walls, and dwellings constructed from mudbrick, wood, and stone. The landscape also featured palaces and well-organized road systems. Archaeological endeavors have uncovered remnants of Nubian cities, including the Royal City of Merowe, which is renowned for its so-called "Roman baths." These baths exemplify the cultural exchange between the African kingdom and Greco-Roman Mediterranean traditions. Among Sudan's World Heritage Sites, the Nubian pyramids in Merowe stand out as the most recognizable architectural legacies of this historical period, [56], [57], [58] and [59].



Figure 1: The Amon Temple at Naqaa

3.2.4 Medieval Nubia

Figure 2 below illustrates the ninth-century throne hall of Dongola, as captured in 1821.



Figure 2: The Ninth-Century Throne Hall of Dongola, as Illustrated in 1821

During the period spanning 500 to 1500 AD, Medieval Nubia presided over this region. The original inhabitants of the Christian kingdoms of Makuria, Nobadia, and Alodia developed distinctive architectural styles in their cities. Notable examples include the Faras Cathedral, renowned for its intricate friezes and wall paintings, the Great Monastery of St. Anthony, and the impressive Throne Hall of the Makurian kings which is an imposing structure resembling a fortress located in Old Dongola [60]. Most of these architectural marvels were excavated and meticulously documented before being submerged under the waters of Lake Nasser in the 1960s and 1970s.

3.2.5 The Arrival of Islam and Arabization

During the 16th and 17th centuries, several Islamic kingdoms emerged in the southern and western regions of Sudan, most notably the Funj Sultanate, with its capital in Sinnar, and the Sultanate of Darfur, centered in Al-Fashir. This period was characterized by significant transformations in both religion and societal behavior, leading to a slow but profound process of Islamization and Arabization

throughout Sudan. These sultanates and their cultures persisted until the Ottoman Egyptian invasion in 1820, with the Sultanate of Darfur enduring until 1916, [61].

Figure 3 below depicts the ancient palace of Sinnar, illustrated by Frederic Cailliaud in 1821. During this period, significant cultural transformations occurred, notably the increasing adoption of the Islamic faith and the widespread use of the Arabic language. This shift was accompanied by the construction of mosques and Islamic schools, which became integral components of social life. Foreign travelers, including Frederic Cailliaud, reported various cultural advancements, particularly in the architectural development of towns and structures, [62] and [63].



Figure 3: The Ruined Palace of Sinnar, an illustration by Frederic Cailliaud, 1821

Under Turkish-Egyptian rule from 1821 to 1885, the city of Khartoum transformed from a military encampment into a thriving regional center. This expansion was characterized by the establishment of numerous brick houses, notable official buildings, including the first governor's palace, the mudiriya (government offices), and several foreign consulates. In 1829, Governor-General Ali Khurshid Agha oversaw the construction of Khartoum's first mosque, alongside the establishment of a dockyard and new military barracks, [64] and [65].

The Mahdist state, which lasted from 1885 to 1899 following the defeat of General Gordon's forces, left a profound architectural legacy in Omdurman, the political and national capital during this era. Today, visitors can explore the reconstructed tomb of Muhammad Ahmad, known as al-Mahdi, the former residence of his successor, Abdallah ibn Muhammad, now housing the Khalifa House Museum. Notable structures include Abdul Qayyum Gate and remnants of the fortifications known as Al Tabia, all of which reflect Omdurman's Islamic heritage. Additional significant sites comprise mosques and graves of revered religious leaders, such as Sheikh Hamed el Niel, while Souk Omdurman serves as an essential traditional market. These elements collectively highlight the rich historical tapestry of the region, as noted in *The Grove Encyclopedia of Islamic Art and Architecture*, [66], [67], [68] and [69].

3.3 Traditional Architecture

In many regions of the country, traditional homes and structures of vernacular architecture are crafted from locally sourced materials, including cow dung, mud bricks, stones, and a variety of trees and plants. These buildings frequently feature decorative painted ornaments that embody the local culture. Typically, rectangular or square in shape, these homes are constructed by their future occupants, often with assistance from the surrounding community. Below, Figure 4 illustrates an external view from the Khalifa House, overlooking the Tomb of the Mahdi.



Figure 4: Perspective from Khalifa House overlooking the Tomb of the Mahdi

The traditional rectangular or square box house, known as the bayt jalus, characterized by its flat roof and constructed from materials such as pure dried clay, sun-dried mud, brick, or cow dung plaster (known locally as zibala), remains the predominant architectural style in Sudan. In its most authentic form, wooden frames are utilized solely for the roof, windows, and doors. This design is prevalent throughout the country, with the exception of the southern regions, where heavy rainfall necessitates the use of sloping grass roofs. The box house style is exemplified in its most complete form in Omdurman, a city established by Khalifa Abdallah (1885–1898), which served as the capital of Sudan for 13 years.

