PEOPLES DEMOCRATIC REPUBLIC OF ALGERIA
MINISTRY OF HIGHER EDUCATION AND SCIENTIFIC RESEARCH
BLIDA-01 UNIVERSITY
INSTITUTE OF ARCHITECTURE AND URBANISM
Department of Architecture

Master thesis in Architecture.

Workshop theme: Urban Architecture/ OVAMUS Laboratory

Compactness as a Principle of Urban and Architectural Design and Sustainability

F.C.P : Eco-district of Hadjeret Ennous

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Academic year : 2024/2025

Acknowledgements:

First and foremost, we offer our deepest gratitude and praise to Allah, the Almighty the source of strength, wisdom, and patience. It is by His will that we were able to move forward, overcome challenges, and complete this project with perseverance and hope.

This work would not have been possible without the unconditional love, presence, and unwavering support of our parents. To you, who have believed in us from the very beginning, encouraged us in moments of doubt, and carried our dreams as if they were your own — thank you from the bottom of our hearts. Your trust gave us strength, and your love was our greatest comfort.

We are deeply grateful to those who guided us throughout this academic journey:

Pr. BENHAMOUCHE Mustapha, **Dr. CHETTAH Saif Eddine**, **Ms. HALAIMIA Anfel**, and **Mr. TELEMSANI Karima** thank you for your valuable guidance, your patience, your insightful advice, and your constant support. Your presence gave structure and meaning to our work. You challenged us, inspired us, and helped us grow both intellectually and personally.

A special thank you to the jury members **Dr. LAHLOU Siham** and **Dr. BOUZINA Adlan** for taking the time to evaluate our work, and for the attention, feedback, and insights you shared with us. Your presence on this important day means a great deal to us.

Our sincere appreciation also goes to all the faculty members of the Institute of Architecture and Urbanism at the University of Blida. Each one of you has played a role in shaping our education and our vision as future architects. Your dedication and passion have left a lasting mark.

Finally, to everyone who supported us along the way with a kind word, a helping hand, or simply their belief in us thank you.

This project is the fruit of a journey filled with learning, growth, and human connection. And if there's one thing this experience has taught us, it's that success is never achieved alone it's built together, with patience, with resilience, and most of all, with heart.

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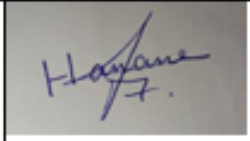
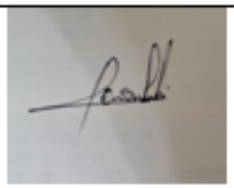
Signature Signature	 

Dedication

First and foremost, I would like to thank Allah, the source of all wisdom and strength. Without His will, none of this would have been possible.

I want to begin by expressing my deepest gratitude to my parents—the pillars of my journey.

To my father, who has always been my strength. You supported me through every step, believed in me even when I doubted myself. I am incredibly lucky to have you in my life. Through your sacrifices, your seriousness, and your strong sense of responsibility, you've shown me what it means to lead by example.

To my wonderful mother, the one who gave me everything, expecting nothing in return. You are my softness, my safe place, my silent strength. No words will ever be enough to do you justice. Without your presence, your love, and your constant support, I would never have come this far. Because of you… I am here today. Thank you, from the bottom of my heart.

To my brothers, Amine and Youcef—I've always looked up to you. I grew up wanting to be like you. Thank you for your unwavering support. I never felt alone—you've always been there, like a shield.Amine, you always used to tell me:Incha'Allah t3awdi annes."Well, today I can finally answer: ma3awedtch el 3am… w rani hna lyoum hh.

To Affaf, my sister, my second mother… Your heart is so big. You've always supported me with such incredible tenderness. I'll never forget that moment in my first year, when I wanted to quit everything, and you looked at me and said: "No, you can do it. I believe in you." You are truly one of a kind.

To Hanane, my sister-in-law, but above all, my sister at heart. The distance may be short, butyour impact is great. Thank you for being there, for your genuine support and your beautifulenergy.

To my project partner, Hanane—on the first day, I was scared. Scared of what these five years would be like… But Allah placed a golden soul in my path. You're not just a teammate, you've become a friend, a sister. I'm so proud we shared this journey together.

To all my friends—those who walked beside me during these five years—thank you for every moment, every laugh, every stressful night. You made this road brighter.

And finally… to myself. Yes, I am proud of me. Proud for holding on, for pushing through despite the doubts and the hard times.

Alhamdulillah… I'm here today. And I am truly grateful.

FERROUKHI Khadidja,

Dedication

Alhamdulillah Today, I stand before the result of many years filled with effort, tears, doubts, and inner battles but also love, support, and small silent victories.

This thesis is not just a project. It's a piece of me, and of all the people who walked this path with me.

To my father, You spent your life facing the desert, far from us, so we could dream of a better future. Every word of this thesis carries a part of your sacrifice. You don't speak much, but your silence is full of love and strength. Thank you for everything, Papa.

To my mother, My queen, my strength, my safe place. You carried me when I had no energy left, you prayed for me when I couldn't speak. You were a mother, a father, a rock. I can never repay what you've given me, but I promise to keep making you proud.

To my brothers, Hicham, who for five years was my driver, my protector, my anchor. Even tired, even quiet,you were there. **Djamel,** with your teasing: "do you ever stop studying?" but always supporting me in yourown way. Thank you for believing in me.

To my sisters-in-law, Bouchra and **Hanaa,** Thank you for always being there, Your presence has meant so much.

my angels Timo and Dania,your love and smiles gave me strength when I needed it most.

To my cousin Maram, We faced this year side by side through sleepless nights and shared tears. You're more than a cousin, you're my soul sister. May Allah ease your path and grant you all the success you deserve.

To my aunt Akila and her husband Madani, Your gift a PC given with pure kindness helped me keep going when I needed it most. May Allah reward you deeply.

My friends,Thank you for every moment, every smile. Even from afar, you were close to myheart.

Khadidja, my partner, my architectural soul sister the one destiny brought back to me. We were friends in primary school, then life took us in different paths. But we did Bac exam in the same room. We reconnected on the very last day, not knowing it was the beginning of something even deeper. You're the sister my mother didn't give me, but life did.

And finally, Thank you **to myself**. To the girl I was, and the woman I've become. Thank you for holding on through the exhaustion, the doubt, the silent tears. For standing back up every single time. I'm proud of you.

This thesis holds a piece of my heart. And in that heart, there's all of you.

KHALI Hanane

Abstract

The coastal town of Hadjret Ennous, located in Tipaza, Algeria, is undergoing rapid urbanization that threatens its fragile ecosystems, historical heritage, and valuable agricultural lands 46% of which are at risk of urban conversion. Despite its exceptional landscape potential, nestled between the sea and mountainous terrain, the town faces deep structural imbalances: a spatial disconnect between the historic center and new urban peripheries, insufficient tourism infrastructure, poor mobility, and increasing land pressure.

This local situation reflects a broader national challenge, as 37% of Algeria's population is concentrated on just 1.9% of its coastal territory, intensifying environmental stress. Addressing these issues, the thesis proposes a bioclimatic eco-district based on a multiscale territorial diagnosis (using GIS, citizen surveys, and diachronic analysis from 1962 to 2024), as well as adapted international urban models from the Mediterranean context.

Covering 39.8 hectares, the project is built around four strategic pillars: controlled densification using local stone and stabilized earth materials, sustainable mobility through an electric BRT system and pedestrian/cycling networks, ecological corridors preserving the coastal strip with urban agriculture, and regenerative architecture including a solar-powered market, water reuse systems, and a bioclimatic thalassotherapy center. This innovative model cuts building energy use by 63%, nearly doubles green space per inhabitant, prevents the artificialization of farmland, and reduces car dependency by 31%.

It offers a replicable solution for other coastal towns in Algeria (such as Aïn Tagourait, Stidia, and Azzefoun), embodying national strategies like SNAT 2030 and ICZM 2020–2030, and turning environmental constraints into drivers of shared territorial resilience.

Keywords : Compactness, Sustainable urban development, Eco-district.

Résumé

La commune de Hadjret Ennous, située sur la côte algérienne dans la wilaya de Tipaza, fait face à une urbanisation rapide qui menace à la fois ses écosystèmes fragiles, son riche patrimoine historique et ses terres agricoles, dont près de la moitié risquent d'être urbanisées. Malgré un cadre naturel exceptionnel, entre mer et montagnes, la ville souffre de déséquilibres structurels profonds : rupture entre le noyau historique et les extensions urbaines récentes, infrastructures touristiques insuffisantes, mobilité défaillante et pression foncière croissante.

S'inscrivant dans le contexte plus large de la littoralisation du pays – où 37 % de la population vit sur moins de 2 % du territoire côtier –, cette situation appelle une réponse territoriale innovante et durable. À travers une approche méthodologique mêlant diagnostic territorial multiscalaire (SIG, enquêtes citoyennes, analyse diachronique) et références méditerranéennes adaptées, le mémoire propose un éco-quartier bioclimatique de 39,8 hectares fondé sur les principes de la ville compacte, de l'éco-quartier et de l'urbanisme régénératif.

Le projet s'organise autour de quatre axes : densification maîtrisée avec des matériaux locaux, mobilité douce grâce à un BHNS électrique et un maillage piéton/cyclable, corridors éco-écologiques sur le littoral, et infrastructures régénératives à énergie positive.

Ce modèle innovant réduit la consommation énergétique de 63 %, double presque la surface d'espaces verts par habitant, limite drastiquement l'artificialisation des sols agricoles et pourrait être reproduit dans d'autres communes côtières, contribuant ainsi à une résilience territoriale partagée et durable.

Mots-clés : Compacité, développement urbain durable, éco-quartier.

ملخّص

تعاني بلدية حجرة النوس الساحلية، الواقعة بولاية تيبازة، من وتيرة عمرانية متسارعة تهدد نظمها البيئية الهشة، تراثها التاريخي، وأراضيها الزراعية الخصبة، حيث أن 46% منها مهددة بالتحول العمراني. ورغم تمتعها بموقع طبيعي فريد يجمع بين البحر والسلسلة الجبلية، تواجه المدينة اختلالات هيكلية عميقة، أبرزها الانفصال المجالي بين النواة القديمة والامتدادات الحديثة، ضعف في البنية التحتية السياحية، إشكاليات في التنقل، وضغط عمراني متزايد.

وتعكس هذه الوضعية تحدياً وطنياً أكبر، حيث يتركز 37% من سكان الجزائر على 1.9% فقط من الشريط الساحلي، مما يزيد من الضغط البيئي. في هذا السياق، يقترح هذا البحث إنشاء حي إيكولوجي مناخي على مساحة 39.8 هكتار، انطلاقاً من تشخيص ترابي متعدد المقاييس (باستخدام نظم المعلومات الجغرافية، واستبيانات المواطنين، وتحليل زمني من 1962 إلى 2024)، مستلهماً من نماذج عمرانية متوسطية ناجحة.

يرتكز المشروع على أربعة محاور: تكثيف عمراني مضبوط باستعمال الحجر المحلي والتراب المعالج، تنقل مستدام عبر حافلات كهربائية عالية الخدمة وشبكات للمشاة والدراجات، ممرات بيئية زراعية على الشريط الساحلي، وعمارة متجددة تشمل سوقاً مغطاة بطاقة إيجابية، نظم إعادة استعمال المياه الرمادية، ومركز علاج بمياه البحر بتصميم مناخي.

يساهم هذا النموذج في تقليص استهلاك الطاقة بـ63%، ويزيد المساحات الخضراء للفرد بـ107%، ويمنع التمدد العمراني على الأراضي الزراعية، كما يقلل الاعتماد على السيارة بـ31%. ويمكن تعميمه على مناطق ساحلية أخرى بالجزائر مثل عين تاقورايت وستيديا وأزفون، ليجسد بُعداً تطبيقياً لسياسات SNAT 2030 وGIZC 2020-2030، محوّلاً التحديات البيئية إلى فرص لتعزيز صمود وتنمية ترابية مشتركة.

الكلمات المفتاحية

التكتل، التنمية الحضرية المستدامة، الحي البيئ

Workshop Objective:

Introduction to the general theme of the master's degree "URBAN ARCHITECTURE":

Urban architecture focuses on the design, planning and development of urban spaces, such as cities, districts and public spaces. It is a discipline that combines elements of architecture, urban planning, landscape and engineering to create functional, aesthetic and sustainable urban environments.

Urban architecture is first and foremost functional. It aims to create spaces and buildings that meet the needs of the city's inhabitants, by ensuring efficient infrastructures, accessibility, the movement of people and vehicles, and the availability of services.

Urban architecture must reflect the cultural and historical identity of the town or district. This often means preserving historic monuments, integrating public art and respecting local architectural styles.

Sustainability is an essential aspect of urban architecture. This is expressed through the integration of ecological solutions such as green spaces, the use of streets and squares as air channels, the efficient management of resources, and the use of sustainable and eco-responsible materials.

The aesthetic values and visual appearance of urban spaces are crucial. Good urban architecture must provide attractive and harmonious environments, taking into account the beauty of buildings, public squares and parks.

Good urban planning promotes fluid connectivity between different parts of the city, with well-designed transport networks, cycle paths and pedestrian walkways. It must also promote social inclusion by creating spaces that are accessible to all, regardless of age, economic status or physical ability.

Urban spaces must be designed to withstand challenges such as natural disasters, such as floods and earthquakes, climate change, and growing demographic pressures.

(Pr. Benhamouche,2024).

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List of abbreviations:

- **S.U.D.:**Sustainable Urban Development;
- **ICZM:** Integrated Coastal Zone Management;
- **SNAT 2030:** National Territorial Planning Scheme 2030 (Algeria);
- **PAW:** Wilaya Development Plan (Provincial-level planning);
- **ZET :** Tourism Expansion Zone;
- **S.U.:** Urban Sector;
- **S.A.U.:**Area for Urbanization;
- **S.U.F.:**Future Urban Sector;
- **PDAU:** Master Plan for Development and Urban Planning;
- **POS:** Land Use Plan;
- **APC:** People's Municipal Assembly (Local governing body in Algeria);
- **CFPA:** Vocational Training and Apprenticeship Center;
- **GIS:** Geographic Information System;
- **RDC:** Ground Floor (Building level designation);
- **BHNS:** Bus with High Level of Service (Transport system);
- **AMSL :** Above Mean Sea Level;
- **LOS:**Level of Service (Infrastructure performance indicator);
- **SDGs:** Sustainable Development Goals (UN);
- **EEA :** European Environment Agency;
- OECD: Organisation for Economic Co-operation and Development;
- **IPCC:** Intergovernmental Panel on Climate Change;
- **T3/T5 :**Housing Typology (T3 = 3-room apartment, T5 = 5-room apartment);
- **BHLS:** Bus with High Level of Service (Synonymous with BHNS).

CHAPITRE I

Introductory Chapter

1. General introduction:

The imperative for sustainable urbanism has transitioned from a theoretical aspiration to an operational necessity, driven by escalating environmental, social, and economic imperatives (Lehmann, 2010). This urgency is acutely manifested in coastal regions globally, where decades of rapid urbanization concentrate intense demographic growth, economic activity, and environmental vulnerability. Algeria exemplifies this trend, experiencing distinctive coastal urban transformations characterized by accelerated, often unplanned, spatial expansion. This pattern frequently yields detrimental consequences for both residents' quality of life and regional ecological resilience.

Algeria exhibits a pronounced phenomenon of *littoralisation*, marked by intense socio-economic concentration along its 1,640 km Mediterranean coastline (Plan Bleu, 2005; FAO, 2021; Belkadi, 2022). This zone, encompassing merely 4% of the national territory, supports approximately two-thirds of Algeria's population. More specifically, the designated coastal area (45,000 km², 1.9% of territory) sustains 37% of the population at a density of 274 inhabitants/km² (FAO, 2021). Urbanization rates surged from 26% (1962) to 59.4% (1998) (Kateb, 2003), with coastal municipalities demonstrating accelerating annual population growth—reaching 2.8% during 1998–2008 compared to 2.6% in 1988–1998 (FAO, 2021). Crucially, coastal municipalities now constitute roughly three-quarters of the population within their respective wilayas (FAO, 2021).

This accelerated coastal urbanization manifests as extensive sprawl and *conurbation*, frequently consuming high-value agricultural land (FAO, 2021). Driven by natural amenities, tourism potential, and the northern concentration of industry and infrastructure (including Algiers, Oran, and Annaba) (FAO, 2021; Kateb, 2003), migration towards the coast intensifies. Significantly, this macro-trend obscures underlying spatial restructuring: urban growth increasingly favours peripheral agglomerations distant from traditional metropolitan cores (Kateb, 2003; Popp, 2008).

The wilaya of Tipaza, situated west of Algiers, epitomizes this dynamic of accelerated coastal urbanization and its transformative impact (Belkadi, 2022; Horizons, 2024). The town of Tipaza itself exhibits significant spatial imbalances and insufficient capacity relative to demand, resulting in site saturation (Belkadi, 2022). Subsequent growth has occurred through fragmented, duplicative settlement patterns (Belkadi, 2022). While endowed with

substantial tourist, agricultural, cultural, archaeological, and landscape assets (Belkadi, 2022), recent decades have seen intensified development negatively impact its natural environment (GeoEcoTrop, 2021).

Recognizing these pressures, Algeria established the Integrated Coastal Zone Management (ICZM) Strategy 2020–2030 (adopted 2015, updated 2021) (GIZ, 2023; PAP/RAC, 2021). This framework aims to protect coastal biodiversity and promote environmentally responsible resource use, serving as both a planning instrument for sustainable development and a mechanism for inter-agency coordination (PAP/RAC, 2021). Despite this strategic intent, effective coastal preservation confronts substantial obstacles (Kreri, 2022), as urbanization and migration towards coastal cities persist, often outpacing regulatory containment efforts (Kateb, 2003).

Within this complex coastal context lies Hadjret Ennous, a 3,000-hectare coastal municipality within Tipaza, positioned between sea and mountain. Despite possessing remarkable natural capital—including a scenic coastline, diverse landscapes, and historical heritage—the town contends with significant structural deficiencies. These encompass underdeveloped tourism infrastructure, fragmented urban integration, inadequate mobility networks, and a progressive erosion of its distinctive urban and landscape character. Recent phases of urbanization, characterized by poorly managed densification disconnected from the historic core, have exacerbated these imbalances. Critically, uncontrolled sprawl increasingly encroaches upon adjacent agricultural lands, vital for the town's long-term ecological and economic sustainability.

The future of Hadjret Ennous is significantly shaped by national and provincial spatial planning frameworks. Promoting balanced territorial development at the national level, the National Spatial Planning Scheme (SNAT, 2030) places a strong emphasis on safeguarding coastal areas, maintaining agricultural land, enhancing cultural and natural heritage, and fostering sustainable tourism. Hadjret Ennous, a coastal commune with abundant natural resources but growing development pressures, is a prime example of these ideas.

The Wilaya Development Plan (PAW) of Tipaza suggests a number of strategic orientations at the provincial level that are adapted to the unique circumstances of the commune. Given the region's importance to the environment, tourism, and agriculture, the PAW places a high priority on protecting the area's fertile agricultural land, which makes up 46% of the commune's surface—and upholds stringent coastal protection laws, such as the national law-

established 100- and 300-meter setback zones. The plan suggests new tourism-oriented developments along the coast, including a promenade, recreational spaces, a hotel, and bungalows that blend in with the surrounding landscape, to make up for the Grand and Petit Vichy Zone d'Expansion Touristique (ZET) being partially lost as a result of the installation of a thermal power plant.

While restricting growth into natural or agricultural areas, the PAW also advocates for urban densification within the current built environment, especially in the main agglomeration (S.U.1, S.U.2, S.U.3). In order to avoid the steep and unstable terrain in the commune's east and south, future urbanization is focused on controlled sectors (S.A.U. and S.U.F). Furthermore, the development of a strong dedication to environmental sustainability is demonstrated by the creation of a 72-hectare recreational forest park, the restoration of degraded areas, and the preservation of the 2,399-hectare forest domain.

Another top priority is infrastructure upgrades. The RN11 highway will be widened to alleviate seasonal traffic congestion, stormwater management will be improved with gabion walls and retention structures, and electrical lines will be undergrounded to lessen their visual and environmental impact. In order to revitalize the urban core and improve the quality of life, new public amenities are also suggested to meet the needs of the expanding population. These include schools, a polyclinic, a youth hostel, recreational and cultural areas, and commercial zones.

The SNAT 2030 and the Tipaza PAW work together to offer Hadjret Ennous a logical and progressive vision that strikes a balance between development and preservation, fortifies territorial equity, and establishes the groundwork for a resilient, inclusive, and sustainable coastal community.

Analysis of these documents is essential to align the proposed intervention with higher-level strategic objectives, ensuring the eco-district project functions as a locally responsive implementation of national and provincial sustainability mandates.

The empirical realities of Hadjret Ennous, synthesized with the strategic directives of Algeria's SNAT and Tipaza PAW, and contextualized by the global SDG agenda, necessitate a fundamental reimagining of the town's development pathway. This reconceptualization demands a sustainable urban paradigm meticulously balancing growth imperatives, heritage integrity, and ecological responsibility. Urban compactness, therefore, emerges as the foundational strategic lens for intervention, concretely manifested in the proposed eco-

district. Defined for this context, the eco-district constitutes a purposefully designed, managed, and regenerative urban entity advancing sustainability through: 1) Robust Economic Viability; 2) Adherence to Stringent Environmental Performance Criteria (e.g., sustainable mobility, waste valorization, eco-construction); and 3) Promotion of Socio-Spatial Equity via functional and programmatic diversity (integrating housing, commerce, public amenities, and agricultural productivity).

2. Research problematic:

As established, Hadjret Ennous occupies an exceptional coastal location. Its natural landscape assets – including scenic beaches and tranquil environs – represent significant potential for tourism development. This potential is further amplified by proximity to regional historical and cultural sites, positioning the town as a prospective visitor destination. However, a critical constraint impedes this trajectory: **a pronounced deficit in tourism infrastructure and facilities**. The absence of modern amenities and services severely limits the town's attractiveness and impedes its broader economic and tourism-driven growth. Consequently, substantial natural and cultural capital remains fundamentally underutilized.

The town's port and forest constitute significant yet underperforming assets. Their potential contribution to local socio-economic vitality is hampered by **spatial disconnection and functional isolation from the urban core**. Inadequate accessibility – manifested through insufficient road improvements and dedicated pedestrian/cyclist pathways – restricts usage and prevents their integration into the town's economic and social fabric. This spatial fragmentation diminishes their capacity to act as catalysts for local development.

Resident mobility faces substantial barriers due to **inadequate pedestrian infrastructure and deficient public transport provision**. Essential travel for accessing services, commerce, and daily activities is complicated by this inefficient mobility network. This limitation transcends mere inconvenience; it actively constrains local economic dynamism, restricts social interaction, and degrades overall quality of life by hindering equitable access to urban opportunities and reducing participation in community life.

Recent phases of urban development exhibit **a disregard for the established morphology and character of the historic core**. New constructions, reaching heights of up to eight storeys, introduce a stark formal and scalar incongruity, disrupting the visual coherence and identity of the original urban fabric. Compounding this, despite outward expansion, the town

contends with **a severe housing shortage and inadequate, poorly managed densification**. This exacerbates urbanization challenges and negatively impacts the living environment.

The absence of **comprehensive long-term planning and sustainable resource management** fundamentally hinders balanced urban development. Ad hoc urbanization, persistent infrastructure inadequacies, and suboptimal resource allocation stem from this lack of strategic foresight. This planning vacuum detrimentally affects resident quality of life and jeopardizes the town's long-term prosperity, resilience, and ecological sustainability. Critically, the region's most valuable coastal land, predominantly publicly owned, faces intense pressure. While Hadjret Ennous possesses limited irrigated farmland, significant portions have undergone irreversible conversion to urban uses, eroding both agricultural capacity and landscape identity.

Existing planning frameworks, notably the Master Plan for Spatial Planning and Urban Development (PDAU) and the Land Use Plans (POS) (2009), identify key intervention priorities for the area:

- **Enhancing Accessibility:** Improving public transport networks and pedestrian infrastructure.
- **Promoting Sustainable Densification:** Optimizing land use through environmentally responsive urban development, incorporating green spaces, ecological infrastructure, and low-energy buildings. Functional diversity – integrating housing, commerce, and services – is emphasized to reduce trip generation and foster sustainable mobility.
- **Community Engagement and Policy Support:** Underlining the necessity of resident involvement and supportive public policies for environmental initiatives.

These directives underscore the imperative to **integrate infrastructure enhancement and accessibility improvements within urban development strategies**. This necessitates revisiting urban planning paradigms and prioritizing efficient, sustainable transport networks. Concurrently, the **strategic integration of ecological solutions and green spaces** into the urban matrix is paramount for addressing environmental imperatives while elevating resident well-being.

Addressing the multifaceted challenges outlined above demands **a fundamentally reconceived, sustainable approach to urban development**. This approach must reconcile immediate population needs with long-term environmental stewardship and resource

conservation, fostering managed urbanization, social cohesion, and ecologically sustainable economic growth. Informed by this complex problematic, the research addresses two core questions:

1. **How can urban densification be strategically pursued within Hadjret Ennous' extension areas through enhanced infrastructure and accessibility, effectively bridging the new development with the historic core while respecting the integrity of the existing urban fabric?**
2. **How can the Mediterranean panorama be intrinsically integrated into the town's urban development strategy, ensuring a sustainable approach that actively preserves the natural environment and valorizes its landscape assets?**

3. Hypothesis:

To answer the research questions, the following assumptions were made:

❖ Designing a project that meets the tourism needs of both areas by creating joint and complementary activities can ensure ongoing interaction while leveraging the Mediterranean setting.

❖ To ensure a sustainable connection between the new extension and the old town, developing efficient infrastructure while preserving the historic identity is essential. This requires sustainable mobility solutions and harmonious integration of both sectors. Environmental stewardship—through renewable energy adoption and green space management—is equally critical for balanced development that respects the town's cultural heritage.

4. Research Objectives:

This thesis addresses the central research question through a critical examination of the **eco-district**, rigorously adapted to the socio-spatial and environmental realities of Hadjret Ennous. Moving beyond the development of an innovative urban-architectural proposition, the research interrogates the town's interconnected socio-environmental vulnerabilities, economic constraints, and policy implementation gaps. The primary objective is to **formulate contextually responsive design strategies** for a regenerative eco-district,

integrating core principles of *smart densification, functional-programmatic diversity, soft mobility networks,* and *landscape stewardship*.

