Architecture Image Studies

Vol.7, Issue 1, pp.3104-3113, 2026
DOI: https://doi.org/10.62754/ais.v7i1.1394

https://journals.ap2.pt/index.php/ais/index

Towards Thermal Requalification of a Degraded University Campus Node in Hot-Arid Climates. The Case of Biskra City, Algeria

Nabila Bouabdallah[1], Djamel Alkama[2]

Abstract

University campuses in hot-arid climates frequently exhibit a paradox that classical urban design theory cannot explain: a geometrically central, well-connected outdoor space remains socially empty, while an adjacent space of lesser structural prominence sustains rich voluntary activity. At the university of Biskra, Algeria, the central plaza — the primary pedestrian node of the campus, where all major routes converge — functions in summer as a mandatory crossing point only, while the adjacent central garden retains its role as a place of social gathering and extended stay. Spatial configuration theories — primarily Lynch's node concept and Gehl's pedestrian quality framework — were formulated in temperate climates where thermal accessibility of outdoor space could be taken for granted. Applied to hot-arid contexts, they identify the right spatial variables but cannot account for the seasonal reversal in plaza use: the plaza is socially active in winter, void in summer, with its spatial configuration unchanged between seasons. This study argues that the missing variable is thermal viability — the physiological capacity of a space to sustain voluntary presence — which functions as a threshold condition that gates all other attractiveness factors. Through a multi-method comparative study combining microclimatic investigation, behavioral observation and user perception survey, the study demonstrates the dominant role of thermal conditions in shaping spatial preference, showing that adjacent spaces can exhibit fundamentally different usage patterns due to microclimatic variation. The study contributes to climate-responsive design by emphasizing the importance of vegetation and shading in enhancing outdoor usability and demonstrating how extreme conditions suppress voluntary activity regardless of spatial quality, and that the garden's vegetated microclimate already provides the locally validated design precedent for plaza requalification. The study extends Lynch's node concept by proposing thermal viability as a necessary fourth condition for nodal function in hot-arid climates.

Keywords: *Thermal Comfort, Outdoor Spaces, University Campus, Hot-Arid Climate, Node Theory, Vegetation, Biskra.*

Introduction

Beyond being merely a collection of isolated buildings, the morphology of a university campus is fundamentally defined by its outdoor spaces as a whole. These spaces constitute the essential conceptual and socio-functional infrastructures for the success and development of the university ecosystem and to the well-being of its users [1, 2]. Rather than acting as mere residual voids between academic blocks, these outdoor spaces serve as a genuine connective tissue (a structural framework) that ensures the site's spatial continuity (buildings interconnection), the organization of movement, and the creation of structuring visual landmarks vital to the identity enhancement of the place [3, 4].

In addition to their purely spatial function, these shared spaces form the beating heart of social and intellectual life in higher education institutions. They encourage informal encounters and incidental cross- disciplinary exchanges between the various actors of the academic community [5]. As places for relaxation, entertainment, and collaborative activities, they transform the campus into an inclusive environment that strengthens a sense of belonging and social cohesion [6, 7]. By extending the academic experience beyond the classroom walls, outdoor spaces provide a complete break from the

[1] Depatement of Architecture, Mohamed Khider University-Biskra (MKUB), Biskra 07000, Algeria. nabila.Bouabdallah @univ-biskra.dz, (Corresponding Author)
[2] Department of Architecture, University of 08 May 1945-Guelma, Guelma 24000, Algeria. alkama.djamel@univ-guejma.dz

confined and stressful atmosphere of lecture halls. This helps reduce stress levels among students and contributes to the mental recovery, restoration and overall well-being of users [8, 9].

However, the ability of an open university space to fully fulfill its role — meaning to become a true living space rather than a mere transit zone— depends on several key factors. These include three-dimensional morphology, accessibility, the degree of spatial enclosure, the availability of necessary infrastructure and urban furniture, vegetation density, shading, and favorable local microclimatic conditions, which strongly influence user stay time [4, 10,11]. Understanding how these factors combine and identifying those that are decisive is the central problem of this study.