In the southern areas, where the climate is wetter and vegetation is more abundant than in the north, round huts featuring thatched conical roofs are commonly found. These tukul huts are traditionally constructed from dried mud, grass, reeds, and wooden poles. Additionally, various semi-nomadic groups in Sudan, such as the Beja, Baggara, and Rashaida (known locally as Zebedia), have established mobile camps and continue to reside in tents to this day, [70] and [71].

Long before the Turkish invasion of Sudan in the early 1820s, the coastal city of Suakin had already emerged as a vital port and commercial hub under the stewardship of its Turkish and Arab inhabitants. However, following the establishment of Port Sudan as a modern city and harbor in 1909, Suakin fell into a state of disrepair, leaving behind only remnants of its former grandeur. In his work titled *The Coral Buildings of Suakin*, British art educator Jean-Pierre Greenlaw, who founded the School of Design in Khartoum, documented the town's historical state. He described Suakin as a jewel of architecture, crafted between the 16th and 20th centuries, tailored to the coastal conditions of the Red Sea. This architectural style featured two to three-story houses with vertical walls adorned with multiple shuttered windows and distinctive mashrabiya, complemented by roof terraces (kharjahs) where residents could enjoy the refreshing moonlit or starlit evenings. The exterior walls of these structures were whitewashed, accentuating the mashrabiya and intricately carved wooden doors, which were further embellished with decorative stone door-hoods. Its distinctive location on a flat island within a lagoon lent Suakin a singular beauty.

Further evidence of Ottoman cultural influence in Sudan is reflected in the graves of Ottoman rulers, characterized by their qubba domes, located on today's Baladiya Street in Khartoum, [72].

Other structures that reflect the Turkish cultural influence in Sudan include the graves of Ottoman rulers, distinguished by their iconic qubba domes, located on Baladiya Street in present-day Khartoum, [73].

3.4 Anglo-Egyptian Rule in the 20th Century

Following the defeat of the Mahdist State, with its capital in Omdurman, by the British Imperial Army under Lord Kitchener in 1898, the urban landscape of downtown Khartoum was meticulously developed in accordance with colonial spatial zoning regulations, showcasing a series of patterns reminiscent of the Union Jack. British urban planner William McLean crafted the first master plan for Khartoum, a city once referred to as the "jewel in the crown" of British colonies in Africa, [74].

Between 1900 and 1912, new edifices designed in European architectural styles emerged, including the Government House (currently the President's Palace) and several governmental structures along Nile Street. Key educational institutions were also established during this period, most notably the Gordon Memorial College, which would eventually evolve into the main campus of the University of Khartoum, along with its School of Medicine and the Catholic Comboni College. In 1902, the first school for girls was inaugurated; today, it continues to operate as Unity High School.

The al-Kabir Mosque, built in the Egyptian architectural style, was inaugurated for Friday prayers in Khartoum during Khedive Abbas Pasha Helmy's visit to Sudan on December 4, 1901. Around 1910, notable ecclesiastical structures like the former Anglican All Saints Cathedral (now the Republican Palace Museum) and the Catholic St. Matthew's Cathedral were completed in a neo-Romanesque style. In 1926, the Ohel Shlomo Synagogue was constructed in Sephardic style on what was then Victoria Avenue (now Al-Qasr Street) to serve the Jewish community of greater Khartoum, [75], [76], [77] and [78].

For travelers, Khartoum offered several accommodations, including the Gordon Hotel and, later, the Acropole Hotel, which has been managed by Greek owners since 1952. The city's infrastructure was bolstered by markets such as Souq al-Arabi, along with banks, offices, and extensive railway services, which included the establishment of the first bridges over the Nile—the Blue Nile Bridge in 1909 and the Omdurman Bridge in 1926. Additionally, Khartoum North saw the establishment of a large prison in 1903, now known as Kobar Prison, which continues to operate today and lends its name to the surrounding neighborhoods.

Despite the fact that these developments primarily catered to foreign interests and largely excluded the Sudanese population, the newly independent Republic of Sudan was able to inherit a relatively efficient system of education, public administration, transportation, recreation, and various other amenities, [79], [80] and [81].

Provincial towns and cities such as Kassala, El-Gadarif, El-Obeid, Port Sudan, Shendi, Atbara, and Wad Medani also experienced significant transformations necessary for colonial governance. These areas saw the emergence of modern buildings, long-distance roads, and vital infrastructure, including a railway system connecting major economic centers, [82].

3.5 Modern Architecture Post-Independence

In the early years following Sudan's independence, new architectural projects were undertaken by foreign architects, including notable figures such as Peter Muller, George Stefanidis, Alick Potter, and Miles Danbi. Among their contributions was the design of the Examination Hall at the University of Khartoum. In 1957, the Faculty of Architecture was established at the university, with Alick Potter serving as its inaugural Head of Department and professor.

