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Workshop theme: Environment, technology and architecture

Thesis: Balancing outoodr and indoor comfort throughout Nature-based solutions (NBS) in an Ecocultural center.

PEF : Leveraging Urban Acupuncture by Designing an Ecocultural Centre in Miliana west entrance.

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Appreciation

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I dedicate this work, first and foremost, to my family, the unwavering foundation of my journey.

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LAOUAMERIA Widjdane

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BAHRI Aicha

Abstract

To effectively meet the spatial and environmental needs of an underutilized neighborhood in Miliana, a northern Algerian city with a sub-humid climate, this research adopts an integrated approach focused on sustainability, outdoor thermal comfort, and urban revitalization. Based on typo-morphological analysis, sensorial reading of the site, and qualitative inputs from surveys and interviews, the proposed project envisions an **eco-cultural center** supported by **high-quality public spaces**. The aim is to restore social interaction and cultural expression through an architectural language that blends **contemporary design with local identity**.

The concept of **urban acupuncture** was employed to guide small-scale yet strategic interventions capable of revitalizing the urban fabric while respecting existing socio-spatial dynamics. In parallel, **Nature-Based Solutions (NBS)** are used to improve the microclimate, balance indoor and outdoor thermal comfort, and reduce urban heat island effects. Environmental simulation tools supported the climate-responsive design process and spatial validation.

Keywords: Miliana, sub-humid climate, eco-cultural center, outdoor thermal comfort, urban revitalization, sustainability, Nature-Based Solutions (NBS), typo-morphological analysis, microclimate, architectural identity, urban acupuncture, public space, environmental resilience.

Résumé

Afin de répondre efficacement aux besoins spatiaux et environnementaux d’un quartier sous-utilisé à Miliana, ville du nord de l’Algérie au climat subhumide, cette recherche adopte une approche intégrée axée sur la durabilité, le confort thermique extérieur et la revitalisation urbaine. S’appuyant sur une analyse typo-morphologique, une lecture sensorielle du site ainsi que des enquêtes et entretiens qualitatifs, le projet propose la création d’un éco-centre culturel accompagné de grands espaces publics de qualité.

Le projet s’appuie sur le concept de l’acupuncture urbaine, permettant des interventions ciblées à petite échelle capables de réactiver le tissu urbain existant tout en respectant les dynamiques socio-spatiales locales. En parallèle, des Solutions Fondées sur la Nature (SFN) sont intégrées pour améliorer le microclimat, équilibrer le confort thermique intérieur/extérieur et limiter les effets des îlots de chaleur urbains. Les outils de simulation environnementale ont permis d’optimiser la conception bioclimatique et la validation des choix spatiaux.

Mots-clés : Miliana, climat subhumide, éco-centre culturel, confort thermique extérieur, revitalisation urbaine, durabilité, solutions fondées sur la nature (SFN), analyse typo-morphologique, microclimat, identité architecturale, acupuncture urbaine, espace public, résilience environnementale.

ملخص

من أجل تلبية الاحتياجات المكانية والبيئية في حي مهمّش بمدينة مليانة، الواقعة شمال الجزائر ذات المناخ شبه الرطب، تعتمد هذه الدراسة على مقاربة متكاملة تركز على الاستدامة، والراحة الحرارية الخارجية، وإعادة إحياء النسيج الحضري.

بُني المشروع على تحليل شكلي-مورفولوجي وقراءة حسية للموقع، إلى جانب بيانات نوعية جمعت عبر استبيانات ومقابلات. ويقترح المشروع إنشاء **مركز ثقافي بيئي** مدعوم بـ **مساحات عمومية عالية الجودة** تهدف إلى إعادة تفعيل الحياة الاجتماعية والتعبير الثقافي، من خلال تصميم معماري يجمع بين **الحداثة والهوية المحلية**. تم اعتماد مفهوم **الوخز الحضري** لتوجيه تدخلات استراتيجية صغيرة الحجم تهدف إلى إعادة تنشيط الأنسجة الحضرية القائمة بشكل متناغم مع السياق الاجتماعي والمكاني.

كما تم دمج **الحلول المعتمدة على الطبيعة** لتحسين المناخ المحلي، وتحقيق توازن في الراحة الحرارية بين المساحات الداخلية والخارجية، والحد من ظاهرة الجزر الحرارية. وقد دعمت أدوات المحاكاة البيئية عملية التصميم المناخي والتحقق من الخيارات المعمارية.

الكلمات المفتاحية :مليانة، مناخ شبه رطب، مركز ثقافي بيئي، الراحة الحرارية الخارجية، الإحياء الحضري، الاستدامة، الحلول المعتمدة على الطبيعة، التحليل المورفولوجي، المناخ المحلي، الهوية المعمارية، الوخز الحضري، الفضاء العام، المرونة البيئية.

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Abbreviations

APRUE	Agence Nationale pour la Promotion et la Rationalisation de l’Utilisation de l’Énergie
NBS	Nature-Based Solutions
UNEP	United Nations Environment Programme
IPCC	Intergovernmental Panel on Climate Change
WHO	World Health Organization
UA	Urban Acupuncture
PMC	PubMed Central
UNIDO	United Nations Industrial Development Organization
PMV	Predicted Mean Vote
SET	Standard Effective Temperature
UTCI	Universal Thermal Climate Index
PET	Physiological Equivalent Temperature
Tmrt	Mean Radiant Temperature
RH	Relative Humidity
SRI	Solar Reflectance Index
IUCN	International Union for Conservation of Nature
ISO 20473	International Standard: Optical Properties of Materials
DIN 51130	German Standard for Slip Resistance of Floor Surfaces
P.O.S	Plan d’Occupation des Sols (Land Use Plan)
COS	Coefficient d’Occupation du Sol (Land Occupation Ratio)
PDAU	Plan Directeur d’Aménagement et d’Urbanisme (Master Plan for Development and Urban Planning)
PET	Physiological Equivalent Temperature
EPA	Environmental Protection Agency

Glossary

Climate resilience	The capacity of ecosystems and societies to anticipate, adapt, and recover from climate disruptions. (IPCC, 2022)
Climate change	Long-term shifts in weather patterns primarily due to human activities and greenhouse gas emissions. (UNEP, 2021)
Global warming	The increase in Earth's average temperature, now exceeding 1.1°C above pre-industrial levels. (IPCC, 2023)
Energy efficiency	Reducing energy use while maintaining performance, often through insulation or efficient systems. (IEA, 2023)
Sustainable and passive design	Design approaches that minimize energy use and environmental impact through natural strategies like orientation and ventilation. (Yeang, 2008)
Hygrothermal comfort	Human thermal comfort determined by the interaction between humidity and temperature. (ASHRAE, 2017)
Indoor comfort	A state of well-being indoors, considering temperature, air quality, lighting, and noise levels. (ISO, 2005)
Outdoor comfort	Thermal well-being in open spaces, affected by shade, breeze, materials, and humidity. (Nikolopoulou & Steemers, 2003)
Thermal regulation	Passive and active systems that maintain interior comfort despite external temperature variations. (Givoni, 1998)
Albedo	The reflective capacity of a surface; high-albedo materials reduce surface temperatures and heat buildup. (Oke, 1987)
Balance of urbanization	Achieving harmony between built environments, ecosystems, and human activity. (Beatley, 2011)
Densification	Increasing building or population density to optimize urban infrastructure and reduce sprawl. (Burton, 2000)
Ecological restoration	Assisting the recovery of degraded ecosystems to regain function and biodiversity. (SER, 2004)
Urban heat islands (UHIs)	Urban areas that are significantly warmer than nearby rural zones due to built surfaces and human activities. (Oke, 1987)
Nature-Based Solutions (NBS)	Using natural processes (like trees or wetlands) to solve urban and environmental challenges. (IUCN, 2020)

Urban acupuncture	Strategic, small-scale interventions that revitalize urban areas through targeted positive change. (Lerner, 2003)
Revitalization	Reactivation of underused or declining urban areas through social, economic, or spatial strategies. (Roberts, 2000)
Spatial vitality	The capacity of a space to support social activity, interaction, and movement. (Gehl, 2011)
Urban centrality	The spatial and functional importance of a site within the urban hierarchy. (Hillier, 1996)
Ripple effect (urbanism)	When a localized urban intervention produces broader social or spatial impacts. (Gehl, 2011)
Environmental heritage	Natural features and ecosystems valued for their ecological, cultural, or historical significance. (UNESCO, 2008)
Cultural heritage	Monuments, traditions, and practices inherited across generations for their symbolic and historical value. (UNESCO, 2003)
Cultural hub	A multifunctional space for cultural exchange, creation, and interaction. (Evans, 2009)
Balance of urbanization	Achieving harmony between built environments, ecosystems, and human activity. (Beatley, 2011)

The Pedagogical Approach of the "Architecture and Environment" Studio

The "Architecture and Environment" studio set out to raise students' awareness of a contextual and integrated approach, harmoniously combining the urban and architectural scales while adhering to sustainability principles. This approach seeks to address the major challenges of the 21st century, notably climate change, which remains the most urgent ecological issue humanity faces today. Furthermore, under the overwhelming pressure of globalization, architectural identity has weakened. It is within this framework and context that the studio positions itself, aiming to find a balance between urban, architectural, identity-related, and environmental requirements.

To achieve this objective, a cross-disciplinary urban analysis was implemented, combining typomorphological, sensory, and SWOT analyses. The typomorphological analysis focuses on reading the urban form through two temporal dimensions: a diachronic perspective that studies territorial development along with the formation and transformation of the city, and a synchronic analysis that helps identify, through the logic of the urban fabric, the types and existing dysfunctions in the area of intervention. Through this approach, students are expected to uncover the climatic responses inherently embedded within each part of the urban fabric.

The sensory analysis complements the spatial reading by incorporating the perception and lived experiences of users in urban space. This contributes to identifying the city's urban image, or its legibility. Finally, the SWOT analysis serves as a synthesis approach, allowing students to revisit the urban analysis and identify the strengths, weaknesses, threats, and opportunities of their study area. From this, they are expected to propose solutions and develop an urban strategy accordingly. This approach is considered essential for understanding urban dynamics, diagnosing existing dysfunctions, and offering solutions to improve the daily lives of inhabitants.

In response to the issues identified, students are required to propose a coherent and adapted urban program, integrated within the previously defined urban strategy. This is aimed at resolving dysfunctions and enhancing the strengths of the territory, thereby supporting sustainable urban development. Within this precise contextual framework, students are to select and develop their final year projects in direct relation to the specific challenges of their study area.

By relying on the contextual characteristics of their projects as well as on a scientific and technical literature review, students will be able to identify the most significant area of consumption within their projects. This step allows them to target passive strategies that enhance the environmental performance of their proposals, focusing on a single environmental aspect such as hygrothermal comfort, visual comfort, or both indoor and outdoor thermal comfort—particularly in relation to the impact of outdoor design. In parallel, students are expected to integrate passive strategies such as orientation, insulation, building composition, vegetation, natural ventilation, etc., to improve comfort and energy efficiency in their projects.

In addition, a thematic research and analysis process was undertaken to design functionally and environmentally coherent spaces. The thematic analysis addressed various aspects: environmental, formal, functional, and structural, as well as other parameters such as biodiversity, materials, and landscape integration.

Finally, students dedicated themselves to architectural design in the strict sense, striving to reconcile architectural requirements with environmental performance. To this end, several tools, methods, and specialized software were made available to support students in refining their proposals and evaluating their environmental impact. This pedagogical approach is intended to train architects who are capable of designing environmentally respectful, and at times innovative, architectural projects that respond to today's climatic challenges.

Studio Coordinator: Dr. Soufiane Boukarta

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INTRODUCTION

CHAPTER 01

1.1 General introduction

In the face of growing environmental challenges, the architectural field is increasingly called upon to rethink its practices to align with climate resilience and energy efficiency imperatives. A building’s design should address space demands and include environmentally friendly features that raise comfort and well-being. In 2021, APRUE (Agence Nationale pour la Promotion et la Rationalisation de l’Utilisation de l’Energie) pointed out that the building sector in Algeria alone is responsible for 46% of annual global energy consumption, highlighting the urgent need for sustainable and passive design approaches.

The study is carried out in Miliana, a town in northern Algeria with a sub-humid climate, elevated land and a history of Berber, Ottoman and colonial influences. Although Miliana has a rich culture, the area to its west is neglected, poorly connected and lacks a strong infrastructure. Ecological restoration is both challenging and possible in this area.
Because of this setting, the project proposes the design of an Eco-Cultural Center that will act as a nature-based acupuncture approach offering a minimal yet strong improvement for urban spaces. The intervention is guided by the question:
How can we enhance sustainability and achieve a balance of urbanization in Miliana while considering outdoor hygrothermal comfort, eco-cultural densification, and the revitalization of the western entrance?

The idea is supported by adding NBS and passive techniques to keep the indoor and outdoor conditions in harmony. The European Commission (2021) points out that nature-based solutions are driven by nature’s strengths to create novel ways to address different challenges around us. The UN Environment Programme also stresses that green infrastructure improves the city’s resistance to climate change, reduces heat islands and improves the quality of air.

The project achieves this by introducing greenery, rebuilding water ways and designing more breathable urban areas, lowering energy use and increasing how people enjoy and use the space.The approach leverages bioclimatic and performative tools such as, ENVI-met, Meteonorm, and Climate Consultant, enabling a data driven understanding of solar exposure, ventilation, humidity, and temperature cycles.

By using the approach of urban acupuncture, the project plans to come up with a model that can be used again in other communities. Therefore, this thesis advocates for a climatically responsive, culturally rooted, and human-centered architecture that catalyzes both environmental sustainability and urban revitalization.

1.2 General problematic

Whilst weather and climate are related, the terms mean different things. Weather describes the temporary, daily state of the atmosphere in a particular region, while climate shows the average patterns and trends over a period. Science proves that Earth's climate is quickly and rapidly changing, largely due to a rise in global temperatures (IPCC, 2021). NASA explains that most of the warming is due to raised greenhouse gases, including carbon dioxide, methane and nitrous oxide which are caused by humans burning fossil fuels, removing forests and releasing emissions from factories (2022).

The result of these disruptions has included serious harm to nature and society. It is clear that climate change is linked to global warming, more powerful and frequent storms, less species diversity, weakened natural areas and troublesome health outcomes (World Health Organization [WHO], 2021). At the same time, the concept of the ecological footprint developed by Rees and Wackernagel in the 1990s sheds light on the fact that human activities use more resources than the Earth can replace and humanity has remained in overshoot mode since the 1980s (Global Footprint Network, 2022).

The issues mentioned impact city life differently and call for answers that fit each city. The city of Miliana, located in northern Algeria and characterized by a sub-humid climate, is now facing many changes. The city saves and celebrates its valuable heritage, but it also suffers from challenges of urban increases, discomfort due to climate and a loss in natural balance.

A particularly important area is the western side of Miliana, where unstructured expansion and past political instability have resulted in neglect. The survey results reveal that residents feel that their community is disregarded and they need higher levels of security, places for social gathering and to become more integrated into the city. A lot of people indicated a wish to have outdoor areas where everyone can come together and bond during all seasons, representing the hope for cities to be more welcoming and flexible for all.

As these needs change, urban planners and designers are left with a major question.

In what ways can Miliana's western entrance be renewed so that it restores balance in the city, protects the environment, meets demands for safety and continues the city's heritage and usability during all seasons?

1.3 Specific problematic

Architecture that can withstand extreme weather helps make outdoor and indoor spaces more comfortable in areas where the climate is extreme. Usually such strategies involve passive designs, adaptable spaces and proper use of local elements from nature to lessen our energy needs and benefit the people in them (Givoni, 1998; Olgyay, 2015). If we look back at old urban practices in Algeria, mainly in areas like Miliana with mountains, we see a strong link between the city's structure and the local climate. Back then, architects used shaded streets, courtyards and plant buffers to smartly deal with changes in weather and extreme heat.

Miliana, known for its rich cultural and environmental heritage, now faces a growing disconnect between contemporary urban development and the site's natural context. Nowhere is this more visible than in the city's western entrance, a transitional zone exposed to strong sunlight, changing humidity, and wind currents. Community surveys and site observations reveal that outdoor spaces are underutilized during peak climatic extremes while indoor spaces increasingly rely on mechanical cooling, thus intensifying energy consumption and reducing overall sustainability.

This situation brings about impacts on people and the planet. City residents have to transform their routines as the weather changes which demonstrates that the usefulness of outdoor space can be disconnected from one season to another. There are also fewer plants, buildings are either simple boxes and they are often made of concrete and asphalt—all of which add to heat and make natural coolness scarce. These problems are made worse by the fading of typical elements such as patios, arcades and seasonal places for people to gather, as those spots helped keep the neighborhood cool and connected residents.

Even with these problems, Miliana still has a lot of potential. Being aware of the landforms, wind patterns and background sun allows design proposals that support and encourage the surrounding communities. The problem is figuring out how to provide year-round comfort without disturbing culture, while using less energy, mainly in places that affect people's daily urban life.

Considering all of the above, the following questions emerge:

1. What design choices can make outdoor areas near the western entry of Miliana benefit from temperature and climate changes, giving comfortable conditions for everyone both indoors and outdoors?

2. With what planning ideas can the scale and design of new neighborhoods assist in restoring balance between cultural heritage, response to climate and use by residents?

1.4 Hypothesis

To address the climatic and socio cultural challenges identified in the western entrance of Miliana, we propose the following hypotheses:

1. By applying Nature-Based Solutions (NBS) including vegetation, water features, and shading devices combined with a strategic use of the site's topography, it is possible to establish a more effective balance between outdoor and indoor comfort. These interventions aim to mitigate heat stress in open areas and improve usability, particularly during peak climatic conditions.

2. Semi outdoor spatial configurations, such as courtyards, shaded corridors, and transitional zones, can function as thermal buffers that reduce indoor energy demands. When adapted to Miliana's natural elements such as prevailing winds, solar exposure, and elevation, these spaces can significantly contribute to microclimatic regulation and enhance user well-being throughout the year.

3. An integrated architectural approach rooted in urban acupuncture, the focusing on localized, small-scale interventions can amplify ecological and cultural benefits. By designing a cultural facility that includes outdoor and semi outdoor components, a project with outdoor and semi-outdoor parts can improve the climate at the site, encourage people to socialize and bond the city with its history and the natural world. This strategy supports a harmonious balance between sustainable development, cultural preservation, and spatial vitality.

1.5 Objectives

- Bring life back to the abandoned western entrance of Miliana by creating a lively cultural and outdoor space.
- Reconnect the project with nature by using natural elements like wind, sun, and vegetation to improve comfort.

- Reduce energy use through smart design choices such as natural ventilation and shading.
- Highlight Miliana’s identity in a modern way by blending traditional elements with contemporary architecture.

1.6 Theme choice criteria

The choice of this theme is rooted in the desire to revive a neglected area of Miliana that carries deep historical, cultural, and environmental significance. Once a small city with a rich past, Miliana has seen parts of its urban fabric abandoned, specifically at its western entrance, due to periods of insecurity and the resulting psychological impact on its community. This reality has created a spatial and social disconnect.

Our interest lies in reintegrating life into this area through a project that blends natural elements, community activities, and architectural sensitivity. The proposal aims to use Miliana’s heritage, cultural memory, and ecological richness as tools for healing socially, psychologically, and economically.By selecting this theme, we address both the city’s strengths and its difficulties and have the chance to build an area that supports well-being, sustainability and helps everyone connect with their community again.

1.7 Research methods

Our research followed two main steps:

1. Literature Review: In this first step, we studied existing research to better understand the main concepts, methods, and results used by other authors. This helped us build a strong base to compare and discuss our own findings. At this stage, we also identified the most suitable method to test our hypothesis. We included a thematic analysis to understand the types of activities that should be integrated into our project. All of this is explained in detail in the second chapter.

2. Field and Experimental Work: The second step involved applying what we learned in real conditions. We combined two approaches: the typo-morphological study (to understand the physical layout of the area) and a sensorial approach (to observe how people feel and move in the space). We also used surveys and interviews to gather opinions from users of the site. A SWOT analysis helped us summarize this work and define a main strategy for our design.

To improve our design's environmental performance, we used simulation software such as Meteonorm, Climate Consultant, ENVI-met.

1.8 Research structure

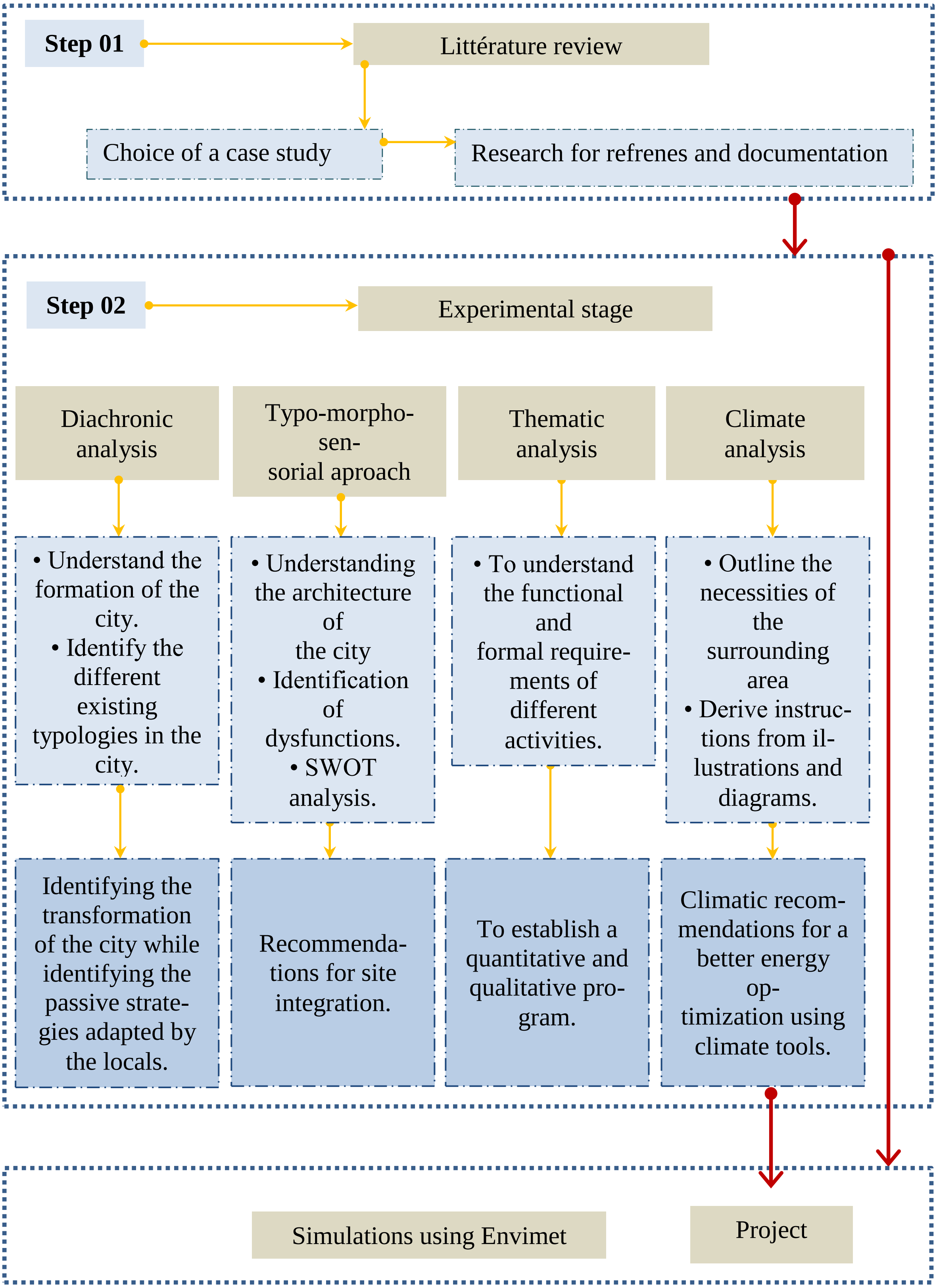

Figure 1.1 : a diagram showing reaserch structure.

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CHAPTER 02

2.1 Introduction

In this chapter of our research, the main objective is to chart a path toward the knowledge necessary to address the hypotheses discussed in the first chapter. To do so, we will explore key concepts from both architectural and environmental approaches, focusing on urban acupuncture, which emphasizes targeted, strategic interventions, and nature-based solutions (NBS), which aim to enhance both indoor and outdoor thermal comfort sustainably.

This journey will help us better understand how to integrate these principles to promote a sustainable and functional urban balance.

2.2 Part 1: Architecture

2.2.1 Extension and Urban Balance

The essential principle of urban architecture ensures the harmonization of various components which exist within urban areas. The discipline provides founding principles to help urban designers and architects develop spaces that fulfill operational needs yet support societal relatedness and protect environmental resources. This study presents essential guiding principles for urban balance together with analytical assessments of case examples and theoretical frameworks with special emphasis on spatial arrangement and social connection.To achieve urban balance, one must fully understand how spaces interact within urban spaces. The study of how spatial relationships affect social behavior depends on both space syntax and urban morphology as explained by Karimi (2023). The design of well-planned built spaces inherently creates spaces which promote interaction naturally between people. The urban layout design aligns itself with these principles through connections which generate social participation across urban spaces, thereby reinforcing the relevance of spatial coherence and the dynamic interplay between built form and human activity. Modern architecture takes harmony as a basic element to achieve balanced environments. According to Li, Li and Ji (2024), designers should develop spaces that match specific cultural characteristics as well as social norms of their community. Contemporary urban projects that integrate traditional elements can build resident belonging and support community identity according to architectural innovations.

Bahrainy et al. (2016) present the Principles of Urban Design which establish a need to develop functional places with visual attractiveness.
Urban balance surpasses symmetric arrangements to include a comprehensive system that treats environmental aspects and social elements and cultural influences as core components.

The implementation of these influences promotes the improvement between spatial efficiency and social interaction in urban design.

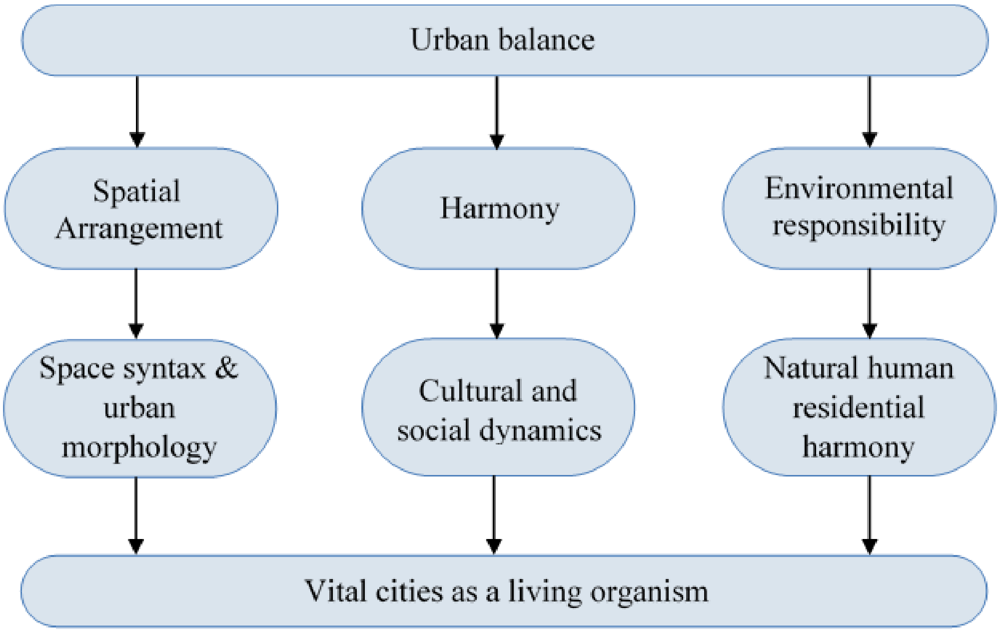


Figure 2.1: Diagram Showing Urban Balance and Its Role in Shaping the Built Environment based on Karimi2023, Bahrainy 2016, Li, Li and Ji 2024.
Source: authors.

Alsancak neighborhood in Izmir serves as a powerful example of urban balance according to Tanrıverdi (2025). According to Tanrıverdi (2025) the urban configuration of this region shows that public space planning and street layout operations influence or restrict social gathering. Open-space configuration in Alsancak establishes a harmonious community framework that allows people to connect effortlessly with their surrounding environment thus building social connections.

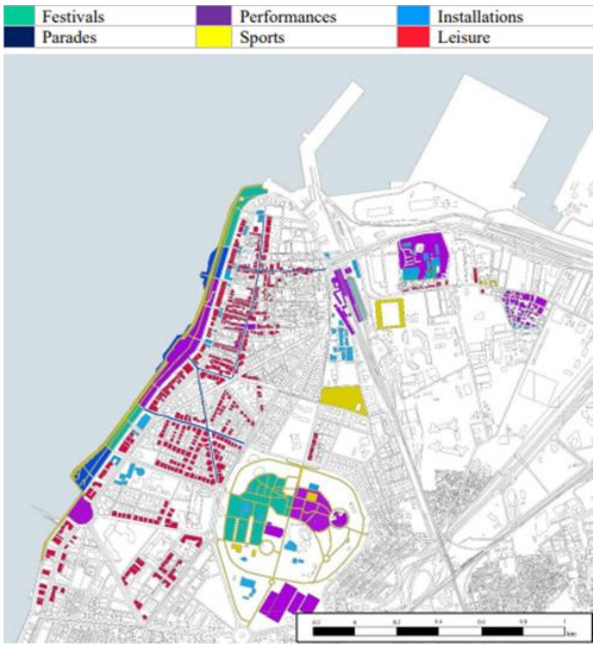


Figure 2.2: Location of all convivial events and activities in alsancak.
Source: Tanrıverdi 2025.

An important method to obtain urban equilibrium exists through the creation of natural-human residential harmony. Peng et al. (2024) support architectural designs which combine sustainability concerns with attractive designs. Architectural alignment to public emotional needs combined with ecological duty creates spaces which become more pleasant places to live.

Evolution of cities depends fundamentally on urban morphology which controls social contact patterns between city residents. Success in urban planning depends entirely on the complex link between space structure and human conduct. Urban environments become adaptable and reflective through the complete understanding of these spatial dynamics which helps architects along with planners to create such structures. Bahrainy and Bakhtiar (2016) advocate for an integrated method of urban design to handle current difficulties of cities.

Architecture must achieve urban balance through uniting aesthetic, functional and environmental factors because these elements constitute essential components essential to successful development. Research along with practical examples helps architects achieve maximum benefits from their designs through social connection and community harmony in urban areas. Urban morphology operates as an essential condition which will guide the development of contemporary urban spaces through city transformation.

2.2.2 Creating New Urban Centrality as an urban balance potential

The development of new urban centrality locations serves as a fundamental approach to achieve sustainable urban development by promoting social, economic and environmental resurrection. Moderna urban centralities transform vacant urban spaces into multitasking areas that combine community facilities with cultural programs and economic development activities. Urban planning through centrality goes beyond physical cluster distribution because it actively builds spaces which unite diverse functional elements to connect people socially while sustaining balanced metropolitan development (Zhao & Li, 2020).

Urban centrality development requires the acknowledgment of key regenerable areas followed by planning-based integration systems that turn them into functional focal points. The concept touches multiple aspects such as cultural facilities together with public spaces and green infrastructure and accessible transportation systems. These locations aim to achieve economic strength along with cultural relevance because they enhance neighborhood identity toward broader city development (Yuan & Jiang, 2019).

The urban acupuncture framework incorporates specific strategic planning techniques to enact minimal intervention strategies which stimulate new centralities to generate beneficial consequences for the adjacent urban environment. The particular sites within larger plans benefit from urban acupuncture to regenerate themselves through this precise strategic method which strengthens the influence of interventions for enduring urban impact (Choi et al., 2021).

2.2.3 Urban acupuncture

Urban acupuncture is an urban design strategy inspired by the practice of medical acupuncture where small precise interventions activate broader transformations in the city fabric, this concept focuses on targeted actions in key urban locations aiming to release social environmental and economic energy flows that improve overall urban well-being.

Jaime Lerner described urban acupuncture which shows that limited strategic actions directed at cities will produce extensive results without large infrastructure costs or financial commitments (Lerner 2014). Lerner prioritizes urban simplicity and recognizes both environmental and social dimensions of the city.

Based on his human scale approach in urbanism Jan Gehl (2010) endorses practical pedestrian-based modifications that boost public interaction because modern environmental adaptations result in substantial advantages regarding social connections and urban wellness (Gehl 2010).

Urban acupuncture states that cities possess natural energy points throughout their rhythms and designers can contribute to urban well-being by making purposeful changes in specific locations (Gehl and Svarre 2013).

2.2.3.1 The Role of Urban Acupuncture in Revitalization

Urban acupuncture, as a strategic urban planning method plays an important role in revitalizing underused and neglected or fragmented urban spaces. Rather than relying on large scale expensive transformations, this approach focuses on small and targeted interventions that trigger big changes in the urban fabric. These subtle actions often generate what is known as a ripple effect, amplifying their influence way more far than their original location and scale.

The idea that a small and precise urban gestures can lead to meaningful spatial and psychological impact has been explored by theorists such as Jaime Lerner and Marco Casagrande.

These interventions do not merely change the physical environment, but also activate the surrounding community, elevate social interaction, and rekindle emotional and symbolic connections with place. As Casagrande (2010) explains, urban acupuncture aims to "manipulate the collective sensuous intellect of a city"—activating the latent energies of the urban environment through minimal but impactful actions.

2.2.3.2 Small interventions and the ripple effect

The effectiveness of urban acupuncture comes from its dual mechanism of powerful large-scale effects which emerge from small-scale interventions. Limited yet budget-conscious interventions align with specific urban contact points which serve as stress points or empty spaces until fixed to trigger beneficial consequences throughout entire districts.

The consequences created by these interventions spread into both physical space and human emotional condition. A new public bench alongside restored alleyways and small green areas pushes urban repairs forward by initiating more projects and attracting more people and triggering economic developments (Lerner, 2014).

When residents experience urban areas they develop psychological feelings of care and belonging connected to place identity revitalization. When residents perceive an improvement their community usually enters into a beneficial cycle where safety increases along with social interaction and collective pride (Montgomery 2013).

Various international studies validate that minimal precise interventions successfully revamped complete neighborhoods.

2.2.3.3 Case Study: Cheonggyecheon Stream Restoration in Seoul

One of the most celebrated examples of urban acupuncture is the **Cheonggyecheon Stream Restoration Project** in Seoul, South Korea. In the early 2000s, the Seoul Metropolitan Government removed an aging highway to uncover and restore the historical stream beneath it, transforming 3.6 miles of urban infrastructure into a lively public space.

This single intervention rippled across Seoul’s environmental, social, and economic domains, illustrating how a localized action can achieve metropolitan-scale revitalization.

Figure 2.3: Houses along Cheongyecheon circa 1945.
Source: Image Courtesy of Seoul Metropolitan City History Committee.

Figure 2.4: View of the Cheonggye Stream 2020.
Source: Efired via Shutterstock.

Below is a structured overview of the project's multidimensional impacts:

Table 2.1: Environmental Impact of Cheonggyecheon Restoration. Source: compiled by authors based on Carrasco2024.

Impact Category	Description
Temperature Reduction	3.3°C to 5.9°C lower than nearby areas, mitigating urban heat islands (Carrasco, 2024)
Air Quality	35% reduction in nitrogen dioxide concentrations (Carrasco, 2024)
Biodiversity	Plant species increased from 121 to 365; fish species from 7 to 23 (Carrasco, 2024)

Table 2.2: Social and Economic Impact. Source: compiled by authors based on Robinson & Hopton 2011.

Impact Category	Description
Public Use	64,000 daily visitors including 1,408 tourists; $1.9 million/year economic contribution (Robinson & Hopton, 2011)
Connectivity	22 new pedestrian/vehicular bridges improved mobility (Robinson & Hopton, 2011)
Economic Revitalization	$1.98 billion investment in surrounding redevelopment (Robinson & Hopton, 2011)

2.2.4 Cultural hubs and outdoor spaces

2.2.4.1 The Role of Cultural Hubs in Urban Revitalization

Urban spaces receive a transformative impact through cultural hubs which bring together these three essential elements of renewal that are neglected space revitalization and social cohesion with economic growth promotion. These centers host the meeting point of cultural expression alongside creative industries along with public engagement to revitalize urban areas. Cities successfully draw local residents with tourists and investors through the reuse of vacant spaces and historic structures that maintain their local identity according to UNESCO (2017) and PMC (2024). Culture hubs in Hong Kong like Tai Kwun and PMQ showcase sustainable preservation of historical buildings through contemporary cultural programming. The integration of this strategy results in improved urban looks and strengthens community relationships to their local areas. Local economies and employment rates increased after the Guggenheim Museum's establishment in Bilbao (PMC, 2024).

Through events and exhibitions Hubs enable diverse groups to interact which leads to increased inclusivity and lowers social inequalities (UNESCO, 2017).

Figure 2.5: Guggenheim Museum, Bilbao, Spain.
Source: Merodio n.d.

Figure 2.6: Tai Kwun Cultural Hub, Hong Kong.
Source: Iwan Baan 2012.

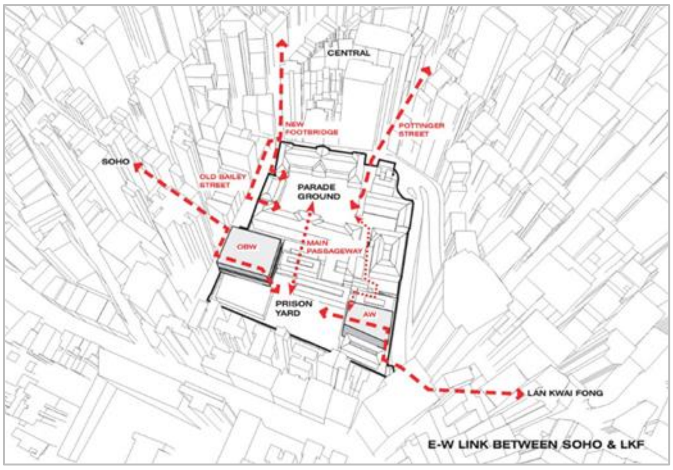


Figure 2.7: Tai Kwun Cultural Hub, Hong Kong.
Source: Herzog & de Meuron Architecture Studio.

Cultural identity functions as an effective urban preservation technique because it brings people back to their origin while drawing visitors who want genuine opportunities to experience local heritage. Heritage sites that undergo revitalization projects become shared symbols of both communal memory and public pride and boost community connection with their environment.

Modern urban development through cultural identity does not involve only heritage areas since new spaces can emerge through revitalizing underused spaces.

Dubai together with Singapore succeeded in developing brand new cultural identity through contemporary structure combined with historical storytelling that manifests their specific past and future orientation.

The combination of original locations with new revitalized areas draws authentic tourism visitors together with creating neighborhood feelings for local residents.

Cultural heritage functions as a tourism attraction element through visible communities taking as an example Mumbai that promotes Bollywood entertainment and Kingston which presents reggae music thus drawing worldwide audiences to strengthen their economic impact (World Bank–UNESCO Report, 2021).

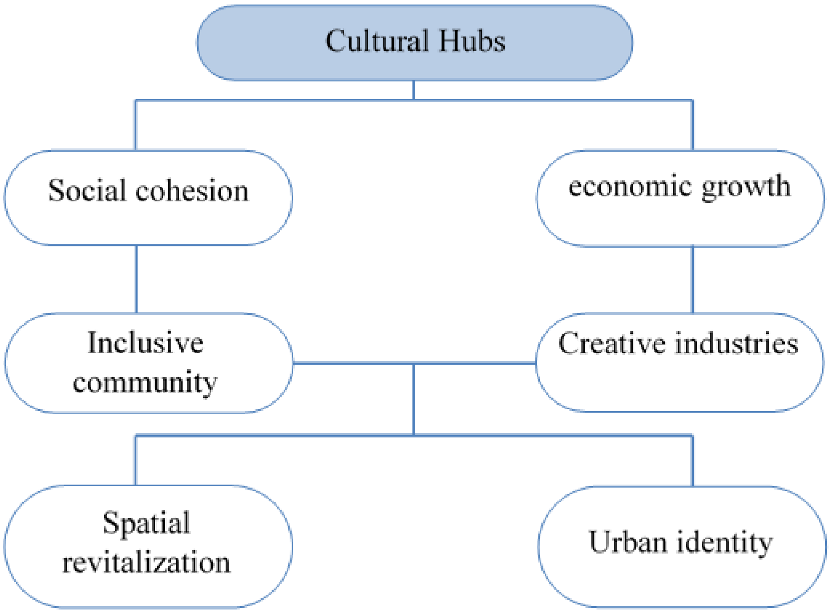


Figure 2.8: Diagram Showing the Importance of Cultural Hubs for Social Cohesion.
Source: compiled by authors based on the World Bank–UNESCO Report, 2021.