According to classical urban design theories, the quality of an outdoor space is primarily assessed through its spatial configuration, even its architecture, which corresponds to the three-dimensional arrangement of its buildings, pathways, and voids [12]. When this arrangement is clear—characterized by distinct outlines, balanced proportions, and obvious directions that eliminate visual confusion — it transmits immediate visual signals. These allow users to find their way around easily and feel secure, thus generating the "legibility" that is crucial for activating social life [3].

This psychological translation of physical form highlights the importance of spatial security, which is essential for the development of sedentary and social activities. In this respect, a space that is too vast and lacks landmarks tends to generate a feeling of vulnerability akin to the desert’s immensity, driving users towards a rapid and linear transit. Conversely, an architectural configuration that shapes a well-defined boundary (the effect of enclosure or framing) provides a sense of physical security, encouraging people to pause and engage in discussion.

It is precisely this interaction that gives rise to the concept of “legibility”, referring here to the ease with which individuals can decipher the environment, anticipate routes, and identify sub-spaces. For an outdoor space to be fully and sustainably invested by its users, it must therefore first be easily decoded [13]. To this end, the renowned theorist Kevin Lynch [3] explains that this environmental legibility relies on the articulation of five key elements: paths, edges, districts, landmarks, and nodes. It is the harmonious assembly of these components that allows individuals to understand space in order to better appropriate it.

While university campuses present a wide typological diversity of open spaces — ranging from transitional spaces like pedestrian walkways to sedentary zones like plazas, squares, or lawns — this research focuses specifically on the concept of the "node" as the primary object of study. This choice is justified by the strategic role this entity plays in the spatio-functional organization and social life of campuses. As a place where flows converge, circulations are linked, and social activity is intense, the node emerges as the major connecting element capable of combining both a spatio-morphological dimension (the centrality of flows) and a socio-behavioral dimension (the co-presence and concentration of activities) [14].

At these specific crossroads individuals stop, sit, and are subjected to the effects of the local microclimate over an extended period. While pathways are traversed and landmarks are contemplated from a distance, nodes, on the other hand, represent the places where university life takes root and is fully experienced [3]. The node thus constitutes the most relevant space for jointly assessing the spatial legibility of a site, the collective practices unfolding within it, and the direct influence of climatic conditions on user comfort and attendance [15]. This dual function of the node therefore calls for a cross-analytical approach, both morphological and behavioral, allowing us to simultaneously grasp its place in the spatial organization of the campus and the dynamics of activity it fosters. It is from this perspective that the approaches of Kevin Lynch and Jan Gehl prove not only complementary but indispensable.

In Kevin Lynch's seminal work [3], the concept of the node emerges as the primary source of urban vitality, as it gathers flows, organizes movement, and enhances the city's legibility. It differs from a simple street intersection through its structural connectivity and strong imageability, a quality that makes it a memorable and meaningful space. The arrangement of these nodes ensures the animation and social appropriation of the place by creating, for example, an enclosure effect conducive to a sense of security. Applying Lynch's theory to the university context, nodes are not merely cognitive landmarks but also essential points of articulation within the space, where circulation, encounters, pauses, and social activities converge, thus supporting collective life by acting as platforms for exchange between different, strictly pedagogical timeframes. This approach allows us to adapt the theory of imageability, initially developed for cities, to the study of university outdoor spaces.

While Lynch [3] through his theory of imageability, provided a powerful conceptual framework for understanding how the morphological elements of university public spaces — particularly nodes — facilitate users' perception, memorization, and cognitive structuring of the site, his approach remains essentially morphological and static. It accurately describes what makes a space legible and memorable but fully overlooks the physiological conditions that allow users to linger. It is at this level that Jan Gehl's [4] behavioral approach intervenes, complementing the Lynchian vision by introducing the dynamics of usage and emphasizing the conditions of presence within university outdoor spaces.

