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# Assessing Urban Green Space Accessibility for Sustainable Development in Mostaganem, Algeria: A Space Syntax Approach

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## ABSTRACT

*The rapid urbanization of Mostaganem, Algeria, has led to significant challenges in the accessibility of urban green spaces (UGS), crucial for promoting environmental sustainability and public health. This study uses a space syntax approach, specifically angular segment analysis (ASA), to assess UGS accessibility at city-wide and local scales. By integrating quantitative measures like "Choice" and "Integration" with Geographic Information Systems (GIS), the research identifies spatial disparities in green space distribution and accessibility, with global integration values ranging from 0.469 to 0.801. Results reveal unequal distribution, infrastructure inadequacies, and safety issues affecting accessibility. The study highlights areas like Boudjemaa and Emir Abd El Kader, which offer high connectivity, while others like Jannat El Aarif suffer from limited accessibility. Recommendations include enhancing transportation infrastructure, prioritizing green spaces in urban planning, and diversifying facilities to improve accessibility and promote social inclusion. This research provides a comprehensive framework for policymakers and urban planners, aiming to optimize urban green space accessibility and contribute to sustainable urban development in Mostaganem, aligning with global efforts towards equitable urban environments.*

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| Highlights: | Contribution to the field statement: |
|---|---|
| - Urban green spaces in Mostaganem, Algeria, face significant accessibility challenges due to rapid urbanization.<br>- The integration of Angular Segment Analysis (ASA) with Geographic Information System (GIS) methodologies reveals spatial disparities in green space distribution.<br>- Inequitable distribution of green spaces negatively impacts accessibility and urban quality of life. | This study advances urban planning methodologies by integrating Angular Segment Analysis (ASA) with Geographic Information System (GIS) to assess urban green space accessibility in Mostaganem, Algeria. By identifying spatial disparities and proposing targeted improvements, it provides actionable insights for policymakers and urban planners, enhancing urban development strategies and contributing to equitable and sustainable urban environments. |

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## 1. Introduction

Since 2008, there has been a notable transition towards urbanization globally, marked by the urban population exceeding the rural population for the first time in the annals of humanity (United Nations, 2022). This shift underscored the consistent pattern of urbanization, especially in regions with lower levels of development, where Asia and Africa emerge as the primary focal points (van Maarseveen et al., 2018).

Algeria, the largest African country, has encountered a significant challenge of rapid population growth following the attainment of independence in 1962. This urban population rate has witnessed a notable increase from 33.2% in 1962 to 73.7% in 2020, with projections indicating a further rise to 85% by the year 2050, as reported by the United Nations in 2018 (United Nations, 2019). Throughout the past three decades, the predominant approach to urban planning has involved a simultaneous expansion of urban areas, and increased land consumption (Leghrib et al., 2021). This particular strategy has discernible implications for the availability and accessibility of public parks and other green spaces within the Algerian context.

The process of rapid urbanization has been accompanied by a multitude of challenges, encompassing environmental concerns, health hazards, and social inequalities (Anwar et al., 2023), thus underscoring the need for a concentrated effort toward sustainable urban development. The dearth of green spaces within urban areas stands out as a prominent ramification of swift urbanization witnessed in numerous global cities (Li et al., 2022). Algerian authorities, through urban and territorial planning documents such as SNAT 2025 and SNAT 2030, are promoting sustainable development by providing long-term guidelines and perspectives. This policy has notably enhanced various aspects of urban quality of life, including public transportation, public spaces, and urban green spaces. For example, the implementation of Law No. 07-06 of May 13th, 2007, outlines specifications for the management, protection, and development of green spaces, resulting in significant improvements. According to the Ministry of Environment (2021), the area of urban green spaces increased from 80 million square metres in 2014, with a ratio of 2.06 m² per capita, to 174 million square metres, or a ratio of 4.01 m² per person, in 2021. However, this ratio still falls short of the World Health Organization's international minimum standard of 9 m² per person.

Despite these advancements, the policy lacks detailed specifications regarding the distribution of urban green spaces within urban areas and their usability. This includes aspects such as adaptability for different uses and groups of users, as well as their accessibility. This gap hinders the full realization of the potential benefits of urban green spaces, limiting their contribution to enhancing the quality of urban life and sustainable development. Much like other regions, Mostaganem in Algeria is grappling with the repercussions of accelerated urban growth, particularly in terms of the quality and quantity of available green areas. Algeria ranks 4th in the Arab region with a Sustainable Development Goals (SDGs) index score of 67 out of 100. However, it faces significant challenges related to target 11.7, which focuses on urban green and public spaces as part of sustainable cities and communities' goals, as highlighted by the recent Arab Region SDG Index and Dashboard Report (Bayoumi et al., 2022).

UGS play a crucial role in offering a diverse array of advantages, which span across various dimensions. These advantages encompass environmental benefits such as the enhancement of air quality (Lee et al., 2015), the mitigation of water pollution, protection against soil erosion, and the improvement of the aesthetic appeal of urban areas. Moreover, UGS contribute to social benefits by enhancing the overall well-being and health of residents (Addas, 2023; Festa et al., 2022; Vilcins et al., 2022), generating employment opportunities, boosting tourism, and addressing issues related to climate change adaptation and biodiversity preservation. Consequently, it is imperative to ensure the appropriate design of green spaces to materialize these benefits effectively, along with implementing accessibility measures in alignment with the idea that green spaces play a role in fostering positive outcomes.

The issue of providing equal access to green areas in urban settings persists, especially in rapidly expanding metropolitan regions such as Mostaganem, Algeria. Consequently, the quantification and comprehension of the availability of UGS using the configurational metrics of Space Syntax theory could positively impact the physical and social performance of UGS within a city.

Given the challenges posed by rapid urbanization, the lack of prioritization for green spaces, and the absence of comprehensive studies within the Algerian context, this research aims to investigate the intersection of accessibility and sustainability of urban green spaces (UGS) in Mostaganem. By reviewing the current availability of green spaces and analysing the characteristics of 12 existing green spaces within the urban spatial network, the study focuses on the role of space syntax angular segment analysis in assessing spatial configuration and accessibility. This research aims to provide a novel understanding of the role and importance of green spaces within the urban planning framework of Mostaganem, thereby contributing to the broader discourse on sustainable urban development in Algeria.

### 1.1 Urban Green Spaces Accessibility Assessment

Beyond the space syntax community, several studies have investigated urban green spaces (UGS) from diverse perspectives using different methods. In particular, remote sensing (RS) and geographic information systems (GIS) have been utilized to analyze and quantify the spatiotemporal dynamics and changes of UGS (Chen et al., 2017; Wang et al., 2018) and evaluate their characteristics, such as abundance, spatial distribution, and species composition (Shahtahmassebi et al., 2021). Furthermore, RS and GIS-based suitability analyses are used to strategically identify suitable locations for UGS development (Moisa et al., 2023). Further research has focused on other localized concerns, such as the concept of human thermal comfort (Ahmadi Venhari et al., 2019), as well as strategies to mitigate urban heat island (UHI) effects and land surface temperature (LST) (Du et al., 2017; Gherraz et al., 2020; Yu et al., 2018).

By definition, accessibility refers to the convenience of accessing numerous destinations from various origins within the urban network across different spatial scales. It holds significant importance in determining the placement of public amenities to enhance usability for a broad population or restrict usage to a smaller community (Huang et al., 2023).