2.2.4.2 The Relationship between Cultural Hubs and Outdoor Public Spaces

Outlying cultural hubs expand their social influence by developing harmonious relations between indoor facilities and outdoor public spaces.

The connection works as an open access point for people to participate in cultural activities throughout the community. The cultural hubs use adjacent public spaces as performance locations for attracting wide audience. Both indoor hub events and outdoor entertainment create an interconnected cultural environment which upgrades urban living conditions (UNIDO, 2022).

Richard Florida through his work on "quality of place" establishes how integration becomes vital. The three core elements of such spaces include structural elements of neighborhoods alongside the mixing of individuals and the active lifestyle within them according to Florida. Together these structural components increase the attractiveness of both the hub facility itself while boosting its nearby locations (UNIDO, 2022).

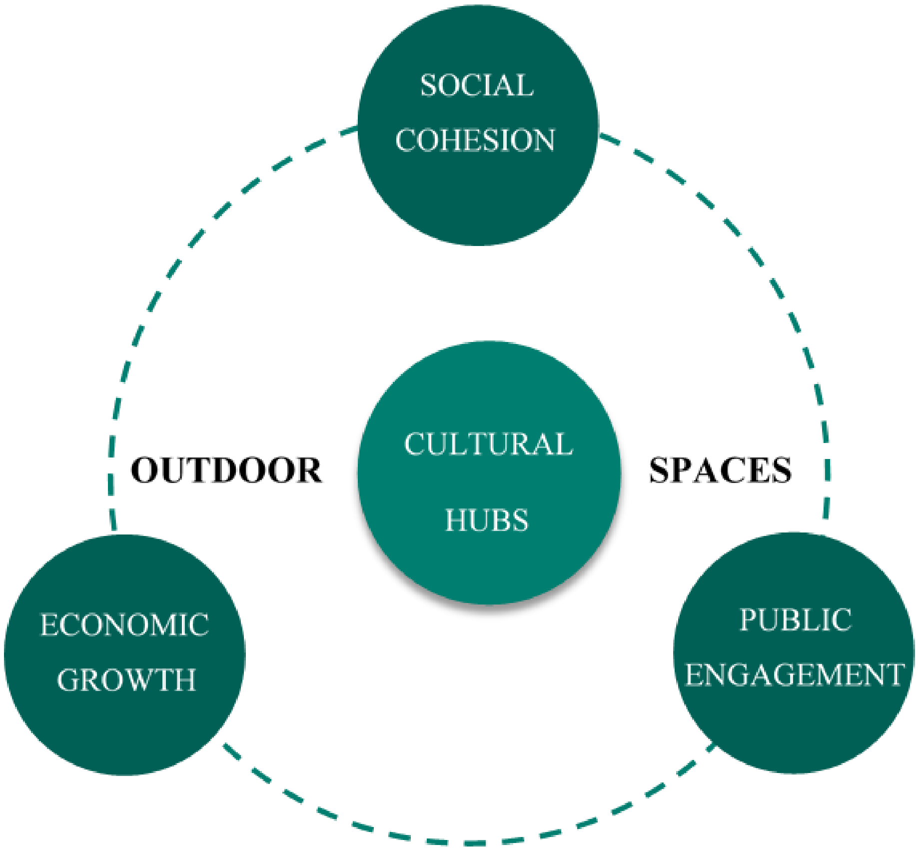


Figure 2.9: Cycle Diagram Showing the Relationship between Cultural Hubs and Outdoor Spaces.
Source: compiled by authors based on UNIDO, 2022.

2.3 Part 2: Environmental

2.3.1 Understanding Outdoor Comfort

Outdoor spaces acquire their thermal condition along with environmental quality to produce a perception and reaction quality from users.

The factors that influence outdoor comfort include temperature alongside humidity together with wind conditions and shade effectiveness and vegetation density and water elements in the area.

2.3.1.1 Factors influencing outdoor comfort

- **Temperature**: High temperatures reduce outdoor comfort, leading to discomfort and a decrease in social interaction (Boukarta, 2024).

- **Humidity**: High humidity levels, combined with high temperatures, intensify discomfort by reducing the body's ability to cool itself (Lundgren et al., 2020).

- **Wind**: Wind can enhance cooling, but too much wind can create uncomfortable conditions (Almeida et al., 2019).

- **Shading**: Proper shading through vegetation or architectural elements can significantly reduce heat gain (Boukarta, 2024).

- **Vegetation**: Trees, green roofs, and urban forests are effective at cooling the environment through shading and evapotranspiration (Strass et al., 2021).

- **Water**: Water features such as fountains, ponds, and misting systems have a cooling effect through evaporative processes (Lundgren et al., 2020).

2.3.1.2 Outdoor Thermal Comfort Assessment: Overview of Evaluation Indices

The assessment of outdoor thermal comfort stands as a critical factor for developing urban settings which offer both comfortable living habitats and climate-adapted designs.

Researchers have established multiple bioclimatic indices for studying human heat sensation across open environments. The combination of meteorological parameters together with human response factors by means of physiological and behavioral traits results in a quantifiable measure for thermal comfort assessment.

2.3.1.2.a. PMV (Predicted Mean Vote)

Fanger (1970) established PMV as a comfort evaluation method which calculates indoor temperature satisfaction through the mean thermal sensation reported by numerous people. The evaluation tool finds extensive usage indoors but shows inadequacy outside because it fails to accurately account for solar radiation and wind speed impacts (Fanger, 1970).

2.3.1.2.b. SET (Standard Effective Temperature)

SET defines the perceived indoor thermal conditions through its conversion of environmental temperature values into standard temperature readings under standardized ventilation conditions and humidity levels and specific clothing needs. SET proves useful primarily in intermediate and border areas of both buildings and spaces yet demands comprehensive information allocation since it cannot adjust successfully to severe outside weather conditions.

2.3.1.2.c. UTCI (Universal Thermal Climate Index)

UTCI evaluates outdoor comfort by applying a simulation of how people naturally regulate their body temperature. UTCI presents a method suitable for international comfort analysis while handling wind conditions and solar effects in addition to human bodily processes yet becomes challenging to apply directly to urban design without digital tools (Jendritzky et al., 2012).

2.3.1.2.d. PET (Physiological Equivalent Temperature)

The Physiological Equivalent Temperature (PET) provides a complete user-friendly index that measures outdoor thermal comfort based on combined environmental factors. PET enables users to describe temperature feelings that occur outdoors when compared to indoor conditions by generating a measurement in degrees Celsius (Matzarakis et al., 1999).

PET requires a combination of Air Temperature (Ta) with Mean Radiant Temperature (Tmrt) for understanding radiative heat exchange along with Relative Humidity (RH), Wind Speed (v) and two physiological constants: fixed metabolic heat production of about 80 W/m² and clothing insulation of about 0.9 clo.

The modeling tools RayMan for the older versions and biomet for the versions coming after 3.1 and ENVI-met execute these inputs to create simulations of microclimatic scale radiation together with airflow and vegetation effects (Matzarakis et al., 2007).

The thermal discomfort evaluation process known as PET has gradually become more common throughout Algiers, Blida and Constantine together with other North African and Mediterranean urban environments because of its ability to suit various climate patterns. Research conducted in summer conditions reveals that poorly shaded built-up areas with minimum green elements frequently generate PET values in excess of 35°C thus creating uncomfortable environments marked by thermal stress (Bouchahm et al., 2012; Djellouli & Bouchahm, 2018).

2.3.1.2.d.1 Calculation & requirements

PET builds on the human energy balance, which can be expressed by the MEMI model as:

$$M - W = C + R + E_{res} + C_{res} + E_{sw} + S$$

Where:

- M: Metabolic heat production
- W: Mechanical work
- C: Convective heat exchange
- R: Radiative heat exchange
- Eres: Latent heat loss via respiration
- Cres: Sensible heat loss via respiration
- Esw: Evaporative heat loss through sweating
- S: Heat storage in the body

This balance reflects the dynamic interaction between the body, the climate, and clothing insulation (Matzarakis et al., 1999; Jendritzky et al., 2012).

To calculate the PET the following climatic variables are required (VDI 3787, 1998), see table below and for the assessment and classification of thermal Sensation (adapted from VDI 3787), see table 2.4 below:

Table 2.3: Climatic Variables Required to Calculate Physiological Equivalent Temperature (PET). Source: Adapted from VDI 3787 (1998).

Parameter	Symbol	Description
Air Temperature	T_a	Dry-bulb temperature (°C)
Relative Humidity	RH	% humidity
Wind Speed	v	Measured at 1.1 m (m/s)
Mean Radiant Temp	T_{mrt}	Integrated solar and thermal radiation

- Thermal Sensation Classification (adapted from VDI 3787)

Table 2.4: Thermal Sensation Classification. Source: adapted from VDI 3787.

2.3.1.3 Outdoor Comfort and Wind Speed

PET Value (°C)	Thermal Sensation	Physiological Stress Level
< 4	Very Cold	Extreme Cold Stress
4 – 8	Cold	Strong Cold Stress
8 – 13	Slightly Cool	Moderate Cold Stress
13 – 18	Cool	Slight Cold Stress
18 – 23	Comfortable	No Stress
23 – 29	Slightly Warm	Slight Heat Stress
29 – 35	Warm	Moderate Heat Stress
35 – 41	Hot	Strong Heat Stress
> 41	Very Hot	Extreme Heat Stress

Outdoor thermal comfort directly depends on wind speed since this environmental factor creates significant changes in the perception of heat or coolness in outdoor areas.The human body receives cooling benefits through wind because of its increased rate of convective heat transfer.

Knowledge about how outdoor comfort relates to wind speed enables proper design of spaces that create welcoming thermal environments (Almeida et al. 2019).

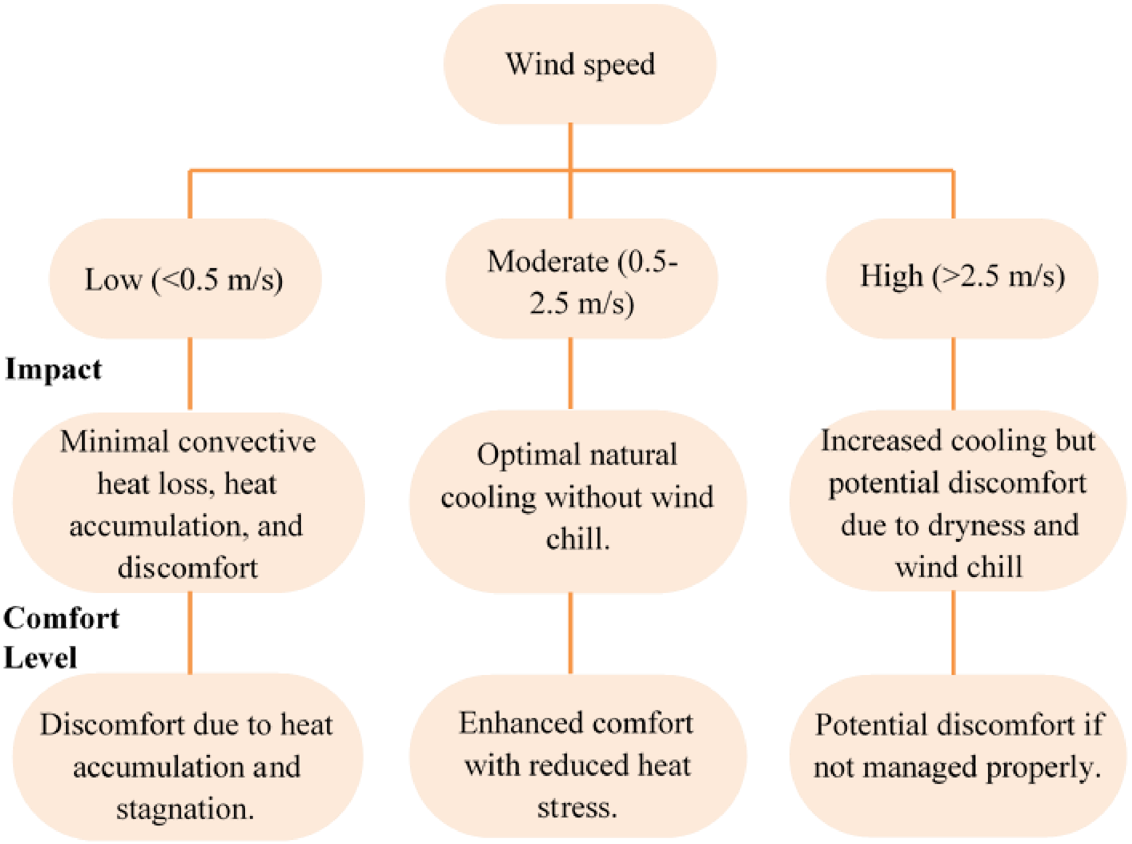


Figure 2.10: Diagram Showing the Impact of Wind Speed on Outdoor Comfort.
Source: compiled by authors Adapted from Lundgren 2020 and almeida.

2.3.1.4 The Role of Outdoor Comfort in Public Interactions

The thermal conditions outside strongly affect human conduct in public environments. Multiple studies demonstrate how comfortable temperature settings inside public areas increase social participation thus producing productive urban communities. Different weather conditions create thermal discomfort which results in the exclusion of vulnerable community members such as elderly adults and children when they attempt to use public outdoor areas. The success of inclusive dynamic communities depends on knowing how to improve outdoor comfort environments (Almeida et al., 2019; Lundgren et al., 2020).

In a survey done in Tokyo, 45% of individuals who visited different public parks with trimodal thermal comfort elements (such as shading and cooling fountains) reported increased social interaction (Miyazaki et al., 2016).

According to a study conducted by Salata et al 2019, urban parks with vegetation and shading could increase the time spent in the park up to 35% compared to unshaded areas.An examination in Copenhagen showed that 68% of testers chose to participate in outdoor activities under comfortable temperatures instead of choosing hot and uncomfortable environments (Hwang et al., 2017).

2.3.2 High-Albedo Materials with Earthy Tones: Climate Adaptation through reflective design for a better outdoor comfort

During summer season architectural surfaces in sun-exposed areas like northern Algeria specifically Miliana experiences severe solar radiation heat. High-albedo materials serve as passive cooling elements because these materials return a significant portion of sunlight while allowing minimal absorption. Building overheating is reduced through this technique while the urban heat island effect becomes limited and thermal comfort increases (Akbari, Pomerantz, & Taha, 2001; Santamouris, 2013).

2.3.2.1 Climatic Relevance of High-Albedo Surfaces

The solar radiation reflection rate varies from zero to one because albedo represents the amount of solar radiation that a surface reflects. The elevation of albedo properties on pavements and façades and roofs reduces summertime surface temperatures in built spaces between 10–25°C (Santamouris, 2013).

Diminished cooling requirements become possible throughout Algeria's Mediterranean region when installing high-albedo surfaces can significantly lower cooling demands, especially for urban zones with dense, thermally absorptive materials.

High-albedo surfaces result in ambient air temperature reduction through experimental testing in hot cities such as Cairo and Athens under shared climatic stressors (Synnefa, Santamouris, & Akbari, 2007). According to the U.S. EPA (2008) materials having albedo values higher than 0.4 are thought to adequately reduce solar heat gain.

2.3.2.2 Material and Color Selection: Warm, Light, and Earthy

To align with Algerian architectural heritage and Miliana’s color palette for warm light earthy tones, the following materials were selected based on both visual warmth and albedo performance:

Table 2.5: Social and Economic Impact. Source: authors.

Material Type	Color Options	Albedo Range	Notes
Lime-based plaster	Chalk white, light beige	0.45–0.65	Breathable, traditional (Santamouris, 2013)
Stabilized earthen render	Pale terracotta, ochre clay	0.40–0.60	Low-embodied energy (Akbari et al., 2001)
Ceramic tile (unglazed matte)	Sienna, ivory, sandstone	0.50–0.65	Durable & reflective (Synnefa et al., 2007)
Reflective paint (eco-line)	Straw, almond, soft gold	0.60–0.85	Commercially verified SRI (EPA, 2008)
Tadelakt lime finish	Desert gold, camel brown	0.50–0.65	Moroccan tradition with high reflectivity
SRI concrete	Ash beige, dusty sand	0.35–0.50	Reflective if lightly pigmented (EPA, 2008)

2.3.2.3 Technical Framework: SRI as a Decision Tool

Beyond albedo, the Solar Reflectance Index (SRI) represents a complete assessment indicator that combines solar reflectance values with infrared beam emissivity. Materials with a high Solar Reflectance Index are now required for sustainable certification such as LEED as they effectively decrease surface temperature (U.S. EPA, 2008).

Table 2.6: Minimum Recommended SRI Values for Roofs and Pavements. Source: U.S. Green Building Council, 2009; Cool Roof Rating Council, 2009.

Application	Minimum Recommended SRI	Justification
Roofs	78	To minimize heat gain and improve roof longevity
Pavements	29	To lower surface heat and enhance outdoor comfort

2.3.3 Nature-Based Solutions for Outdoor Comfort

Actions known as Nature-Based Solutions (NBS) use protected nature reserves as well as sustainable management and restoration techniques of natural or modified ecosystems to deliver societal benefits which simultaneously promote biodiversity protection and human well-being (Cohen-Shacham et al., 2016).

The International Union for Conservation of Nature (IUCN) established a definition of NBS which refers to strategies that depend on natural processes to handle climate change together with food security and disaster risk reduction challenges. Due to their incorporation of nature-based elements architects and urban designers use NBS to create improved comfort in external areas which achieves better heat regulation together with better air quality while increasing the overall quality of life.

2.3.3.1 Key Types of Nature-Based Solutions

NBS can be categorized into several key types, including:

- Vegetation Integration: This includes green roofs, urban forests, and community gardens that enhance biodiversity and provide cooling effects.
- Water Solutions: Techniques such as rainwater harvesting and artificial wetlands help manage stormwater and improve water quality.
- Shading Devices and Passive Cooling Techniques: These solutions reduce the need for mechanical cooling by utilizing natural shading from trees and structures.

These types of NBS contribute significantly to enhancing urban comfort by creating more livable spaces (Peng et al., 2021).

2.3.3.2 Vegetation Strategies for Enhancing Outdoor Thermal Comfort in Sub-Humid Climates

Enhancing urban environment with greenery is a tried-and-true way to make open spaces more comfortable. Through its ability to provide shade, evapotranspiration, and wind control mechanisms, urban vegetation acts as a cooling agent. When vegetation is carefully placed and selected for certain outdoor spaces, the microclimate quality in sub-humid climate zones significantly increases, improving comfort and sustainability throughout the summer.

2.3.3.2.a Green Corridors: Definition and Benefits

Green corridors function as aligned plant formations which link together parks along with nature reserves and urban green areas thus enabling ecological connections as well as biodiversity growth. These urban corridors function as multiple components for urban areas.

- **Temperature Regulation**: The shade from tree and shrub covers helps minimize air temperatures and also reduces surface heat. The reduction of outdoor air temperatures ranges from 2 °C to 6 °C based on vegetation density together with plant variety (Rahman et al., 2020).
- **Air Quality Improvement**: Plants function as air filters which remove pollutants as well as particulate matter while improving city air quality (Nowak et al., 2014).
- **Enhanced Biodiversity**: Green corridors create enhanced biodiversity through their habitat connections which helps develop a balanced ecosystem (Tzoulas et al., 2007).
- **Recreational Opportunities**: Green spaces provide the community with recreational facilities which promote well-being through walking and cycling spaces (Chiesura, 2004).

2.3.3.2.a.1 Case Study: Green Corridors in Lisbon, Portugal

The city of Lisbon established green corridors which link different parks along with its natural reserves across its urban territory. The corridors incorporate specific design plans that purpose to boost local biodiversity together with recreation facilities and climate comfort benefits. A study conducted by Oliveira et al. (2011) evaluated green spaces in Lisbon where larger parks with trees created air temperature drops reaching 2 °C thus demonstrating the power of green corridors as urban heat mitigators.

Figure 2.11: Green Corridor in Lisbon, Portugal
Source: MAP Landscape Studio (n.d.).

2.3.3.2.b Vegetation Choices for Sub-Humid Climates

The selection of suitable vegetation stands as a vital factor for achieving maximum thermal comfort in sub-humid climates. Key considerations include:

Native Species serve the dual benefit of indigenous fitness to regional plants alongside climate conditions thus making upkeep and plant survival more efficient (McPherson 1994).

The placement of deciduous trees beside walkways grants shade in summer months while permitting sunlight access during winter months which results in balanced temperature comfort (Shashua-Bar et al., 2009).

Low-growing plants between trees can help lower surface temperatures along with fueling evapotranspiration processes according to Armson et al. (2012).

2.3.3.2.c Recommended Plant Species for Sub-Humid Climates

Table 2.7: Recommended Plant Species for Sub-Humid Climates. Source: authors.

Common Name	Height (Approx)	Characteristics
Red Maple	12–21 m	Deciduous; provides ample shade; vibrant fall color (Dirr, 1998)
American sycamore	20–30 m	Deciduous; large canopy; tolerant to urban conditions (Peper et al., 2001)
Eastern Rebud	6–9 m	Deciduous; early spring blossoms; moderate shade (Dirr, 1998)
Swithgrass	1–1.8 m	Perennial grass; drought-tolerant; ornamental (Mitchell et al., 1997)
Black-eyed Susan	0.3–0.9 m	Perennial; attracts pollinators; low maintenance (USDA NRCS, 2006)

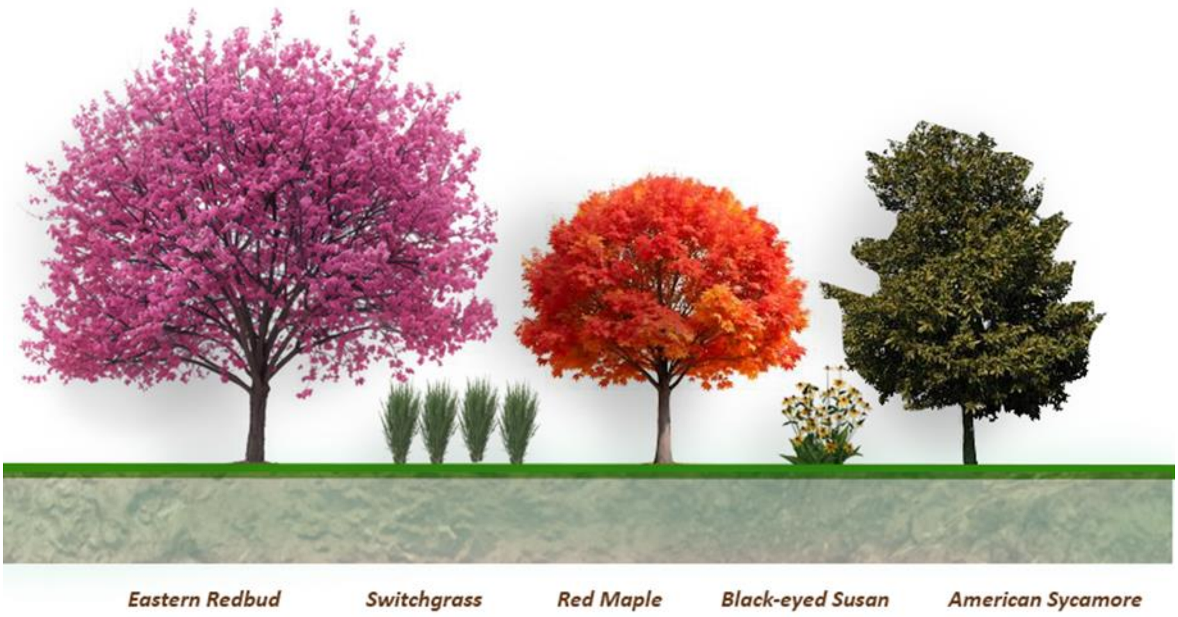


Figure 2.12: Image Showing Recommended Plant Species for Sub-Humid Climates.
Source: authors.

The graph shows empirical research-based values which demonstrate how vegetation helps regulate urban temperatures according to empirical studies. Key findings include:
Temperature Reduction: Urban planners should strategically position trees because this placement depreciates air temperatures by 1.1°C and helps people feel better during hot dry weather (Shashua-Bar et al., 2009).
Street Surface Temperature Reduction: Street areas that include trees in urban canyons benefit from reduced street surface temperature levels that drop to as much as 12°C which results in better pedestrian comfort (Oliveira et al., 2011).

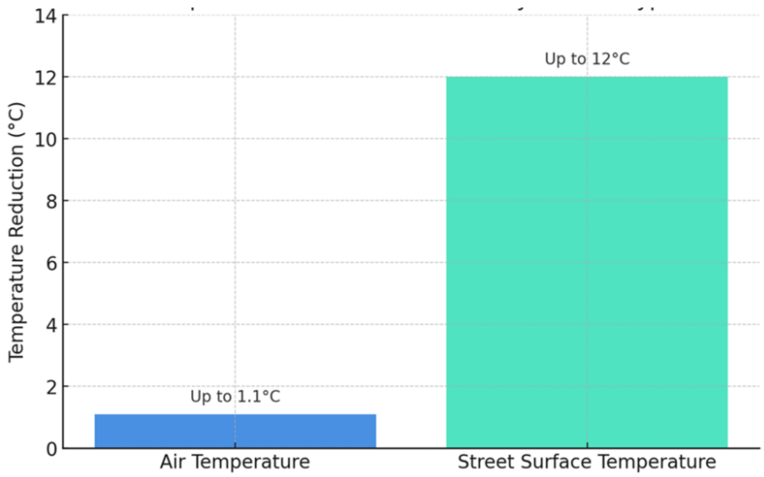


Figure 2. 13: Image Showing Recommended Plant Species for Sub-Humid Climates.
Source: Oliveira et al., 201; Shashua-Bar et al., 2009 adapted by authors.

Outdoor thermal conditions together with urban heat mitigation receive enhanced protection through the use of vegetation per this data analysis. The data graph outline the performance of tree canopy through two measurement sets for air cooling and pavement heat reduction in city territories.

2.3.3.3 Water-Based Cooling Strategies

The sub humid environment in which humidity and temperature levels stay moderate makes water based cooling systems work effectively to improve outdoor thermal comfort conditions. The strategies based on evaporative cooling principles create temperature reduction through the heat-absorbing power of water during its evaporation process. The application of key cooling methods depends on the combination of water mist systems and water cascades which require individual structural considerations with established performance measurement protocols and established regulatory standards.

2.3.3.3.a Water Mist Systems

The dispersion of water mist droplets produces aerosols that cool down the air through evaporation. The effectiveness of water mist systems in sub-humid areas depends significantly on their droplet size while being affected by ambient temperature and relative humidity and airflow patterns in the area.

Scientific evidence proves that water mist technology effectively lowers surrounding temperatures. The combination of water mist spray with fan operation conducted at the Osaka Japan location revealed immediate temperature reduction for skin through thermal relief during summer heat (Farnham et al. 2015). Under sub-humid environmental conditions the cooling performance remains noticeable although it may reach lower levels.

The optimal performance from misting systems will occur when droplets maintain 10 to 30 micron diameters because this range allows quick evaporation alongside minimal wetness. The required droplet size can be obtained through high-pressure nozzle systems that work between 50 to 70 bar (Ulpiani, 2019). Placing nozzles according to local wind patterns improves air cooling efficiency across the area.

Table 2.8: Challenges and Solutions for Implementing Water Mist Systems as a Nature-Based Solution (NBS). Source: Ulpiani, 2019.

Challenge	Description	Proposed Solution
Water Consumption	Efficient water use is crucial, especially in regions with water scarcity.	mplement systems with flow rates of 1–2 liters/min per nozzle to balance efficiency and conservation.
Humidity Control	Compliance with local water usage regulations and health standards is essential.	Operate misting systems during lower ambient humidity periods and integrate sensors to adjust mist output.
Maintenance	Clogging of nozzles and filters can compromise system performance.	Regular cleaning and use of water with low mineral content to reduce buildup frequency.
Regulations and Standards	Compliance with local water usage regulations and health standards is essential.	Ensure water meets potable standards to prevent the spread of waterborne diseases.

2.3.3.3.b Water cascades

Water cascades (further known as falling water walls) operate through evaporative cooling by maximizing the surface contact between water and air. A vertical flow of water allows part of its water to evaporate while the surrounding temperature decreases (Santamouris et al., 2017).

- **Effectiveness in Sub-Humid Climates**

Experimental data reveals that water cascades lower environmental temperatures between 2 to 3 degrees Celsius when installed with shading systems and ventilation channels (Wong et al., 2010; Ghaffarian Hosseini et al., 2017).

Santamouris et al. (2017) performed research on Mediterranean climate areas (sub-humid to semi-arid) to demonstrate that vertical water surfaces offer PET (Physiological Equivalent Temperature) reduction of 3.5 degrees Celsius based on material type along with environmental conditions.

- **Design Considerations**

To enhance evaporation performance of cascades it is essential to increase their height and width (Santamouris et al., 2017).

The cooling process becomes more effective when using heat-conducting materials such as stone or metallic composites because they emit absorbed heat to the outside (Ghaffarian Hoseini et al., 2017).The placement of cascades towards dominant wind directions creates better convective flow that elevates their evaporation levels to improve cooling performance (Wong et al., 2010).

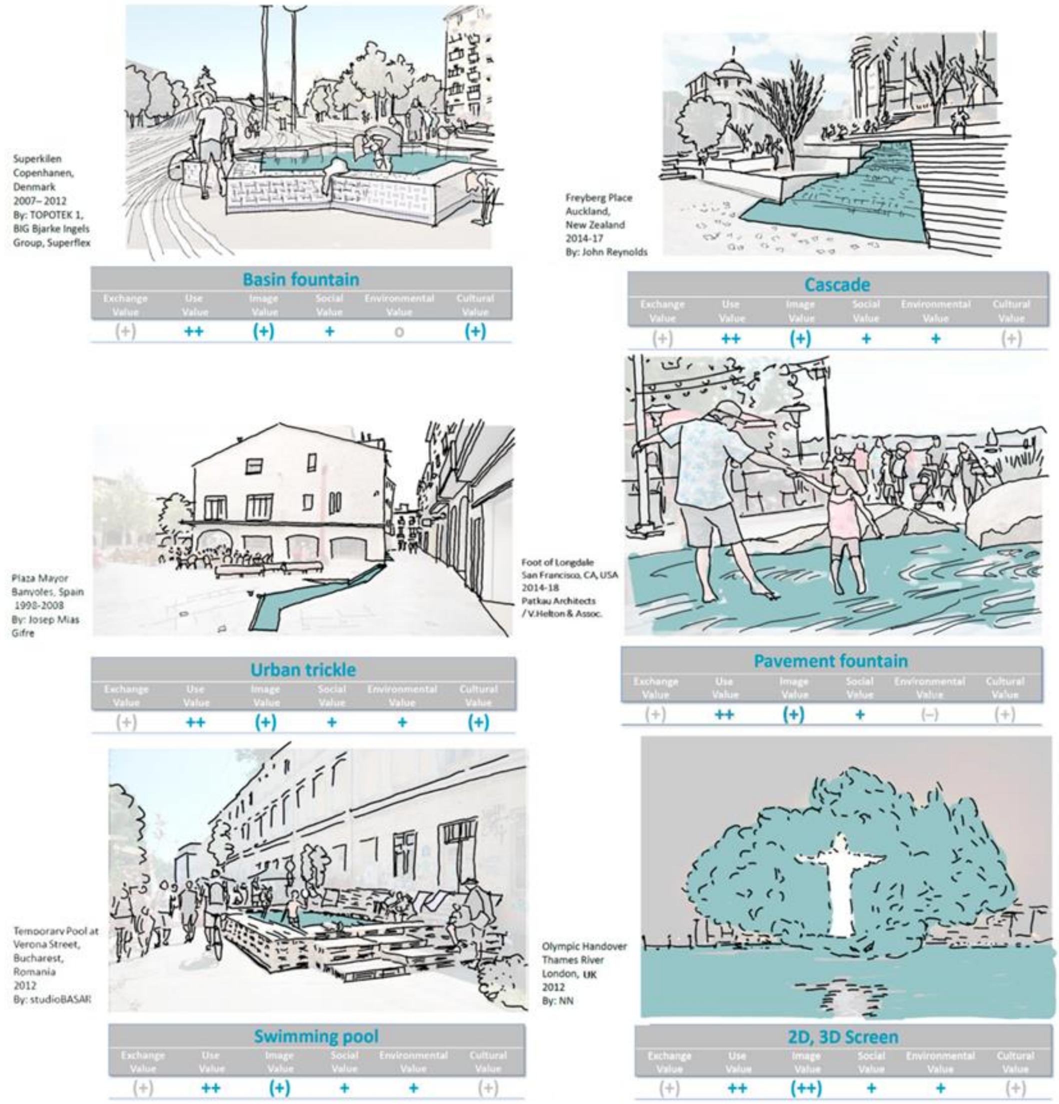


Figure 2.14: Identified morphological types of water elements in hardscaped urban public spaces, summary of their potential influence on values of public space. Denotations: + = moderate positive impact on the value of public space; ++ = significant impact on the v value of public space; − = moderate negative impact on the value of public space; (x) = values in parentheses—significantly dependent on detailed design.
Source: Langie, K., (2022).

- **Technical and Regulatory Challenges**

Water Quality: To avoid algae and biofilm accumulation Cascades need built-in filtration systems as part of their design. Public water installations using water as a cooling mechanism are required by ISO 20473:2007 and WHO guidelines to maintain drinking water quality when the water comes in contact with the public (World Health Organization, 2011).

Structural Integrity: The water installations necessitate structural design to handle the water's dynamic weight load. According to Ghaffarian Hoseini et al. (2017), water weight capacity depends on flow rate for walls featuring 4-meter cascades with weights between 80-120 kg of water per square meter.

Safety Norms: The DIN 51130 standard requires anti-slip ratings of R11 or higher for wet surfaces around the cascade. Surfaces should have minimum slopes of 1.5–2% to guide excess water into drainage channels (DIN Standards, 2013).

2.3.3.4 Shading Strategies

Buildings need passive design shading strategies to reduce heat gain and improve comfort levels as well as minimize energy usage. Three main types of devices exist for shading purposes including stationary devices together with mobile shading elements and nature-integrated systems. Shading occurs significantly through topographical formations together with built constructions.

2.3.3.4.a Passive Shading Devices

- **Fixed Shading Devices:** Such devices form an integral part of buildings when established as architectural components such as overhangs and fins and louvers serving to shield against sunlight rays. The research of Shahdan et al. (2018) showed that tropical climate conditions benefit from fixed horizontal louvers which minimize cooling load demands to 20% reduction. The unyielding design quality of these systems produces lower daylight access in the winter season.

- **Movable Shading Devices:** they feature adjustable louvers along with blinds and shutters which occupants can move according to solar angles and their own requirements. Studies conducted by Yang and Yao (2012) established that movable shading devices provide a 10% reduction in energy usage over fixed shading devices because they can be adjusted for seasonal conditions.

- **Integration with Nature Shading:** Use nature-based solutions with plants (green walls, pergolas with Climbing plants), add dynamic shading and cooling by evapotranspiration. Studies have shown that they can reduce the wall surface temperature for up to 10°C, which also has a strong impact on thermal comfort in the building (Perini et al., 2011).

2.3.3.4.b Effects of Topography on shading

The natural landscape with its slopes and surrounding hills obviously impacts shading and solar exposure. In the Northern Hemisphere, solar radiation falls more on south-facing slopes making them more suitable for harnessing solar energy whereas north-facing slopes remain cooler which is favorable to avoid heat gain. Site planning that is strategic of these can maximize natural shading and thermal comfort (Givoni, 1998).

2.3.3.4.c Built and Natural Elements for Shade

In the urban scene, it is neighboring buildings, walls, and constructed canopies that provide essential shading. Research conducted in Ahvaz, Iran, showed that mean radiant temperature (MRT) and Physiologically Equivalent Temperature (PET) can be lowered by 34- and 17.6 °C, respectively, as a result of urban shading, without compromising thermal comfort (Nasrollahi et al., 2021).

2.3.3.4.d Efficiency of Shading Devices in Reducing Heat Gain

The performance of shading devices depends on design variables, material properties, and climatic conditions. A report on the combined effect of vertical and horizontal elements in egg-crate shading devices demonstrates the same, achieving lower energy consumption. Shahdan et al. (2018) concluded that such configurations are more effective than other shading types at reducing solar heat gain.

Choosing the right materials for shading devices can make or break the performance. Materials that exhibit high thermal inertia, like concrete and brick, absorb and gradually release heat, thereby smoothing out temperature fluctuations. On the other hand, materials such as aluminum and wood have lower thermal inertia but can be favored for their lightweight and aesthetic properties. The table below summarizes thermal characteristics of some common shading materials.

Table 2.9: Statistical Evidence on the Impact of Nature-Based Solutions (NBS).Source: compiled by authors.

Category	Impact	Example
Heat-Related Mortality	Increasing tree cover by 30% can reduce premature mortality during heatwaves by 20%.	Barcelona's green infrastructure plan (Kabisch et al. 2017)
Cost-Effectiveness	Green roofs reduce urban runoff and are more cost-effective over time than technical systems.	Rotterdam's implementation of green roofs (Kabisch et al., 2017)
Air Pollution Control	Urban trees remove between 850–2000 tonnes of air pollutants annually, improving public health.	London's tree planting initiatives (Tallis et al., 2011)
Multi-Benefit Performance	NBS projects deliver co-benefits like improved mental health, urban attractiveness, and property value increases.	European cities implementing NBS across various sectors (Kabisch et al., 2017)

2.3.3.5. Indoor Comfort and the Courtyard Effect

Traditional architectural design includes courtyards above all else especially in sub-humid climate areas such as Miliana Algeria. The strategic courtyard design enables thermal control which adjusts climate conditions of both interior and exterior zones using passive elements.

2.3.3.5.a Influence of Courtyards on Thermal Regulation

The courtyard function represents a method of thermal regulation which enables ventilation through natural means while reducing interior heat levels. Natural ventilation chambers found in warm areas function to ventilate architecture through buildings while creating shaded areas that improve thermal comfort according to Al-Hemiddi and Al-Saud (2001). Different design proportions alongside orientation elements determine how well courtyards function in practice. Research shows unexposed courtyards tend to generate excessive solar heat which leads to increased daytime indoor temperatures (Ghaffarian Hoseini et al., 2015).

2.3.3.5.b Interaction between Indoor and Outdoor Climates

The courtyard's design mediates the relationship between indoor and outdoor environments. The proper distribution of courtyard dimensions allows airflow that helps buildings stay cooler through passive heat reduction thus providing better comfort conditions for interior spaces. Unfavorable courtyard designs produce heat entrapment that causes discomfort to occupants. Architectural changes to courtyards in Algiers demonstrate their influence on indoor thermal conditions along with hygrothermal comfort according to Boukarta (2024).

2.3.3.5.c Strategies to Balance Indoor Comfort

- Natural Ventilation:The courtyard design of the buildings enables natural ventilation because it lets fresh air in through cross-breezes which flushes out warm air. The passive cooling technique offers essential heat and humidity reduction in sub-humid regions. Operable windows along with vents help maximize this effect.

- Thermal Mass:High thermal mass materials such as stone and adobe when used in courtyard walls will store day heat which they release at night to stabilize interior temperatures. Thick walls in traditional Algerian buildings demonstrate how this method promotes thermal comfort as explained by El Harrouni et al. (2022).

- Passive Cooling:The incorporation of courtyard vegetation delivers shade and helps evaporate moisture which produces surrounding air temperature reduction. As per González-Molina et al. (2018) the addition of vegetation which covers over 50% of courtyard surface area leads to substantial improvements in thermal comfort levels.

2.3.3.5.d Courtyard Proportions and Their Effectiveness

Thermal performance of a courtyard can be influenced by height to width ratio. For example, a study on human thermal comfort in Laghouat courtyards, which tested several proportions to find the optimum values (Boukarta, 2024). Although contextually specific, these findings offer important insights into courtyard programming and design balance. The same tendency in the different sub-humid climates like Miliana, Algeria, can be expected, although specific studies will be needed to provide suitable guidelines.

Table 2.10: Impact of Courtyard Height-to-Width Ratios on Indoor Thermal Comfort. Source: authors.

H/W Ratio	Thermal Comfort Impact	Key Findings
0.5 (e.g., H:5m, W:10m) Source : Kedissa et al., 2017	Increased solar exposure; higher indoor temperatures	Lower H/W ratios result in courtyards receiving more direct sunlight, leading to increased solar heat gain and elevated indoor temperatures.
1.0 (e.g., H:10m, W:10m) Source : Martinelli & Matzarakis, 2016	Balanced shading and daylight; moderate indoor temperatures	An H/W ratio of 1.0 provides a balance between shading and natural light, contributing to moderate indoor temperatures and improved thermal comfort.
2.0 (e.g., H:20m, W:10m) Source : Boukarta, 2024	Excessive shading; reduced daylight; cooler indoor temperatures	Higher H/W ratios lead to increased shading, which can reduce indoor temperatures but may also limit natural daylight penetration.