Starting in the 1960s, Sudanese architects Abdel Moneim Mustafa and Hamid El Khawad, both of whom had studied in the United Kingdom, embarked on numerous contemporary projects throughout Sudan. Their notable works include the Lecture Theatre at the University of Khartoum, as well as facilities for the Department of Biochemistry in the Faculty of Agriculture and the Structures Laboratory in the Faculty of Engineering and Architecture, [83], [84], [85], [86] and [87].

Abdel Moneim Mustafa also designed several prominent buildings, such as the headquarters for the Arab Bank for Economic Development in Africa, the El-Ikhwa commercial complex, El-Turabi Primary School, and various apartment buildings in Khartoum's central business district. Among the first graduates from the Faculty of Architecture were Omer Al Agra and El Amin Mudather, both of whom contributed to the design of the university's Faculty of Veterinary Medicine building, [77], [88], [89] and [90].

Austrian architect Peter Muller was responsible for the design of the new Polytechnic complex, which eventually evolved into the Sudan University of Science and Technology. This extensive campus includes multi-story academic buildings, a library, workshops, hostels, staff residences, and a stadium. Furthermore, he designed the Bata Shoe factory located in Khartoum North's industrial area, [91] and [92].

In Omdurman, the Al-Nilein Mosque, featuring a distinctive dome and an interior devoid of supporting pillars, was inaugurated in the mid-1970s at the confluence of the White and Blue Nile. Nearby, the National Assembly building, designed by Romanian architect Cezar Lăzărescu in a brutalist style that evokes classical temple architecture, was completed in 1978. Additionally, Ahfad University for Women, one of several higher education institutions in Omdurman, was established in 1966, [93], [94] and [95].

3.6 Contemporary Architecture in the 21st Century

In the early years of the 21st century, Khartoum witnessed the emergence of several significant architectural landmarks. Notable among these is the five-star Corinthia Hotel, which was inaugurated in 2009 and funded by the Libyan government. That same year also saw the completion of the Telecommunications Tower. Another key structure is the El Mak Nimr Bridge, which spans the Blue Nile and links downtown Khartoum with Khartoum North; it was completed in 2007. Additionally, the Tuti Bridge is recognized as Sudan's first suspension bridge, [96], [97] and [98].

The Salam Centre for Cardiac Surgery, designed by an Italian firm, was finalized in 2010 and earned the prestigious Aga Khan Award for Architecture in 2013. That very year, the Greater Nile Petroleum Oil Company Tower was erected by a company based in Abu Dhabi. Another notable example of contemporary architecture in the capital is the main building of the Open University of Sudan, which opened its doors in 2004 in the suburban area of Arkawet, [99].

4. Conclusions

Urban planning has traditionally been perceived as a tool for overseeing and regulating the growth of towns and cities. However, in the developing world, conventional planning methods have often fallen short in effectively addressing the multifaceted challenges posed by rapid urbanization, including poverty, social exclusion, informality, and increased vulnerability.

The benefits and challenges associated with urbanization can be summarized as follows:

Advantages

- A. Increased Land Value:** Urbanization can enhance land values, potentially leading to a rise in housing prices.
- B. Improved Lifestyle:** The introduction of amenities such as parks and public spaces promotes a healthier lifestyle, fostering greater health awareness among residents.
- C. Advancement in Healthcare Services:** The presence of better healthcare facilities is crucial to society's wellbeing, as it addresses illnesses, emergencies, and accidents through effective diagnosis and treatment.
- D. Efficient Use of Transport Infrastructure:** Urbanization can enhance the efficiency of parking and transportation infrastructure.
- E. Reduced Household Transport Costs:** Families may experience lower expenditures on transportation due to improved urban planning.
- F. Support for Local Businesses:** Urban development can increase the viability of local shops and services, bolstering the local economy.
- G. Promotion of Active Transport:** Urban designs that encourage walking and cycling can lead to significant health benefits.
- H. Decreased Dependence on Cars:** Enhanced urban environments can reduce the necessity for car ownership, thereby lowering emissions.

Disadvantages or Limitations:

- A. Long-Term Inefficiency:** Over time, urban plans may become ineffective due to the relentless growth of urban populations, resulting in overcrowding that can induce stress and pressure on individuals.
- B. Unreliable Public Transport:** Public transport systems may not meet expected reliability levels, and increased private vehicle parking can lead to congested city streets.
- C. Challenges of Rapid Urbanization:** This phenomenon occurs when the influx of populations into

urban areas outpaces the development of necessary infrastructure, often as a consequence of economic shifts that leave rural residents and farmers in a state of poverty.

In summary, while urbanization presents various opportunities for enhancement and growth, it is imperative to address the inherent challenges to ensure sustainable and equitable development in urban environments.

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