The unequal distribution of urban green spaces within cities poses significant challenges, in front of them those related to "Accessibility", necessitating thorough spatial assessments to guarantee social and environmental equity for the urban residents. Choosing unsuitable locations for UGS can result in reduced accessibility for the intended populations they are meant to serve, potentially leading to inefficiently utilized or neglected spaces, and, at the extreme, misused spaces that could be exploited for illegal and criminal activities (Hillier, 2007).

Diverse methods are used to quantify and understand the accessibility of UGS, such as GIS-based network analysis (Buckland & Pojani, 2023), and location-based methods that consider the traditional definition of accessibility in terms of the ease of reaching different land uses through available modes of transportation (Morales et al., 2019).

On the other hand, Space Syntax offers quantitative assessments of different levels of accessibility within the urban spatial network since it examines accessibility through network centrality, focusing solely on the topological and geometric characteristics of urban layouts.

Studies highlight the significance of spatial syntax methods in assessing the accessibility of UGS to enhance their physical and social functionality within a city (Long et al., 2023; Tannous et al., 2021). The advantage of space syntax lies in its ability to describe how the overall spatial structure or morphology influences the accessibility of UGS from a spatial relations perspective.

### 1.2 Urban Green Spaces as a Key to Sustainable Cities

UGS are increasingly acknowledged as key elements of sustainable urban development, contributing to environmental quality, social well-being, and economic prosperity. They play a pivotal role in fulfilling various United Nations Sustainable Development Goals (SDGs), specifically, they contribute to the achievement of the eleventh goal concerning sustainable cities and communities, and its seventh target that emphasizes "ensuring universal access to safe, inclusive, and accessible green and public spaces, particularly for women, children, older individuals, and those with disabilities" (Bayoumi et al., 2022).

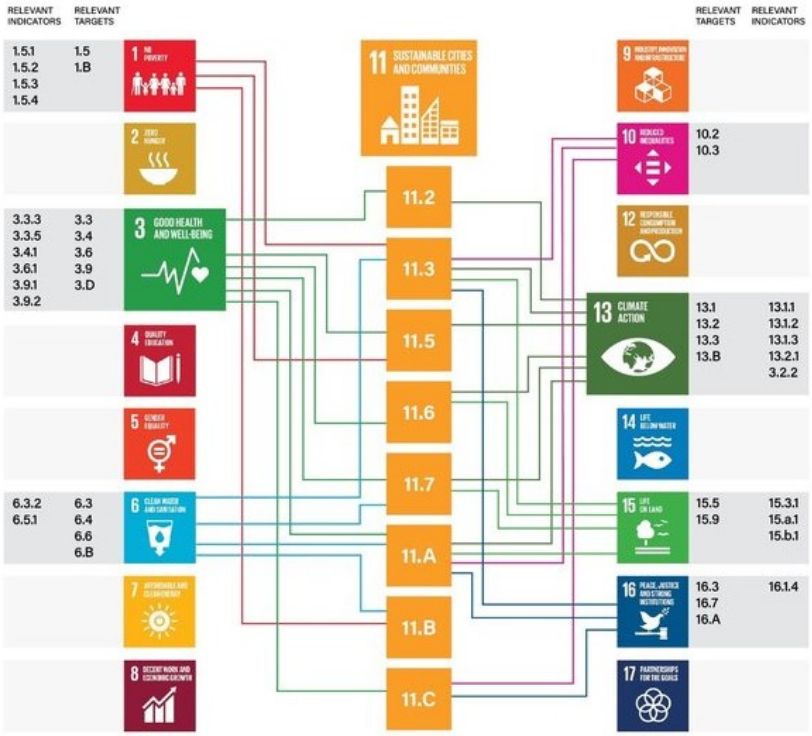


**Figure 1.** The interconnectivity between SDG 11 targets and the other SDGs and their respective targets (Source: Orsetti et al., 2022).

In this context, UGS serve a purpose beyond mere ornamentation, constituting a crucial component of an ecosystem that fulfils a diverse array of physical and social roles and functions (Tannous et al., 2021). The significance of UGS to the urban environment can be seen through many lenses. These spaces offer a wide spectrum of advantages, encompassing various aspects, ranging from environmental to social and economic dimensions (Belmeziti et al., 2018; Dipeolu et al., 2020; Lee et al., 2015).

The importance of UGS lies in the environmental advantages it offers, such as mitigating the urban heat island (UHI) effect and decreasing the energy expenses associated with cooling structures. The presence of green areas in urban settings helps in reducing air, water, and noise pollution, while also potentially compensating for greenhouse gas emissions by absorbing CO2 (Haq, 2011; Strohbach et al., 2012). Additionally, urban greenery contributes to stormwater attenuation by serving as a flood mitigation strategy (Pataki et al., 2011). Other ecological benefits encompass the conservation of biodiversity and natural habitats (Roy et al., 2012).

From a health perspective, UGS permit health-promoting activities, such as encouraging physical exercise, enhancing overall public health, and improving the psychological well-being of urban residents (Tok et al., 2020). Another significant aspect of UGS lies in its social advantages. Research indicates that incorporating UGS can lead to a decrease in crime rates and vandalism, a reduction in

stress levels, and an encouragement of physical activity through the creation of a greener and safer environment (Branas et al., 2011). Furthermore, UGS offer opportunities for social engagements to take place, potentially aiding in the mitigation of social isolation (Haq, 2011), fostering the development of social capital, promoting social unity, and reinforcing connections within communities (Mears & Brindley, 2019; Wolch et al., 2014).

## 2. Case Study Presentation

Mostaganem is a coastal city in the northwest of Algeria, located approximately 350km away from the capital Algiers (Figure 2). The littoral and touristic municipality of Mostaganem covers an area of 50km square and offers a rich canvas for studying the spatial dynamics of urban green spaces. It provides an array of urban green space amenities, including lively parks, gardens, and open public spaces.