2.4 Synthesis

2.4.1 Synthesis of part 1: Architecture

Urban acupuncture emerges as a strategic, small-scale yet high-impact approach for revitalizing neglected urban zones, especially in historically layered cities.. The approach uses strategically placed sensitive insertions like cultural hubs which activate social economic and environmentally beneficial renewal processes.

Micro-interventions function as catalysts which stimulate both community participation and local cultural activities and neighborhood identity within spaces that have been left empty or unused in urban areas.

This methodology reactivates spaces in Algerian middle northern cities like Miliana without eliminating their historical memory when colonial and post-colonial patterns fight against each other.

Cultural hubs operating within the scope of urban acupuncture create social spaces where people meet while exchanging art and healing their urban surroundings. Such projects transform neglected sites by implementing adaptive reuse methods and participatory design techniques to preserve neighborhood stories and architectural identity. These specific interventions form a grassroots strategy which links nonfunctional urban areas back to the city's fabric by creating sustainable connections between history and future development.

2.4.2 Synthesis of part 2: Environmental

Nature-based solutions (NBS) exist as climate-resilient and low-tech solutions to modern thermal comfort issues at urban and architectural levels.

Ecological integration together with biomimicry principles forms the backbone of NBS because they use water elements vegetation and shading systems to mitigate urban heat and regulate moisture and enhance ventilation which becomes critical for sub-humid Mediterranean climates.

The implementation of green corridors together with carefully selected drought-resistant species promotes public space cooling while courtyards function as thermal buffer components between indoors and outdoors resulting in comfortable breathable microclimates.

NBS become more effective when architects use them as passive shading elements and natural cooling mechanisms and reflective materials throughout building design which minimizes dependency on mechanical systems and boosts indoor air quality.

Various studies confirm their ability to create measurable benefits by decreasing surface temperatures and maximizing public zone occupancy and energy system performance.

The integration of traditional spatial logics including Algerian courtyards combined with natural building systems leads to dual benefits of enhanced comfort and preservation of contextual value and environmental peace.

These environmentally effective nature-based solutions generate quantifiable changes which affect different urban signs that span from public health to economic viability. The selected examples in Statistical Evidence on the Impact of Nature-Based Solutions (NBS) highlighted in the following table (Table 2.11) demonstrate practical benefits across different domains.

The examples showcase their ability to serve multiple functions because they surpass their function as heat regulators by strengthening environmental sustainability and community health while ensuring long-term financial advantages.

Table 2.11: Thermal Characteristics of Common Shading Materials.Source: Integrated Environmental Solutions; Thermtest Inc. (2021).

Material	Thermal Conductivity (W/m·K)	Specific Heat Capacity (J/kg·K)	Density (kg/m³)	Description / Use in Shading
Concrete	1.40	880	2400	High thermal mass, good for fixed shading and walls
Wood (Oak)	0.17	2400	700	Natural shading, moderate insulation
Aluminum	237	900	2700	Used in movable louvers; requires insulation to reduce heat gain
Terracotta	0.60	1000	1920	Often used in brise-soleil and mashrabiya panels

2.4.3 General synthesis

The project to build a cultural center in Miliana focuses on the western city entrance because it will help bring new life to a previously deserted vacant area of the municipality. The urban acupuncture strategy led to this location selection because it relies on meaningful small-scale interventions that create significant urban effects. The redevelopment aims to restore this inactive area through active use which will connect it back to the city structures and maintain its primary identity.

A lasting urban development requires meaningful public participation to succeed. Actual and sustained public involvement requires ensuring thermal comfort from within buildings and beyond their walls. The implementation of Nature-Based Solutions (NBS) serves as the connector between spatial quality improvements and environmental welfare boosting efforts. The implementation of NBS serves two purposes in this area: it improves microclimatic conditions while providing support for open-space activities including community events throughout during all the seasons of the year.

Our environmental strategy integrates several NBS elements tailored to the sub-humid climate of Miliana:

- **Green corridors** that connect the project zones, offering shading, biodiversity, and evaporative cooling.

- **Terraced gardens** designed in harmony with the site's topography, planted with resilient native species suited to moisture and seasonal heat.

- **Water features** such as artificial ponds and misting cascades that enhance cooling and sensory quality.

- **Topography-integrated shading devices**, combining built elements with landscape to modulate light, airflow, and shelter.

By including an interior courtyard, the project's key architectural features highlight traditional Algerian architecture. Because it serves as a thermal transition zone between the internal and outdoor environments and as insulation for heating, the courtyard is a crucial component of traditional living typologies. In order to preserve local identity and project identity, the design element also serves as a cultural expression that embraces architectural heritage.

A comprehensive strategy for sustainable urban development that incorporates social effectiveness with environmental considerations and economical viability is achieved by combining urban acupuncture with nature based system integration and architecture preservation requirements. Through the development of places that offer functional value and purpose while maintaining a strong relationship to their site, this strategy ensures long-lasting performance while facilitating public life and improving climate resilience.

2.5 Example Analysis

The main objective of this part of the thesis is to gain the knowledge and tools necessary to approach the architectural design of a cultural center. This is done through the study and analysis of existing projects, taking into account various architectural aspects such as design, construction, energy performance, sustainability, cultural and social impact, among others. Special attention will be given to key design elements, including structure, form, function, light, space, texture, color, materials, and environmental impact. For this purpose, we have selected three case studies (both national and international) and analyzed them using a framework based on three categories: form, envelope, and environment (see figure below).

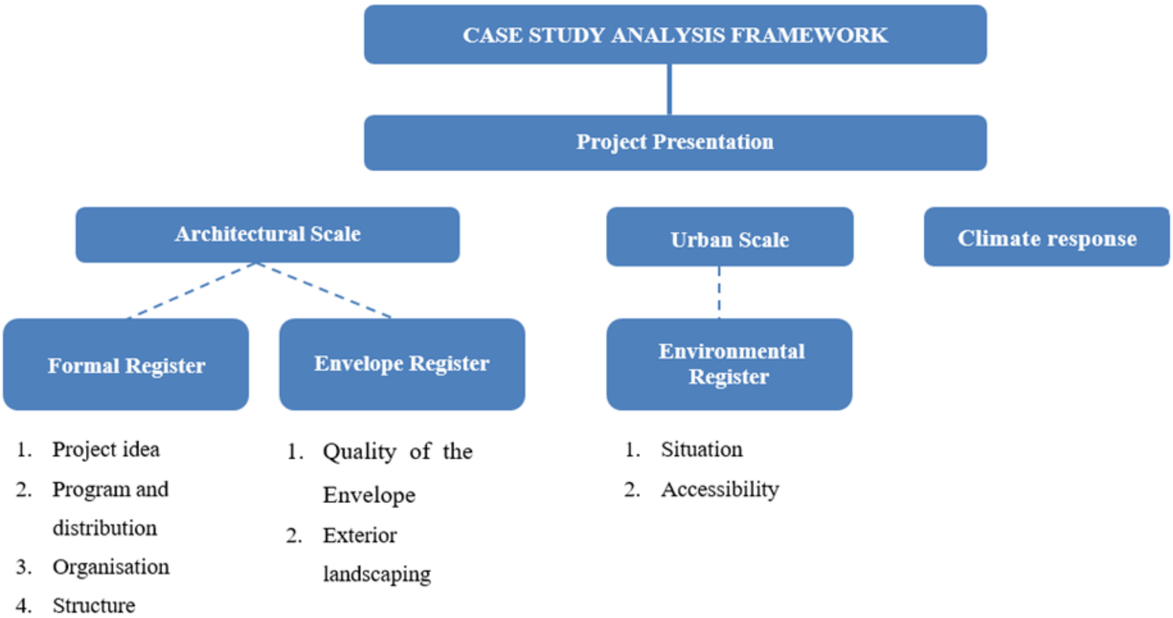


Figure 2.15: Diagram representing the case study analysis framework.
Source: authors.

2.5.1 Project Presentation

Before analyzing the selected case studies, we first present the chosen projects based on the evaluation grid mentioned above. The examples were selected using specific criteria to match our design goals. The selection includes one national project and two international projects.

Table 2.12: Presentation of examples. Source: studio, 2024, treated by Authors.

Zhejiang Lishui Guyanhuaxiang Art Center China	**Atrium of Light - Community Center of Fragrant Lake** China
	
Choice Criteria	
The site demonstrates an effective approach to historical restoration by using regional architectural elements for continuity when regenerating architectuural settings. The heritage context which incorporates public cultural activities makes this design appropriate for Miliana due to its complex Ottoman and colonial history.	This project offers valuable understanding for developing emotionally intelligent climate-aware community accommodation spaces. Its bright atrium along with green integration and placid architectural approach makes it a facility that matches the need for welcoming healing spaces which improve the quality of life in Miliana's transitional urban areas.Additionally, its sensitive adaptation to a **sloped site** demonstrates how architecture can embrace challenging topographies while maintaining spatial harmony and accessibility.
Features	
- Reinforces continuity of pedestrian paths - Respects existing topography and urban grain - Acts as a cultural landmark within a low-scale urban fabric - Supports cultural tourism while preserving local traditions	- Acts as a soft connector in a residential area - Open to all directions, encouraging access from multiple paths - Blends into green context with low visual dominance | - Provides quiet zones, social spaces, and activity areas - Fosters everyday interaction rather than formal cultural display
Project area	
20,000 m²	2,284 m²

Table 2.13: Example analysis 01, Source: line+ studio, 2024, treated by Authors.

Analysis register — **International project 01: Zhejiang Lishui Guyanhuaxiang Art Center**

Urban scale

1. Environmental

Situation

Located in Guyan Huaxiang, a historic artistic and cultural town in the Liandu district, Lishui city, Zhejiang province, China.

COS: 0.32 - CES: 48% - Height: R+2.

Orientation: East-West.

Accessibility

The Perfumed Lake Community Center is set back from main roads to preserve tranquility while remaining accessible via secondary paths leading to peripheral parking areas. Immersive pedestrian trails and inclusive facilities (ramps and elevators) ensure smooth transitions between the urban and natural environments

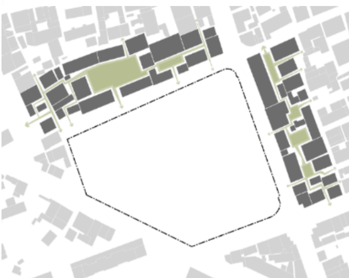
Architectural scale

2.Form

Project idea

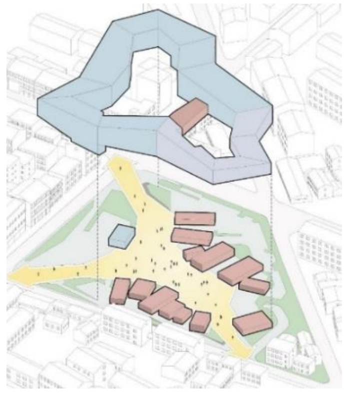
It is designed to integrate art with daily life Key concepts include:

- Art and Community Integration: Blending contemporary art exhibitions with everyday activities to encourage public engagement.
- Diverse Functionality: Accommodating various uses such as exhibitions, retail, leisure, and educational programs.
- Cultural Context: Reflecting local heritage and fostering artistic community engagement through open public spaces.



Program and distribution

The Center is organized around a central suspended volume dedicated to exhibitions, positioned above a base integrated into the urban fabric. The program combines ground-floor commercial spaces, intermediate community areas, and upper-level art galleries. This layout encourages social interaction while maintaining a strong visual and symbolic connection to the surrounding landscape.

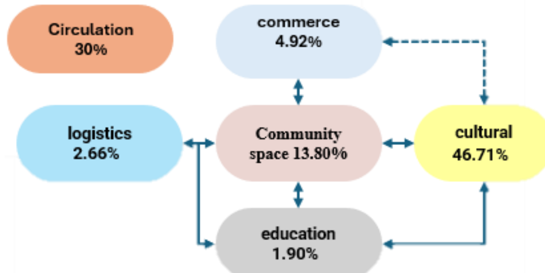


Business
exhibition
Public Education and Communication

Organisation

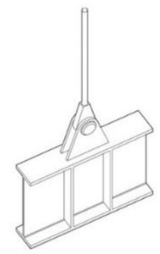
The center contains five main functions:

- Cultural (Exhibition, reading)
- Community space
- Logistics (administration , service areas)
- Commerce (Public Interaction , Maintenance and Utility)
- education



Structure

- Overhanging Design: The building has a striking upper section that extends outward, creating large exhibion spaces.
- Materials: Made with a steel frame and concrete covered with slate tiles for a natural look.
- Circulation: Features skybridges and elevated walkways with hanging cables for easy movement between different areas.

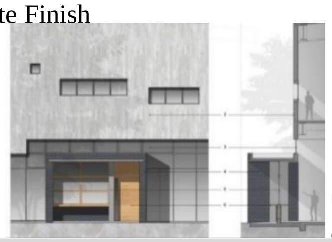


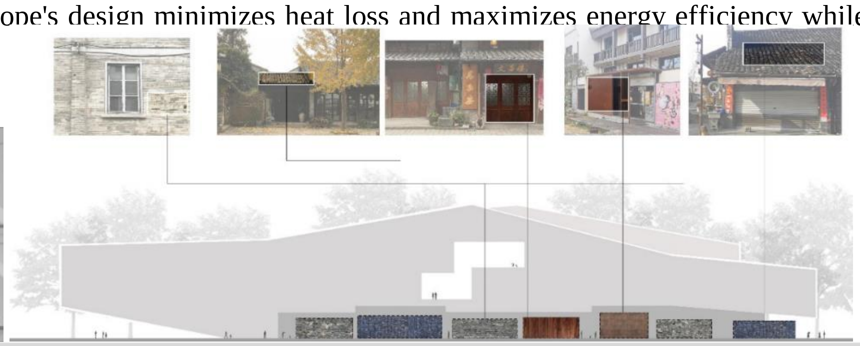
3.Envelope

Quality of the Envelope

The building envelope is crafted from high-quality materials, primarily featuring board-formed concrete that presents a warm texture, softening the imposing scale of the structure. This choice fosters a dialogue between contemporary architecture and the traditional vernacular of the surrounding area.The envelope's design minimizes heat loss and maximizes energy efficiency while ensuring durability.

1. Wooden Formwork Concrete Finish
2. Low-E Glass
3. Small Gray Tiles
4. Waterproof Gypsum Board Ceiling





Exterior landscaping

The landscaping around the art center features various-sized courtyard squares that serve as public spaces for community activities. These outdoor areas are designed to facilitate social interactions, markets, and events, reflecting traditional communal spaces found in towns.

Climate response

- Natural lightine : large windows and
- Shading Devices: Control heat and improve comfort.
- Sustainable Materials: Wood formwork concrete and slate tiles improve efficiency and blend with the environment.
- Nature Integration: Open courtyards connect the design with the landscape.

Table 2 14: Example analysis 02, Source: line+ studio, 2024, treated by Authors.

Analysis register — **International project 02: Atrium of Light - Community Center of Fragrant Lake**

Urban scale

1. Environmental

Situation

Located in the northern outskirts of Wuhan, within the Fragrant Lake Cultural Tourism Resort, Hubei province, China.

COS: 0.25 – CES: 42% – Height: R+1.

Orientation: North-South with slight variations to adapt to the natural topography.

Accessibility

The Fragrant Lake Community Center is set back from main roads to preserve the site's tranquility while remaining accessible via secondary pathways leading to peripheral parking areas. Immersive pedestrian trails and inclusive features such as ramps and elevators ensure universal access, facilitating a seamless transition between the urban and natural environments.

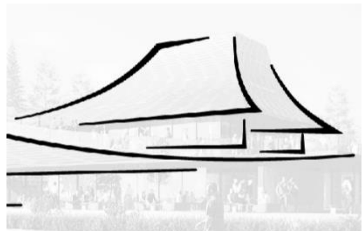
pedestrian access

Architectural scale

2.Form

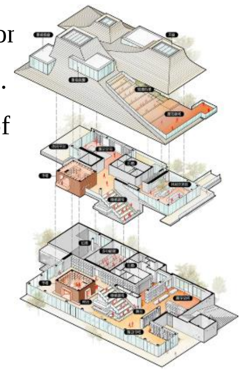
Project idea

- Traditional Influence: Inspired by Jingchu culture, the design features sloping roofs, floating cornices, and tones reminiscent of the Yellow Crane Tower, blending tradition with function.
- Lake Orientation: Positioned to maximize views and light, the design connects with Fragrant Lake through open spaces and glass surfaces, fostering tranquility and community interac²ion.



Program and distribution

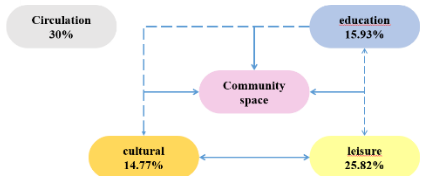
The Center is organized around a luminous atrium connecting reading areas, exhibition spaces, and a multipurpose theater. Observation terraces along the roof offer views of the natural surroundings, promoting community interaction and harmony with the landscape.



Organisation

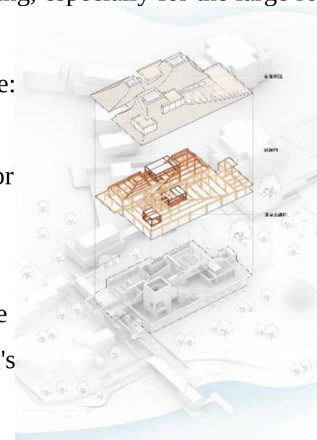
The center contains four main functions:

- Cultural (Exhibition, theatre)
- Community space
- leisure
- education



Structure

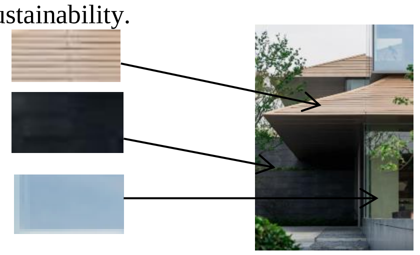
- Reinforced Concrete Base: The foundation is made of reinforced concrete, providing stability and support for the building, especially for the large roof structure above.
- Steel Roof Structure: The roof utilizes a partial Steel framework allowing for larger spans and dynamic shapes. This structure supports the building's distinctive sloping roofs.



3.Envelope

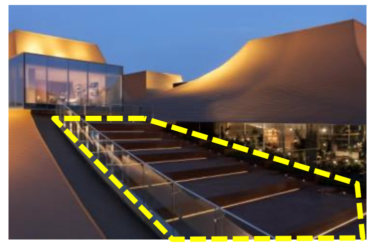
Quality of the Envelope

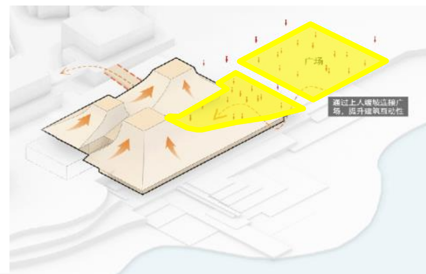
The quality of the envelope of the Fragrant Lake Community Center is based on durable materials such as concrete, glass, and metal, ensuring both resilience and seamless integration with the surrounding landscape. Large windows and skylights optimize natural light, reducing energy consumption and creating a bright, inviting atmosphere. Additionally, the envelope ensures high thermal performance, contributing to the building's environmental sustainability.



Exterior landscaping

Terraces, observation platforms, and walkways surround the Center, with a roof offering panoramic views of the lake and forest. These areas foster community gatherings and relaxation, blending indoor and outdoor experiences.





Climate response

- Natural light: Large windows reduce the need for artificial lighting.
- Ventilation: Openings allow fresh air circulation, minimizing cooling needs.
- Biophilic design: Use of plants and natural materials enhances well-being.
- Atrium: Regulates indoor temperature and lowers energy consumption.
- Water management: Rainwater harvesting and greywater reuse conserve water.

2.5.2 Recommendation

After analyzing the case studies, we came to the recommendations that shall be considered when designing our project (table 2.15)

Table 2.15: Thematic research recommendation. Source: authors.

Environmental	Form		Envelope	Climate response
Urban concept	Architectural concept	Program concept	Structural aspect	
- The building should ensure both indoor and outdoor comfort to encourage community interaction. - The design must incorporate sustainable strategies to mitigate heat through material choice, form orientation, and ecological integration. - The project should adopt a punctual intervention strategy—aligned with urban acupuncture principles—to reactivate degraded neighborhoods and improve local ecosystems. - The site should be enhanced with vegetation and water elements to regulate microclimate and promote biodiversity.	- The building form should integrate with the site's topography, offering shaded areas and fluid circulation that accommodates diverse user flows. - The architecture should express symbolic identity at the urban scale to attract users and define place character. - A proportional patio—both in width and height—should be introduced to enhance thermal comfort and spatial quality for both interior and exterior areas.	- The building should accommodate a flexible and adaptable program that evolves with community needs. - Public spaces should be planned to support cultural expression, informal gatherings, and intergenerational use. - The program should offer hybrid functions, combining heritage preservation with modern cultural demands. - Ground floors should be visually open, with large openings to support street-level interaction and pedestrian engagement.	- The building envelope should employ light-colored materials with high solar reflectivity to reduce heat gain. - Facade materials should be selected for their thermal inertia and insulation properties to maintain interior comfort. - The envelope should feature an innovative facade system with adaptive shading devices, responsive to both interior functions and external climatic exposure. - The structural design should accommodate the site's slope, ensuring that the building is embedded harmoniously into the terrain.	- The building should incorporate a central patio or atrium to support passive ventilation and daylighting. - The design must integrate vegetation, water elements, and shading structures to optimize thermal comfort. - Orientation and massing should respond to prevailing wind directions, solar exposure, and topographical conditions to enhance natural airflow and regulate interior temperatures. - The layout should be developed in accordance with PET (Physiological Equivalent Temperature) comfort indices, ensuring year-round usability of public spaces.

2.5.3 Project's program

By merging the spatial qualities of cultural institutions with the dynamics of contemporary public spaces, we developed a program that responds to the daily needs of the community. The design offers diverse cultural, educational, and leisure activities while honoring local identity and heritage (see Table 2.20). A qualitative programming phase was first carried out, considering the formal and functional aspects of each activity, including spatial configuration, furniture needs, environmental comfort, and technical requirements. This helped define the primary and secondary spaces associated with each function. Following this, a quantitative programming table was established. For a comprehensive overview, please refer to the annex.

Table 2.16: Main and secondary functions of our project. Source: authors.

Main Function	Sub-Functions
Culture	- Exhibition Halls, Immersive Experience Rooms (Sensation Spaces), Cultural Education rooms and art studios
Commerce	- Artisan Textile Shops, Jewelry Boutique, Poetry and Literature Corner, Traditional Clothing Store, Herbal Remedy Shop, Culinary Spaces (Traditional Food Market), Perfume and Soap Workshop, Art Gallery, Bookstore
Education	- Training and Workshop Rooms, Reading Lounges And a library, Archival Storage Spaces, Research and Classrooms
Administration	- Public Relations Office, Event Coordination Office, Facility Management and Technical Services Office
Leisure	- Rest Areas (Indoor & Outdoor Seating Spaces), Recreational Zones (Play Area, Cafeteria, Courtyard for Informal Use)

2.5.4 Conclusion

The analysis of case studies involving cultural centers, urban acupuncture, and nature-based solutions (NBS) in sub-humid climates has provided meaningful insights for the development of our project. These examples not only inspired the design direction but also highlighted key strategies and challenges specific to our climatic context. By studying how similar projects respond to environmental and social needs, we've established a strong foundation for a design that is both sustainable and climate-responsive. The goal is to create a modern cultural hub that reflects local identity, meets everyday community needs, and offers engaging, comfortable spaces for leisure, interaction, and discovery.

CASE STUDY

Chapter 03

3.1 Introduction

The city of Miliana offers natural richness along with multiple historical layers that yield discovery opportunities and creates fascinating structures for analysis. A project at Miliana will achieve success with richness when it develops strong ties to the city while integrating with its environmental situation.

The site analysis produces optimum project integration through separating and decomposing and breaking down essential elements into a well-ordered understanding of their relationships. The research about external references for the city and site analysis consists of three main dimensions which proceed in the following order: 1. Climate analysis, 2. Diachronic (historical) analysis and 3. The project derives its final recommendations from an application typo-morpho-sensorial analysis.

3.2 City presentation: Miliana

3.2.1 City choice criteria

- Cultural and Historical Value:

The North African city of Miliana presents multiple historical layers including Berber, Islamic and Ottoman and colonial structures thus creating excellent conditions for architectural studies based on context.

- Strategic Territorial Position and Topographical Identity

Environmental adaptive design benefits from the location's mountainous zone which presents specific climatic and landscape features.

- Alignment with Workshop Objectives

The site enables direct examination of urban climate concerns while facilitating architectural problem-solving for both understanding and solving environmental issues which aligns with the workshop's academic framework.

Figure 3.1: the characteristics of the choice criteria of the city of Miliana.
Source: authors.

3.2.2 Name origin

Through various historical periods the name Miliana acquired its present form by adopting characteristics from Berber and Roman and Arab civilizations.

- Berber and Roman Origins: The historical city before Arab conquest bore the name *Zucchabar* which possibly stemmed from the Phoenician or Libyco-Berber languages. Different interpretations reveal this name may refer to a wheat market or worship Abadir the sacred mountain deity located at Zaccar Massif (Abbas-Kebir 2013). During the Roman period the city gained status as *Colonia Iulia Augusta Zucchabar* when Augustus ruled the empire (The Editors of Encyclopaedia Britannica, 2014).

The origin of the city name Manliana or Malliana stems possibly from the Roman nobility gens *Manlia* which controlled estates in this region (Abbas-Kebir, 2013).

- Arabic Reinterpretation: Following Arab conquest the name changed to Meliana (مليانة), an Arabic word that meant fullness, probably because the city had plentiful land and water resources (Abbas-Kebir, 2013). The city achieved renewed life during the 10th century through Buluggin ibn Ziri who rebuilt it over the remains of previous Roman buildings (The Editors of Encyclopaedia Britannica, 2014).

3.2.3 Geographical situation

3.2.3.1 Territorial scale

Miliana is a town located in the Aïn Defla province, in the northeastern part of the province. It is situated approximately 119 kilometers southwest of Algiers.

Built on a rocky outcrop at an altitude of 720 meters on Mount Zaccar, its geographical coordinates are approximately 36.18° North latitude and 0.7° East longitude.

(Wikipedia, 2025)

Miliana is a town located in the wilaya of Aïn Defla, in north-central Algeria. The wilaya is bordered to the north by the provinces of Tipaza and Blida, to the eastby Médéa, to the south by Tissemsilt, andto the west by Chlef. Miliana occupies a strategic location within this network, benefiting from its proximity to multiple major provinces (Wilaya d'Aïn Defla, 2023).

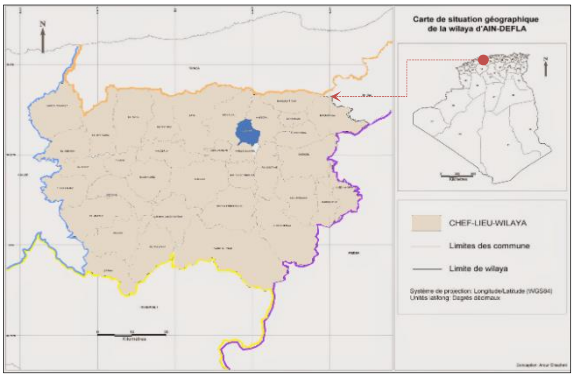


Figure 3.2 : Territorial situation of Miliana.
Source: Website carte Algérie, edited by the authors.

3.2.3.2 Regional scale

At the regional scale, Miliana shares borders with several neighboring communes. To the north, it is adjacent to Aïn Torki and Ben Allal; to the south, it borders the commune of Khemis Miliana. To the east, it again meets Aïn Torki, while to the west, it is bordered by Ben Allal (Daïras de la wilaya de Aïn Defla, 2023).

Figure 3.3: Regional situation of Miliana.
Source: Website carte, edited by the authors.

3.2.4 Accessibility

The location of Miliana benefits from provincial and national road routes which support regional moves across the area. The National Road 4 (RN4) goes through the southern regions of Aïn Torki and passes by the southeastern Miliana limit before continuing to Khemis Miliana and Sidi Lakhdar to reach Oran (Wikipedia, 2024).

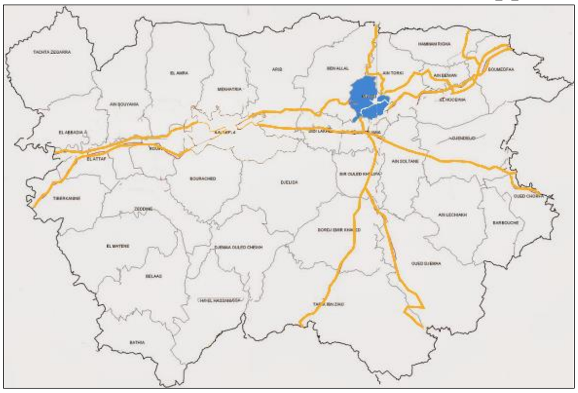


Figure 3.4: Accessibility of Miliana.
Source: Website Découpage Administratif de l'Algérie et Monigraphie & Google Earth, edited by the authors.

- National Road 66 (RN66) provides a connection between Miliana and Khemis Miliana and continues through Tipaza to enhance access to the northern coastal areas (Wikipedia, 2024).
- The transportation network in local communities heavily depends on provincial roads because of their essential function in area mobility. The CW12 route provides access between Miliana and Aïn Torki whereas the CW3 road extends from Miliana to reach the Ben Allel commune thereby connecting local areas (El Watan, 2023).

3.2.5 Population

The population of Miliana reached 44,201 according to the 2008 census data where male and female numbers were almost equal at 22,212 and 21,989 respectively. According to the age distribution Miliana shows a young population makeup where 29,907 people which represent 67.7% of the total population are between 15 and 64 years old. The statistical data implies that population growth potential matches the necessary workforce requirements thus underlining the importance of sustainable urban planning (Office National des Statistiques de l'Algérie, 2008).

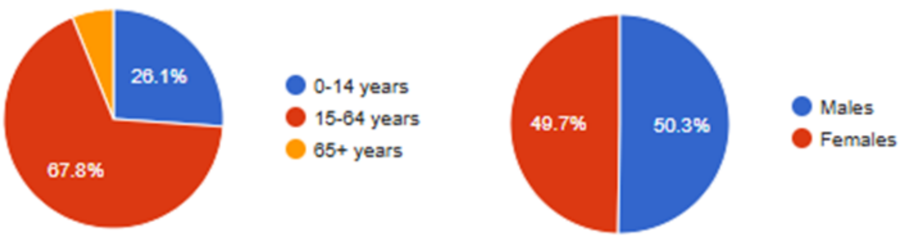


Figure 3.5: Accessibility of Miliana.
Source: Office National des Statistiques de l'Algérie, via CityPopulation.de.

3.3 Climate analysis

The climatic data used for the simulations cover the period from 2007 to 2021 for the city of Miliana, obtained from the website climate.onebuilding.org. The bioclimatic analysis is carried out using the psychrometric chart of Climate Consultant V6, developed by the University of California. See Figure 3.11 below. The study is based on the adaptive thermal comfort model.

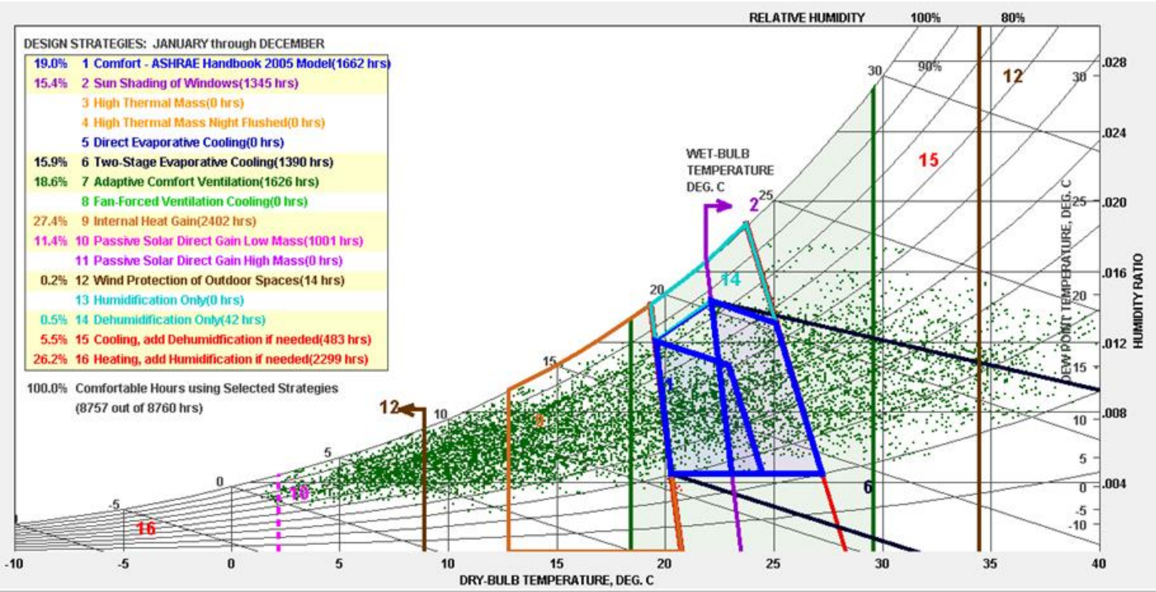


Figure 3.6: Psychrometric chart for Miliana.
Source: Climate consultant.

Miliana experiences 19% comfort according to the ASHRAE Handbook 2005 model (1662 hours/year) and 18.6% adaptive comfort ventilation (1626 hours/year), indicating a significant portion of the year where natural ventilation and environmental factors contribute to thermal comfort.

To enhance comfort, several strategies are recommended, including sun shading of windows, which improves comfort for 1345 hours/year. Adaptive comfort ventilation aligns well with the local climate, providing natural cooling for 1626 hours/year. While high thermal mass, evaporative cooling, and passive solar gain are less effective on their own, they could complement the natural ventilation system and contribute to overall energy efficiency and comfort.

3.3.1 Recommendations of climate analysis

Daily temperature

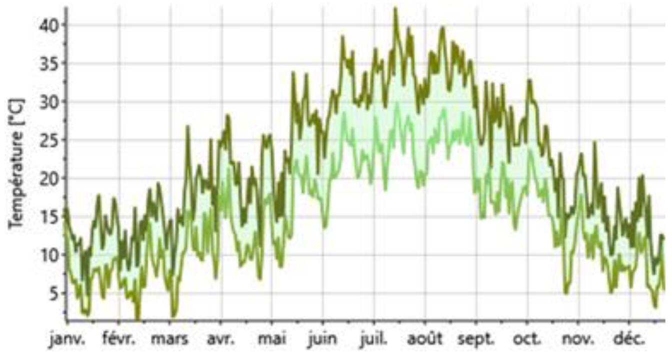


Figure 3.7: Daily temperature at Miliana.
Source: Meteonorme 7.

Miliana's climate shows a wide temperature range from -3°C to ~40°C. Average highs are 25–30°C, and lows are around 5–10°C. With 9 cooler months and only 3 hot months, the design should focus on insulation and keeping spaces warm most of the year, while also ensuring shade and ventilation for the hotter months.

Radiation

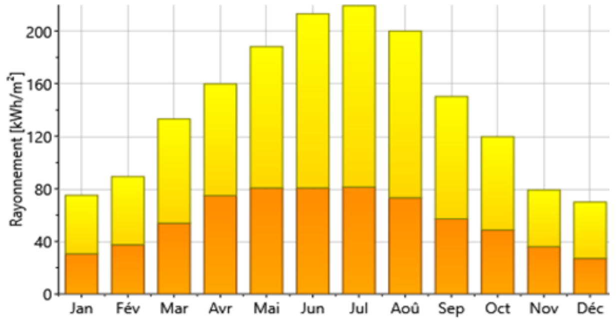


Figure 3.8: Radiation range at Miliana.
Source: Meteonorme 7.

Miliana receives 1694 kWh/m²/year of solar radiation, with a peak in summer (213–219 kWh/m²) and a minimum in winter (70–75 kWh/m²). Solar panels would be highly effective, especially from May to August, but would remain useful year-round.

Sunshine duration

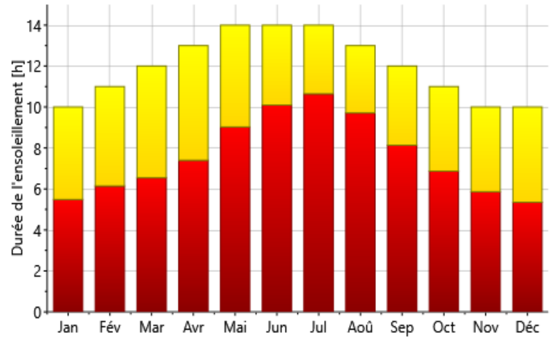


Figure 3.9: Sunshine duration.
Source: Meteonorme 7.

Miliana's sunlight varies seasonally, with shorter, cloudier winters (4–5 hours of sunshine) and long summer days (up to 12 hours of sunshine). This highlights the need for passive solar heating in winter and shading strategies in summer to prevent overheating.

Precipitation

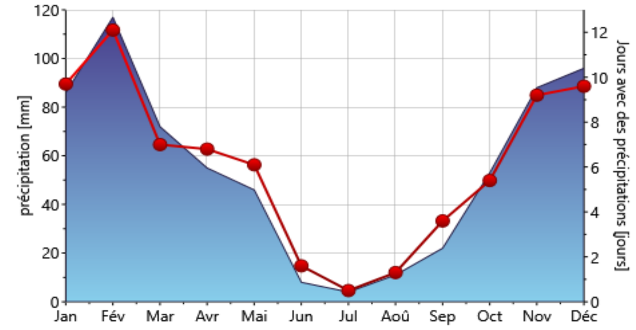


Figure 3.10: Precipitation.
Source: Meteonorme 7.

Miliana receives an average of 660 mm of rainfall annually, with most precipitation in winter and very little in summer. This highlights the need for rainwater harvesting, proper drainage to manage winter rains, and drought-resistant landscaping for the dry summer months.

Humidity

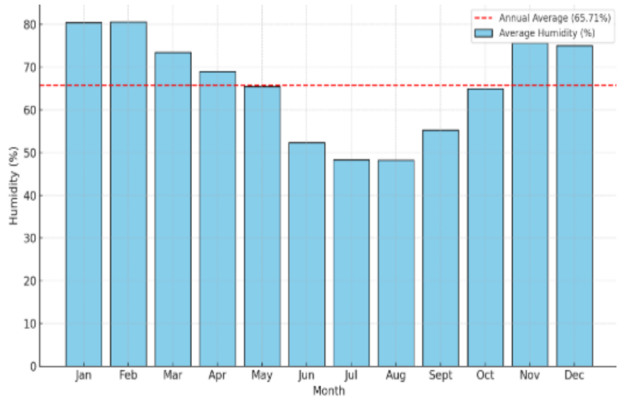


Figure 3.11: Humidity.
Source: Meteonorme 7.

Miliana receives 660 mm of annual rainfall, mostly in winter, with minimal summer precipitation. This calls for rainwater harvesting, efficient drainage to prevent waterlogging, and drought-resistant landscaping for dry months.

Wind

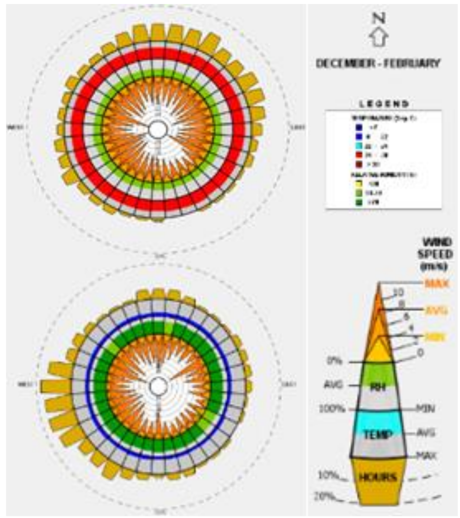


Figure 3.12: Wind wheel.
Source: Climate consultant 6.

Miliana receives around 660 mm of rainfall per year, with a peak during winter and a dry summer (only 4–11 mm). It is essential to capture and store water during the wet season, ensure proper drainage, and use drought-resistant plants.

Szokolay diagram

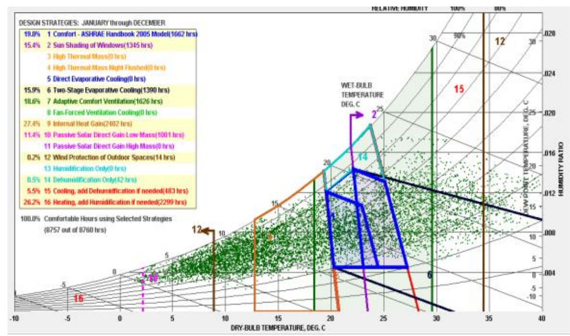


Figure 3.13: Szokolay diagram.
Source: Climate Consultant 6.