The study targets five core objectives to translate theoretical principles into actionable, place-specific interventions:

1. **To conceptualize a regenerative eco-district prototype** that advances sustainable habitation while delivering *aesthetically coherent, functionally resilient,* and *culturally resonant* spaces within Hadjret Ennous.
2. **To enhance territorial connectivity** through integrated sustainable mobility networks, strengthening multimodal linkages between the **historic core**, peripheral extensions, and **adjacent urban centers**.
3. **To design a contextually embedded intervention** that actively *preserves coastal ecosystems, valorizes agricultural land,* and enhances Mediterranean landscape integrity while optimizing visitor experience.
4. **To ensure occupant well-being and social equity** through evidence-based application of bioclimatic design, community-centric amenities, and sustainable construction systems.
5. **To safeguard environmental resilience** through strategic protection of agricultural resources and integration of circular economy principles.

5. Methodological framework:

1.1.Integrated Research Approach:

A mixed-methodology approach will be employed, structured around three interconnected research strands designed to address Hadjret Ennous's specific coastal-urban challenges:

1. Critical Case Study Review: Comparative evaluation of Mediterranean Eco-Districts and regenerative coastal developments to identify transferable strategies for smart densification, circular resource flows, and tourism-resilient economies.
2. Diagnostic Territorial Analysis: Comprehensive assessment of spatial, socio-economic, and environmental conditions using GIS and landscape-layer mapping, focusing on coastal vulnerability, agricultural land fragmentation, mobility gaps, and heritage interfaces.
3. Iterative Design Prototyping: Development and performance testing of context-responsive solutions through regenerative design modeling, bioclimatic simulation, and community feedback integration.

Consequently, we conducted our research through three main phases:

Phase 1: Foundational Research and Critical Analysis

- Theoretical Framework: Establish principles of *regenerative coastal urbanism*, integrating compactness, circularity, and landscape stewardship.
    - *Contextual Literature:* Scholarly works on coastal compactness, Eco-Districts, and Mediterranean sustainable tourism.
- Case Study Interrogation: Benchmark international projects against diagnostic findings to derive context-adapted strategies.

Phase 2: Contextual Grounding

- Data Collection & Curation: Systematically gather and evaluate primary sources:
    - *Policy Documents:* SNAT 2030, Tipaza PAW, ICZM Strategy, PDAU/POS (2009).
    - *Spatial Data:* Topographic/land-use maps, satellite imagery, agricultural cadastres.
- Territorial Diagnostics: Employ GIS and landscape-layer analysis to:
    - Map socio-environmental conflicts (e.g., urban sprawl vs. farmland, heritage fragmentation).
    - Quantify mobility deficits and ecosystem degradation.
    - Identify synergies between SDGs, SNAT/PAW directives, and local needs.
- Field Validation: Site surveys documenting coastal dynamics, heritage assets, mobility bottlenecks, and agricultural land encroachment.

Phase 3: Regenerative Design Proposition

- Spatial Strategy Development: Generate integrated solutions through:
    - Strategic Territorial Scheme: Macro-scale integration of coastal protection, agricultural belts, and mobility corridors.
    - Regenerative Urban Plan: Zoning for eco-productive landscapes, climate-adapted densification, and heritage-sensitive tourism nodes.
    - Bioclimatic Architectural Prototypes: Housing/commerce modules prioritizing local materials, passive cooling, and circular water-energy systems.

6. Research tools:

In our thesis, we adopted a combination of **field methodology**, **urban analysis tools**, and **digital design software** to ensure a comprehensive and coherent approach to studying and designing the requalification of Hadjret Ennous.

1.2. Data Collection

To better understand the needs and expectations of the local population, and to complement our spatial analysis, we used two main data collection methods:

- **Household Questionnaire**: We conducted a public survey targeting residents of Hadjret Ennous. The responses were collected through a structured questionnaire and analysed statistically, with the results presented in percentages.
- **Interview with Local Authorities**: We conducted a semi-structured interview with the mayor () of Hadjret Ennous, which allowed us to gain insight into the municipality's priorities, ongoing projects, and urban challenges.

1.3.Urban and Territorial Analysis Tools

For a deeper spatial understanding of the study area, we used:

- **ArcGIS**: This Geographic Information System (GIS) software was essential for analysing the physical, environmental, and functional characteristics of the site. We used it for mapping land use, natural constraints, infrastructure networks, and development trends.

1.4.Digital Design and Visualization Software

To develop and visually communicate our urban proposals, we used the following tools:

- **AutoCAD**: For drafting masterplans, technical drawings, and base maps of the urban intervention.
- **SketchUp**: To model urban forms and buildings in 3D.
- **Enscape**: Used in conjunction with SketchUp to produce photorealistic renderings and animated walkthroughs.

- **Photoshop**: To enhance plans and diagrams with textures, colors, and contextual elements.
- **Illustrator**: For vector graphics, layout design, and diagrammatic representation.

7. Thesis structure:

Our thesis is structured in three main chapters, organised as follows (see figure 1 below):

Chapter 1: Introduction and Research Framework

This chapter positions the investigation of "Compactness as a Principle of Urban and Architectural Design and Sustainability" within the context of an "Urban Architecture" workshop, specifically focusing on the Mediterranean coast due to pressing urbanization challenges and Algeria's intense littoralization. This chapter justifies the selection of Hadjret Ennous as its emblematic case study, highlighting the site's significant natural capital, historical value, and critical geography, while also synthesizing its systemic challenges including unmanaged densification, fragmented mobility, agricultural land erosion, and deficient tourism infrastructure. The research imperative arises from a critical gap analysis revealing a disconnect between policy frameworks (SNAT/PAW) and on-the-ground implementation practices. Consequently, it hypothesizes that an eco-district model could serve as a vehicle for achieving regenerative coastal urbanism. To explore this, the study outlines a methodological roadmap employing a mixed-methods approach, progressing from diagnostic analysis through theoretical development to regenerative design proposals, explicitly linking its objectives to broader Sustainable Development Goals (SDGs) and national SNAT targets.

Chapter 2: Theoretical Foundations and Critical Precedents

This chapter establishes a conceptual framework centered on Sustainable Coastal Urbanism, demanding a nuanced approach to compactness that actively balances ecological resilience and heritage integration. It advances the model of Regenerative Eco-Districts as a core strategy, promoting circular economies, productive landscapes, and socio-spatial equity within the coastal context. To translate these concepts into action, the study defines key Operational Principles: implementing smart densification criteria sensitive to fragile ecologies, ensuring mobility-as-justice within fragmented territories, and establishing landscape stewardship mechanisms, potentially drawing on applications of the German-Swiss Method. These principles are critically informed by the analysis of relevant Mediterranean precedents,

examining how other regions have managed the coastal-terrestrial interface, fostered tourism-agriculture symbiosis, and executed heritage-led regeneration. The precedent analysis specifically assesses the transferability of these strategies and lessons learned to the unique challenges and opportunities of the Algerian littoral context.

Chapter 3: Hadjret Ennous, Diagnostic Analysis and Regenerative Intervention

This chapter is composed of two main parts:

Part A: Multi-Scalar Territorial Diagnosis

This section presents a comprehensive diagnostic analysis of Hadjret Ennous across multiple scales. At the macro-scale, GIS analysis aligned with national planning frameworks (PAW/SNAT) maps coastal vulnerability and assesses patterns of agricultural land fragmentation, while also identifying critical mobility network gaps exacerbated by the interface between tourism zones and residential areas. A diachronic evolution study traces the historical stratification of the town's urban form from 1962 to the present, revealing the impact of policy-driven spatial changes over time. Synthesizing findings at the micro-scale, a SWOT matrix crystallizes the site's core tensions, contrasting its significant heritage assets with persistent infrastructural deficits.

Part B: Regenerative Design Proposition

Building directly on the diagnostic findings, this part proposes a transformative regenerative framework. The Strategic Territorial Scheme establishes an integrated structure combining coastal protection buffers, eco-productivity corridors, and a reconfigured mobility spine. This informs a detailed Regenerative Urban Plan designating zones for climate-adapted densification carefully calibrated with heritage-sensitive tourism clusters, supported by circular resource flow systems diagramming integrated water, energy, and waste management. At the architectural scale, Bioclimatic Prototypes for housing and commerce demonstrate the application of local materials, passive cooling strategies, and integrated community amenities. Finally, a Validation Framework ensures practical feasibility and policy relevance through a policy alignment matrix (SNAT/PAW/ICZM) and defined environmental performance indicators.

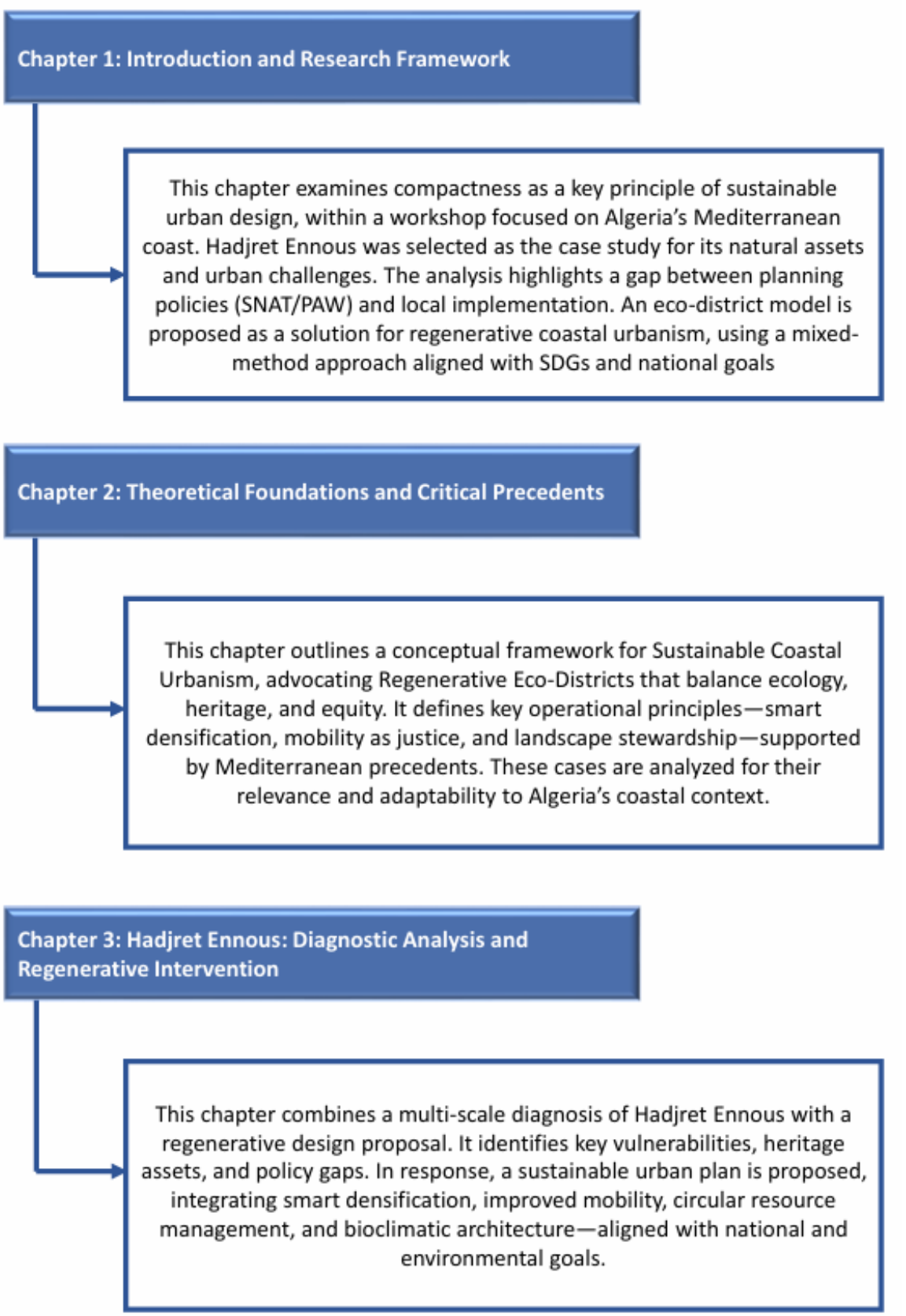

Figure 1:Diagram illustrating thesis structure. Source: Author, 2025.

CHAPITRE II

Theoretical Foundations and Critical Precedents

Introduction:

This chapter articulates a conceptual framework predicated on Sustainable Coastal Urbanism, necessitating a calibrated approach to urban compactness that explicitly reconciles ecological resilience with heritage conservation imperatives. Central to this framework is the proposition of the Regenerative Eco-District paradigm as a foundational strategy, designed to foster circular economic models, productive landscape integration, and socio-spatial equity within coastal zones. To operationalize these concepts, the study delineates core operational principles encompassing: the application of smart densification criteria responsive to fragile ecologies; the implementation of mobility-as-justice frameworks addressing territorial fragmentation; and the establishment of landscape stewardship mechanisms, informed by potential methodological applications of the German-Swiss Method. These principles are critically derived from, and substantiated by, an analysis of pertinent Mediterranean precedents. This precedent analysis critically examines regional strategies for managing coastal-terrestrial interfaces, cultivating tourism-agriculture symbiosis, and executing heritage-led regeneration. Crucially, the analysis incorporates a rigorous assessment of the methodological transferability of these strategies and derived insights to the distinct challenges and opportunities characterizing the Algerian littoral context.

1. Compactness as a lever for sustainable urban development:

Demonstrating how urban compactness functions as both a core component and a strategic lever for sustainable urban development necessitates clarifying the latter's fundamental principles, thereby elucidating the relationship between the two concepts.

1.1. SUSTAINABLE URBAN DEVELOPMENT (S.U.D):

1.1.1. Definition of the S.U.D:

Sustainable urban development constitutes the process of planning and constructing urban environments to be environmentally responsible, socially inclusive, and economically viable, representing the fundamental pillars of sustainable development (Camagni & Gibelli, 1998). Its objective is to meet current resident needs while ensuring the thriving of future generations. Camagni & Gibelli (1998, pp. 6-27) further define it as "a process of synergetic integration and co-evolution between the major urban sub-systems (economic, social, physical, environmental) which guarantees a non-decreasing level of well-being for the local population in the long term." This concept is also characterized as "a systemic approach that

must reconcile three dimensions: long-term versus short-term, global versus local, and public participation" (Charlot-Viadieu & Outrequin, 2009). Key principles identified by Da Cunha et al. (2017) include: an operational, open, and participatory programming approach throughout urban development stages; a transformative conceptualization of the city; assigning nature a central urban role; and prioritizing energy management.

The origins of sustainable urban development (SUD) can be traced to mid-20th century sustainable development discourse, evolving from earlier 'hygienic principles' focused on integrating planted open spaces to improve quality of life in polluted industrial environments detrimental to human health (Kaika, 2005). Ebenezer Howard's (1902) Garden City model, aiming to combine urban and rural benefits while maintaining green belts (Salomon Cavin, 2005), and 19th-century landscape planners' advocacy for planted urban paths, were foundational influences.

SUD policy centres environmental and human concerns within urban planning, aiming to achieve high-quality urban life for all while preserving resources (Dind, 2006). Consequently, residents benefit from improved living conditions in dense areas, fostering vibrant, attractive neighbourhoods. The future challenge lies in developing a more open, continuous urban form that establishes a new balance, ensuring: long-term maintenance of natural resources (energy, materials, ecosystems); strengthened social cohesion and solidarity; and sustained economic resources (personal income, infrastructure maintenance) (Dind, 2006).

The challenges of SUD policy are integral to urban renewal (UR), a primary tool for advancing sustainable development. UR focuses on reusing abandoned spaces—industrial, port, or urban wastelands and derelicts—to limit sprawl, reduce pressure on natural/agricultural areas, and revitalize neglected zones. This approach aims to create synergies between three core concepts: sustainability, environmental justice, and equity.

1.1.2. S.U.D. objectives:

The 17 Sustainable Development Goals (SDGs), adopted by the United Nations in 2015, include a specific urban target: SDG 11 aims to "Make cities and human settlements inclusive, safe, resilient and sustainable" by transforming them into environmentally respectful, inclusive spaces capable of addressing current and future challenges.

Ensuring Accessibility & Equity: SUD promotes social inclusion by reducing exclusion for disadvantaged groups and residents of marginalized areas. Given housing access in market

economies depends on payment ability, public authorities must ensure equitable, affordable access to housing for vulnerable groups (e.g., unemployed, elderly, disabled), necessitating legislative reviews for social housing allocation. SUD also advocates functional diversity and mixed land uses to counteract urban specialization, requiring rational distribution and diversification of facilities. (Figure 3)

- **Improving Urban Health**: SUD combats air and water pollution through industrial emission controls, clean energy promotion, and improved sanitation. It implements efficient waste management (recycling, reduction) and creates green/recreational spaces to enhance quality of life and mental health. Measures also include preventing environment-linked illnesses and enhancing disaster resilience, incorporating accessibility for the disabled.

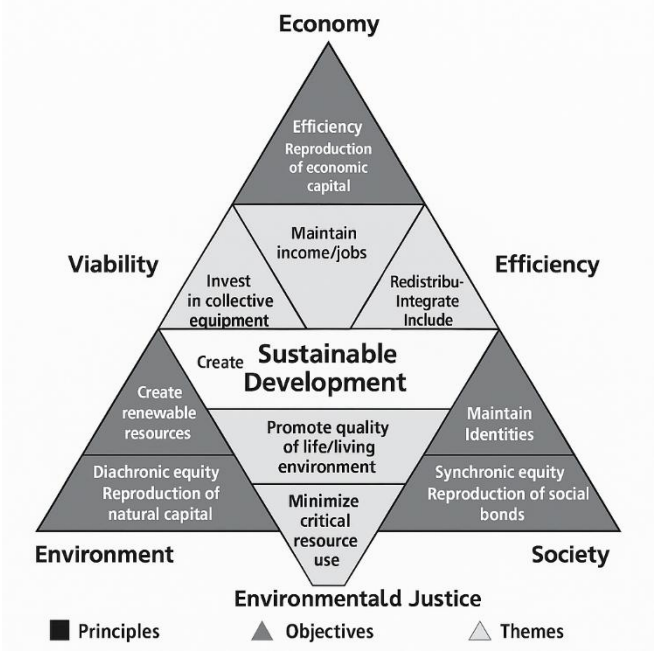

Figure 2: The Sustainable Development Triangle: Viability, Efficiency, and Environmental Justice (translated by

- **Enhancing Urban Heritage**: SUD protects both natural (site, topography, climate-related) and built heritage of artistic/cultural value. This safeguards urban identity, memory, and transmits cultural references to future generations, ensuring continuity. Public authorities and citizens share this duty, recognizing heritage's role in stimulating urban development.
  - Promoting Economic Development: SUD stimulates local economies by creating jobs in sustainable sectors (e.g., renewable energy, green tech) and enabling economic diversification to minimize impacts.
- **Managing Resources Sustainably**: SUD encourages renewable energy adoption (solar, wind, geothermal) and reduced consumption in buildings/transport. It promotes sustainable water management (rainwater harvesting, wastewater reuse, groundwater protection) and waste reduction, reuse, and recycling. This context fosters compact urban planning, emphasizing reasoned densification to limit sprawl and preserve agricultural/natural areas.

1.2. Eco-Districts:

1.2.1. Eco-district; brief definition:

- A sustainable district is an urban area that intentionally incorporates environmental, social, and economic considerations into its planning and management. It emphasizes balanced urban development by fostering social cohesion, diversity, and community spaces while promoting local economic growth, employment opportunities, and principles of good governance such as transparency, participation, and partnership.[1] (Figure 4). The terms 'eco-district' and 'sustainable district' are frequently used interchangeably by urban planners and development stakeholders, both denoting projects with ambitious sustainability goals across environmental, social, and economic dimensions.

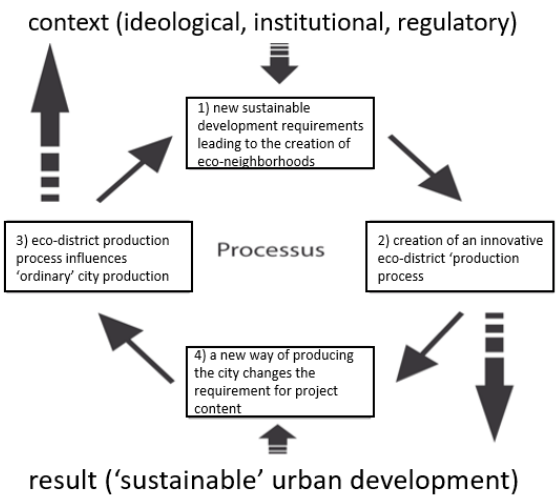

Figure 3: ECO-DISTRICT Processes , Source: https://journals.openedition.org/geocarrefour/9558,Translated bv: Authors

- At its ore, a sustainable neighbourhood is a mixed-use space that cultivates a strong sense of community, ensuring long-term livability and attractiveness for residents and workers. It must address the evolving needs of present and future populations while enhancing overall quality of life. In accordance with the Bristol Accord (2005), such neighbourhoods should be safe, inclusive, and well-planned, offering equitable access to opportunities and services while minimizing environmental impact.

1.2.2. Building blocks of Eco-Districts:[2]

- **Purpose of a Sustainable Neighbourhood** : A sustainable neighbourhood must align with broader urban planning objectives while addressing human-centered

[1] ARENE-IMBE : Quartier Durable-Guide d'expérience européennes-avril 2005-p12

[2] http://www.lesenr.fr/sustainable urbanism/objectives/85-issues-sustainable-neighbourhood-development.html

concerns, ensuring coherence with the city's long-term development goals (Bristol Accord, 2005).

- **Operation of an Eco-District :** Each eco-district should implement a structured framework, including operational classifications and potential certifications, to standardize sustainability practices and ensure accountability (cf. LEED-ND, 2009).
- **Structure of an Eco-District :** The structural design of an eco-district serves as a stabilizing element, integrating resilient infrastructure and adaptable urban forms to support long-term viability.
- **Transformation of an Eco-District :** An eco-district is not a static entity but a dynamic system undergoing continuous economic, energy, and social evolution. Its development is an iterative process, requiring flexibility to adapt to changing conditions.
- **Surrounding Environment of the District :** The district interacts with both its natural environment (e.g., ecosystems, resources) and built environment (e.g., infrastructure, urban fabric). Sustainable growth depends on responsible resource utilization—borrowing materials and energy from its surroundings while minimizing ecological disruption (Girardet, 2008).

1.2.3. Types of Eco-Districts :

There are 4 types of Eco-Districts:

a- Proto-quarters:

- Emerging from the 1960s eco-village movement, proto-quarters were pioneered by environmental activists and specialists, primarily in Northern Europe. These early experiments in sustainability were typically situated on urban peripheries or in rural areas, focusing on alternative living models that prioritized ecological principles. (Figure 4).

Figure 4 : Eco-district , source : Pinterest Passivhaus Woodland Community - Kent , source : Pinterest

b- Prototype districts:

Teveloped in the 1990s alongside the mainstream adoption of sustainable development and the Aalborg Charter (1994), prototype districts emphasized technological innovation, often at the expense of social and participatory dimensions. These projects served as flagship demonstrations of sustainable urban planning, integrating advanced energy-efficient technologies and environmental solutions. (Figure 6).

Figure 5 : Eco-district , Canada , source : Pinterest *https://www.olx.ua/d/uk/obyavlenie/prodam-dom-nedostroy-iz-treh-kaartir-uchastok-4-sotki-IDXgPIu.html*

c- Typical districts:

Marking a shift from experimentation to scalability, typical districts emerged as replicable models, spreading from Northern to Southern Europe and the Mediterranean. Unlike their predecessors, they are less visually distinct and operate within conventional urban renewal frameworks. Their development leverages lessons from prototype districts while adapting to local planning traditions. (Figure 7)

Figure 6 : Sustainable district , Eco-quartier Châtelet source: Pinterest

d- Agro-districts: the agricultural dimension of Eco-Districts:

Agro-districts represent a specialized form of eco-district that integrates urban agriculture and local food systems into sustainable urban development. Key characteristics include:

- **Urban Agriculture:** Incorporation of farms, community gardens, and greenhouses for local food production.
- **Short Supply Chains:** Direct linkages between producers and consumers to reduce food miles.
- **Sustainable Resource Management:** Use of permaculture, aquaponics, and composting to minimize waste.
- **Biodiversity Enhancement:** Creation of green corridors and habitats to support urban ecosystems.
- **Community Engagement:** Participatory management of agricultural spaces to foster social cohesion.
- **Renewable Energy Integration:** Adoption of solar energy, rainwater harvesting, and other sustainable technologies. (Figure 8)

Figure 7 : agro-districts, source : https://www.grandparisamenagement.fr/operations/agro

1.2.4. Principles of Eco-Districts:[3]

The European Association of Local Authorities Inventing Their Energy Future, established in 1990 and now encompassing over 1,000 towns across 30 countries, outlines key environmental, social, and economic principles for sustainable district development. These principles include:

- **Governance:** Effective district management through inclusive participation, representative leadership, and transparent decision-making.

[3] http://www.lesenr.fr/sustainable urbanism/objectives/85-issues-sustainable-neighbourhood-development.html

- **Transport and Mobility :** Well-connected infrastructure prioritizing public transport, walkability, and cycling to reduce car dependency while ensuring access to employment and services.
- **Environment :** Promotion of low-energy or positive-energy buildings, waste reduction, recycling, sustainable materials, and water conservation to ensure a clean and safe living environment.
- **Economy :** A thriving local economy that fosters job creation, innovation, social solidarity, and long-term sustainability.
- **Services ;** Equitable access to public, private, shared, and voluntary services for all residents.
- **Equity :** Fairness for current and future generations in resource distribution and opportunities.
- **Diversity :** Socially cohesive neighborhoods with a mix of demographics, incomes, and age groups.
- **Mixed Functions :** Avoidance of rigid zoning by integrating residential, commercial, and industrial spaces, distinguishing sustainable districts from conventional suburban developments.