By demonstrating that the quality of an outdoor space is also measured by its capacity to foster optional and social activities—true indicators of its vitality—beyond purely necessary activities, Gehl proves that the visual quality or centrality of a hub is not enough to guarantee its vitality: the crucial shift from simple obligatory transit (crossing the square) to voluntary social activity (stopping to chat) is conditioned by a set of qualitative criteria. From this perspective, users only linger if the environment offers comfortable seating, protection from external aggressions, and welcoming edges (the edge effect). In the context of the campus, this approach helps us understand how nodes, beyond their directional role, contribute to collective life and the social appropriation of outdoor spaces by being welcoming, comfortable, and conducive to stopping, meeting, and appropriating them.

Taken together, these two theoretical frameworks appear to constitute a comprehensive analytical toolkit for understanding why some spaces generate social life while others remain deserted. However, they share a fundamental limitation that neither explicitly formulated: their theories were developed and validated in temperate climatic contexts, where the thermal accessibility of outdoor spaces could be taken for granted. Neither Lynch, who developed his analytical framework in Boston, New Jersey, and Los Angeles, nor Gehl, whose seminal work focused primarily on Copenhagen and northern European cities, had to question the possibility that a space could be morphologically well-configured, visually identifiable, and theoretically conducive to optional activities, while remaining socially empty due to a radical physiological constraint: severe outdoor thermal stress that exceeds the human body's tolerance thresholds.

This research addresses precisely this critical gap. We hypothesize that external thermal comfort is not merely a secondary parameter, but rather the true limiting or triggering factor in the vitality of a space. While the spatial configuration creates the potential for occupancy, microclimatic conditions that determine the reality of its use, and this across all temporal scales (throughout the day and with the changing seasons).

Materials and Methods

Study Area

This study was conducted at the central campus of Mohamed Khider University of Biskra (MKUB), a major city in southeastern Algeria (34°48′ N, 5°44′ E) (Figure 1). According to the Köppen-Greiger climate classification, Biskra belongs to the BWh zone, corresponding to a hot Saharan climate (Figure 2) [16]. This latter, as shown in Figure 3, is characterized by arid and hot summers, during which daytime outdoor temperatures can exceed 42°C. This heat load is exacerbated by high-intensity direct solar radiation (356.7 hours), minimal relative humidity (25.06%), very low annual rainfall (< 150 mm) and weak (3.57 m/s), hot, dry winds, insufficient to provide significant evaporative cooling [17]. These severe conditions exacerbate pedestrians' thermal discomfort.

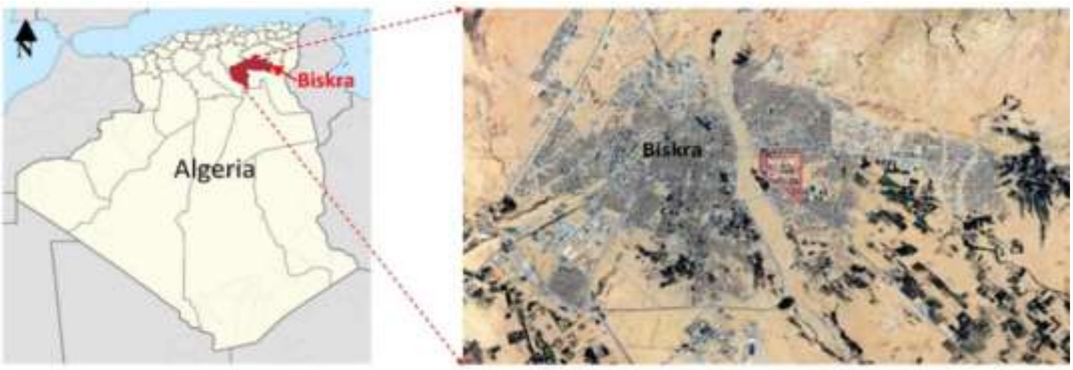

Figure 1: Location of university campus.

Source: authors, 2025

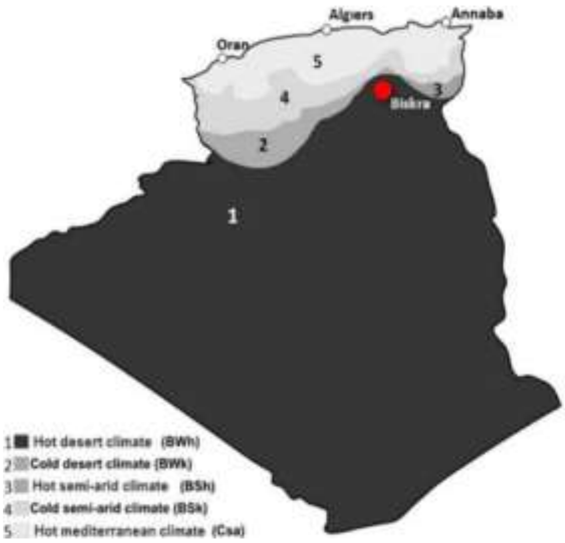

Figure 2: Climate classification of Biskra**.**

Source : Naouri et al., 2017

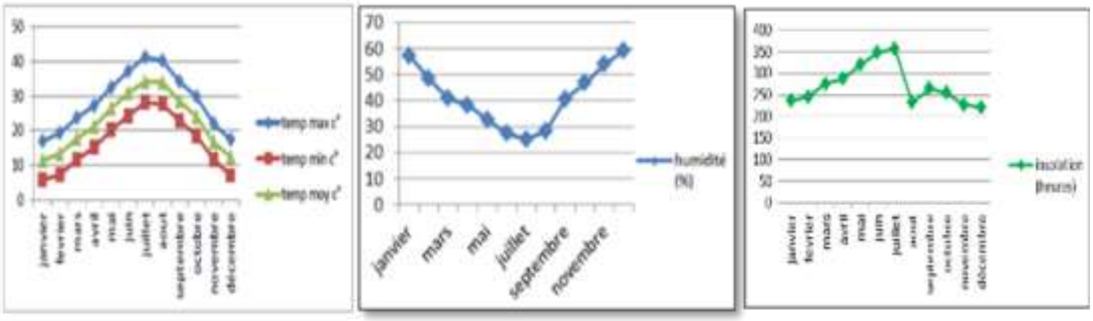

Figure 3 : Climate data of Biskra**.**

Source : O.N.M Biskra, 2020

Located in the heart of the city of Biskra, within a dense, heterogeneous urban fabric (Figure 1), and being the historical, administrative (home of the rectorate), and scientific heart of the institution (the birthplace of its fundamental faculties), the central campus hosts roughly 18.000 students, representing 60% of the university's total teaching load, with a daily flow of between 11,000 and 14,000 people. This latter generates an intense pedestrian and vehicular traffic.

In terms of morphology, the central campus presents a heterogeneous urban fabric, characterized by an alternation of low-rise blocs and some recent vertical buildings. Its outdoor design is heavily mineralized dominated by low-albedo surface materials (asphalt, concrete) (vast plazas exposed to solar radiation) which absorb intense daytime solar radiation and release it as heat at night, thereby exacerbating the heat island effect. In turn, the site's vegetative component appears particularly fragmented and limited to some few common local species (palms, ficus). Thus, this site is an ideal in situ laboratory for evaluating how spatial morphology and microclimate influence the behavior and social practices of its users.

The spatial layout of the University of Biskra's central campus is organized around a central outdoor pedestrian axis linking the main entrance, the car parks, the central spaces (the square and the garden) and the various teaching buildings (Figure 3). Applying an analytical approach inspired by Lynch's work to this layout reveals a clear and striking nodal hierarchy: whilst the main entrance serves as the point of access, the central square and the garden constitute the dominant nodes of the site. Ideally situated at the intersection of the routes leading to the faculties, these two spaces concentrate the majority of pedestrian traffic and social activities. In short, they form the functional and social heart of the institution.

With diametrically opposed spatial and environmental characteristics, offering two contrasting physical typologies, these two spaces prove ideal for our research. The comparative in situ assessment of these two spaces aims to measure the direct impact of the ‘mineral–vegetation’ pairing on the local outdoor thermal environment and on users’ behavior and practices. From a thermophysical perspective, the central square is a highly mineralized space, exposed to direct solar radiation and conducive to the rapid movement of students (transit) seeking comfort. Conversely, the central garden offers a shaded landscape that encourages prolonged stays and social interaction. This morphological and behavioral difference provides the empirical basis essential for this study.

Figure 4 : MKUB Campus spatial layout and the study sites.

Source : authors, 2025

Methods and Materials

To translate our socio-spatial diagnosis into quantifiable and usable data, we developed a mixed-methods approach based on an in-situ microclimatic measurement campaign coupled with a behavioral observation and a questionnaire survey. The objective is to correlate the physical parameters of the two studied nodes with students' spatial experience and sensory perceptions within the space in order to precisely measure the impact of heat stress on users. To overcome the constraints of the academic calendar while capturing the most critical thermal conditions for users, the measurement and behavioral observation campaign took place during the month of June. This period of high academic activity (classes, exams, thesis defenses, etc.) ensures maximum student presence on campus despite the already sweltering heat. This approach allows us to directly link real social dynamics with the most severe climatic constraints for a holistic understanding of spatial attributes and usage patterns in open spaces and help mitigates the biases that could arise from relying on a single method and strengthens the validity of the findings through data triangulation. The investigation days were rigorously selected based on local weather forecasts in order to target typical days of intense heat. These are characterized by clear skies, maximum solar radiation, and low wind speeds. The overall campaign was thus spread over three representative study days.

Microclimatic measurements were conducted across six measurement points distributed equally between the two studied spaces to best capture the site's microclimatic and morphological diversity. Within the central plaza, the three points were located to track the evolution of heat and projected shadows. They include a point at the center of the plaza (permanently exposed), a point on the western edge near the parking lot, and a point under the arcades (offering fixed structural shading). Within the central garden, three points were selected to evaluate the thermal efficiency and cooling capacity of the vegetation. They integrate a fully cleared and sunny zone (control point), a semi-shaded zone under sparsely foliated trees, a fully shaded zone beneath a dense canopy.

This methodological choice allows for a fine capture of microclimatic variations within each space and a comparison of data across the entire thermal gradient, from full solar exposure to the maximum shading provided by the tree canopy. All climatic parameters (air temperature, relative humidity, wind speed, and surface temperature) were recorded at these measurement points using digital instruments (Testo 480 multifunction anemometer) (figure 5) at a fixed height of 1.1m above the ground.

Figure 5 : Anemometer testo 480**.**

Source: authors, 2025

Alongside the physical measurements, and in order to record the students' reactions to the heat, we used a standardized observation method at both study sites. This research tool enabled us to record the following socio-physical variables at four-minute intervals, using a behavioral analysis grid:

- **Density and spatial distribution:** instantaneous mapping of land use to locate clusters of students.
- **Types of activities:** distinction between dynamic activities (rapid transit flows) and static activities (discussions, revision, rest).
- **Body postures:** identification of the positions adopted (sitting on street furniture, standing, leaning against walls).
- **Passive adaptation strategies:** identification of the spontaneous seeking of shade provided by architectural features (arcades) or vegetation (the garden's canopy).

Across all our study sites, physical surveys were carried out during four strategic time slots: from 8.00 am to 9.00 am (arrival of users), from 12.00 pm to 1.00 pm (solar noon and the onset of intense overheating), from 14:00 to 15:00 (peak accumulated heat across the site), and from 17:00 to 18:00 (outflow of students and the onset of thermal radiation from materials). This protocol covers periods of peak student traffic as well as zenithal thermal stress peaks (particularly at solar noon at 12.00 and the peak of accumulated heat at 14.00), which directly influence the occupancy of the premises. Each series of measurements was repeated over three different days to ensure their representativeness and to account for spontaneous daily weather variations. The average values obtained over the three days are presented in the results section.

In order to supplement the visual observations (analysis of the spatial experience) with an assessment of users' subjective thermal comfort (thermal perception), a questionnaire survey was conducted on site. A total of 130 questionnaires were distributed in the field. Following a screening process to exclude incomplete questionnaires, a sample of 120 valid questionnaires was collected from students spread across the two study areas (the square and the garden). This sample of 120 respondents provides a sufficient and balanced statistical basis for a representative analysis of the students' thermal sensation ratings, shade preferences and levels of discomfort.

The final distribution of these questionnaires shows a higher number of respondents in the central garden than in the central square. Far from being a methodological bias, this proportional sampling accurately reflects the reality of footfall patterns and the actual occupancy density on campus during the summer months. The extreme thermal discomfort in the central square causes students to move through the area more quickly and reduces the number of stationary participants available. Conversely, the comfort provided by the shade in the garden encourages spontaneous gatherings and makes users more willing to take part in the survey. This asymmetrical distribution is, in itself, an initial indicator of the impact of the microclimate on the usability of the space, a detailed analysis of which will be presented in the Results section.

The structure of the questionnaire survey is organized around four main areas:

- **Thermal sensation:** assessed on the standard 7-point scale (ranging from -3: very cold to +3: very hot) to measure the degree of discomfort caused by the heat.
- **Thermal preference:** used to determine expectations regarding changes to the thermal environment (wanting it cooler, wanting no change, wanting it warmer).
- **Assessment of the physical environment:** a qualitative assessment of the level of shade available (insufficient, acceptable, satisfactory) and the type of flooring.
- **Adaptive behavior:** identification of students' priority choices for improving their comfort (drinking water, changing their route, seeking shade under the arcades or in the garden).

Results and Analysis

Analysis of Microclimatic Parameters and Thermal Gradients in Situ

Analysis of the field measurements reveals contrasting microclimates and a very marked daily temperature pattern between the central paved square and the central landscaped garden. Table 1 shows the average values recorded at the most representative points in each space during the four key time periods.

Table 1. Daily Evolution of Microclimatic Parameters in the Two Spaces.

Study areas	Time periods	Ta (°C)	RH (%)	Ts (°C)	Va (m/s)
Central plaza Point P1 : center	08h00-09h00	32.5	35%	34.5	0.8
	12h00-13h00	41.2	16%	53.8	1.1
	14h00-15h00	43.8	11%	59.5	1.2
	17h00-18h00	41.8	15%	51.2	0.9
Central garden P6 : shade	08h00-09h00	31.8	39%	28.1	0.5
	12h00-13h00	39.1	24%	37.6	0.4
	14h00-15h00	40.1	22%	38.9	0.4
	17h00-18h00	39.5	26%	38.2	0.3

Source: Authors, 2025

Combining these four time periods reveals the campus's actual thermodynamic behavior throughout the day:

The Reception Phase (08:00–09:00): Temporary Thermal Comfort

Early in the morning, the temperature difference between the plaza (32.5°C) and the garden (31.8°C) is minimal. The surface temperatures (Ts) of the ground have not yet absorbed the solar radiation. At this time of day, the central plaza is perfectly comfortable, which explains why behavioral observations note a gathering of students there, particularly on the northern edges, in the shade cast by the adjacent building and beneath the arcades.

Midday (12.00–13.00): The Onset of Heat Stress

By midday, the situation changes dramatically. In the central square, the air temperature rises to 41.2°C and the ground (the paving) begins to overheat (53.8°C). At the same time, the garden begins to act as a buffer: the difference in air temperature is already 2.1°C in the garden's favour. This is the precise moment when behavioural observations show students fleeing the square for the garden.

The Peak Period (14:00–15:00): Maximum Asymmetry

It is a time of extremes. The central plaza becomes a radiant 'oven with the ground reaching nearly 60°C. The discomfort is absolute, with an ambient temperature of 44.5°C. In contrast, the central garden maintains stable temperatures thanks to the shade provided by its canopy of vegetation. The difference in ambient temperature is therefore 3.7°C, whilst the difference in solar radiation between the two spaces is 20°C; this peak confirms the tendency to avoid the plaza and the concentration of respondents in the garden.

Late Afternoon (5.00–6.00 Pm): The Phenomenon of Thermal Restitution

Even as the sun sets, the central plaza remains uncomfortable (Ta at 41.8°C). The paving and concrete, having stored heat all day, continue to release it through thermal radiation (Ts at 51.1°C). The garden, on the other hand, cools down much more quickly and maintains a pleasant relative humidity (26 %), thus continuing to serve as a refuge for students at the end of the academic day.