1. Use cross-ventilation to reduce cooling needs.
2. Apply passive cooling with water features and shading.
3. Incorporate thermal mass to stabilize indoor temperatures.
4. Control sunlight with external shading systems.
5. Improve insulation for comfort in cooler months.
6. Manage humidity with breathable wall assemblies.

Szokolay diagram

Table 3.1: Table of Mahoney. Source: Authors.

Table	Recommendation
1	Compact plans to reduce energy loss and optimize space usage.
2	Openings should be in the north and south walls, positioned at human height on the wind-exposed side. Include interior wall openings for better airflow.
3	Design buildings with double orientation to allow intermittent air circulation and natural ventilation.
4	Openings should cover 20–35% of the wall surface for optimal airflow and natural lighting.
5	Provide protection against rain using shading devices or overhangs to prevent water infiltration.
6	Use massive constructions to ensure thermal stability, with a time lag greater than 8 hours for heat regulation.
7	Employ massive roof constructions with a time lag greater than 8 hours to maintain thermal comfort year-round.

3.4 Diachronic analysis

3.4.1 Historical overview

Miliana is an Algerian city with a rich historical past. Located at the foot of Mount Zaccar, it has witnessed numerous eras that have shaped its urban and architectural identity. Its history spans from the Roman period to the present day, with significant influences from various civilizations. Here is an overview of its evolution through the ages.

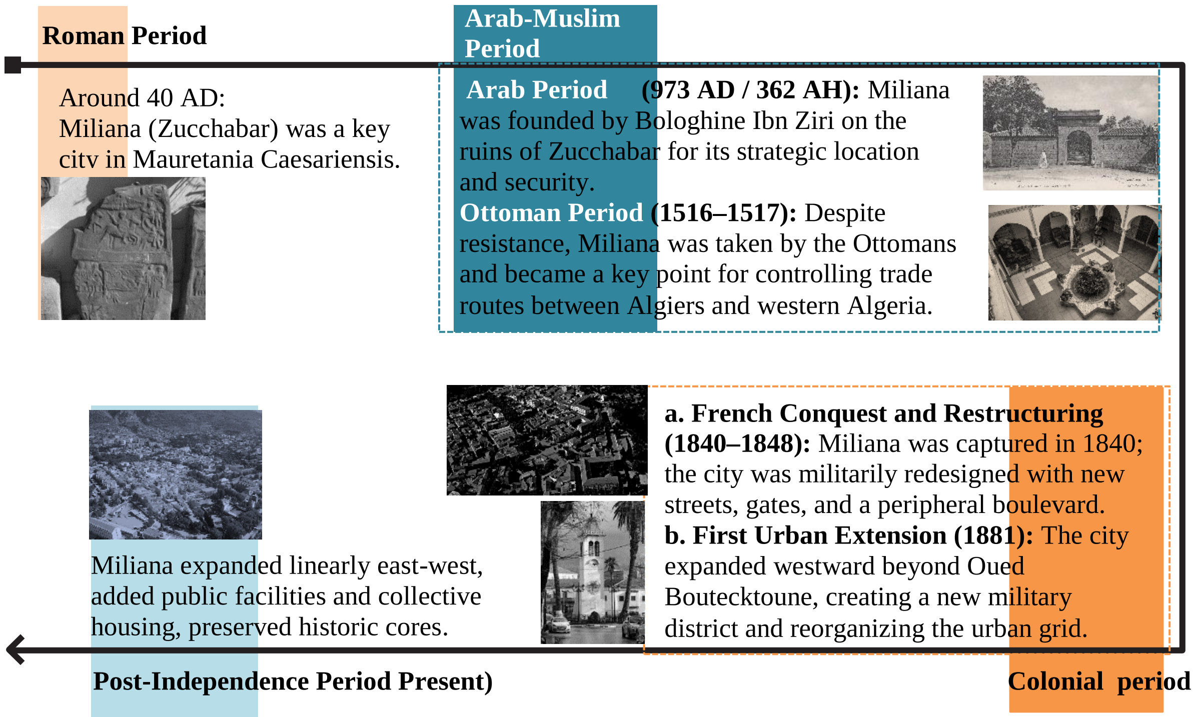


Figure 3.14: Historical Overview of the City of Miliana.
Source: Official Website of the Ministry of the Interior, Local Authorities, and Urban Development; compiled by the authors.

3.4.2 City evolution

3.4.2.1Roman Period

During the Roman era, the Romans built fortified outposts such as Oppidum-Novum, located near present-day Aïn Defla. Its main role was to control the eastern plain of Tivaga Municipium (modern-day Les Attafs) and defend the region against nomadic incursions. Miliana, then known as Zucchabar, was one of the major cities of Mauretania Caesariensis, second only to Caesarea.

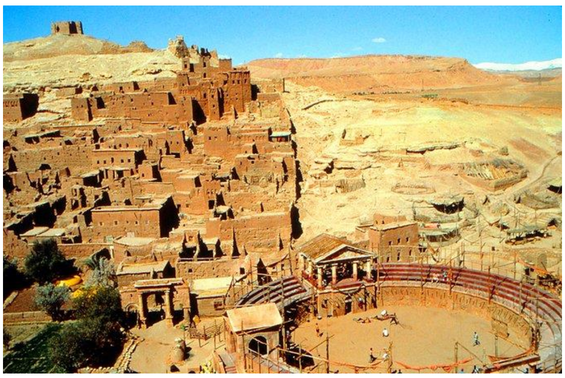


Figure 3.15: visual reconstruction of Zucchabar,Highlighting its Roman urban form.
Source: Harney, G.[@OptimoPrincipi]. (2020, April 30).Zucchabar during the Roman period on X.

The city of Miliana initially had a military-based settlement structure, given the importance of its territory, later becoming a fortress, and eventually evolving into a city given the importance of its territory, later becoming a fortress. The main achievements from this period include the construction of a defensive wall with three gates:

- North Gate: Leading towards Cherchell and Hammam Righa.
- West Gate: Leading towards Ain-Defla

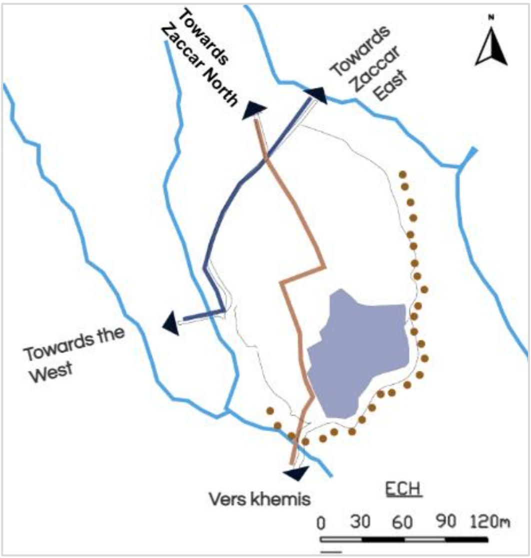


Figure 3.16: Map of the Roman Period.
Source: Cadastral map before 1840, modified by the authors.

The Roman presence valleys documanus cardos enclosure

3.4.2.2 Arab-Muslim Period

Arab Period: With the arrival of Muslims in the 10th century, Miliana was founded by Bologhine Ibn Ziri in 973 AD (362 AH) on the ruins of ancient Zucchabar. The site was chosen for its security and strategic control over the surrounding plain, making it a central point in the region. The new city inherited the Roman urban legacy but was adapted to Islamic architectural and urban principles, including the construction of a mosque and defensive walls.

Figure 3.17: Historic photograph of the courtyard and sacred basin at Si Ahmed Ben Youcef Mosque in Miliana, Algeria.
Source: Unknown photographer (n.d.).

Figure 3.18: The inner courtyard of Dar El Amir Abdelkader, showcasing traditional Algerian residential architecture.Source: Museum of Emir Abdelkader (2014).

2 **Ottoman Period:** In the 16th century, the Barbarossa brothers led the Ottoman expansion into Algeria. Although Miliana fiercely resisted the Ottoman occupation, the city was eventually conquered in 1516–1517 after clashes with local defenders. Under Ottoman rule, Miliana became a key stronghold for controlling inland trade routes between Algiers and the west.

The main urban characteristics of the city during this period include:

- Dense urban fabric with narrow, winding streets.
- Limited public spaces, primarily the El Batha Mosque and the market.
- The city was fortified by a wall (an ottoman wall built over a Roman one).
- Houses and buildings served as the central urban units.
- Eastern Gate: Towards Algiers.
- Western Gate: Towards Oran.
- Southern Gate: Leading to khemis.
- The Casbah, along with its wall and garden, formed a scenic viewpoint (belvedere).

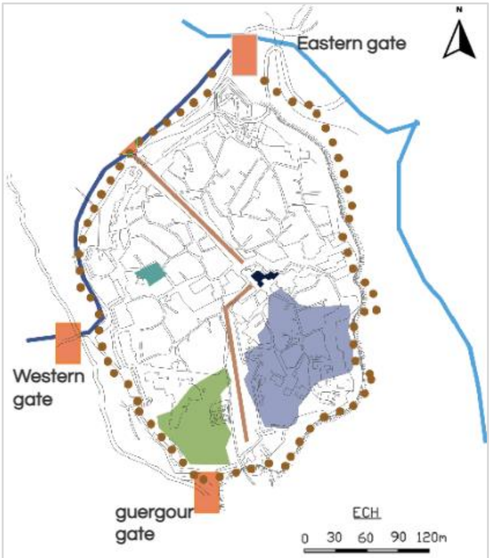
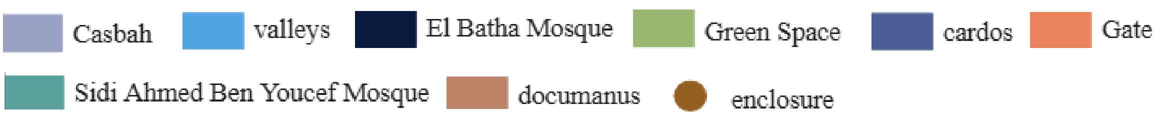


Figure 3.19: Map of the Ottoman Period. Source: Cadastral map before 1840, modified by the authors.



3.4.2.3 French Colonial Period

1-The Conquest and Restructuring of the City (1840–1848):

During the early years of French colonization, Miliana played a pivotal role in the resistance movement. Emir Abdelkader had transformed the city into a defensive base, establishing munitions depots and weapons foundries. In 1840, following intense military confrontations, the French forces captured the city. However, resistance persisted through continued attacks led by local fighters and troops loyal to the Emir.

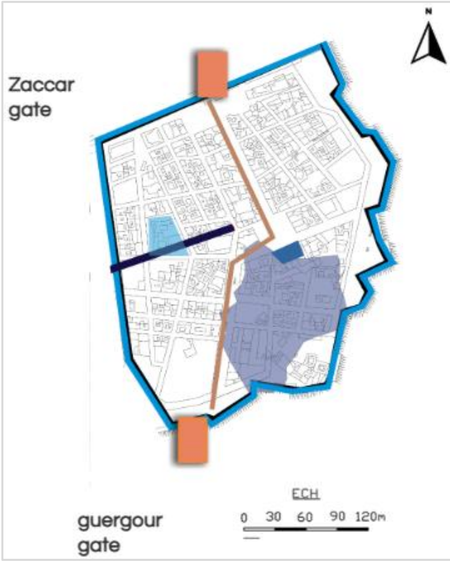
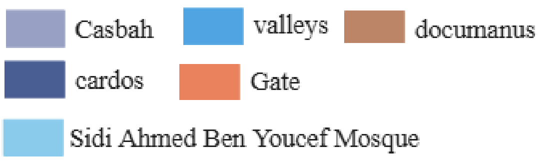


Figure 3.20: Map of the Colonial Period.
Source : Cadastral map before 1840, modified by the authors.



Following the French capture of Miliana in 1840, the city underwent major military led urban transformations. In 1841, the Zaccar Gate and Rue Saint-Paul were created to facilitate the military movement. The Ottoman era wall was partially restored, damaged houses were demolished or repurposed for colonial use, and a new square was opened in front of El Batha Mosque, preserving only its minaret. By 1844, a rectilinear street grid replaced the organic layout, façades were rebuilt, plane trees planted, and a broad peripheral boulevard was introduced marking the first colonial imprint on the city's urban fabric.

2-The First Urban Extension (1881):

Urban expansion began toward the west, especially beyond the Oued Boutecktoune. Between 1844 and 1867, a military zone was established, followed by the orthogonal layout of the Maghraoua axis, linking Zaccar and Oran gates. This urban logic, slightly offset from the historic core, introduced a new city rhythm. The oued was canalized to allow the creation of Boulevard d'Isly (1849–1852), and a new defensive wall enclosed this extension with a western gate, formalizing a paired structured colonial city.

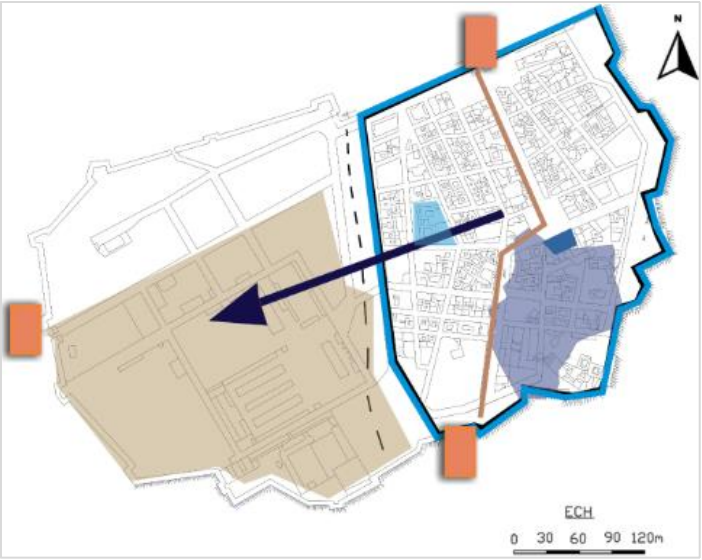


Figure 3.21: Colonial era map.
Source: Cadastral map before 1867, edited by the authors.

3-The Second Urban Extension (1950–1960):

In the mid of the 20th century, Miliana expanded northward beyond its ramparts. This phase was characterized by civic and residential developments, including the creation of a public garden, construction of social housing blocks (HBM), and the emergence of a suburban pavilion style architecture. This marked a shift from military to civilian planning logic, reflecting post-war urban policies focused on population growth and modern amentities.

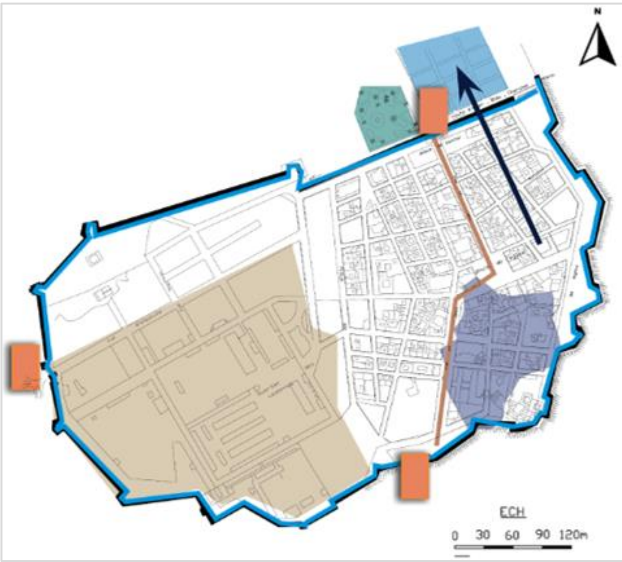


Figure 3.22: Map of the Colonial Period.
Source: Cadastral map before 1930, edited by the authors.

Church Square
Military Zone
Saint-Paul Street
Sidi Ahmed Ben Youcef Mosque
public garden
Gate
Collective Housing

3.4.2.4 Post-independence Period.

- **1962-1990s**

Following independence, Miliana experienced limited urban growth, primarily expanding towards the northwest where the terrain was less rugged. The development of the Korkah district followed a flexible urban pattern, integrating existing rural pathways and pre-existing dwellings. Although the city center underwent some renovation efforts, comprehensive planning was absent until the introduction of the P.D.A.U. (Master Plan for Urban Development) and the P.O.S. (Land Use Plan) in 1994, marking the beginning of a more structured urban management phase.

- **-1990s–present**

Today, Miliana exhibits a fragmented urban fabric: the pre-colonial and colonial layouts remain well-structured, while recent extensions follow a linear East–West axis. New public facilities have been developed, and collective housing has expanded along the urban periphery. The transformation of Dar El Emir into a museum reflects a growing focus on heritage preservation. However, the city suffers from spatial and physical discontinuities, with weak connections between urban sectors, which hinders overall territorial cohesion.

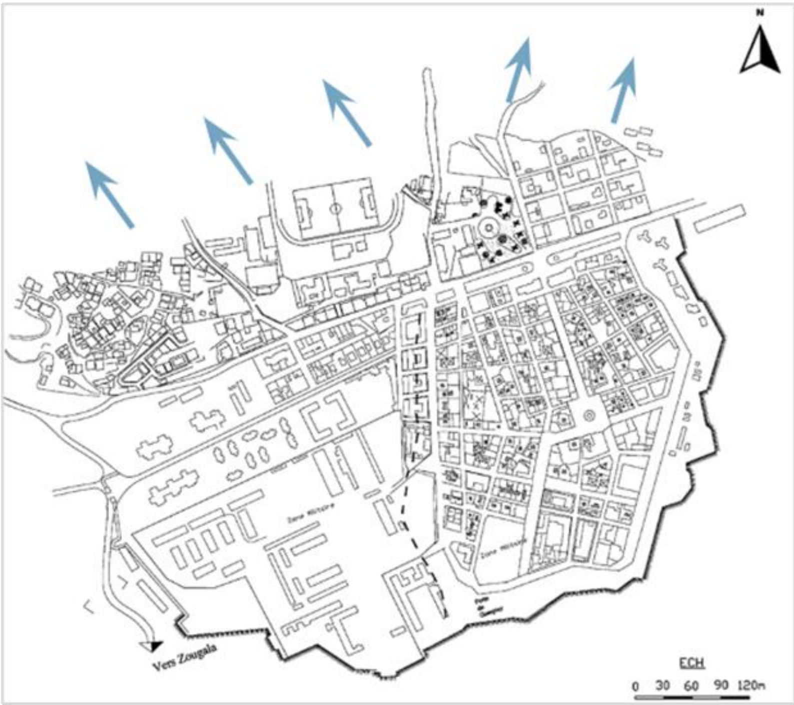


Figure 3.23: Map of the.Post-independence Period.
Source: Cadastral map before 1999 edited by the authors.

- **Synthesis of the Genesis**

Even now, the urban development of Miliana shows successive changes and every period reveals its own contribution to the urban character:

Ottoman era
Colonial era
Post-independence era

Figure 3.24: Map of the Stratification of the City.
Source: PDAU map 2011, edited by the authors.

1- **Roman traces:** Although limited, the Roman presence established the foundation of a strategic settlement, notably through defensive positioning and territorial control.
2- **Historic core:** The city's urban identity is primarily shaped by the Arab-Muslim and Ottoman periods, characterized by organic street layouts, enclosed residential quarters, and defensive enclosures.
3- **Colonial restructuring:** French colonization introduced geometric planning, administrative facilities, and orthogonal street grids, especially in the western extension, much of which remains under preservation.
4- **Post-independence expansion:** Urban growth followed national development policies, integrating modern housing units, public infrastructure, and new neighborhoods beyond the historical limits.
5- **Contemporary fabric:** Today, Miliana reflects a blend of conserved heritage and recent development, with growing peripheral zones shaped by the PDAU and other planning instruments.

3.4.3 Permanent Elements

Miliana has experienced a succession of various civilizations, and in each period, the city served a different purpose. This can be concluded based on the permanent elements the city retains.

Main wilaya road
City Wall
Colonial era
Military zone
Public Space
Ottoman era
Structuring Route

Figure 3.25: Map of permanent elements.
Source: Cadastral map before 1999 modified by the authors.

3.4.4 Summary of Climate Responses

After examining how the city changed over three periods, I believe it is necessary to study the city's features at three scales: environment, form and envelope, in each period. The study is designed to give us a clearer picture of what cities do to adapt to climate factors.

3.4.4.1 Ottoman era

Table3.2: Summary of Climate Responses of the ottoman era. Source: authors.

Environmental	Form	Envelope
- **Orientation:** Designed to shield against cold winter winds and maximize winter sunlight while also reducing exposure to intense summer sun.	- **Sloped Roofs:** Facilitate drainage of snow and rain while reducing heat buildup in summer. - **Courtyards:** Offer shaded, cooler areas in summer and protect from cold in winter, enhancing natural ventilation. - **Narrow, Curved Streets:** Reduce cold wind impact and create shaded, cooler microclimates in summer.	- **Materials:** Thick stone, rammed earth, and clay walls provide excellent thermal insulation against both heat and cold. - **Compact Urban Layout:** Dense, closed blocks minimize heat gain in summer and help retain warmth in winter. - **Small Windows with Wooden Shutters:** Limit heat gain in summer and minimize heat loss in winter, while maintaining privacy.

3.4.4.2 Colonial era

Table3.3: Summary of Climate Responses of the ottoman era. Source: authors.

Environmental	Form	Envelope
1- **Paved streets for Snow Clearance:** Streets are adapted for effective snow removal. 2- **Public Gardens and Parks:** Integrated into urban planning to provide green spaces. 3- **Tree Planting:** Strategically placed to offer shade and help regulate temperature	4- -**Moderately Sloped Tile Roofs:** Help with snow and rain drainage while reflecting a blend of local and European styles. 5- **Heated Interiors:** Equipped with fireplaces and stoves for winter warmth. 6- **Wide, Straight Streets:** Facilitate better circulation and ease of access, enhancing mobility. **Circular Windows above Doors:** Improve natural in buildings.	7- **Materials:** Use of brick along with fireplaces and stoves for effective heating. 8- **Rigid Street Alignment:** Creates a uniform skyline, allowing buildings to receive similar exposure to climatic conditions. 9- **Standardized Building Volumes:** European styles dominate, sometimes incorporating local elements, enhancing a visually cohesive cityscape. 10- **Compact Urban Fabric Aligned with Streets:** Buildings are closely packed yet follow the street alignment, maximizing land use and creating a unified, efficient layout that enhances pedestrian comfort

3.4.4.3 Independence era

Table3.4: Summary of Climate Responses of the ottoman era. Source: authors.

Environmental	Form	Envelope
11- **Optimized Orientation:** Minimizes heat loss. 12- **Improved Drainage Systems:** Efficiently handles melted snow, reducing water accumulation	13- **Flat or Slightly Sloped Roofs:** Integrated with modern drainage systems to handle rain and snow effectively. 14- **Diverse Building Forms:** Adapted to contemporary needs 15- **Wider, Open Streets:** Often lined with trees, featuring sidewalks for pedestrian comfort	16- **Modern Materials:** Use of concrete, glass, and insulation materials like polystyrene and mineral wool for improved thermal performance. 17- **Flexible Building Heights and Volumes:** Allowing better space management with more spread-out constructions, reducing uniformity and adapting to varying environmental needs.

3.5 Urban analysis

3.5.1 Introduction

Building upon historical foundations, this chapter presents a comprehensive typo-morphological and sensorial analysis of the urban fabric. It addresses the delimitation of boundaries,examines the road network,shows the relationships between districts, built environment, plot configuration and public spaces. This detailed reading of the city's structure unveils its spatial particularities and informs the development of context-sensitive strategic interventions for the project.

3.5.2 Delimitations of the study perimeter

3.5.2.1 Situation

Miliana is a town in north-central Algeria, located within the wilaya of Aïn Defla, approximately 119 km southwest of Algiers. It sits atop Mount Zaccar at 720 meters above sea level (36.18° N, 0.7° E), offering a strategic position near major provinces such as Blida, Tipaza, Médéa, and Chlef (Wikipedia, 2025; Wilaya d'Aïn Defla, 2023).

Figure 3.26: Case study location- City scale.
Source: Google earth, edited by authors.

Administratively, Miliana is bordered to the north by Aïn Torki and Ben Allal, to the east by Aïn Torki, to the south by Khemis Miliana, and to the west by Ben Allal (Daïras de la wilaya de Aïn Defla, 2023).

3.5.2.2 Site choice criteria

The project site was chosen following a detailed urban analysis, which highlighted the western part of Miliana as an underdeveloped and fragmented area. This district suffered significantly during the Black Decade, leading to a decline in activity and making the western entrance less frequented over time. Our site, positioned near this entrance and along the axis leading to the historic core, presented an opportunity to serve as a strategic point of revitalization. Additionally, the local Plan d'Occupation des Sols (POS) identifies it as a poche vide à urbaniser, confirming its potential for development and justifying our intervention.

- **Site**

Figure 3 27: Site.
Source: Google earth, edited by authors.

- **Strategic Access**: Located on National Route N12, the site benefits from strong regional connectivity.
- **Historic Proximity**: Positioned near the western entrance to Miliana's historic center, it holds heritage value and potential to reconnect the fragmented western district with the city's urban memory.
- **Focal Point:** Its elevated position gives the site strong visual dominance, making it a natural urban focal point and potential beacon for the western district.
- **Green Interface:** A green space facing the site enhances its environmental quality and opens possibilities for landscape integration.

3.5.3 Road system

3.5.3.1 Road hierarchy

Miliana features a road network that combines two configurations: the loop system and the grid system. This overlap creates what could be described as a "false grid." The city's accessibility is primarily through the main wilaya road, followed by a secondary network that directs traffic flow to various neighborhoods in Miliana.

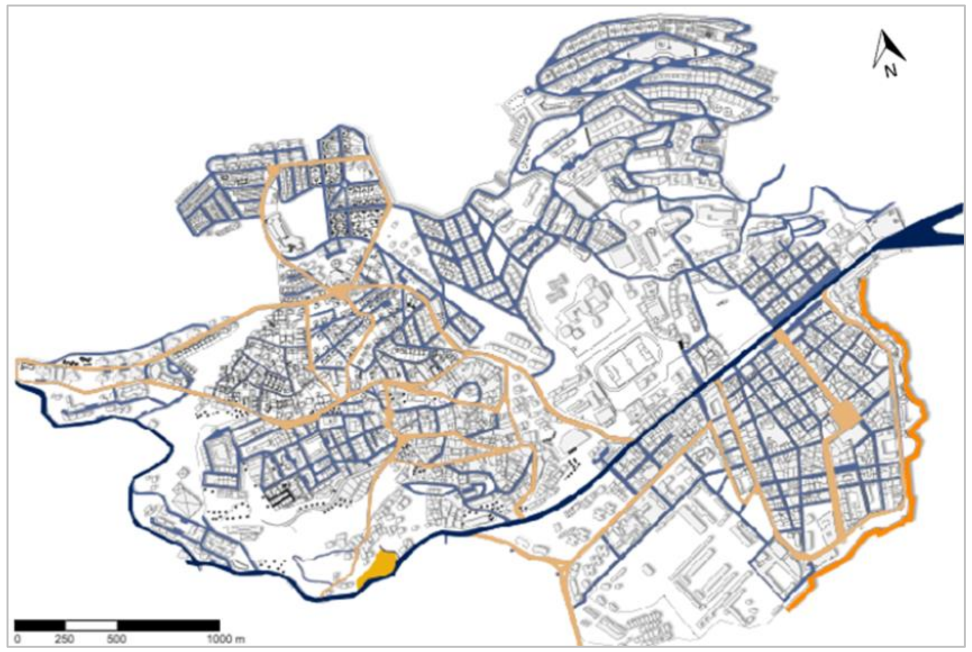


Figure 3.*28*: Road Network Map.
Source: PDAU 2010 map edited by the authors.

3.5.3.2Node Network

A dense concentration of nodes is observed in the city center compared to the outskirts. This is due to the grid system, which creates a mesh of nodes, enhancing access and orientation. However, in the upper areas near the mountains, accessibility decreases, limiting entry points and connections with peripheral zones.

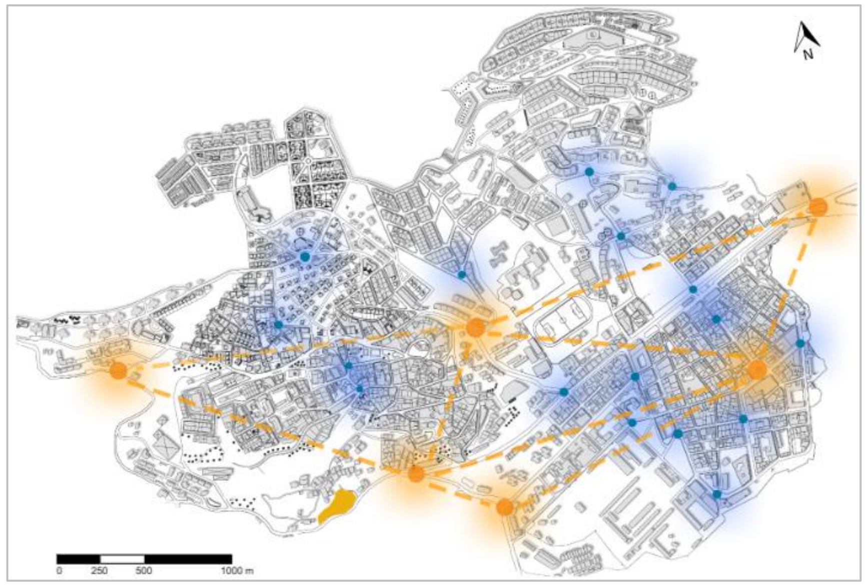


Figure 3.*29*: Node Map.
Source: PDAU 2010 map edited by the authors.

3.5.3.3Parking Area

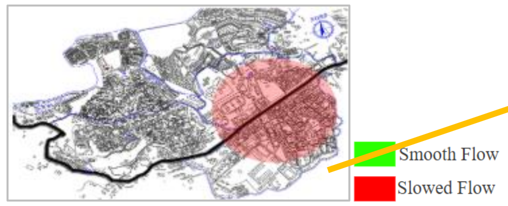
Miliana has enough parking spaces in the newer parts of the city, but the historic center does not have enough, showing a need for better planning to improve accessibility in this area.

road	Dimension	Type
	10 m	Dual Carriageway
	5 m	Single Carriageway

Figure 3.30: Map Showing Parking Areas.
Source: PDAU 2010 map edited by the authors.

3.5.3.4 Mobility and Traffic Flow

Miliana generally enjoys smooth traffic flow with minimal congestion. However, slight slowdowns are observed around the bus station and taxi stand.



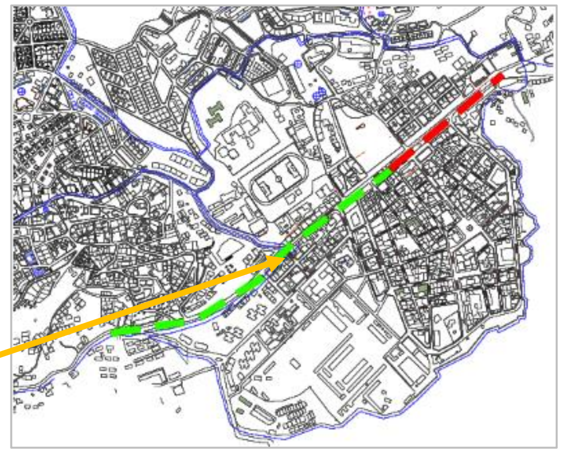


Figure 3.31: Traffic Flow Map of Miliana.
Source: PDAU 2010 map edited by the authors.

3.5.3.5 Road Safety

Miliana's road safety varies by area: most regions have planned sidewalks, providing higher safety. However, the western entrance zone has a higher risk due to a lack of proper infrastructure.

Perception of Insecurity

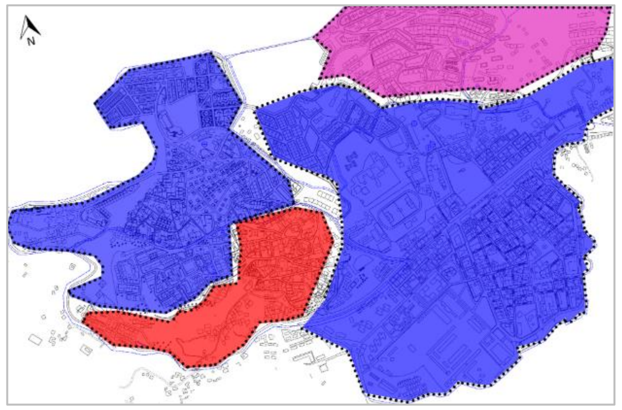


Figure 3.32: Road Safety Map of Miliana.Source: PDAU 2010 map edited by the authors.

Synthesis Despite its complex topography, Miliana has an efficient road system adapted to its geographical features. The combination of loop and grid systems enables functional accessibility while integrating well with the urban fabric.

3.5.4 Plot system

In the center of Miliana, the plot layout is characterized by relatively regular lots of medium to small size. In contrast, as you move toward the post independence extensions, the plots become larger, often due to the presence of collective buildings constructed during this period.

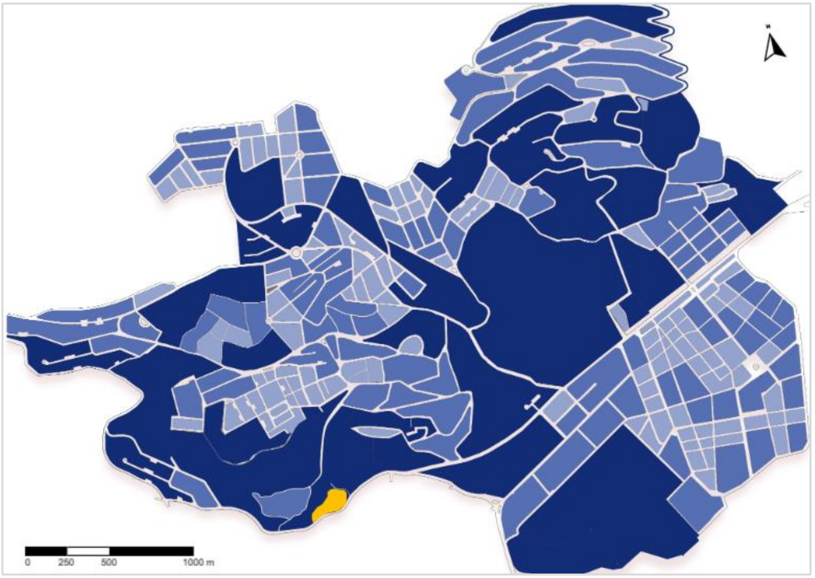
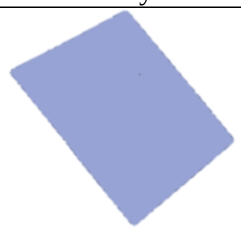
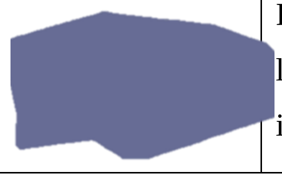


Figure 3.33: Road Safety Map of Miliana.
Source: PDAU 2010 map edited by the authors.

Synthesis When looking at the dimensions and shapes of blocks in the urban grid, it's clear that it's important to adapt plot shapes to the environment. In areas with complex topography like the post-colonial zone, irregular plots fit the landscape better. In flat areas, a regular grid is more efficient. This strategy can help in future planning to create projects that blend well with the surroundings.

3.5.4.1 Geometry and dimensions

Table 3.5: Geometry and dimensions of plots from different fabrics. Source: authors

Colonial fabric		The plot is regularly shaped, often trapezoidal or rectangular.	
Post colonial fabric		In new fabric, land parceling is losing its old geometric shapes and is becoming more organic in form.	

3.5.5 Building system

The map shows a denser concentration of buildings in the city center, highlighting the historical urbanization and the centralization of activities in this area. This density gradually decreases towards the outskirts in the new urban fabric, reflecting more recent and less structured expansions.

Figure 3.34: Map of buildings.
Source: PDAU 2010 map edited by the authors.

3.5.5.1 Building condition

The building conditions in Miliana reveal a stark contrast: the historic center, with its Ottoman and colonial structures, mostly requires restoration due to poor or average condition. In contrast, the newer peripheral areas are in good shape.

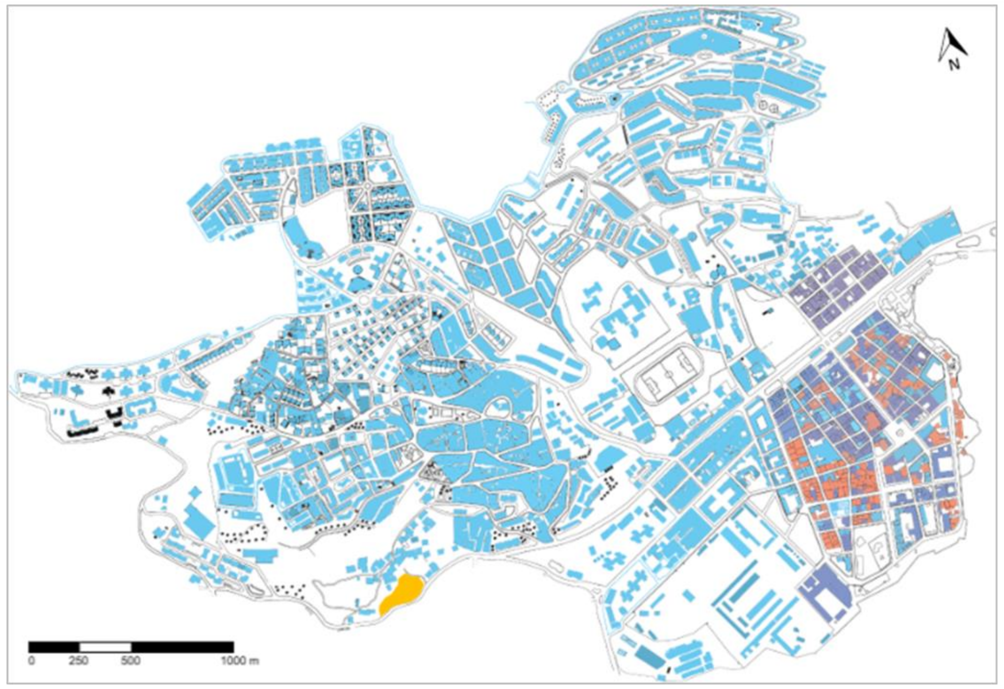


Figure 3.35: Building condition map.
Source: PDAU 2010 map edited by the authors.

3.5.5.2 Land use patterns

Miliana's center offers diverse amenities (healthcare, education, administration, culture), while the northwest is dominated by residential areas with limited infrastructure. This calls for a more balanced distribution of public services across the city.

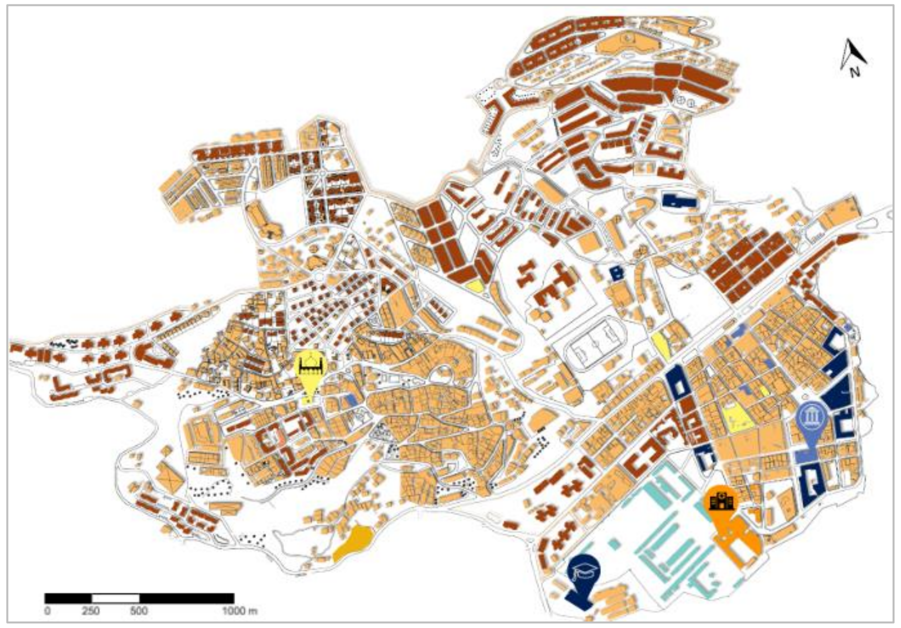


Figure 3.36: Land use patterns map.
Source: PDAU 2010 map edited by the authors.