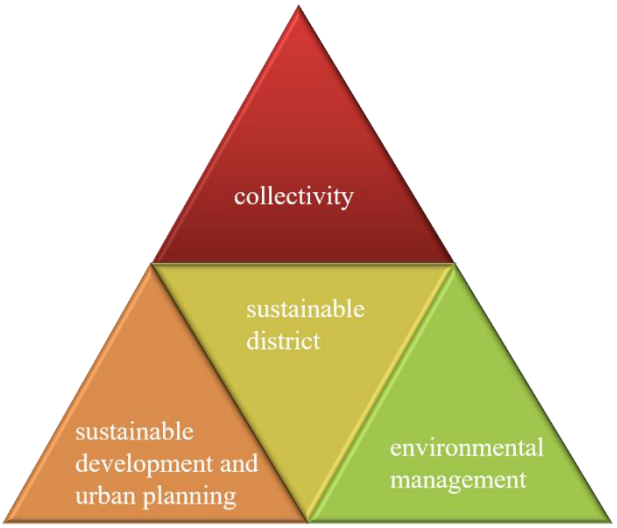

Figure 8 : The three themes of a sustainable district

,Source : https://www.usherbrooke.ca/environnement/fileadmin/sites/environnement/documents/Essais2012/Savard_M 18-07- 2012_.pdf

- **Identity :** A strong local culture and shared activities that foster belonging, supported by a well-defined neighborhood center. (Figure 10)

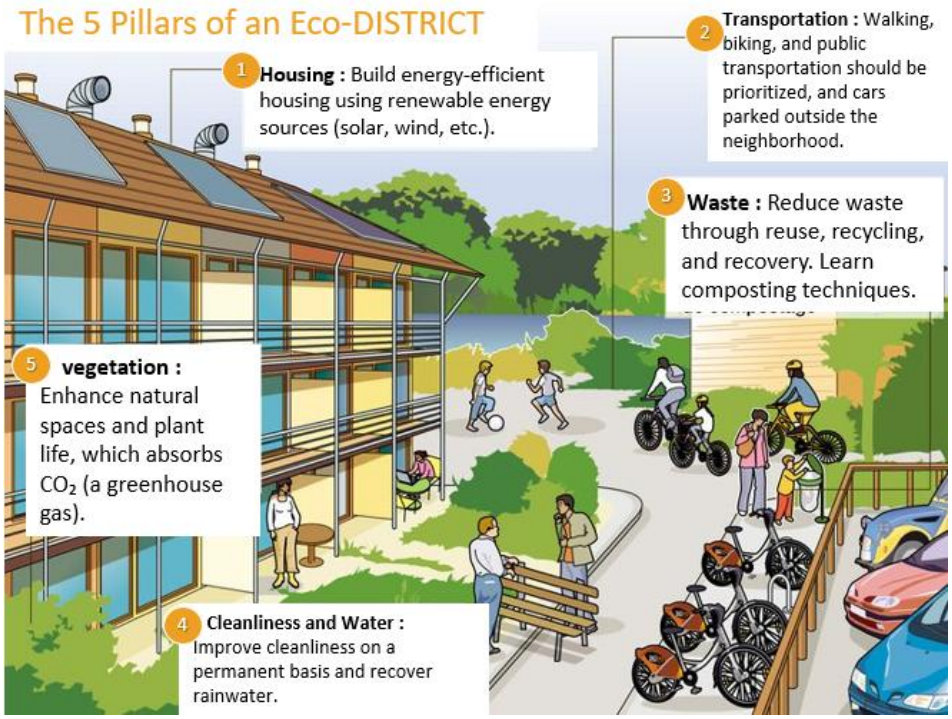

Figure 9 : pillars of eco-district , Source : https://www.lafrap.fr/podcasts/l-ecologie-se-partage-en-quartiers

Translated by: Authors

1.2.5. Objectives of Eco-Districts:[4]

Eco-Districts operationalize the three pillars of sustainable development—environmental, socio-economic, and cultural through integrated spatial and technical considerations.

- **Environmental Objectives:** A sustainable neighbourhood treats land as a scarce, non-renewable resource, ensuring that today's built environment becomes a resilient heritage for future generations. By leveraging local resources and addressing global ecological challenges, such districts contribute to urban sustainability at multiple scales.

[4] CHARLOT-VALDIEU C. et OUTREQUIN P. Mai 2006, Sustainable development and urban renewal.

- **Integration into the Urban Fabric :** District sustainability hinges on enabling responsible lifestyles and vibrant communities. As noted by José Palma (University of Lisbon), an expert in environmental psychology and leader of the One Planet Living initiative:

"A successful district must feel alive—its vitality is revealed through organic use, adaptation, and the creativity of its residents. Lasting neighborhoods possess a 'soul,' requiring design flexibility that invites human innovation rather than imposes rigid structures."(Jane Jacobs,2007). Sustainability also demands intergenerational continuity. Neighborhoods must function as living laboratories, where lessons learned are documented and shared across contexts or future generations. This requires spaces that make intangible values—community knowledge, cultural practices—tangible and aspiration**a**

1.3. Compactness as a key principle of Eco-District:

1.3.1. Definition of compactness:

Jane Jacobs(2007)[5] posited that "The compact city is the key to sustainable development: it limits urban sprawl, reduces motorised travel, and optimises the use of resources." This assertion underscores the fundamental role of urban form in achieving sustainability objectives. Jacobs' work consistently championed dense, interconnected neighborhoods, arguing that compact urban fabric promotes vitality, sustainability, and social inclusion while countering the detrimental effects of sprawl (Jacobs, 1961).

The compact city model represents a comprehensive approach to urban development, characterized by three core principles:

- **High-density development** to maximize land use efficiency and support vibrant street life
- **Mixed-use zoning** that integrates residential, commercial, and cultural functions to enhance proximity and reduce transport needs
- Prioritization of public transit and active mobility infrastructure to minimize automobile dependence

[5] Jane Jacobs, a famous urban planner and social critic

Research demonstrates that this model yields significant sustainability benefits, including reduced per capita energy consumption (Newman & Kenworthy, 1999), lower greenhouse gas emissions from transport (Ewing & Cervero, 2010), and more efficient use of urban land (Burton, 2002). Moreover, by concentrating amenities and services within walkable distances, compact cities foster social interaction and economic opportunity while improving overall quality of life (Gehl, 2010).

Contemporary implementations, such as Barcelona's superblocks and Paris's 15-minute city initiative, validate Jacobs' insights while adapting them to modern urban challenges. These cases demonstrate how compact urban form can be enhanced through intelligent design and technology to address contemporary sustainability imperatives.

1.3.2. Evolution of compact cities: 6

The concept of compact urban development finds its earliest manifestations in medieval Islamic cities (7th-15th centuries CE), where urban centers like Fez and Cairo demonstrated prototypical characteristics through their high-density built environments, narrow pedestrian-oriented streetscapes, and integrated land-use patterns combining religious, commercial, and residential functions (Hakim, 2008). These historical precedents established fundamental principles of efficient urban space utilization that would later re-emerge in contemporary urban theory (table 1).

Table 1 : The evolution of compact cities , source : author

Period	**Characteristics**	**Events/Influences**
Islamic Cities (7th-15th century)	High density, narrow streets, mixed-use spaces, integrated religious and commercial centers.	Adaptation to arid climates, social and religious needs.
Pre-Industrial Era	Naturally compact cities, narrow streets, proximity to resources.	Limited transportation, need for security (city walls).
Industrial Revolution	Rapid urbanization, overcrowding, poor living conditions.	Industrialization, rural exodus.
20th Century (Urban Sprawl)	Expansion of suburbs, low density, car dependency.	Rise of automobiles, pursuit of space.
1970s-1980s	Environmental awareness, birth of the compact city concept.	Oil crises, environmental movements.

[6] The Compact City: A Sustainable Urban Form

1990s-2000s	Global adoption, mixed-use development, efficient public transit.	Sustainable development summits (e.g., Rio 1992).
Today	Smart cities, climate resilience, 15-minute city concept.	Sustainable Development Goals (SDGs), technological innovations.

The Industrial Revolution precipitated a significant divergence from this model, as European cities like London experienced uncontrolled densification without corresponding infrastructure development, resulting in severe public health consequences (Hall, 2014). This led to a reactionary planning paradigm in the early-to-mid 20th century that prioritized suburban expansion and automobile dependency - a model that subsequent research would reveal as environmentally and socially unsustainable (Newman & Kenworthy, 1999).

The oil crises of 1973-1979 and growing ecological consciousness prompted a critical re-evaluation of urban form, with scholars and practitioners rediscovering the benefits of density, mixed-use development, and transit-oriented design (Jenks et al., 1996). This period marked the theoretical foundation for modern compact city principles that have been operationalized in contemporary urban practice. (cf. Table 1)

Current exemplars of compact urbanism demonstrate the model's adaptability to modern challenges:

- Barcelona's superblock (superbilla) program reconfigures urban mobility
- Copenhagen's cycling infrastructure achieves modal shares exceeding 60%
- Paris's 15-minute city concept optimizes neighbourhood self-sufficiency (Moreno et al., 2021)

1.3.3. Key Characteristics and Defining Criteria of Compact Cities:[7]

Compact cities represent an integrated urban development model that prioritizes spatial efficiency, sustainability, and livability through several core principles (Figure 11):

[7] The Compact City: A Sustainable Urban Form

a- Urban Intensification & Density

Compact cities emphasize higher-density development within existing urban footprints, minimizing sprawl and optimizing land use. Density serves as the foundational metric, measured through population and housing concentration per land area:

- Regional Variations:
- Europe: 50+ housing units/ha (5,000/km²) in urban cores (OECD, 2012).
- North America: 25+ units/ha (2,500/km²) in urban centers (Ewing & Hamidi, 2015).
- Asia: Often exceeds 100 units/ha (10,000/km²) due to land scarcity (Jenks et al., 2012).
- Benefits:
- Supports public transit viability (min. 30 units/ha for frequent service; Newman & Kenworthy, 2015).
- Reduces per capita transport emissions by 40–50% (OECD, 2012).
- Preserves 60–80% more greenfield land vs. sprawl (EEA, 2016).

b- Mixed-Use Development & Functional Integration

Compact cities integrate residential, commercial, and recreational uses at neighborhood scales, creating 24-hour communities:

- Reduces vehicle miles traveled by 20–40% (Ewing & Cervero, 2010).
- Enables 15-minute neighborhoods (Moreno et al., 2021).
- Enhances street vitality and local economies (Jacobs, 1961).

c- Transportation Innovation & Accessibility

- High-density, contiguous development enables:
- Efficient public transit (frequent service, <10-min intervals).
- Complete streets with pedestrian/cycling networks (Gehl, 2010).
- Walkability: Street connectivity indices >1.4 (Dill, 2004).
- Proximity: 80% of daily needs within 500m (WHO, 2018).

d- Environmental Performance

- Energy: 35% lower heating/cooling demand (EEA, 2015).
- Emissions: 40–50% fewer transport CO_2 emissions (IPCC, 2014).
- Biodiversity: Green corridors enhance urban ecosystems (Beatley, 2010).

e- Social Outcomes

- Health: Active transportation improves public health (Stevenson et al., 2016).
- Social Capital: Increased casual interactions (Leyden, 2003).

  Economic Productivity: Agglomeration benefits (Ahrend et al., 2014).

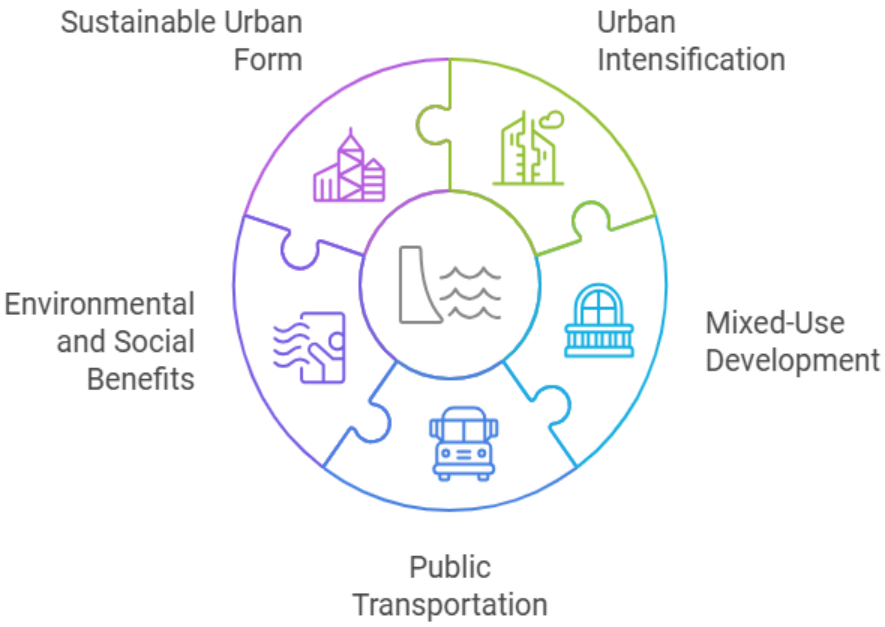

Figure 10 : characteristics of the Compact City, source author.

Synthesis: Interconnected Criteria for Compact Urbanism

The above characteristics density, mixed-use, transit accessibility, environmental resilience, and social equity are not isolated but mutually reinforcing. High density enables efficient transit; mixed-use supports walkability; contiguous development reduces sprawl costs. Together, they form a systemic framework to address contemporary urban challenges while advancing sustainability (OECD, 2012; IPCC, 2014). However, contextual adaptation remains critical, as seen in regional density variations or local infrastructure needs as detailed hereafter.

2. Case studies analysis:

2.1. Lyon's Confluence project: [8]

2.1.1. Location:

The Confluence district, in the south of Lyon's peninsula, is a former industrial and port site. In the 2000s, the city of Lyon launched a redevelopment project to turn it into an exemplary eco-district, combining urban density, functional diversity and environmental sustainability. (Figure 12)

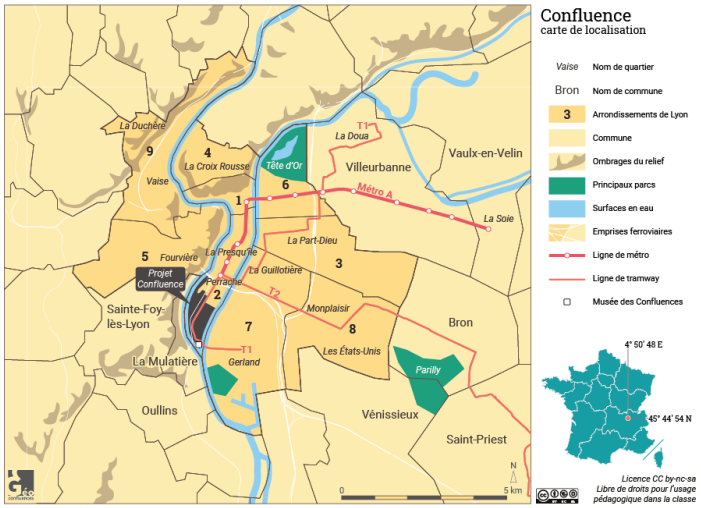

Figure 11 : Location map , Source : https://geoconfluences.ens-lyon.fr/informations-scientifiques/dossiers-regionaux/lyon-

2.1.2. Project objectives:

- Créer un quartier dense et compact tout en préservant la qualité de vie ;
- Intégrer des bâtiments à haute performance énergétique et des espaces verts ;
- Favoriser la mixité sociale et fonctionnelle (logements, commerces, bureaux) ;
- Devenir un modèle d'urbanisme durable en Europe.

2.1.3. Description:

This project aims to transform 150 hectares of industrial wasteland into a dense, multifunctional district with 17,000 residents and 25,000 jobs by 2030. It is based on the principles of sustainability, social mix and smart city, with a high level of densification, housing, offices, shops and transport infrastructure.

However, despite its environmental and social ambitions, critics point to the impact of neoliberal logic, with the dominance of private developers, which could limit accessibility for people of modest means. The project therefore faces tensions between sustainability, social justice and the privatisation of urban space. (Figure 13)

[8] https://geoconfluences.ens-lyon.fr/informations-scientifiques/dossiers-regionaux/lyon-metropole/articles-scientifiques/confluence

Figure 12 : Map of the Confluence project , source : https://geoconfluences.ens-lyon.fr/informations-scientifiques/dossiers-regionaux/lyon-metropole/articles-scientifiques/confluence

2.2.ZAC de la Berge du Lac - Ginko eco-district : [9]

2.2.1. Location:

The ZAC du Bonhomme eco-district is located in La Seyne-sur-Mer, a commune in the Var department in the Provence-Alpes-Côte d'Azur region. It is located on the Mediterranean coast, offering uninterrupted sea views and a privileged living environment. (Figure 14)

Figure 13 : The ZAC du Bonhomme Eco-district, Source : https://agencedevillers.com/projet/projets-urbains/bordeaux-zac-de-la-berge-du-lac-ecoquartier-ginko

2.2.2. Objectives:

- Environmental sustainability: Ecological construction (low-energy buildings, sustainable materials), rainwater management and preservation of coastal ecosystems.
- Social mix: Diversified housing (including social housing) for all incomes. and public facilities (schools, crèches, shops).
- Quality of life: green spaces, parks and coastal paths. with soft mobility (cycle paths, footpaths).
- Climate resilience: Adaptation to coastal risks (erosion, rising sea levels).

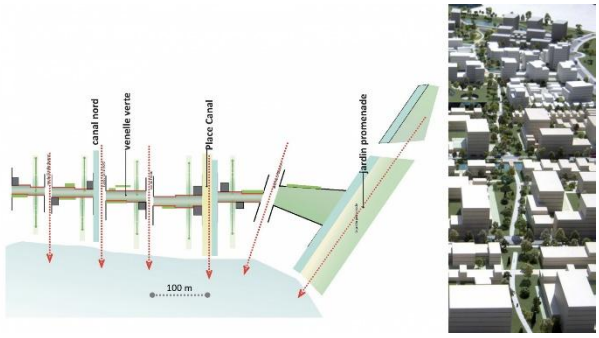

Figure 14 : The pathways of the Ginko eco-district ,Source :https://agencedevillers.com/projet/projets-urbains/bordeaux-zac-de-la-berge-du-lac-ecoquartier-ginko

In addition, even if there are challenges of compactness, 1000 homes are being built on 15 hectares of land. (Figure 15)

[9] https://agencedevillers.com/projet/projets-urbains/bordeaux-zac-de-la-berge-du-lac-ecoquartier-ginko

2.2.3. Description:

The ZAC du Bonhomme Eco-district in La Seyne-sur-Mer aims to transform 15 hectares of urban wasteland into a dense, multifunctional district, housing around 1,000 homes and incorporating commercial spaces, public facilities and sustainable transport infrastructure. Scheduled for completion by 2030, the project is based on the principles of sustainability, social mix and smart city, with a high level of densification and a focus on quality of life and preserving the coastal environment.10 (Figure 16).

Figure 15 : The ZAC du Bonhomme Eco-district map , source : https://www.etamine.coop/ecoquartier-zac-

des-docks-a-saint-ouen-93/

2.3.The Vergers Ago-district in Meyrin (Switzerland) :

The Les Vergers Eco-district in Meyrin (Switzerland) is a model of sustainable development that combines ecological housing, green spaces and soft mobility. Designed to promote a social mix and ecological transition, it includes low-energy buildings, urban vegetable gardens and public infrastructure such as a school and local shops.

[10] *https://www.etamine.coop/ecoquartier-zac-des-docks-a-saint-ouen-93/*

Its relationship with the farmland is central: part of the land has been preserved for organic crops, shared gardens and educational activities. The surrounding farmland creates a natural transition with the rural areas and supports short circuits[11], strengthening the local economy and biodiversity. (Figure 10)

Figure 16: The Vergers Ago-district in Meyrin, Source : https://www.farralakis.ch/aspects-architecturaux-des-amenagements-exterieurs-ecoquartier-les-vergers-meyrin/

[11] **short circuits :** refers to a production and distribution system where agricultural products are sold directly or almost directly from the producer to the consumer, over short distances

Conclusion

This second chapter has laid the theoretical foundation necessary for developing a context-responsive and innovative urban intervention in Hadjret Ennous. By exploring and interconnecting the paradigms of the Compact City, the Eco-District, and Regenerative Urbanism, the chapter establishes a conceptual matrix that addresses urban density, sustainability, ecological restoration, and socio-spatial equity.

The comparative analysis of three Mediterranean case studies—Lyon Confluence, Ginko in Bordeaux, and Les Vergers in Meyrin—provided concrete and transferable strategies aligned with Algerian coastal challenges. Each precedent offered a different lens: hydro-social integration, energy-positive housing, and productive landscape design. These insights helped to build a critical benchmarking framework, enabling us to adapt successful international models to the specific morphological, climatic, and cultural context of Hadjret Ennous.

This chapter confirmed that sustainable urban development cannot rely on imported solutions alone, but rather on adaptive models rooted in local realities. The integration of theory and case studies has served as a bridge between diagnosis and design, guiding the next stage of the thesis: the spatial translation of these concepts into a real urban and architectural proposal.

CHAPITRE III

URBAN DIAGNOSIS AND EMPIRICAL PROJECT IN HADJRET ENNOUS

Introduction:

This third chapter represents the **operational phase** of the research. It aims to translate the insights from the territorial diagnosis (Chapter 1) and the conceptual-comparative framework (Chapter 2) into a concrete, site-specific design proposal. Drawing on the principles of **urban compactness**, **territorial ecology**, and **regenerative planning**, this chapter presents the **design workshop** for the coastal commune of Hadjret Ennous.

The proposed intervention is structured around a **bioclimatic masterplan**, integrating spatial, environmental, social, and economic dimensions. The goal is to develop a **compact and climate-resilient eco-district**, grounded in four strategic pillars: controlled densification, soft mobility, eco-ecological corridors, and energy-positive bioclimatic architecture. This chapter outlines the design methodology, the spatial strategies adopted, the architectural typologies introduced, and the ecological systems embedded in the proposal.

Figure 17 : View of Hadjret Ennous between sea and mountains, Source: https://www.facebook.com/share/18xtwQkuTr/

1. Holistic Context Analysis: From Physical Landscapes to Urban Fabric in Hadjret Ennous

1.1. Geographical location:

Hadjret Ennous is a coastal town in north-central Algeria, at the western end of the wilaya of Tipaza. It covers an area of 3,000 hectares and is 15 km west of the capital of the Cherchell daïra and 47 km from Tipaza, the wilaya capital. The town is bordered to the north by the Mediterranean Sea and surrounded to the south by the majestic Chenoua-Zaccar massif, which offers a unique natural landscape.Situated around 90 km west of Algiers, the country's capital, Hadjret Ennous stands out for its picturesque setting, between unspoilt coastline and verdant mountains (cf,figure19).

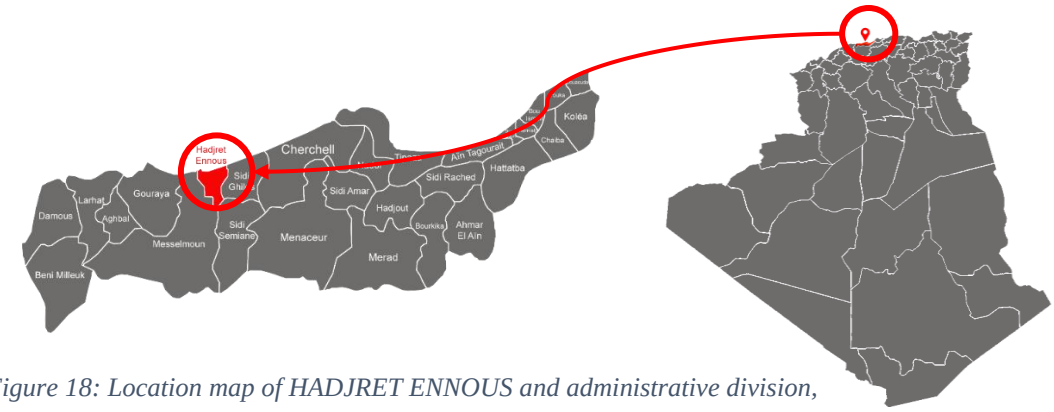

Figure 18: Location map of HADJRET ENNOUS and administrative division, Source: Wikipedia / Treaty: Autor

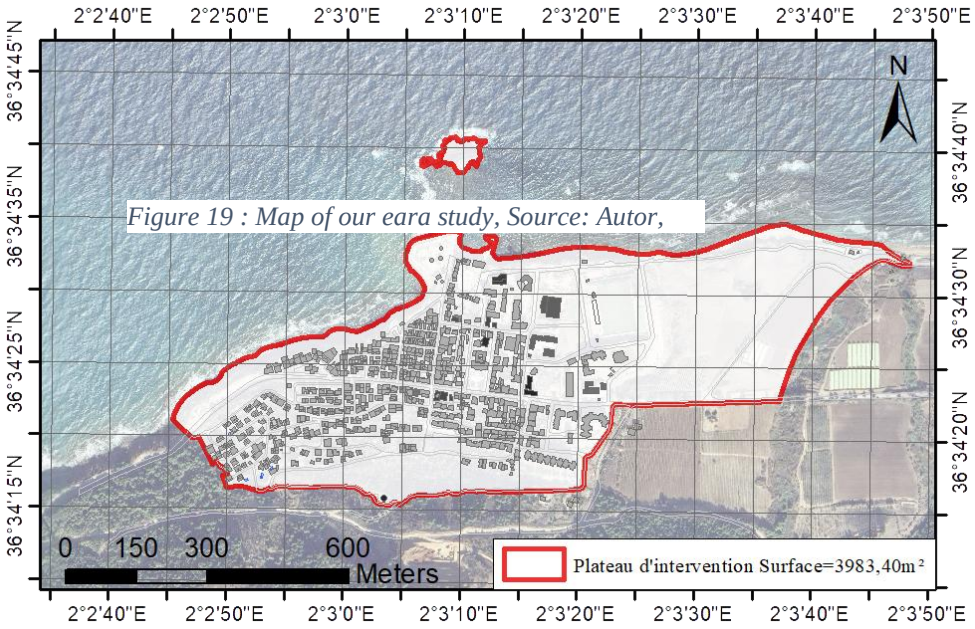

Figure 19 : Map of our eara study, Source: Autor,

As part of our study (cf: Figure 20), we analysed the three parts forming the «P.O.S 01, P.O.S 02, P.O.S 03» of Hadjret Ennous.