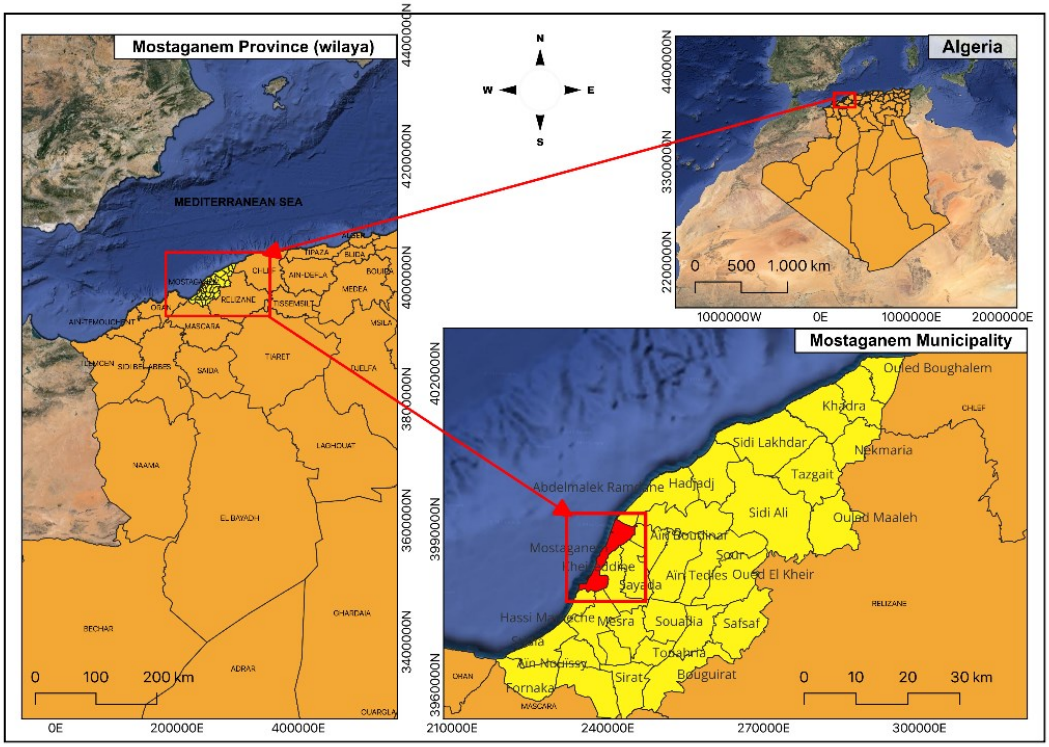


**Figure 2.** Location map.

**Table 1:** Urban Green Spaces physical features.

| ID | UGS name | Type | Area (ha) | Scale | Location |
|---|---|---|---|---|---|
| 1 | **Mostaland** | Park | 43.497 | National | North-east |
| 2 | **Emir Abd El Kader** | Garden | 2.352 | Community | Downtown |
| 3 | **Jannat El-Aarif** | Garden | 2.015 | | South |
| 4 | **Houria** | Park | 1.887 | | East |
| 5 | **Foussha** | Garden | 1.446 | | South-west |
| 6 | **Matrba** | Plaza | 1.220 | | North-east |
| 7 | **El Arsa** | Park | 1.170 | | East |
| 8 | **Es-salam** | Garden | 0.342 | Neighborhood | South |
| 9 | **1st November** | Plaza | 0.272 | | Downtown |
| 10 | **Salamandre** | Plaza | 0.213 | | South-west |
| 11 | **Boudjemaa** | Garden | 0.132 | | Downtown |
| 12 | **Barail** | Square | 0.107 | | Downtown |

Therefore, our case study comprises twelve UGS and recreational parks of various sizes operating at multiple scales—national, community, and neighbourhood levels (Table 1). The spatial arrangement of the examined UGS is illustrated in Figure 3.


**Figure 3.** Urban green spaces geographical distribution.

## 3. Material and Methods

The assessment of the accessibility and connectivity of UGS is conducted through two key phases: data collection and data analysis (Figure 4). For the initial phase, OpenStreetMap (OSM) provides basic data on the road centrelines network, while UGS are digitized using GIS tools in addition to high-resolution images captured for detailed examination.

Thereafter, the analysis phase comprises a multidimensional approach implemented via two datasets, physical properties and syntactic measures. The first dataset includes physical characteristics such as size, operating scale, and spatial distributions. Thus, the second dataset encompasses the syntactic measures of the Angular Segment Analysis of Space Syntax theory.

Space Syntax theory provides a framework for exploring spatial patterns within a particular environment and their impact on social behaviour, human movement and urban accessibility. Originally developed in the 1970s by *"Bill Hillier"* and "*Julienne Hanson"* at University College London, the theory investigates how the layout and connectivity of spaces in a built environment influence human activities and relationships (Hillier & Hanson, 1984). Examining the spatial interactions between different areas, the theory sheds light on how people navigate and use environments, thus providing an understanding of how spatial design can affect movement patterns and the quality of social interactions within a community (Hillier, 2007). Angular segment analysis provides a more precise understanding of spatial relationships and connectivity within urban environments, it refines integration analysis by incorporating angular weights into street segment connections. Unlike Axial analysis, ASA models curved streets using multiple street segments that connect at their ends. These segments are then processed and analysed as a single spatial entity. In addition, ASA has opened up new perspectives for further research into urban planning, architecture and transportation, and is helping to design more efficient, inclusive and sustainable environments (Turner, 2007; van Nes & Yamu, 2021).

The ASA employs integration and choice to measure accessibility and compare the configurational properties of the urban fabric under scrutiny (Turner, 2007, 2009). Moreover, the normalization of these measures remains useful in investigating the inner structure of an urban fabric since it incorporates angular, topological, and metric distances (Hillier et al., 2012; Serra & Hillier, 2019). Accordingly, the syntactic outcomes of the road network of Mostaganem municipality are extracted from "DepthmapX" software and then exported to "QGIS".

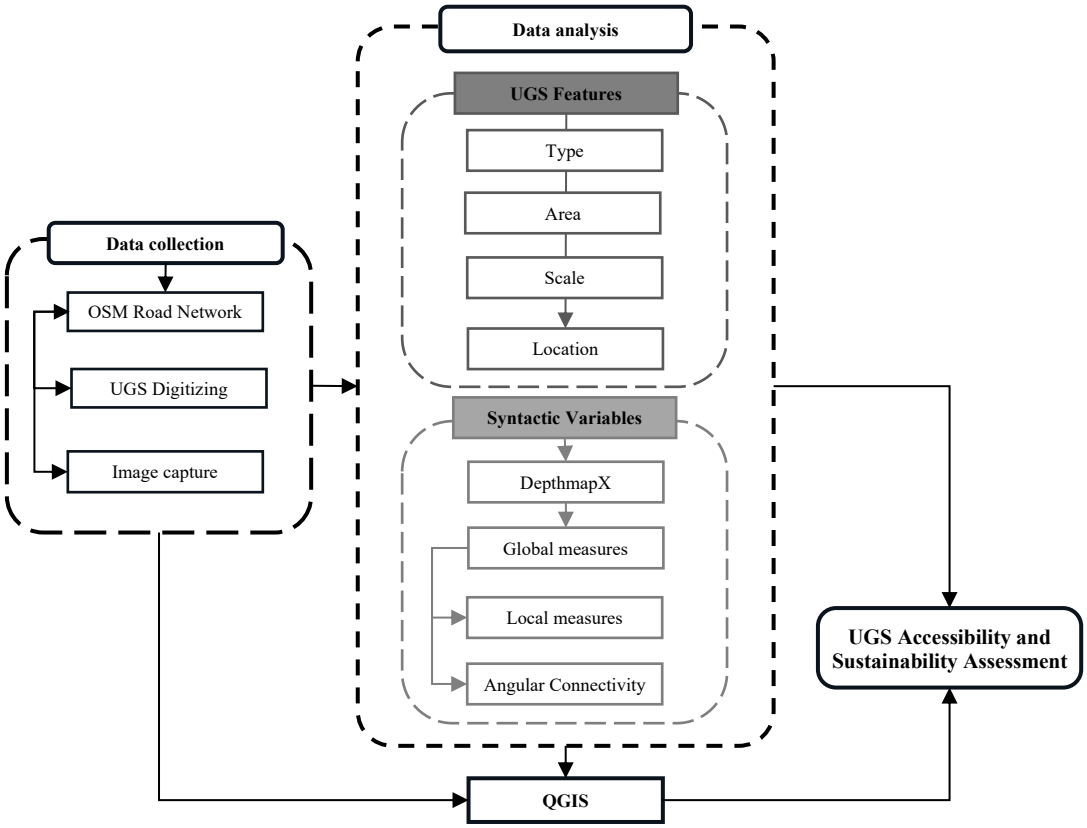


**Figure 4.** Flowchart of the methodological approach.

Therefore, the accessibility assessment involves several measures such as angular connectivity, normalized angular choice (NACH), and normalized angular integration (NAIN) on a global scale (Rn), and local metric scale within various radii comprising R200, R400, and R800 meters.