3.5.5.3 Landmarks

Miliana's landmarks can be categorized into three distinct types:

1.Architecturally Notable
2.Buildings: Hospital, Military zone, Mosque of Sidi Ahmed Ben Youcef, Market, l Amir Abdelkader Museum
3.Notable Public Spaces: Public garden, Main squares
4.Famous Local Landmarks: bus station, swimming pool, stadium, saint jean primary school, abdou high school, mustapha ferroukhi high school, sonelgaz, clock square, bab el gharbi.

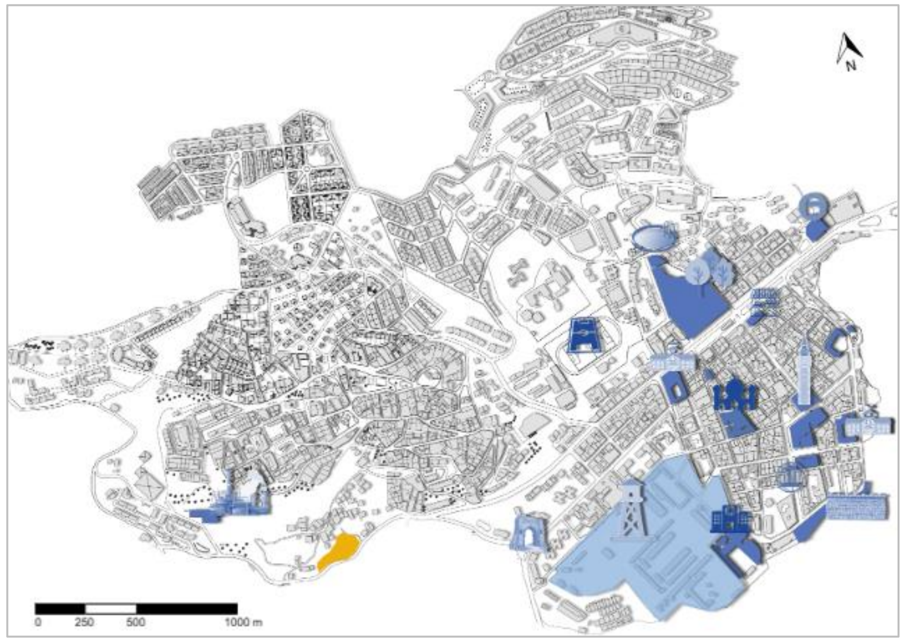


Figure 3.37: Map showing landmarks.
Source: PDAU 2010 map edited by the authors.

The city's center, with its more concentrated and historical landmarks, is generally more repairable than the edges, which have seen more recent developments and require different planning approaches.

Figure 3.38: Famous landmarks in Miliana.
Source: Google photos..

3.5.5.4 Alignment

- In the colonial fabric, buildings are aligned along straight, linear roads, creating an orderly and structured layout.
- In the post-colonial fabric, while the roads are more curved and irregular, the buildings still follow the road alignments, maintaining a sense of order despite the less linear design.

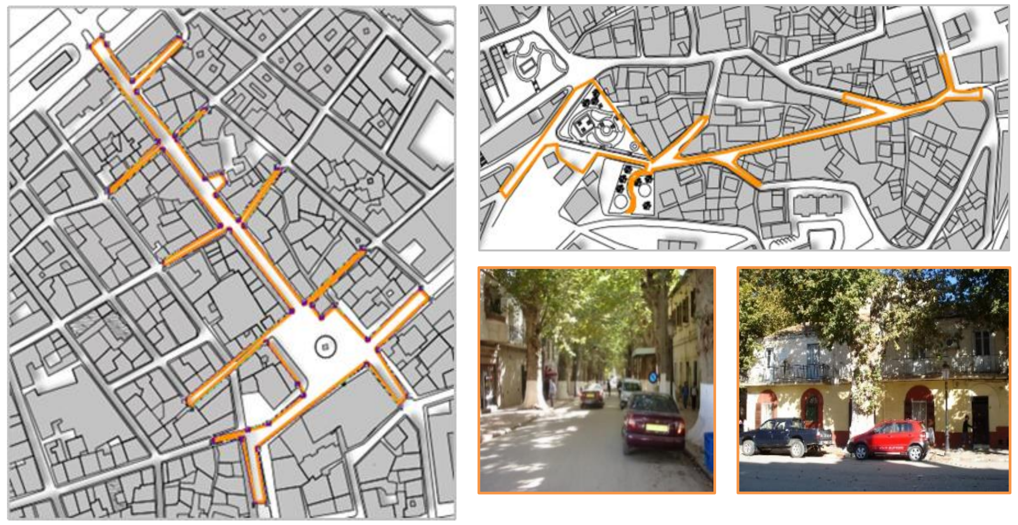


Figure 3.39: Alignment on different fabrics.
Source: PDAU 2010 map edited by the authors
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3.5.5.5 Density (COS, CES)

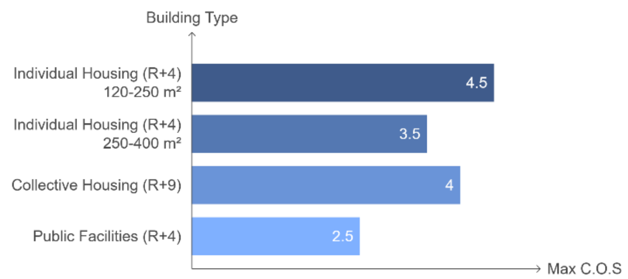

Figure 3.40: Land occupation coefficient (C.O.S) for different building types.

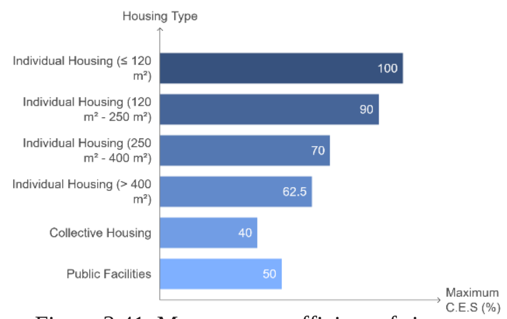

Figure 3.41: Maxomum coefficient of site coverage (C.E.S) by housing type.

Source: authors.

3.5.5.6 Facade

Dominant Architectural Style The city center is often characterized by a blend of dominant architectural styles that reflect the historical and cultural evolution of the city, notably the Moorish style.

Moorish Style:

This style is characterized by elements such as mosques, which are central places of worship for Muslims, broken arches, domes, minarets, inner courtyards, and carefully crafted exterior decorations.

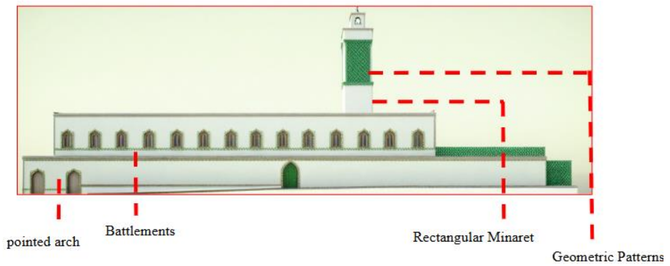

Figure 3.42: Mausoleum of Sid Ahmed Ben Youcef.
Source: Facade Treated by the Authors.

Neo-Moorish Style

This style is one of the reviving exotic architectural styles, using decorative ornaments inspired by the ancient architecture of various Muslim countries.

Figure 3.43: Theatre of Miliana.
Source: Facade Treated by the Authors.

Neoclassical Style

This style is part of the movement advocating a return to Antiquity, aiming to create architecture that meets the needs of the time. It is recognizable by the following characteristics: symmetry, tectonic features, linearity, and a simplified decor.

Figure 3.44: Seat of the Daira of Miliana.
Source: Facade Treated by the Authors.

Contemporary Style

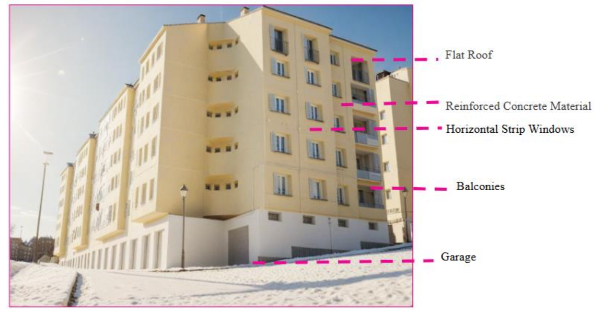

Figure 3.45: collective building from post-independence period.
Source: Google photos.

3.5.5.7 Building height

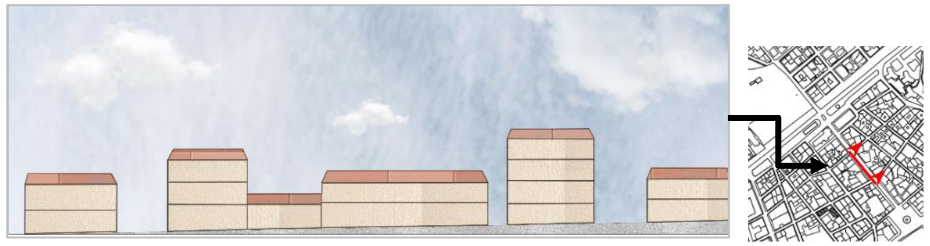

Figure 3.46: Street elevation buildings hieght.
Source: Authors.

Center of Miliana:

- Building height ranges from ground level (RDC) to two floors.
- Creates a human scale and intimate atmosphere.

Independence Fabric:

- Building heights increase.
- Individual houses often have four levels.
- Collective buildings typically range from six to seven floors.

3.5.5.8 Texture

Colonial period: The dominant colors were light tones such as white, beige, and ochre, with smooth textures, and materials like stone and plaster.

Post-colonial period: The colors became more varied but often remained neutral (white, gray, beige), with more modern textures (smooth concrete, glass).

Figure 3.47: Street elevation buildings height.
Source: Google photos.

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Synthesis In Miliana, there is a clear distinction between colonial and independence urbanism. The colonial fabric, structured by closed blocks, creates dense and continuous building masses typical of the colonial model, and is enriched with numerous architectural landmarks that aid in navigation. In contrast, the post-colonial plots adopt open blocks for collective buildings, with few visual references, making it more difficult to navigate these areas. This sudden shift in urban planning logic presents a challenge in integrating the old and new urban fabrics of the city.

3.5.6 Public space system

Miliana is divided into **green spaces** and public spaces.In the city center, the public spaces, though few in number, meet the needs of the population, complemented by some green areas that provide a sense of well-being. In contrast, in the post-colonial areas, although there are empty plots designated for greenery, they are rarely developed or landscaped.

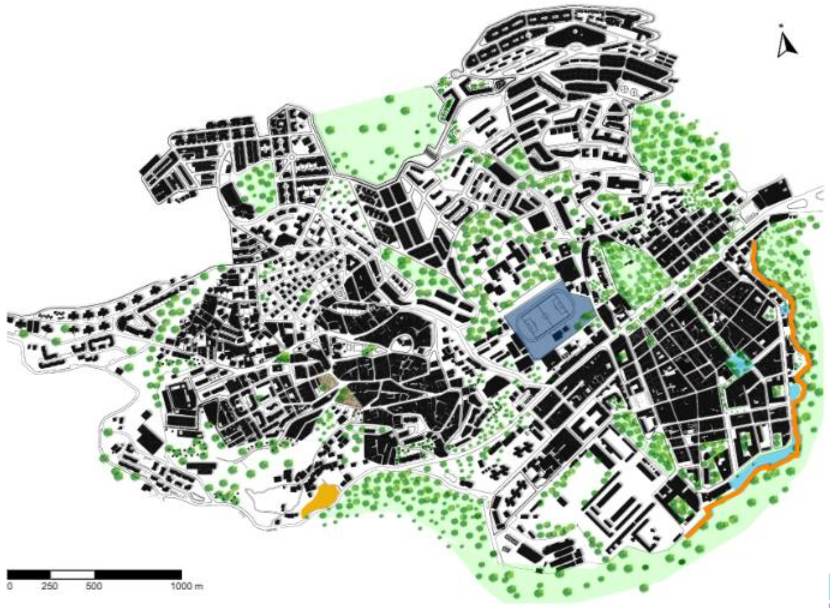


Figure 3.48: Map of public spaces.
Source: PDAU 2010 map edited by the authors

3.5.6.1 Built/unbuilt ratio (spatial distribution)

A ratio of 63% built-up area and 37% open spaces.

The open spaces include green vacant spaces and small squares.

A harmonious integration between the natural environment and public spaces in the city center. However, in the northwest, despite the available space, the complex topography, compact built-up areas, and limited landscaped spaces make it less developed compared to the center.

Figure 3.49: Map of built and unbuilt areas.
Source: PDAU 2010 map edited by the authors.

Figure 3.50: Public Garden of Miliana.

Figure 3.51: Swimming pool of Miliana.
Source: Google photos.

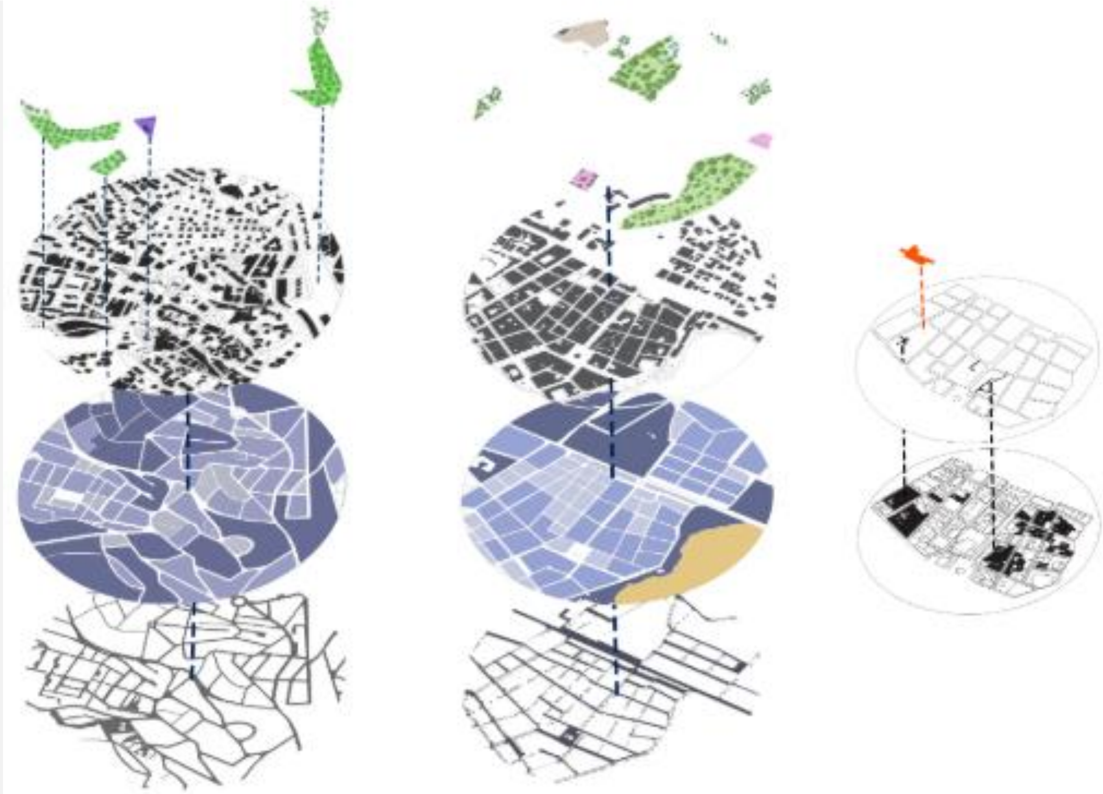
Figure 3.52: The clock tower of Miliana.

Synthesis In the post-colonial fabric, the complex topography presents a real challenge for urban planning, but it should not prevent the creation of well-designed public spaces. The neighborhoods need meeting places and social spaces to strengthen the connection between residents. A more coherent planning approach, tailored to the specific characteristics of the land, is essential to ensure better quality of life and cohesion in these living spaces.

3.5.7 General conclusion

The development of any project should respect the existing heritage while effectively integrating new buildings and public spaces.

Overcoming topographical challenges and enhancing connectivity are crucial to creating an urban environment that improves the quality of life and strengthens social ties in Miliana.



Post-colonial fabric **colonial fabric** **Ottoman fabric**

Figure 3.53: Synthesis of the different historical fabrics of Miliana.

3.5.8. Sequential Analysis

Positioned at the western entrance of Miliana, the site represents a transitional zone between the urban fabric and the natural landscape. Dominated by the abandoned Sonarem factory, this sequence lacks urban cohesion and presents an unstructured, underused environment. thanks to the site’s topography, the southern side offers a strong visual opening towards the valley the northern edge remains closed off and inactive due to industrial remains and the absence of public oriented design.

Despite its calm atmosphere and rich natural setting, the area suffers from poor night-time visibility, a lack of pedestrian infrastructure, and an overall sense of disconnection. These conditions reduce its attractiveness and functionality as a city gateway, particularly in comparison to the more dynamic eastern entrance.

In this context, the project aims to requalify the sequence by reinforcing spatial continuity, improving visual and physical accessibility, and enhancing safety. Through landscape integration, improved mobility, and architectural interventions that respond to both the site’s constraints and its scenic potential, the western edge can be revitalized as a meaningful urban threshold, one that reconnects Miliana to its landscape and redefines its entrance identity.

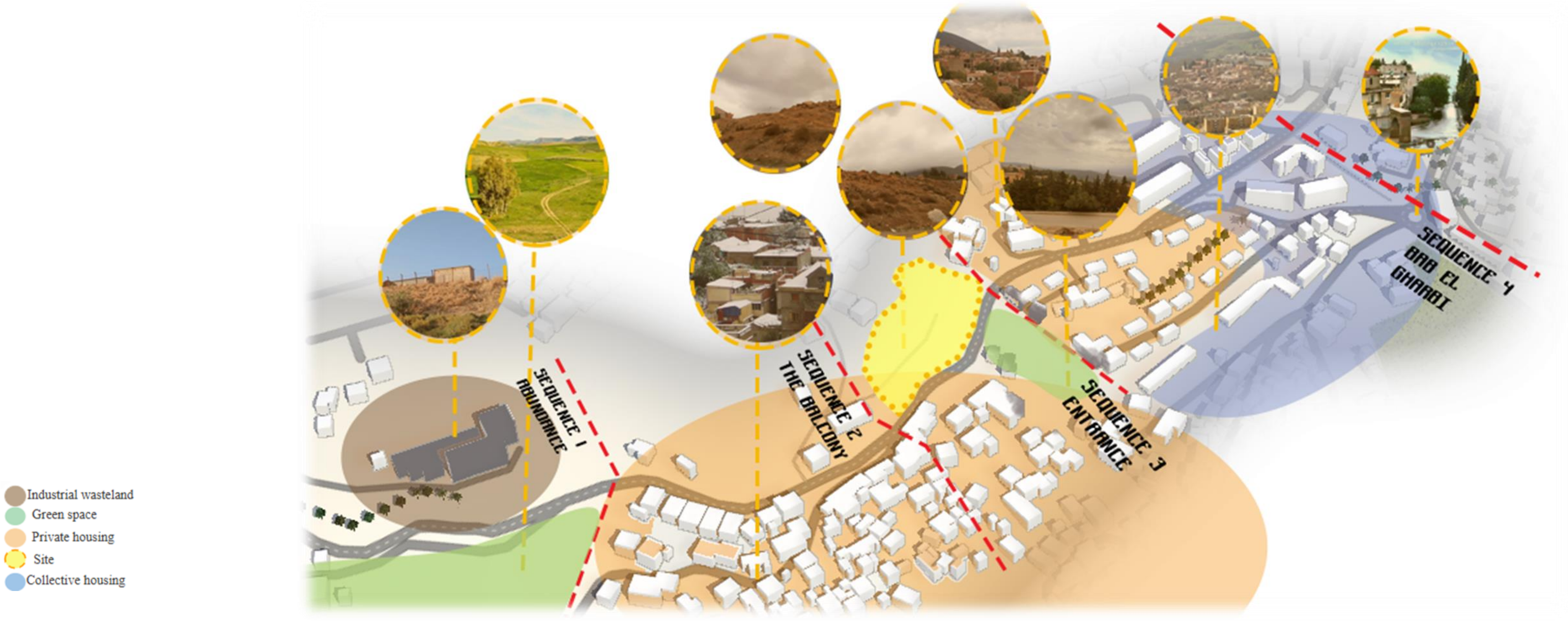


Figure 3.54: Sequential analysis.
Source: authors..

1. Abundance

The entrance to the city feels distant and abandoned, with an old factory and an unused green space, creating a sense of remoteness.

2. The Balcony

You begin to feel like you’re entering the city. A residential area gives a sense of life, but an empty lot makes it feel less welcoming, and private properties create a sense of exclusivity.

3. The Entrance

Similar to the previous sequences, with residential buildings and a small woodland of trees that add some nature but still contribute to the feeling of abandonment. The goal is to make it more inviting.

4. Bab El Gharbi

This is a lively, welcoming area with buildings on both sides of the road. Collective housing and ground-floor shops create a dynamic, active atmosphere.

3.5.9 SWOT

Table3.5: SWOT. Source: authors.

STRENGTH	**Road network system**	1- Well-connected network, smooth circulation.	1- No sidewalks in the early sections, making walking dangerous. 2- Slowdowns at bus and taxi stations.	**Road network system**	WEAKNESS
STRENGTH	**Building system**	1- Varied architectural styles enrich the heritage. 2- Variation in building heights: R+2 in the center, R+6/7 on the outskirts, creating a dynamic skyline.	1- The difference between closed blocks (in the center) and open blocks (on the outskirts) creates an uneven experience. 2- High density in the center, low density in the extensions..	**Building system**	WEAKNESS
STRENGTH	**Plot system**	1- Regular, medium-sized plots in the center, facilitating organization. 2- Large post-colonial plots, promoting collective housing.	1- Irregular plots on the edge, making planning difficult. 2- Lack of clear structure in certain areas.	**Plot system**	WEAKNESS
STRENGTH	**Public space system**	1- Landscaped gardens and small squares in the center, green spaces on the outskirts.	1- Few public spaces in the post-colonial areas. 2- Green spaces often left neglected.	**Public space system**	WEAKNESS
OPPORTUNITIES	**Road network system**	1- Addition of sidewalks and bike lanes for increased safety. 2- Optimization of transit stops for better flow.	1- Potential increase in traffic without adequate infrastructure. 2- Lack of pedestrian safety due to the absence of sidewalks	**Road network system**	THREATS
OPPORTUNITIES	**Building system**	1- Rehabilitation of industrial wastelands for new functions. 2- Sustainable construction for energy efficiency.	1- Heritage degradation if new developments do not respect the existing fabric. 2- Urban fragmentation due to a lack of planning.	**Building system**	THREATS
OPPORTUNITIES	**Plot system**	1- Rehabilitation of industrial wastelands for new functions. 2- Sustainable construction for energy efficiency.	1- Development pressure could lead to disorganized growth. 2- Difficulty in integrating new constructions.	**Plot system**	THREATS
OPPORTUNITIES	**Public space system**	1- Creation of a green space network connecting the center and the outskirts. 2- Development and enhancement of existing green spaces.	1- Risk of privatization reducing accessibility. 2- Ongoing degradation of green spaces due to lack of maintenance.	**Public space system**	THREATS

3.5.10 Conclusion: Strategies

In conclusion, the comprehensive typo-morpho-sensorial analysis presented in this chapter has yielded significant insights into the structure and dynamics of the urban fabric, fostering a deeper understanding of the city's specific characteristics and subtleties. These insights form a robust basis for guiding strategic interventions and informed decision-making within the framework of the current project. By building on the knowledge derived from this analysis, it becomes possible to address urban challenges more effectively and to seize emerging opportunities, thereby contributing to the city’s enhancement and sustainable development. The proposed strategies (Table 3.7), as map (Figure 3.56), emerge from the cross-analysis of the SWOT matrix dimensions, detailed on the following page (Table 3.6).

Table3. 6: Strategies. Source: authors.

	STRENGTH	WEAKNESS
OPPORTUNITIES	**Building system:** Leverage architectural diversity to rehabilitate historic buildings. **Plot system:** Use large plots for mixed-use projects (cultural tourism center). **Public spaces:** Connect green spaces to create a continuous green network. **Road network:** Improve pedestrian infrastructure and public transportation. **Sequential analysis:** Accessible Road Network + Improvement of Pedestrian Infrastructure. Panoramic Views + Development of Community Spaces	**Road network:** Install sidewalks and pedestrian crossings to secure entry sequences. **Plot system:** Reorganize large plots to incorporate public amenities. **Sequential analysis:Calm Environment + Impact of Aging Infrastructure:** The peaceful environment could be threatened by the abandoned factory. Addressing it would improve tranquility and aesthetics. **High Accessibility + Safety Concerns:** Accessibility could be compromised by safety issues. Improving pedestrian pathways can reduce risks and maintain ease of access.
THREATS	**Building system:** Protect historic buildings from aggressive developments. **Public spaces:** Preserve existing green spaces in the face of land development pressure. **Sequential analysis:** Absence of Sidewalks + Need for Infrastructure Improvements Limited Activities + Potential for Local Businesses: The lack of activities can be addressed by introducing local businesses and events, revitalizing the area and attracting more people.	**Building system:** Regulate new constructions to prevent disorderly urbanization. **Plot system:** Harmonize irregular plots for better urban development. **Public spaces:** Create public spaces in isolated areas. **Road network:** Improve infrastructure and secure pedestrian movement by installing sidewalks and public lighting. **Sequential analysis:**Insufficient Lighting + Security Issues Noise Pollution from Traffic + Limited Community Engagement

- **Global strategy:**

The chosen global strategy is **eco-cultural densification and revitalization of Miliana's western entrance**. It aims to enhance the area's identity and climate resilience through compact, culturally rooted development and nature-based outdoor spaces.

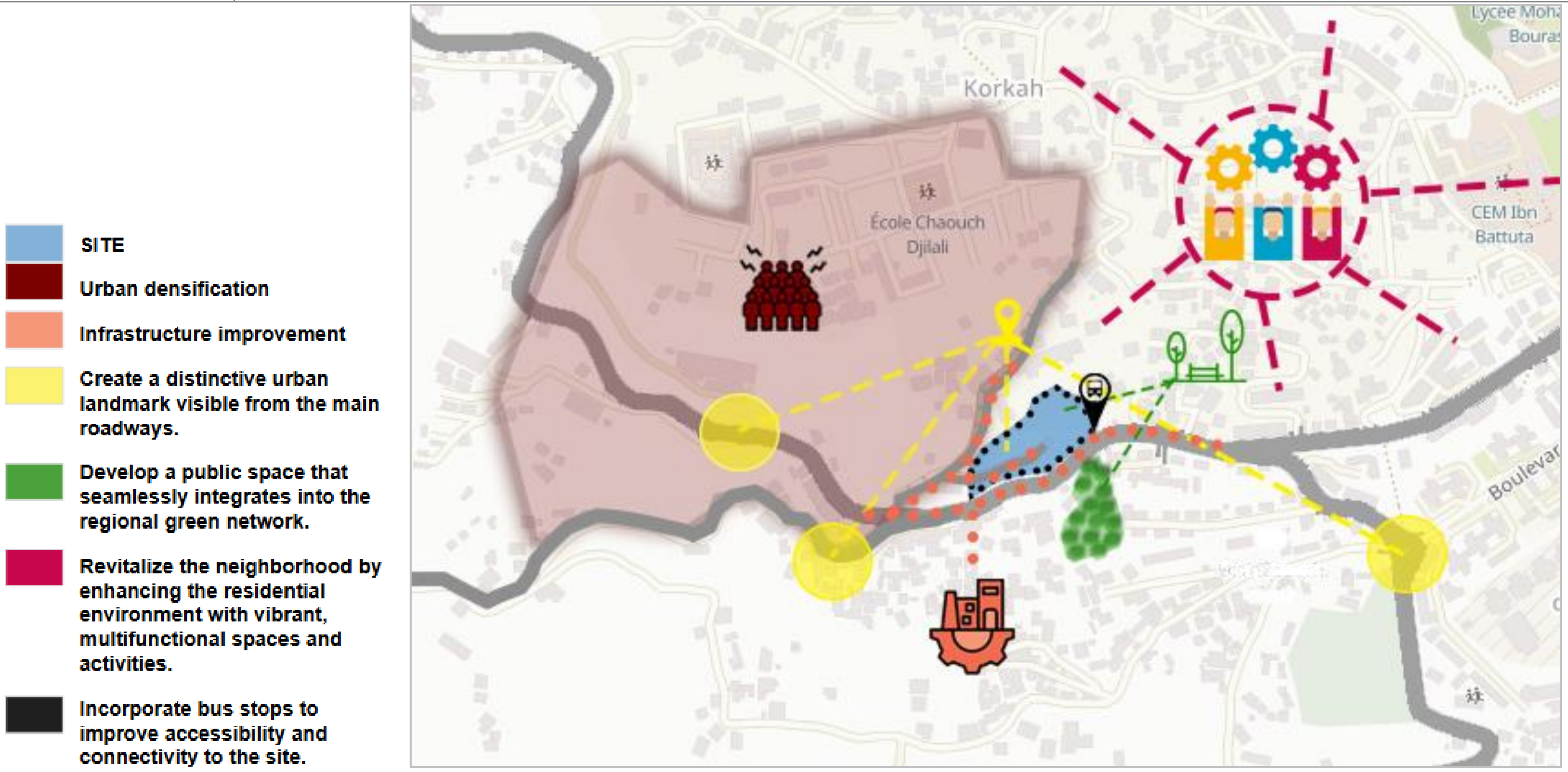


Figure 3.55: Strategies map.

Source: Google earth, edited by Authors.

3.6. Conclusion and recommendation

	Environment	Form		Envelope	Climate responses
	Urban aspect	**Architectural aspect**	**Program aspect**	Structural	
Diachronic analysis	Organic development along topography with scattered courtyards and visual continuity with nature; calm residential fabric	- Fragmented masses responding to topographic contours; low-rise buildings grouped around open spaces - Local architectural vocabulary: internal patios, porosity between indoor and outdoor life; architecture as a climate and social mediator	Historical madrasas and gathering spaces embedded in the urban fabric with strong communal orientation	Thick walls, high thermal inertia; light earth tones; limited, recessed openings for solar protection	Integration with nature through gardens, and natural terraces along slopes; ecological coherence through topography and vegetation
Synchronic analysis	Urban densification with multifunctional public space; integration into green network; visibility from main roads; improved connectivity via bus stops	- Dynamic, stepped architectural form adapting to cliff; massing fragmented into volumes with visual porosity; gesture toward openness and landmark effect -One internal courtyard for lighting and microclimate; blending modern expression with traditional cues	Cultural and educational program promoting interaction: learning halls, community rooms, exhibition spaces; indoor-outdoor continuity	Minimalist façade with light-reflective tones matching Miliana’s landscape; use of modern shading devices (brise-soleil, louvers); large controlled openings	Strategic orientation; shaded courtyard as thermal regulator; water elements and plants to lower ambient temperature; passive techniques for ventilation

Table3. 7: Strategies. Source: authors.

3.7 Site analysis

3.7.1 Site choice - urban planning

Our site is located at the western entrance of Miliana, functioning as a transitional zone between the surrounding periphery and the historic core of the city. Abandoned during Algeria’s Black Decade, it has remained disconnected from the urban fabric and lacks any formal urban structure, presenting both a spatial void and an opportunity for renewal.

1 The PDAU identifies the area as a "poche vide à urbaniser" an empty zone to be urbanized, highlighting its potential for reintegration into the city through public, cultural, commercial, and sports-oriented functions. The POS complements this vision to activate the site and enhance social life at the city’s edge.

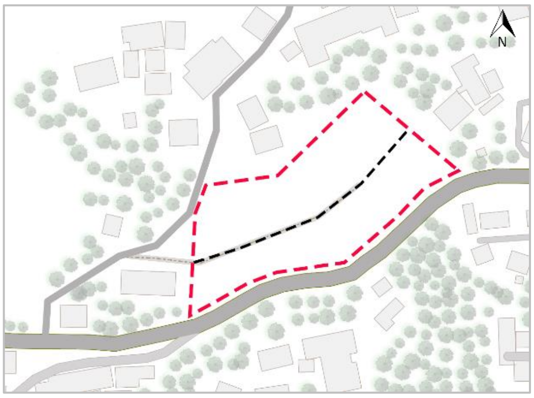


Figure 3.56: site choice - urban division step 01.
Source: openstreetmap, edited by authors.

2 Due to the absence of a pre-existing urban grid, we chose to develop a new spatial logic based on the site’s natural topography rather than external urban alignments. We began by setting a respectful distance from the existing housing, then shaped the project boundaries according to the terrain’s morphology regularizing the edges while preserving the site's inherent form.

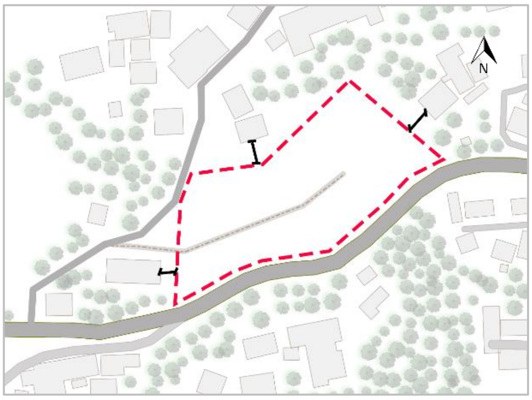


Figure 3.57: site choice - urban division step 02.
Source: openstreetmap, edited by authors.

3 We began by defining the site’s shape through its natural topography, retreating from the surrounding residential edges and using the terrain to guide a more coherent spatial framework. The site’s boundaries were slightly regularized, but its overall form remains closely tied to its original morphology.

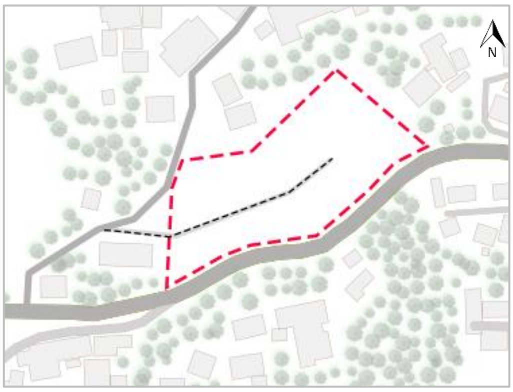


Figure 3.58: site choice - urban division step 03.
Source: openstreetmap, edited by authors.

During this process, we identified a desire path, an informal trail formed by habitual pedestrian movement which naturally crossed the site. This existing human trace provided a meaningful cue, reinforcing our decision to divide the land into two distinct platforms. The path’s orientation and use not only reflected intuitive circulation but also contributed to the overall spatial hierarchy of the project.

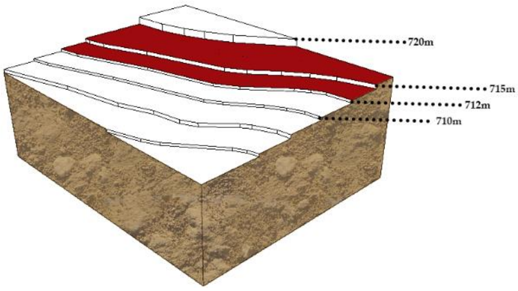


Figure 3.59: site choice - urban division step 03.
Source: topo expo, edited by authors.

4 Following the PDAU and POS guidelines, we proposed a cultural center that integrates public gathering spaces and multifunctional areas. This intervention not only responds to the city's planning strategies but also reactivates a long-neglected zone, positioning it as a gateway of cultural and social vitality at the entrance of Miliana.

Figure 3.60 : Site choice - urban division step 04.
Source: openstreetmap, edited by authors.

3.7.2 Site synthesis

Surface:5500 m^2
COS: 2.5
COS m^2: 11,025 m^{22}
CES = 50 %
CES m^2:2205 m^2
Slope 01: 21.83%
Slope 02: 5.1%

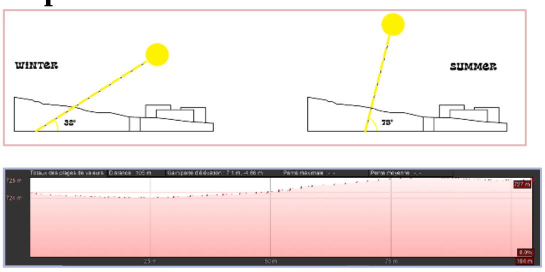


Figure 3.61: a. Site analysis synthesis, b. Site section.
Source: openstreetmap; Google earth, edited by authors.

3.8 Fundamental concepts of the project

To easily identify the fundamental concepts, it is necessary to define our project's vision and mission.

To revitalize the western entrance of Miliana by transforming an abandoned transitional zone into a vibrant, inclusive, and sustainable urban landmark. The project aspires to reanimate this overlooked area through architecture that respects the environment, enhances quality of life, and reestablishes continuity with the city's historical and cultural core.

To achieve this vision by designing a culturally rooted and ecologically responsive intervention that reflects Miliana's rich historical identity. The project aims to foster social interaction, attract visitors, and reconnect the community with a neglected part of the city, thereby turning it into an active and meaningful civic space.

Figure 3.62: Vision and mission of our project.
Source: Authors.

The project's concepts are divided into three main categories: **urban**, **programmatic**, and **architectural**. For each, we developed initial sketches and ideas as a form of early brainstorming to guide the design process.

1- Urban Concepts
2- Program Concepts
3- Architectural Concepts

3.8.1. Urban concepts

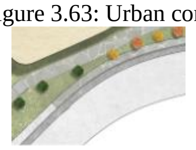
1- Urban Acupuncture

We applied the principle of urban acupuncture by treating the site as a strategic intervention point. Positioned centrally within the plot, the project is designed to stand out as a local landmark visible from the main road.

Figure 3.63:Urban concepts.

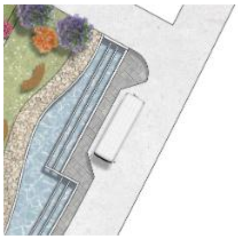
3.8.1. Urban concepts

Figure 3.63: Urban concepts.



2- Urban Safety and Walkability

We introduced street lighting, sidewalks, and pedestrian pathways to ensure safety, comfort, and active mobility within and around the site.



3- Connectivity

To improve access and encourage movement, we integrated a nearby bus stop, reinforcing public transport links and reconnecting the site with its surroundings.

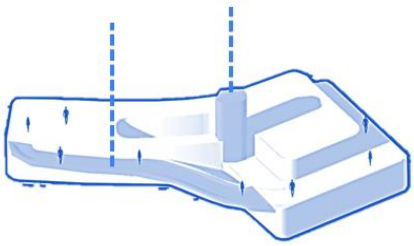
4- Inclusivity

Despite the site's natural slope and platform division, project is fully accessible to persons with reduced mobi (PMR). Ramps and adapted circulation paths ensure inclusi throughout both the building and public spaces.

5- Biophilic Design and Outdoor Comfort

Using Nature-Based Solutions (NBS) such as vegetation, shaded areas, and cooling elements, we aimed to enhance exterior thermal comfort and encourage yea -round use of outdoor spaces.

6- Urban Signal



An observation tower and a panoramic ramp were integrated as symbolic features. The tower acts as both a visual landmark and a beacon, especially in an area lacking proper lighting infrastructure.

7- Multi-Scale Impact

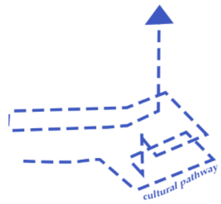
The intervention is designed to operate on three urban scales: firstly, **environmental**, by enhancing microclimate and green integration, **social**, by promoting gathering, interaction, and inclusivity.finally, **economic**, by attracting visitors and revitalizing the area's potential.

3.8.1. Program concepts

Figure 3.64: Program concepts.

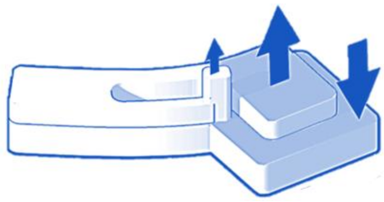
1- Cultural Pathway

A clear parcours leads visitors through the various exhibition and activity zones, ensuring a fluid and engaging cultural experience.



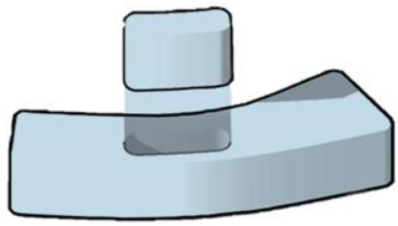
2- Fragmented Design

The multi-platform site layout is reflected in a fragmented architectural composition, allowing the program to adapt organically to topographical shifts.



3- patio Feature

Inspired by Miliana's traditional houses, a patio was integrated to provide natural ventilation and a central social void, reinforcing spatial hierarchy and passive comfort strategies.