These sections, which distinctly represent the Hadjret Ennous town center and its new extension, were carefully examined in order to extract the relevant characteristics. with an area of 3983.40m².

The municipality of HADJRET ENNOUS is limited administratively by:

- **To the north:** The Mediterranean Sea;
- **To the south:** The commune of SIDI SEMIANE;
- **To the east:** The commune of SIDI GHILES;
- **To the west:** The municipality of MESSELMOUN. (cf: Figure 21)

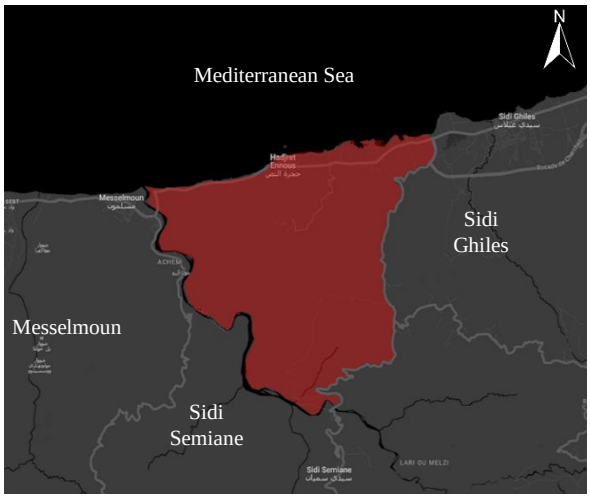

Figure 20 : Map of the municipality, Source : https://mapstyle.withgoogle.com / Treaty : Autor

1.2.Historical Evolution:

Hadjret Ennous (previously known as Fontaine-du-Génie during French colonisation).

- **Roman Period:**

The territory of Hadjrat Ennous held significant strategic value during the Roman era due to its abundant natural resources, particularly hydraulic resources and granite deposits. Extensive Roman settlement occurred, with dwellings concentrated in the present-day village core and along the coastline. Settlements were strategically positioned near river valleys to optimize access to essential water sources.

Figure 21: Tit Oua man, Source: https://notrejournal.info/IMG/pdf/info_958_fontaine_du_genie.pdf

These resources were critical for domestic use, irrigation, and sustaining the region's renowned olive cultivation. The reliance on water profoundly shaped local agricultural and artisanal development, an association so intrinsic that it is strongly linked to the toponym "Tit Oua man[12]"(Jean-Claude ROSSO,2015,pp2). (cf: Figure 22)

Figure 22: Roman column, Source : fontaine du genie,galerie de cartes postales;http://alger-roi.fr

Material evidence of Roman occupation persists within the landscape. This includes engineered water springs, vital for provisioning the population and supporting agrarian activities. Further archaeological features comprise a prominent stone boat structure situated atop the mountainous terrain and a monumental granite column (approximately 10m in height and 1m in diameter) located centrally within the urban area. This column serves as a significant territorial marker, unequivocally attesting to the Roman presence and underscoring their enduring architectural and cultural influence within the region. (cf: Figure 23)

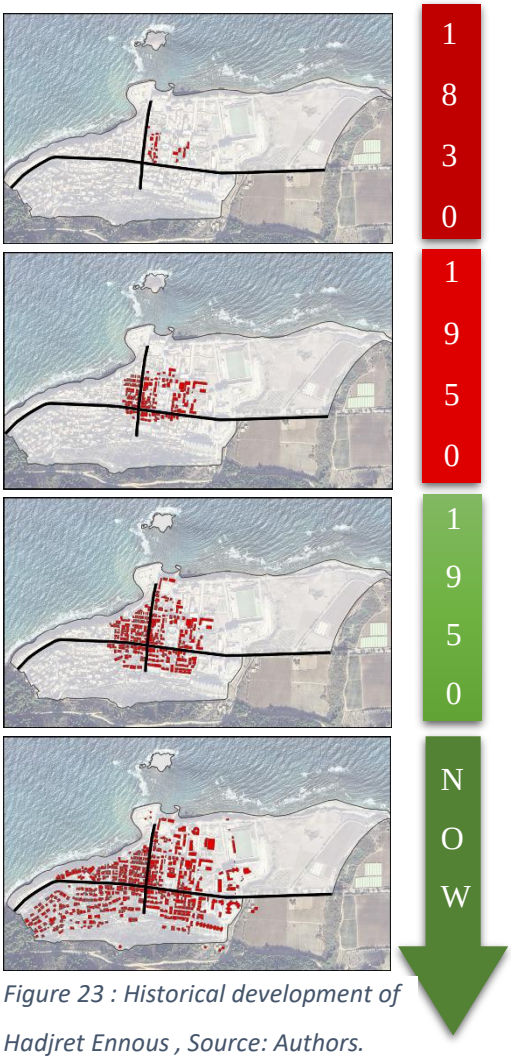

Figure 23 : Historical development of Hadjret Ennous , Source: Authors.

[12] (the source of water), is the oldest and most original name for the place. Its name is associated with a water source located near the road leading to the top of the mountain. Available at: https://notrejournal.info/IMG/pdf/info_958_fontaine_du_genie.pdf

- **French Colonial Period :**

During the 19th-century French colonial period, significant Roman-era structures were deliberately dismantled to facilitate the establishment of extensive vineyards. The resultant stone material was systematically repurposed in the construction of new colonial farms and residences. This architectural practice synthesised local materials (notably the reclaimed Roman stone) with imported colonial techniques, creating a distinct hybrid built environment. (cf: Figure 24)

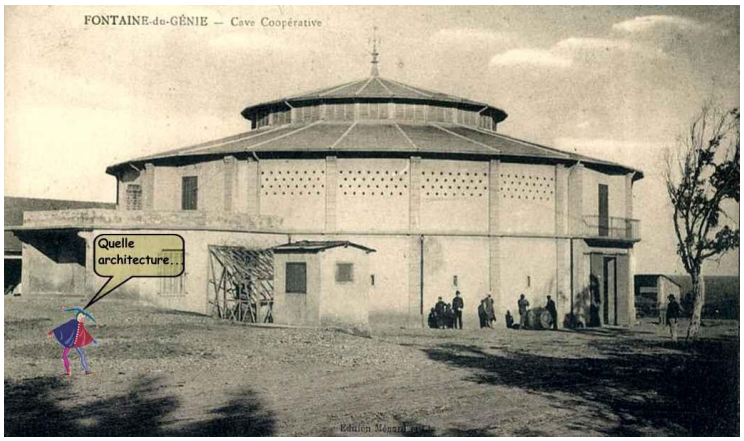

Figure 24 : Cave Coopérative, Source : fontaine du genie,galerie de cartes postales;http://alger-roi.fr

These interventions precipitated profound transformations in the village's socio-economic fabric and resource utilization patterns, persisting until Algerian independence in 1962. Mirroring earlier Roman exploitation, this era witnessed a marked intensification of granite extraction. This activity materialised physically in the landscape through the development of a dedicated quarrying site, reflecting the scale of operations. Furthermore, to enable efficient export, a maritime terminal was constructed on the adjacent coastline. Granite was transported from the mountainous extraction zones to this port via an engineered aerial cable transport system, significantly streamlining international shipment.

The French colonial period instigated profound and lasting transformations across the region. The systematic dismantling of Roman structures to accommodate viticulture and facilitate mineral extraction fundamentally reconfigured spatial organization and patterns of local resource exploitation. This process irrevocably compromised significant elements of the pre-colonial historic fabric.

- Subsequent industrialization, particularly intensive granite extraction, further altered the landscape. Relics of this era—including abandoned quarry sites and the specialized export port—stand as tangible evidence of resource over-exploitation. These activities precipitated substantial modifications to both the natural topography and the evolving urban morphology. (cf: Figure 26)

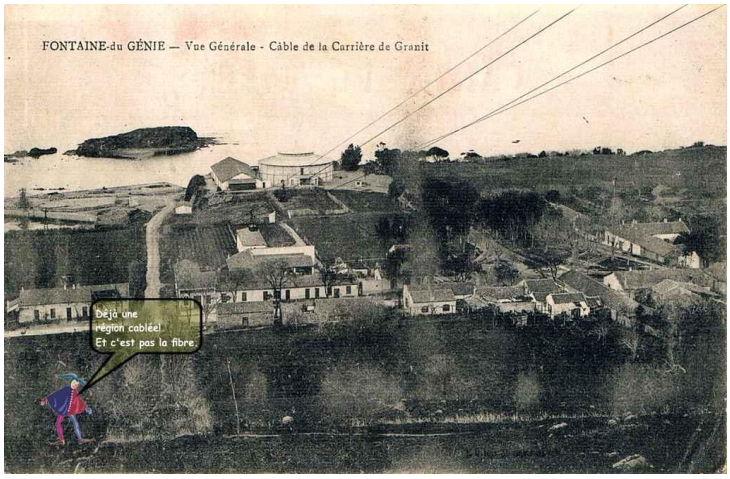

Figure 25: General View of Hajdret Enous and Cable of the Granite Quarry, Source : fontaine du genie,galerie de cartes

- Critically, the underdeveloped status of these successive historical strata (Roman and colonial) has created a vacuum in heritage-led planning. Consequently, contemporary urban expansion often proceeds in an unregulated manner, failing to integrate the region's significant architectural and cultural legacy into development frameworks. This oversight neglects a foundational component of local identity and sustainable place-making. (cf: Figure 27)

Figure 26: Public Square of « Fontaine de Genie », Source : fontaine du genie,galerie de cartes postales;http://alger-roi.fr

➢

1.3.Natural and physical features:

1.3.1. Topography:

Hadjret Ennous exhibits pronounced physiographic stratification, which directly informs land-use suitability and construction methodologies. Three distinct altitudinal zones are defined: (cf: Table 2).

Table 2 :Altitudinal Zoning and Corresponding Development Strategies in Hadjret Ennous, Source : Author.

Zone	Altitude	Characteristics	Development Approach
Coastal Plain	0–50 m	Low-lying relief; high suitability for public spaces and low-impact tourism infrastructure.	Corrosion-resistant materials; strict coastal setback regulations.
Intermediate Slopes	50–200 m	Moderate gradients requiring contour-aligned structures.	System terracing for erosion control; stepped foundations to preserve terrain integrity.
Mountainous Zone	>200 m	Steep slopes, high wind exposure, and limited accessibility.	Limited siting; structurally integrated local stone construction for slope stabilization.

The municipality's terrain ranges from coastal flats (0 m AMSL) to rugged highlands exceeding 500 m, generating significant morphological complexity. This gradient has historically governed settlement patterns, resulting in three determinant factors:

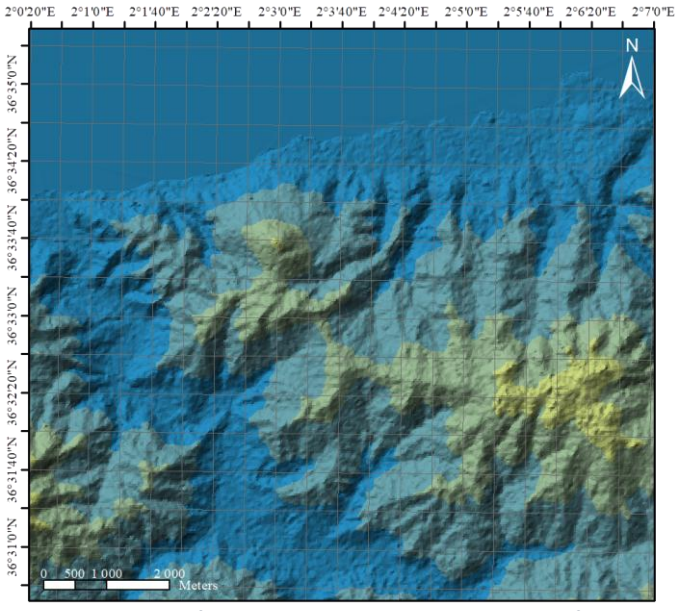

Figure 27: tin of Hadjret ennous, Source: Autor, Software:

- **Slope Dominance:** >60% of the territory's inclined surfaces restrict horizontal expansion, necessitating vertical adaptation strategies;
- **Maritime Proximity:** The Mediterranean coastline functions as both an economic catalyst (tourism/fisheries) and a constraint due to coastal vulnerability;

- **Path Dependency:** Urban form evolved through iterative adaptation to topographic barriers, with historical growth corridors following permeable low-gradient zones. (cf: Figure 36 & 37)

The confluence of marine adjacency and orographic confinement has rendered slope management and coastal resilience foundational to Hadjret Ennous's spatial organization.

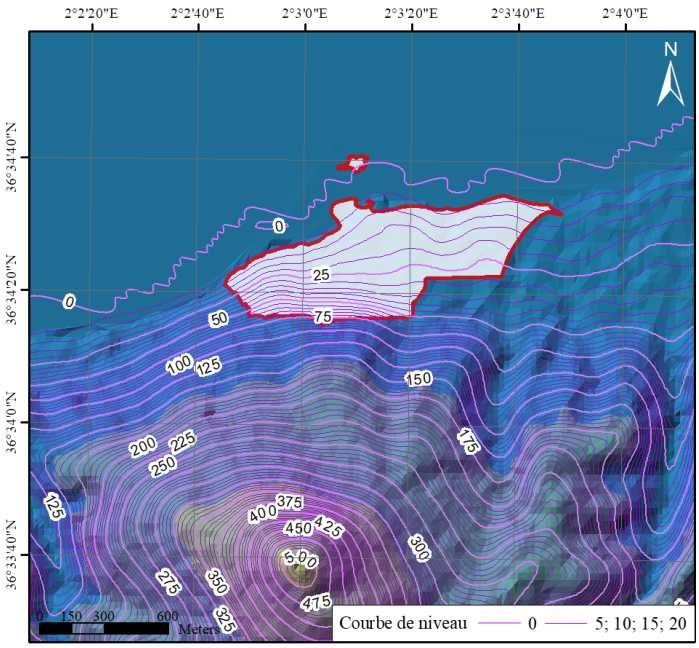

Figure 28:Contour of Hadjret ennous, Source: Autor, Software:

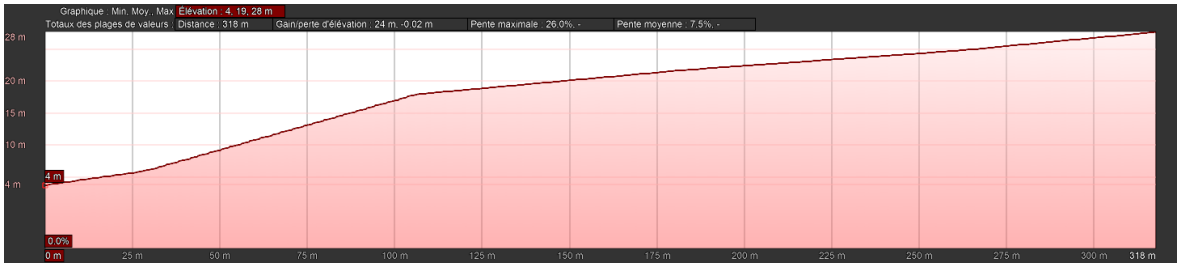

Figure 29: Hadjret ennous slope, Source: Google maps.

1.3.2. Climate:

The Hadjret Ennous region is characterised by a Mediterranean climate.

- Temperature:

The Climate Meteogram[13] shows the annual change in of maximum (red: 15°-

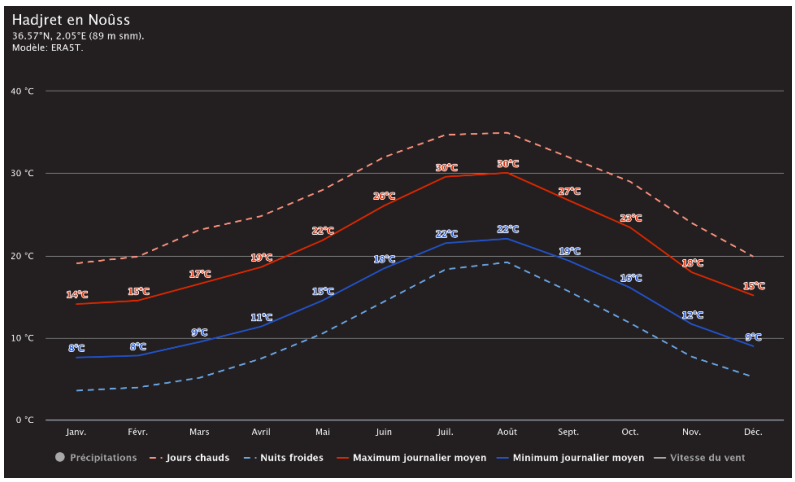

Figure 30: Meteogram of Temperature, Source: https://www.meteoblue.com/

[13] Simulated historical climate & weather data for Blida (no date) meteoblue. Available at: Simulation de données climatiques et météorologiques historiques pour Hadjret en Noûss - meteoblue

30°) and minimum blue and minimum temperatures (blue / 8°- 22°) at Hadjret Ennous, characterised by Mediterranean climate. (cf: Figure 28)

- Rainfall:

The Hadjret Ennous region exhibits a distinct Mediterranean precipitation regime, characterised by concentrated autumn-winter rainfall. Peak monthly accumulation occurs in November (≈90 mm), with secondary maxima in January and March (≈75 mm respectively. A progressive attenuation of precipitation commences in spring, evidenced by a May mean of 45 mm. Summer months demonstrate pronounced moisture deficit, culminating in July's extreme aridity (2 mm). The seasonal hydrological cycle recommences in September (mean: 30 mm), simultaneously terminating the antecedent dry period and initiating the annual wet phase.an average of 30 mm recorded. This marks the conclusion of the preceding dry season. (cf: Figure 29).

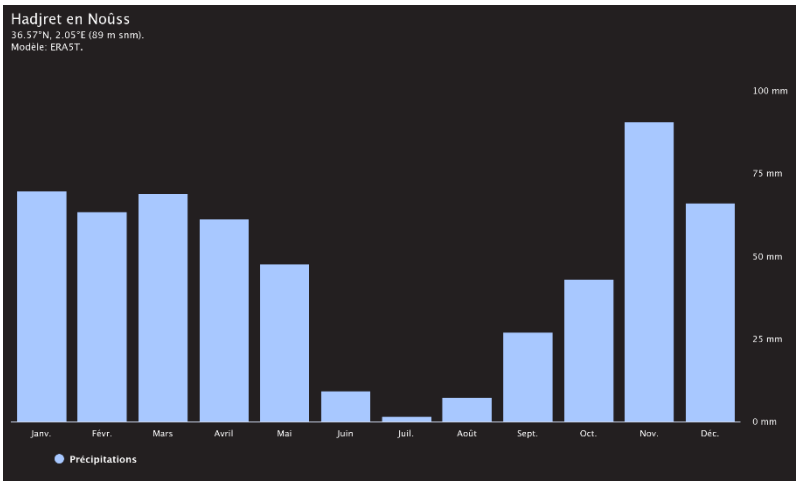

Figure 31: Meteogram of Rainfall, Source: https://www.meteoblue.com/

- WIND:

The compass rose[14] for Hadjret Ennous shows that the prevailing winds blow mainly from the east (ENE)[15]and west (W), with speeds varying mainly between 5 and 20 km/h. Some stronger

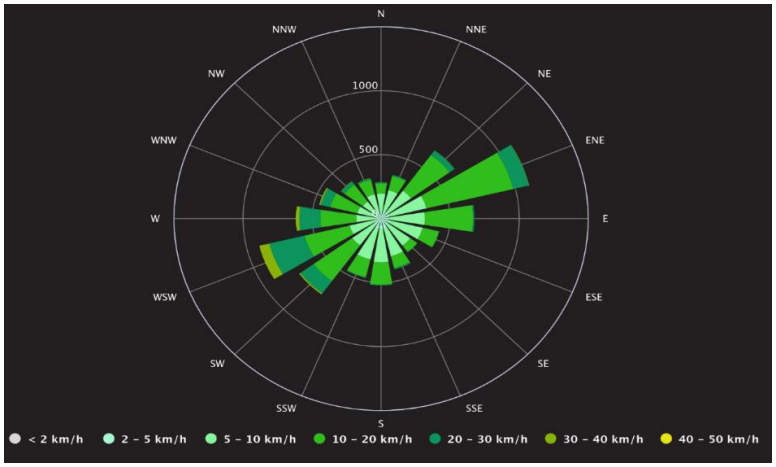

Figure 32: The wind rose, Source: https://www.meteoblue.com/

[14] is a graphic representation of the cardinal points and intermediate directions, used in cartography and navigation to facilitate orientation. It can also be used to display wind direction and speed data over a given period. In meteorology, it is used to analyse the prevailing winds in a region.
[15] East-north-east

gusts, between 20 and 30 km/h, are also observed in certain directions. (cf: Figure 32)

- The climate change:

The diagram shows a progressive increase in average temperatures at Hadjret Ennous between 1979 and 2024, confirming the impact of climate change. The intensification of warm anomalies highlights the urgent need to limit warming in order to achieve the global temperature [16]target, in particular by reducing greenhouse gas emissions and taking sustainable initiatives. (cf: Figure 33)

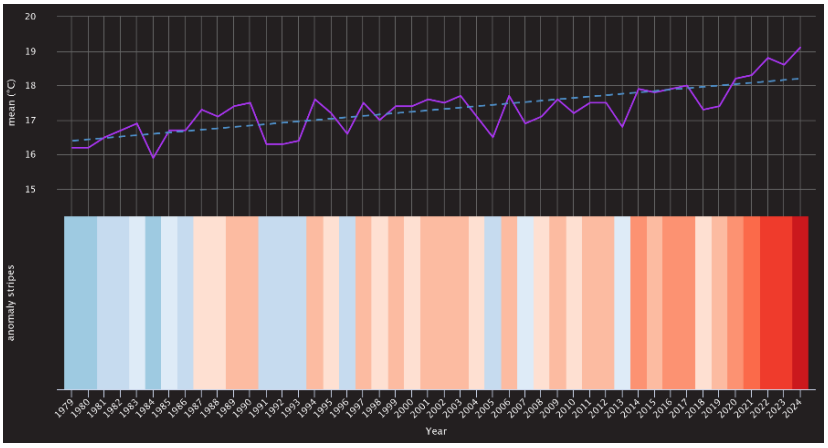

Figure 33: Climate change Diagram, Source : https://www.meteoblue.com/

1.3.3. Agricultural Potential:

Hadjret Ennous is located on the coast of the region of Tipaza, in the Chenoua-Zeccar area, an area of great landscape and ecological diversity. The area is bordered by natural resources, and is characterised by its rich biodiversity and potential for sustainable development. It opens out into the Mediterranean Sea to the north, giving it

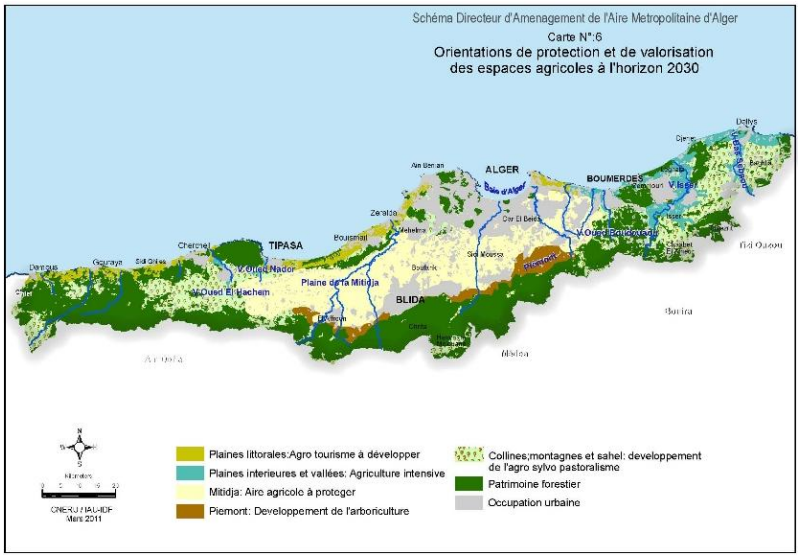

Figure 34: map of agricultural land potential, Source: SDAAM

[16] The agreement reached in Paris in 2015 sets out a global framework to limit global warming to well below 2°C, preferably 1.5°C (degrees Celsius), compared with pre-industrial levels.

a coastline that is favourable to maritime and tourism activities, while also contributing to the landscape identity of the region. (cf: Figure 34)

Further inland, the region's class 1 and 2 agricultural plains are a major opportunity for developing intensive farming and agro tourism. Such fertile land is ideal for sustainable farming, contributing to the local economy and protecting food security. (cf: Figure 35).

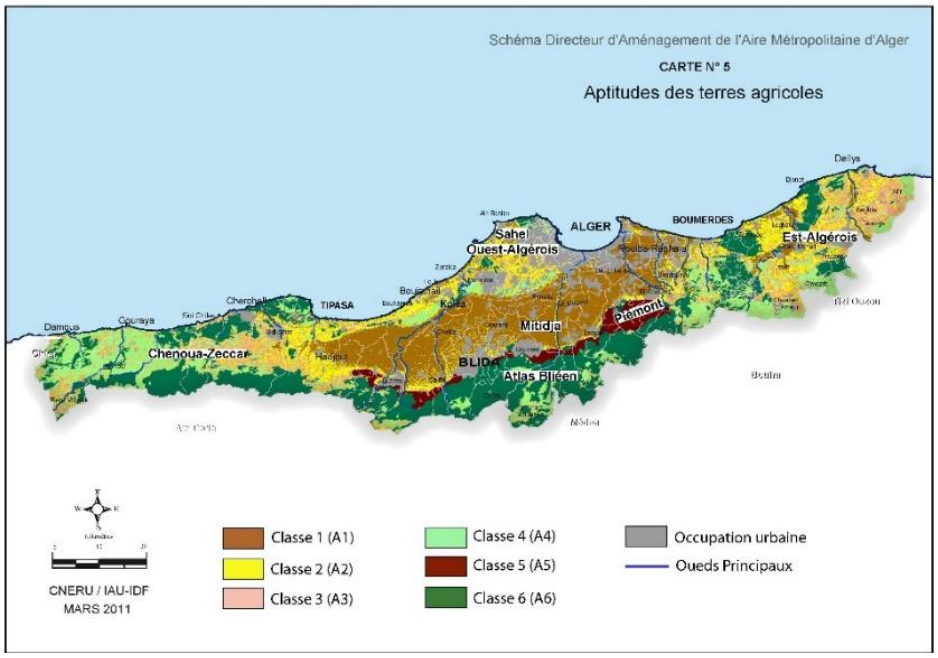

Figure 35: map of agricultural land potential, Source: SDAAM

The mountainous terrain of the Chenoua-Zeccar area to the south forms a natural barrier, creating a unique landscape and home to a diverse range of flora[17] and fauna[18].