Angular Connectivity characterizes the structure of the local urban network by representing it as a graph composed of nodes and edges. This metric effectively captures the extent to which different parts of the urban network are interconnected. Analysing the nodes and edges, provides a comprehensive view of how well-integrated the various segments of the urban landscape are, revealing critical insights into the network's overall connectivity and coherence.

Normalized Angular Integration (NAIN) highlights the relative accessibility or movement potential of a road element within the network, indicating the topological closeness of a road element to all other elements. At specific metric radii, NAIN reveals spatial hierarchies for local sub-centres by assessing movement potentials and relative accessibility. This enhanced understanding of NAIN illuminates the density of road elements and the distribution of sub-centres within a region. By emphasizing their location and connectivity, NAIN provides valuable insights into the overall spatial structure and dynamics of the urban network.

Furthermore, employing GIS enhances the thorough assessment of accessibility and enables accurate digitization and analysis of the extracted syntactic measures, thereby improving visualization and guiding strategic decisions in urban planning.

## 4. Results and Discussions

The angular segment analysis provides a refined insight into urban spatial patterns of Mostaganem city, through the prism of Space Syntax theory, specifically via the two key measures of normalized angular choice and normalized angular integration (Hillier et al., 2012). The highest values appearing on the global NACH metrics reveal the major urban arteries within the urban layout, highlighting highways such as RN 90, RN 11 and the main thoroughfares, namely avenues Benyahia Belkacem, Ould Aissa Belkacem, Khattab Abdelkader, Mohamed Khemisti, and boulevards Benkara Mostafa and Dahra, being the main arteries of movement, distinguished by high NACH values around 1.487 (Figure 5. A). They constitute the backbone of urban connectivity, guiding the flow of people and resources. Besides, the NAIN map reveals a no-edge effect, where segregated urban structures appear on the periphery and the most integrated layouts are clustered around the city centre core. This concentration signifies the centrality and urban vitality of downtown areas (Figure 5.B). The juxtaposition of high NACH and NAIN values on main roads and in downtown highlights the interaction between vehicular traffic efficiency and urban centrality. The values of NACH and NAIN also enable us to distinguish the disparities in use and accessibility among these urban spaces according to their locations.

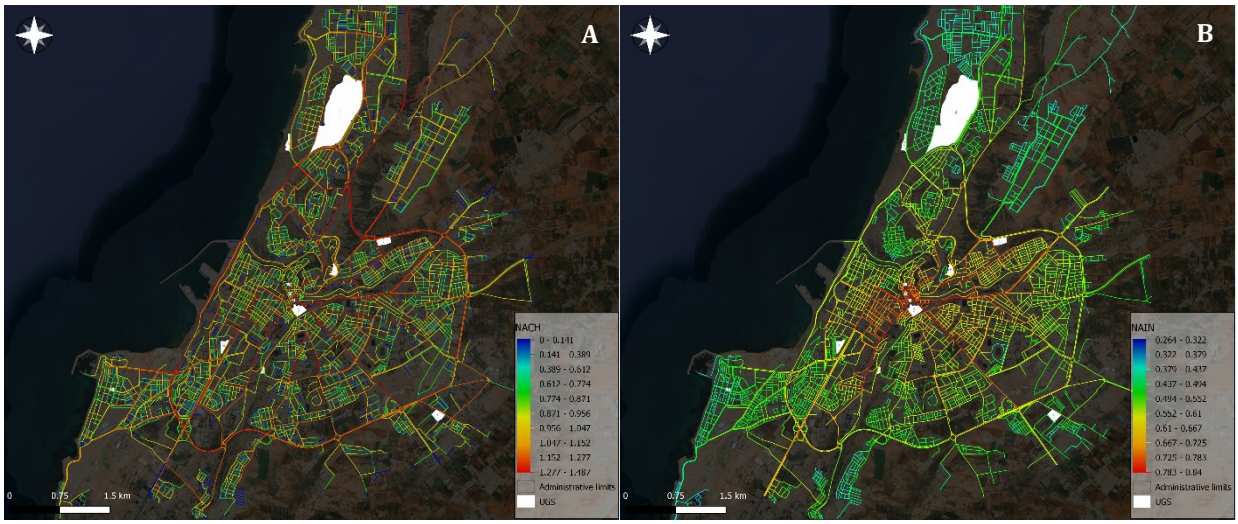


**Figure 5.** Visual representation of the global measures of NACH Rn and NAIN Rn.

The subsequent table presents the derived findings of the syntactic measures of the Angular Segment Analysis, providing insights into Angular connectivity, global and local normalized angular Choice and Integration (Table 2).

**Table 2:** Syntactic measures of the Angular Segment Analysis:

| ID | UGS name | Angular connectivity | NAIN R | NAIN R200 | NAIN R400 | NAIN R800 | NACH R | NACH R200 | NACH R400 | NACH R800 |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | **Mostaland** | 1.815 | 0.524 | 1.399 | 1.674 | 2.116 | 1.013 | 1.605 | 2.472 | 3.404 |
| **2** | **Emir Abd El Kader** | 2.445 | 0.781 | 2.003 | 2.361 | 2.690 | 1.255 | 3.143 | 4.190 | 4.940 |
| **3** | **Jannat El-Aarif** | 1.567 | 0.518 | 1.228 | 1.388 | 1.784 | 0.793 | 1.240 | 1.959 | 2.842 |
| **4** | **Houria** | 1.738 | 0.731 | 1.604 | 1.942 | 2.298 | 1.295 | 1.987 | 2.999 | 4.163 |
| **5** | **Foussha** | 1.885 | 0.551 | 1.275 | 1.736 | 2.203 | 0.571 | 1.479 | 2.037 | 2.422 |
| **6** | **Matrba** | 1.820 | 0.552 | 1.386 | 1.670 | 2.130 | 1.155 | 2.039 | 2.806 | 3.743 |
| **7** | **El Arsa** | 1.247 | 0.606 | 1.309 | 1.670 | 2.249 | 1.078 | 2.080 | 3.121 | 4.256 |
| **8** | **Es-salam** | 1.549 | 0.621 | 1.242 | 1.823 | 2.335 | 0.974 | 1.913 | 3.149 | 4.456 |
| **9** | **1st November** | 2.626 | 0.736 | 1.903 | 2.220 | 2.560 | 0.873 | 2.729 | 3.289 | 3.791 |
| **10** | **Salamandre** | 3.482 | 0.469 | 1.781 | 2.021 | 2.150 | 0.810 | 2.746 | 3.261 | 3.332 |
| **11** | **Boudjemaa** | 4.008 | 0.801 | 2.101 | 2.365 | 2.698 | 1.157 | 3.015 | 3.764 | 4.410 |
| **12** | **Barail** | 3.425 | 0.720 | 1.982 | 2.270 | 2.593 | 0.742 | 2.556 | 2.892 | 3.200 |

On the global scale, Boudjemaa, Emir Abd El Kader, 1st November, and Barail exhibit high connectivity and accessibility within their immediate environment (Figure 6). Located in the city center core areas and surrounded by economic and social functions, these spaces serve as central hubs for social interactions, recreational activities, and cultural events. Boudjemaa and Barail, situated in a bustling commercial district, attract numerous visitors seeking recreational opportunities within the historical urban fabric. The second city's largest park "Emir Abd El Kader" serves as a verdant oasis amidst the urban setting, offering playgrounds and relaxation amenities.