Spatial Use Patterns

This analysis focuses on understanding human behavior as how students use and move through these two spaces. Clear typologies were established for each activity, distinguishing between active, passive engagements, and social/interactive (Table 2). Active activities include movements like walking or moving from one place to another, while passive activities involve standing or sitting. The social interactions include gathering, group conversations, and socializing. The analysis involves systematically tracking and mapping static activities, such as standing and sitting, alongside dynamic movements over time. This approach reveals spatial usage patterns and identifies areas where interactions naturally occur more frequently.

Table 2. Activity Classification.

Activity Level	Activity Type
Active	Walking around, moving from a place to another
Passive	Sitting, standing
Social / interactive	gathering, group conversations, and socializing

Source : Authors, 2025

The findings reveal that thermal conditions can override spatial importance. Despite being spatially adjacent, the garden and plaza exhibit fundamentally different usage patterns due to microclimatic differences. Despite its strategic location as a structurally critical space within the campus circulation network, the plaza exhibits low occupancy and is primarily used for transit, particularly during hot periods due to its high thermal stress that limits its usability. In contrast, the central garden, positioned as a central node, functions as a gathering space, attracting high pedestrian density throughout the year as it benefits from a favorable microclimatic condition that enhance its attractiveness and functionality. Users demonstrate a clear tendency to occupy thermally comfortable environments (the garden), directly associated with lower thermal stress and the presence of vegetation, reinforcing the concept of thermal preference.

Subjective Thermal Perception and Adaptation Strategies

Analysis of Thermal Sensation Vote (TSV)

The subjective data collected from the 120 valid questionnaires provide a striking confirmation of the in-situ microclimatic monitoring. When cross-analyzing the Thermal Sensation Votes (TSV) based on the 7-point standard scale, a profound divergence emerges between the two central nodes during the peak hours of 12h00 and 14h00.

The central plaza: responses reveal an absolute thermal discomfort. Votes are heavily concentrated on the extreme indices of +3 (hot) and +2 (warm), accounting for over 85% of the total sample during the 14h session. This severe sensory friction explains the rapid transit behavior observed on site; students refuse to linger in an environment they perceive as hostile.

The central garden: although the regional climate of Biskra remains inherently canicular, the dense canopy cover and evaporative cooling from the vegetation significantly mitigate the microclimatic strain. Thermal Sensation Votes (TSV) within this green node contrast sharply with the central plaza, shifting toward neutral (0) and slightly warm (+1) categories. This thermal relief is further corroborated by the observed pedestrian dynamics; unlike the rapid transit behavior noted in the plaza, the garden promotes prolonged stay durations, as users actively seek its shading effects to restore thermal equilibrium. Consequently, these findings underline the critical role of urban green infrastructure in buffering extreme heat stress and enhancing subjective thermal comfort in arid regions.

Thermal Preference:

In perfect correlation with the expressed sensations, the expectations for environmental alteration —measured via TSV —reflect an urgent need for adaptation in the central plaza. Respondents express a radical demand for cooling, with a majority (30 / 40 surveyed students) voting for the indices -2 (want much cooler) and -1 (want cooler). In the central garden, the trend reverses toward thermal satisfaction: an overwhelming majority of the 80 respondents opt for the index 0 (no change) or 1 (a little change). This result demonstrate that the garden successfully maintains the microclimate within the thermal tolerance threshold of the users.

Conclusion

This research investigated the intricate relationship between spatial morphology, microclimatic performance, and human behavior within the outdoor spaces of university campuses in hot-arid regions. By hybridizing Kevin Lynch's cognitive mapping framework with Jan Gehl's socio-behavioral approach, this study addressed a critical gap in traditional urban design theories, which frequently overlook the physiological constraints imposed by extreme climates.

The empirical findings gathered at MKUB validated the core hypothesis: while spatial configuration and nodal centrality create the architectural potential for occupancy, microclimatic comfort acts as the ultimate limiting or triggering factor for its social activation. Seasonal and diurnal observations revealed a striking paradox: during winter, both the mineral central plaza and the vegetated central garden function effectively as active, attractive socio-spatial nodes. However, under summer canicular conditions, their trajectories completely diverge.

The central plaza —dominated by low-albedo paving and asphalt —transforms into a severe radiant trap, with surface temperatures nearing 60 °C. This microclimatic friction forces an absolute behavioral shift, turning a theoretical node of stagnation into a hostile transit corridor where over 85% of users express maximum thermal discomfort (+3). Conversely, the central garden utilizes its vegetative potential to act as a micro-spatial buffer, lowering the air temperature by up 3.7°C and offering a vital thermal refuge that sustains student interaction and stay time throughout the entire year.

This study demonstrates that thermal conditions play a decisive role in shaping spatial preference and usage patterns in university campuses. The comparison between a vegetated garden and an exposed plaza reveals that even adjacent spaces can exhibit drastically different levels of usability. The findings highlight the importance of integrating vegetation and shading strategies to enhance outdoor comfort and support active campus life. Designing thermally comfortable transit spaces (the plaza) is as important as designing destinations (the garden), especially when such spaces are unavoidable within the movement network.

Ultimately, mitigating outdoor thermal stress is not a secondary landscape luxury, but a fundamental physiological prerequisite. Transforming campuses livable, inclusive, and socially sustainable ecosystems requires an integrated design paradigm where architectural morphology and urban bioclimatology are synthesized to serve the well-being of the student community.

References

[1] Marcus, C. C., and Francis, C., 1997, “People places: design guidlines for urban open space”, John Wiley & Sons.

[2] Salama, A., 2008, “When good design intentions do not meet users expectations: Exploring Qatar University campus outdoor spaces”, ArchNet-IJAR Int. J. Archit. Res, 2, 57–77.

[3] Lynch, K., 1964, “The image of the city”, MIT press.

[4] Gehl, J., 2012, “Life Between Buildings”, Princeton University Press

[5] Salama, A., 2009, “Design intentions and users responses: Assessing outdoor spaces of Qatar University Campus”, Open House Int, 34, 82–93

[6] Alnusairat, S.; Al-Shatnawi, Z.; Ayyad, Y.; Alwaked, A.; Abuanzeh, N., 2022, “Rethinking Outdoor Courtyard Spaces on University Campuses to Enhance Health and Wellbeing: The Anti-Virus Built Environment”, Sustainability,14, 5602

[7] Selingo, J.J., 2017, “The Networked University: Building Alliances for Innovation in Higher Education”, London:Pearson

[8] Kaplan, S., 1995, “The restorative benefits of nature: toward an integrative framework”

[9] Shu, Y., Wu, C., & Zhai, Y., 2022, “Impacts of landscape type, viewing distance, and permeability on anxiety, depression, and stress”, International journal of environmental research and public health, 19(16), 9867.

[10] Oke, T. R., 2002, “Boundary layer climates”, Routledge.

[11] Carmona, M., 2021, “Public places urban spaces: The dimensions of urban design”, Routledge.

[12] Jacobs, A. B., 2013, "Conclusion: Great Streets and City Planning: from Great Streets" The urban design reader. Routledge, 214-217.

[13] Nayak, S. R., Dash, S. P., Rajalaxmi, K., Adhesh, & Pati, D. J., 2025, “Enhancing Legibility and Park Utilization Towards Strengthening Socio-Spatial Interactions in Open Spaces”, In Environmentally Sustainable and Socially Resilient Urban Development and Management (pp. 229-247). Cham: Springer Nature Switzerland

[14] Hillier, B., & Hanson, J., 1989, “The social logic of space”, Cambridge university press.

[15] Long, Y., & Baran, P. K., 2012, “Does intelligibility affect place legibility? Understanding the relationship between objective and subjective evaluations of the urban environment”, Environment and behavior, 44(5), 616-640.

[16] Peel, M. C., Finlayson,B.L., &McMahon, T.A., 2007, “Updated world map of the Köppen-Geiger climate classification”, Hydrology and Earth System Sciences, 11(5), 1633-1644.

[17] Office National de la Météorologie de Biskra, 2025.