This area is particularly well-suited to the development of forestry and agro-sylvo-pastoralism, balancing agriculture and environmental protection. Water resources are essential to the ecological balance of the area and to the irrigation of farmland. These water resources support farming activities and contribute to the area's resilience in the face of climatic challenges.

This exceptional natural context means that Hadjret Ennous has great opportunities for harmonious development, integrating managed urbanisation and environmental conservation, with a view to sustainability and enhancing its natural assets.

1.3.4. Natural risks:

[17] Totality of plant species present in an ecosystem, essential for oxygen production and carbon storage. (Source: Gaston, K.J., & Blackburn, T.M., 2000. Pattern and Process in Macroecology. Blackwell Science).
[18] Species that inhabit a given environment and contribute to the balance of ecosystems. (Source: Blondel, J., 1995. Biogeographie, Approche écologique et évolutive. Masson.)

Hadjret Ennous is located in seismic zone III, which indicates high seismic activity. This classification means that the region is extremely exposed to earthquakes, with active seismic faults in the area. (cf: Figure 34).

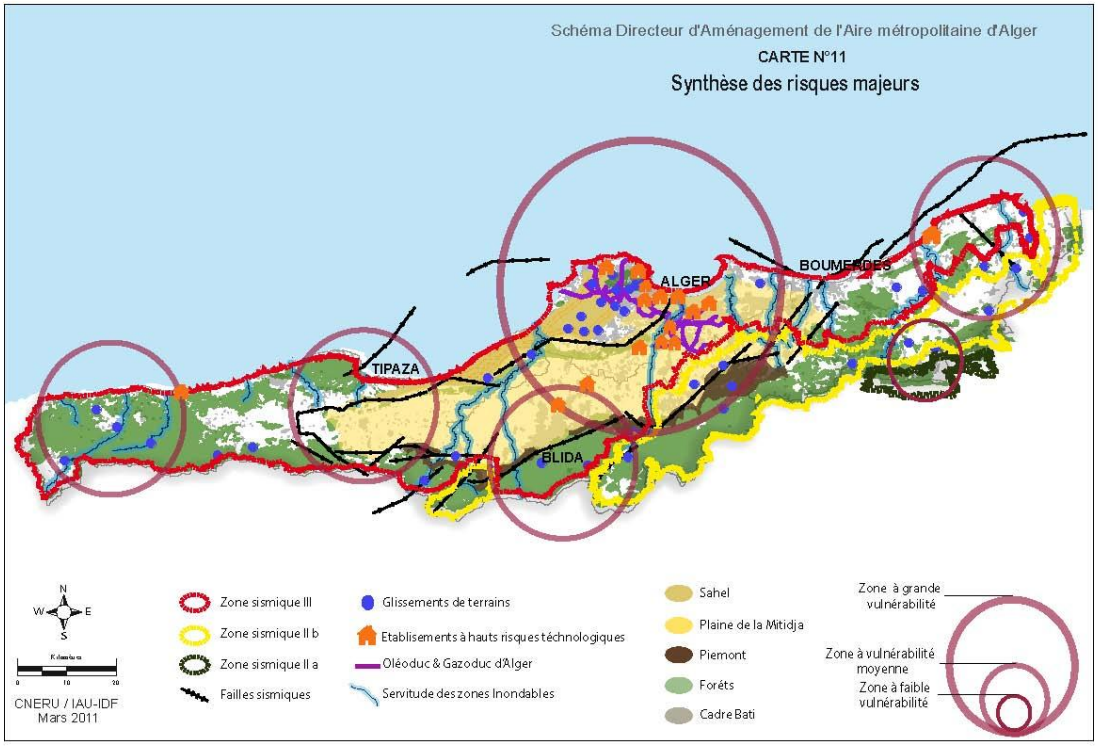

Figure 36: Map of main risks, Source: SDAAM

Summary of natural and physical features of Hdjret Ennous:

- Under-exploited environmental potential: Hadjret Ennous boasts a wealth of maritime, agricultural and ecological resources, but their development is limited.
- Farmland under threat: The fertile plains offer opportunities for agriculture and agro tourism, but urbanisation threatens to weaken them.
- Endangered biodiversity: The Chenoua-Zeccar massif is a precious ecosystem, but one that is under increasing human pressure.
- Strategic water resources: Water is essential for agriculture and ecological balance, but can be damaged by climate change and over-exploitation.
- High earthquake risk: Located in zone III, Hadjret Ennous is highly exposed to earthquakes, making it necessary to adapt and secure urban development.
- Contrasting relief: Altitudes ranging from 0 to 500 m, influencing urban development and shaping the city's expansion.
- Maritime assets: The sea plays a key role in the town's development.

1.4.Population and Social Context of Hadjret Ennous

Hadjret Ennous, a mid-sized urban center in northern Algeria, had a population of **2,150 inhabitants in 2015**, which increased to **2,424 by 2023** (latest census data). This growth reflects a moderate demographic trend, positioning the town among Algeria's **lower-density urban areas** (see Figure 37).

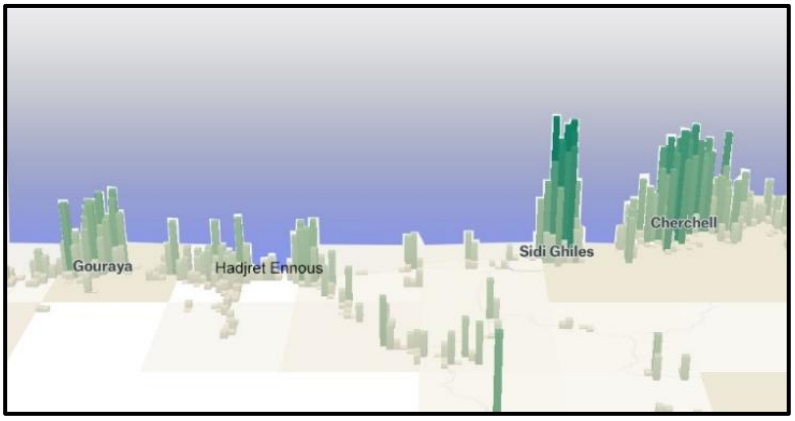

Figure 37: population map of Hadjret Ennous, Source : https://pudding.cool/2018/10/city_3d / Treaty : Autor

Given its relatively small population size compared to larger Algerian cities, Hadjret Ennous presents unique **socio-spatial dynamics** that must inform urban planning strategies. The **social dimension**—including population density, growth trends, and community needs—is a critical factor in assessing sustainable urban development.

Key Implications for Urban Planning:

- **Demographic Considerations:** The town's moderate population concentration necessitates tailored infrastructure scaling to avoid over- or under-provisioning of services.
- **Equitable Development:** Urban interventions should prioritize **inclusive growth** to address potential disparities in service accessibility.
- **Future-Proofing:** Projections based on current growth rates should guide long-term land-use and housing policies.

These statistical insights will serve as a foundational reference for shaping context-sensitive urban actions in our study area.

1.5.Urban features:

1.5.1. Infrastructure And Traffic Circulation:

a. Road Network Hierarchy:

- Hadjret Ennous exhibits a functionally stratified road system comprising three distinct tiers:
- Primary Arterial Roads (RN11): Facilitates interurban connectivity and regional mobility, serving as the principal corridor for through-traffic.
- Secondary Collector Roads: Distributes traffic locally between neighbourhoods, experiencing recurrent congestion during peak hours due to limited capacity.
- Tertiary Access Roads: Provides parcel-level connectivity between developments and higher-order roads, characterized by severely constrained throughput.

b. **Traffic Flow Characteristics:**

Traffic circulation maintains adequate operational efficiency for most of the year. However, pronounced seasonal fluctuations occur during summer months when tourist influx generates significant volume increases, particularly along coastal access corridors. This periodicity necessitates adaptive traffic management strategies.

c. Infrastructure Performance Assessment:

- Adequately Served Zones: Areas with appropriately scaled infrastructure maintain Level-of-Service (LOS) standards commensurate with existing demand profiles.
- Deficiency Hotspots: Critical bottlenecks emerge at geometrically deficient intersections and along undersized local streets, manifesting as recurrent congestion and elevated collision risks during peak periods. (cf: Figure 38)

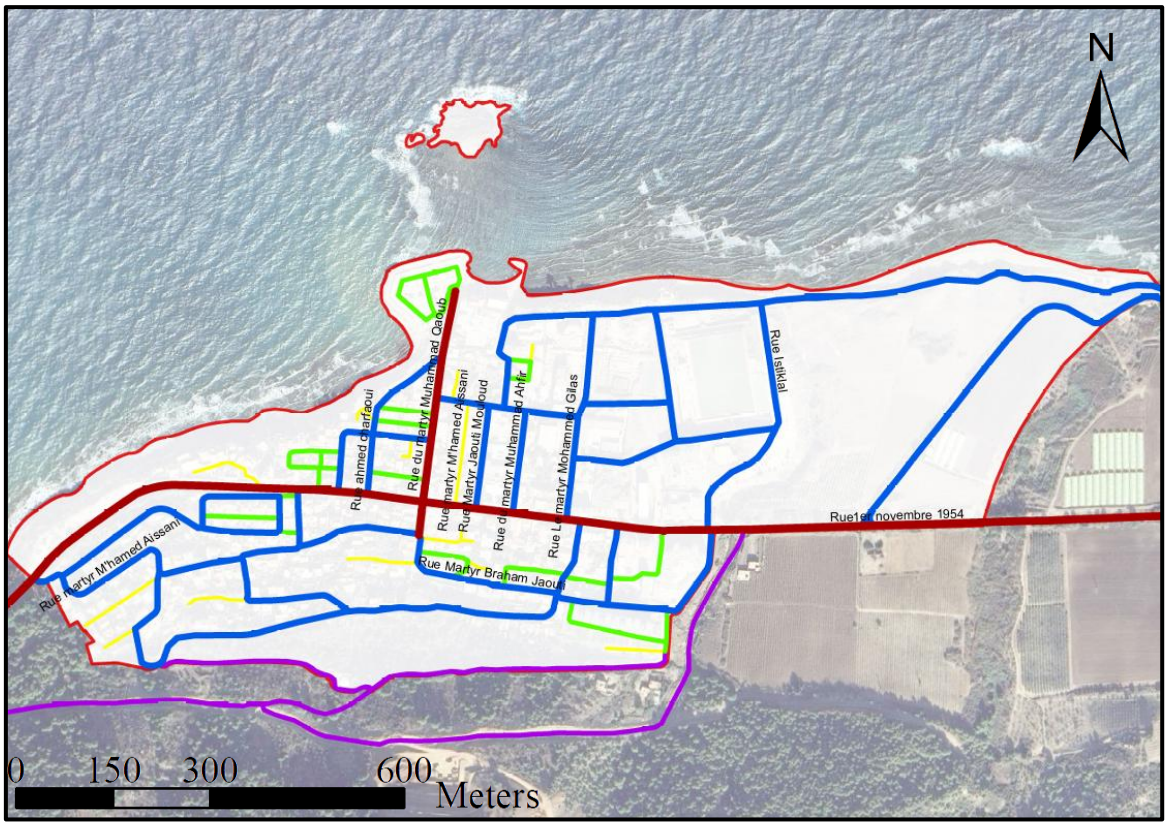

Figure 38: streets Map of Hadjret ennous, Source: Autor, Software: Arc Gis.

1.5.2. built and unbuilt areas:

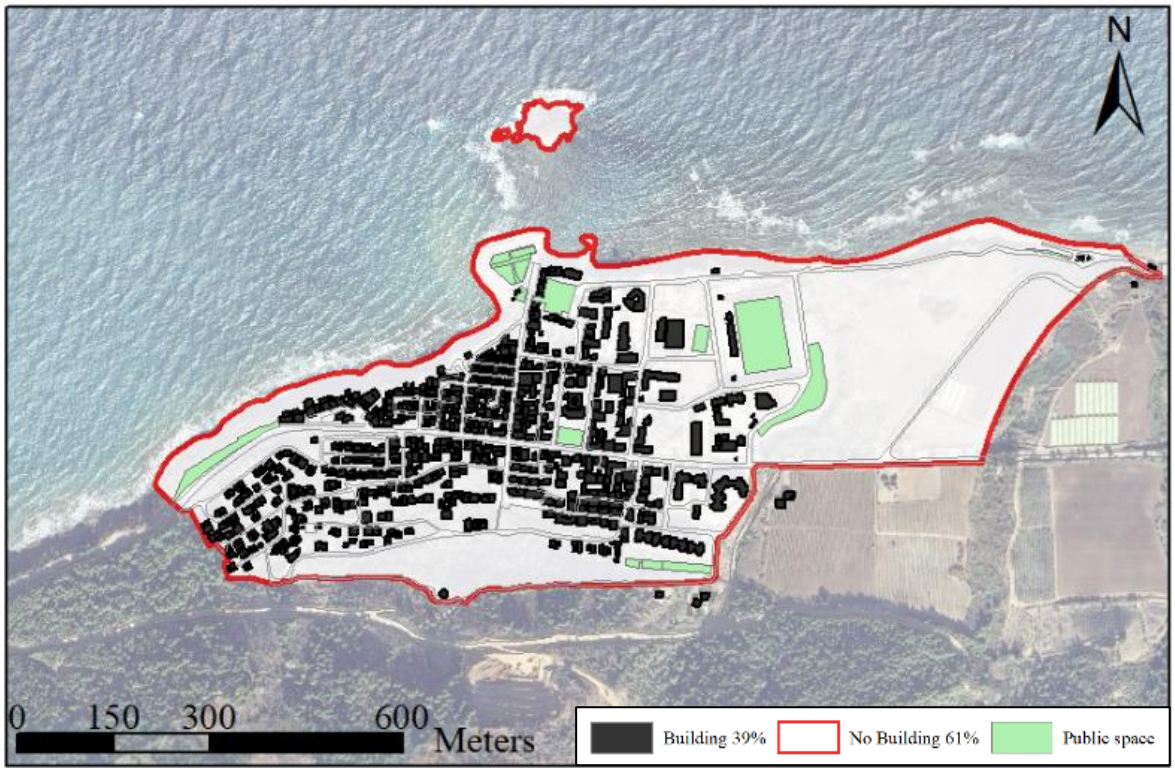

Figure 39: Map of undeveloped land, Source : Autor, Software :Arc Gis

- Urban Planning [19]Project. We must therefore take these statistics into account, in the development of urban actions in our study area. (cf: Figure 39)

1.5.3. Urban Blocks And Plots:

a. Orthogonal Urban Morphology (Historic Core): The pre-existing urban fabric exhibits a rigorously geometric configuration, characterized by elongated, regularly shaped plots organized within rectilinear or square blocks. This orthogonal layout reflects deliberate historical planning principles, likely originating from an era prioritizing formal urban order. Straight streets intersecting at right angles establish a hierarchical network that functionally demarcates block boundaries, demonstrating systematic spatial organization.

b. Organic Urban Morphology (Contemporary Expansion):

Conversely, newer developments display organic block structures and irregular plot geometries, diverging from orthogonal rigidity. This morphology adapts to topographical constraints and contemporary design paradigms, facilitating greater spatial flexibility. The resultant streetscapes foster pedestrian-oriented spatial diversity, generating visually dynamic and socially engaged environments. This approach represents a critical synthesis of modern planning aspirations with contextual sensitivity to site-specific conditions. (cf: Figure 40)

[19] is the process of designing and organising the development of urban areas, with the aim of creating sustainable, efficient and liveable environments. It involves zoning laws, infrastructure design and taking into account social, economic and environmental factors.

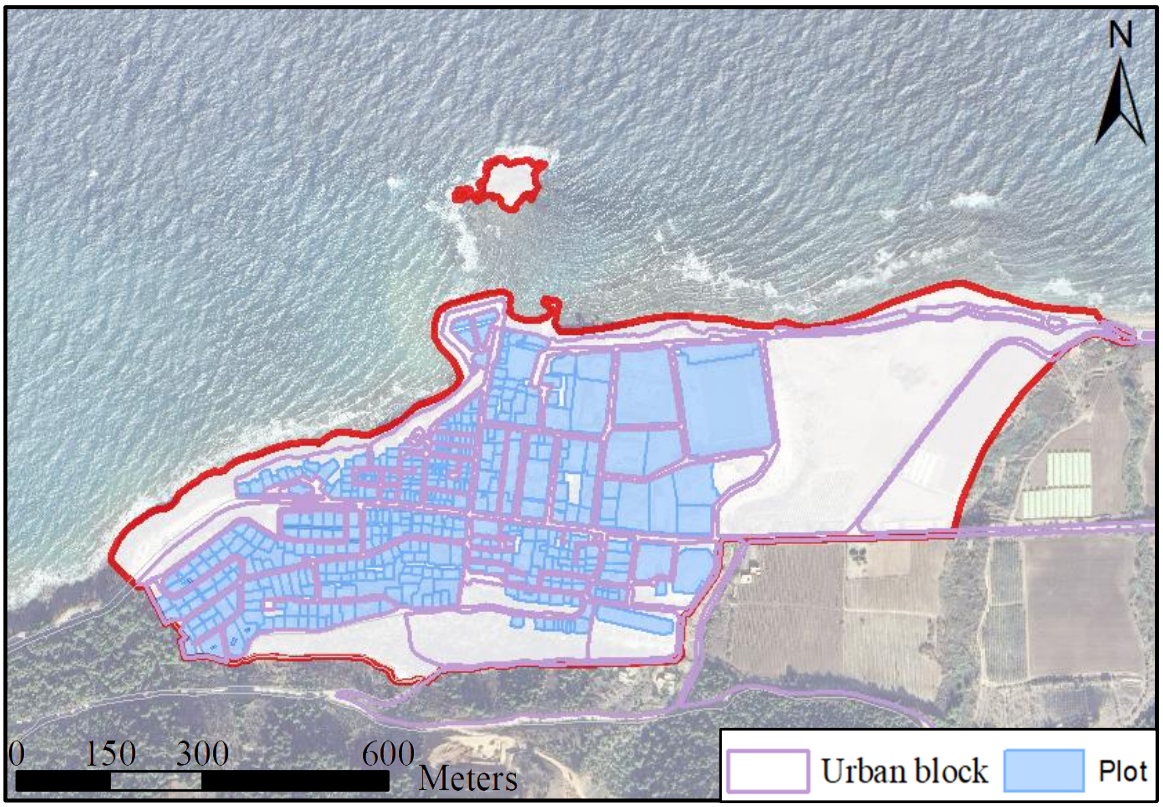

Figure 40: Urban block and Plots Map of Hadjret ennous, Source: Autor, Software: Arc Gis.

1.5.4. Building Outline:

Hadjret Ennous exhibits a morphologically stratified built environment shaped by its coastal topography and terrain constraints. Cartographic analysis reveals a predominance of low-rise structures across the urban core, characterized by:

- Ground-floor constructions (Rez-de-chaussée, RDC) ;
- Low-rise developments (1–2 storeys; *C+1/R+1* and *C+2/R+2*).

Medium-rise buildings (3–4 storeys; *C+3/R+3* and *C+4/R+4*) concentrate in discrete nodal zones, indicating targeted densification. Limited occurrences of high-rise residential blocks (*R+5*) signify emergent vertical intensification.

This settlement pattern demonstrates terrain-responsive adaptation:

- Coastal interface: Strict building height regulation preserving maritime vistas and dune systems;
- Hinterland transition: Gradual porosity toward agricultural peripheries maintaining rural-urban edges;
- Topographic compliance: Structural alignment minimizing cut-fill operations on slopes.

The resultant urban form balances growth management with ecological sensitivity, reflecting vernacular place-making traditions within contemporary development frameworks. (cf: Figure 41)

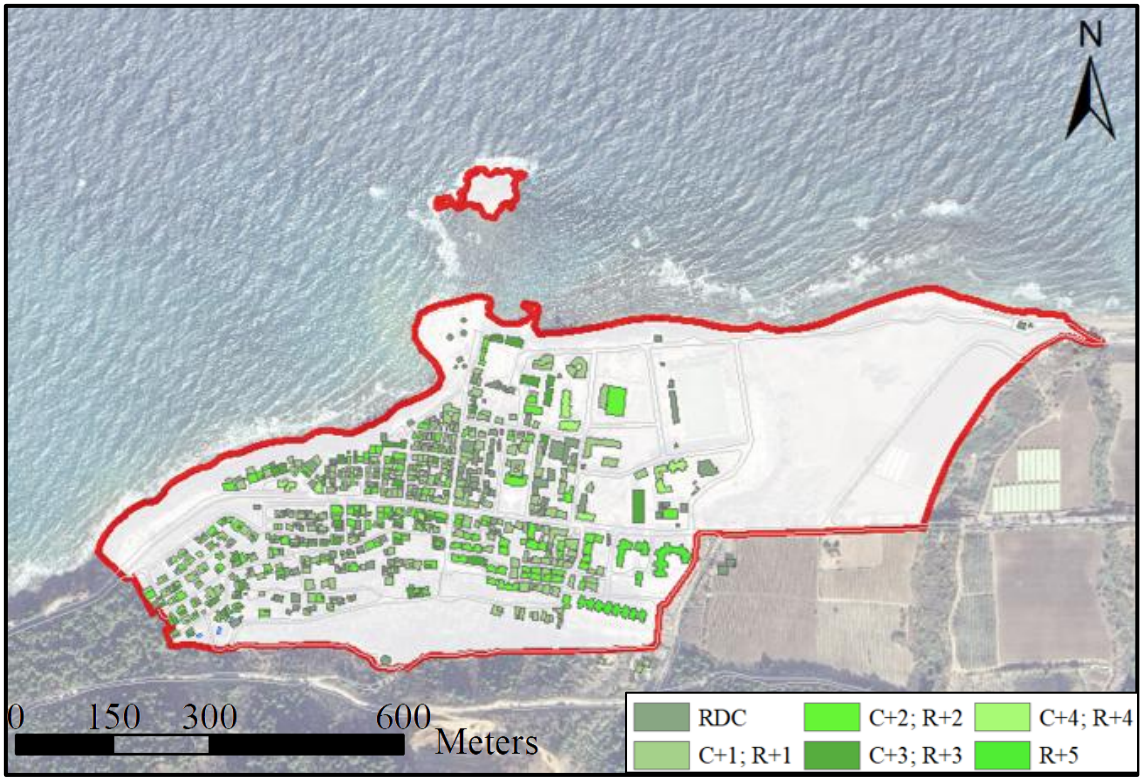

Figure 41:Building Outline map of Hadjret ennous, Source: Autor, Software: Arc Gis.

1.5.5. Building Condition:

The condition of the buildings in Hadjret Ennous is generally satisfactory, with the majority in good condition. According to the data analysed, 91.83% of buildings are well protected, while 4.32% are in medium condition and 1.85% are in bad condition. The map illustrates a balanced distribution of buildings in good condition, while structures in average and poor condition are located in specific areas. Even though the urban fabric is solid overall, the presence of buildings in poor condition underlines the need for carefully targeted renovation

measures to improve the quality of life of residents and strengthen urban resilience. (cf: Figure 42) .

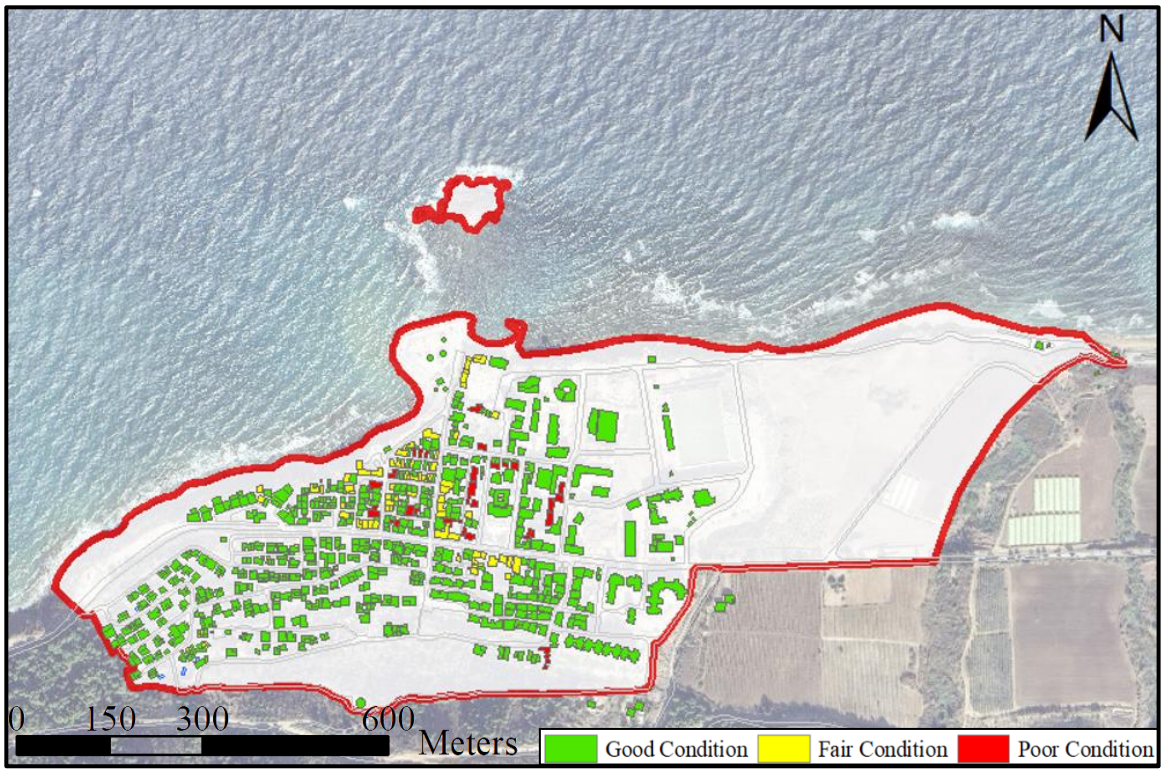

Figure 42:Building Condition Map, of Hadjret ennous, Source: Autor, Software: Arc Gis.