Despite having relatively lower NACH values compared to others, the 1st November Plaza in front of the Badr Mosque exhibits high NAIN values, indicating an optimal ease of access. This accessibility enhances its role as a central urban place with cultural and symbolic significance, fostering community cohesion and spiritual contemplation. These high integration and accessibility metrics extend to the local scale of the various radii (Figure 7), indicating that their location and proximity have a direct impact on accessibility despite the differences in terms of size and functions.

Likewise, Houria Park displays notable accessibility metrics on a city-wide scale, owing to its proximity to the national road 90 (Figure 6). However, varying centrality levels appear within local radii of 200m and 400m, scoring 1.608 and 1.942 respectively. The extensive green spaces of Houria Park blend smoothly with the neighbouring urban forest, creating an outstanding recreational destination for downtime. Nevertheless, there is restricted access to the park from adjacent residential areas, alongside a potential concern for vehicular air and noise pollution (Benameur et al., 2021).

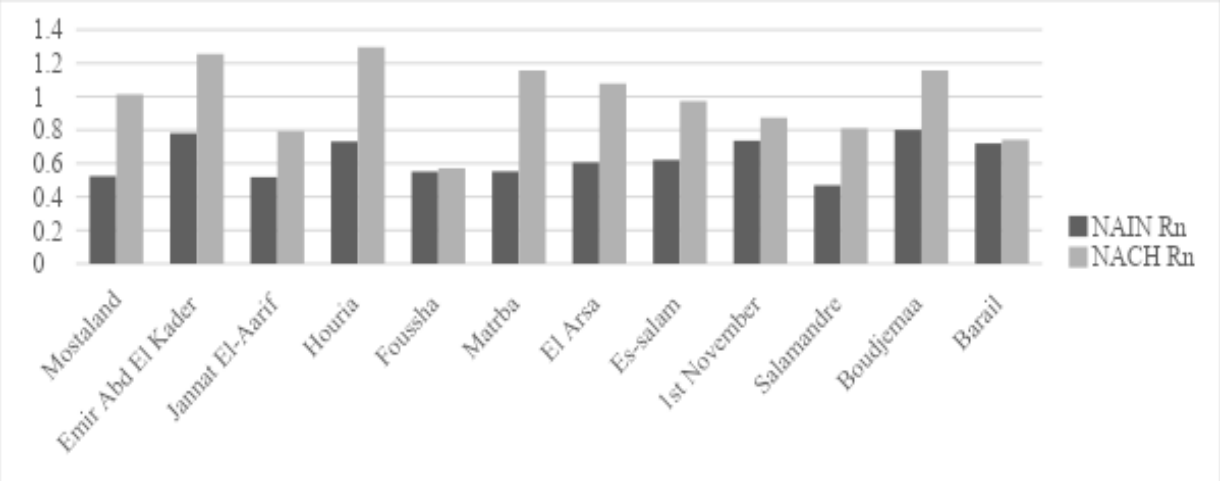


**Figure 6.** Global syntactic measures NAIN Rn, and NACH Rn attributed for the scrutinized UGSs.

The findings further demonstrate moderate integration and accessibility for Es-salam, El Arsa, Matrba, and Mostaland, on both global and local scales. The remoteness of Es-salam Square and El Arsa Park from residential areas may limit their accessibility at both global and local scales. Yet ongoing attempts to address safety issues may improve their usage as neighbourhood green spaces. Within the last two years, these spaces have benefited markedly from their proximity to the Khemisti and El Arsa tramway stations, respectively. Such alternatives potentially address crime and vandalism issues (Ogletree et al., 2022) and enable community revitalization and engagement opportunities.

Similarly, despite the segregation of the northern urban network, Matrba Plaza strikes a balance between global and local priorities, emphasizing moderate accessibility on both scales. Conveniently situated alongside the road leading to the swimming beaches, it offers numerous entertaining opportunities for families and their children. In addition, the promenade and playground areas enhance its appeal as a verdant and scenic place offering panoramic views of the Mediterranean, attracting residents and visitors alike.

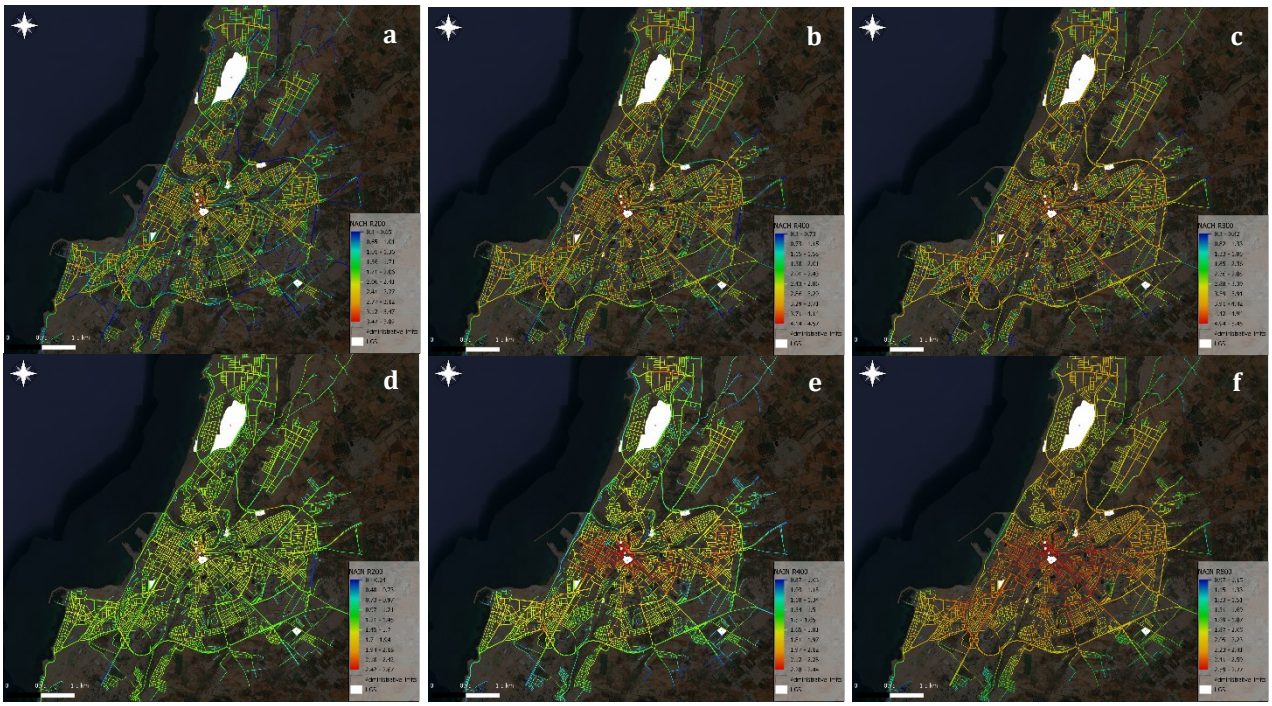


**Figure 7.** Visual representation of the local measures of NACH Rn and NAIN Rn (*a: NACH R200, b: NACH R400, c: NACH R800, d: NAIN R200, e: NAIN R400, f: NAIN R800*).

Located in the north-east of Mostaganem city, Mostaland Park is a comprehensive entertainment venue suitable for visitors and tourists of all ages. It features a variety of high-quality recreational and attraction facilities, including a zoo, indoor and outdoor play structures, a swimming pool, a go-kart track, quad biking trails, a central esplanade with a musical fountain, an artificial lake, picnic areas, a luxury hotel complex, retail outlets and a wide range of catering options. However, the configurational analysis shows a moderate global integration of 0.524, notwithstanding its extensive size and outstanding infrastructure. This highlights several accessibility issues brought on by the location of this national park, which limit its attractiveness and usage.

In addition, the Foussha garden displays a severe concern about accessibility, explained by the moderate integration Rn of 0.551, and the low measures of 1.479, 2.037, and 2.422 for the respective hierarchical radii, despite its ideal location within a residential area of 400 dwellings and its proximity to the main facilities, including the old central station. Consequently, recent redevelopment strategies have been implemented to improve the quality of the garden's interior spaces. Such endeavours sought to provide alternatives to address the current accessibility issue.

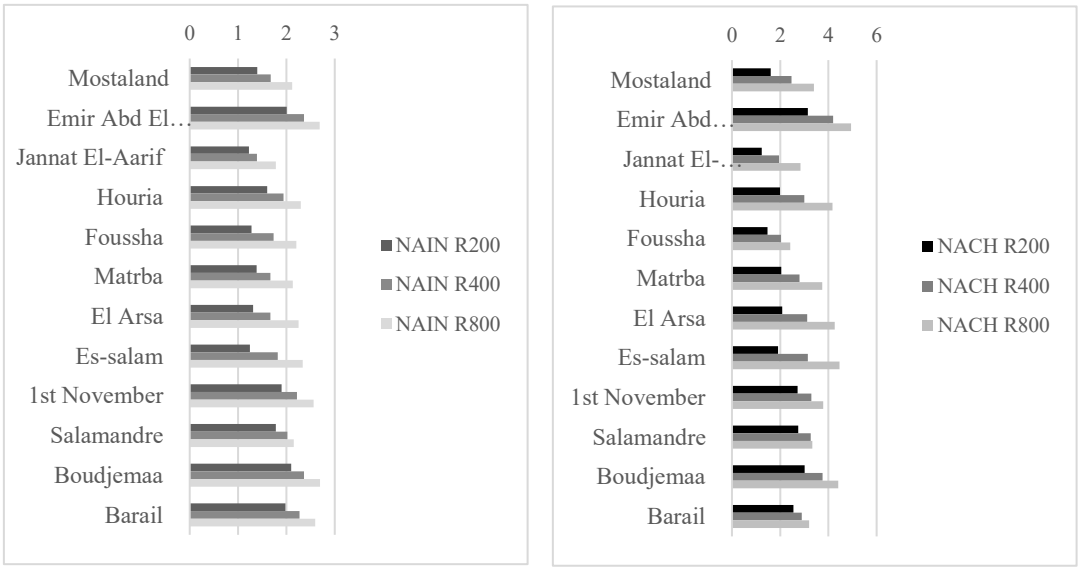


**Figure 8.** Local Normalized Angular Integration and Choice.

Moreover, the location of Salamandre Square on the western outskirts of the municipality illustrates desegregation and difficulty in achieving strong connectivity within the urban fabric. Despite these limitations, this UGS plays a vital local role, illustrated by its ranking in the Pareto diagram, which shows a high degree of integration on different radii, specifically for the 400m radius which corresponds to 5 minutes-walk where the NAIN values reach 2.021 (Figure 9). Salamandre Plaza, also known as Palestine Square, represents a key element of the attractive continuity of the Salamandre Corniche, contributing to the district's appeal as a recreational asset and capturing visitors keen for a convivial family gathering space. Conversely, “Jannat El Aarif” or the connoisseur's paradise, as translated into Arabic, ranked last among the UGS analysed (Figure 9), scoring the least syntactic metrics such as angular connectivity, integration and choice at all levels. This signifies an alarming accessibility problem that requires immediate consideration and improvement to reinforce its socio-cultural functions.

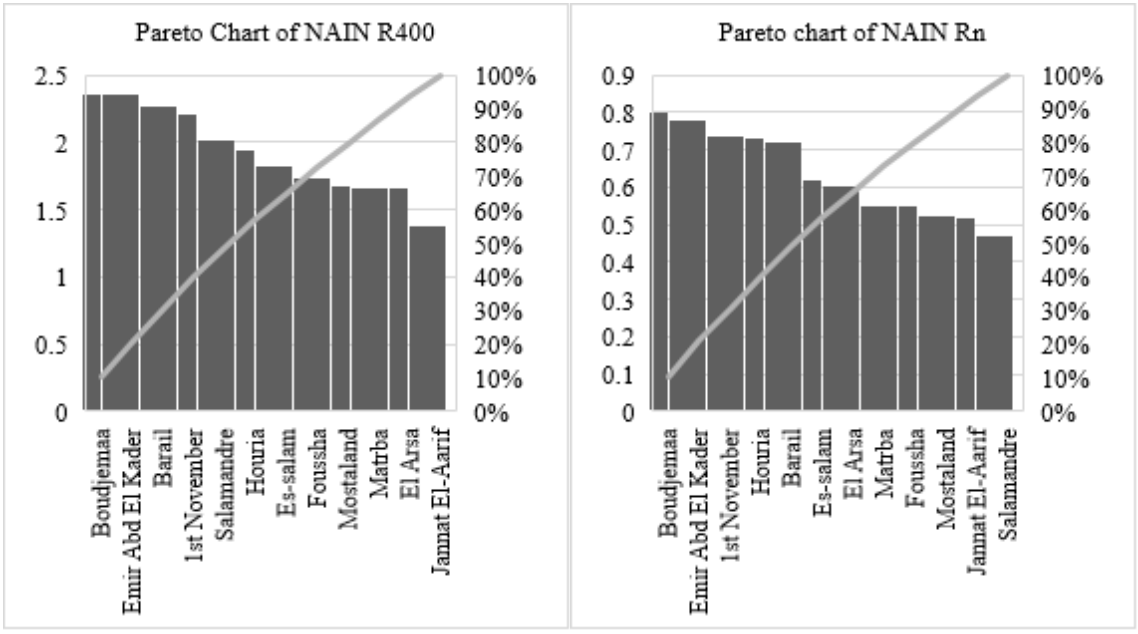


**Figure 9.** Pareto charts of NAIN Rn and NAIN R400.

## 5. Conclusion

This research provides a framework that bridges the relationship between accessibility and sustainability of urban green spaces. The angular segment Analysis enables the assessment of this factor on a global and local scale and provides an insightful comprehension of users' priorities and how these spaces operate and function across various scales. It further highlights the pivotal role of accessibility as a key factor in shaping urban development strategies in Mostaganem City. The analysis of exemplary urban green spaces demonstrates significant disparities in accessibility, highlighting three interrelated challenges:

**1. Unequal Distribution of Green Spaces**: The limited availability of land results in spatial inequality. Urban green spaces in downtown Mostaganem, characterized by high connectivity and accessibility, serve as key hubs for social interaction, recreation, and cultural activities. In contrast, spaces on the city's outskirts, such as Jannat El Aarif, face significant accessibility challenges at both global and local levels. The large size and diverse amenities of Mostaland help mitigate some accessibility issues despite its segregated network, emphasizing the impact of physical attributes like size, location, and spatial quality on user experience and community engagement. While distribution, dimensions, and quality enhance user satisfaction, ease of access ultimately dictates usage.

**2. Lack of Priority in Urban Planning**: Green spaces often receive inadequate development and maintenance due to their low priority in urban planning. This deficiency impacts accessibility for nearby residents and may lead to security and vandalism concerns, as observed in El Arsa and Es-Salam parks.

**3. Insufficient Variety of Facilities**: Many green spaces suffer from a lack of diverse facilities and amenities, negatively affecting their overall quality and functionality. However, recent strategies by authorities to revitalize and restructure these spaces, including Foussha Garden, show promise.

To address these challenges effectively, enhancing infrastructure and transportation networks in peripheral and segregated areas can improve accessibility, promoting sustainable urban mobility. Prioritizing the development and maintenance of green spaces, especially those with high connectivity, can enhance the quality of life and contribute to environmental sustainability. Efforts to improve accessibility to parks and public spaces in peripheral areas can boost community well-being and promote social cohesion. Implementing strategies to improve safety and engage communities can maximize the potential of these spaces, enhancing their sustainability and usability. Moreover, designing urban spaces with mixed land uses and interconnected networks can reduce reliance on private vehicles, promote active transportation, and support a more sustainable urban lifestyle.

This research acknowledges several limitations. There are literature gaps related to the topic within the Algerian context, particularly concerning the application of regulations and laws, which is where the novelty of our research lies. These gaps highlight the need for further detailed studies specific to Algeria's unique urban landscape. Future research should aim to combine the methods used and the findings with surveys and subjective assessments to better understand accessibility and sustainability. Additionally, generalizing the applicability of this approach to other Algerian cities, which share similar issues regarding urban green spaces' accessibility, can provide broader insights and solutions.

By implementing these recommendations and addressing the identified limitations, Mostaganem can overcome current obstacles and ensure equitable access to high-quality urban green spaces for all residents. This research not only contributes to the academic understanding of urban green spaces but also offers practical strategies for urban planners and policymakers in Algeria.

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**Conflict of Interests**
The authors declare no conflict of interest.

**Data availability statement**
The data that support the findings of this study are available from the corresponding author, [Dr. Okba Benameur], upon reasonable request.

**CRediT author statement:**
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**References**
Addas, A. (2023). Influence of Urban Green Spaces on Quality of Life and Health with Smart City Design. *Land*, *12*(5), 960. https://doi.org/10.3390/land12050960

Ahmadi Venhari, A., Tenpierik, M., & Taleghani, M. (2019). The role of sky view factor and urban street greenery in human thermal comfort and heat stress in a desert climate. *Journal of Arid Environments*, *166*, 68–76. https://doi.org/10.1016/j.jaridenv.2019.04.009

Anwar, M. M., Hashim, M., Aziz, A., Stocco, A., Abdo, H. G., Almohamad, H., Al Dughairi, A. A., & Al-Mutiry, M. (2023). Urban Green Spaces Distribution and Disparities in Congested Populated Areas: A Geographical Assessment from Pakistan. *Sustainability*, *15*(10), 8059. https://doi.org/10.3390/su15108059

Bayoumi, M., Luomi, M., Fuller, G., AlSarihi, A., Salem, F., & Verheyen, S. (2022). Arab region SDG Index and dashboard report 2022. In *Dubai, Abu Dhabi and New York: Mohammed bin Rashid School of Government, Anwar Gargash Diplomatic Academy and UN Sustainable Development Solutions Network.*

Belmeziti, A., Cherqui, F., & Kaufmann, B. (2018). Improving the multi-functionality of urban green spaces: Relations between components of green spaces and urban services. *Sustainable Cities and Society*, *43*, 1–10. https://doi.org/10.1016/j.scs.2018.07.014

Benameur, O., Altafini, D., & Cutini, V. (2021). Form, Function and Acoustics: Productive Assets Placement and Relationship Between the Urban Soundscape Patterns and Configuration. *Lecture Notes in Computer Science*, 704–718. https://doi.org/10.1007/978-3-030-86973-1_49

Branas, C. C., Cheney, R. A., MacDonald, J. M., Tam, V. W., Jackson, T. D., & Ten Havey, T. R. (2011). A difference-in-differences analysis of health, safety, and greening vacant urban space. *American Journal of Epidemiology*, *174*(11), 1296–1306. https://doi.org/10.1093/aje/kwr273

Buckland, M., & Pojani, D. (2023). Green space accessibility in Europe: a comparative study of five major cities. *European Planning Studies*, *31*(1), 146–167. https://doi.org/10.1080/09654313.2022.2088230

Chen, B., Nie, Z., Chen, Z., & Xu, B. (2017). Quantitative estimation of 21st-century urban greenspace changes in Chinese populous cities. *Science of The Total Environment*, *609*, 956–965.

https://doi.org/10.1016/j.scitotenv.2017.07.238

Dipeolu, A. A., Akpa, O. M., & Fadamiro, A. J. (2020). Mitigating Environmental Sustainability Challenges and Enhancing Health in Urban Communities: The Multi-functionality of Green Infrastructure. *Journal of Contemporary Urban Affairs*, *4*(1), 33–46. https://doi.org/10.25034/ijcua.2020.v4n1-4

Du, H., Cai, W., Xu, Y., Wang, Z., Wang, Y., & Cai, Y. (2017). Quantifying the cool island effects of urban green spaces using remote sensing Data. *Urban Forestry & Urban Greening*, *27*, 24–31. https://doi.org/10.1016/j.ufug.2017.06.008

Festa, G., Butera, A., & Meraviglia, M. V. (2022). Green Space for health promotion. *Journal of Advanced Health Care*, *4*(3), 5–12. https://doi.org/10.36017/jahc202243212

Gherraz, H., Guechi, I., & Alkama, D. (2020). Quantifying the effects of spatial patterns of green spaces on urban climate and urban heat island in a semi-arid climate. *Bulletin de La Société Royale Des Sciences de Liège*, *89*, 164–185. https://doi.org/10.25518/0037-9565.9821

Haq, S. M. A. (2011). Urban Green Spaces and an Integrative Approach to Sustainable Environment. *Journal of Environmental Protection*, *02*(05), 601–608. https://doi.org/10.4236/jep.2011.25069

Hillier, B. (2007). Space is the machine: A configurational theory of architecture. In *Space Syntax*. London, UK.

Hillier, B., & Hanson, J. (1984). *The Social Logic of Space*. Cambridge University Press. https://doi.org/10.1017/CBO9780511597237

Hillier, B., Yang, T., & Turner, A. (2012). Normalising least angle choice in Depthmap and it opens up new perspectives on the global and local analysis of city space. *Journal of Space Syntax*, *3*(2), 155–193.

Huang, B.-X., Li, W.-Y., Ma, W.-J., & Xiao, H. (2023). Space Accessibility and Equity of Urban Green Space. *Land*, *12*(4), 766. https://doi.org/10.3390/land12040766

Lee, A., Jordan, H., & Horsley, J. (2015). Value of urban green spaces in promoting healthy living and wellbeing: prospects for planning. *Risk Management and Healthcare Policy*, *8*, 131. https://doi.org/10.2147/RMHP.S61654

Leghrib, F., Mazouz, S., Laroui, A., & Benameur, O. (2021). Introducing Urban Growth Models (UGM) in the Algerian Urban Planning Practice: Advantages and Drawbacks. In *Contemporary Approaches in Urbanism and Heritage Studies* (pp. 119–130). Cinius Yayınları Publication. https://doi.org/10.38027/N11ICCAUA2021272

Li, Y.-Y., Ren, B.-T., Chen, Y.-S., Huang, L.-C., & Sun, C.-G. (2022). Multiscale spatiotemporal dynamics analysis of urban green space: Implications for green space planning in the rapid urbanizing Hefei City, China. *Frontiers in Ecology and Evolution*, *10*, 1–18. https://doi.org/10.3389/fevo.2022.998111

Long, Y., Qin, J., Wu, Y., & Wang, K. (2023). Analysis of Urban Park Accessibility Based on Space Syntax: Take the Urban Area of Changsha City as an Example. *Land*, *12*(5), 1–15. https://doi.org/10.3390/land12051061

Mears, M., & Brindley, P. (2019). Measuring Urban Greenspace Distribution Equity: The Importance of Appropriate Methodological Approaches. *ISPRS International Journal of Geo-Information*, *8*(6), 286. https://doi.org/10.3390/ijgi8060286

Moisa, M. B., Merga, B. B., Deribew, K. T., Feyissa, M. E., Gurmessa, M. M., & Gemeda, D. O. (2023). Urban green space suitability analysis using geospatial techniques: a case study of Addis Ababa, Ethiopia. *Geocarto International*, *38*(1). https://doi.org/10.1080/10106049.2023.2213674

Morales, J., Flacke, J., Morales, J., & Zevenbergen, J. (2019). Mapping Urban Accessibility in Data Scarce Contexts Using Space Syntax and Location-Based Methods. *Applied Spatial Analysis and Policy*, *12*(2), 205–228. https://doi.org/10.1007/s12061-017-9239-1

Ogletree, S. S., Larson, L. R., Powell, R. B., White, D. L., & Brownlee, M. T. J. (2022). Urban greenspace linked to lower crime risk across 301 major U.S. cities. *Cities*, *131*.

https://doi.org/10.1016/j.cities.2022.103949

Orsetti, E., Tollin, N., Lehmann, M., Valderrama, V. A., & Morató, J. (2022). Building Resilient Cities: Climate Change and Health Interlinkages in the Planning of Public Spaces. *International Journal of Environmental Research and Public Health*, *19*(3), 1–22. https://doi.org/10.3390/ijerph19031355

Pataki, D. E., Carreiro, M. M., Cherrier, J., Grulke, N. E., Jennings, V., Pincetl, S., Pouyat, R. V., Whitlow, T. H., & Zipperer, W. C. (2011). Coupling biogeochemical cycles in urban environments: Ecosystem services, green solutions, and misconceptions. *Frontiers in Ecology and the Environment*, *9*(1), 27–36. https://doi.org/10.1890/090220

Roy, S., Byrne, J., & Pickering, C. (2012). A systematic quantitative review of urban tree benefits, costs, and assessment methods across cities in different climatic zones. *Urban Forestry and Urban Greening*, *11*(4), 351–363. https://doi.org/10.1016/j.ufug.2012.06.006

Serra, M., & Hillier, B. (2019). Angular and Metric Distance in Road Network Analysis: A nationwide correlation study. *Computers, Environment and Urban Systems*, *74*, 194–207. https://doi.org/10.1016/j.compenvurbsys.2018.11.003

Shahtahmassebi, A. R., Li, C., Fan, Y., Wu, Y., Lin, Y., Gan, M., Wang, K., Malik, A., & Blackburn, G. A. (2021). Remote sensing of urban green spaces: A review. *Urban Forestry & Urban Greening*, *57*. https://doi.org/10.1016/j.ufug.2020.126946

Strohbach, M. W., Arnold, E., & Haase, D. (2012). The carbon footprint of urban green space-A life cycle approach. *Landscape and Urban Planning*, *104*(2), 220–229. https://doi.org/10.1016/j.landurbplan.2011.10.013

Tannous, H. O., Major, M. D., & Furlan, R. (2021). Accessibility of green spaces in a metropolitan network using space syntax to objectively evaluate the spatial locations of parks and promenades in Doha, State of Qatar. *Urban Forestry & Urban Greening*, *58*, 126892. https://doi.org/10.1016/j.ufug.2020.126892

Tok, E., Agdas, M. G., Ozkok, M. K., & Kuru, A. (2020). Socio-Psychological Effects of Urban Green Areas: Case of Kirklareli City Center. *Journal of Contemporary Urban Affairs*, *4*(1), 47–60. https://doi.org/10.25034/ijcua.2020.v4n1-5

Turner, A. (2007). From Axial to Road-Centre Lines: A New Representation for Space Syntax and a New Model of Route Choice for Transport Network Analysis. *Environment and Planning B: Planning and Design*, *34*(3), 539–555. https://doi.org/10.1068/b32067

Turner, A. (2009). Stitching Together the Fabric of Space and Society an Investigation into the Linkage of the Local to Regional Continuum. In D. Koch, L. Marcus, & J. Steen (Eds.), *the 7th International Space Syntax Symposium* (pp. 116.1-116.12).

United Nations. (2019). World Urbanization Prospects: The 2018 Revision. In *Demographic Research* (Vol. 12). UN. https://doi.org/10.18356/b9e995fe-en

United Nations. (2022). Challenges of sustainable urban development. In *Science, Technology and Innovation for Sustainable Urban Development in a Post-pandemic World* (pp. 2–9). United Nations. https://doi.org/10.18356/9789210018920c004

van Maarseveen, M., Martinez, J., & Flacke, J. (2018). GIS in Sustainable Urban Planning and Management. In *GIS in Sustainable Urban Planning and Management*. CRC Press. https://doi.org/10.1201/9781315146638

van Nes, A., & Yamu, C. (2021). Analysing Linear Spatial Relationships: The Measures of Connectivity, Integration, and Choice. In *Introduction to Space Syntax in Urban Studies* (pp. 35–86). Springer International Publishing. https://doi.org/10.1007/978-3-030-59140-3_2

Vilcins, D., Sly, P. D., Scarth, P., & Mavoa, S. (2022). Green space in health research: an overview of common indicators of greenness. *Reviews on Environmental Health*, *39*(2), 221–231. https://doi.org/10.1515/reveh-2022-0083

Wang, J., Zhou, W., Qian, Y., Li, W., & Han, L. (2018). Quantifying and characterizing the dynamics

of urban greenspace at the patch level: A new approach using object-based image analysis. *Remote Sensing of Environment*, *204*, 94–108. https://doi.org/10.1016/j.rse.2017.10.039

Wolch, J. R., Byrne, J., & Newell, J. P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough.' *Landscape and Urban Planning*, *125*, 234–244. https://doi.org/10.1016/j.landurbplan.2014.01.017

Yu, Z., Guo, X., Zeng, Y., Koga, M., & Vejre, H. (2018). Variations in land surface temperature and cooling efficiency of green space in rapid urbanization: The case of Fuzhou city, China. *Urban Forestry & Urban Greening*, *29*, 113–121. https://doi.org/10.1016/j.ufug.2017.11.008

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