4- Community Spaces

Public gathering zones both open and enclosed to support interaction, dialogue, and collective use, anchoring the project within its social context.

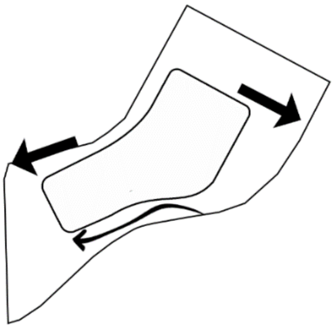
5- Contemporary Cultural LabsCultural

To engage younger audiences and foster creative expression, we included **modern technology spaces** such as a **VR room, podcast studio**, **photography lab**, and a **multipurpose cultural hall**. These facilities offer both freedom of use and opportunities to discover or develop new interests.

3.8.3. Architectural concepts

1- Harmonious Form and Orientation

Figure 3.65: Architectural concepts.



The building's geometry was proportioned in relation to the site's overall dimensions, establishing a formal coherence. Its orientation follows **climatic analysis**, maximizing natural light, passive ventilation, and thermal comfort while harnessing the site's environmental potential.

2- Contextual Dialogue

While the project stands out within its residential surroundings due to its modern architectural language, it maintains a dialogue with Miliana's identity. This is achieved through thoughtful integration of local textures, earthy colors, topographical adaptation, and elements like the central patio, echoing traditional spatial arrangements.

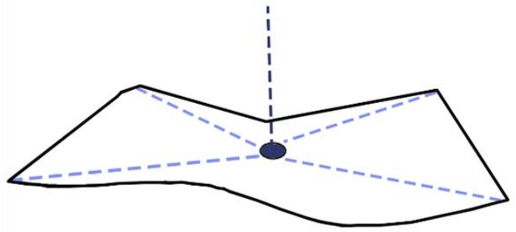
3- Visual Transparency and Landscape Framing

The site's elevated position offers sweeping views of the surrounding **valley and natural landscape**. To celebrate this, we opened the **southern façade**, using controlled transparency. Shading devices were integrated to protect the interior from heat and direct sunlight, while maintaining uninterrupted views and visual connection with nature.

3.9 Form development

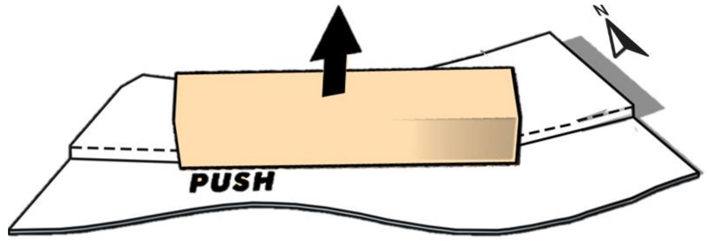
Our volumetric approach is based on two key site analysis recommendations:

1. A compact plan with a courtyard and double-oriented buildings for better functionality and climate response.
2. Following the topographical grid, as the neighborhood lacks a structured urban layout but aligns with the natural landforms.
3. With Miliana’s high-altitude setti ng and a 40% slope, the project is designed as a landmark, standing out while blending with the terrain.



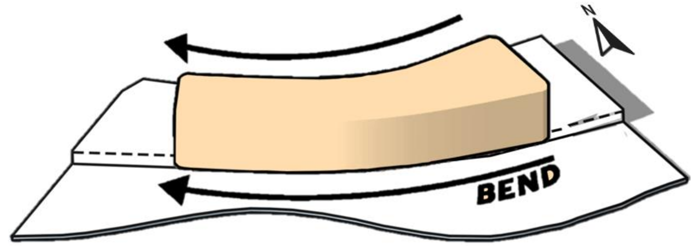
1. Anchoring the Project

To ensure stability and site integration, the project was positioned at the center of the plot, creating a strong connection with the terrain and reinforcing its presence. This central placement also allowed for the integration of a comprehensive Nature-Based Solutions (NBS) system surrounding the building, enhancing both the exterior microclimate and the interior environmental comfort.



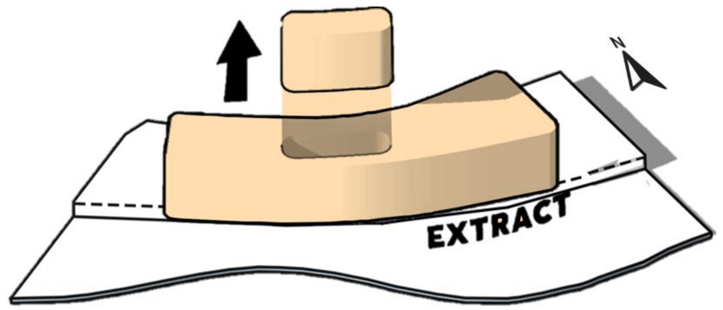
2. Extruding the Initial Mass

A simple parallelepiped volume was extruded from this central point, serving as the base for further transformations while maintaining a clear and functional form.



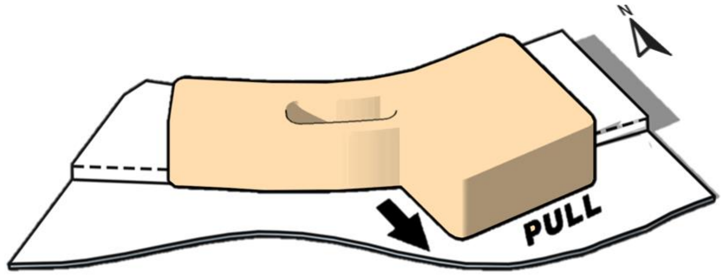
3. Adapting to the Terrain

The mass was flexed to follow the horizontal flow of the natural topography, creating a dynamic shape that blends with the site rather than imposing on it.



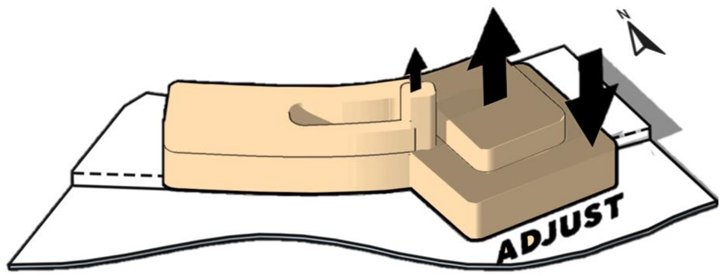
4. Carving the Courtyard

A central void was carved out to form a courtyard, enhancing natural light, ventilation, and spatial balance while reinforcing the compact typology.



5. Stepping with the Slope & Double Orientation

To follow the vertical flow of the slope, another volume was extended, achieving a stepped design that adapts to the terrain while ensuring double orientation for optimal sunlight and airflow.



6. Adjusting Heights for Harmony

The massing was refined to balance proportions, avoiding an overly compact look and ensuring a harmonious integration with the surroundings.

Figure 3.66: cultural center Form development.
Source: Authors.

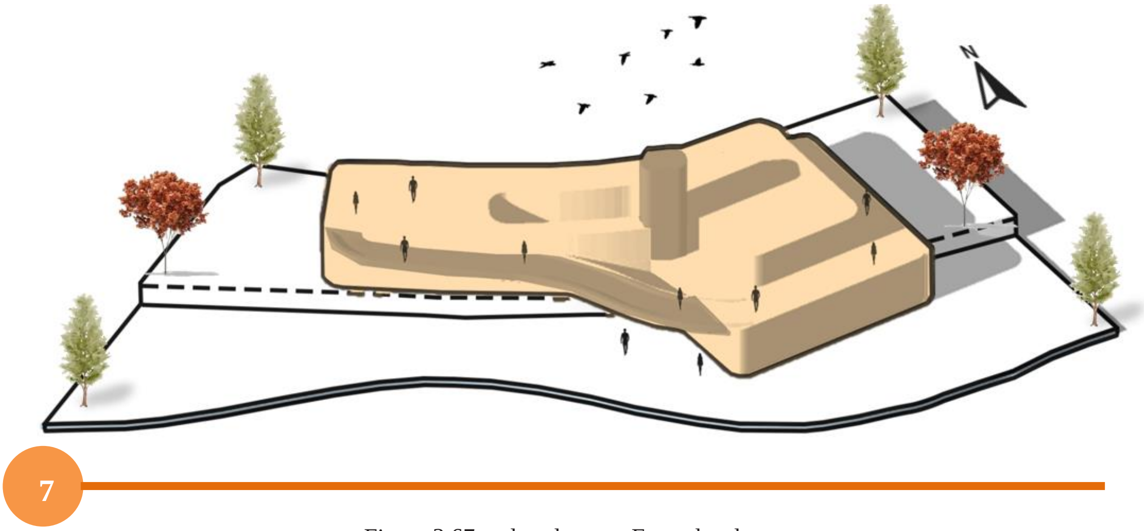


Figure 3.67: cultural center Form development.
Source: Authors.

Two key elements enhance urban connectivity and identity:

- An urban ramp linking the volumes and improving movement.
- An observation tower, acting as a landmark and offering an immersive discovery experience.

These elements make the project a visible and inviting cultural hub, standing out while remaining connected to the city.

3.9.1 Mood board

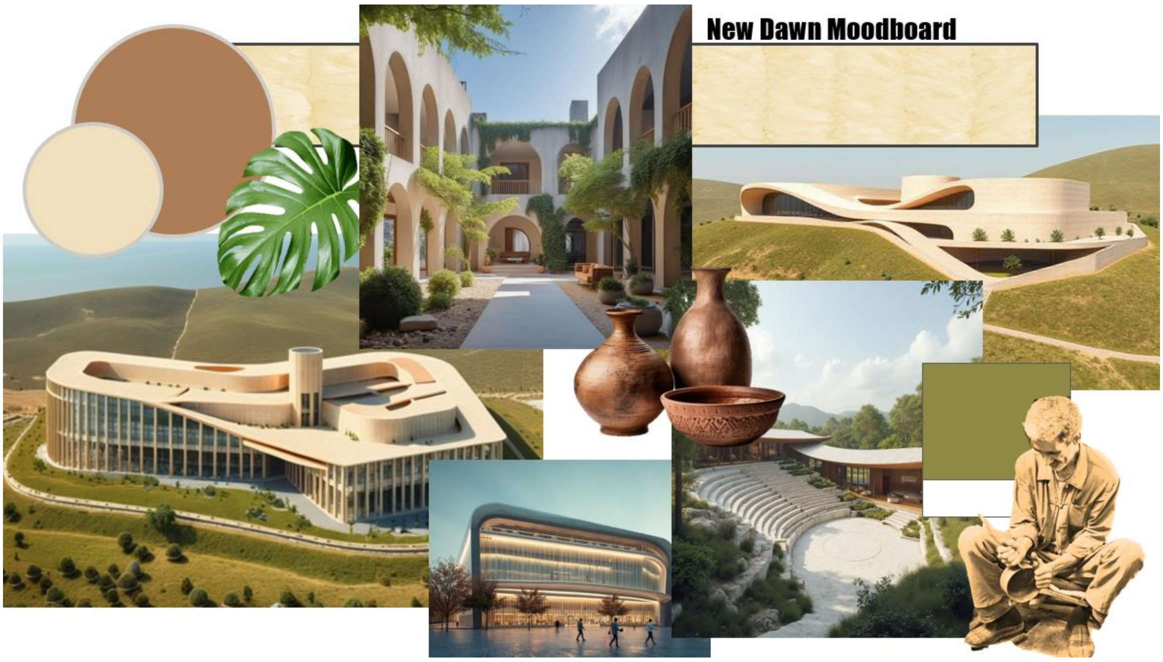


Figure 3.68: Mood board of cultural center.
Source: Ai edited by Authors.

3.10.Spatial organization

The spatial organization of the project is guided by a **hierarchical yet open layout**, where transitions between functions are shaped by shifts in form, direction, or elevation — rather than strict walls or boundaries. This approach allows for **fluid movement**, **visual connectivity**, and a **cohesive user experience** across the site.

The project is structured around five main functions:

- **Commerce**: A gallery of boutiques placed near the main entrance to animate the edge of the site and create an active urban frontage.
- **Culture**: A vibrant core composed of a VR room, artisanal and modern exhibition spaces, a screening room, art studios, and a library with an integrated archive — encouraging both contemporary and traditional cultural expression.

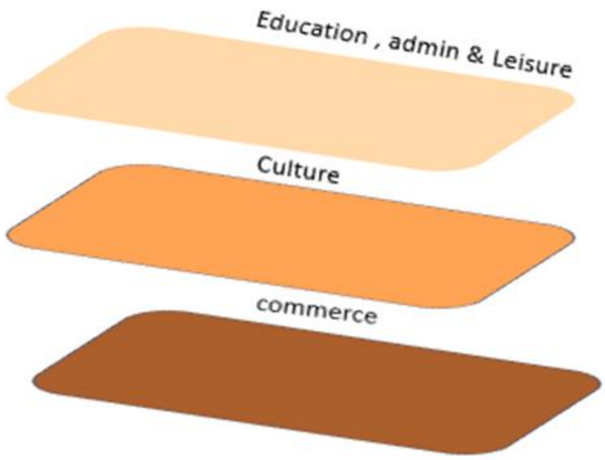


Figure 3.69: spatial organization scheme.
Source: Authors.

- **Education**: A set of classrooms and workshops designed to host creative training and community learning activities.
- **Administration**: A zone of offices that supports the overall management and coordination of the center's programs.
- **Leisure**: A playful and social zone including a gaming room, a podcast and photography studio, a cafeteria, and a rooftop terrace — fostering relaxation, creativity, and youth engagement.

3.10.1 Logic of organization

The project's spatial logic responds directly to the site's topographical duality, structured across two distinct platforms at different elevations. Each platform follows a tailored organizational principle adapted to its function and form.

- **First Platform – Linear Organization**

The lower platform adopts a linear spatial layout, guiding users along a continuous pathway. It hosts commercial functions and a multipurpose auditorium, encouraging smooth progression from one space to another.

This sequence creates a fluid transition from public interaction at the entrance to more focused cultural engagement deeper within the site.

- **Second Platform – Centralized Organization**

  The upper platform is divided into two central configurations. On one side, spaces are organized around a patio, reflecting traditional courtyard typologies that foster light, ventilation, and social interaction. On the other side, an atrium-centered layout structures the program vertically and spatially, offering natural illumination and visual connectivity across levels.

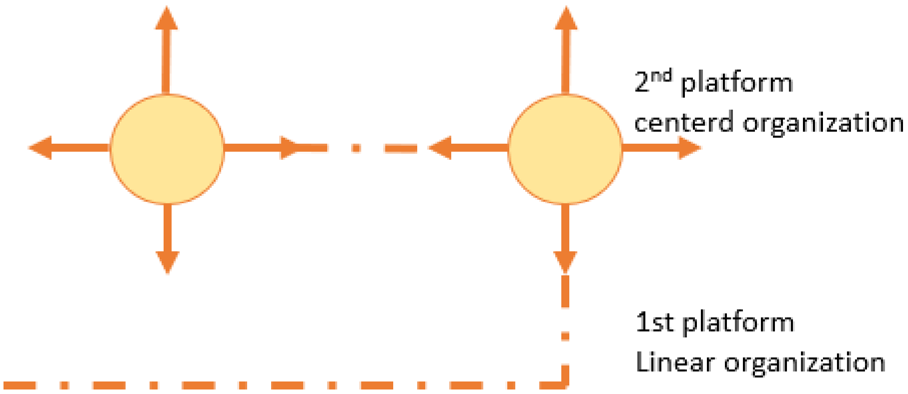


Figure 3.70: scheme of the different logics of organization in different platforms.
Source: Authors.

Together, these organizational strategies balance openness and orientation, guiding visitors intuitively through the site's layers while embracing the terrain's complexity and architectural purpose.

3.10.2 Horizontal circulation

The project's horizontal movement system is designed to reflect both clarity and experiential richness:

• On the first platform, circulation follows a linear axis, guiding users along acontinuous path through the commercial and cultural spaces.

Within the boutique zone, the internal flow resembles that of a traditional souk, offering a semi-organic navigation pattern where users can meander between small-scale retail units, evoking a lively marketplace atmosphere.

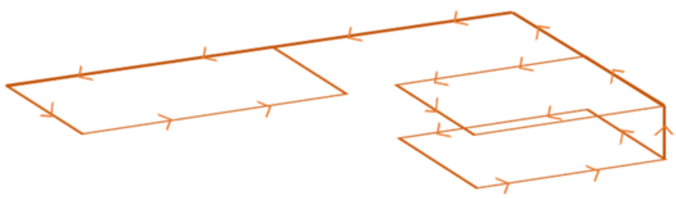


Figure 3.71: circulation flow scheme.
Source: Authors.

- On the second platform, circulation is structured around two central nodes: One side orients around a patio, enabling fluid movement and natural gathering points and the other side is organized around an atrium, where circulation radiates outward and upward, reinforcing spatial legibility and connectivity across levels.

This dual-horizontal approach enhances orientation, encourages exploration, and connects the site's functional layers while respecting its topographical logic.

3.10.3 Vertical circulation

Vertical access throughout the project is designed to be inclusive, efficient, and spatially expressive:

- On the **first platform**, **stairs and elevators** are distributed strategically at the corners and transition zones, ensuring accessibility and smooth vertical flow.
- Upon reaching the **second platform**, vertical circulation becomes more centralized, with a core system located within the **atrium**, allowing for **controlled transitions** along the cultural pathway. From this level, users can ascend to the **upper floor** either through an **external ramp** which offers gradual elevation and scenic views, or via **central stairs** integrated within the atrium volume.
- The final ascent leads to the **observation tower**, an iconic vertical element designed to offer panoramic views of the surrounding landscape, functioning as both a **landmark** and a **destination** within the spatial journey.

Together, the horizontal and vertical circulation systems ensure a **seamless, inclusive, and layered user experience**, adapting to the terrain while supporting the architectural narrative we want to convey.

3.10.4 Exterior Public Spaces and Landscape Design

The exterior spaces are not conceived as a conventional continuous park or formal garden but they encircle and interlace with the main building creating a discontinuous but connected natural landscape which facilitates the movement, meeting and climatic comfort.

To increase outdoor comfort, especially in summer (hot seasons), the landscape design consists of Nature-Based Solutions (NBS). These comprise a diversity of native plants: varieties of trees, shrubs and ground covers that can moderate microclimate conditions by evapotranspiration and shade. The social sphere is interspersed with informal seats, a shaded open air theatre to host cultural and social activities and morning benches that are set in such a way as to induce reading or just enjoying the cool breeze.

The spatial layout is characterized by a strong principle of accessibility: all outdoor areas are fitted with ramps, which provides complete circulation of people with reduced mobility (PMR). A sequence of small scale water features to add to the sensory experience and help with passive cooling is complemented by a network of green corridors, carefully planted to direct the flow of movement and provide shade.

This considerate landscape design actually does more than just frame the architectural volumes it also creates a friendly, open, and environmentally sensitive public realm that can support all-year-round usage and help to cement the project as a lively community hub.

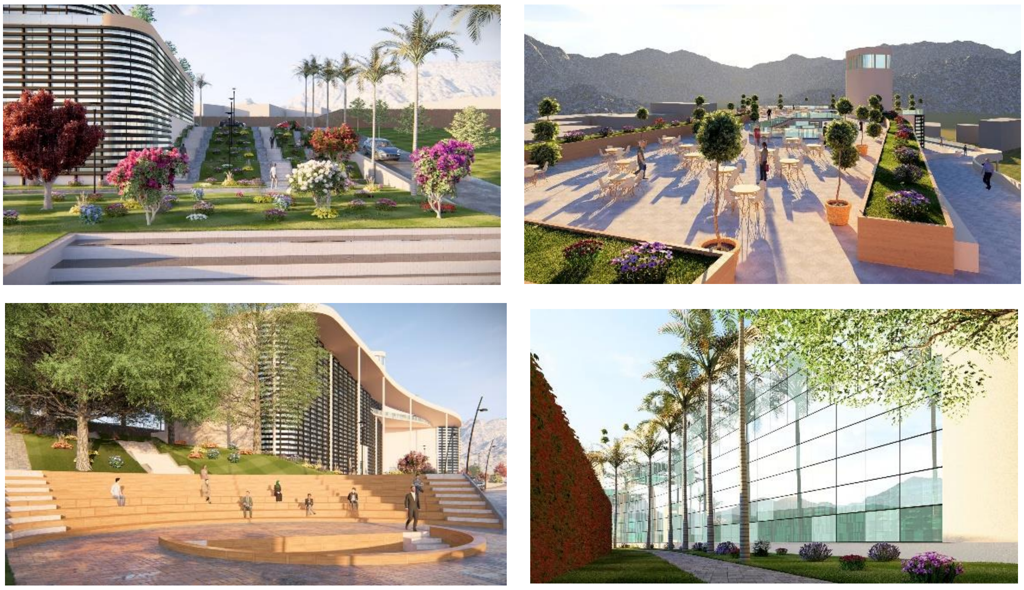


Figure 3.72: Different views from the exterior public space.
Source: Authors.

3.10.5 Urban furniture

Urban furniture and planting were carefully incorporated to assist with the revitalization of the site and address some of the weaknesses highlighted during the SWOT analysis, especially in regards to inaccessibility and safety. To enhance urban security and safer movement within the site, street lighting, sidewalks, and a bus stop were included. Located on the road, the tower serves as a visual landmark, increasing visibility at night and spatial orientation at a place where there was no light and distinguishing marks.

Figure 3.73: Different urban furniture from the exterior public space.
Source: Authors.

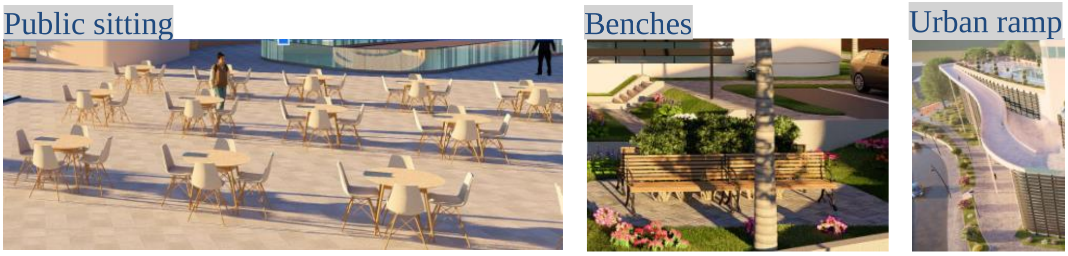


Figure 3.74: Different urban furniture from the exterior public space.
Source: Authors.

Benches, bins, sitting are all components of urban furniture that invite people to use them and socialize. Landscaping will use native and drought-resistant plants and permeable surfaces to enhance comfort, decrease urban heat, and promote ecological stability. Collectively, the interventions have created a safer, more accessible, and climate-responsive public space.

3.11. Envelope analysis

3.11.1 Façade

The façade was conceived as a synthesis of several guiding concepts, each informing a specific aspect of its design logic:

- **Response to Topography:** since the building is deployed across a steep slope resembling a cliff, the architectural massing was horizontally stratified. This approach not only facilitated accessibility across levels but also visually anchored the project into the terrain. To support this logic, the façade adopted a horizontal rhythm, aligning with the form's extension along the platforms to soften the perception of vertical drop and create a stable visual base.

Figure 3.75: Facades of our project. Source: Authors.

- **Climatic Strategy and transparency**: as the main façade faces south, thermal protection was essential. A system of **dynamic horizontal louvers** was developed, supported by vertical elements, to balance between maximizing transparency and minimizing solar heat gain. This passive strategy allowed for natural light control, thermal regulation, and maintained aesthetic coherence.

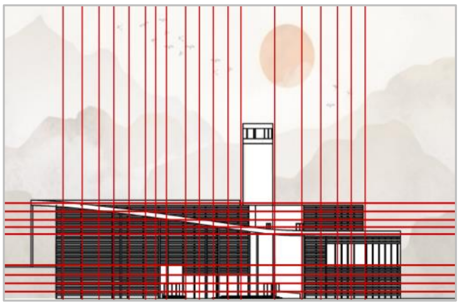


Figure 3.76: Rythme of the facade. Source: Authors.

- **Urban Signal**

As part of the neighborhood's revitalization strategy, the project integrates a clear **urban signal**, a spatial marker composed of two key elements: the **pedestrian ramp**, which gradually lifts users into the site while framing views and guiding circulation; and the **observation tower**, a vertical landmark visible from the main road. Together, these elements create a dialogue between ground and sky, movement and pause, and contribute to both spatial legibility and nighttime orientation.

Figure 3.77: Urban Signal (ramp, tower).
Source: Authors.

- **Façade Influence"**: the overall approach was inspired by Norman Foster's *Carré d'Art*, reflecting a **High-Tech Minimalist** language where structure and skin perform environmentally. However, rather than applying it directly, the concept was **reinterpreted through the lens of Miliana's identity**, integrating Foster's vocabulary with local values.

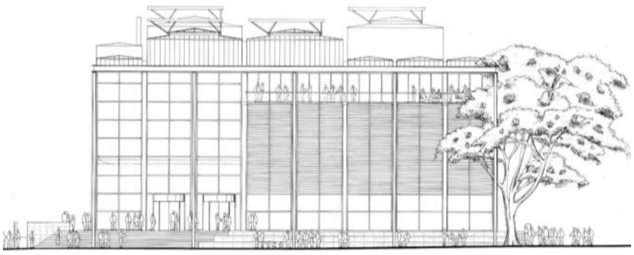


Figure 3.78: Carré d'Art by Norman foster.
Source: foster and partners website.

- **Aesthetic Integration:** to root the project within its context, a palette of warm earthy tones, textured plaster, and glazed mirrored glass was selected, echoing Miliana's surrounding landscape and architectural textures. This ensured the building does not impose itself but reflects, both literally and metaphorically, the richness of its environment.

Figure 3.79 : Different views from our project. Source: Authors.

At night, the project transforms into a luminous landmark, radiating a warm and inviting ambiance. The strategic use of **transparent materials** was not only an aesthetic choice but also a deliberate response to **urban security concerns**, allowing the building to remain visually open and well-lit after sunset. This transparency, combined with integrated façade lighting and the illuminated observation tower, reinforces the site's role as an **urban signal**, enhancing orientation, ensuring safety, and encouraging nighttime activity within the revitalized neighborhood.

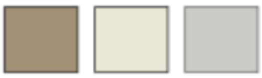


Figure 3.80 : Views at night from our prject.
Source: Authors.

-Envelope analysis -Structure - Materials

In order to balance heritage preservation, climate adaptation and functionality, we chose modernized materials with a local touch.

The material palette was carefully selected to balance **technological performance** with **contextual integration**. The primary structure utilizes **reinforced concrete**, ensuring durability, stability, and adaptability to the site's topography.

For the façade, **high-tech powder-coated aluminum louvers** in a warm beige tone were employed to provide solar protection, accentuate horizontality, and reflect the regional color palette. **Beige plaster** was chosen for wall finishes, referencing Miliana's vernacular tones while enhancing thermal inertia. **Double-glazing** was applied to all major openings to ensure optimal daylighting and insulation performance. Finally, **water features and integrated greenery** were introduced in the outdoor spaces, contributing to passive cooling, microclimatic balance, and user well-being.

Figure 3.81: Different materials used in our project. Source: architextures.

3.11.2 Structure

3.11.2.1Construction system

The building employs a hybrid structural system composed of reinforced concrete columns and beams, accommodating varying spans across the site. This approach allows for flexible spatial arrangements, with smaller bays of approximately 6 meters for enclosed or modular functions, and larger spans reaching up to 12 meters in open areas such as exhibition halls. The variation in column spacing responds to both functional needs and the site's sloped topography, ensuring structural efficiency while maintaining architectural coherence.

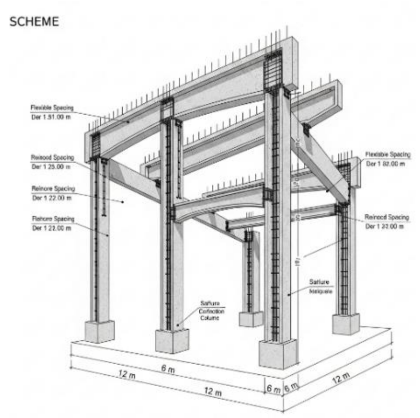


Figure 3.82: a scheme that shows different spacing between columns. Source: authors, enhanced by AI.

On the southern façade, a secondary skin of horizontal beige louvres is positioned approximately 50 cm from the glazed surface, functioning as both a shading device and an aesthetic layer. These louvres are suspended from vertical support elements that are securely fixed to both the ceiling and the ground, creating a visually light yet structurally stable system that balances solar protection with transparency and rhythm.

Figure 3.83: Facade that shows horizontal louvres.
Source: authors, enhanced by AI.

3.12 Environmental strategies used in the project

Table3.8: Environmental strategies applied on the site. Source: authors.

Strategy	Environment	Form	Envelope	figures, source: authors
Microclimate Enhancement	Use of NBS elements (vegetation + water) to improve thermal comfort.	Courtyard integrated in compact form to provide shade and regulate temperature.	Light-colored materials with high albedo to reduce heat absorption.	
Circulation and Accessibility	Central building placement allows vegetation around and promotes airflow.	Layered massing creates shaded areas on site.	Entrance ramp provides shaded transition space.	
Mobility and Walkability	Pedestrian pathways and a bus stop improve connectivity and accessibility.	–	–	
Shading and Transparency	–	Horizontal louvers maintain visual openness while reducing solar gain.	Dynamic louvers (set 50 cm from glass) regulate sun exposure while allowing ventilation.	

3.13 Thermal simulation: of the exterior space with ENVI-Met v3.0

3.13.1 Simulation protocol

Table3.9: Simulation protocole. Source: authors.

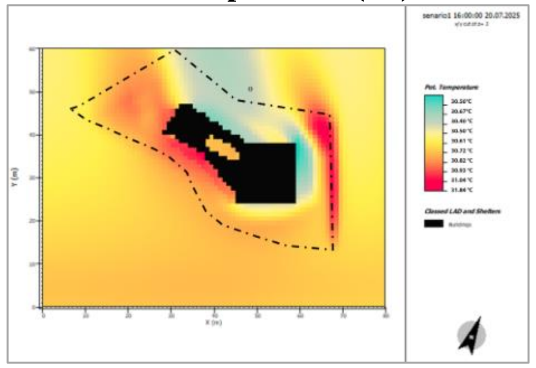
Element	Description
Study Site	New dawn, miliana , 36°18'13"N 2°12'52"E , a modern cultural center
Objective	Assess microclimate before and after adding vegetation or shading features
Simulation Scenarios	Scenario A: Existing site with pavement (baseline) Scenario B: With vegetation and trees
Key Metrics	PET, Tmrt, air temperature, wind speed, relative humidity
Project's footprint	**40%**
Green spaces	50%
Paved surfaces.	10%
simulation date	20 July at 3pm
simulation time	8hours

3.13.2 Presentation of the Simulation Tool

ENVI-met is an environmental simulation tool widely used in the fields of sustainable urban design, landscape planning, architecture, and environmental impact assessment. It enables the modeling and analysis of climatic and environmental conditions at a precise microclimatic scale.

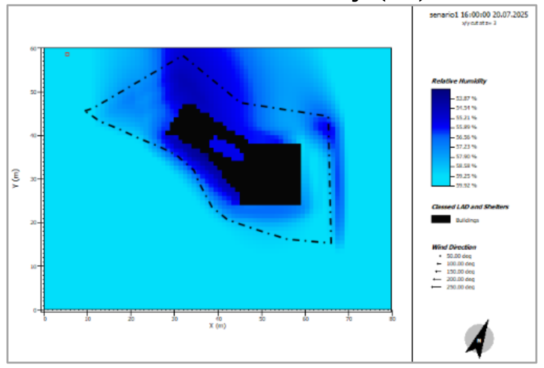
✓ **Scenario 1 : Without Vegetation (Bare Terrain)**

Air Temperature (°C)



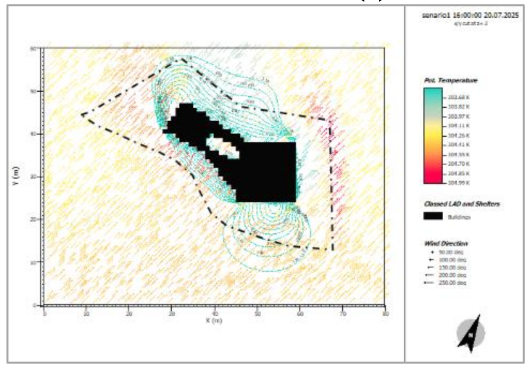
In the first case, the ground is bare and covered with hard, impermeable surfaces, without any trees or plants. The potential temperature goes from 34.04°C to 30.56°C. The northern part of the site is the coolest, with values between 30.56°C and 30.61°C, probably because it gets less sun. The patio, which has no plants but is partly enclosed, is a bit warmer at 30.93°C; the heat likely gets trapped there. The southern area is the warmest, with values between 31.04°C and 31.84°C, as it receives more direct sunlight.

Relative Humidity (%)



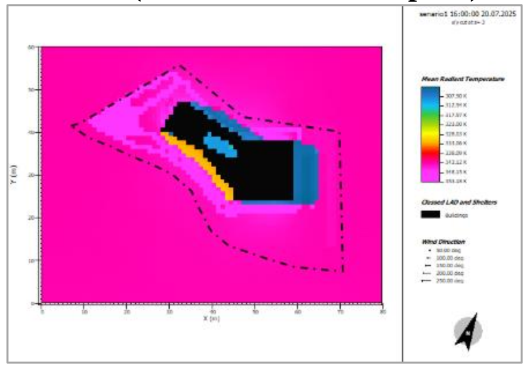
In this scenario, the relative humidity around the building ranges from 53.87% to 56.56%. This is higher than the initial outdoor humidity in Miliana, which is 48.33%. The increase is caused by lower surface temperatures near shaded or built areas, which reduce evaporation rates and help retain more moisture in the air. However, since there is no vegetation, the air humidity is not actively increased by natural sources like plants.

Wind Direction (°)



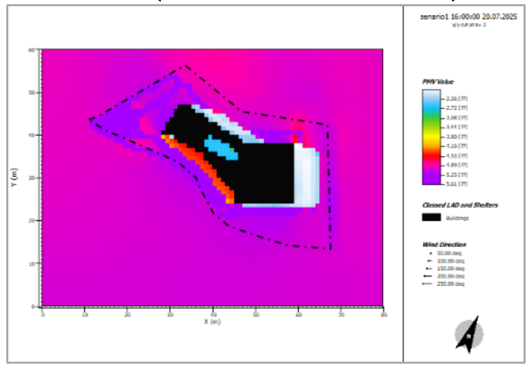
The wind comes from the southwest, but the building blocks the flow, creating wind shadows and turbulence behind it (to the northeast). These zones show weaker airflow and can trap heat. Surface and air temperatures are higher near the building, especially on the downwind side, with values above (30°C). This effect is typical of urban heat islands. The lack of vegetation also means no evaporative cooling, so heat builds up faster. The coolest zones are found farther from the building. Overall, the site has poor

MRT (Mean Radiant Temp °C)



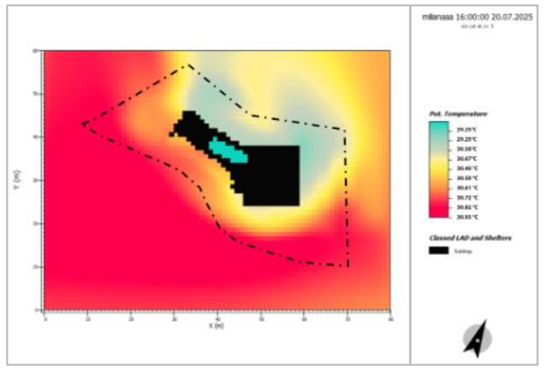
The map shows extreme radiant heat, with MRT peaking at 79.25 °C, especially in areas exposed to direct sun and surrounded by heat-retaining materials. Colors shift from orange to magenta, signaling very high thermal radiation. Only minimal shading is provided by the building, which has negligible impact on the overall heat exposure.

PMV (Predicted Mean Vote)

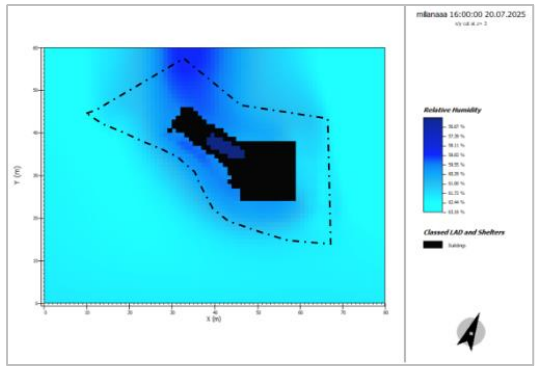


The PMV values around the building range from 1.33 to 5.61. These numbers indicate a strong sensation of heat and high thermal discomfort, especially in areas with higher values. A PMV above +3 is classified as "very hot", and values over +5 represent extreme heat stress, which confirms that the outdoor environment is highly uncomfortable due to the lack of vegetation and shading.

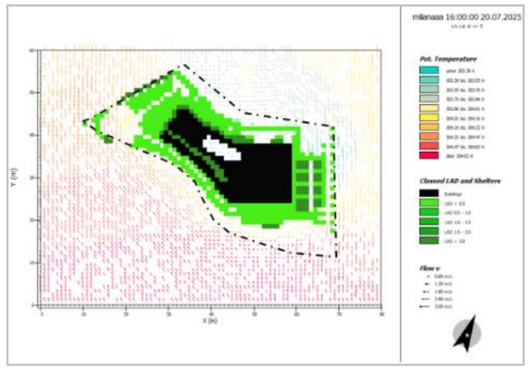
✓ **Scenario 2 : With Vegetation (Trees and Plants)**



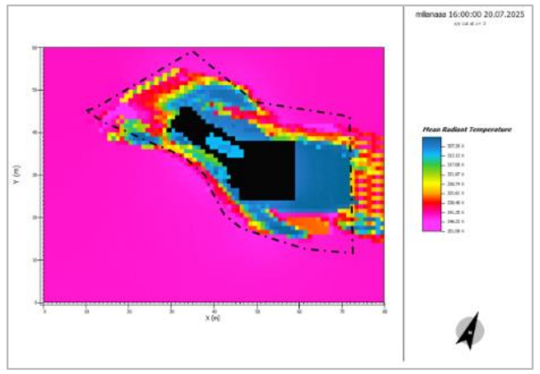
In the second case, vegetation and trees were added to the site. As a result, temperatures dropped in all areas. The north is now cooler at 29.25°C, the patio is 29.85°C, the entrance is 30.40°C, and the south is 30.93°C. Even though the patio still has no vegetation, its temperature went down a little. This is likely because the cooler air and shade from nearby green areas help lower the temperature even in places without direct planting.



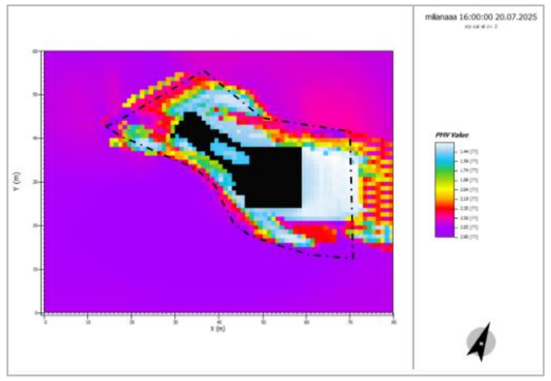
With the addition of vegetation around the building, relative humidity increases to values between 58.52% and 60.25%. This rise is a direct result of evapotranspiration; the process by which plants release water vapor into the air. The trees and green areas actively contribute to higher moisture levels in the atmosphere around the site.



The wind comes from the northeast and reaches up to 3.00 m/s, helping to ventilate the site. Trees and plants guide and soften the wind, reducing turbulence and improving airflow near the building. The northeastern and eastern parts of the site benefit the most, as wind can move freely through green areas and open paths. Although a wind shadow still forms behind the building, it is less severe thanks to the surrounding vegetation, which maintains air movement and cooling. This setup supports a more



Vegetation reduces surface and radiant temperatures drastically, with MRT dropping to 33.85 °C in shaded and vegetated areas (shown in blue and green). Trees and greenery block direct solar radiation, cool surfaces through evapotranspiration, and create comfortable shaded zones that reduce radiant heat stress.



In the second scenario, after adding vegetation, the PMV values drop significantly, ranging from 1.44 to 0. The eastern part of the terrain reaches a PMV of 0, which represents optimal thermal comfort. This improvement is directly linked to the presence of trees and plants, which reduce air temperature, increase humidity, and provide shade, all of which contribute to a more comfortable outdoor environment.

Based on the simulation data and thermal conditions in Miliana, the calculated Physiological Equivalent Temperature (PET) dropped from 37.9°C without vegetation to 29.6°C with the integration of vegetation and water features. This decrease of 8.3°C demonstrates a substantial enhancement in thermal comfort, transitioning from conditions of extreme heat stress to an acceptable range of outdoor comfort. The result affirms the crucial role of Nature-Based Solutions (NBS) in regulating microclimates and mitigating urban heat stress through evapotranspiration and shading effects. These improvements directly support pedestrian well-being and promote more livable public spaces (Höppe, 1999).

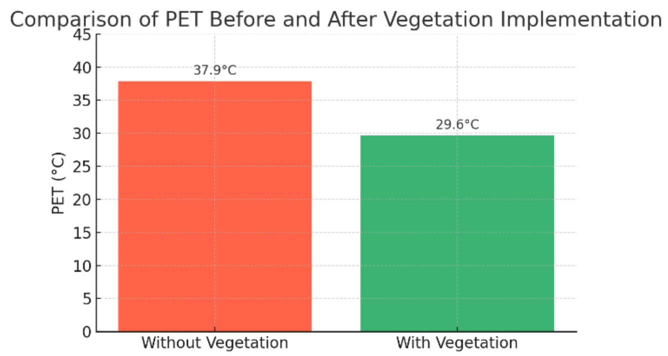


Figure 3.84: A diagram showing PET index in both scenarios.
Source: empirical formulas from Houppe, 1999 edited by authors.

Table3.10: Synthesis of a simulation at 4pm in the summer (20 july). source: Envi-met.

Parameter	Initial Climate (Miliana)	Scenario 1 – Without Vegetation	Scenario 2 – With Vegetation	Difference (Sc.1 → Sc.2)
Air Temperature (°C)	34.96	**34.04**	**29.25**	↓ **4.79 °C**
Relative Humidity (%)	48.33	56.56	58.52	↑ **1.96%**
Wind Speed (m/s)	2.2	**0.49**	**0.49 to 0.97**	↑ up to **0.48 m/s**
Wind Direction (°)	140.87 (SE)	Southwest (SW)	Northeast (NE)	Direction shift
PMV (Predicted Mean Vote)	—	5.61 (extreme heat stress)	optimal comfort	↓ **5.61** (major improvement)
MRT (Mean Radiant Temp °C)	49	**69.25** (very high)	**33.85** (significantly cooler)	↓ **35.4 °C** (huge improvement)
PET (°C)	—	**37.9°C**	**29.6°C**	**↓8.3°C**

3.13.3 Conclusion and Discussion

The presented microclimatic analysis demonstrated how the incorporation of environmental measures resulted in a favorable influence on a small site of about 5,500 m 2, with almost half of this area covered by built form and hardscape. Although in this project the possibility of outdoor activities is restricted by this area, the thermal comfort reached high levels due to the use of the approaches to the climate-responsive design and Nature-Based Solutions (NBS).

The simulation established a considerable downturn on the air temperature (4.79 o C) as well as mean radiant temperature (35.4 o C), humidity levels as well as ventilation particularly in vegetation areas. Though without the use of greenery, the central courtyard was formed and this was possible due to the use of cross-ventilation and passive cooling of the nearby vegetation. Solar protection, thermal equilibrium, transparency, and improved visibility at night were achieved using light, reflective materials of facades and horizontal louvres that multiplied as a form of extra safety in the city.

Some of the design decisions are sub-optimal however in simulation: The amphitheatre in the south face had the lowest rate of drop by 1C even though the conditions of the whole site were improved. This is more probable because of its much exposure to direct sun, as well as the fact that it has been constructed to face the slope; a factor that was protective of the major winds direction, but exposed the house to high amount of solar heating. This implies that there is a trade-off between wind shield and solar exposure.

There was noted improvement in the air temperature and comfort during the interior courtyard though the application of high thermal inertia materials like red brick could have impeded the dissipation of heat which could probably lead to low rate of cooling in the peak time.

These results indicate that although the overall approach worked, certain spatial and materials decisions can be improved.

3.13.4 Recommendations for Improvement

- RedesignIng solar-exposed areas (such as the amphitheatre) to accommodate retractable shade structures, pergolas or vegetation buffer zones especially south-facing directions. Or making changes in geometry, to add a bit of vertical shading without losing entirely the logic of the slopes terrain.
- Replacing high-thermal-inertia materials (e.g., red brick) in semi-covered or hot interior locations, such as patios, with cooler surface, less thermal capacity materials such as light-colored stone, or permeable concrete, or ceramic tile with high albedo.

While the dense nature of the plot limits additional green interventions within its boundaries, a broader opportunity exists: the project is surrounded by areas classified as **“Zone à urbaniser”** under the **PDAU** (Plan Directeur d'Aménagement et d'Urbanisme). These underutilized and unstructured spaces provide significant potential for **expanding the green ratio beyond the site**, contributing to both the **project's microclimate** and the **broader ecological network** of Milian.

GENERAL CONCLUSION

CHAPTER 04

4. General Conclusion

Within the framework of the specialization Architecture, Environment, and Technology, this thesis addressed the spatial and climatic challenges of Miliana, a historically significant city in northern Algeria. Despite its rich heritage and layered urban fabric, Miliana today faces fragmentation in its urban pattern and increasing thermal stress due to rising summer temperatures. This research was driven by a dual ambition: to reconnect the city with its cultural identity and to propose ecologically responsive design strategies that enhance outdoor and indoor comfort.

The project was sited in the western sector of Miliana, a zone marked for future development in the PDAU yet suffering from abandonment and underutilization. Our intervention—a cultural center—was conceived not only as a building but as a landmark and narrative device. It reactivates the city's western edge through an architectural expression rooted in memory and environmental balance. The programmatic choice was symbolic and spatially strategic: reconnecting with Miliana's "roots" while generating a new pole of attraction through public, inclusive, and climate-conscious design.

The methodological approach combined typo-morphological analysis, climatic diagnostics, and environmental simulations using ENVI-met v3.0. The hypothesis that integrating nature-based solutions (NBS) could significantly enhance outdoor thermal comfort was validated: air temperature and MRT were reduced by several degrees in vegetated zones, and PMV levels approached comfort thresholds. A courtyard typology, compact volume, double orientation, and layered design adapted to site topography were key design elements. The microclimatic behavior of the interior courtyard confirmed the relevance of these strategies.

On the urban scale, the project applied the concept of urban acupuncture by stitching together the abandoned western sector with its surroundings, fostering environmental, social, and economic resilience. Furthermore, by leveraging the flexible classification of the site as a "zone à urbaniser," the intervention initiates a long-term vision for sustainable district development.

While the project has demonstrated promising results in terms of environmental performance and spatial integration, it also highlights the need for broader-scale interventions. Future research and design efforts could benefit from expanding the scope beyond a single site, adopting a networked approach at the neighborhood scale. This would amplify the impact of urban acupuncture strategies and enable a more cohesive, inclusive, and climate-resilient transformation of Miliana's western sector.

BIBLIOGRAPHIC REFERENCES

Books

- ASHRAE. (2017). *ASHRAE handbook: Fundamentals*. American Society of Heating, Refrigerating and Air-Conditioning Engineers.
- Bahraini, H., & Bakhtiar, A. (2016). *Urban design: Definition, knowledge base, and principles*. In *Toward an Integrative Theory of Urban Design* (pp. 5–28). Tehran: Shahid Beheshti University Press.
- Beatley, T. (2011). *Biophilic cities: Integrating nature into urban design and planning*. Island Press.
- Bloch, A. (2002). *Miliana par les textes*. Éditions Sindbad-Alger.
- Dirr, M. A. (1998). *Manual of woody landscape plants: Their identification, ornamental characteristics, culture, propagation and uses* (5th ed.). Stipes Publishing.
- Fanger, P. O. (1970). *Thermal comfort: Analysis and applications in environmental engineering*. McGraw-Hill.
- Gehl, J. (2010). *Cities for people*. Island Press https://islandpress.org/books/cities-people
- Gehl, J. (2011). *Life between buildings: Using public space*. Island Press.
- Gehl, J., & Svarre, B. (2013). *How to study public life* (Vol. 2). Island Press.
- Givoni, B. (1998). *Climate considerations in building and urban design*. John Wiley & Sons.
- **Gsell, S.** (1911). *Atlas archéologique de l'Algérie* (Feuille XIII: Miliana N 70). Alger / Paris: Adolphe Jourdan & Fontemoing & Cie.
- Hillier, B. (1996). *Space is the machine: A configurational theory of architecture*. Cambridge University Press.
- Jacobs, J. (1961). *The death and life of great American cities*. The Modern Library.
- McPherson, E. G. (1994). *Cooling urban heat islands with sustainable landscapes*. In R. H. Platt, R. A. Rowntree, & P. C. Muick (Eds.), *The Ecological City: Preserving and Restoring Urban Biodiversity* (pp. 151–171). University of Massachusetts Press.
- Roberts, P. (2000). The evolution, definition and purpose of urban regeneration. In P. Roberts & H. Sykes (Eds.), *Urban regeneration: A handbook* (pp. 9–36). SAGE.
- Slimani Aït Saada. (2013). *Histoire des lieux : El Asnam, Miliana, Ténès*. Éditions Hibr, Alger.
- World Health Organization. (2011). *Guidelines for drinking-water quality* (4th ed.). https://www.who.int/publications/i/item/9789241548151

Journal Articles & Scientific Papers

- Alcoforado, M. J., & Andrade, H. (2006). Nocturnal urban heat island in Lisbon (Portugal): Main features and modeling attempts. *Theoretical and Applied Climatology, 84*(1–3), 151–159. https://doi.org/10.1007/s00704-005-0163-9
- Almeida, M. G., Silva, P. L., & Ferreira, J. A. (2019). Wind speed and outdoor thermal comfort. *International Journal of Sustainable Urban Design, 23*(4), 45–59.
- Armson, D., Stringer, P., & Ennos, A. R. (2012). The effect of tree shade and grass on surface and globe temperatures in an urban area. *Urban Forestry & Urban Greening, 11*(3) ,245–255. https://doi.org/10.1016/j.ufug.2012.05.002
- Bouchahm, Y., Bourbia, F., & Belhamri, A. (2012). Thermal comfort in urban spaces: An Algerian case. *Energy Procedia, 18,* 282–290. https://doi.org/10.1016/j.egypro.2012.05.034
- **Boukarta, S.** (2024). *Impact of the courtyard geometry on cooling energy demand in arid zones: Univariate regression-based approach*. *SSP – Journal of Civil Engineering, 19*(1).
- Carrasco, M. (2024). Re-naturalization of Cheonggye Stream in Seoul. *ArchDaily*. https://www.archdaily.com/1020945/Chiesura, A. (2004). The role of urban parks for the sustainable city. *Landscape and Urban Planning, 68*(1), 129–138. https://doi.org/10.1016/j.landurbplan.2003.08.003
- Costa, A. L., Lopes, A., Rodrigues, M., & Santos, F. D. (2016). Climate change adaptation through urban green infrastructures: A case study in Lisbon. *Sustainability, 8*(3), 290. https://doi.org/10.3390/su8030290
- Djellouli, Y., & Bouchahm, Y. (2018). Outdoor thermal comfort in Algiers using PET and ENVI-met. *Energy Procedia, 153,* 300–305. https://doi.org/10.1016/j.egypro.2018.10.039

Journal Articles & Scientific Papers

- GhaffarianHoseini, A., Berardi, U., AlWaer, H., Chang, S., & GhaffarianHoseini, A. (2017). What is an intelligent building? Analysis of recent interpretations from an international perspective. *Architectural Science Review, 60*(4), 313–326. https://doi.org/10.1080/00038628.2016.1223742
- Huang, L., & Kang, J. (2021). Thermal comfort in winter incorporating solar radiation effects at high altitudes—Case of Lhasa. *Building Simulation, 14*(6), 1633–1650. https://doi.org/10.1007/s12273-020-0743-x
- Karimi, K. (2023). The configurational structures of social spaces: Space syntax and urban morphology in the context of analytical, evidence-based design. *Land, 12*(11), 2084. https://doi.org/10.3390/land12112084
- Matzarakis, A., Mayer, H., & Iziomon, M. G. (1999). Applications of a universal thermal index. *International Journal of Biometeorology, 43*(2), 76–84. https://doi.org/10.1007/s004840050119
- Matzarakis, A., Rutz, F., & Mayer, H. (2007). Modeling radiation fluxes in complex environments—Application of RayMan model. *International Journal of Biometeorology, 51*(4), 323–334. https://doi.org/10.1007/s00484-006-0061-8
- Nasrollahi, N., Namazi, Y., & Taleghani, M. (2021). Urban shading and canyon geometry in hot climates. *Sustainable Cities and Society, 65*, 102638. https://doi.org/10.1016/j.scs.2020.102638
- Nikolopoulou, M., & Steemers, K. (2003). Thermal comfort and psychological adaptation as a guide for designing urban spaces. *Energy and Buildings*, *35*(1), 95–101.
- Santamouris, M. (2013). Using cool pavements as a mitigation strategy to fight urban heat island—A review. *Renewable and Sustainable Energy Reviews*, *26*, 224–240. https://doi.org/10.1016/j.rser.2013.05.047
- Synnefa, A., Santamouris, M., & Akbari, H. (2007). Estimating the effect of cool coatings on energy loads and thermal comfort in residential buildings. *Energy and Buildings, 39*(11), 1167–1174. https://doi.org/10.1016/j.enbuild.2007.01.005
- Wong, N. H., Tan, C. L., & Chen, Y. (2010). Study of thermal performance of extensive rooftop greenery systems in the tropical climate. *Building and Environment, 45*(1), 128–138. https://doi.org/10.1016/j.buildenv.2009.06.017
- Yuan, Z., & Jiang, Y. (2019). Urban centrality and regeneration strategies: Shaping sustainable urban spaces. *Journal of Urban Planning and Development, 145*(2), 245–258. https://doi.org/10.1061/(ASCE)UP.1943-5444.0000497
- Zhao, H., & Li, S. (2020). Reimagining urban centralities in post-industrial cities. *Urban Design International*, *25*(4), 293–304.

- https://doi.org/10.1057/s41289-020-00124.

Websites, Studio Work & Online Reports

- Abbas-Kebir, B. (2013). *Miliana: Guide historique et culturel*. Retrieved from https://www.algermiliana.com/pages/miliana/
- The Editors of Encyclopaedia Britannica. (2014, April 11). *Miliana*. https://www.britannica.com/place/Miliana
- Integrated Environmental Solutions. (2021). *Environmental design and thermal performance tools*. https://www.iesve.com/
- Line+ Studio. (n.d.). *Maison de la culture Hassan El Hassani de Médéa*. https://www.lineplus.studio/en/
- Line+ Studio. (n.d.). *Atrium of Light: Community Center of Fragrant Lake*. https://www.lineplus.studio/en/works_cont_1785.html?ctid=129
- Line+ Studio. (n.d.). *Zhejiang Lishui Guyanhuaxiang Art Center*. https://www.lineplus.studio/en/works_cont_1793.html?ctid=129
- Mrs Physics. (n.d.). *Thermal conductivity table*. https://www.mrsphysics.co.uk/
- Thermtest Inc. (n.d.). *Thermal conductivity of materials*. https://thermtest.com/materials
- UNESCO. (2003). *Convention for the Safeguarding of the Intangible Cultural Heritage*. https://ich.unesco.org/
- UNESCO. (2008). *Operational guidelines for the implementation of the World Heritage Convention*. https://whc.unesco.org/
- IUCN. (2020). *Nature-based solutions*. https://www.iucn.org/theme/nature-based-solutions/
- IPCC. (2022). *Climate Change 2022: Impacts, adaptation and vulnerability*. https://www.ipcc.ch/report/ar6/wg2/
- IPCC. (2023). *Synthesis report of the Sixth Assessment Report (AR6)*. https://www.ipcc.ch/ar6-syr/
- IEA. (2023). *Energy Efficiency 2023*. https://www.iea.org/reports/energy-efficiency-2023
- UNEP. (2021). *Emissions Gap Report 2021*. https://www.unep.org/resources/emissions-gap-report-2021

Conference Proceedings

- Borna, M. (2013). *How microclimate impacts social interaction*. International Conference on Global Climate Change, Yıldız Technical University, Istanbul, Turkey.

Standards & Technical Guidelines

- ISO. (2005). *ISO 7730: Ergonomics of the thermal environment*. International Organization for Standardization.
- VDI. (1998). *VDI 3787 Part II: Environmental meteorology*. Association of German Engineers.
- DIN Standards. (2013). *DIN 51130: Testing of floor coverings – Determination of the anti-slip properties*.

Softwares

- Climat consultant 6.0
- Métronome 8
- Envi-met 3.1
- •Sketchup 2022
- Autocad 2023.
- Enscape 3.0.
- Photoshop 2022
- Illustrator 2022
- InDesign 2022
- Google earth pro

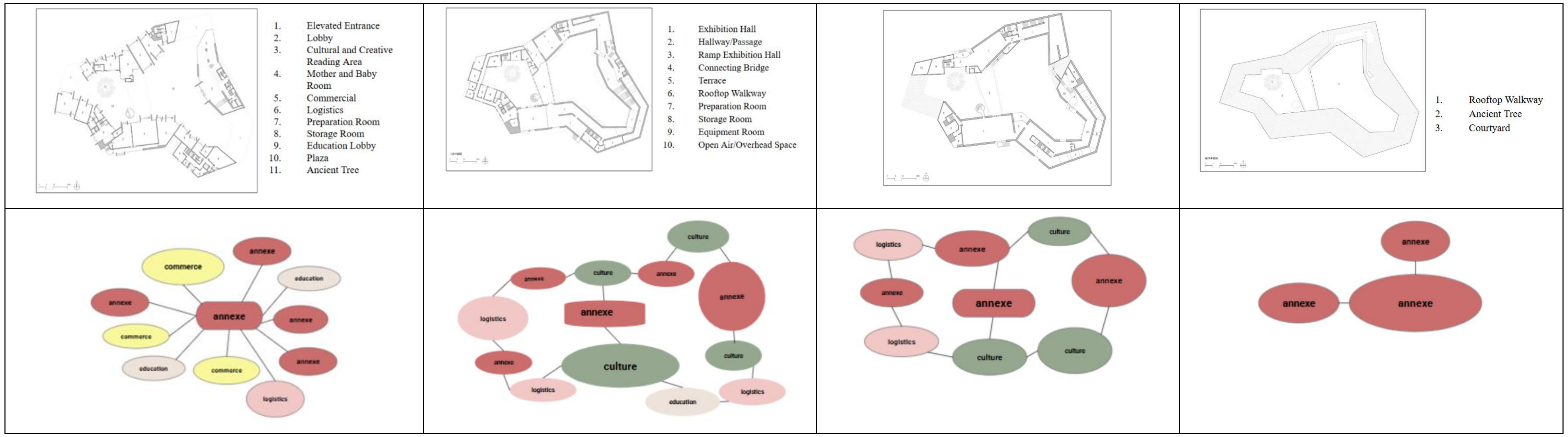
APPENDICES

1. Examples Analysis

1.1. Zhejiang Lishui Guyanhuaxiang Art Center

➢ Spatial Distribution

Table A.1 : Spatial organization .source : authors.



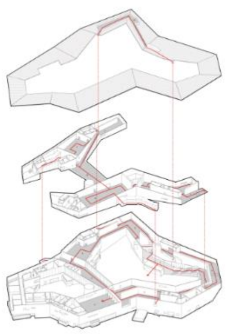
➢ Space distribution

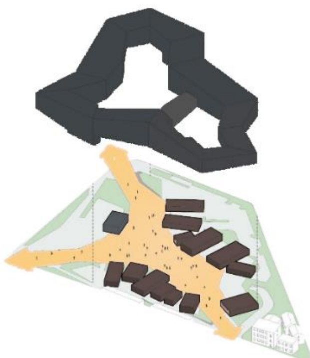
- **Horizontal Circulation:** Open areas and pathways ensure smooth movement between commercial, cultural spaces, and courtyards.
- **Vertical Circulation:** Elevated walkways and bridges enable seamless navigation and visual connections across floors.

➢ Form and envelope

Compactness : The building features a compact, closed block structure with internal courtyards that enhance unity and spatial connection while maintaining a cohesive architectural presence and harmony with the environment.

Complexity : The design has a flexible shape, with a big upper part and smaller structures at ground level. This allows space for people to walk through and gather. The courtyards break up the building, creating different spaces and encouraging community interaction while keeping the design connected.





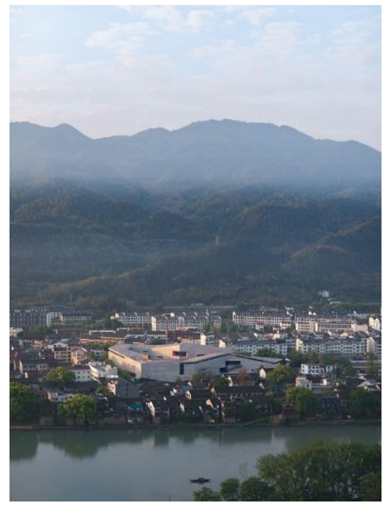
➢ Opulation and Area Contex

- Population of Lishui: As of recent estimates, Lishui's population is approximately 250,000 residents.
- Area of Art Center: The center occupies 20,000 square meters (or 2 hectares)

➢ Ratio Calculation

Area per person= Area of Art Center/ Population =20,000 m² / 250,000=0.08 m2/person

- the art center's scale can be considered large relative to the local context
- compared to miliana with a population of 44201 Residents the area of a large scae center would be 3 536,08m²



1.2. Atrium of Light - Community Center of Fragrant Lake

- **Population and Area Context**
  - Population of Hong'an County: According to the 2020 census, Hong'an County has a population of 510,189 residents.
  - Area of the Community Center: The Atrium of Light Community Center covers 2,284 m².
- **Ratio Calculation**

$$\text{Ratio} = \frac{\text{Area of Community Center (in square meters)}}{\text{Population of Hong'an County}} = \frac{2,284\,\text{m}^2}{510,189} \approx 0.00448\,\text{m}^2 \text{ per person}$$

  - its footprint is relatively **small** when compared to the large population it serves. This suggests that the center is designed to be a focal point for community engagement rather than a large hub
  - compared to miliana with a population of 44201 Residents the area of a large scale center would be **3 17,415194m²**

- **Vegetal Density**

The design preserves the dense vegetation, including local forests, creating a serene natural setting with landscaped pathways and shaded areas that maintain ecological balance.

- **Natural Elements:**

The center maximizes views of Lac Parfumé and surrounding forests through terraces, observation platforms, large windows, and openings, ensuring a seamless connection between interior spaces and nature.

- **Form and envelope**

- **Compactness**

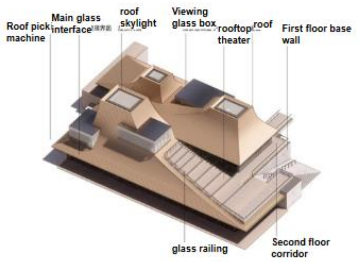
The building is relatively compact, yet it stretches horizontally to adapt to the terrain and follow the natural lines of the site.

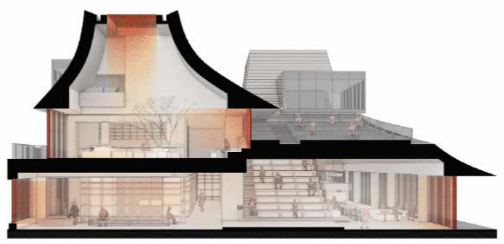
- **Complexity**

The complexity lies in the multi-level roof design, featuring floating cornices and platforms that add dynamic nuances to the building's outer envelope.

- **Lighting and Shading**

Strategic use of skylights atrium and glazed surfaces maximizes natural light. The building is designed to create varied lighting atmospheres across both interior and exterior spaces.





- **Spatial organization**

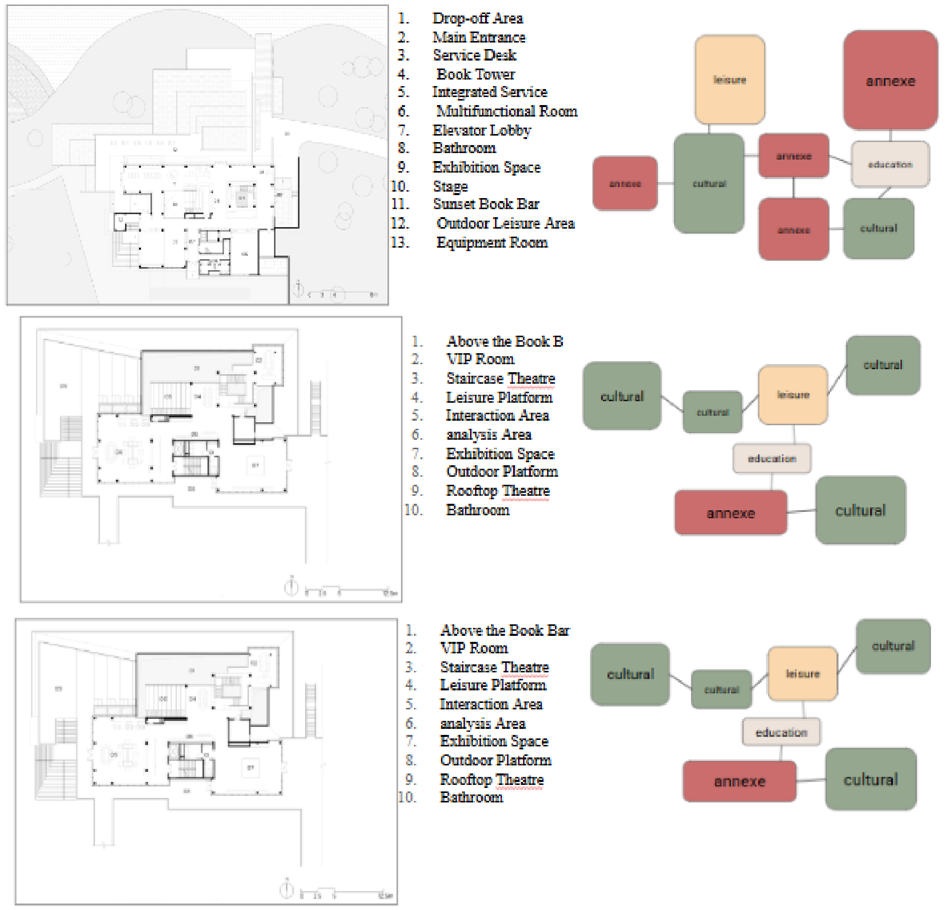


Figure A.1 : Spatial organization .source : authors

- **Space distribution**

- **Horizontal and vertical circulation**

Horizontal circulation: Open, interconnected spaces with wide corridors for easy movement between areas.

Vertical circulation: Staircases and ramps, with a central atrium linking different levels, allowing natural light and seamless flow.

Main Function	Space	Area (m²)	Furniture Needed	Lighting Needed
Cultural Function	Cultural and Creative Reading Area	245 m²	Reading tables, chairs, bookshelves	Soft ambient lighting, task lighting
	Plaza	2000 m²	Benches, seating areas, landscaping	Outdoor lighting, accent lights
	Exhibition Hall	200 - 430 m²	Display panels, seating for visitors	Adjustable track lighting, spotlights
	Multifunctional Hall	75 m²	Movable seating, stage equipment	Flexible lighting options
	Screening Room	95 m²	Projector screen, comfortable seating	Dimmed lighting for screenings
	Classroom	25–65m²	Desks, chairs, whiteboards	Overhead fluorescent lights
	Ramp Exhibition Hall	100m²	Display cases, seating	Natural light with adjustable fixtures
	Open Air/Overhead Space	110m²	Seating, art installations	Natural light
	Commercial Spaces	60 - 250 m²	Retail displays, counters	Bright display lighting
	Café	250m²	Tables, chairs, counter space	Warm ambient lighting
Educational Function	Education Lobby	110 m²	Informational displays, seating	General ambient lighting
	Mother and Baby Room	10 m²	Changing tables, seating	Soft lighting for comfort
Logistics and Support Function	Logistics Room	5 - 35 m²	Shelving units	Task lighting
	Preparation Room	16 m²	Worktables	Task lighting
	Storage Room	22 m²	Shelving units	Utility lighting
	Equipment Room	90m²	Storage racks for equipment	Utility lighting
Public Interaction Function	Elevated Entrance	120 m²	Reception desk, seating	Welcoming ambient lighting
	Lobby	245 m²	Seating areas, information displays	Soft ambient lighting
	Connecting Bridge	35m²	Benches	Natural light
	Terrace	250m²	Outdoor furniture	Outdoor ambient lighting
	Rooftop Walkway	170m²	enches	Ambient outdoor lighting
Maintenance and Utility Function	Cleaning Room	50m²	Storage for cleaning supplies	Utility lighting

➢ Programme

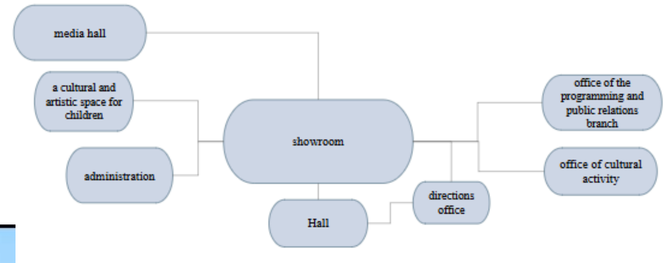
Main Function	Space	Area (m²)	Equipment and materials	Area for equipment (m²)	Circulation area (m²)	Area per person(m²)	Capacity (per)
Cultural Function	Cultural and Creative Reading Area	245	Bookshelves, seating, lighting, reading tables	20	30	4.5	50 - 60
	Plaza	2000	Outdoor seating, landscaping, fountains	200	300	5	1000
	Exhibition Hall	300 - 450	Display panels, lighting, pedestals, seating	40	50	1.5	200 - 300
	Ramp Exhibition Hall	100	Display panels, lighting	15	20	4	50 - 70
	Screening Room	95	Projector, screen, seating, acoustics	10	15	2.5	50 - 60
	art studios	25 - 65	Desks, chairs, blackboard, projector	5	5	1.5	20 - 40
	Stage	21	Lighting, sound equipment, backdrops	5	5		50
	Viewing Box	15	Seating, safety rails	5	3	1.5	10 - 15
	modern Exhibition Space	60 - 66	Display panels, lighting	5	10	3	30 - 40
	Multifunctional Hall	75	Stage, seating, lighting	15	20	2.5	50 - 100
	conference hall	300	Chairs, tables, projector, LED screens, sound system, microphones, lighting with dimmers, acoustic panels	45-60	90–120	3	100-120
Social/ Leisure Function	Sunset Book Bar	36	Shelves, tables, chairs, lighting	5	5	3	20
	Outdoor Leisure Area	63	Seating, planters, shading structures	10	15	1.5	80 - 100
	Rooftop Theatre	63	Seats, lighting, sound equipment, screen	10	10	2.5	50
	Outdoor Platform	15	Chairs, tables, planters	3	3	1.5	10
	Leisure Platform	12	Seating, planters, shading elements	2	3	1.2	10
	VIP Room	12	Sofas, chairs, lighting, tables	2	3	1.5	8
	Café	250	Tables, chairs, kitchen equipment	40	30	2.5	80 - 100
Commercial Function	gallery	60 - 250	Shelving, counters, product displays	10	15	3	30 - 50
Logistics and Support	Logistics Room	5 - 35	Storage shelves, bins, carts	2	5	2	5
	Preparation Room	16	Kitchen equipment, counters, shelves	3	5	1.5	10
	Storage Room	22	Shelving units, storage bins	5	5	3	5
	Equipment Room	90	Large equipment storage (e.g., AV, tools)	15	15	5	20
Maintenance and Utility	Cleaning Room	50	Cleaning supplies, shelving, equipment	5	5		2

➜ project infos

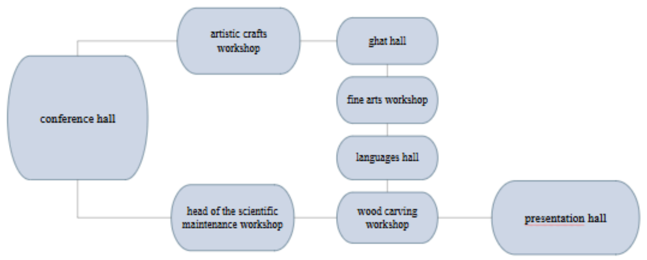
Location: Cité M'Sallah, Médéa, Algeria, 26000

Building Type: house of Cultural

Area: 7416 m²



level 0



level -1

Main Function	Space	Area (m²)	Equipment and materials	Area for equipment	Circulation area	Area per person	Capacity
Educational Function	Education Lobby	110	Seating, information desk, brochures	20	15	2.5	40 - 50
	Mother and Baby Room	10	Changing table, seating, baby care items	3	2	2.5	4
	Multifunctional Room	30 - 35	Changing table, seating, baby care items	3	2	2.5	4
	Book Tower	15 - 20	Shelves, books, seating	5	3	1.5	10
	Interaction Area	35	Interactive displays, seating, tables	10	5	2.5	20 - 30
	Analysis Area	15	Desks, computers, chairs, shelves	3	3	1.5	10
	Information Room/Data Room	9	Computers, storage for information	2	2	1.5	5
	classrooms	15-20					
Public Interaction Function	Lobby	245	Seating, information desk, display areas	40	40	2.5	100
	Terrace	250	Seating, planters, lighting	30	50	2.5	150
	Rooftop Walkway	170	Railings, benches, lighting	20	30	3.5	50
	Main Entrance	30	Signage, lighting, seating	5	5	2.5	20
	Drop-off Area	24	Signage, seating, planters	5	5	3	4
	Service Desk	15	Desk, computers, informational materials	3	5	3	4
	integrated Service	15	Desk, informational materials	3	5	3	4
	Elevator Lobby	9	Elevator buttons, seating, signage	2	2	2.5	4

- **Survery**

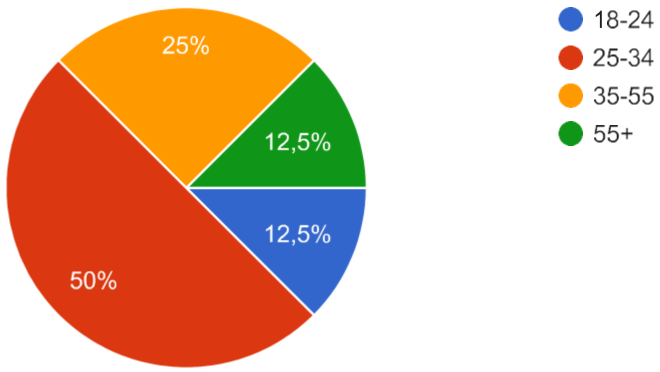
استبيان حول حياة المدينة لسكان مليانة

8 réponses

Publier les données analytiques

الفئة العمرية (يرجى تحديد واحدة)

8 réponses



الوظيفة (اختياري):

4 réponses

طالبة

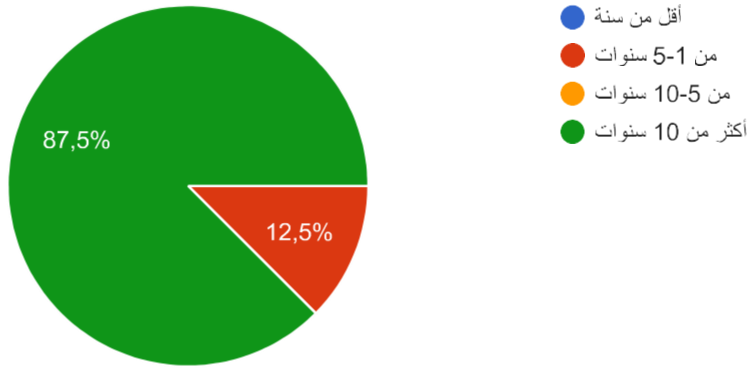
موظف

ممرض

Retraitée

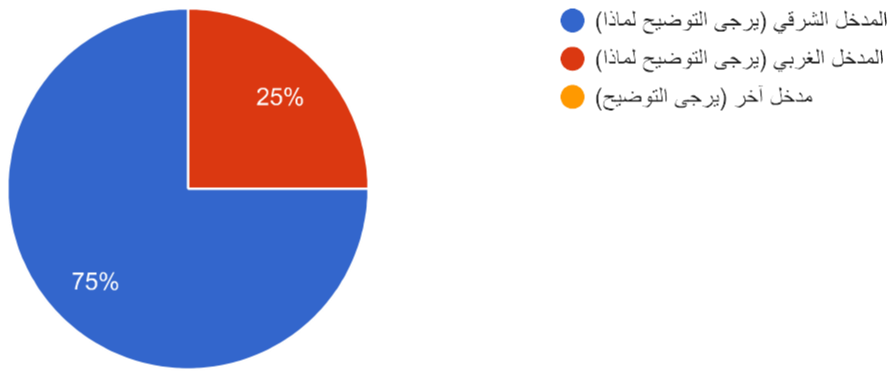
منذ متى وأنت تعيش في مليانة؟

8 réponses



أي مدخل لمدينة مليانة تستخدمه غالبًا؟

8 réponses



مدخل آخر (يرجى التوضيح)

3 réponses

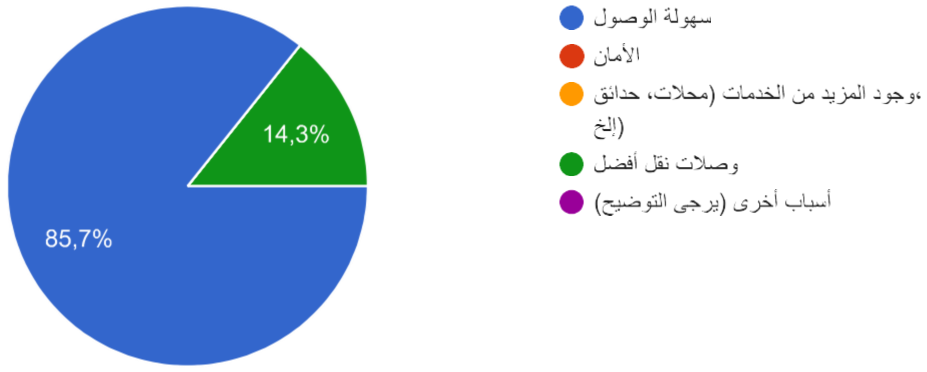
اسرع

البليدة و الجزائر

الطريق معبدة بشكل افضل

إذا كنت تفضل المدخل الشرقي، فما الأسباب الرئيسية لذلك؟ (اختر كل ما ينطبق)

7 réponses



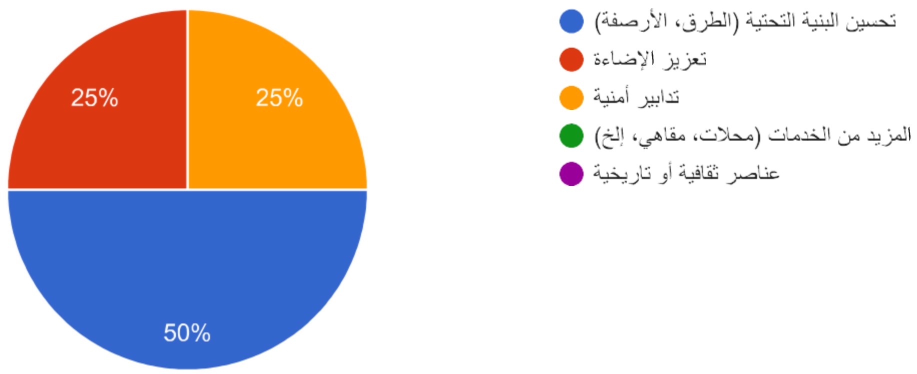
أسباب أخرى (يرجى التوضيح)

0 réponse

Il n'y a actuellement aucune réponse à cette question.

في رأيك، ما الذي ينقص أو يمكن تحسينه في المدخل الغربي؟

8 réponses



إذا كنت ستقترح مشروعًا أو مرفقًا جديدًا في المدخل الغربي، ما نوع المشروع الذي تقترحه ولماذا؟

8 réponses

وسائل النقل

ملاعب و مرافق ترفيه

عناصر ثقافية

متاجر كبرى لعدم وجودها في الولاية بصفة عامة

توسيع الطرقات

الاستعان بمهندسين مؤهلين

بناء مركز شرطة و تعزيز الانارة

توسيع في طريق

ما هي المناطق التي تجدها أكثر جاذبية في مليانة، ولماذا؟

6 réponses

الحديقة العمومية لانها كثيفة بالأشجار

لا يوجد

السور الروماني

زكار وصور

وسط المدينة

سور مليانة الروماني، لوجود العديد من المناظر الجميلة

يرجى مشاركة أي أفكار أو اقتراحات إضافية حول الحياة الحضرية في مليانة

3 réponses

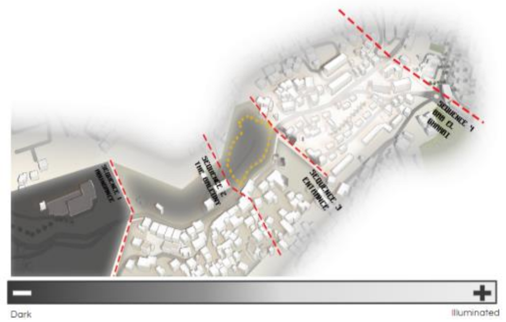
ينقصها المرافق الصحية الخاصة بشدة

إنعدام مرافق حياة عصريك

بناء مرافق الترفيه (مدينة ملاهي، salon de thé، مركز تجاري كبير)
بناء مستشفى آخر

2. Sequential Analysis

➢ Ambience (Lighting)



- **Morning:**

In the morning, the lighting is pleasant across all sequences, with no shadow effects due to the topography.

Sequence 1: At night, it becomes very dark, lacking public lighting, which makes it feel more abandoned

Sequence 2: In this sequence, the upper side of the road remains dark at night. The lighting from the houses in the residential area helps illuminate the road, but the welcoming atmosphere is diminished by the darkness of the empty plot on the opposite side.

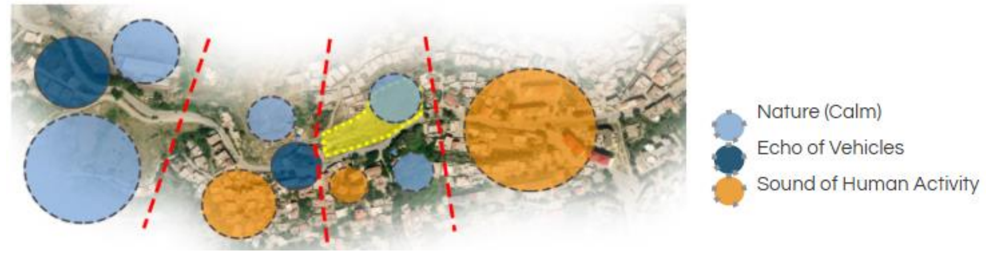
Sequence 3: At night, the situation is similar to the first sequence, with the area remaining partially lit by the upper Korkah neighborhood, providing limited lighting from this elevated zone.

Sequence 4: At night, the vibrant urban life and the lighting of ground-floor shops create a welcoming and well-lit atmosphere, enhancing the lively, convivial character of this key urban node.

➢ mobility

From the first to the third sequence, there are no sidewalks, making these areas dangerous for pedestrians. Only paved pathways exist, which limits pedestrian safety and their access to these spaces. Sidewalks only begin from the fourth sequence.

➢ Acoustics



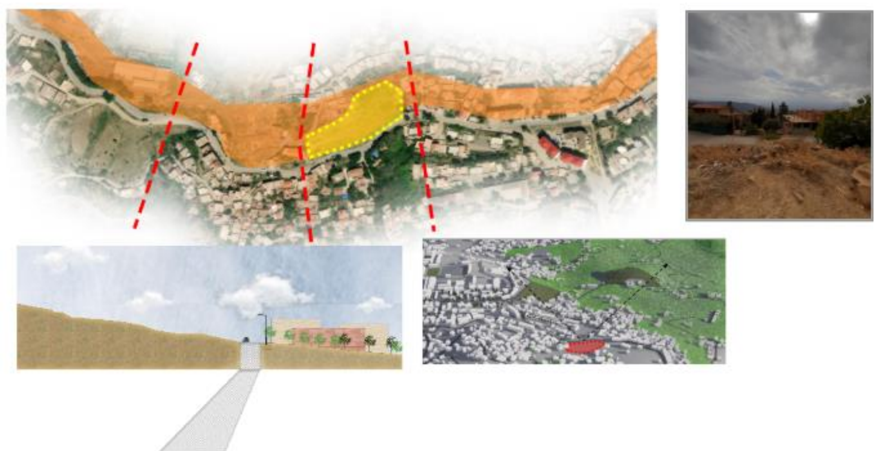
In the first sequence, the environment is very quiet, allowing the surrounding nature to be heard. However, due to the abandoned factory, one can also hear the echo of vehicles entering the city. As we move into sequences 2 and 3, the sound of human activity begins to be heard, and in the final sequence, the atmosphere becomes more vibrant, with a noticeable increase in urban activity and life.

➢ Ambience (Security)

$$\text{Average Flow}=\frac{25\ \text{vehicles}}{\frac{1}{12}\mathit{HOURS}}=300\ \text{vehicles per hour}$$

The neighborhood is accessible via the main road of the city, allowing for easy access by vehicle. However, pedestrian access is limited: the only bus stop is located starting from the fourth sequence, and the path leading to this stop is not very safe. On the other hand, vehicular traffic flows smoothly, and there is no congestion.

➢ Visual Field



Due to the slope topography, the neighborhood is crossed by a road that creates a "balcony effect." When standing on the upper side of the road, one enjoys a clear view of the entire city, extending all the way to the Khemis Valley. This positive visual aspect is valuable as it enhances the sense of belonging and connection to the surrounding landscape.

3. Climate analysis

- Location: Miliana
- Latitude: 36°18'10" North
- Longitude: 2°13'35" East

- **Air Temperature (°C):**

T°C	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	High	Amt Annual Average
Max	11.95	12.27	16.15	20.56	24.36	29.89	34.00	34.95	28.34	24.73	16.55	13.59	34.95	19.91
min	5.62	4.87	7.50	10.33	12.89	18.93	21.16	21.41	17.34	13.77	8.48	6.93	4.87	30.08
Avg T°	8.78	8.57	11.82	15.44	18.62	24.41	27.58	28.18	22.84	20.75	12.51	10.26	low	TAR, temperature range

- **Relative Humidity:**

Group 1: RH below 30%
Group 2: RH between 30% and 50%
Group 3: RH between 50% and 70%
Group 4: RH above 70%

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Average
Average Humidity (%)	80.44	80.62	73.44	68.98	65.47	52.35	48.33	48.17	55.23	64.94	75.63	75.01	65.71
Humidity Group	4	4	4	3	3	3	2	2	3	3	4	4	3

- **precipitation and winds:**

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Annual Average
Average Precipitation (mm)	86	117	72	55	46	8	4	11	22	53	88	96	660
Dominant Winds	SW	S/W	S	S	S	S	SE	S	S	S	SW	SW	
Secondary Winds	S/W	N	N/E	N/E	N/O	S/W	S/W	N/E	S/E	E	N/W	S/W	

Im=P/T+10
P : Précipitation annuelle
T: Température moyenne.

Im=660/(19.91+10)

Im= 22.07

Valeur de l'indice	Type de climat
0 < IDM < 5	Hyper aride
5 < IDM < 10	Aride
10 < IDM < 20	Semi-aride
20 < IDM < 30	Sub-humide
30 < IDM < 55	Humide

Indicators	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Average Monthly Maximum (°C)	11.95	12.27	16.15	20.56	24.36	29.86	34.00	34.95	28.34	27.73	16.55	13.59
TCJ max (°C)	25	25	24	28	28	28	30	30	28	28	28	28
TCJ min (°C)	20	20	20	21	21	21	22	22	21	21	20	20
Average Monthly Minimum(°C)	5.62	4.87	7.50	10.33	12.89	18.93	21.16	21.41	17.34	13.77	8.48	6.93
TCJ max (°C)	20	20	20	21	21	21	22	22	21	21	20	20
TCJ min (°C)	14	14	14	14	14	14	14	14	14	14	14	14
Day (°C)	F	F	F	F	/	C	C	C	C	/	F	F
Night (°C)	F	F	F	F	F	/	/	/	/	F	F	F
Humidity Group	4	4	4	3	3	3	2	2	3	3	4	4

AMT=temp annuelle moyenne TAM =19.91

Comfort limits		AMT over 20 °C Day	AMT over 20 °C Night	AMT 15-20 °C Day	AMT 15-20 °C Night	AMT below 15 °C Day	AMT below 15 °C Night
Humidity groups	1	26-34	17-25	23-32	14-23	21-30	12-21
	2	25-31	17-24	22-30	14-22	20-27	12-20
	3	23-29	17-23	21-28	14-21	19-26	12-19
	4	22-27	17-21	20-25	14-20	18-24	12-18

- **Indicators:**

	J	F	M	A	M	J	J	A	S	O	N	D	total
H1 Essential Ventilation													0
H2 Desirable Ventilation													0
H3 Rain Protection													0
A1 Thermal Inertia					X	X	X	X	X	X			6
A2 Sleeping Outdoors						X	X	X	X				4
A3 Cold Season Issues	X	X	X	X	X					X	X	X	8

	Stress Thermique	G.H.	EDT	Pluie
H1	C.diurne	4		
	C.diurne	2 - 3	-10°	
H2	/. diurne	4		
H3				+200
A1		1- 2- 3	+10°	
A2	C.nocturne	1- 2		
	C.diurne C.nocturne	1- 2	+10°	
A3	F.diurne F.nocturne			

→ Recommandation:

H1	H2	H3	A1	A2	A3	
0	0	0	6	4	8	
			0-10			Building oriented along an east-west longitudinal axis to reduce sun exposure
			11 ou 12		5-12	Compact plan with interior courtyards
					0-4	

- Spacing between buildings:

H1	H2	H3	A1	A2	A3	
0	0	0	6	4	8	
11 ou 12						Large spacings to promote wind penetration
2-10						As above, but with protection against hot/cold winds
0 ou 1						Compact plans

- **Position of openings :**

H1	H2	H3	A1	A2	A3	
0	0	0	6	4	8	
3 -12						Openings in the north and south walls, at human height on the wind-exposed side.
1 ou 2	2 -12		0- 5			
			6-12			As above, but including openings made in the interior walls.
0	0 ou 1					

- **Air circulation :**

H1	H2	H3	A1	A2	A3	
0	0	0	6	4	8	
3 ou 12						Building with single orientation. Layout allowing for continuous air circulation.
			0-5			
			6-12			Building with double orientation allowing for intermittent air circulation.
0	0 ou 1					Unnecessary air circulation.

- **Dimensions of openings:**

H1	H2	H3	A1	A2	A3	
0	0	0	6	4	8	
			0 ou 1		0	Large 40 to 80% of the north and south facades.
					1-12	Medium 25 to 40% of the wall surface.
			2- 5			
			6-10			Intermediate 20 to 35% of the wall surface.
			11ou 12		0-3	Small 15 to 25% of the wall surface.
					4-12	Medium 25 to 40% of the wall surface.

- **Protection of openings:**

H1	H2	H3	A1	A2	A3	
0	0	0	6	4	8	
					0-2	Protect from direct sunlight.
			2-12			Provide protection against rain.

- **Walls and floors:**

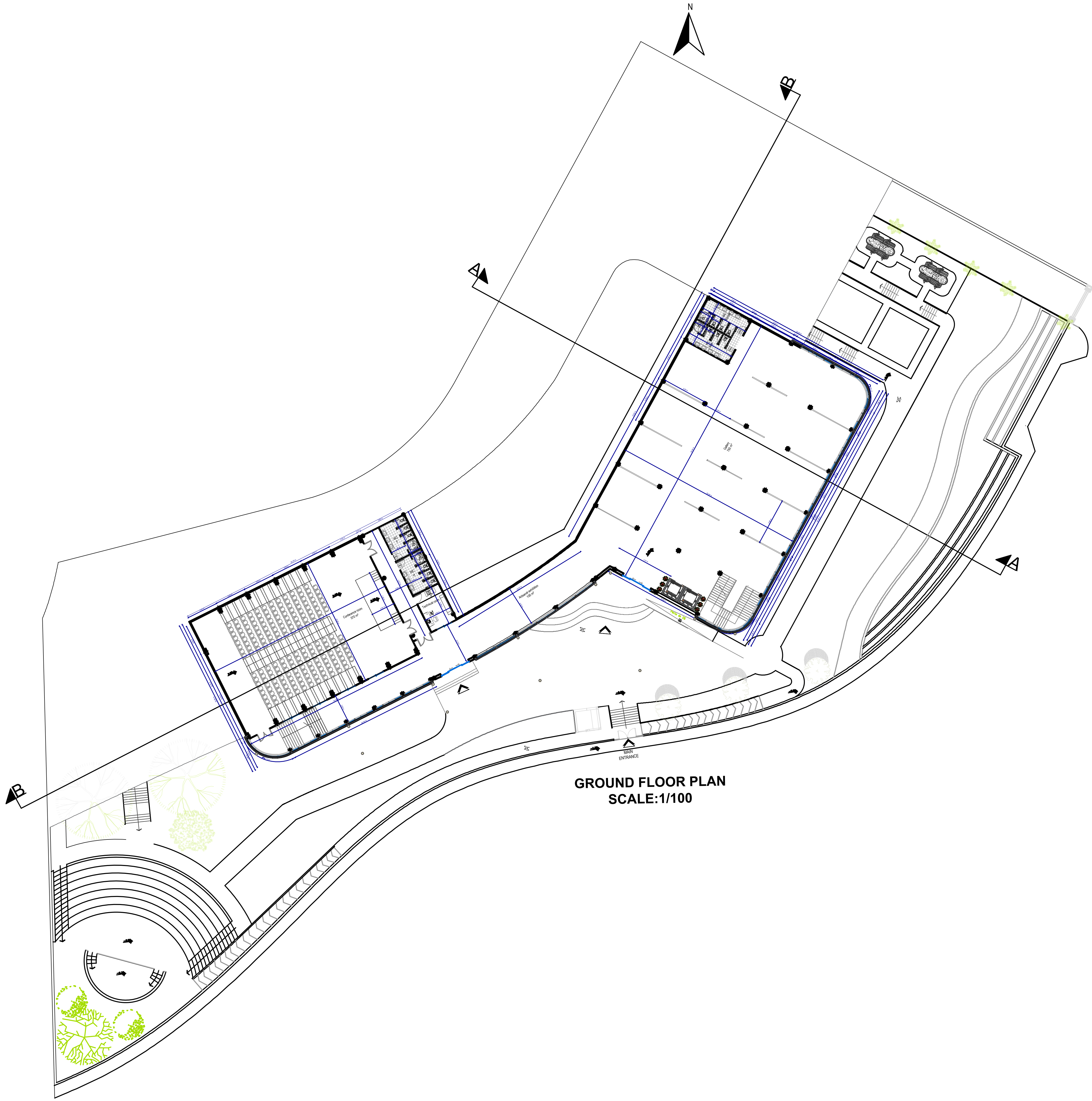
H1	H2	H3	A1	A2	A3	
0	0	0	6	4	8	
			0-2			Light constructions, low thermal inertia.
			3- 12			Massive constructions, time lag greater than 8 hours.

- **Roof:**

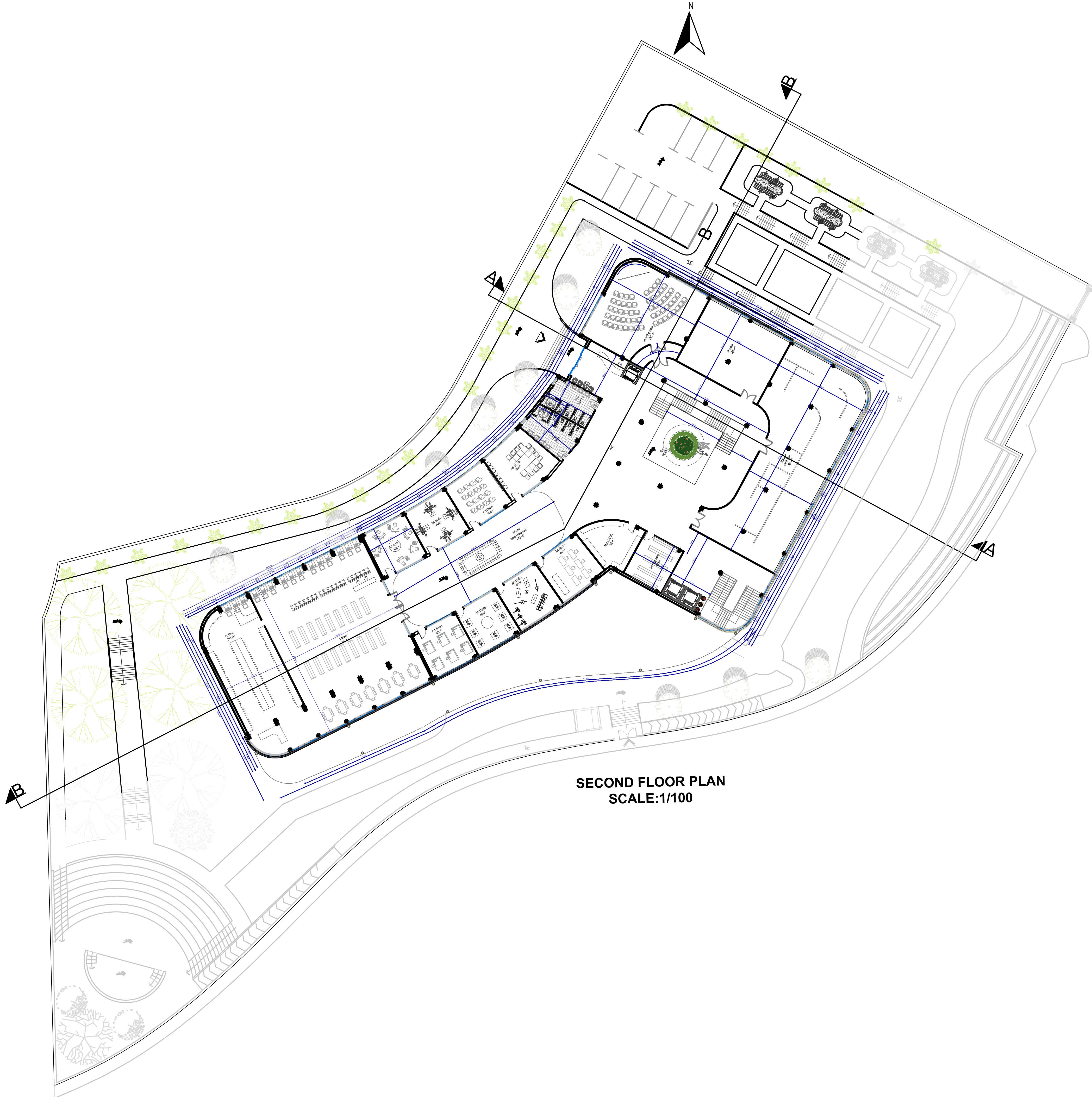
H1	H2	H3	A1	A2	A3	
0	0	0	6	4	8	
10-12			0-2			Light constructions, reflective roofing and air gap.
			3- 12			Light and well-insulated.
0- 9			0-5			
			6-12			Massive constructions, time lag greater than 8 hours.

→ **Summary of the Mahoney table**

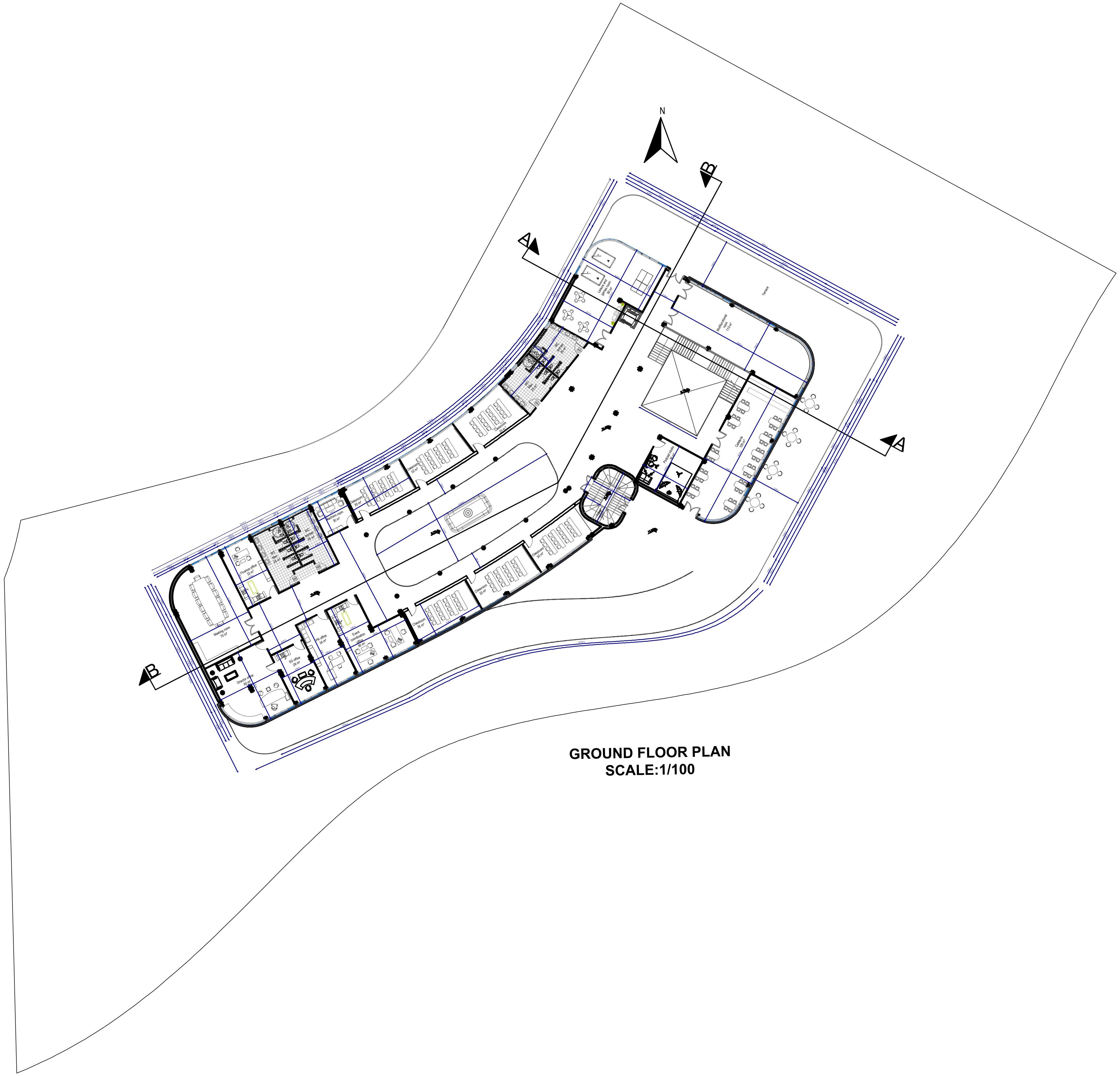
- Spacing between buildings → Compact plans
- Position of openings → Openings in the north and south walls, at human height on the wind-exposed side. but including openings made in the interior walls.
- Air circulation → Building with double orientation allowing for intermittent air circulation.
- Dimensions of openings → Intermediate 20 to 35% of the wall surface.
- Protection of openings → Provide protection against rain.
- Walls and floors → Massive constructions, time lag greater than 8 hours.
- Roof → Massive constructions, time lag greater than 8 hours.



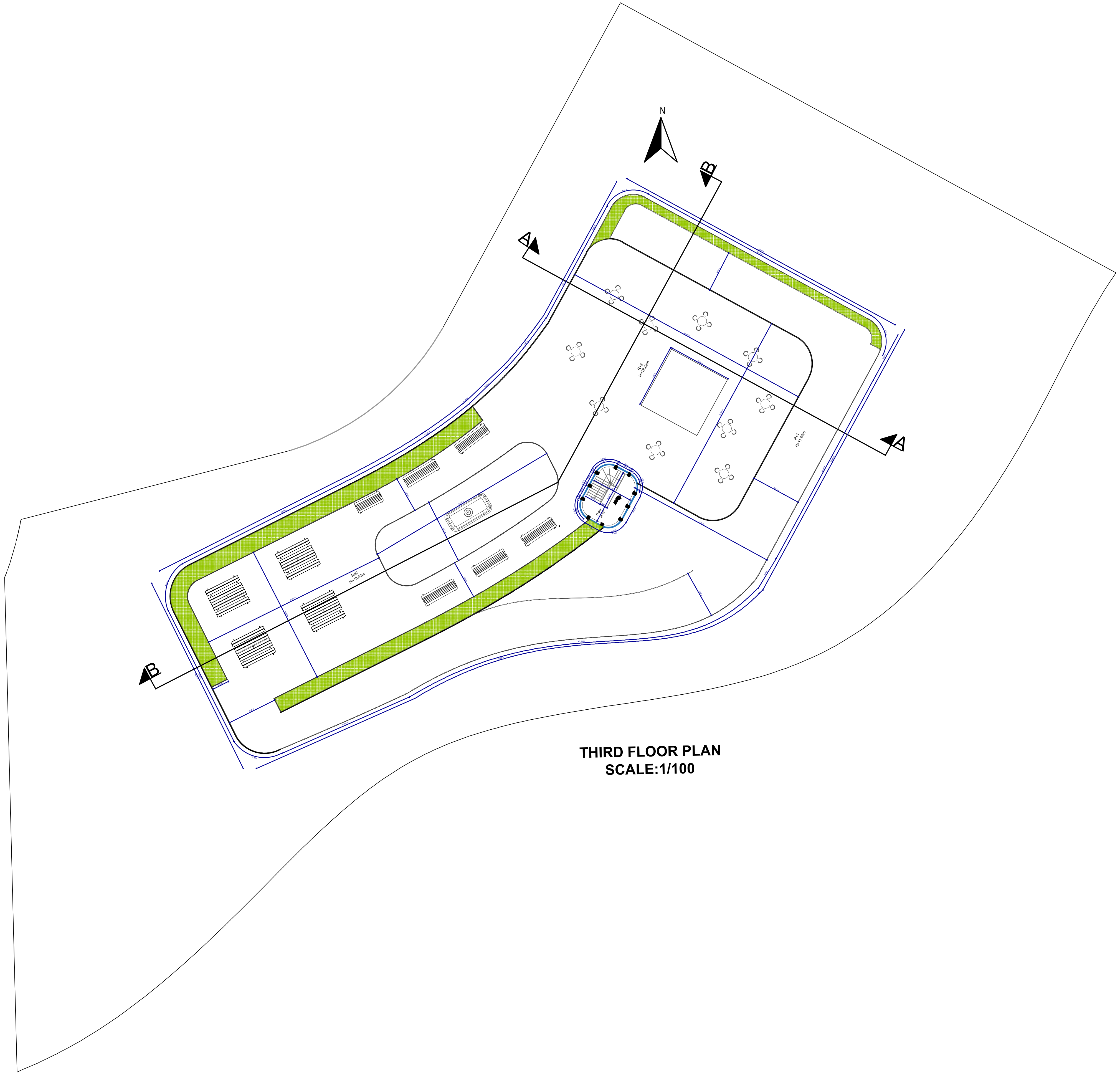
GROUND FLOOR PLAN
SCALE:1/100



SECOND FLOOR PLAN
SCALE:1/100

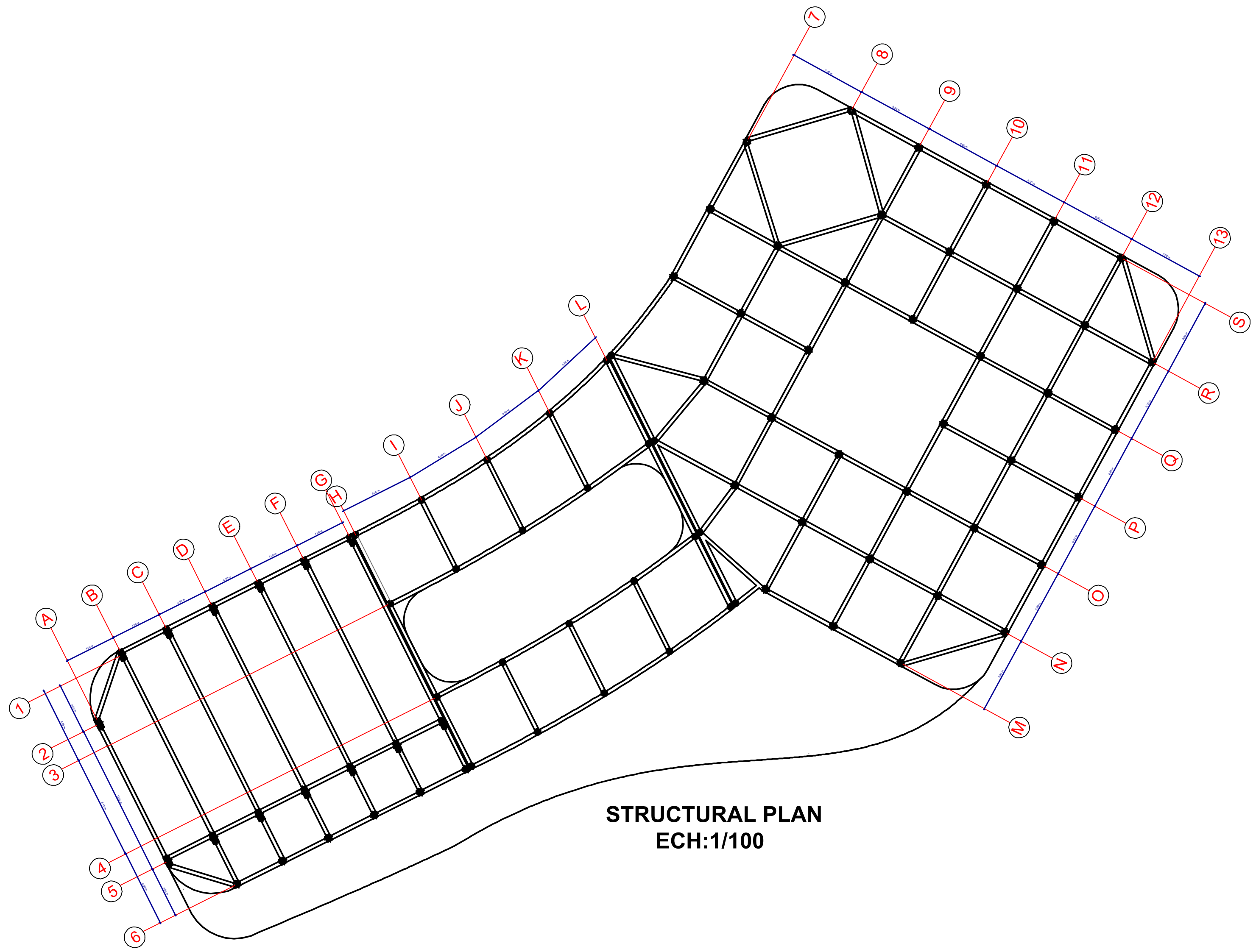


GROUND FLOOR PLAN
SCALE:1/100

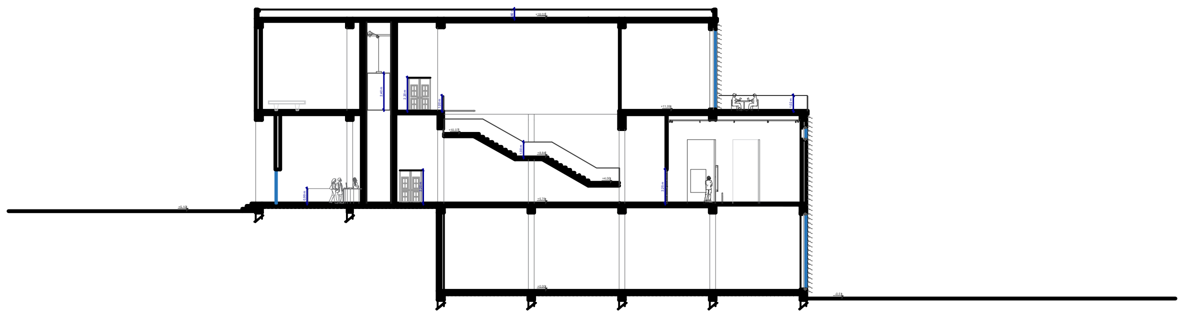


THIRD FLOOR PLAN
SCALE:1/100

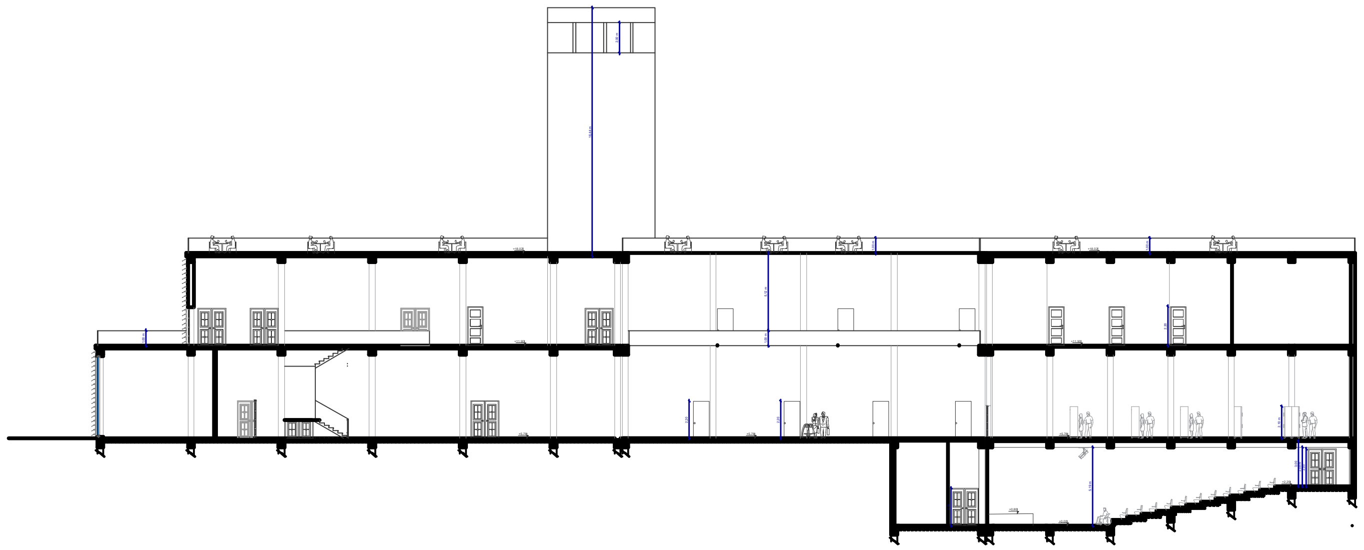
R+2
R+1
R+2
RDC
R+1
RDC
R+1
R+1
R+2
R+1
R+1
RDC
R+1
R+1
R+1
R+2
R+2
R+2
R+1
R+1
R+1



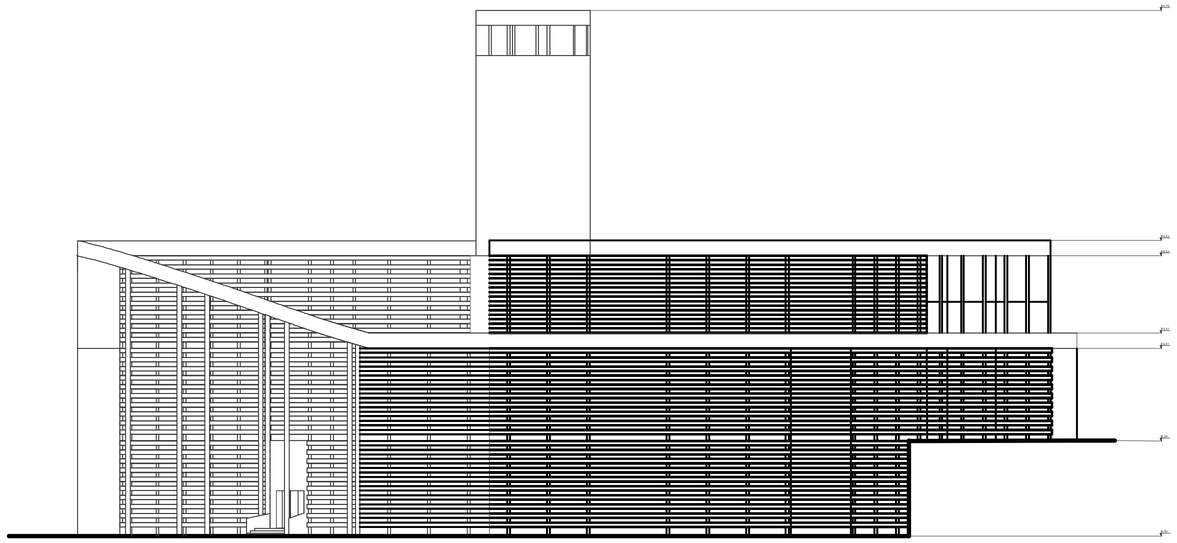
STRUCTURAL PLAN
ECH:1/100



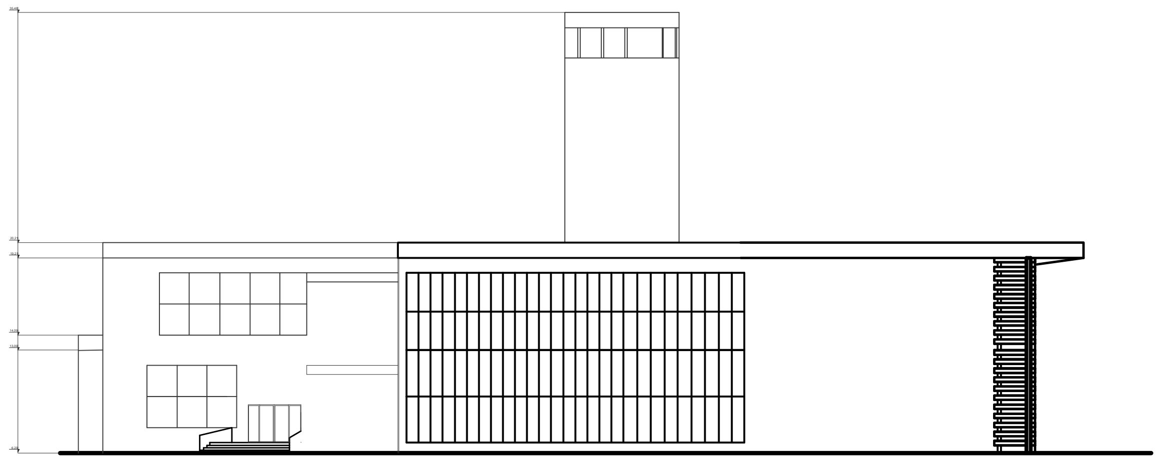
SCTION A-A SCALE:1/100



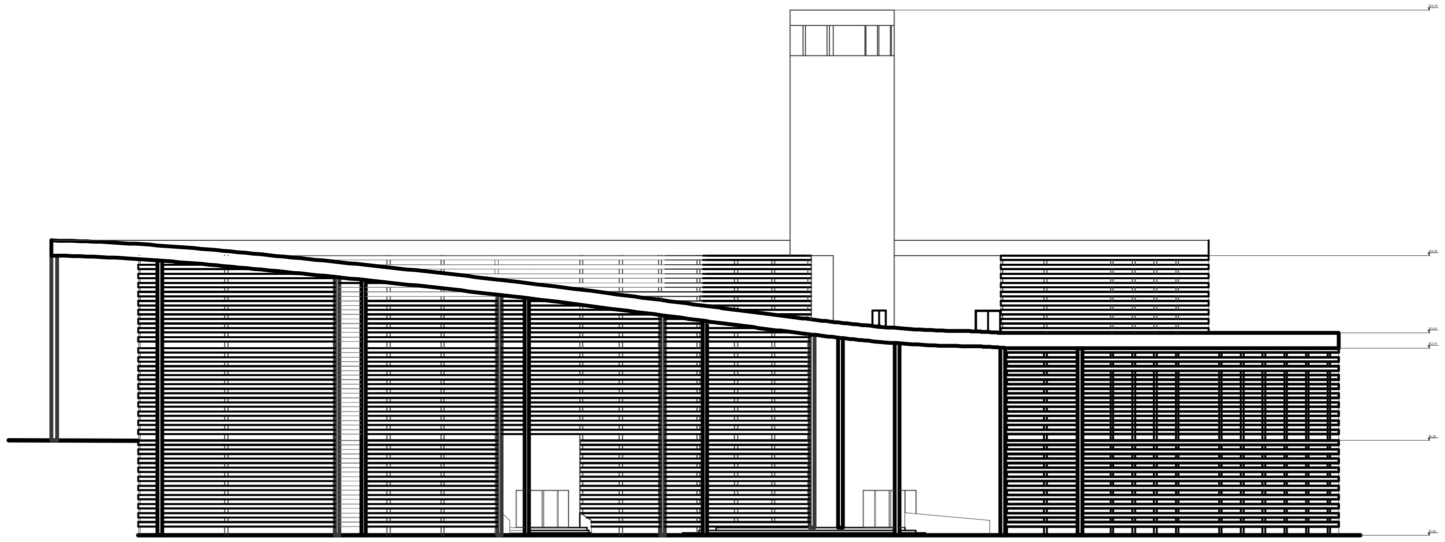
BROKEN PLANE SECTION B-B SCALE:1/100



EASTERN ELEVATION
SCALE:1/100



WESTERN ELEVATION
SCALE:1/100



MAIN ELEVATION
SCALE:1/100