1.5.6. Functional Diversity and Service Provision:

Hadjret Ennous demonstrates a moderately diversified functional base meeting essential resident needs, though spatial distribution reveals opportunities for optimization. The activity mosaic comprises five interdependent subsystems:

Administrative & Civic Infrastructure:

Core municipal operations center around the Assemblée Populaire Communale (APC), supported by critical security infrastructure: a gendarmerie, police precinct, and dedicated civil protection unit. Cultural capital is maintained through a public library serving as a literacy and community hub.

Educational Ecosystem:

A tiered educational framework exists:

- Primary schools (foundational education);
- Collège (secondary education continuity);
- Centre de Formation Professionnelle et d'Apprentissage (CFPA) delivering vocational training across age cohorts.

Commercial & Service Economy:

Economic functions cluster in:

- Covered market (agglomeration of local commerce);
- Shopping center (retail/service consolidation);
- Post office (financial/administrative services node).

Recreational Infrastructure

Leisure facilities leverage coastal and terrestrial assets:

- Multipurpose hall (community event hosting);
- Indoor sports complex (formal athletic activity);
- Diving club (maritime recreation development).

Socio-Cultural Anchors

Dominant residential zones integrate with:

- Central mosque (spiritual and communal gathering);
- Limited public greenspace (identified deficiency).

Functional Assessment

While essential service provision establishes a baseline livability threshold (Fig. XX), critical gaps persist:

- Mobility Deficits: Pedestrian connectivity between functional zones remains suboptimal, particularly linking hillside residential areas to coastal amenities;
- Green Space Deficiency: Current provision falls below WHO-recommended 9m² per capita thresholds;
- Economic Diversification: Limited specialized services (e.g., healthcare, banking) necessitate extra-communal travel.

Strategic enhancements should prioritize green corridor development, non-motorized transport networks, and heritage-sensitive infill to elevate sustainability metrics while preserving community identity. (cf: Figure 43)

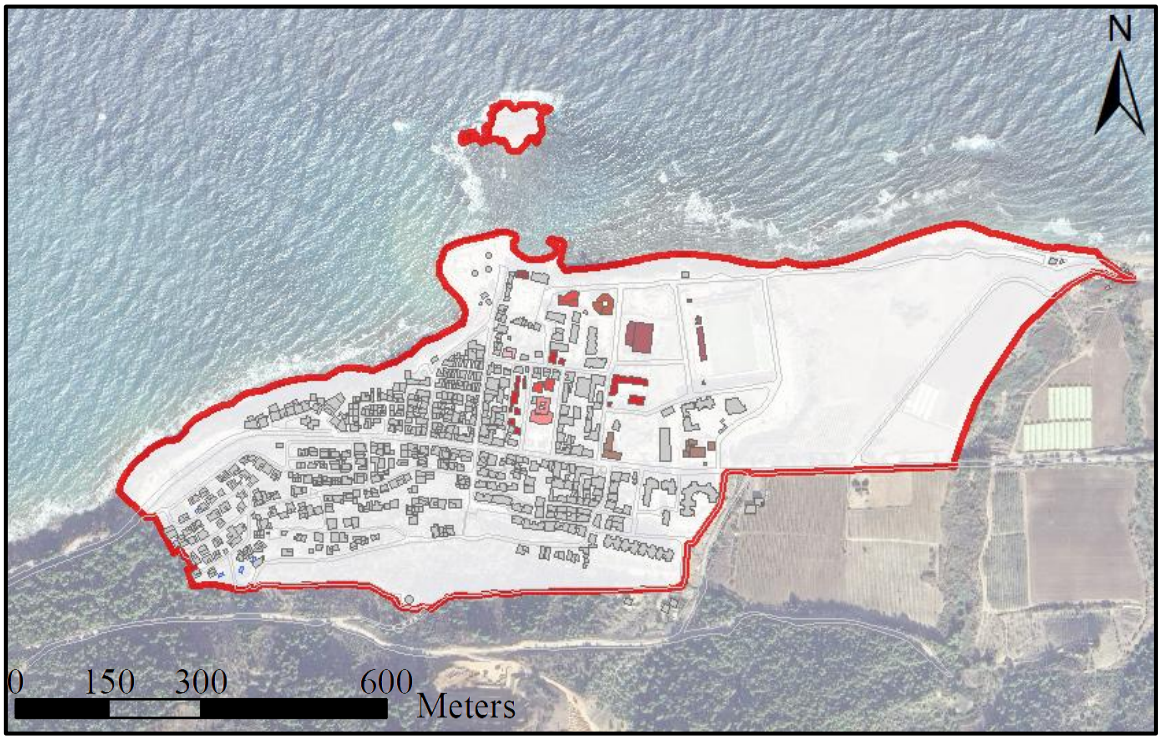

Figure 43: Activite Map, of Hadjret ennous, Source: Autor, Software: Arc Gis.

2. Urban Challenges and development constraints in Hadjret Ennous

2.1.Identification statutory land easements (servitudes) analysis

2.1.1. Coastal setback encumbrances:

- In this city, the regulations stipulate a 100-metre setback from the coastline, a provision that considerably restricts the feasibility of constructing residential properties in this area. Confronted with this challenge, a strategic realignment of our land-use planning has been necessitated, entailing the consolidation of all public facilities and infrastructure

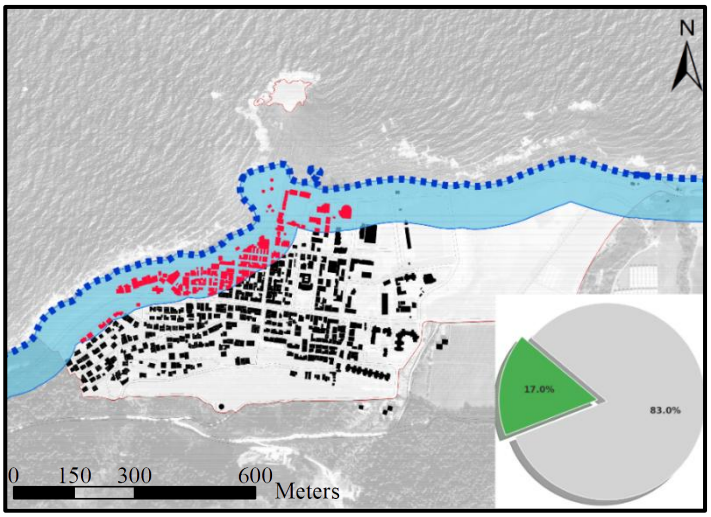

Figure 44: Sea easement map of Hadjret ennous, Authors

within the confines of this easement strip. This includes the consideration of the 65 existing houses in order to optimise the available space while complying with current standards. (cf: Figure 44)

2.1.2. Transportation Corridor encroachments:

The easement for the main road imposes a setback of 35 metres on both sides of its axis. In this town, 56 houses have been constructed within the designated zone, thereby creating a problem through their contribution to the deterioration of the main road. In order to rectify the current situation, it would be a viable option to consider repositioning the primary thoroughfare along the pre-existing road. (cf: Figure 45).

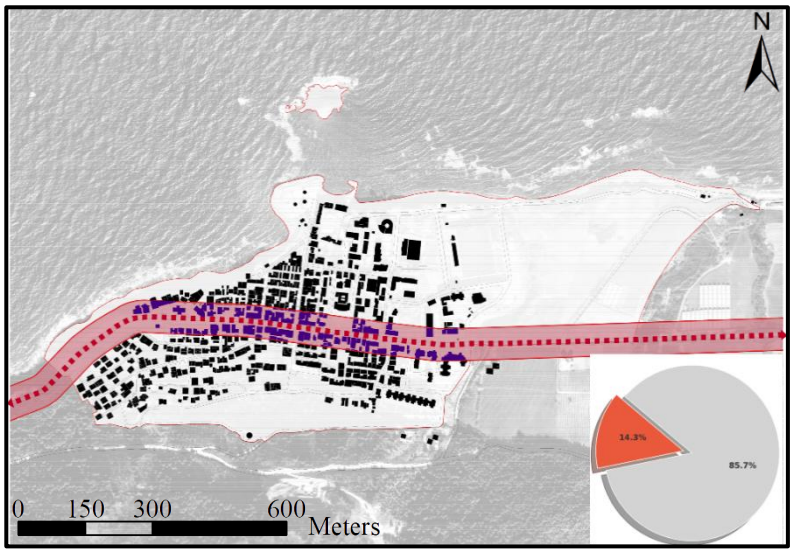

Figure 45: Road easement map of Hadjret ennous, Source: Autor,

2.1.3. Geohazard Restriction Zones:

The presence of a forest easement and a landslide line poses a significant challenge to the town, primarily due to the steepness of the slope. Moreover, the regulations stipulate that no construction is permitted in this area, thereby significantly restricting the potential for development. In order to guarantee the stability of the ground and prevent the risk of landslides, it is essential to construct a retaining wall, which is a major challenge. Moreover, the area is not directly connected to the city, despite the historical presence of a cable car. (cf: Figure 46).

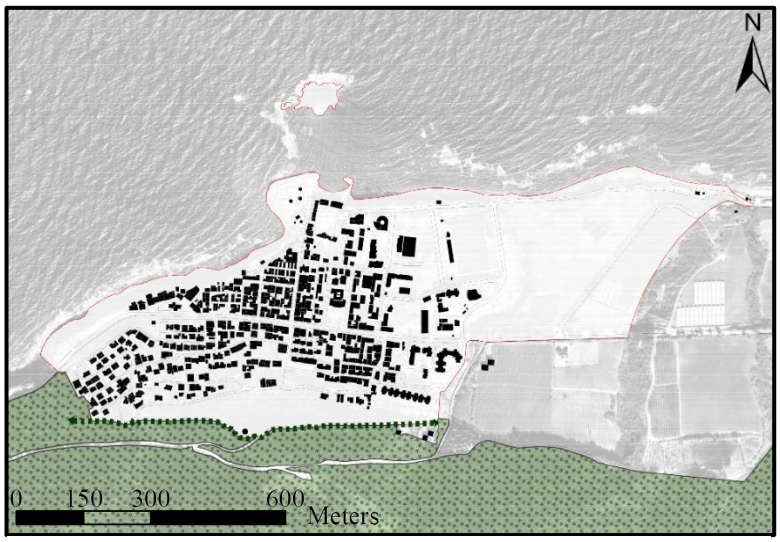

Figure 46:Foret easement map of Hadjret ennous, Source: Autor,

2.1.4. Utility infrastructure encumbrances:

The power line of electricity is situated within a 15-metre easement within the town, which poses a potential risk due to the hazards associated with high voltage installations. Moreover, the wadi easement extends for a distance of 15 metres, thereby imposing restrictions on development in the surrounding area. The presence of this easement is imperative in order to prevent the risk of flooding and erosion. However, it is also important to note that it limits the scope for construction and urban development. (cf: Figure 47).

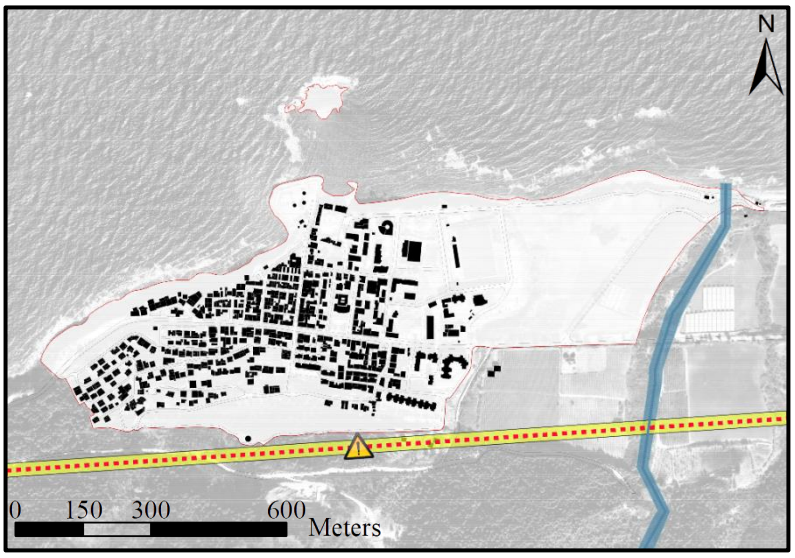

Figure 47: Electric Cable Easement and river map of Hadjret ennous,

2.2.Key Problems Affecting the Intervention Zone:

2.2.1. Coastal connectivity deficits:

The city's unique geographical feature of direct road access to the sea is a valuable asset that is not possessed by many other cities. However, the configuration of these thoroughfares is such that they are characterised by a lack of width, vitality, and the absence of a seamless connection between the town and the coast. This paucity of development and activity has a deleterious effect on the appeal of these access points, which in turn limits their use by residents and visitors alike. It is therefore essential to rethink these routes by

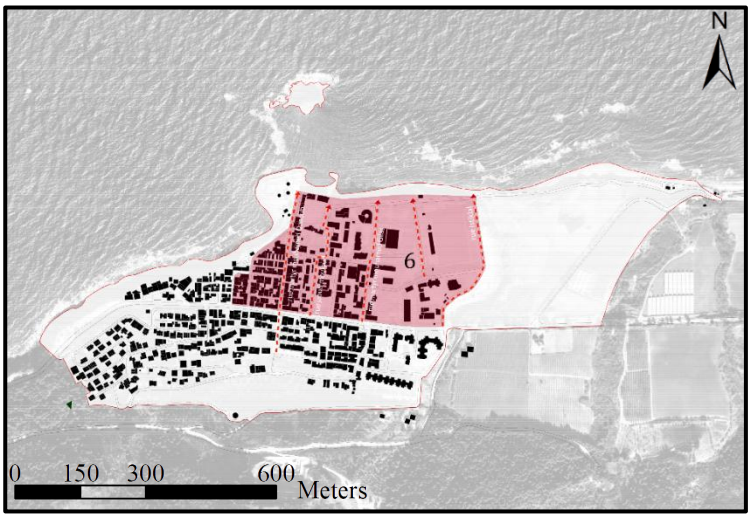

Figure 48:Problem map sea view of Hadjret ennous, Source: Autor, Software: Arc Gis and Treaty by Software: Illustrator.

widening them and making them more dynamic to strengthen the link between the town and the sea. (cf: Figure 48).

2.2.2. Urban morphology discontinuities:

In the urban fabric, the ancient traces of the city are distinguished by a more regular and well-structured layout. However, over time, these patterns have not been adhered to, resulting in a more organic and less orderly evolution of urban development.

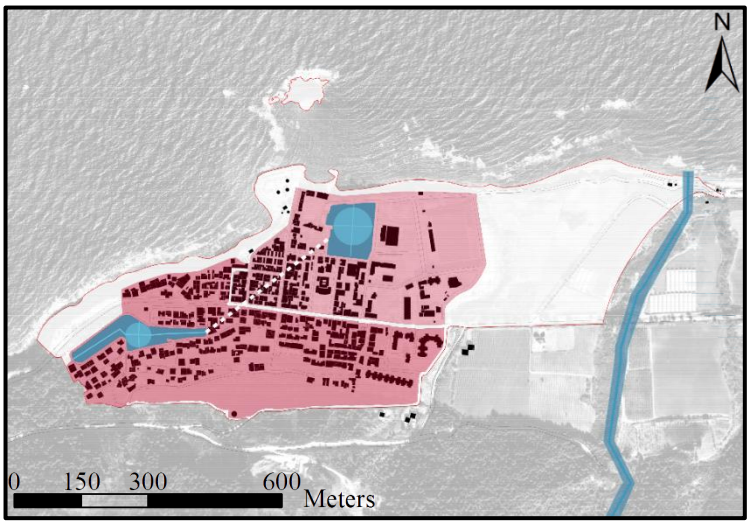

Figure 49 : Urban grid problem map of Hadjret ennous, Source:

Furthermore, the transition between these two forms of urban development is relatively brief, thereby creating a visible contrast between the well-planned, older areas and the more haphazard extensions of the town. (cf: Figure 49).

2.2.3. Equitable service provision gaps:

A paucity of public facilities is evident in several areas of the city. While certain facilities are available, their distribution is uneven, thereby impeding accessibility for a segment of the population. Of particular concern is the area to the left of the town, which is entirely devoid of public facilities, resulting in an imbalance in spatial planning. Furthermore, the existing facilities provide insufficient coverage to meet the needs of all residents, thereby exacerbating existing disparities in access. (cf: Figure 50).

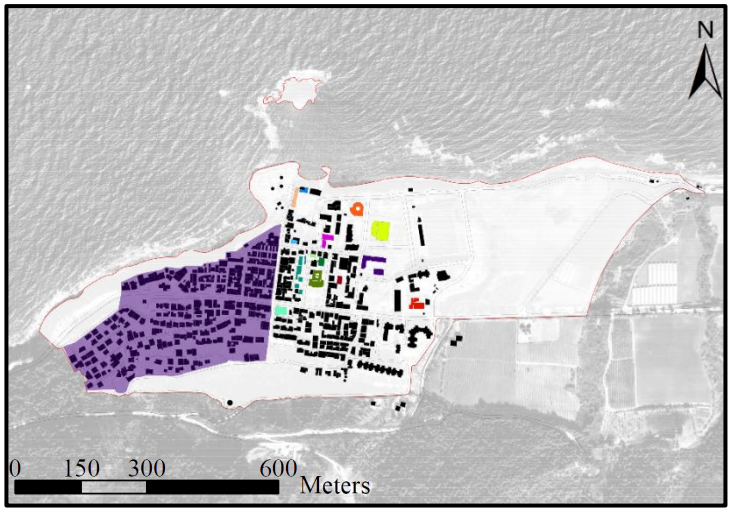

Figure 50: Problem animation port map of Hadjret ennous, Source:

2.2.4. Cultural-Geographic Asset Integration:

The town derives its name, Hadjret Ennous, from a substantial stone that was discovered in the sea in proximity to the coast. The geographical feature under consideration is distinguished by its proximity to the city and relatively low sea level, which facilitates ease of access to the port. (cf: Figure 51).

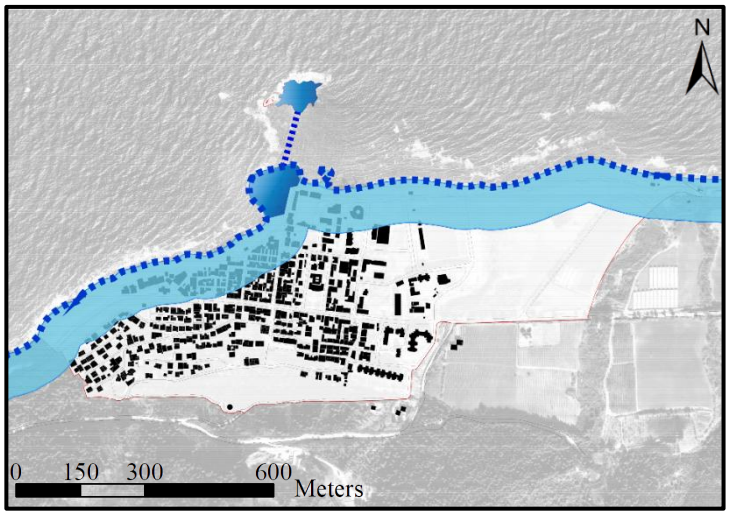

Figure 51 : Problem animation port map of Hadjret ennous, Source: Autor, Software: Arc Gis and Treaty by Software:

The Community surveys quantitatively validated the cultural and symbolic importance of the Hadjret Ennous stone, with 94.8 % of respondents identifying it as a defining element of local identity. This consensus positions the geological feature as a potential anchor for cultural tourism and placemaking strategies (Fig. 52). All the statutory land-use restrictions and environmental risks in Hadjret Ennous are synthesised in figure 54 below. The spatial data provides a regulatory compliance baseline for urban interventions in the project site.

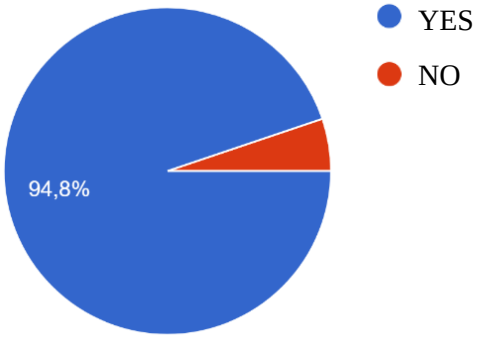

Figure 52 : Do you think the emblematic stone of Hadjret Ennous Al Nasr has tourism potential?

2.3.Towards a compact city in Hadjret Ennous: local implementation challenges

2.3.1. Facility Needs Assessment

Algeria's urban development strategies, guided by the Ministry of Spatial Planning and Environment (MATE), emphasize equitable access to services as part of compact city planning. Using MATE's theoretical equipment grid, we tried to evaluate Hadjret Ennous, which is a 1,500-inhabitant community against compact urbanism benchmarks, revealing critical gaps in infrastructure provisioning (Table 3).

Table 3 : Facility Needs Assessment in Hadjret Ennous

Category	Facility	Compact City Criteria	Status in Case Study	Implications
Health	Health center	Essential for 15-minute neighborhoods (WHO, 2018)	**Missing** (0 facilities)	Limits healthcare access, contradicting compact urbanism's proximity principle.
Cultural	Library	Supports social equity and education (UN-Habitat, 2020)	**Missing** (0 facilities)	Reduces cultural vitality and lifelong learning opportunities.
Leisure	Public park	Critical for green space per capita (10–15m²/inhabitant recommended by EEA, 2015)	**Missing** (0 parks; requires 1.5 hectares for 1,500 inhabitants)	Impacts recreation, mental health, and urban biodiversity.
Education	Primary school	Compact cities prioritize walkable schools (<500m) (Dill, 2004)	**Sufficient** (1 school; 10-minute walk)	Aligns with compact city accessibility standards.
Religious	Mosque	Proximity to daily services (5-minute walk ideal) (Gehl, 2010)	**Sufficient** (1 mosque; 5-minute walk)	Meets compact neighborhood criteria.
Sports	Sports field	Promotes active lifestyles (Stevenson et al., 2016)	**Sufficient** (1 field; 15-minute walk)	Supports health but could be closer (<10 mins for optimal use).

2.3.2. Identified Challenges

➢ Critical Service Gaps:

- Absence of health centers and libraries directly conflicts with compact urbanism's social equity and accessibility goals.
- Parks are entirely missing, undermining environmental and health benefits of green spaces.

➢ Spatial Mismatch: While schools and mosques meet accessibility standards (5–10 minute walks), sports fields (15-minute walks) exceed the ideal 10-minute threshold for daily amenities.

- Policy-Implementation Gap: MATE's equipment grid theoretically supports compact development, but on-ground execution lags, particularly for cultural/health infrastructure.

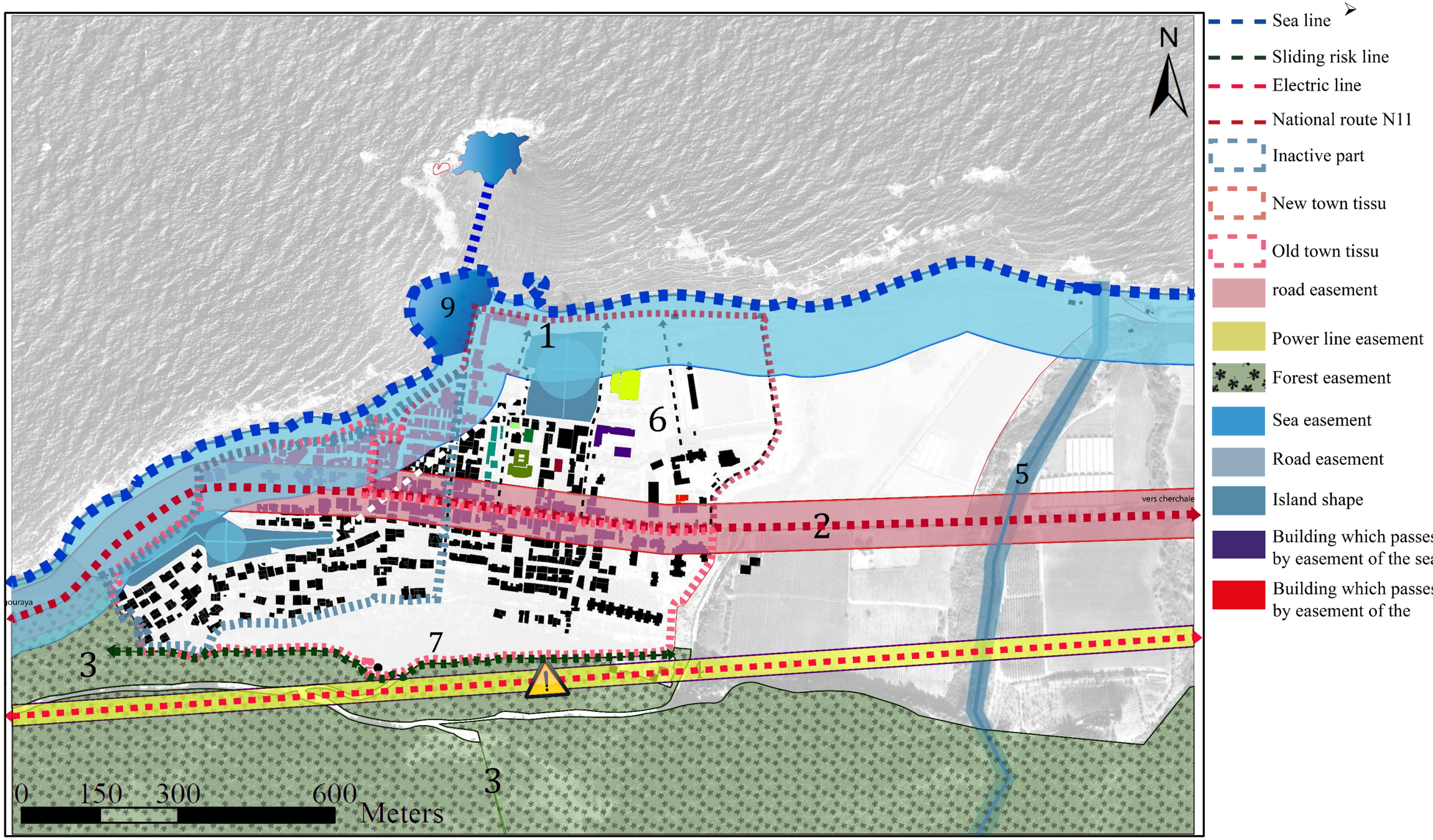

Figure 53: Hadjret Ennous: Statutory Constraints and Urban Risk Exposure, Source: Autor, Software: Arc Gis and Treaty by Software: Illustrator.

3. Integrated urban strategies for the redevelopment of Hadjret Ennous: enhancing the dialogue between nature and the built environment:

According to the analysis we conducted on the study area, we have proposed an action plan to enhance this area, animate it, and develop its touristic and agricultural activities through an appropriate exploitation of its resources and effective management of its negative aspects to improve them. (cf: Figure 54)

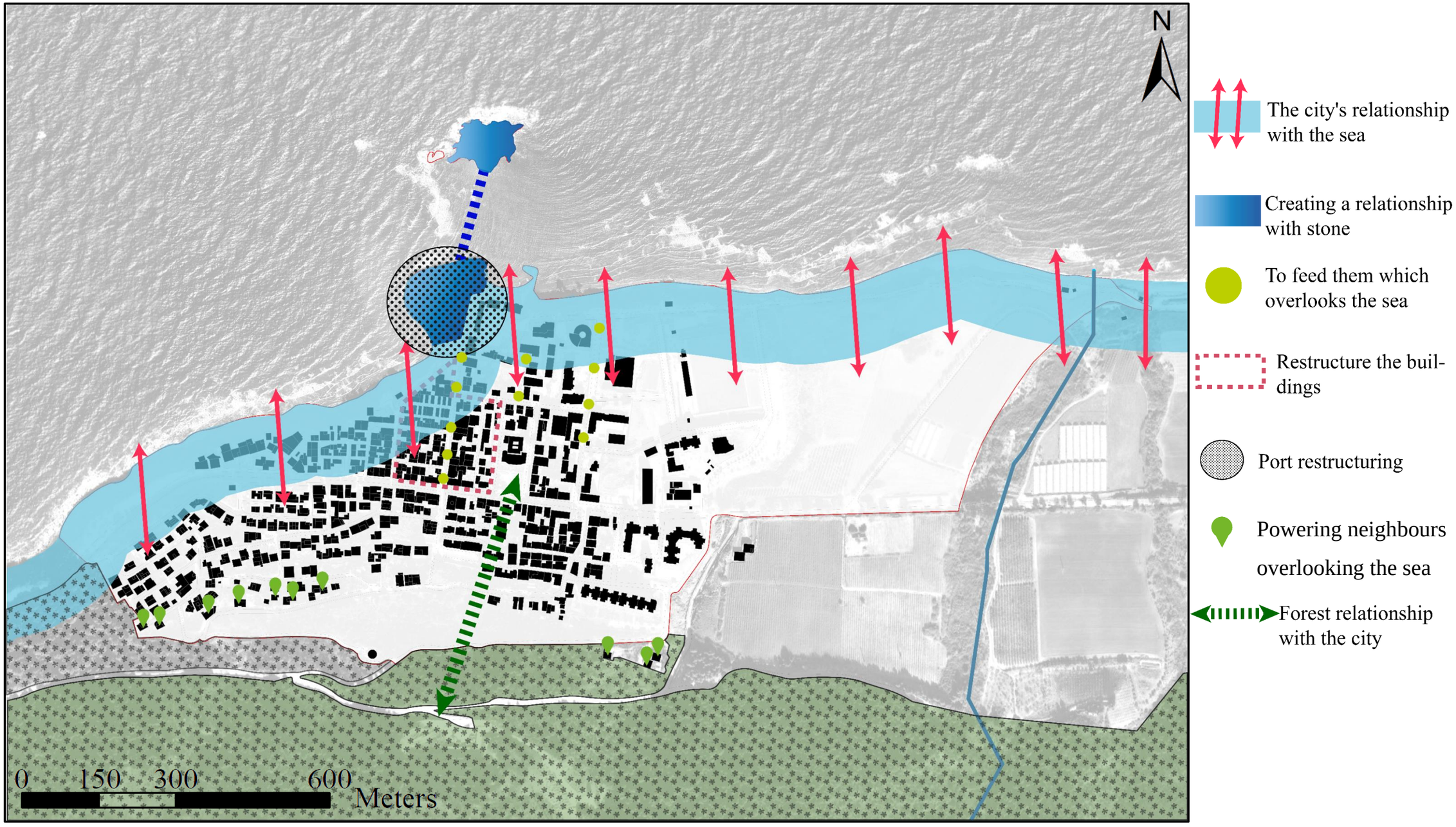

Figure 54 : Main principles' scheme foriIntegrated urban strategies in Hadjret ennous, Source: Authors, Software: Arc Gis and Treaty by Software: Illustrator.

3.1. The Eco-District of Hadjret Ennous:

3.1.1. Genesis of the master plan

The aim of our project is to enhance an area that is currently underdeveloped by transforming it into a compact, dynamic and harmonious eco- district. The aim is to create a high-quality living environment that respects the local identity while building on the site's natural features. It's not just a question of spatial planning, but of an overall vision that meets the needs of local residents, makes the most of local resources, and is part of a sustainable development approach. Throughout this work, we have tried to provide concrete answers to the specific urban challenges of the site, by integrating innovative solutions inspired by ecological urban planning and the principles of rational densification.

This project is part of a sustainable urban development approach through the design of a compact eco-district, conceived as a structured alternative to the negative impacts of urban sprawl (Figure 55). The choice of compactness aims primarily to limit uncontrolled urban expansion, particularly towards the coastal areas and agricultural lands, whose preservation has become a major environmental concern.

Rather than relying on an existing urban fabric, the project proposes the creation of a new dense urban entity, organized according to a clear and functional layout. This framework connects the main components of the district—housing, facilities, economic activities, and public spaces—through a logic of proximity and complementarity (Figure 56).

Sustainability is the core foundation of the project. It is reflected in the integration of bioclimatic principles, the promotion of soft mobility, responsible management of natural resources, and particular attention to the quality of urban environments. The overall objective is to foster a more responsible and healthier lifestyle, adapted to contemporary environmental and social challenges.

Finally, the project addresses a real shortage of equipment and activities currently missing in the city, by incorporating cultural, artisanal, recreational, and sports functions. These additions aim to establish a new urban polarity—attractive, inclusive, and capable of enhancing the local dynamics of the territory.

Figure 55 : Location of the project, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

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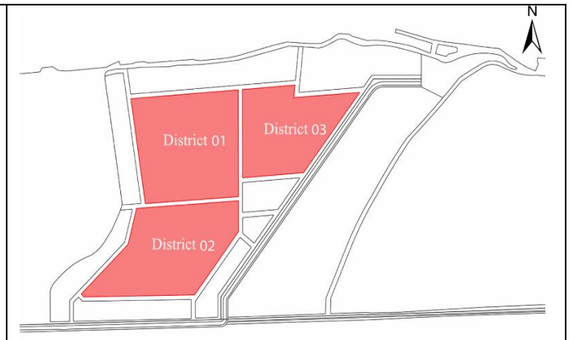
<td> 
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<td>1. The main access roads linking the existing town to the new project are shown in blue. The yellow lines represent the streets that already exist within the project site.</td>
<td>2. Building on these access points, we extended and added parallel roads to strengthen links with the city and open views toward the sea, ensuring smooth urban continuity and a strong coastal connection.</td>
<td>3. The road layout was shaped by a strategic division of the site, responding to both current and future urban needs. It prioritizes high residential density, introduces a seafront promenade to enhance the coastline, and restructures the existing market to support a more vibrant and connected urban life.</td>
<td>4. We established a neighborhood system made up of three main districts, each with a density of 80 housing units per hectare. This configuration meets the first criterion of compactness, which, according to our research, ranges between 50 and 100 units per hectare.</td>
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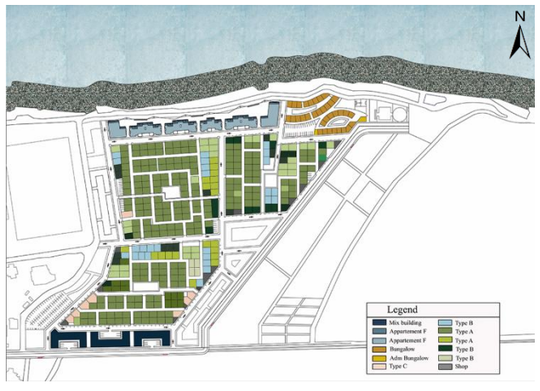
<td> 
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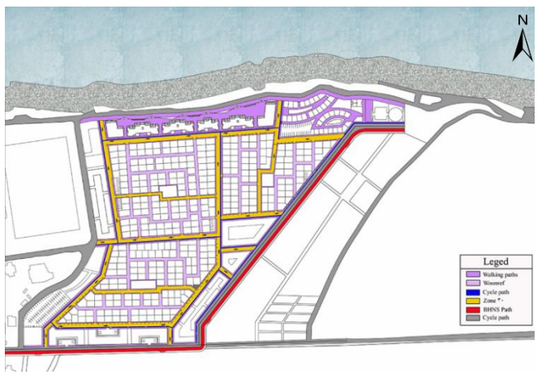
<td> 
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<td>5. We included market, sports, thalassotherapy, and educational areas to ensure functional diversity.</td>
<td>6. A range of housing types, from T3 to T5, promotes social mix—meeting key compactness criteria.</td>
<td>7. We introduced a High-Level Service Bus (BHLS) running on a dedicated, non-polluting line, along with safe pedestrian streets, 30 km/h zones, and paving stones to calm traffic.</td>
<td>8. Finally, we introduced a green grid — a network of green spaces — to improve ecology, reduce heat, and create a healthier environment.</td>
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Figure 56 : design process of the project, Source: Author, Software: AutoCAD, Treaty by Software: Illustrator and photoshop.

3.1.2. Key actions and strategies:

The key actions and the main strategies adopted in designing our Eco-District are multiple and mainly translate our findings in the second chapter of our thesis, which highlight the key concepts and lessons from international projects (Figure 56).

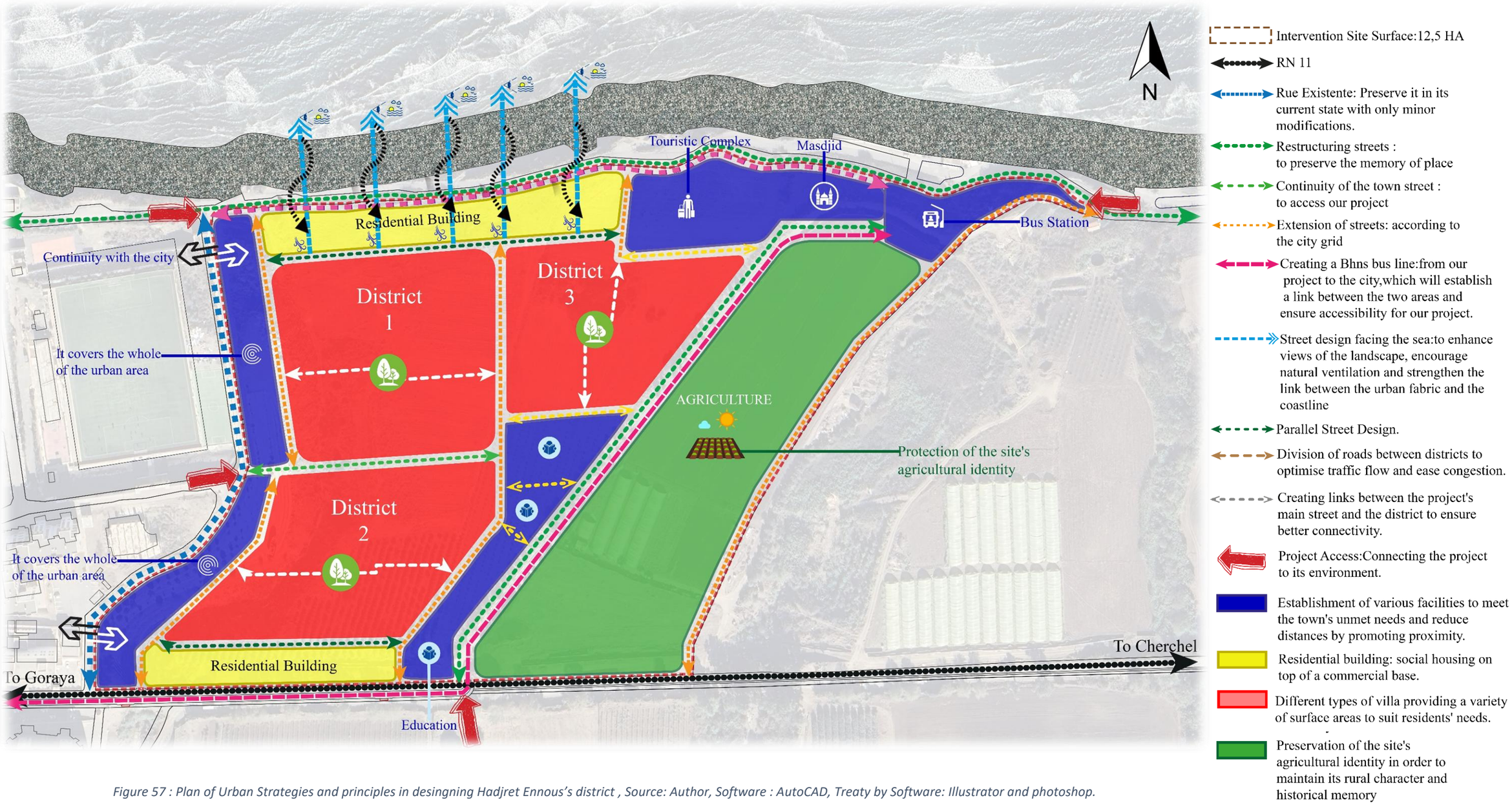

Figure 57 : Plan of Urban Strategies and principles in desingning Hadjret Ennous's district , Source: Author, Software : AutoCAD, Treaty by Software: Illustrator and photoshop.

The resulting Master plan of the project based on the aformentionned priciples and strategies is illustrated in Figure 59.

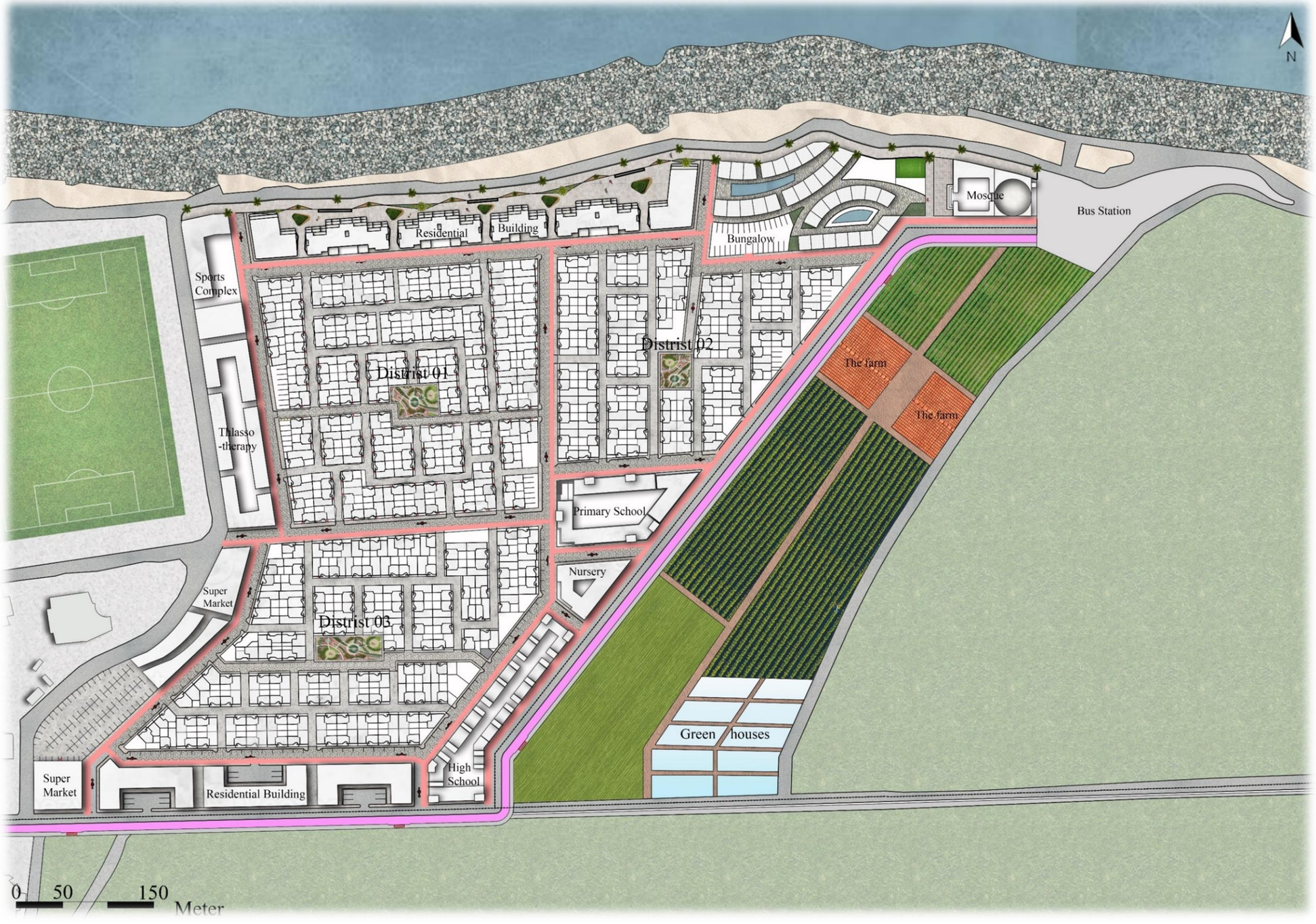

Figure 58:Master plan, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

Our master plan strategically integrates the project site's topography, with natural landforms directly informing the Ecodistrict's spatial organization. Key elevation differentials—including coastal gradients and landslide-prone slopes—are visualized in the Spot Elevation Plan (Figure 58)

Figure 59: Spot Elevation Plan, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

Conclusion:

This chapter has operationalized the diagnostic insights and theoretical frameworks established earlier into a transformative bioclimatic masterplan for Hadjret Ennous. Confronting the commune's complex realities—coastal vulnerabilities, seismic risks, fragmented morphology, and underutilized cultural-ecological assets—the proposal embodies a regenerative urban model grounded in compactness, territorial ecology, and community-centric design. By strategically integrating statutory constraints into the planning logic, the eco-district reimagines coastal setbacks as public promenades, landslide buffers as terraced green infrastructure, and floodplains as permeable water landscapes. This approach transcends regulatory compliance, transforming limitations into catalysts for innovation.

The 80-unit/hectare density achieves controlled intensification without sacrificing seismic resilience or agricultural preservation, while the 15-minute neighborhood framework rectifies spatial inequities through decentralized facilities. Crucially, the design harmonizes with local identity: Roman archaeological strata inform placemaking, the namesake coastal stone (validated by 94.8% resident consensus) anchors cultural tourism, and vernacular materiality guides slope-responsive architecture. Climate adaptation is woven throughout—from BHLS transit reducing seasonal traffic impacts to solar-integrated buildings countering warming trends. The resulting "green grid" stitches mountains to sea, restoring biodiversity corridors while cooling microclimates.

Ultimately, this project demonstrates how constrained Mediterranean territories can pioneer sustainable transitions. By treating topography as an active design partner, community input as foundational data, and heritage as living infrastructure, Hadjret Ennous offers Algeria a replicable blueprint. It proves that coastal cities need not choose between preservation and progress when ecology, history, and risk are co-authors of urban form—a testament to compact urbanism's capacity to reconcile human aspirations with planetary boundaries.

General Conclusion

General Conclusion:

This thesis uses the theoretical idea of a small, regenerative eco-district to address the sustainable revitalisation of Hadjret Ennous, a seaside municipality in Tipaza, Algeria. The study addresses the urgent need to balance tourism growth, agricultural resource preservation, cultural heritage protection, and environmental resilience in the face of unsustainable urbanisation trends. It is situated within Algeria's national discourse on Tourism Expansion Zones (ZETs). Hadjret Ennous is a prime example of a territorial paradox: unchecked urban growth coexists with substantial natural, historical, and landscape capital.

This master's thesis explores in depth the sustainable redevelopment of the coastal commune of Hadjret Ennous (Tipaza, Algeria) through the conceptualization and design of a compact, regenerative eco-district. Framed within Algeria's broader strategy for the development and revalorization of Tourism Expansion Zones (ZET), the research responds to the growing tension between the preservation of natural, agricultural, and cultural assets, and the pressures of uncontrolled urban expansion. It is worth recalling that Hadjret Ennous is part of a ZET, a category of strategic coastal zones designated for tourism, yet it remains under-equipped and structurally vulnerable. This study therefore aims to establish an alternative development model rooted in ecological and spatial intelligence.

The central research question posed is as follows:
How can we formulate a dense, integrated, and climate-resilient urban framework that ensures the long-term redevelopment of Hadjret Ennous, while safeguarding agricultural resources, revitalizing coastal ecosystems, and celebrating cultural heritage?

It is also worth recalling that this question arises within a national context marked by a dual challenge: on the one hand, addressing the structural weaknesses in urban planning across Algerian coastal towns; and on the other, unlocking the potential of these zones as levers for sustainable tourism and local development. To answer this, the thesis was structured around a tripartite methodology, each phase contributing to the progressive refinement of the design framework.

Phase 1: Territorial Diagnosis

The initial phase consisted of a multi-layered diagnosis of the spatial, social, and environmental conditions of Hadjret Ennous. Tools such as QGIS (version 3.28) were

employed for geospatial analysis, allowing the mapping of land uses, topography, ecological buffers, and infrastructure gaps. Additionally, diachronic cartographic analysis (1962–2024) helped trace urban growth trends and quantify the transformation of agricultural zones over six decades.

An on-the-ground survey involving 58 residents was conducted, providing essential insights into local perceptions of land value, public space quality, and mobility patterns. The diagnosis also incorporated risk assessments relating to coastal erosion, marine submersion, and seismic activity (given the location's classification in Zone III of Algeria's seismic zoning).

Findings from this phase revealed that approximately 46% of the commune's agricultural land is fragmented or at imminent risk of conversion. Moreover, there is a functional and morphological disconnection between the historic nucleus of the town and its more recent peripheral extensions—contributing to the erosion of identity and sense of place. Public spaces are few, poorly maintained, and not aligned with pedestrian or environmental continuity. Meanwhile, high car dependency—exacerbated by limited access to public transport—has intensified both social disconnection and ecological degradation.

It is worth recalling that this phase not only diagnosed the current situation, but also defined the performance baselines against which future scenarios could be evaluated. Importantly, it also highlighted the untapped potential of Hadjret Ennous, including its agricultural plains, coastal edge, mountain-sea interface, and Roman and colonial-era built heritage—forming the raw material for the next design phase.

Phase 2: Conceptual Framework and International Benchmarking

In the second phase, the study developed a conceptual and comparative foundation, drawing upon three interlinked urban paradigms:

- **Compact City Model**: Advocating for rational land use, optimized density (50–100 dwellings per hectare), walkability, and a reduction in urban sprawl through intensified urban cores and mixed-use zoning ;
- **Eco-District Principles**: Emphasizing decentralized ecological systems (for energy, water, and waste), inclusive governance mechanisms, and participatory planning as a way to anchor communities in sustainable practices ;

- **Regenerative Urbanism**: A forward-thinking approach that not only seeks to preserve existing ecosystems but also to **restore, enhance, and reconnect** natural processes (e.g., water cycles, biodiversity corridors, and soil fertility) with the urban fabric.

To operationalize these paradigms, the study reviewed three benchmark Mediterranean case studies:

a. **Lyon-Confluence (France)** :A model for reintegrating urban rivers and flood-prone areas through the creation of hydro-social corridors. This directly informed the proposed reactivation of the Oued Mazafran riverbanks in Hadjret Ennous.
b. **Ginko District in Bordeaux (France)** : Demonstrated the feasibility of energy-positive housing clusters using local bioclimatic materials like stabilized earth and natural stone, which aligns with the material palette proposed for Hadjret Ennous.
c. **Les Vergers in Meyrin (Switzerland)** : A peri-urban agricultural district that integrates productive landscapes, community-supported agriculture, and green public spaces into a unified design strategy.

It is worth recalling that these case studies were not applied blindly; rather, each was critically assessed and adapted to local Algerian constraints and potentialities, creating a context-sensitive yet globally informed framework for action.

Phase 3: Design Workshop and Project Implementation

Building on the diagnosis and conceptual layers, the third phase materialized as an urban design and architectural proposal for a compact eco-district in Hadjret Ennous, structured around four strategic pillars:

a. Controlled Densification

- Housing clusters planned at 80 dwellings/ha, focused around natural ventilation courtyards.
- Mix of social housing, mid-income units, and shared facilities to foster inclusivity and community resilience.

b. Soft Mobility Systems

- A dedicated electric Bus Rapid Transit (BRT) line connects the central nucleus, coastal promenade, and public institutions ;
- Complementary cycling paths and pedestrian greenways enable non-motorized access and reduce reliance on cars.

c. Eco-Ecological Corridors

- Coastal and risk-prone zones (including the 100m coastal buffer) are transformed into green infrastructure, combining rainwater harvesting, community gardens, vermicomposting units, and seasonal market spaces ;
- These corridors serve dual functions: environmental regulation and local food security.

d. Bioclimatic and Regenerative Architecture

- Flagship buildings (e.g., market hall, thalassotherapy center) incorporate passive solar design, earth-based construction, thermal mass, and building-integrated photovoltaics ;
- 80% of materials proposed are sourced locally, reducing embodied energy and promoting the local economy.

Projected Impacts and Performance Indicators

The implementation of the proposed eco-district would result in the following measurable improvements:

- +107% increase in green public space (from 4.2 to 8.7 m² per inhabitant) ;
- –31% reduction in motorized transport dependency, improving air quality and reducing congestion ;
- 0% loss of Class I agricultural land, reversing the current trend of ~5.2% annual loss ;
- –63% reduction in building energy consumption, cutting from 142 to 53 kWh/m²/year.

These results illustrate not only the technical and ecological feasibility of the project, but also its capacity to respond directly to the core research question. The proposal offers a balanced, context-sensitive urban model that integrates densification, resilience, and identity preservation—positioning Hadjret Ennous as a prototype for climate-conscious Mediterranean coastal development.

The compact, regenerative eco-district model developed for Hadjret Ennous is not a site-specific anomaly but a scalable, adaptable planning framework that can be tailored to other Algerian coastal towns facing similar environmental, urban, and socio-economic pressures. Many of these communes share common vulnerabilities—loss of agricultural land, unstructured urban growth, ecosystem degradation, and insufficient infrastructure for

sustainable tourism while also offering unique local assets that can serve as catalysts for place-based regeneration.

a. **Aïn Tagourait (Tipaza)** : Strategically located near Algiers, this coastal town is marked by fragmented land use, threatened farmland, and a lack of coherent urban morphology. Its proximity to the capital makes it increasingly vulnerable to speculative urbanization and unregulated tourism development. An eco-district here could implement compact mixed-use housing, reclaim peri-urban agricultural lands through productive landscape design, and reintegrate colonial-era farm structures as heritage learning or agri-tourism facilities, preserving rural memory while supporting local economies.
b. **Ténès (Chlef)** : As a town with a rich architectural and maritime heritage, Ténès is also exposed to high seismic risk and faces growing friction between its urban core and its natural peripheries. An eco-district located along its underutilized coastal edge could reestablish the interface between city and sea, encourage vertical or terraced construction strategies compatible with seismic design codes, and activate cultural tourism circuits through curated routes linking historic medinas, traditional ports, and agricultural hinterlands.
c. **Stidia (Mostaganem)** : Currently experiencing rapid transformation into a tourism hub, Stidia hosts sensitive ecological systems including dunes, wetlands, and coastal forests. However, this transformation remains largely unplanned. A regenerative eco-district here could introduce eco-lodges integrated into the landscape, enhance blue-green infrastructure for natural stormwater management, and adopt circular water systems to treat and reuse greywater for agriculture or public irrigation, transforming environmental constraints into sustainability assets.
d. **Ziama Mansouriah (Jijel)** : Situated between coastal cliffs and inland forests, this commune's steep terrain and erosion-prone slopes require adaptive, low-impact development strategies. An eco-district could be articulated around climate-responsive terraced housing, built with locally sourced materials to minimize site disturbance, and combine eco-tourism and forest stewardship programs to generate economic value while conserving ecological functions.
e. **Azzefoun (Tizi Ouzou)** : Perched at the convergence of mountain and sea, Azzefoun is rich in cultural heritage and artisanal practices, yet its rural-urban edge remains spatially underutilized. An eco-district expansion could serve as a peri-urban transition zone,

blending stone masonry, stepped gardens, and workshops for local crafts into a fabric that supports heritage continuity, low-carbon housing, and economic diversification.

f. **Gouraya (Tipaza)** : Bordering a protected national park, Gouraya holds immense ecological and touristic value, but this status also imposes development restrictions. A carefully controlled eco-district could act as a buffer interface between the park and the city, enabling ecological corridors, sustainable tourist housing, and educational centers promoting biodiversity awareness, without compromising the ecological integrity of the surrounding reserve.

This thesis establishes that a compact, regenerative eco-district is a practical and adaptable model capable of transforming Algerian coastal zones into living, sustainable, and community-oriented spaces—in harmony with SNAT 2030 guidelines, ICZM strategies, and international climate resilience efforts.

It advocates for urban planning that transitions cities from mere resource consumers into regenerative agents: productive, inclusive, responsible, culturally rooted, and ecologically aware.

This work sets the stage for multi-disciplinary, national-scale research-action, suited to architects, economists, ecologists, urban planners, sociologists, and engaged citizens. It also underscores the need for Algeria to integrate this approach into national policies—making regenerative, cooperative, and life-centered Eco-Districts the new norm for resilient, sober, and socially equitable urban development.

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Annexes

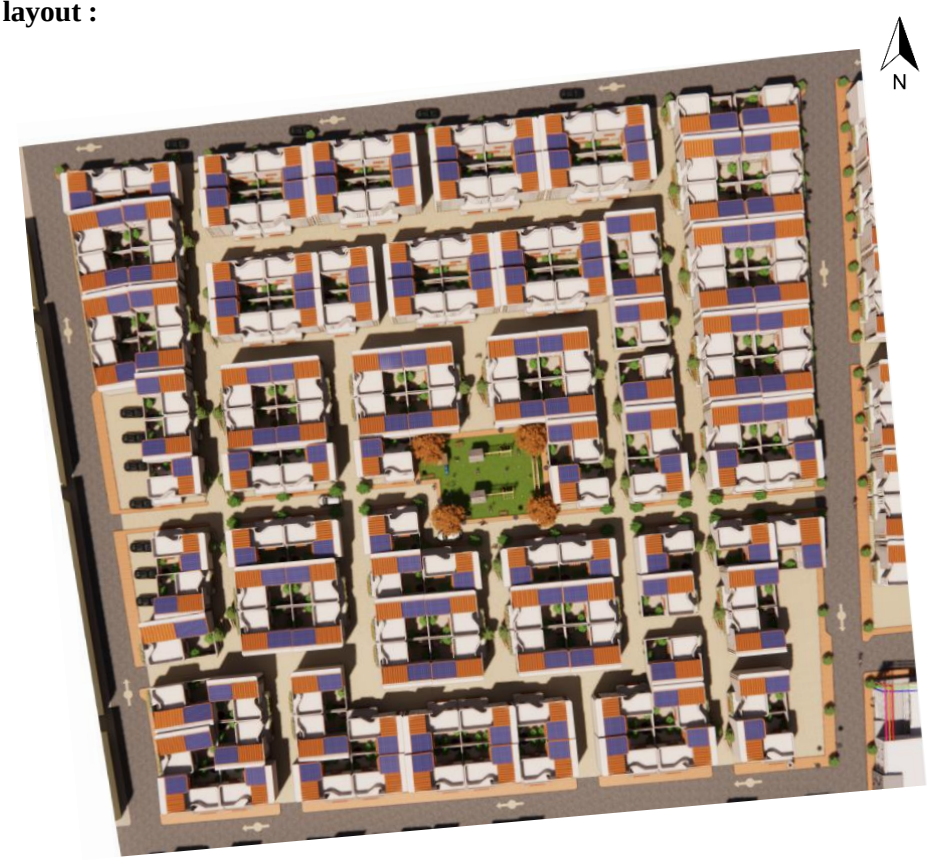
Eco-district project:

Our project is a sustainable and community-focused residential district that blends modern comfort with local cultural values. We've designed a network of villas arranged in a compact and thoughtful layout that encourages social interaction while preserving privacy. Pedestrian paths, surrounded by greenery and rest areas, connect the entire neighborhood, while car access is limited to the perimeter to ensure a peaceful and safe environment—especially for families and children.

At the center of the neighborhood, we've created a large public space that serves as the heart of the community, featuring play areas, leisure zones, and green spaces that invite relaxation and connection. Each villa is tailored to its specific plot, and the architectural design reflects Algerian traditions, with elements like chicane entrances and moucharabieh façades that provide privacy, ventilation, and sun protection.

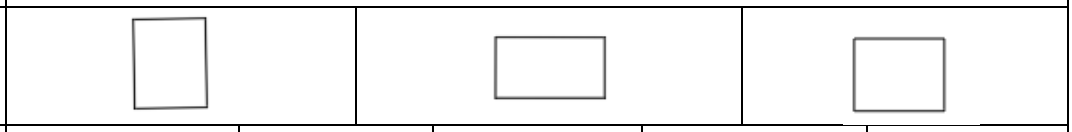
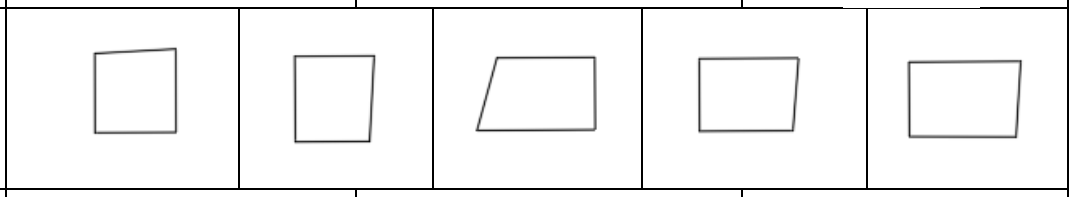
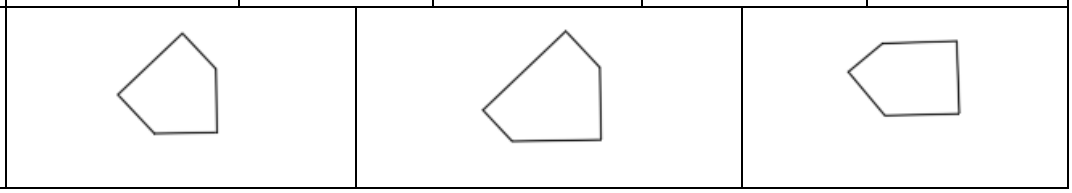
To reinforce the eco-friendly nature of the project, we've integrated solar energy systems, recycling stations, rainwater collection solutions, and plenty of greenery to improve air quality and reduce the urban heat effect. Together, these features make our project a truly resilient, environmentally conscious, and welcoming place to live.

External layout :

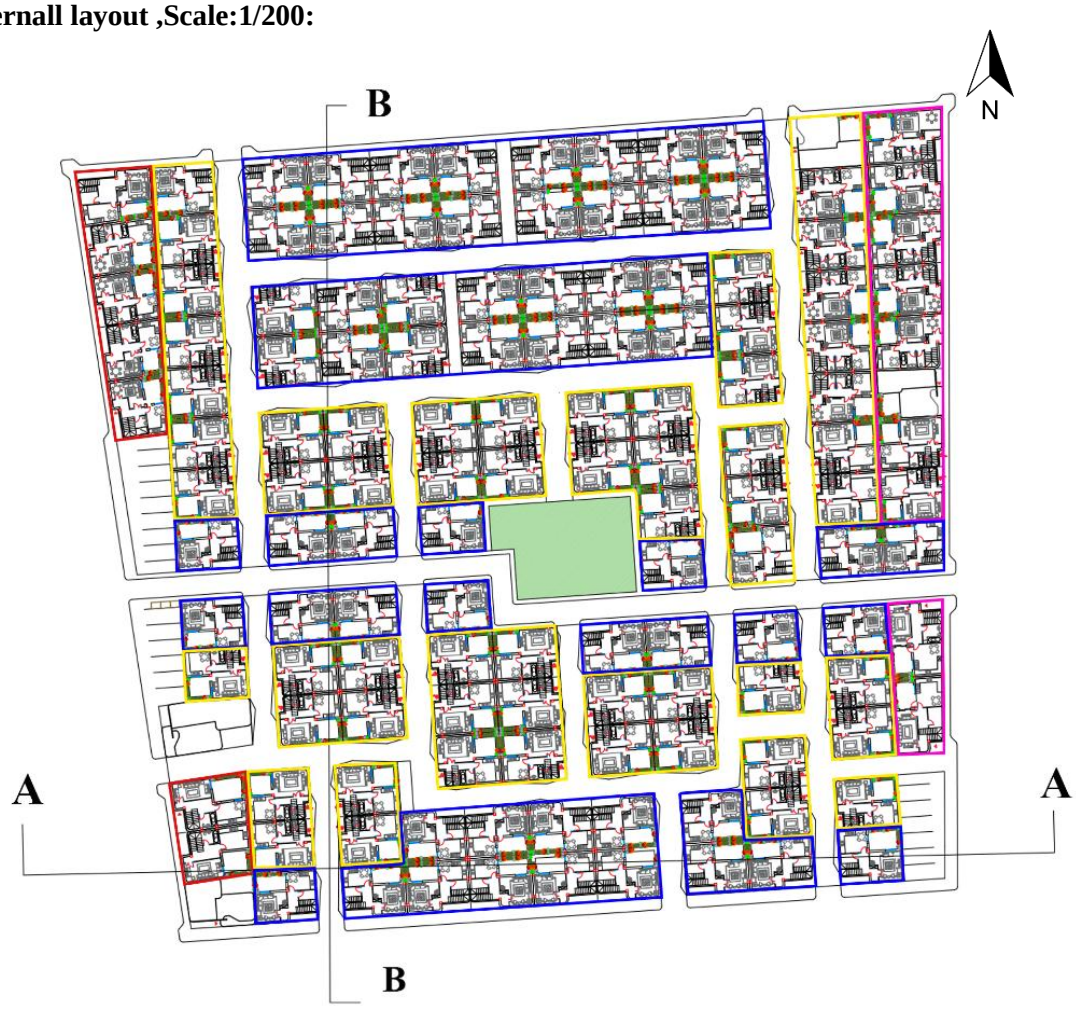


This table presents different plot shapes categorized into three types (A, B, and C) along with the number of occurrences for each type.

Table 4:Classification of Land Plot Types by Shape

Types	Plot
A:218	
B:127	
C:7	

Internall layout ,Scale:1/200:



Section(B-B):

Figure 60:Section (B-B), Source: Author, Software : AutoCAD, Treaty by Software: photoshop

Section(A-A):

Figure 61:Section (A-A), Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

Urban Elevation:

Figure 62:Urban Elevation, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

Solar panel system:

The solar panels are fixed using a mechanical system, typically mounted on strong rails that are securely attached to the roof slab, ensuring maximum stability even in strong winds. However, it's essential to make the fixing points completely waterproof to prevent any water leakage. Once the panels are installed, they capture sunlight and convert it into direct current (DC). Since our household appliances run on alternating current (AC), an inverter is needed to convert the DC into usable AC electricity. This electricity then passes through the distribution board also known as the protection box which connects the solar system to the home's electrical network and ensures a safe and balanced flow of energy. To improve the system's efficiency, batteries can be added to store the excess electricity produced during the day, allowing us to use it at night or during cloudy weather. This reduces our reliance on the national grid and increases our energy independence.

Figure 63:Axonometric view of villa, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

1) Installation of a system:

a. Capturing sunlight:

b. Conversion to alternating current (using an inverter):

c. Use or injection into the grid:

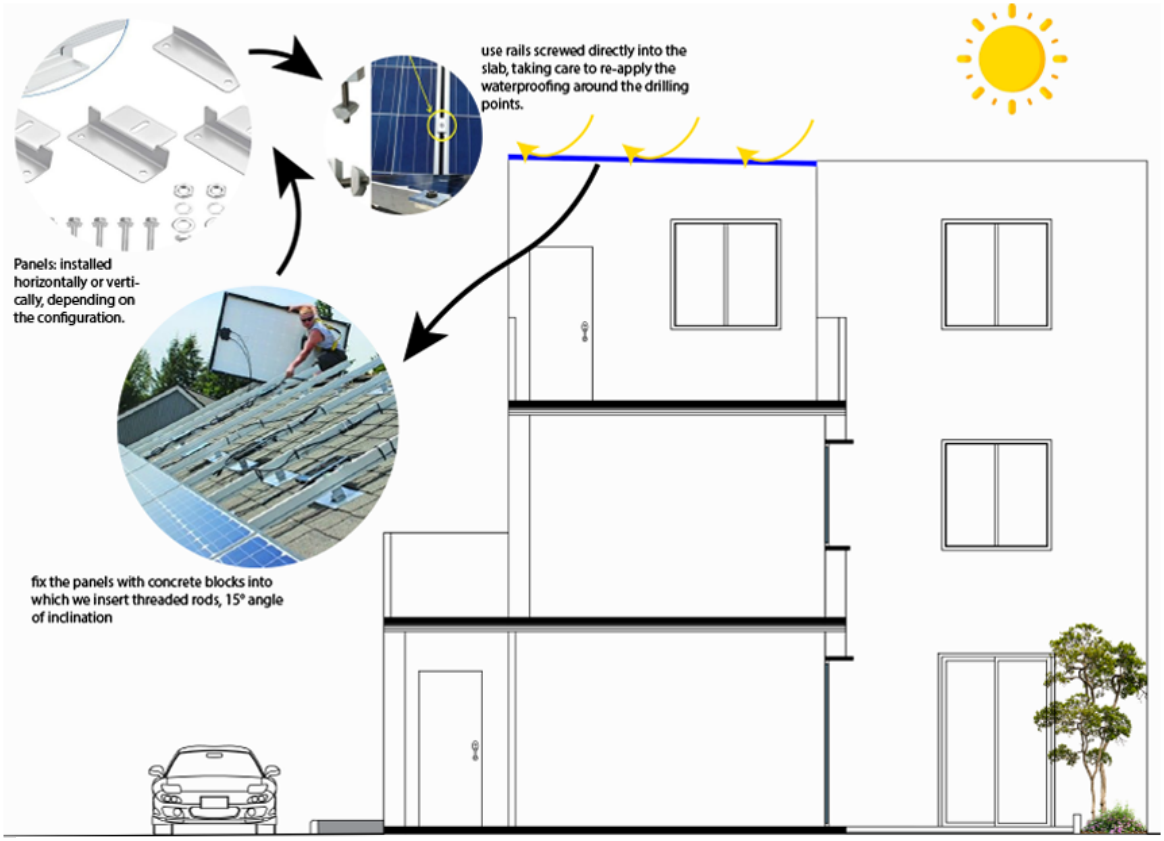


Figure 64:Solar panel system, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

2)

Figure 65:Solar panel system2, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

Vegetation consept :

Vegetation has been integrated into the patios. This has two main aims:

- To improve sensory comfort by providing freshness, calm and better air quality;
- Capture more CO_2, thanks to plants that play an active role in fighting pollution.

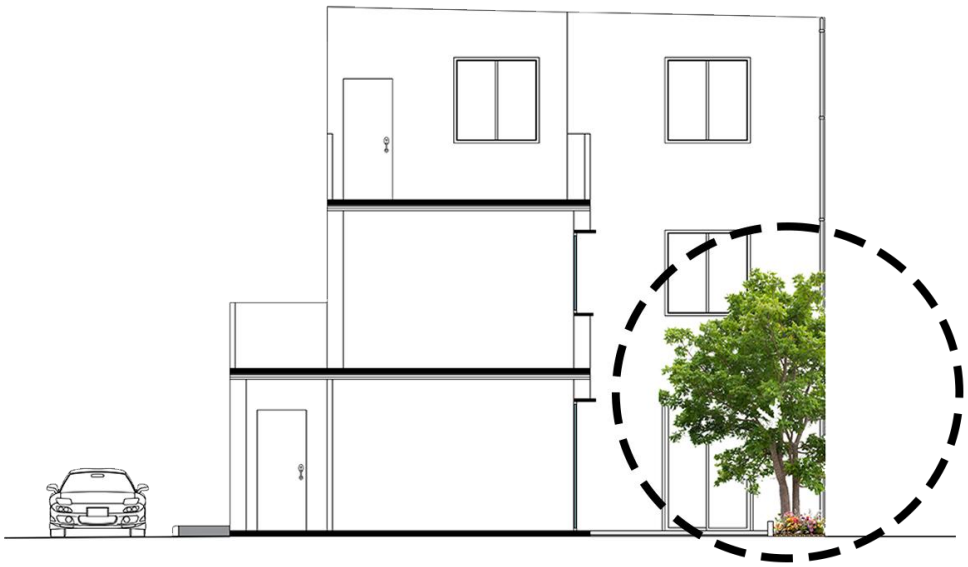


Figure 66:Sction of Vegetation consept for a house, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

3) Limit and recycle waste :

We added recycling points throughout the neighborhood to encourage proper waste sorting. These points allow residents to easily separate materials like paper, plastic, glass, and metal from regular waste. This initiative helps reduce landfill use, promotes eco-friendly habits, and contributes to a cleaner and more sustainable environment.

4) water recovery :

Rainwater is collected and directed to a retention basin, where it is naturally filtered to remove impurities. This process helps reduce the risk of flooding during heavy rainfall by slowing down and controlling the water flow. At the same time, it contributes to the conservation of water resources, making the system both environmentally friendly and sustainable for the community.

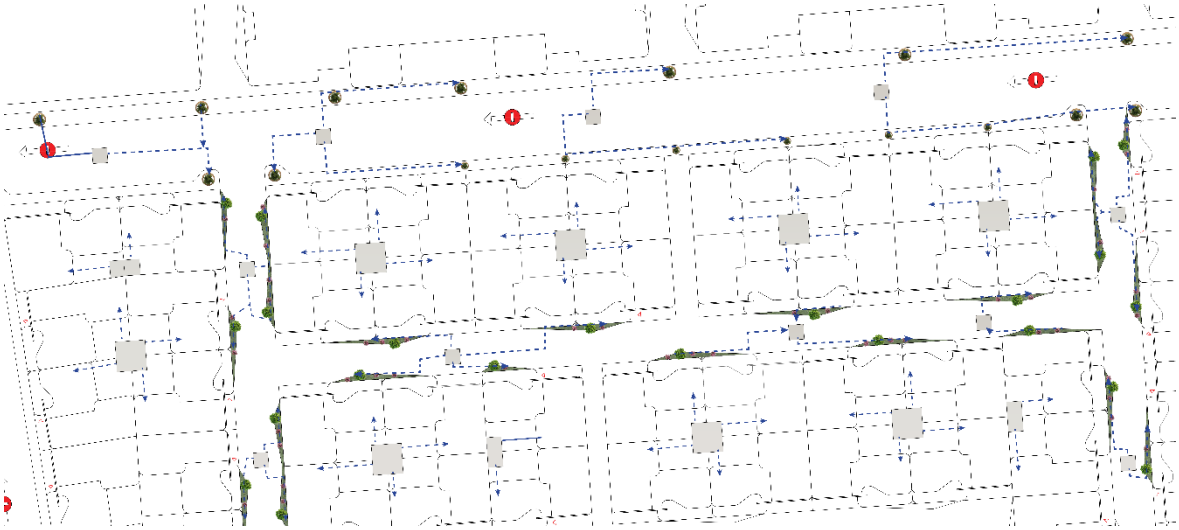


Figure 67:layout of water recovery , , Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

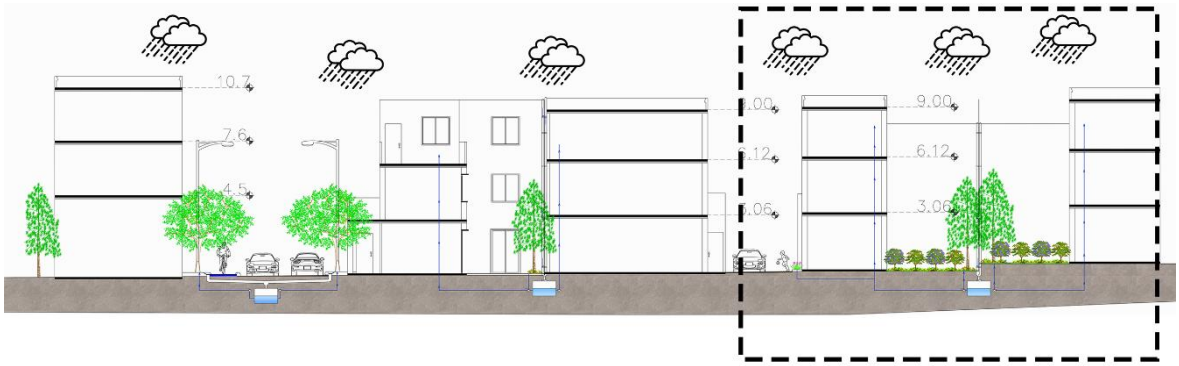


Figure 68:Section of water recovery, , Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

Azure & Nature Residence :

In the final phase of our project, we aimed to create a living environment that is both functional and enjoyable, while staying true to the coastal character of the site. The ground floor, especially along the seaside promenade, was carefully designed with commercial galleries to support local businesses and enhance the daily lives of residents. Private garages were also included to ensure comfort and ease traffic congestion.

The buildings follow a stepped layout with zigzag entrances, offering greater privacy. They feature a variety of apartment types (T3, T4, T5), all double-oriented to allow for natural light and cross-ventilation. Flower boxes on the balconies bring greenery, reduce noise, and create a smooth transition between indoor and outdoor spaces.

Figure 69:Perspective View of the Seaside Promenade, Source: Author, Software : SketchUp & enscape.

Architecturally, the elevation adopts a Mediterranean style to reflect the site's identity. Light colors, natural materials, stone balconies, and tiled roofs are inspired by local traditions. A key design feature is the use of arches in the commercial galleries. Varying in size, these arches echo the rhythm of sea waves, creating a soft and welcoming atmosphere along pedestrian paths.

Section:

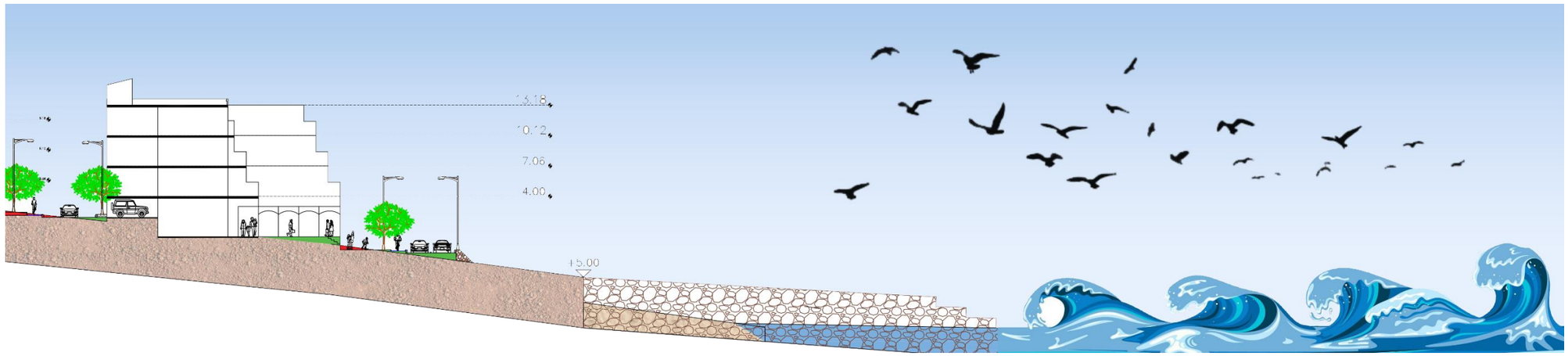


Figure 70:Section, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

Urban Elevation:

Figure 71:Urban Elevation, Source: Author, Software : AutoCAD, Treaty by Software: photoshop.

Outdoor Atmospheres: