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**the vectorial digital fingerprint of the city functioning as a
decision support tool for local authorities**

**F.C.P: Occupational housing center within the suggested extension of
Bou Saada city.**

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Dedication

This work is dedicated to all the people that contributed to making me the person that I have become today.

All the experiences that you can encounter in life can only enhance your mindset however you are the one responsible for choosing the angle you see things from

This work is dedicated first to my parents who have supported me, taught me, raised me, and encouraged me to take long adventures even when I was down or barely picking myself up I was blessed with guides, best friends, and protectors all combined in a family unit.

My dear father's soul, taught me to face forward and never look down, his motto was: "There's nothing in this world that you can't learn" and it became a sacred mindset in my brain for every thought and every move

My strong mom always seemed to be holding herself together and keeping the situation stable without making anyone uncomfortable or noticing her tiredness, I salute you for setting a strong family woman example for me and my sister

My one and only sister, always served as the candle holder for me, guided me through life, and shielded me like a second mother

To my grandparents that was rooting for our success and academic achievements boosting us and being proud openly while rooting and praying for us privately

To all of my family aunts, uncles, and cousins that always blew off steam with me to help me regain spirits and hype my actions

I would also like to dedicate this paper to all the teachers and professors that I have crossed paths with till this day, I thank god for always handing me the good ones, and for that, I would like to state that you are the reason I hold myself up today

To my friends and colleagues at the institute, as we were together for five years, each one brought an impact on my life that helped me see things differently and gain social knowledge I did not dispose of earlier

To my supervisor Dr. Dahmani that had the patience and wisdom and tolerance to influence us to become our best version and push through our limits for the sake of ourselves, the country, and Allah.

To my urban project group this year, I don't think I've ever got attached to anyone as quickly as this year, god made a plan of gathering all the good people in this workshop for I have only witnessed good deeds from you

To my friends and neighbors and the rest that I failed to mention, you marked your place and now it's my time to make it into what's best.

Words of Appreciation:

First of all, we would like to express our gratitude towards Allah the Almighty for giving us health and willpower to begin and end this dissertation.

This work certainly bears our signature, but it remains the fruit of a whole team. It is therefore the combination of the efforts of each other that has led to the results that we present here. It seems to us, as such, at the time when this study ends, to express our gratitude and appreciation to all those who have contributed. This work would not be so rich and would not have been possible without the help and supervision of Dr. DAHMANI Krime, we thank him for the quality of his exceptional supervision, and for his patience, rigor, and availability during our preparation of this dissertation. Our thanks go to Mrs. RAHMANI for her practical help, her support morale, and encouragement, our thanks also go to all our teachers for their generosity and the great patience they were able to show despite their academic and professional duties. Our sincere thanks go to the members of the jury, Mr. AOUISSI Khelil Bachir, Mr SEDOUD Ali, Mr BOUKARTA Soudiane & Mr BOUDANI Abdelkader for accepting to judge and evaluate our present work.

We will not let this opportunity pass without thanking all the teachers and the staff of the Institute of Architecture and Urbanism of Blida for their help, valuable advice, and for their interest in our training.

Finally, to all the people who have contributed directly or indirectly to the development of this work find here the expression of our deep gratitude.

Our workshop content:

The optimal development and livability of new or old cities in their climatic and geographical contexts take center stage in the new vision of Urban Project. By declaring the old functional urban planning methods obsolete, this optimal vision has adopted the urban project approach on a large scale. Algeria has committed to all international agreements by signing conventions and protocols to address the difficult environmental situation, aiming for sustainability as the driving force.

This urban project has come to continue a process of conceptualization without an exit. Architecture encourages mastering the design and implementation through operational tools for optimal systemic design close to a living and human system. Our workshop: "Urban Project" Master 2 has outlined three research themes: the first revolves around the renovation of the old city, the second on the recovery of the potential of the Oasis, and the third is the proposal of an urban extension according to a programmatic and real approach. Our workshop has come in a climate where the search for alternatives in the design of master plans for cities to build on themselves is strongly required and urgent.

Tourism takes a place in this vision, seeing the tourist character of the Boussaada area. We worked on the ground as a single group in terms of field questionnaires in collaboration with local services, especially after signing a convention between our university and the APC of Bou Saada. For this reason, we found that history is full of information and lessons for a broader and deeper urban vision by adopting scientific methods such as those of Alain Borie, P Panerai, and others.

In this optimistic vision, we have proposed three urban projects worked on by the entire workshop and subgroups, seeing the heaviness of the task. Our primary objective is to propose an extension project with the participation of half of the workshop and others by the other half. This led us well towards shared development plans by the whole workshop.

The writing work of the memories took place in two stages: a collective one, which includes parts written with all members of a group or subgroup, such as the methodological approach, the questioning context, the urban project part, and the analysis of the city; and a second individual one, such as the study of examples, the specific problem, and the punctual project. The common part is carried out in a climate of mutual aid and partnership.

Summary:

Through witnessing the life of a city, the main core always seems to grow prosperously at first, until it reaches a certain degree where its resources are exhausted and can't provide nor invest in any future growing parts and that's why we notice the edges of cities always being outcasted compared to the city headquarters, as a result of this act, suburbs start surfacing, by the citizens, in a detached and an unplanned behavior, causing imbalance to the main system since the city ends up claiming it as a part of it is growing on its territory.

as the main core barely survives while the suburbs grow even further, the city loses its definition as a unit and acts as broken fragments unable to manage the main core nor its surrounding areas, which leads to the death of the city itself, a topic portrayed by Jane Jacobs in her book "the death and life of great American cities" which proves the heavy weight this problem has brought to the table

The main objective of the work is to predict future agglomeration heads while making a system that will link these tissues to allow the city to grow in a balanced, attached, and healthy way

translated and represented in the shape of math equations and vectors which will facilitate the conversion into computer coding language and its insertion into a software

As many have tried before to create an inflexible system dismissing the urbanist and architect's role, their impulses were rejected as the humanitarian impact; mainly the constant change and time factor has not been taken into consideration.

The different approach of this initiative is that the habitants are to be portrayed as the main characters, meaning creating a city that perfectly fits its own citizens as a glove and that will allow every city to have its own unique pattern, shape, and look

This technique is yet to be called "the city's own digital fingerprint"

It also keeps the city always updated on the changes occurring at every moment, preventing the waste of effort and time traditional urbanists suffered from by the time the city layout reaches the execution phase, but also plans out for the long-term efficiency of the program.

Bou Saada like many other cities, has witnessed many attempts to resuscitate the city back to life, unfortunately, it only increased the gap between the existing town and the future

layout, even in the citizens' speech we noticed them referring to the proper city as the old town and the new constructions as the new city which was the number one sign that the previous actions were absolute failures, nevertheless, the great increase in the unemployment rate, the decrease in the water pressure and quantity running in the oasis hence the death of the surrounding farming lands and the fast urbanization of a fertile area, all of these facts required immediate intervention in order to prevent the death of a city that was once appointed as the first capital of the country for the immense amount of potentials that it held in it .

Keywords:

future agglomeration, digital fingerprint, vectors, pattern.

ملخص:

من خلال مشاهدة حياة المدينة ، يبدو أن النواة الأساسية تنمو دائمًا بشكل مزدهر في البداية ، حتى تصل إلى درجة معينة حيث يتم استنفاد مواردها ولا يمكنها توفير أو الاستثمار في أي أجزاء تنمو في المستقبل وهذا هو السبب في أننا نلاحظ حواف دائمة ما تكون المدن منبوذة مقارنة بمقار المدينة ، ونتيجة لهذا الفعل ، تبدأ الضواحي في الظهور ، من قبل المواطنين ، بطريقة منفصلة وغير مخططة ، مما يتسبب في خلل في النظام الرئيسي حيث ينتهي الأمر بالمدينة إلى المطالبة بها كجزء من أنها تنمو على أراضيها.

نظرًا لأن اللب الرئيسي بالكاد يبقى على قيد الحياة بينما تنمو الضواحي أكثر ، تفقد المدينة تعريفها كوحدة وتعمل كأجزاء مكسورة غير قادرة على إدارة النواة الرئيسية ولا المناطق المحيطة بها ، مما يؤدي إلى موت المدينة نفسها ، وهو موضوع تم تصويره بقلم جين جاكوبس في كتابها "موت وحياة المدن الأمريكية الكبرى" الذي يثبت الوزن الثقيل الذي جلبته هذه المشكلة إلى طاولة المفاوضات

الهدف الرئيسي من العمل هو التنبؤ برؤوس التكتلات المستقبلية مع إنشاء نظام يربط هذه الأنسجة للسماح للمدينة بالنمو بطريقة متوازنة ومتصلة وصحية.

مترجمة وممثلة في شكل معادلات رياضية ومنتجات مما يسهل التحويل إلى لغة ترميز الكمبيوتر وإدخالها في برنامج كما حاول الكثيرون من قبل إنشاء نظام غير مرن يرفض دور المهندس الحضري والمهندس المعماري ، تم رفض دوافعهم باعتبارها تأثيرًا إنسانيًا ؛ بشكل رئيسي لم يؤخذ في الاعتبار التغيير المستمر وعامل الوقت.

النهج المختلف لهذه المبادرة هو أن يتم تصوير السكان على أنهم الشخصيات الرئيسية ، مما يعني إنشاء مدينة تناسب مواطنيها تمامًا كقفاز ، مما سيسمح لكل مدينة بأن يكون لها نمطها وشكلها ومظهرها الفريد.

لم يُطلق على هذه التقنية بعد "البصمة الرقمية الخاصة بالمدينة"

كما أنه يحافظ على المدينة دائمًا على اطلاع دائم بالتغيرات التي تحدث في كل لحظة ، مما يمنع إهدار الجهد والوقت الذي عانى منه العمرانيون التقليديون بحلول الوقت الذي يصل فيه تخطيط المدينة إلى مرحلة التنفيذ ، ولكنه أيضًا يخطط لكفاءة البرنامج على المدى الطويل .

شهدت مدينة بوسعادة ، مثل العديد من المدن الأخرى ، العديد من المحاولات لإعادة إحياء المدينة مرة أخرى ، وللأسف لم يؤدي ذلك إلا إلى زيادة الفجوة بين المدينة القائمة والتخطيط المستقبلي ، حتى في خطاب المواطنين لاحظناهم وهم يشيرون إلى المدينة المناسبة. البلدة القديمة والمباني الجديدة باعتبارها المدينة الجديدة التي كانت العلامة الأولى على أن الإجراءات السابقة كانت إخفاقات مطلقة ، ومع ذلك ، فإن الزيادة الكبيرة في معدل البطالة ، وانخفاض ضغط المياه والكمية الجارية في الواحة ومن ثم الموت. من الأراضي الزراعية المحيطة والتوسع الحضري السريع لمنطقة خصبة ، كل هذه الحقائق تتطلب تدخلًا فوريًا من أجل منع موت مدينة تم تعيينها سابقًا كأول عاصمة للبلاد للكم الهائل من الإمكانيات التي تمتلكها فيه.

الكلمات الدالة:

التكتل المستقبلي ، البصمة الرقمية ، المنتجات ، النمط.

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*Chapter I:
Introductory
Chapter*

I. General introduction:

As metaverse is considered a luxury nowadays yet it's trying to make its way through the different social categories as a plague, real-life community, and the world is suffering from a demographic explosion, water, and edible elements shortage, pollution, and the running out of occupational space,

Yet the time seems to be passing as quickly as thunder, changes keep occurring during the study and data collection phase that by the time the design phase starts the data has already flipped upside down making your effort completely useless to the current adjusted reality.

Numerous disagreements over how to approach a city in a more general manner have arisen, which has caused a variety of urban analyses and interventions to appear in this recently established discipline. However, because each city has its own pattern and personality, it is difficult to generalize in a single approach way.

Taking this as starting point the proper city or the main core of a city always appears to grow prosperously at first, but as its resources are depleted, it can no longer support or invest in any future growing parts. As a result, we observe that the edges of cities are always outcasted compared to the city headquarters. As a result, suburbs start to emerge, by citizens, in an unplanned manner, causing an imbalance in the main system.

Usually how urbanists would approach this matter is to apply numerous amount of analyses have a formal chat with the citizens and proceed to fill their own ego desire in achieving a utopian city that would never meet with realities factors, most of the time the proposed extensions are still thriving and feeding itself from the main core under the concept of avoiding urban cut, however, it only made the situation worse which turned to our attention, maybe attaching it to the existing area as the wrong move to begin with, maybe many centralities should be put out so each area can have a source of consummation.

Bousaada a main example of this topic has different detached fragments while its city is losing its citizens to its lack of provide for basic amenities.

Experimenting with one centrality is the path this paper walks on in order to define the problem in urban acts and compositions.

II. General Problematic :

Considering linguistic science, a language is by default a system, Aldo Rossi made a comparison between the linguistic theory or study and the city (Aldo Rossi, *The City's Architecture*, 1969) There we have concluded that the city or the town is also a system. During its era, Rossi tried to read and unfold the urban tissue through a dichotomy (diachronic/synchronical), although there are other reading dichotomies. according to the linguistics father DE Saussure, there are 4 dichotomies where Aldo Rossi takes part in them..followed by the fact that the father of French urban planning Pierre Lavedan has also considered the science of urban planning as a system (P.LAVEDAN, *The history of urban planning*, 1926)

And for this matter, the dichotomy of continued and container is as basic and indispensable to the rest of the three dichotomies, it's the scientific starting point and platform of urban and architectural programming.

« Thinking has its strategies and tactics too, much as other forms of action have. Merely to think about cities and get somewhere, one of the main things to know is what kind of problem cities pose, for all problems cannot be thought about in the same way. Which avenues of thinking are apt to be useful and to help yield the truth depends not on how we might prefer to think about a subject, but rather on the inherent nature of the subject itself. ». (J. JACOBS, 1961, p428).¹

The city is an undefined organism that falls yet englobes at the same time many disciplines in itself, Strangely working them together as compatible mechanisms, as various fields tried to conduct a definition of their own of what they thought the city represents, it never recovered from being a strange operating core. But what surprises scholars the most is that there is no identical city to another in the world, which can only be compared to the concept of fingerprints and HIV.

The urban space takes today the new connotation of the urban ecosystem first, and in the second time of the organic unit, the real living body with its special needs, endowed with morphology, physiology, and territorial intelligence. Facing all the stakes which are threatening our future, like climate change, hydrous and food stress, the major risks recrudescence, the world energy and financial crisis and, in the same time, the urban

¹ JANE JACOBS, *The Death And The Life Of Great American Cities*, New York, Random House, ISBN: 9780525432852, 1961.

population and urbanization rate rapid growth, the space we need must be at one and the same time a resources supplier, our vital activities protector, and a waste receptor. ²

And for that matter the urban planning system ... has always been a Classic topic yet an ongoing situation. Malish displayed more than twenty systems of different areas around the world in order to emphasize the internationalization of this questioning and in consequence its direct impact on man's everyday life, every system is programmed yet programmable, and this is where the key to understanding the system resides at, that will enlighten us to the method of its adaptation, whether it'll be vectorial or raster (pixelized), all through this domain's advanced technicality.

Many conflicts have surfaced regarding the way a city should be approached in a more general technic which led to a variety of urban analyses & interventions making an appearance in this newly established discipline however the fact that each city held a pattern and a character of its own made it hard to generalize in a single approach way which led us to question :

Can we provide a system that will allow us to design future cities that are adaptive and adaptable at the same time? Is it possible to tame chaos?

² E. BEREZOWSKA-AZZAG., 2013, Mail Of Knowledge – N°16, October 2013, p55.

III. Specific problematic:

« *The introduction of chaos into well-ordered fractal patterns has an interest: they allow us to stick more faithfully to reality...we would like to have some mastery of chaos* » (Vivien Douine, 2023).

Urban chaos can result from changes in urban lifestyles, urban morphology, and typological characteristics of architecture. Managing urban chaos requires a new theory to explore chaos in cities and regions and action plans that perceive the interrelations among daily newcomers to the city. Utopia and design can provide a suitable sense of place and a precise translation of environmental meaning, opposing chaos. Urban densification may affect micrometeorology in major cities, promoting the distribution of anthropocentric pollutant concentrations.

In our local Algerian context Medinas and Ksours, as many scholars have confirmed beforehand that these urban puzzles are one of the richest and most valuable possessions and examples to take in our future urban actions.

Arabic Islamic cities in the Maghrib, especially those founded by Arabic Muslim leaders were the purest in terms of their general Islamic framework and their specific Arabic attributes. The contextual characteristics of these cities, therefore, provide us with valid lessons that can contribute to improving the quality of the contemporary built environment in Arabic Islamic cities, and safeguard the city's historical and cultural identity, which is in danger of being totally lost. Cultural heritage should be understood, protected, and enriched.³

The Arabic North African urban tissue exposes the limitless potential of systematic chaos growth within a city making it ageless and borderless yet stitched to its occupiers morally and physically, making itself a part of nature altho it was man-made without neglecting man's basic necessity and comfort nor overstepping nature boundaries or its sustainable behavior.

Within our study case, we approached the city of Bou Saâda, lately designated as a new delegated wilaya for its massive social-economic, natural, patrimonial heritage and political potential. But unfortunately and as most of the cities of internal administrative possessions are facing their **decline** or **death** as J. JACOBS likes to refer to, still not late to

³ Huyam H. Abudib, March 2016, Archnet-IJAR, Volume 10 - Issue 1 – p341.

recover and gain its administrative freedom, we took the opportunity to pick up the broken fragments and opt for a more efficient and productive city.

this study was conducted as a mere introduction to a general curiosity to test the borders, the growth, and the capacity of a city to survive and last in front of all the factors it undergoes physically, socially, and chronologically, all while elevating the life quality of its citizens and also providing for the future demographic increase.

under this approach we were also led to question; ourselves, Various disciplines, and the world :

- **How can we introduce pure geometrical and spatial parameters to real-life urbanization even under chaotic layouts such as medinas without falling into a pure syntactic trap?**
- **Can social and humanitarian factors get interpreted into concrete settings along the physical linings and formed into different layout catalogs for less time-consuming urban acts?**

IV. Hypothesis:

Identifying the key element that regulates the urban growth of an area, an urban tissue, or a city should be the first act to take in order to approach the most compatible and efficient solution to the problem facing it on urban terms, in the case of Bou Saâda it was conducted that the oasis is the crucial element that the whole city revolves around, a few hypotheses were scripted during our journeys which presents in

- Suggesting an urban intervention that consists of urban planning of a new city as an extension of the old one while assuring the various links between the two. **in order** to remedy the current situation of the proper city.
- Having the watercourse as a base matrix for our punctual and fractal pattern will not only allow the designation of future urban centralities but also define the road system and land use of each nucleus.

V. Objectifs :

Our work is aiming mainly for a number of goals that before were not found to be achieved simultaneously while this thesis is here to support the possibility of it occurring and for that, we try to provide :

- Blowing the steam off the original town social-economically and also resources-wise.
- making a path for the city to grow in a systematic and the most valuable manner.
- putting the citizens ahead and above during the planification process by not only assuring the hope, aspirations, and comfort of its citizens but also restoring morals that reflect on the city's appearance and organization within the exterior and interior urban space domain.
- Enhancing the city's heritage and culture while encouraging its spread again.
- Contributing to the maintenance and restoration of the damaged oasis.

VI. Site choice:

Bou Saâda or “the city of happiness” presents itself as the Sahara’s Gate, owner of the closest oasis to the Mediterranean Sea; within all of its perimeter, recently advocated into a delegated wilaya, the Number one receiver and the birthplace of the Saharian art palette to European artists, and many other achievements this city has displayed that still doesn’t do its actual value any justice.

The city’s evolution involving its urban growth and architectural expression solidifies the “fits as a glove” quote due to the emergence between the oasis “ El Djenna” and what’s man-made and its contribution in all different aspects including the environmental, social-economical, financial and alimentation sufficiency, only to conclude that this city is all rounded on its own and it was high time the city earned an independent Wilaya title.

As of Bou Saâda’s fresh designation, the city within the last years has met a change course of events which led to an abnormal and out-of-her-regular pattern urban growth.

Hence like many other cities, Bou Saâda has witnessed many attempts to resuscitate the city back to life, yet, unfortunately, it only increased the gap between the existing town and the future layout, even in the citizens’ testimony we noticed them referring to the proper city as the old town and the new constructions as the new city which was the number one sign that the previous actions were an absolute failure, nevertheless, the great increase in the unemployment rate, the decrease in the water pressure and quantity running in the oasis hence the death of the surrounding farming lands and the fast urbanization of a fertile area, all of these facts required immediate intervention in order to prevent the death of a city that was once appointed as the first capital of the country for the immense amount of potentials held in it.

VII. Methodological tools:

With our frame of research in 2nd-year master's degree "urban architecture and urban planning" the study displays through the run; a leaning towards a hypothetico-deductive (HD) reasoning, as a result, our work presents itself in three parts and an annexed joint to complement the theme's richness:

1. Theoretical and conceptual approach :

This part focuses on explaining the transitional concept from database to fractal study to operational layout, involving its surrounding study domain for a better understanding of the path taken by the study:

a. Literal/documentation Based research (Bibliographic):

This part treats the data collection related to the treated theme study, and the scientific research of the key concepts (Books, articles, theses or scientific magazines of different authors). This part allowed us to obtain new complementary knowledge to our study theme and concepts.

2. Analytical study approach:

This approach englobes the understanding of the conditions and characteristics of the study area which summons a number of urban tissue analyses and reading technics

a. Historical research (historical approach):

Consists of collecting past data and documents offering an overview of the historical periods that the city underwent and the main events occurring within it, in order to identify the conditions that impacted it the most and the ones that still remain as solid factors in its society, accompanied by the diachronic reading of the city layout and the witness of its evolution throughout time in order to define the direction of its growth and the factors leading to it along the estimation of its morphological development according to the chronological frame.

b. Quality/explorative-based research:

This research focuses on unraveling the case study's conditions and characteristics which summons different analytic approaches, the ones mainly adapted within this thesis are:

- **Historico-morphological analysis:** the diachronic reading of the city layout and the witness of its evolution throughout time in order to define the direction of its growth and the factors leading to it along the estimation of its morphological development according to the chronological frame.
- **Cross-disciplinary analysis (typo-morphology & GIS):** combining the Italian and American urban schools approaches
- **Sustainable and natural analysis**

c. Quantitative & Survey research:

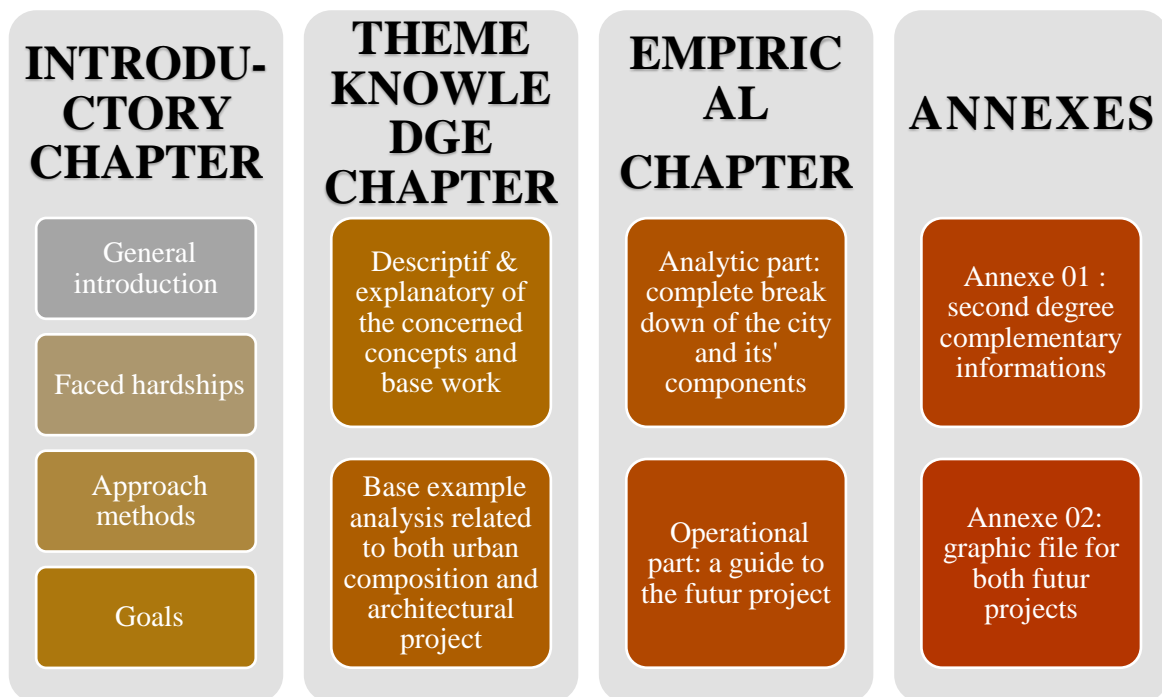
Along with distributing 400 survey papers to the city's citizens all across its part, the papers were all filled, recollected, and the data extracted from it were rearranged by the urban extension axis into a statistical form of study, this process helps with having a better insight into the actual citizens' desires and dissatisfaction with their current situation.

3. Operational & empirical approach:

a. Observational & interactional approach:

Along with the surveys and a couple of site visits that allowed us to have a closer vision and a physical and spiritual interaction with the city and its occupiers also collecting necessary support for our research (pictures, documents, different maps, local experts' contribution...), our workshop attributed an official convention with Bousaada's local administrative commune under the university's frame of operation.

VIII. Thesis' Structure:



Thesis diagram



*Chapter II:
Knowledge*

&

Background



1. Introduction:

Within this chapter, we will proceed not only to explain the different concepts treated and used through our work process from theory to analysis to operation including the different scales of intervention consisting of urban city scale (City extension) till reaching the local and architectural scale (architectural project) but also introducing the different books, articles and the set of references that we approached in order to achieve this study :

2. Digital Representations of Topographic Surfaces:

As MAPPING HAS BECOME AUTOMATED, many new processes, procedures, and packages have been developed. Each approach is more appropriate for one type of map capture and display than for another.⁴

The only programs that we should expect to do a good job of representing the topographic surface are those programs designed to produce digital terrain models from a very large array of critical points subjectively selected in the field or from aerial photographs (e.g., points defining breaks in slope, peaks, ridge lines, stream courses, and low points.) Today there are programs of this type, and some even have the ability to incorporate breaklines where true discontinuities exist (Thorpe, 1988).⁵

2.1. Digital terrain/elevation models:

A digital elevation model (DEM) is one of the most important spatial datasets in many geographical information systems (GIS). It is defined as an ordered or unordered digital set of ground elevation (spot height) for terrain representation. In literature, there are three commonly used terms related to this, namely, digital elevation model (DEM), digital terrain model (DTM), and digital surface model (DSM). The distinction among the three terms is not clear and universally agreed, but some common tenets may apply, as follows. ⁶

- A **DEM** is a “bare” land surface model, which is supposedly free of trees, buildings, or other “nonground” objects.

⁴ Carter, J.R., 1988. Digital representations of topographic surfaces. *Photogramm. Eng. Remote Sens.*, 54(11), pp.1577-1580.

⁵ Carter, J.R., 1988. Digital representations of topographic surfaces. *Photogramm. Eng. Remote Sens.*, 54(11), pp.1577-1580.

⁶ Zhou, Q., 2017. Digital elevation model and digital surface model. *International Encyclopedia of Geography: People, the Earth, Environment and Technology*, pp.1-17.

- A **DSM** is an elevation model that includes the tops of everything, including buildings, treetops, and ground where there is nothing else on top of it.

- A **DTM** is a more generic term referring to a DEM with one or more types of terrain information, such as terrain morphological features, drainage patterns, and soil properties. When dealing with only one terrain information type (i.e., height), this is a DEM. Obviously, DEMs are a subset of DTMs (Li, Zhu, and Gold 2005).

Whether called DEMs, DTMs, or DGMs, these data sets exist in many forms (Burrough, 1986).

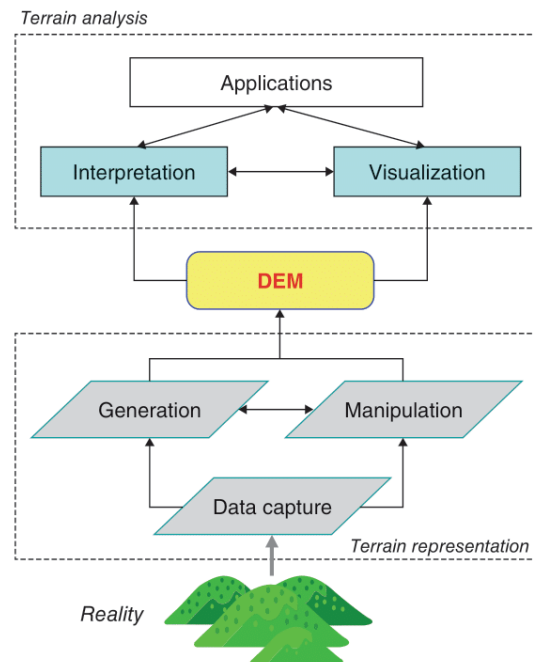
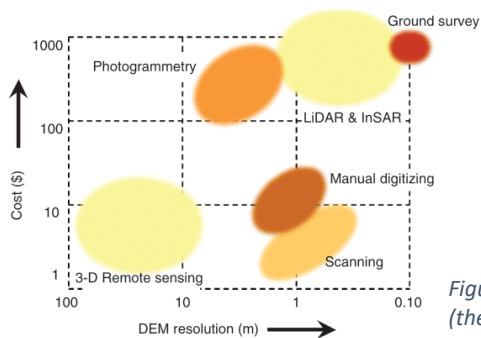


Figure 1: Tasks of digital terrain modeling. Source: (adapted from Zhou and Liu 2006).



While digital elevation data acquisition techniques vary in performance, cost, time, and accuracy, with advantages and disadvantages in different aspects. A simple comparison between the techniques is shown in the figure ahead.

Figure 2: Comparison between different DEM data acquisition techniques (the color shows the speed of data acquisition, the darker the slower) Source: (adapted from Zhou and Liu 2006).

2.2. Digital terrain representation:

Whatever the data acquisition method employed, the resulting data are merely a set of discrete sample points (spot height). They are independent of each other without any inherent relationships among them. In order to fully represent the terrain surface, a model has to be established to define the relationships between these points so that a continuous surface can be formed in a 3-D space⁷. Four data models are commonly used to construct a DEM.

2.2.1. The planar format - regular grid structures (grid, lattice, raster).

2.2.2. Profiles.

⁷ Zhou, Q., 2017. Digital elevation model and digital surface model. *International Encyclopedia of Geography: People, the Earth, Environment and Technology*, pp.1-17.

2.2.3. triangulated irregular networks (TINs).

2.2.4. contour structures.

1. The planar format. - regular grid structures (grid, lattice, raster):

The U.S. Geological Survey (USGS, 1987a) produces and distributes gridded matrices of elevations formatted in the coverages of topographic maps. Elevations in the 1:24,000-scale series are spaced in a square grid 30 meters on a side (called the planar format). The 1:250,000-scale series of DEMs were produced by the Defense Mapping Agency and are distributed by USGS. The elevations in this series are in the so-called arc-second format because they are spaced 3 arc-seconds apart. The arc-second is non square except at the equator where a unit of latitude and longitude are equal. USGS has chosen to call both series of files Digital Elevation Models, or DEMs⁸. Similar matrices have also been called Altitude Matrices (Evans, 1980) and surface matrices (Strumbo, 1985).

2. Profiles:

The topographic surface may also be captured as a series of profiles showing elevations along parallel strips. When built from a stereo-photo model, the points along the profile strips should be taken at all critical points as well as scattered across the surface. When built from an existing topographic map, points along the profile can only be taken where the profile intersects a contour line.⁹

3. Triangulated irregular networks (TINs):

Another form of elevation data capture is the Triangulated Irregular Network or TIN. The TIN is a set of triangular patches fit to the topographic surface and is based on the principle that a flat plane can be fit to any three non-collinear points. TINs are made up of irregular triangles connecting what should be critical points on the surface. In broad areas lacking distinct breaks in slope, mass points are collected to give the general form of the surface.¹⁰

⁸ Carter, J.R., 1988. Digital representations of topographic surfaces. *Photogramm. Eng. Remote Sens.*, 54(11), pp.1577-1580.

⁹ Carter, J.R., 1988. Digital representations of topographic surfaces. *Photogramm. Eng. Remote Sens.*, 54(11), pp.1577-1580.

¹⁰ Carter, J.R., 1988. Digital representations of topographic surfaces. *Photogramm. Eng. Remote Sens.*, 54(11), pp.1577-1580.

4. Contour structures:

And finally, the surface may be represented by the digital definition of contour lines with points captured at bends and flexures in the contour lines. Programs exist to go from one form of data storage to another, but with each transformation, information is lost and the definition of the surface becomes more generalized.¹¹

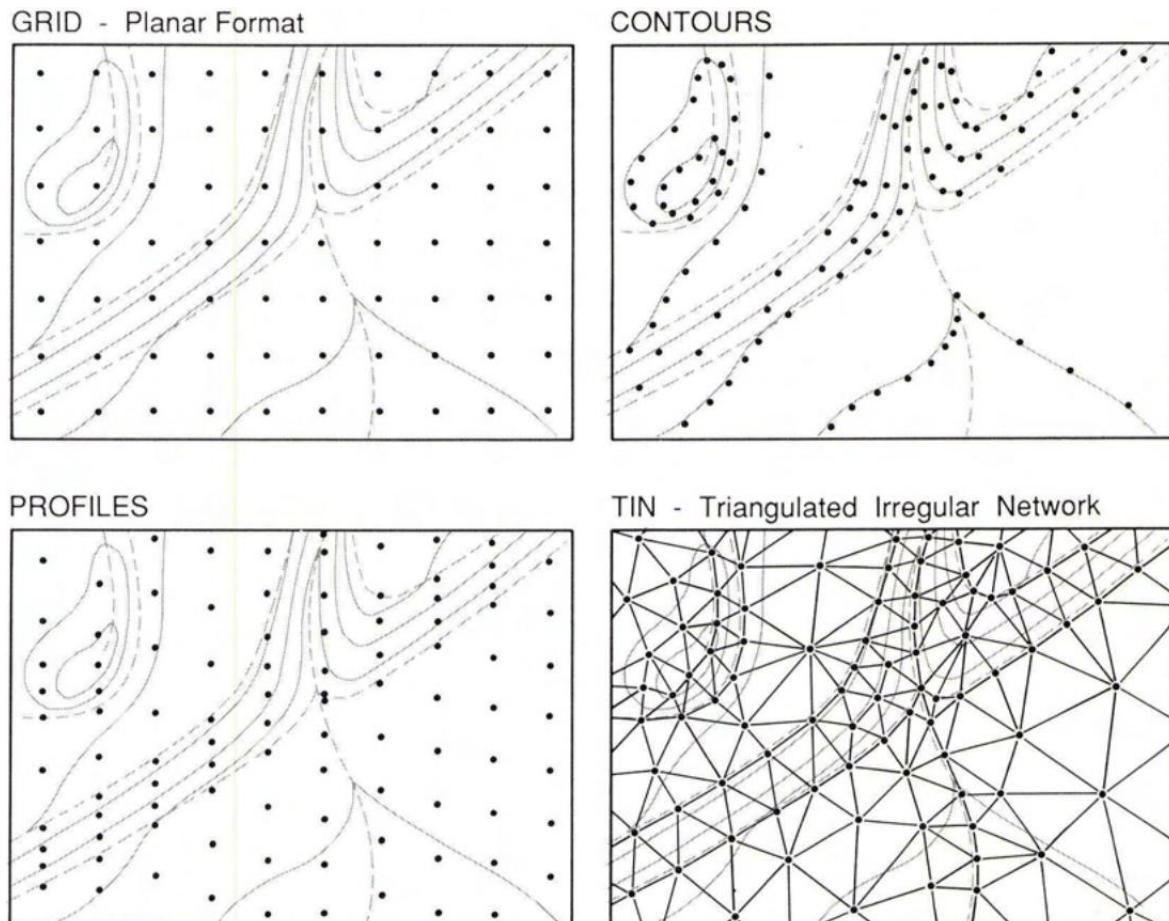


Figure 3: The four basic forms of capture and storage of digital elevation data. The gray solid lines are contours.
Source : Carter, J.R., 1988. Digital representations of topographic surfaces. Photogramm. Eng. Remote Sens., 54(11), pp.1579.

3. Cross-generational and disciplinary urban approaches:

in this title, we will cover three controversial studies or experiments that contributed to seeing the urban planning discipline from different unrelated perspectives:

3.1. The Optimization Champion Blob 1 :

Japanese people always bring up the most unstandardized and common way to approach a solution all while envisioning the most optimizable way to reach their wanted end, in terms

¹¹ Carter, J.R., 1988. Digital representations of topographic surfaces. Photogramm. Eng. Remote Sens., 54(11), pp.1577-1580.

of urban planning japan had a biological approach to set an initial solution for Tokyo's mobility network and that is by cultivating a brainless slime mold in its labs to help set the most efficient & wasteless base layout, but what's most shockingly is the appearance of an influenced set of organization from various disciplines which they also used this method to reoccur electricity, water distribution...etc

The blob (*Physarum polycephalum*) is a strange being. Between animals, plants, and fungus. Unicellular, it expands to cover a maximum surface, then concentrates and melts to keep only the most useful axes for circulating food in its body. Japanese researchers have studied this mode of travel more precisely and have concluded that it constitutes a very efficient spatial optimization method, close to other optimized network structures such as the Tokyo metro. Hence, partially it is quite possible that the network formed by the blob is not optimal from the point of view of the total distance, but that it has better properties of robustness or average distance between the nodes than the solution of the Steiner problem. These are also interesting properties for a railway network, we would certainly like to build the minimum number of tracks, but also to prevent certain areas from becoming inaccessible if a line breaks down, or else to minimize the travel time of passengers, so many parameters which could push to favor another network than the solution to the Steiner problem.¹²

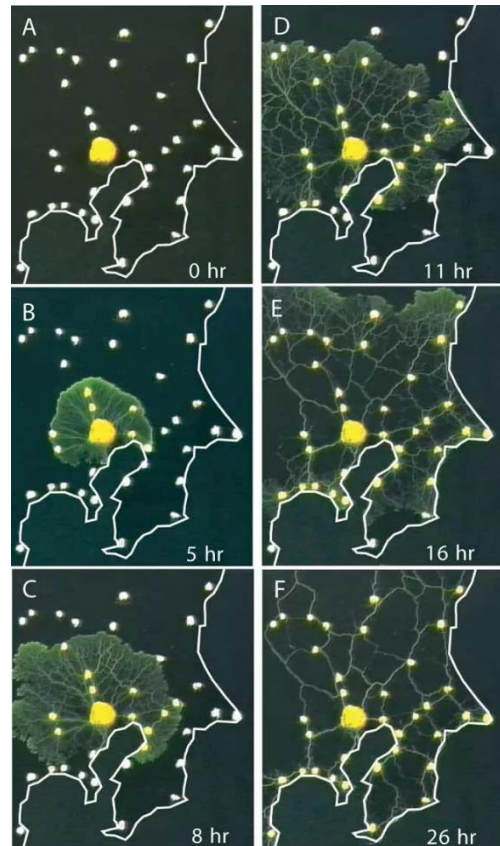


Figure 4: Tokyo main nodes recreated by the oatmeal while the fungus is placed at the center. source: Science/AAAS

The principle of this model is that starting from a space covered with a blob, channels are formed which tend to increase or decrease according to their usefulness for transporting food. The system evolves and when it stops, it reaches a near-optimal structure from the

¹² 'Optimization champion blob 3 – Maths in Turin' (no date). Available at: <http://www.vdouine.net/maths/mej/le-blob-champion-doptimisation-3/> (Accessed: 26 June 2023).

point of view of the energy expended and the robustness to modifications following damage caused to the blob.¹³

The Irony this experiment presents is the complete negligence of the terrain's physical and elevation characteristics which unfortunately lessens the credibility of its layout models but still can be run out as an initial base sketch,

In the attempts of perfecting this method, a question pops into our heads, is there a way to perform this experiment over a bumpy surface or topographic recreational model, such as a 3D printed surface that can help simulate this fungus' behavior to reality's conditions?

3.2. Fractals and chaos in the city :

all phenomena are fractal because shapes with integer dimensions are special cases, and are abstractions in that perfectly integral shapes are impossible to reproduce in reality. Fractals thus appear everywhere and this is what makes the fractal idea so appealing, in that it is so obvious and real, yet so profound.¹⁴

Natural examples of fractals abound, but there are an increasing number of examples of man-made fractals, or rather man-made or artificial phenomena whose description is aided by the fractal concept. Cities are clearly self-similar in a variety of ways.¹⁵

From the streets of Rome to those of Paris via those of New York, we easily realize that the axes of communication also draw particular geometric patterns. These axes of communication deserve our attention: after having studied the organization of their outline, let us examine with the magnifying glass the division of the surface of our cities and try to model them using fractal patterns.¹⁶

3.2.1. Dissecting conduct: enhanced conduct:

The classic way to introduce fractal geometry is to discuss the shape of a coastline. Viewed at a fixed scale, any coastline appears to have a degree of irregularity that can be measured using that scale. As one goes down-scale or nearer to the coastline if one is actually approaching it, the area in view gets smaller, but the scale also gets smaller and it seems

¹³ 'Optimization champion blob 3 – Maths in Turin' (no date). Available at:

<http://www.vdouine.net/maths/mej/le-blob-champion-doptimisation-3/> (Accessed: 26 June 2023).

¹⁴ Batty, M. and Longley, P.A., 1986. The fractal simulation of urban structure. *Environment and Planning a*, 18(9), pp.1143-1179.

¹⁵ Batty, M. and Longley, P.A., 1986. The fractal simulation of urban structure. *Environment and Planning a*, 18(9), pp.1143-1179.

¹⁶ 'Fractals and chaos in the city 2 – Maths in Turin' (no date). Available at:

<http://www.vdouine.net/maths/mej/fractales-et-chaos-dans-la-ville-2/> (Accessed: 25 June 2023).

the degree of irregularity is much the same as that viewed from the higher level. As one continues down-scale examining smaller and smaller nooks and crannies in the coastline, the level of irregularity always seems to be the same in terms of the scale chosen. Such shapes are said to have the property of self-similarity in that what appears at one level appears at the next level, and so on down the hierarchy.¹⁷

But of more profound import was Mandelbrot's demonstration that such shapes have fractional, not integral dimensions. A straight line has dimension 1, a plane 2, but coastlines have a fractional or fractal dimension between 1 and 2, mountains between 2 and 3, and so on.¹⁸

The introduction of chaos into well-ordered fractal patterns has an interest: they allow us to stick more faithfully to reality.

This phrase expresses the fact that scholars through their research time and effort have had enough and are fed up with pure bland geometrical and fractal interpretation, and urban interventions, and are encouraging other fellow scholars and upcoming generations to challenge these “with respect to discrete choice models” (Canova, C., 2020); these bland approaches to opt for a more daring and organic shape.

3.2.2. General concept dissection: (Algorithmic approach):

As introducing randomness into fractal patterns seems like quite the tempting idea, achieving is way harder than it seems, Because although Major efforts have already been mounted to classify fractals by their fractal dimension, and a variety of measurement techniques have been introduced, The key issue underlying a model of a fractal involves the degree to which form can be abstracted and simplified.¹⁹

In this particular method, experimenting with algorithms was the main key to achieving the obtained results, by playing with the rules of a coin flip and basing off the famous Von Koch Flake.

¹⁷ Batty, M. and Longley, P.A., 1986. The fractal simulation of urban structure. *Environment and Planning a*, 18(9), pp.1143-1179.

¹⁸ Batty, M. and Longley, P.A., 1986. The fractal simulation of urban structure. *Environment and Planning a*, 18(9), pp.1143-1179.

¹⁹ Batty, M. and Longley, P.A., 1986. The fractal simulation of urban structure. *Environment and Planning a*, 18(9), pp.1143-1179.

3.2.3. Rules:

Let's start with the Von Koch flake and flip a well-balanced coin. When it lands on tails, we place the point of the triangle outside, when it lands on heads, we place the point of the triangle inside. The "well-balanced" means that there is as much chance of falling on tails as on heads. Technically, nothing could be simpler: to simulate "Heads" or "Heads" with a computer, we randomly draw an integer between 0 and 1. When we get "0" it corresponds to "Heads". When you get "1" it corresponds to "Heads". Any programming language integrates this instruction sometimes called "ALEA", better known by Anglicists as "RANDOM". Then, depending on the result obtained, "0" or "1", "Heads" or "Heads", we change the angles of displacement to their opposites! Nothing could be simpler... And the results obtained are astonishing. We break the beautiful regularity and self-similarity of our fractal pattern and introduce the notion of chaos into this well-ordered set. Look what this gives in the case of the Von Koch triangle then in the case of the Von Koch square... Surprising, isn't it?²⁰

3.2.4. Reality's involvement:

Let's apply this idea to the outline of a country. Choose Italy. We rough out the peninsula using a few well-chosen segments. Each segment is substituted by a

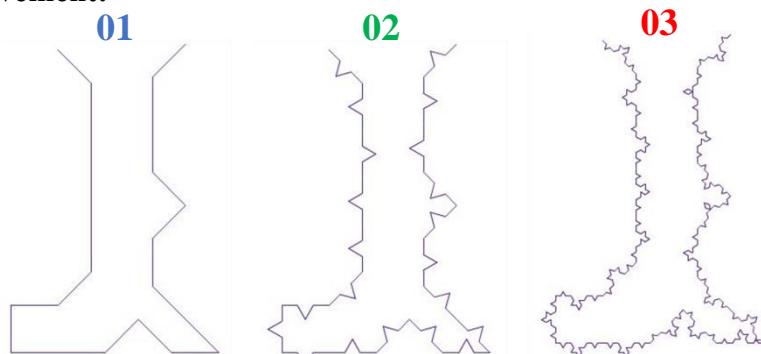


Figure 5: ITALY; Random snowflake shape; variable Von Koch fractals 01-02-03.
Source: <http://www.vdouine.net/maths/mej/fractales-et-chaos-dans-la-ville-3/>

Von Koch fractal. Of course, each segment will not be

substituted by the "same" fractal. Having thrown a coin beforehand for each segment, some will have a point that "comes out" outwards while others will have a point that "enters" inwards. All this is in a perfectly random and therefore chaotic way. closer to reality!²¹

Within Italy resides a town called Palmanova that prescribes the perfect Von Koch snowflake fractal pattern with its 9 9-star-shaped layouts, here as the analysis conducted on it will be presented further in this chapter.

²⁰ 'Fractals and chaos in the city 2 – Maths in Turin' (no date). Available at: <http://www.vdouine.net/maths/mej/fractales-et-chaos-dans-la-ville-2/> (Accessed: 25 June 2023).

²¹ ²¹ 'Fractals and chaos in the city 3 – Maths in Turin' (no date). Available at: <http://www.vdouine.net/maths/mej/fractales-et-chaos-dans-la-ville-3/> (Accessed: 25 June 2023).

4. Written support as methodological tools:

Within this phenomenology of architecture – regarding its meanings and its non-verbal communication – imbalanced architects’ performances may constitute a lack of appropriate meaning and result in inadequate responses to the aspects of reality first observed as problematic, thus contributing to a (more) chaotic urban scenario.²²

In order not to fall into a shortage of base work nor a promiscuous path, meanwhile drawing a clear trajectory for our interventions; we have consulted (04) main scientific references and the methods they relied on, in order to be able to program and design our urban layout:

Housing system definition:

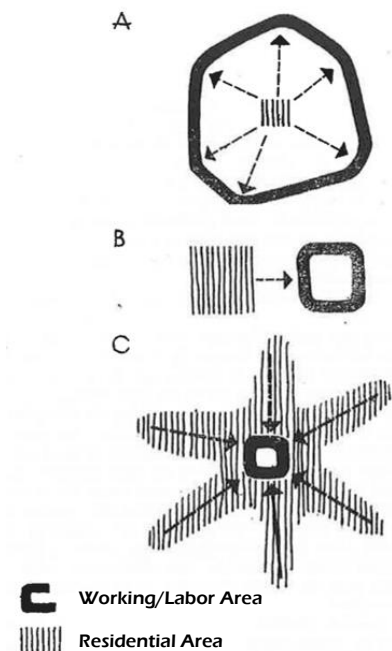
Housing systems, considered in the previously defined sense, - are a fulfillment of the lands reclaimed by man and that also creates a housing network of various levels and degrees of saturation.

The analysis and comparison of these systems, such as they are today, demonstrates their infinite variety.²³

First scale: fundamental work division

Starting with the alternative migration options, dividing the systems into three 03 categories;

- Ⓐ primary (based on extraction; agricultural or mining labor),
- Ⓑ secondary (based on the processing industry),
- Ⓒ tertiary (based on amenities).



²² Canova, C., 2020. Utopia as a practical approach to urban chaos: towards a meaningful design process in Architecture. *Excursions Journal*, 10(1), pp.1-14.

²³ Malisz, B., 1972. The Formation of Habitat Systems: Outline of Threshold Theory. *Dunod, Paris*, pp-74 .

Second scale: Housing System General Classification:

As we can see here; the concept of housing units, presented as a local urban planning tool is a very vast & large notion;

Housing systems		Differentiation based on the fundamental division of the job			
		Primary, based on		Secondary, based on processing industry. 03	Tertiary, based on service activities. 04
		Agriculture 01	Mines 02		
Differentiation based on complexity's degree	Elementary 01	farm	A resided site (coron/crown-shaped) near the mines (shafts)	Industrial resided site	The radius of migration to a single service arrangement (workplace)
	Simple 02	village	A group of housing units (coron/crown-shaped)	City-dominated by	
	Complex 03	village with hamlets	A housing system related to a single deposit	industry	Amenities
				industry	Amenities
multi-complex 04	village conglomerate	Conurbation-dominated by			
		mining	industry	Amenities	

The housing system dynamic:

Highlighting the four main factors of differentiation between these systems or criteria that lead us to form an array of models, these factors are presented as:

- 1) The functional diagram diversity: starts from the multiple workplaces or occupational locations and the illimited amount of combinations that can be made out of them together.
- 2) The housing system complexity degree: that doesn't limit itself to only four (04) degrees, while in reality, we can detect an infinite series of explicit forms, starting from the elementary system, to Amorphism in its entirety.

- 3) Natural conditions of the geographical environment: Combined relief, morphology, geology, hydrography, and local climate of the terrain form the foundation of an infinite variety of housings.
- 4) Social labels: that expand from institutional and political forms and production labels until it reaches various social behaviors, traditions, habits, and people's preferences.

Taking into consideration that these factors proceed simultaneously & are related by multiple interactions, however, in order to bring out conclusions that will serve the housing system's molding, we must dispose of one key factor; and that would be time.

In other words; it is impossible to digest the richness of the housing system's shapes in a reality that's perceived in a static matter in a split second, whereas in the real world, these systems are created in specific conditions and wouldn't stop progressing and morphing with time.

Layering the transformations undergone by the housing system in successional formations:

In this part of the book, the authors emphasize the importance of understanding the chronological and diachronic evolution of urban planning acts and a number of housing systems in order to identify the factors reactions to the speed and the logic of one's housing system growth

However, the part that he relied on most in this chapter was the living conditions' evolution but only based on the 04 four previously mentioned factors and how it is expressed in real-life layout planning.

The role of programming in composing the housing systems:

We might now transition from general aspirations and theories on temporary studies on the long term, to programming the housing systems; whereas the variety of scenarios that can ignite from one each concrete case obliges us to lean on methodological aspects:

- ✓ The layout programming notion is always related to a defined chronological interval (prospective/eventual layout/image & referred layout to the first chronological gap)

- ✓ From a spatial planning perspective, this programming expresses itself through request, laid out areas that are in accordance with the various goals that a housing system is expected to attend to
- ✓ Throughout the planning process, the assigned task is to: acknowledge the grounds and lands layout state from the starting point (at the beginning of the plan), determine and quantify the number of upcoming requirements (at the finishing line of the dedicated period to the plan)
- ✓ In order to acquire that, we'll have to determine the activities' growth within the housing system, in a predefined period, activities expressed through their economic contribution to the economy of the hierarchically superior levels.
- ✓ From here onwards, we start by determining the functionally necessary jobs or employment, at the end of the layout's period in order to calculate the future population of the housing system. taking into consideration groups that are assigned to the amenities services and non-active individuals.
- ✓ Through relying on widely considered spatial norms, it is possible to assign to a variety of groups of users, the necessary surfaces in order to satisfy future essentials in conformity with fixated standards
- ✓ In the process of defining these future requirements, we not only need to take into consideration ones that are related to demographic growth which is quite high (through a fixated standardization) but also the requirements of current users (existent at the beginning of the layout period)

If the creation of such conditions depended only on the program, every change of circumstances would've led to the whole change of the land surfaces as a whole, and for that matter every layout based only on such a program will become an undetermined construction.

What guarantees the essential stability of the plan faced to undefined circumstances are the spatial and functional structures of the housing system.

And for that reason, we consider the program, primarily and essentially, the link that relates to the establishment of a housing system and its evolution.

Futur shaping of housing systems:

According to Malisz, the model plays the role of a compass indicating the path that will get us to the targeted goal, without such a tool, the housing planning and layout will eventually submit to the spontaneous evolution and growth process. And that leads us to admit that the establishment of housing systems is an action that envisions a determined goal ²⁴

Defining the future shape of a housing system is a bigger job than inspiring imagination but rather requires a thorough work of analysis and studies.

In an attempt of dividing the work into big lines, we define two operations:

1) Acknowledging the shape's functions and their interdependences:

This means the research trip for a new shape of a housing system should depart from a current state study and the process that led to it,

It is important to establish and distinguish the healthy elements, that function regularly in the housing system from the ones that require a transformation

2) Assess the extent of their fulfillment by the considered housing system:

We have to determine based on which chosen model it is found more convenient to transform the ill and deficient elements, in other words determining the shape that will provide the right conditions for them to function properly.

Without underestimating the importance of historical and evolutionary analysis, it is important to lean on the recent urban planning evolution.

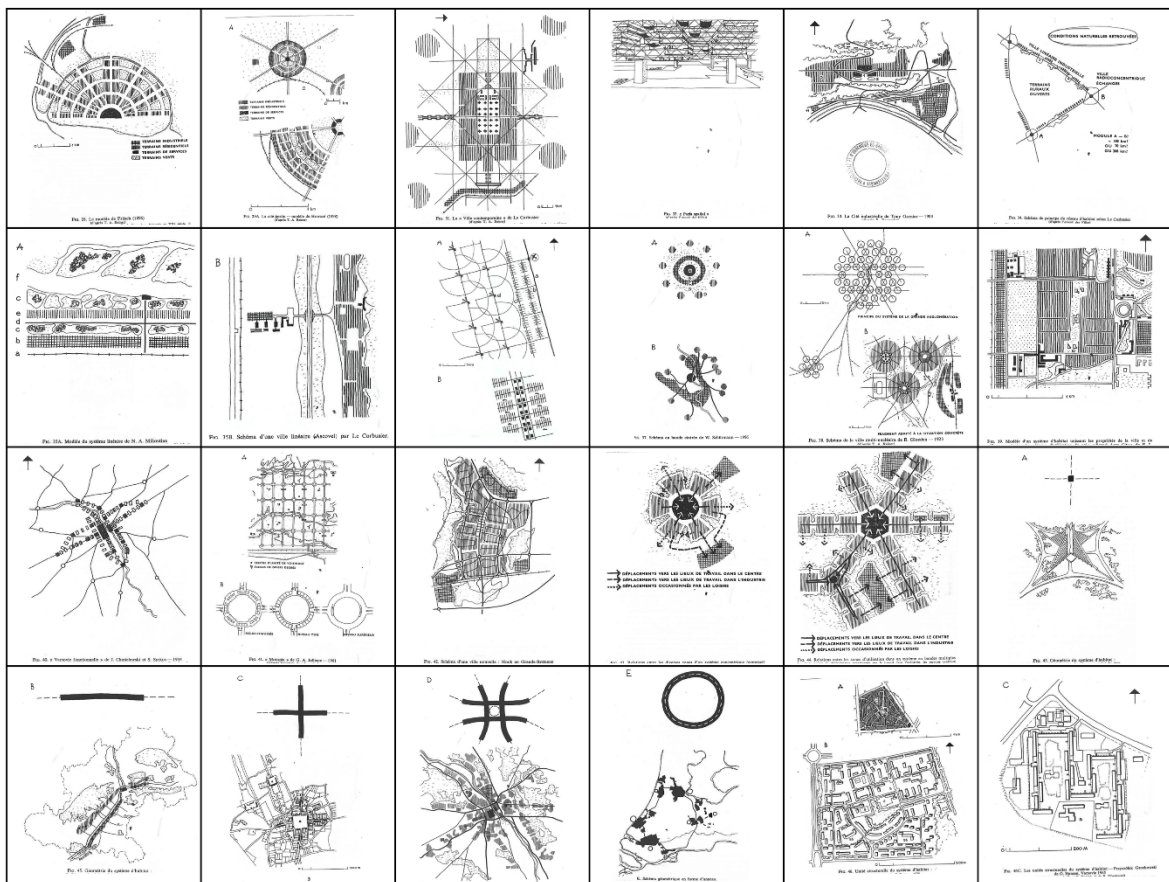
Critical models review and exposition:

In that context we have to review the main ideas in terms of the models, this is essential for us to be able to sketch a method that will allow us to imagine and idealize the future shape of the housing system in its wholesomeness.

the book presents 24 housing system models mainly constructed from cities that underwent a growth process starting from the XIX century, generated by the industrialization and urbanization force, most of them resulted from their fast growth and concentration processes, which makes the fact that most of the suggested theoretical models are founded on the desir of opposing the force of concentration, not surprising at all.

²⁴ Malisz, B., 1972. The Formation of Habitat Systems: Outline of Threshold Theory. *Dunod, Paris, pp-179* .

The 24 models are presented below:



Each model is a selfish, subjective creation of a single man, an individual reaction to the existent environment's conditions, however, these abstract models are relevantly consistent in their diversity and variety in a sense that makes them perceived as a database of means for future shapes of the housing system.

However, a housing system with a defined size should be studied through its structural aspects:

1. **Zoning:** as recalled by the urban planning practice; the distribution of elements in various functions
2. **The geometry of the system:** represented by its main lineare facilities
3. **The complexity of the system:** the way it divides itself into structural units as it gets zoomed in

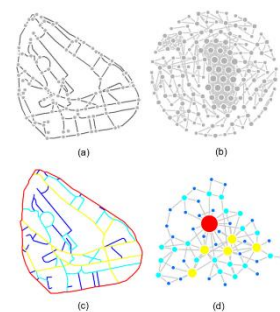
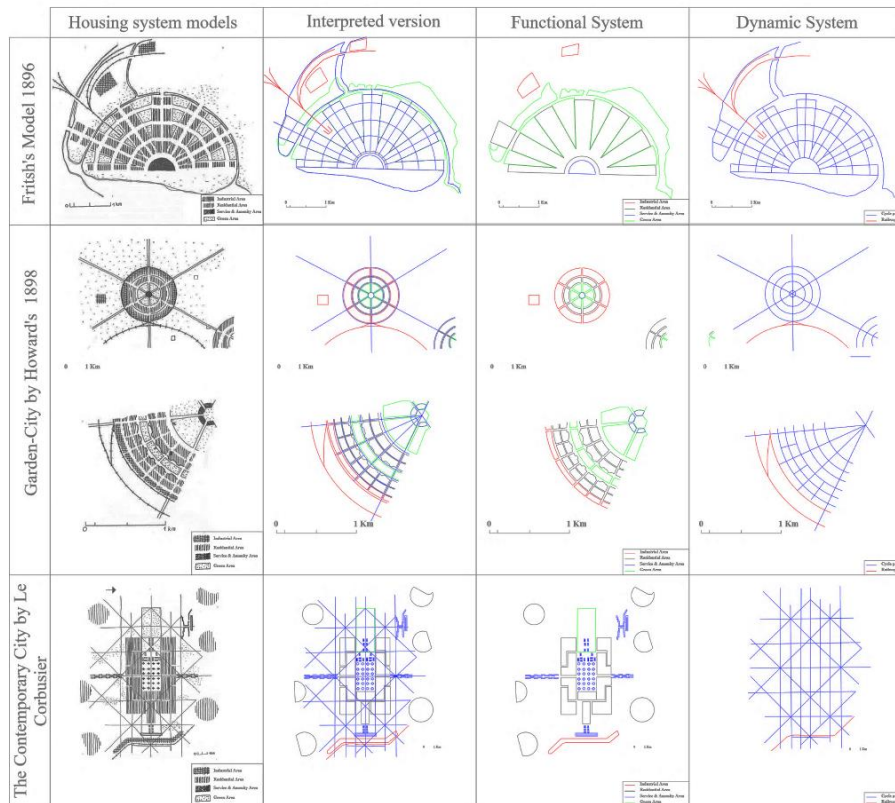


Figure 6: Panels a,b,c,d
 Source: Ma, D., Guo, R., Zheng, Y., Zhao, Z., He, F. and Zhu, W., 2020. Understanding Chinese urban form: The universal fractal pattern of street networks over 298 cities. *ISPRS International Journal of Geo-Information*, 9(4), p.192.

Between the 24 examples we will take 03 three models to decompose into functional and dynamic diagrams which will allow us to plot the layout closer to motion:



The Garden-City Era:

When speaking of this urban form three major characteristics pop into our mind: autonomy, limited size, and green belts²⁵, However, We can't overlook the fact that when the Garden City concept came out it made a big hit, especially with the ongoing overseas competitiveness, we have witnessed many models and personal interpretations of this urban composition, mainly the ball was tossed between the English the American and later on joined by the french urbanists we expose the attractive aspects of this concept we mention:

- Implying this concept on an existent urban tissue helps the tails to indulge the progressive transition from the “mineral frame” as Annelise Gerard described it to the natural one.

²⁵ Bonnefont, JC, 1980. Annelise Gerard. Neighborhood and vicinity unit in French urban planning practice 1919-1973. Geographical Review of the East , 20 (3), pp.259-261.

- The housing system is never a rigid feature, unlikely it's composed of various elements, where each plot assigned a precise use constitutes an elementary unit, whether it held a residential building, a factory, or an amenity service.

However, if we highlight the functional and areal aspects of the spatial structure, it means we never got out of the static aspect of the housing system, hence this latter should be designed as an organism that's constantly under evolution.

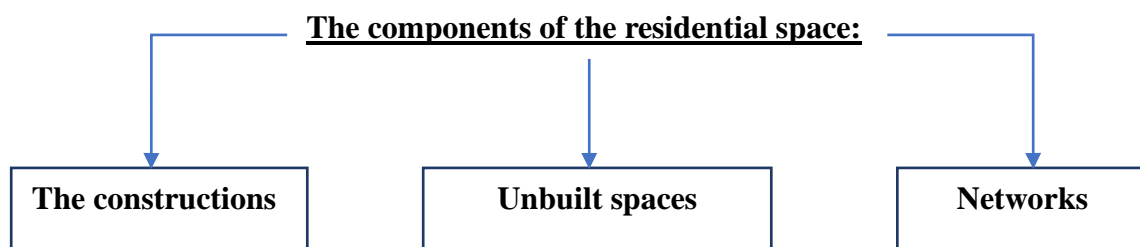
This is where dynamics plays the essential attribute for an abstract model in order to design a breathing housing system, for this matter, scholars, and theorists have conducted two paths to achieve it:

1. Mechanical procedure: solved by the linear system as a first example
2. Organic growth: of the housing system

Residential space and the process of forming the city:

The dialectical relationship of the residential space with the other components of the urban space is one of the most significant descriptive elements for the knowledge and understanding of the history of the city because it is through it that we can grasp and analyze the ideological, economic and physical-spatial "processes"

Intervening in the "training" and in the "development" of the city.



"**The constructions**" include dwellings and annexes, equipment, and technological installations.

"Unbuilt spaces" are made up of landscaped, landscaped spaces or squares, plots, and other open spaces.

"The networks" include the road system, the water, electricity and gas distribution systems, water drainage one of...

Choosing the optimal solution:

Athenes Chart usually refers to the 04 four essential and fundamental functions criteria: accommodating, work, leisure & communication, However These private and collective needs for living and working space, education and health, consumption and exchange, ...²⁶

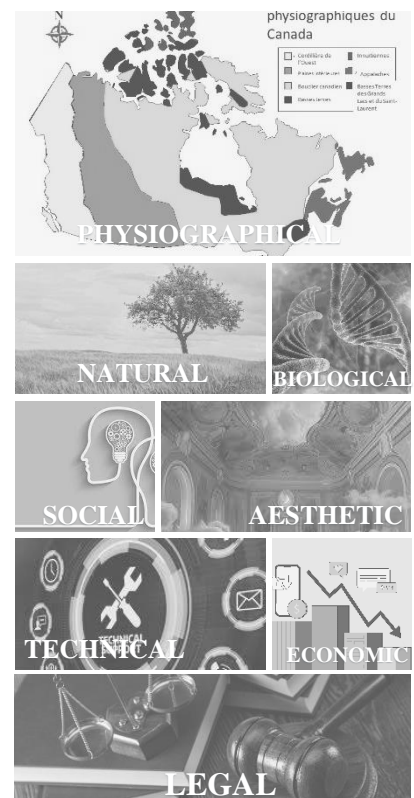
- ✓ are classified according to an "increasing and evolving" scale, in time) and in space, to which we match "threshold of year satisfactions" deemed achievable and generalizable by means of the application of "standards".
- ✓ It is indeed a growing and evolving scale since we are confronted with a real dynamic of needs, that is to say, a movement, more or less accelerated, of training and claiming new requirements from socio-economic and cultural transformations of society.
- ✓ Each country defines its residential space sizing thresholds
- ✓ The position assigned to the various equipment in the spatial organization of the whole determines a "service-accessibility radius", for the equipment, which can promote their optimal use because, through the location, we seek to minimize the negative impact of time and distance factors.

Fortunately, we can reproach this one-sided classification for being deficient from many aspects such as:

- Complet disregard for urban services and amenities
- Restricted to utility aspects while neglecting the social and economic side
- Seeks according to aesthetic relevance to utility requirements

Suggesting a new criteria system is necessary in this case extracted from cross-disciplinary conditions that support an efficient well rounded systematic criteriology:

In order not to fall into the same vicious cycle, new



²⁶ Zucchin, A. (1984). Introduction to operational urban planning and urban composition, Volume 03, University publishing offices, Algiers, pp 01-329.

utility criteria were prioritized in the function and conduct of the housing system adjustments

Synthesis:

Through their evolution, housing systems will never achieve their final stage; it's a chapter that will never end. It is an alive and breathing mechanism, as long as it's occupied it will never die, hence fading can hunt it when it's on its way to shut down.

Even newly founded cities will undergo an eventual transformation and that is how today we can draw at least the big lines of what a city of tomorrow can look like even in the far future.

5. Islamic principles impacting traditional cities (Medinas):

As we may use more common or well-known urban analysis methods pathing the Italian or french or British trajectory into breaking down a city's components but unfortunately these methods are partially not valid in traditional cities such as medinas for their social reliance on morals and abstract principals rather than the physical and elementary ones.

In this title, we will briefly expose the most impacting Islamic principles and beliefs that shape medinas into what they look like right now using Djanet's Ksar as the main model for its resemblance to our case study for having an oasis as the main growth factor of its urban tissue:

5.1. Moral values of Islamic beliefs and their praxes :

5.1.1. Qibla:

is the direction which the faithful Muslim should turn to, in order to perform the ritual of salat, it's the orthodromy that joins the place of prayer to the Kaaba, in the city of Mecca. In mosques, this orientation is indicated by the mihrab²⁷ it also has an impact on the urban grid angle of implantation.

5.1.2. The unicity of god :

Is one of the beliefs that distinguishes Islam from other religions, its influence on the morphology is evident through the existence of the mosque and its central role within the city. The central position of the mosque within an Islamic city is one of the base principles of spatial organization, usually, an englobing road network surrounds a mosque making it a focal point with a street leading to the access door and border wall, this centrality reassures access for all residents with no dead ends between the residential areas.²⁸

5.1.3. Neighboring and family ties:

a neighborhood is composed of a set of rules and social norms for all of its occupiers which they must follow and take into consideration in the matter that they use the space and construct or transform it, for the urban common façade, the exterior of the house has to

²⁷ Islam de France Origin" and involves the idea of facing the place of destination of the qibla, Site Web: <http://www.islamdefrance.fr/main.php?module=articles&id=166>

²⁸ Mr. Ben-Hammouche Mustapha, Urban analysis of Medinas, 2020-2021, pg 06

be integrated and interactive profile wise with its environment. It should be impossible to distinguish it from other neighboring facades.²⁹

5.1.4. Modesty and social consistency:

The presence of modesty among the citizens where no one tries looking superior than others, In other words, neighbors respect the same built height, materials usage, and no embellishment

5.1.5. Intimacy:

The patio, Shikan entrance, reception hall positioning, the man-woman segregation, spatial designation, and the roads' hierarchy (paths, alleys...etc), all are a form of physical interpretation of the intimacy concept.

5.1.6. Charity:

it is the easiest mechanism to identify for it always concerns a public building or service that used to be a Habous, properties on habous are frozen entities that remain unchanged through the course of time, they do not alter their size, shape, or function, except for mosque extensions where they generally adhere to existing Habous buildings. Graveyards, forts, and koranic schools are also usually waqfs.³⁰

5.2.Private sectors mechanisms:

5.2.1. Private legal authority:

expresses the legal authority handed to individuals in possessions of properties or other objects, it allows the actor to behave in complete liberty concerning his property under no one's opinion or permission, as long as there will be no public damage.³¹

5.2.2. The agreements:

Established between residents/neighbors about the rights and services exchanges, conflicts resolving, and mutual aid. It is necessary to choose semi-urban elements such as cul-de-sac,

²⁹ Mr. Ben-Hammouche Mustapha, Urban analysis of Medinas, 2020-2021, pg 06

³⁰ Ibid.

³¹ Ben-Hamouche Mustapha, Architecture and urban planning in the Maghreb in the 19th-20th centuries 'case of Algiers (1800-2000), 2018, Medina Foundation, ENAG Algiers, ISBN: 978-9931-9475-0-9. P51-53.

alleys, the arcs above the access gates on a housing are might express a sort of agreement between the neighbors.³²

5.2.3. The Waqf (endowment):

A charitable act consists of “eternally” allocating real estate for the benefit of an institution for the benefit of a charitable institution (orphanage, hospital, medersa, fountain, mosque, etc.).³³

5.2.4. Resuscitation:

the act of resuscitation consists of working on completely dead land (with no owner) by the bias of construction, agriculture, or any form of usage.³⁴

5.2.5. Precedence’s right:

the government or the present authority obliges the tenants of new construction to take in consideration the existing conditions of the area surrounding their goods/properties (windows, openings, terraces, conjoint wall...etc) as a given restriction.³⁵

5.2.6. Heritage (succession’s right):

A property’s division according to legal laws and functional requirements, It leads to the subdivision of the initial property into fragments as shares legally prescribed according to the subdivision rules (1-accessibility, 2-lighting, 3-use, etc.)³⁶

5.2.7. Pre-emption:

Pre-emption is the priority given to the co-owner in a shared property to substitute himself for an outsider purchaser, if the other co-owner decides to sell his or her share, in other words, the right of objection. According to this principle, shareholders in a collective property that could not be subdivided have the right to prevent each other from selling their shares to an outsider. This principle had the opposite effect of the subdivision that results

³² Ben-Hamouche Mustapha, Architecture and urban planning in the Maghreb in the 19th-20th centuries ‘case of Algiers (1800-2000), 2018, Medina Foundation, ENAG Algiers, ISBN: 978-9931-9475-0-9. P51-53.

³³ Ibid, P53-57.

³⁴ Ibid.

³⁵ Ibid, P57-60.

³⁶ Ibid.

from inheritance law, in that it permits the reunification of the smaller parts into a new, larger property.³⁷

5.2.8. The rights of neighbor:

In this concerns Abdullahi bin Omar narrated that; Prophet Mohamed (P.B.U.H) said:

" ما زال جبريلُ يُوصيني بالجار، حتَّى ظننتُ أَنه سيُورثُني. "
الراوي: عبد الله بن عمر

- ✓ The Built height: the private power gives the right of height extension as long as there is a need or necessity. But respect for the neighborhood often leads to limiting the heights of construction.³⁸
- ✓ Exterior exposure: opening a window or door to the outside is conditioned by the privacy of the surrounding buildings
- ✓ Materialistic competitiveness: building the house among the presence of other houses requires simplicity and the prohibition of any extravagant decoration driven by the desire to stand out and show off an individual high income.

5.3. Public sectors mechanisms:

The mechanisms of the public sector ensure the rights of each individual, their freedom of action, and public interests which will contribute to urban architecture by highlighting the city's urban planning under the Muslim jurists. The main mission is to protect the supreme laws of Islam.

5.3.1. Annoyance, damage, harm (Al-dharar):

In this concern Abdullahi bin Abas narrated that; Prophet Mohamed (P.B.U.H) said:

" لا ضررَ ولا ضرارَ؛ وللرجلِ أن يضعَ خشبَهُ في حائطِ جارِهِ، وإذا اختلفتم في الطريقِ فاجعلوه سبعةَ أذرعٍ ".
الراوي: عبد الله بن عباس.

No harm and no damage, and no hinder of circulation, and one can place his wood on his neighbor's wall, and if you differ in the width of way, let it be seven cubits. That is an

³⁷ Hamouche, M.B., 2009. Can chaos theory explain complexity in urban fabric? Applications in traditional Muslim settlements. *Nexus Network Journal: Architecture, Mathematics and Structure*, pp.217-242.

³⁸ Ben-Hamouche Mustapha, *Architecture and urban planning in the Maghreb in the 19th-20th centuries 'case of Algiers (1800-2000)*, 2018, Medina Foundation, ENAG Algiers, ISBN: 978-9931-9475-0-9. P63.

apparent Islamic value that limits the individual's behavior and manages the freedom to act. Everybody has the right to act but not to harm himself or damage others. There are five types of harm considered in architecture; Smoke harm, odor harm, sound or noise harm, visual harm, and vibration damage. The indirect gateway of the houses was used in Islamic architecture to provide visual privacy. That was done so as not to allow visual penetration from the passersby into the housing unit. Also, windows were treated in a way that prevents harm from both sides, as shown in Figure 3 by using "mushrabiah." A parapet wall is constructed higher than a human so others will not see it while at the roof.³⁹

5.3.2. The general interest, istislab or maslaba:

derived from the general interest. On the physical and spatial levels, the traces of these mechanisms are manifested in large-scale facilities, infrastructures, the defense system, and managing the private domain.

As Social facilities, the authorities ensure the supply and operation of services for public use such as mosques, hammams, hospitals, etc. As for infrastructure, it is the water supply, sanitation, traffic, and public lighting. The defense system is a vital area in the historical context of the 19th century which precedes colonial expansion. The enclosure and the fortification of the city, the barracks, the batteries are therefore an exclusive sector of the authorities. As for the management of the residential space, it consists in controlling the streets and public places, resolving the conflicts that arise from time to time between the residents and eliminating any prejudice that affects community life.⁴⁰

5.4. The language of chaos and fractals applied to Muslim cities:

It is not possible to dissociate chaos and fractals. Due to their interaction, they are either stated together [Crilly et al. 1990; Strogatz 2001], or somewhat interchangeably [Gleick 1988] For instance, according to Kenkel [1996] the fractal dimension can be viewed as a relative measure of complexity, and thus of chaos, while fractals are presented as part of chaos theory [Gleick 1988].

Literally speaking, chaos is a broad term for indicating the science of complexity. It applies to natural sciences such as physics and biology, as well as to human sciences such as

³⁹ Prima, E.C., 2021. The Role of Culture on Islamic Architecture. *Islamic Research*, 4(1), pp.30-34.

⁴⁰ Ben-Hamouche Mustapha, Architecture and urban planning in the Maghreb in the 19th-20th centuries 'case of Algiers (1800-2000), 2018, Medina Foundation, ENAG Algiers, ISBN: 978-9931-9475-0-9. P64.

economy and sociology, whereas fractals are limited to the geometry that is concerned with the application of non-Euclidean analysis, measurements and calculations to complex objects. The two terms are thus used together to explain complexity in real life and describe the inherent irregularity of natural objects.

The “theory” of chaos and fractals has been described as a collection of examples, linked by a common point of view. Its properties are not formally defined and it is thus not an organized theory [Lorimer, Haight and Leary 1994]. Eglash [1999] defined some of the essential properties, which are recursion, scaling, self-similarity, infinity and fractal dimension.⁴¹

5.5. Conclusion:

The language of chaos These design principles may be used to upgrade the workability of the existing residential buildings simply by revising the opening's location, heights, and treatments. Architecture with that dynamic, flexible culture gives its identity a chance to compete globally to survive locally. To differentiate between the history and identity of Islamic architecture, architectural students and experts should study them. There is no conflict in importing and learning other's experiences but no adoption without adaption.⁴²

⁴¹ Hamouche, M.B., 2009. Can chaos theory explain complexity in urban fabric? Applications in traditional Muslim settlements. *Nexus Network Journal: Architecture, Mathematics and Structure*, pp.217-242.

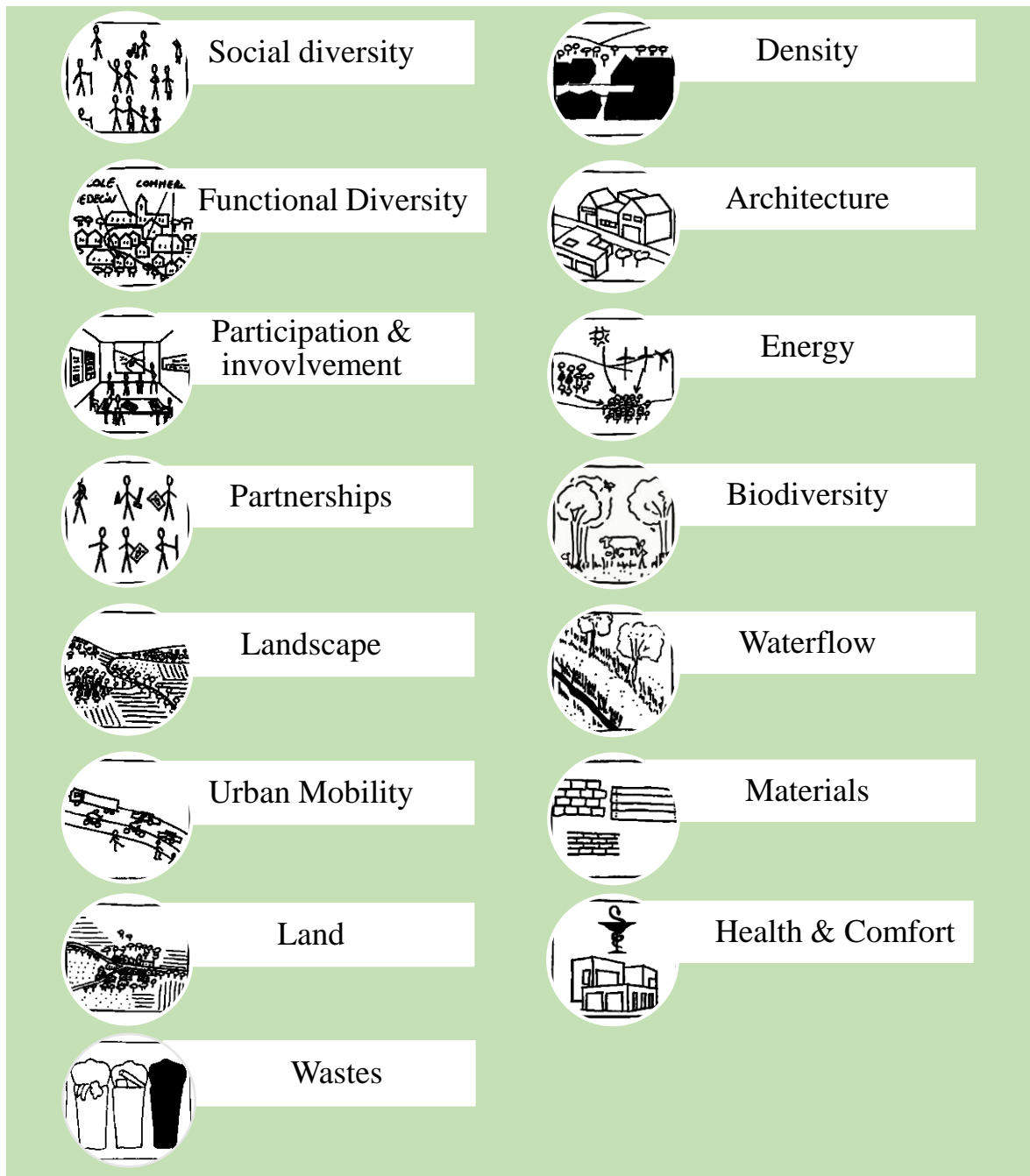
⁴² Prima, E.C., 2021. The Role of Culture on Islamic Architecture. *Islamic Research*, 4(1), pp.30-34.

6. Sustainable vicinity principles:

Climate change, the rationalization of energy use, the need to save soil and preserve agriculture, financial crisis, sustainable development, people's needs, etc. are changing practices. A sustainable housing project must take into account these developments.⁴³



Figure 7: Sustainable housing project's composants
Source: A guide to sustainable housing, proposed by the cross-border network .HABITREG.NET, 2013 edition.



⁴³ A guide to sustainable housing, proposed by the cross-border network HABITREG.NET, 2013 edition .

2. Model analysis :

A. Palmanova city:

Palmanova is an Italian municipality located in the province of Udine, in the autonomous region of Friuli-Venezia Giulia, in northeastern Italy. The town is famous for its 9-pointed star-shaped fortress, designed by Vincenzo Scamozzi. Between the points of the star, bastions allow each point to defend its neighbors. A moat surrounds the city, and three large guarded gates control the entrances. We immediately think of a famous fractal pattern: the Von Koch snowflake .

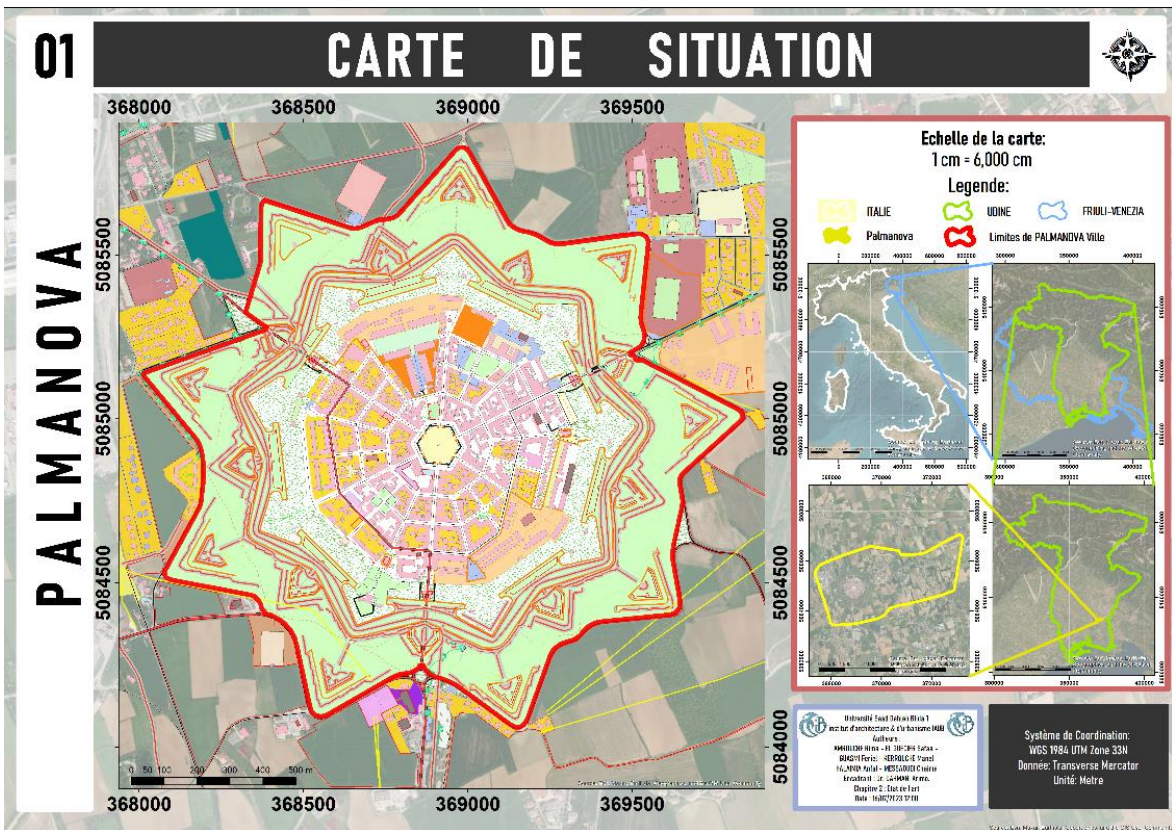


Figure 8: Geographical position.
Source : Authors.

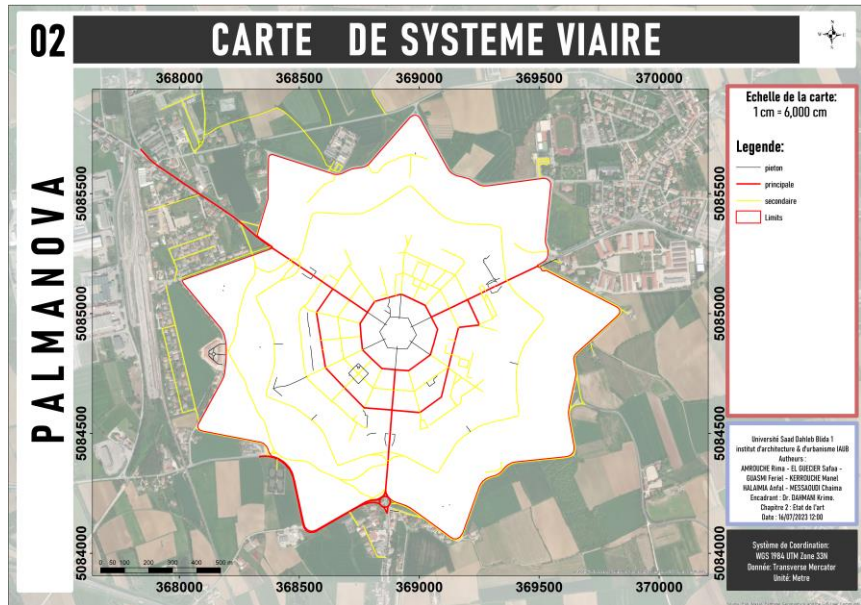


Figure 9: Road system.
Source : Authors.

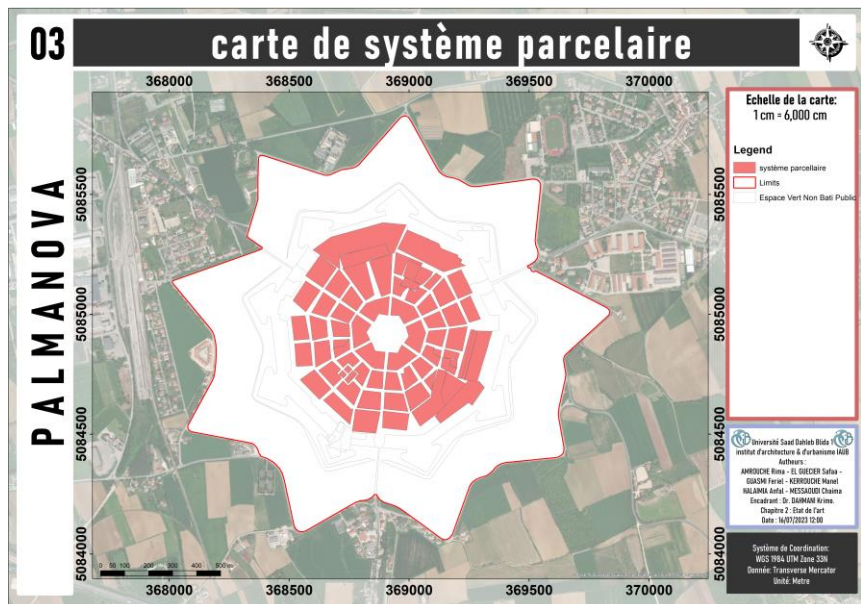


Figure 11: Plot use.
Source : Authors.

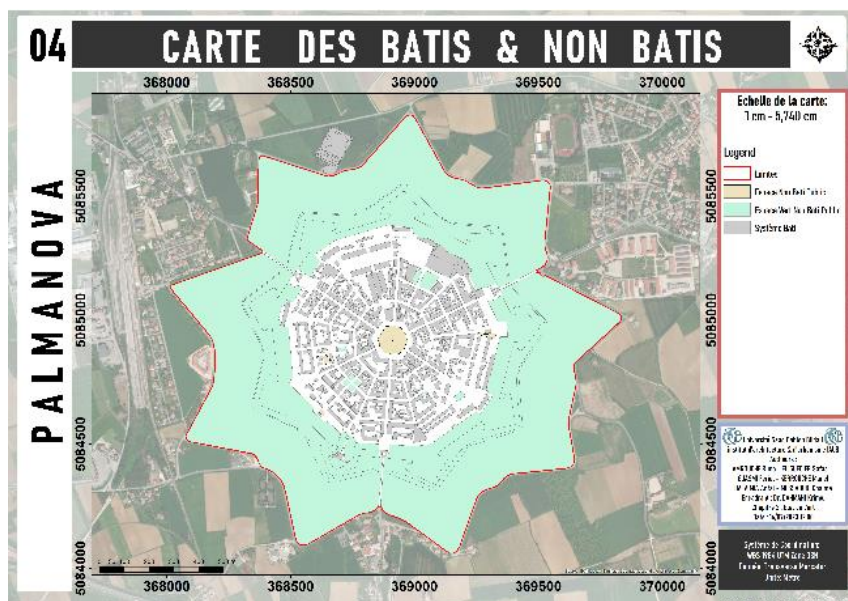


Figure 10: Built & unbuilt state.
Source : Authors.

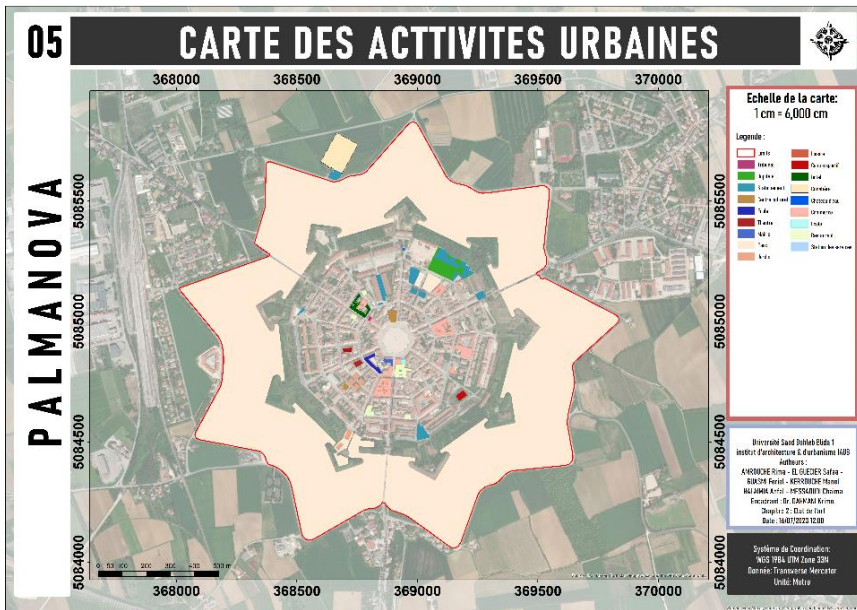


Figure 14: urban activities.
Source : Authors.

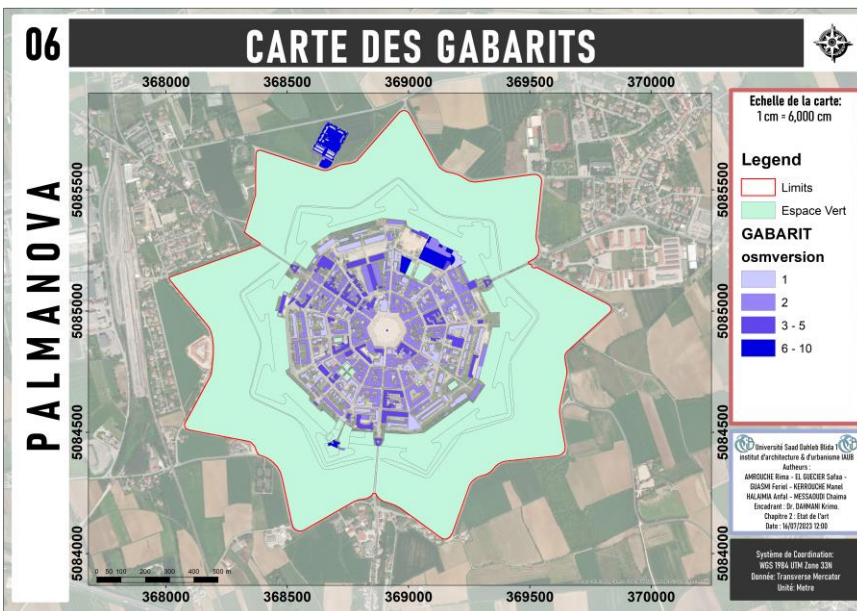


Figure 13: Building heighty.
Source : Authors.

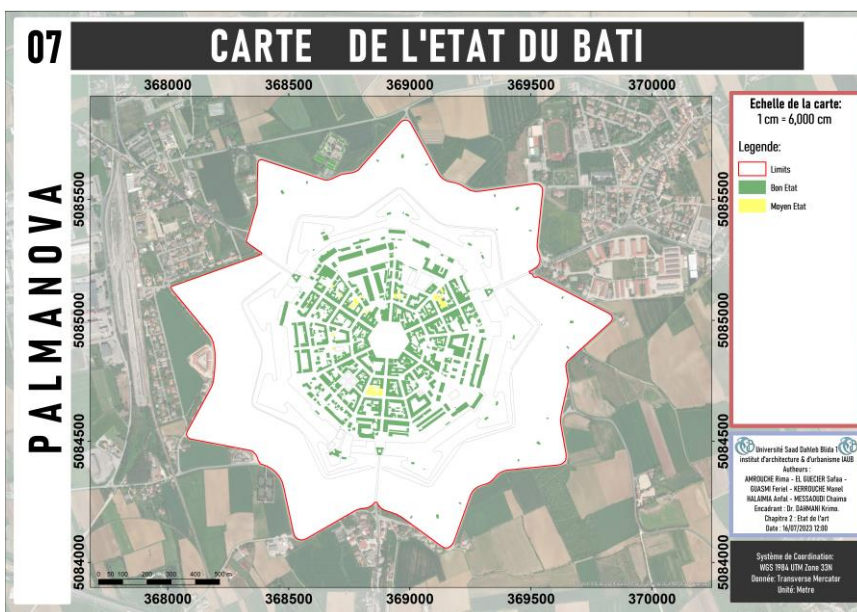


Figure 12: Building State.
Source : Authors.

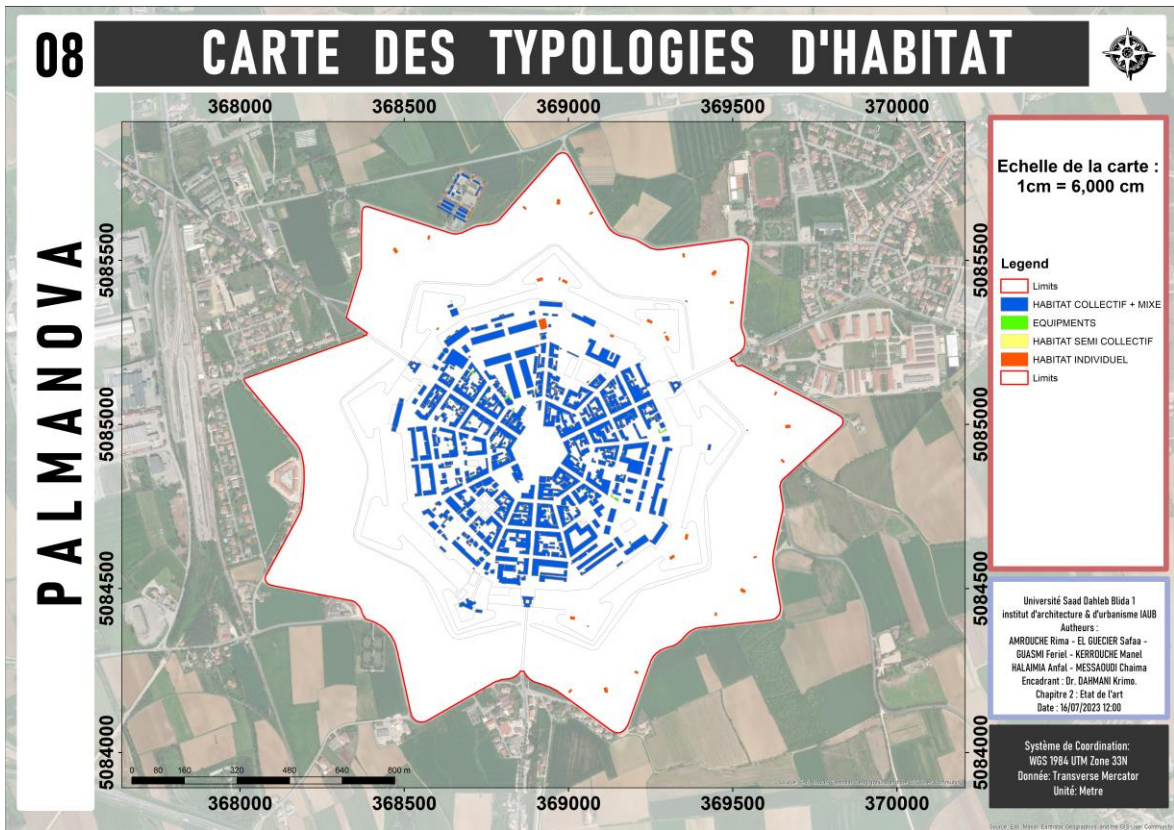


Figure 16: Hosuin / Dwellings types.
Source : Authors.

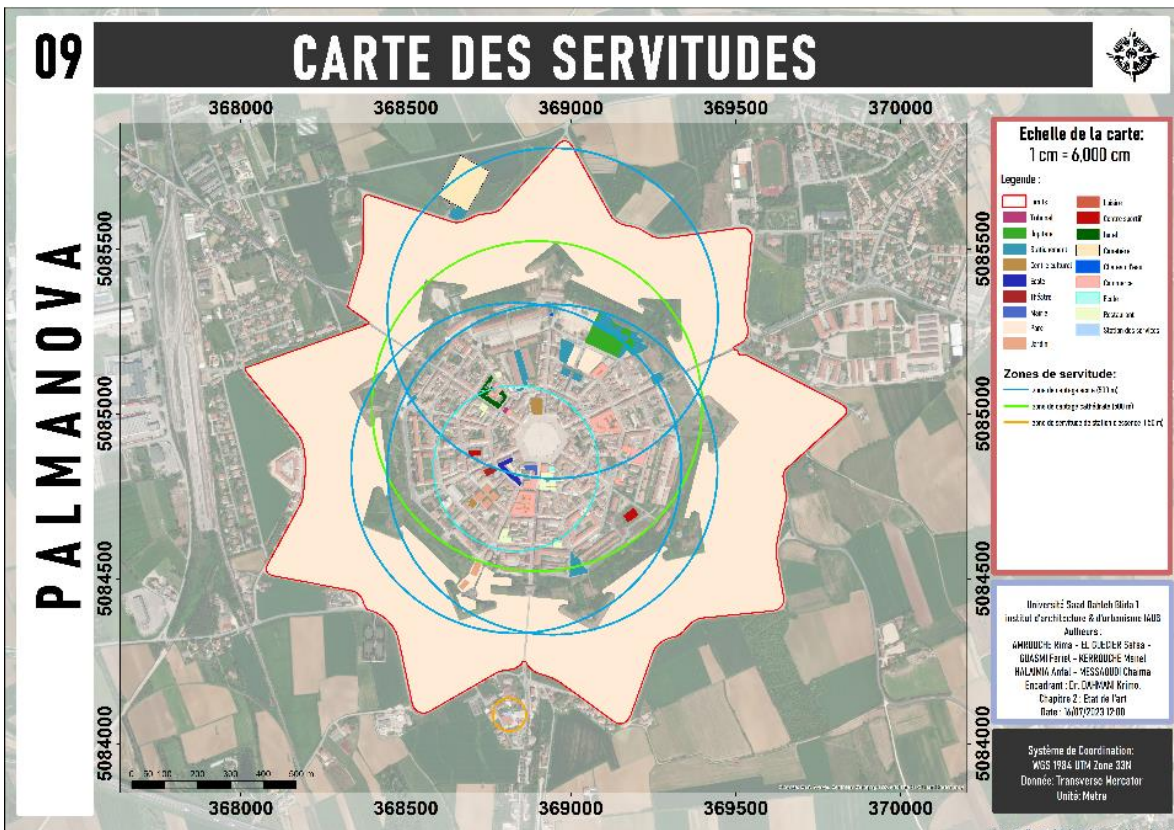


Figure 15: Area definition.
Source : Authors.

B. San-Shui Culture Complex

1. Technical card:



Figure 17: View from across the lotus pond. Image © Qingshan Wu

Architects	ZHUBO DESIGN	Architects in charge	Qiao Zhong, John Siu
Address	m San-shui new town cultural and commercial complex, Funan Road, Sanshui District, Foshan, Guangdong, China	Photographs	Qingshan Wu, Xiang Ao, John Siu
Plot area	138000 m ²	Client	Poly(south china)real estate development Co. Ltd
Year	2019	IA Design	architectural design and research institute of Guangdong province
City	Foshan	country	CHINA

2. Urban environment's aspect:

i. Existing tissu:



Figure 18: site analysis.

source : www.archdaily.com

The surrounding area: consists of a diverse of residential community and multi-function facilities that stimulate a dynamic and an ideal urban

The site location: is based on a rich axis of ecological resources and leisure facilities which turns this project into a linking and enhancing item of this area

ii. Urban intervention:

the project's implantation is defined by two main zones consisting of a festival plaza and a commercial plaza, by taking advantage of the height difference between the water bank

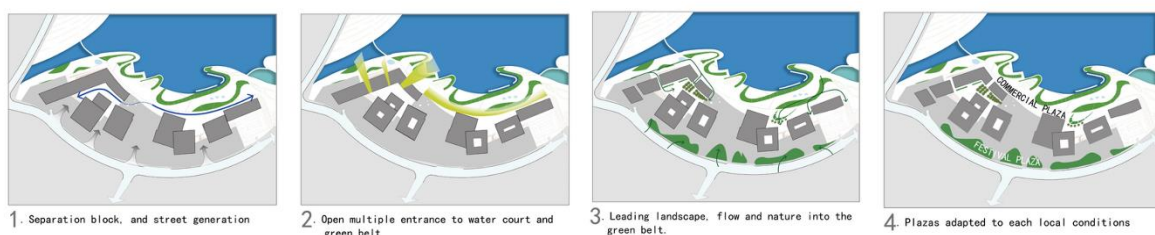
and the municipal road, the architects saw an opportunity of inserting a large platform dedicated to the city, which is the "Festival Plaza".

On the other hand The diversified leisure and commercial facilities created by the project not only attracts the other half of the city but also provides it with a wonderful and substantial weekend.



Figure 19: The two Plaza.

source : www.archdaily.com



1. Separation block, and street generation

2. Open multiple entrance to water court and green belt

3. Leading landscape, flow and nature into the green belt.

4. Plazas adapted to each local conditions

Figure 20: Commercial Plaza.

source : www.archdaily.com

3. Program aspect (function):

- i. the function layout is divided into four buildings each beholds it's own theme(and a number of spaces that correspond to its main function which are; the science and technology information center, The archives, the library and the cultural activity center , as presented in the image.

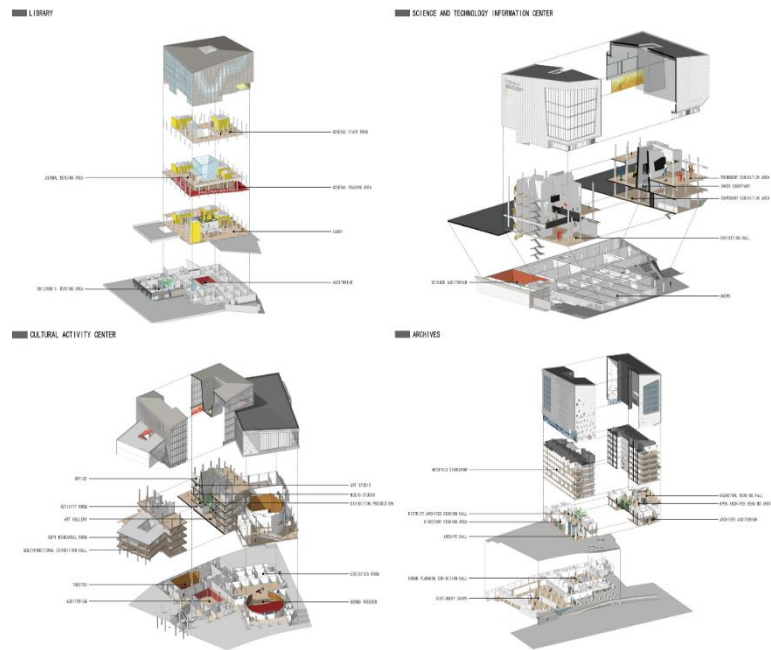


Figure 21: exploded axonometry of the Four buildings.
source : www.archdaily.com

4. Architectural aspect (Form):

- i. Concept formation process:

The process underwent 8 main points in order to achieve the most efficient project within its site not only acheiving functional and formal cohernce but presenting the project as a solution to the urban mobilization

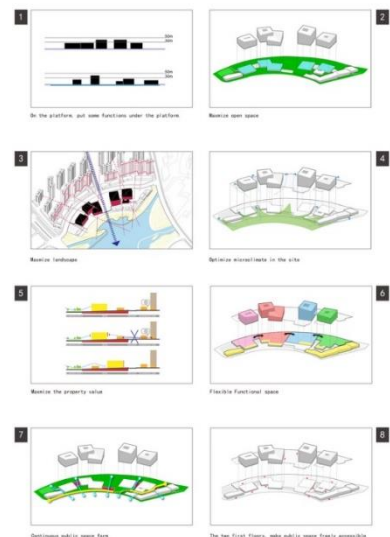


Figure 22: the 8 process points.
source : www.archdaily.com

- ii. Façade treatment:

The façade is designed with a double skin system. According to the different lighting requirements of different spaces in the venue, the windows are

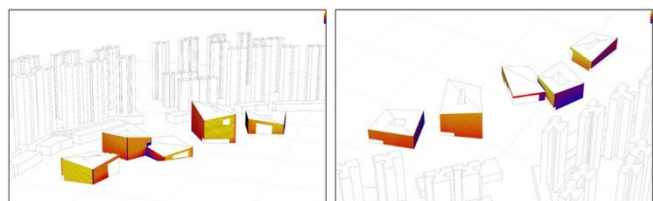


Figure 23: Façade skin in its urban context.
source : www.archdaily.com

properly arranged on the inner surface, and the outer surface itself is a complete sun-shading system.

Since the summer solar radiation is analyzed and calculated for each building facade, such a design strategy also carries cultural connotations

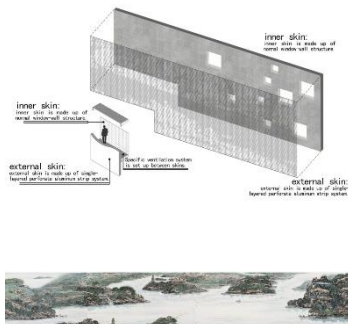


Figure 24: Double skin consistency.

Inspired by Sanquan's new urban planning theory "Mountain-Lake-Island-City-River", we abstracted this concept and transformed it into a traditional Chinese landscape painting with a specific emotion "Fang".

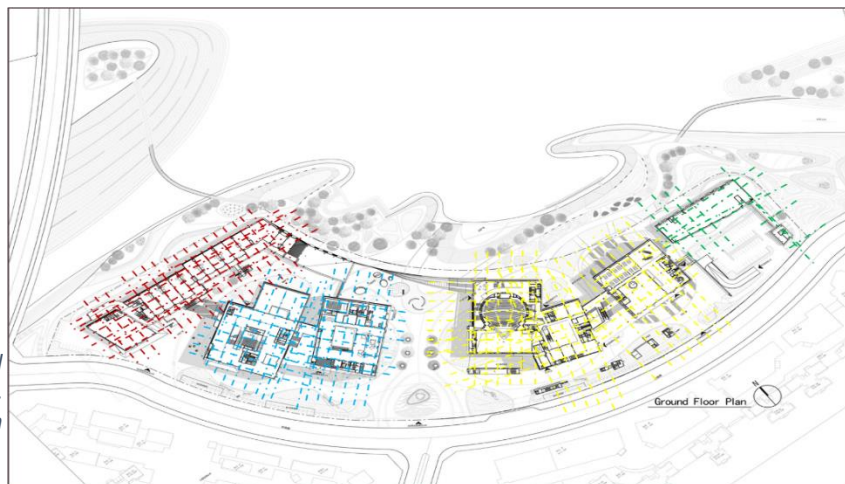
This ecological facade system can greatly reduce cooling energy consumption in summer.

5. Technical and structural aspect:

i. Structural layout:

Every building falls into a grid of its own with a regular pattern that traces the construction's structure and beam placements.

Figure 25: Buildings structural grids.
source : www.archdaily.com



ii. Structural system:

Through the section and inner taken photographs we defined two used systems in the buildings; post-beam and mixte structure between two materials reinforced

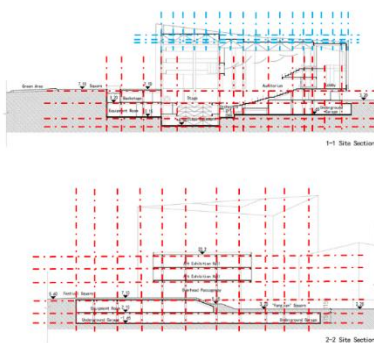


Figure 28: treated project sections.
source : www.archdaily.com

concrete and steel frames

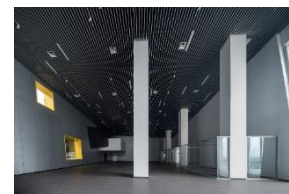
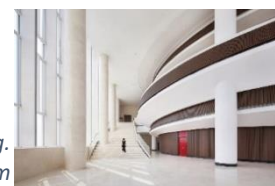
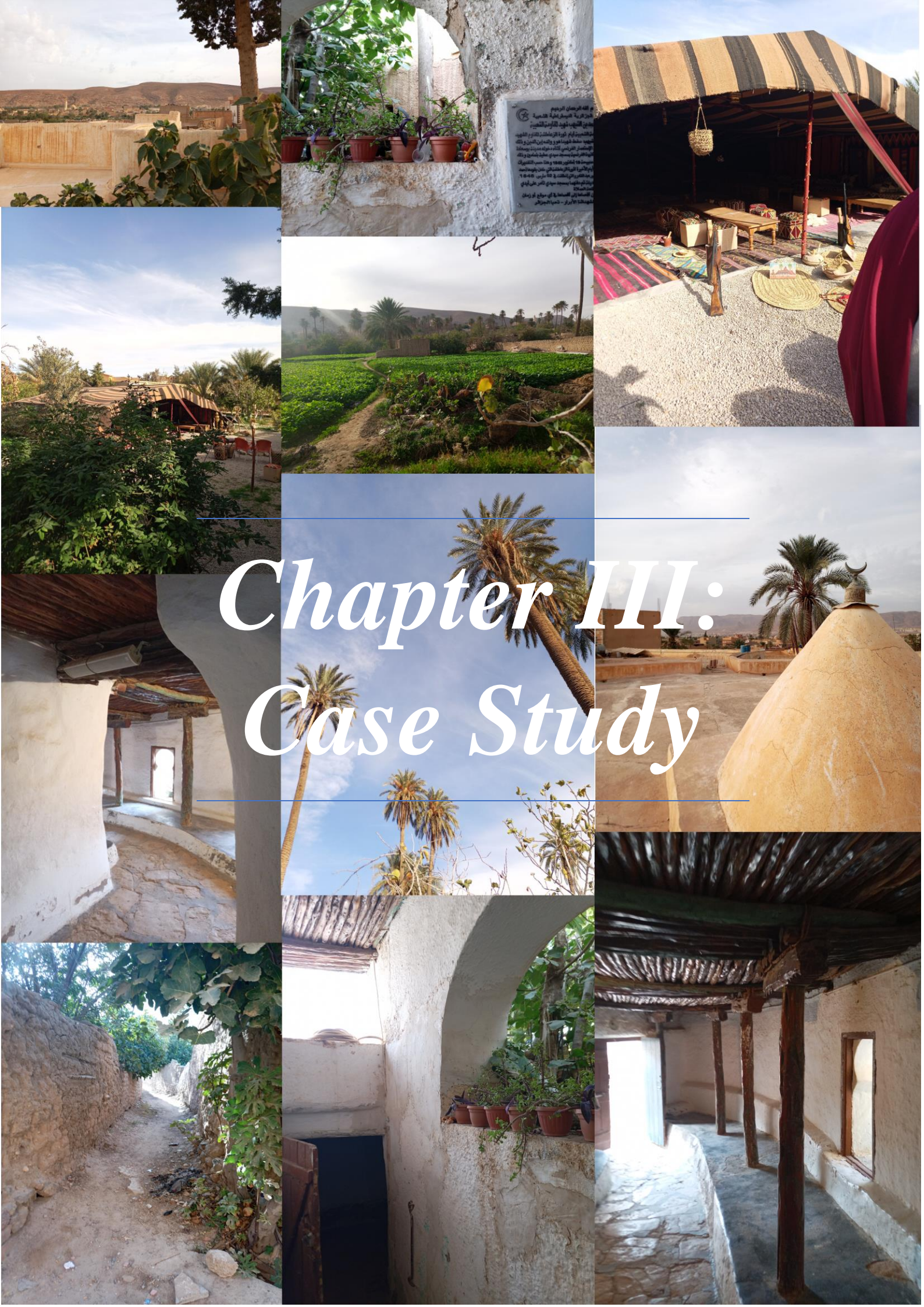


Figure 27: Bearing rectangular posts of the building.
source : www.archdaily.com

Figure 26: Bearing circular posts of the building.
source : www.archdaily.com





Chapter III: Case Study

1. Case Study Analysis:

1.1. Bousaada city presentation:

1.1.1. Location:

Bou Saada (Arabic: بو سعادة, bu s'adah, meaning "place of happiness") is a town and municipality in M'Sila Province, north-central Algeria, situated 245 km south of Algiers. It is located between el-Hodna Depression (a salt lake) and the peaks of the Saharan Atlas Mountains.

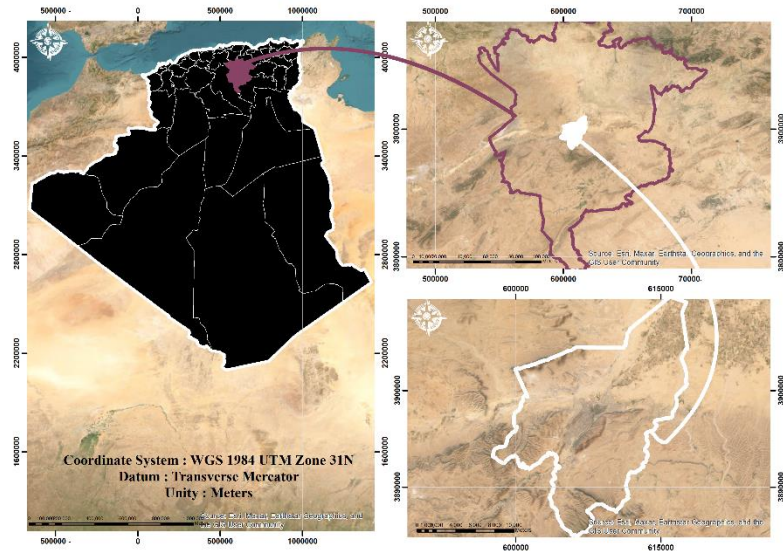


Figure 29: Bousaada geographical location.
Source : Author

1.1.2. Geographic location:

The municipality of Bou Saada is located on the northeastern slopes of the Ouled Naïl mountain range in the Sahara Atlas, bounded by mountainous blocks to the north and northwest, as well as to the south and southeast low-lying regions. It is also located in the southwest of the Chott El Hodna basin at longitude 4.11 degrees east and latitude 35.13 degrees north and is generally considered one of the main poles of the Saharan region.

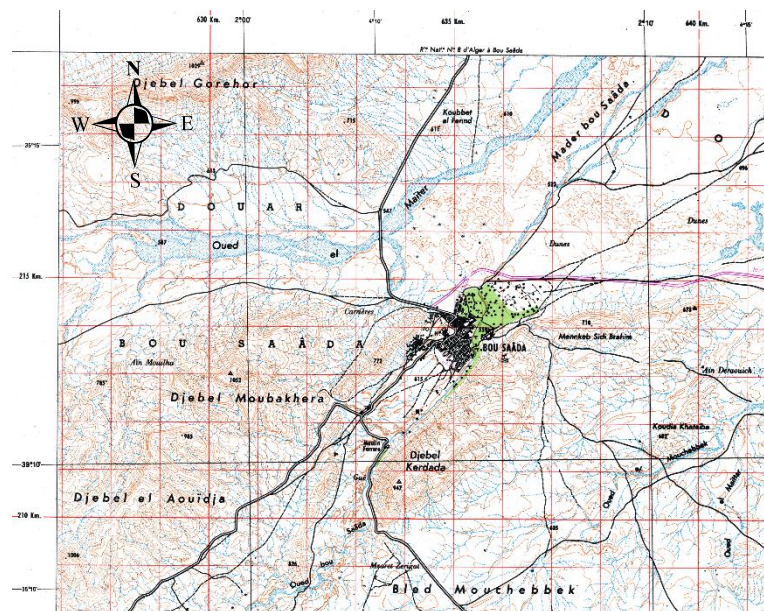


Figure 30: Bousaada Macro state Map, 1961.
Source: INCT

⁴⁴ Britannica, T. Editors of Encyclopaedia (2014, April 17). Bou Saâda. Encyclopedia Britannica. <https://www.britannica.com/place/Bou-Saada>

1.1.3. Administrative location:

The municipality of Bou Saada is located in the southern part of the M'Sila Province, bordered to the north by Ouled Aissa Brahimi and to the northeast by Lamairif, to the east by the municipality of Lahouamid, to the west by Tamsa, and to the southeast and southwest by the municipalities of Oultem and El Hamel. The study area covers an area of 255 km².

The municipality of Bou Saada is characterized by its strategic location, as it is located on the axis of National Road No. 08 linking Algiers-Bou Saada and National Road No. 46 linking Biskra-Jelfa-Bou Saada, thus serving as a link between northern and southern Algeria.

1.1.4. Administrative urban state:

The current urban planning that the city of Bousaada falls into is the same that all of Algeria relies on which is the PDAU POS administrative designation, Bousaada beholds 22 POSs approved in the latest issue of its PDAU 2019, two of them are currently achieved and completed while the others are in the process of their concretization.

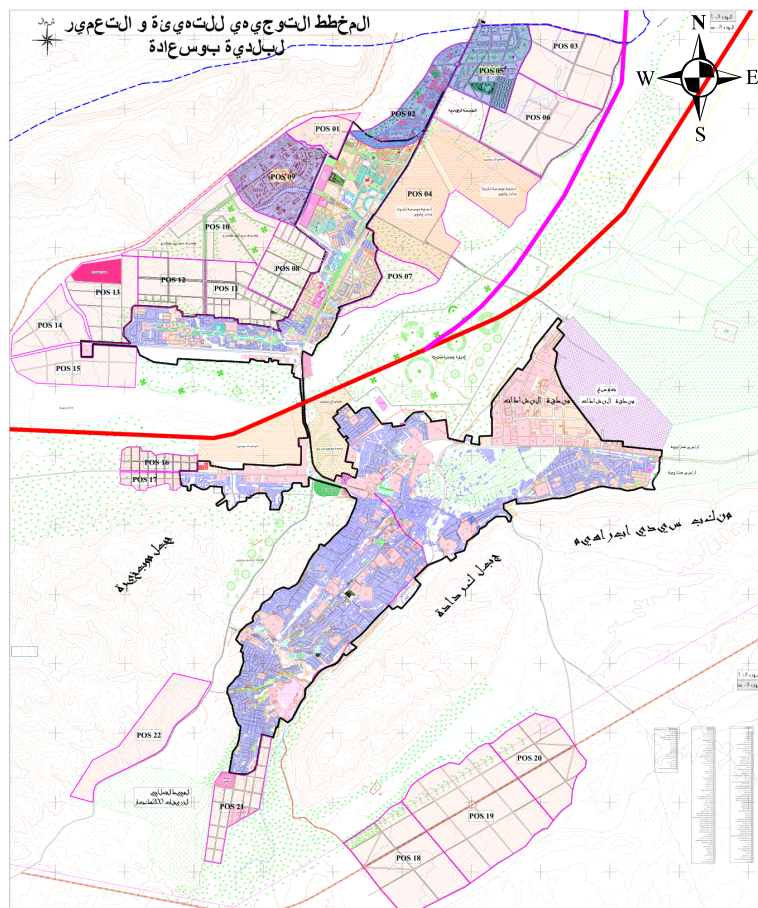


Figure 31: Bousaada's POS layout. source : BOUSAADA PDAU 2019. :

1.1.5. City's brief presentation & borderlines:

Although north of the Sahara, Bou Saâda is a true oasis, spread along the left bank of the Bou Saâda Wadi and standing in pleasant contrast to the nearby barren Ouled Nail Mountains and the often dry salt marsh. The town's old walled quarter (ksar) of arched, winding alleyways lies north of the modern French-built sector. Farther north, thousands of date palms are watered from the steep-banked permanent stream.⁴⁵

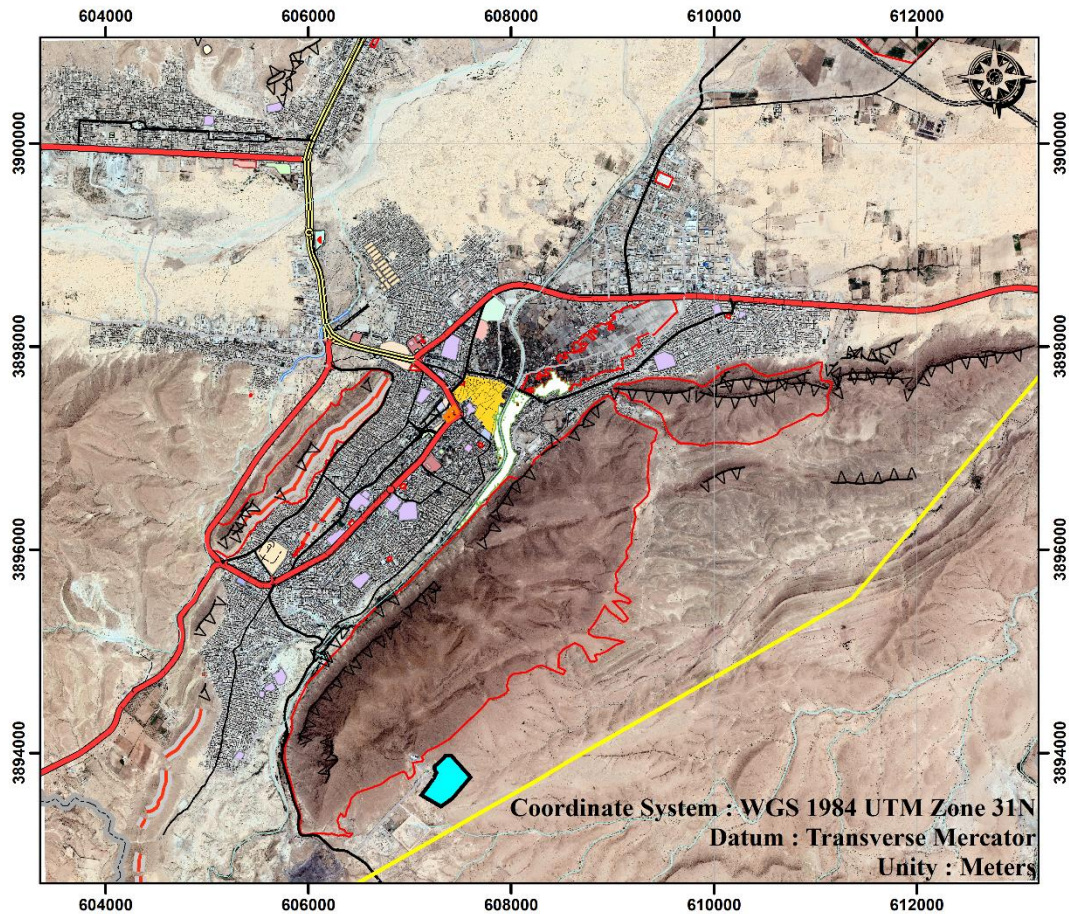
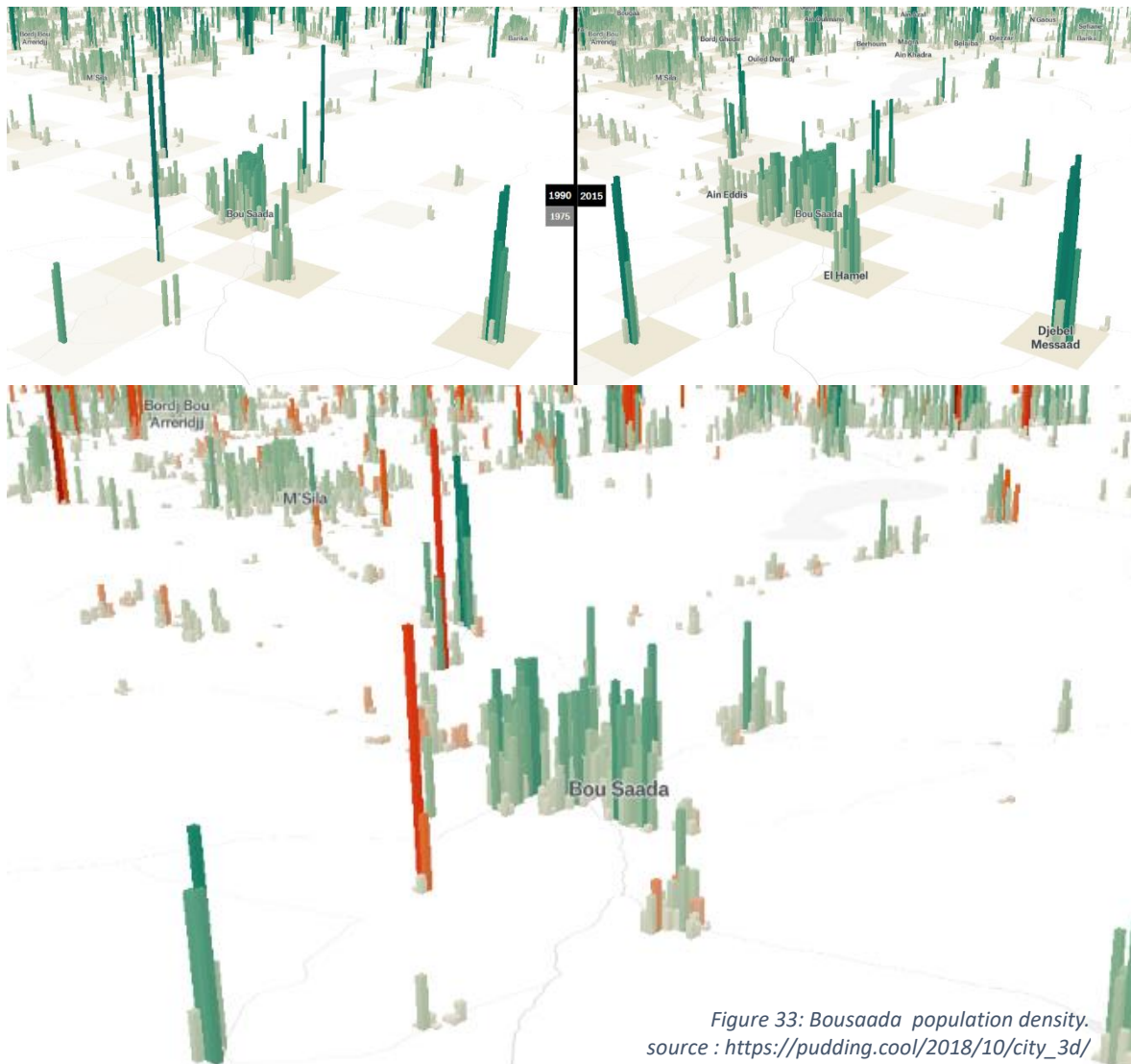


Figure 32: Current Bousaada Layout.
source : Authors.

⁴⁵ Britannica, T. Editors of Encyclopaedia (2014, April 17). Bou Saâda. Encyclopedia Britannica. <https://www.britannica.com/place/Bou-Saada>

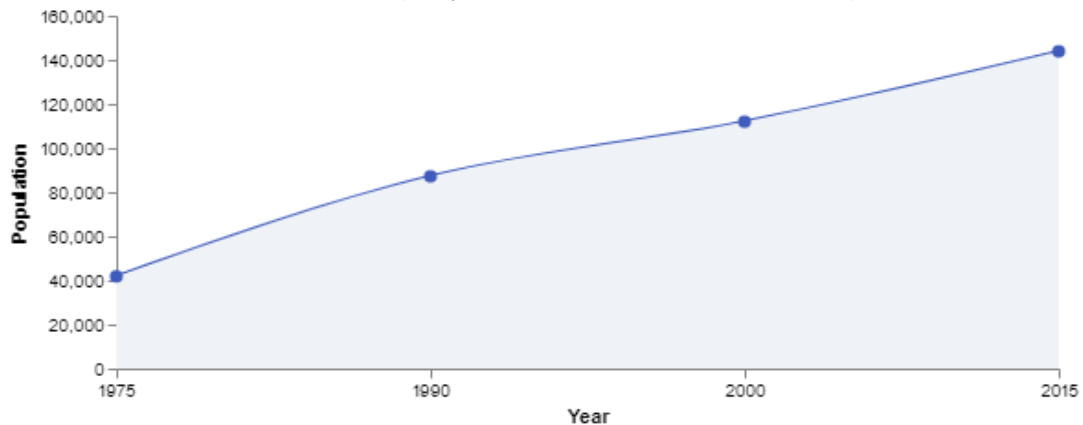
1.1.6. Population:



Each block represents 250to 5,000sq.meters. Taller blocks represent more people.

as of the population density of Bou Saada, it has been known a rapid and continuously increase àwe notice some of its regions getting slowly abandoned being in the suburbs.

Figure 34: population over time source : JRC (European Commission's Joint Research Centre) work on the GHS built-up grid



1.1.7. City Social & Economical Heritage and Pattern:

Long an important caravan center between West Africa and the Mediterranean Sea, the town supports a daily market of jewelry, metalwork, carpets, and the long, tapering bousaadi knives. Both Arab and Berber (Amazigh) nomads frequent the town to trade and rest. Bou Saâda (meaning “place of happiness”) is a popular winter resort. A textile mill is located in the new quarter.

Here’s a picture collage that englobes bousaada city in one set:



Figure 35: Picture Collage of the Workshop's 2nd trip to Bousaada.
Source : Authors

1.1.8. Climate :

c. Temperature:

- Boussaâda has a semi-arid climate with sparse vegetation, a long dry period and short rainy period during the summer.
- The area experiences high intensity of direct and reflected solar radiation, with high temperatures in the summer and very cold winters.
- Diurnal temperatures are high with significant differences between day and night.
- Relative humidity is low with rare precipitation and sandstorms and frequent afternoon winds are common..

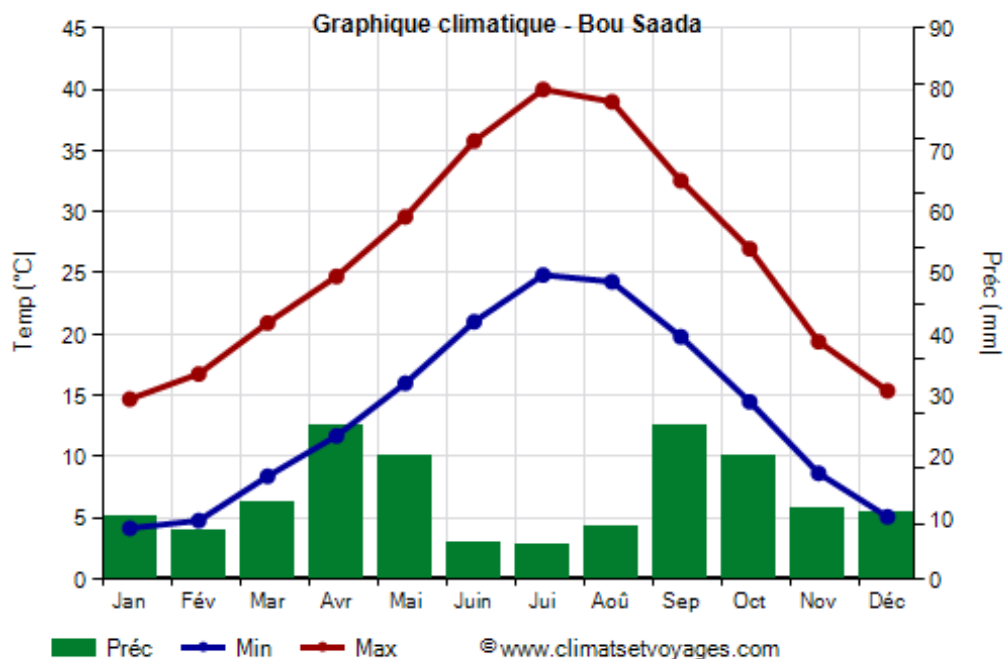


Figure 36: Bousaada Climat data.
source : www.climatsetvoyage.com

d. Wind behavior:

- The city of Boussaâda is situated in an open basin that facilitates the penetration of winds from all directions through intramountain corridors.
- Boussaâda is subject to five types of winds, including the Sirocco, also known as "el Guebli," the west wind, "el Gharbi", the north wind, northwest "Dhahraoui," the north wind, northwest "en Behri," and the east wind "el chergui".

- The Sirocco blows for a month during the summer and can burn vegetation and dry out the atmosphere.
- The west wind is a dry wind that carries clouds without bringing rain.
- The north wind, northwest "Dhahraoui," brings cold and humidity and can be rainy, especially in winter.
- The north wind, northwest "en Behri," is a sea wind that carries rain and snow.
- The east wind "el chergui" brings cold air from the mountain in winter while passing through the Aurès. In summer, it turns into a dry wind.

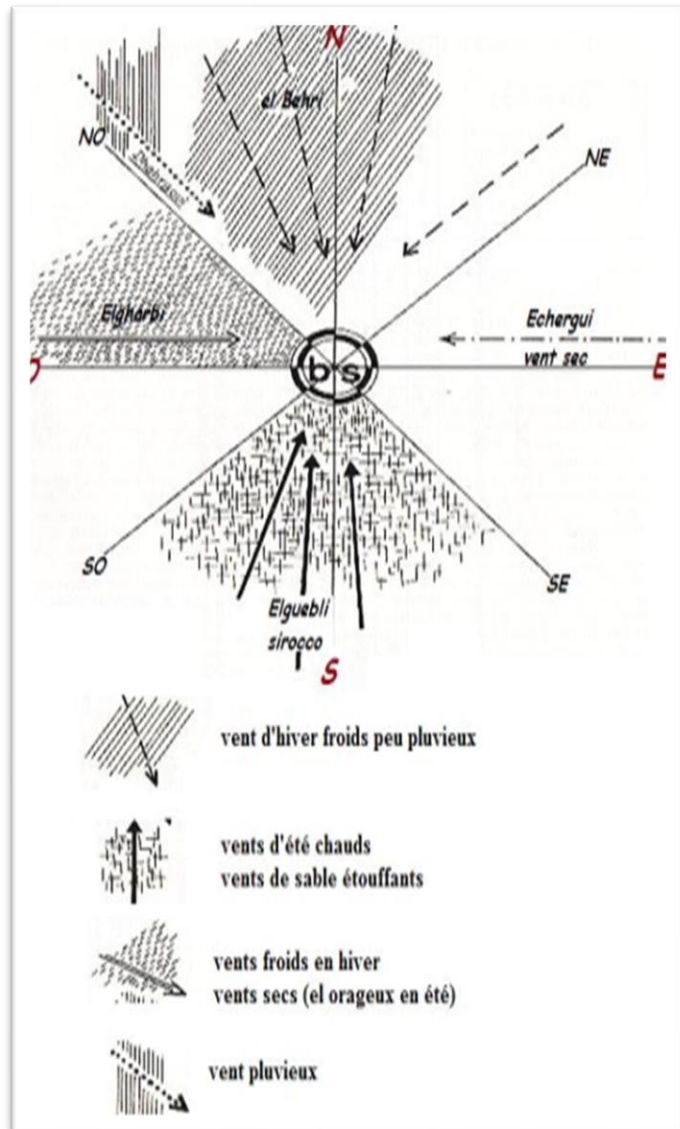


Figure 37: Bousaada wind rose
 source : Youssef, NACIB, 1986. Oasis cultures. Bou-Saâda: essay in social history p38.

1.2. Diachronic Study on the urban growth of Bousaada City's Evolution:

1.2.1. Introduction:

We start by affirming the fact the present is a product of the past; Bousaada in its current existence and operating system is the result of a historical evolvement process, this city's human composition added up to its social and urban tissue, currently, is an outcome of an important interaction between societies and civilization where few of them were diminished however the other remained to shape Bou Saada into the city that it is today.

1.2.2. Prehistorical era:

Unfortunately, there are very few documents that mention this era's existence and impact on the tissue, however, based on a social study made and written by the author; Youcef Nacib, there are some pre-Roman remnants on the right bank between bousaada's river and Hamel.⁴⁶

⁴⁶ Youssef, NACIB, 1986. Oasis cultures. Bou-Saâda: essay in social history.

1.2.3. Roman era:

“There are still families in the region who have preserved the memory of a Roman ancestry... they live in a neighborhood called Dechera el Gueblia where the Romans, it is said, had precisely built their constructions.”⁴⁷

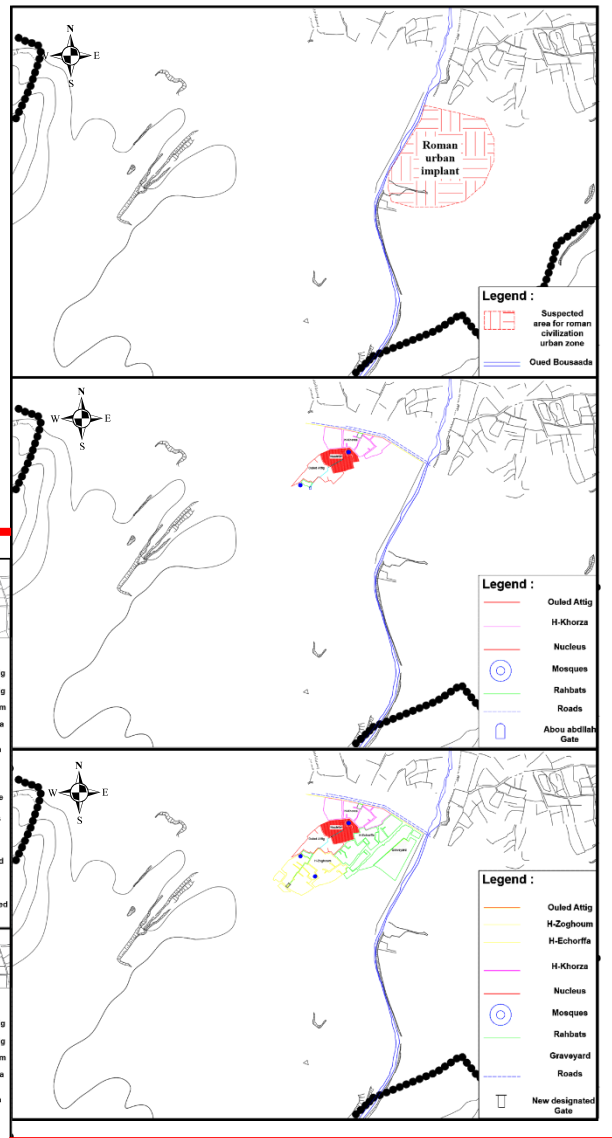


Figure 38: Bousaada first 03 evolutive phases
source : authors
background: PDAU 2019.

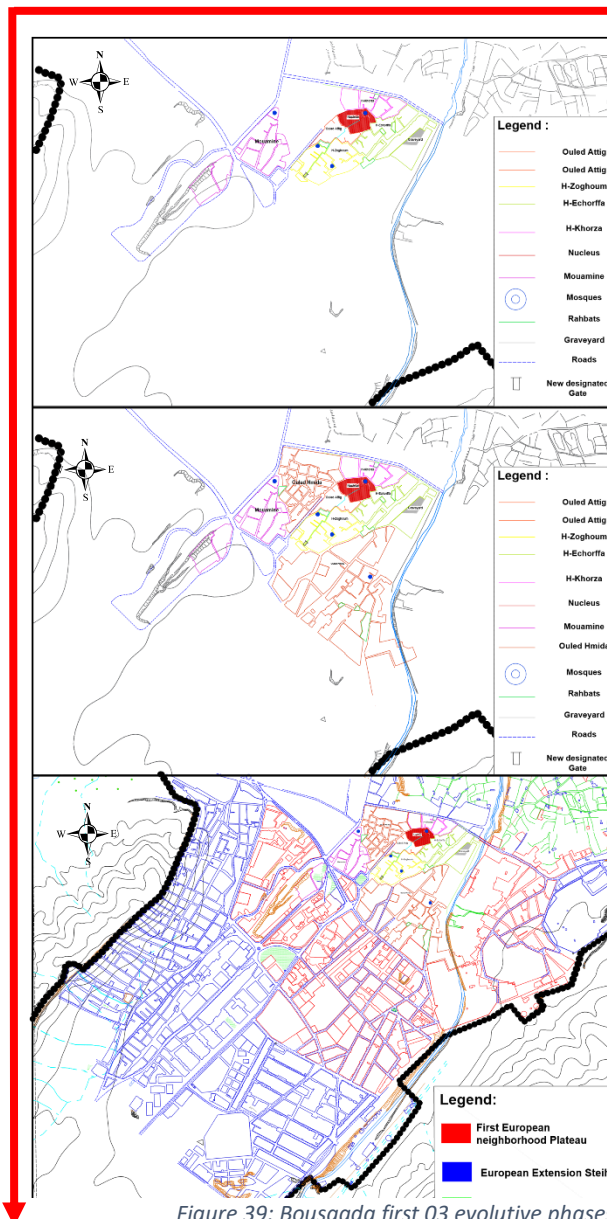


Figure 39: Bousaada first 03 evolutive phases
source : authors
background: PDAU 2019.

1.2.4. Ottoman era:

establishment of the Ksar, ever since the 13th century, the Ksar is considered the proper city of Bousaada with the initiative of two Cheikh “Sidi Thamer & Sidi Slimane”.

The first act came from Sidi Thamer by the construction of Djamaa a nakhla’s mosque on the highest point of the old town and

⁴⁷ Lehuraux, L., 1934. *The Sahara, its oases* . FeniXX.

right near bou saada's river 'Oued'. The first neighborhood was the nucleus "Achacha" occupied by the wali and his children to the descendants of Sidi Thamer. The development of the Khorza and Ouled Attig neighborhoods was significant. The initial core had houses accessed via the Abou Abdallah gate and was radiocentric in shape. The Echorfa and Zoughoumu neighborhoods developed around the mosque/rahbat. Over three centuries, the city's development was influenced by its environment, including a corridor, a wadi, a palm grove, and dunes. The urban fabric was based on a network of intertwined alleys with two main orientations, southwest and northeast. Public space played multiple roles and was integrated between equipment and residential space. In the 16th century, the Mouamine neighborhood to the west marked another significant development.

1.2.5. Colonial Period (1840-1900):

The Ksar extended towards the south, leading to the emergence of the Ouled Hmida neighborhood. The Mouamine neighborhood market became the Pein square and marked the start of the colonial construction towards the south. The French army occupied the Fort, which became a control point for the Ksar and the city. Unplanned extensions appeared due to the saturation of the Ksar to the east, leading to the creation of the first Jewish quarter "Mouamine Gherbi" and the development of a direct axis with a military character. This served as a boundary between the Ksar fabric and the colonizer, leading to the demolition of the enclosure walls. School and administrative facilities were implemented.

1.2.6. Urban Duality (1900-1962):

The European city continued its evolution towards the southwest, with the first planned neighborhood "Plateau" and its extension

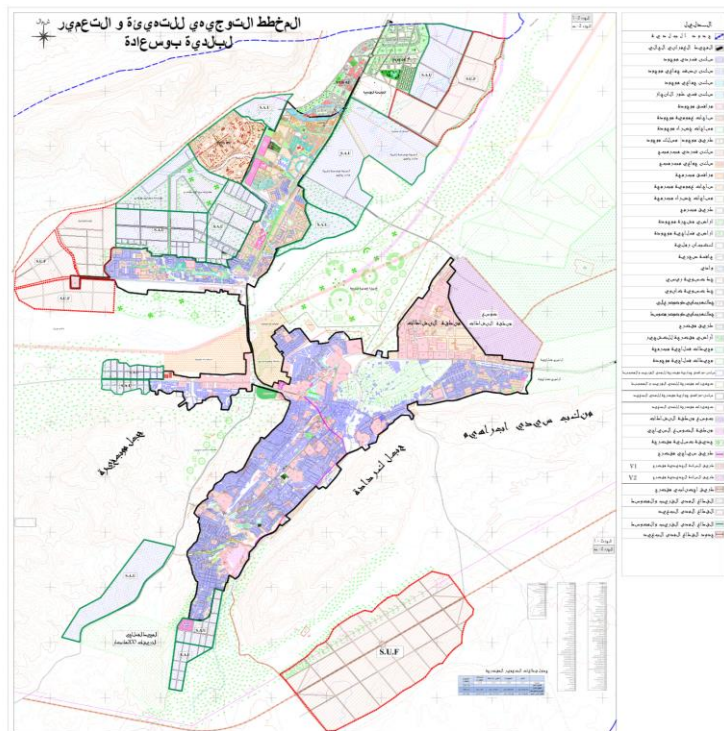


Figure 40: Bousaada defined sectors layout. source: PDAU 2019.

"Steih". Due to natural constraints and French authorities, the Ksar continued its informal evolution outside the Bou Saada wadi and outside Djebel Dalaa.

1.2.7. After Independence:

The city's extension continued towards the west and south. Ksar's historical built environment degraded, with internal operations in the western part and the redevelopment of the market square.

1st extension: A new neighborhood appeared in the northeast near RN8 towards Baskra, on new sites that reversed the spatial relationship, with limited palm groves and the appearance of an industrial zone.

2nd extension: The northwest extension near RN46 towards Algiers marked the adaptation of a modern construction mode with ensembles, activity centers, and equipment.

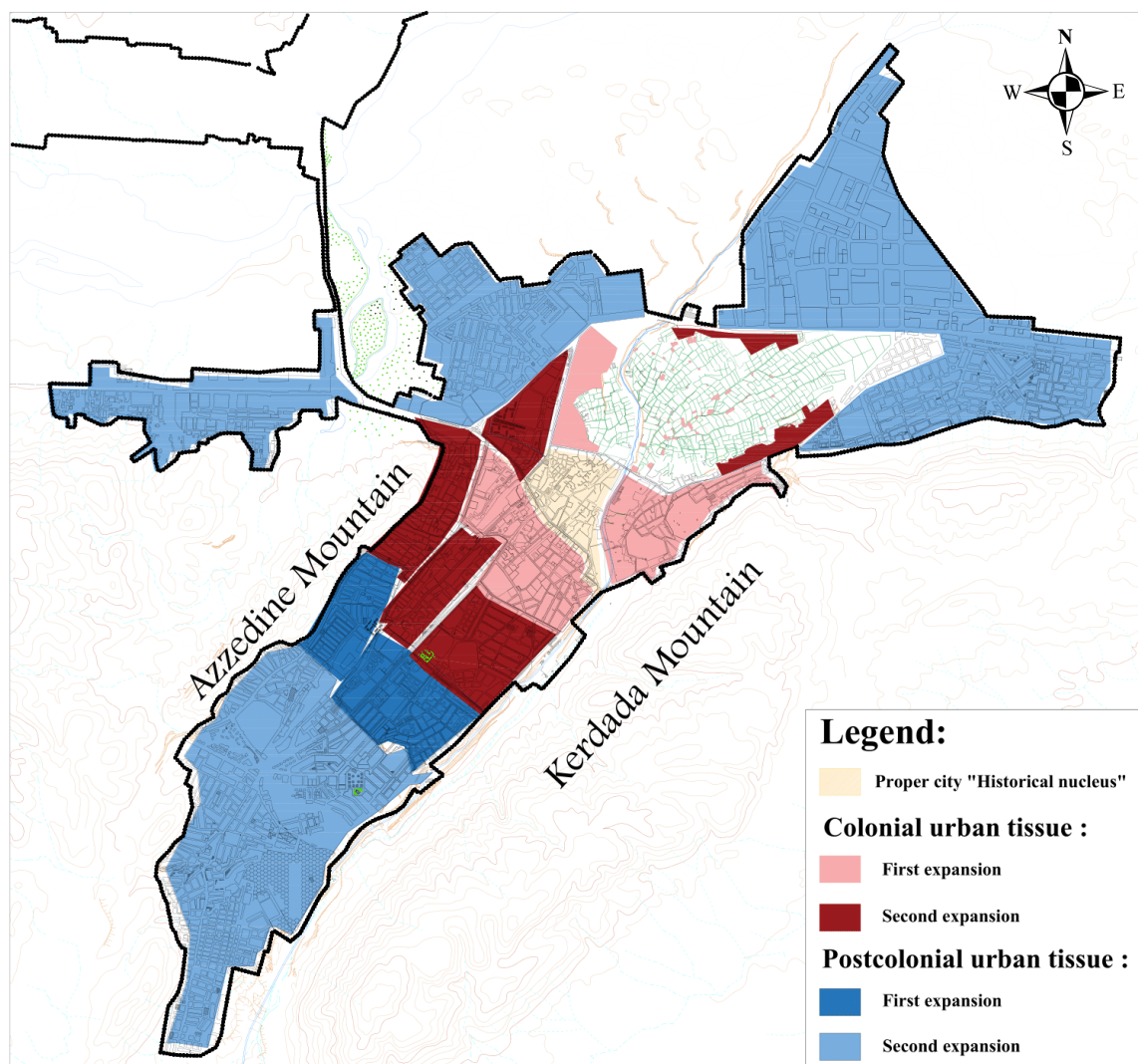


Figure 41: Bousada city's expansion.
source : Authors.
Background: Final Bousaada PDAU 2019.

1.2.8. Synthesis:

- The historical center of Bou Saada is a unique and valuable location due to its natural resources, human capital, and potential for development. Despite undergoing several transformations over the years, it remains a significant cultural and historical site.
- The most notable periods of transformation in Bou Saada were during the Ottoman and colonial eras. These periods brought significant changes to the city's architecture, infrastructure, and social fabric.
- Water sources, such as the Oued Bou Saada, played a vital role in the settlement of the region. They provided a crucial source of water for the palm grove and were a driving force behind human settlement in the area.
- The Ksourien fabric of Bou Saada expanded as the population grew, with a focus on integrating built structures, palm groves, and water sources. This approach has helped to create a unique and harmonious urban environment that is both functional and aesthetically pleasing.
- The site of Bou Saada is both protective and nurturing, with natural features such as the palm grove and water sources providing shelter and sustenance for the community.
- The mosque, square, market, and cemetery are key drivers of social relationships within Bou Saada. The mosque, located in the center of the city, is a hub for communal activity and worship. The square and market, situated at the entrance to the city, provide opportunities for social interaction and commerce without disrupting the social fabric of the community.

Overall, the historical center of Bou Saada is a fascinating and unique location that has undergone significant transformation over the years. Despite these changes, the city has managed to preserve its cultural and historical significance, while also adapting to the needs of a growing population.

1.3. Social Survey:

Surveys play a crucial role in urban planning as they provide valuable information about the needs and preferences of the community, it can also help identify potential issues or challenges that may arise during the urban planning process.

in order to involve the people in deciding how the shape, content, and facilities of the city they aspire to live in, we conducted a survey of 400 people where we gathered 393 distributed on different ranges of society and all across Bousaada. The survey tackled 6 axes that play a role in impacting most urban interventions. (An example of this survey will be shown in be present in the Annexes.)

By studying this survey, we gathered data on a wide range of topics, however, we will mention the answers that influenced our urban intervention the most:

The points, problematics & conclusions that were extracted from this survey were:

- The people recognize the city's privileges in terms of its patrimonial heritage and natural gifts, its image, and its tourism potential.
- The people thrive for the development of the municipality economically and on an urban basis.
- Being aware of the financial and economic deficiency of their area, the people have suggested focusing on three fields: industry, agriculture, and tourism.
- transportation and urban mobility are extremely lacking and inefficient.
- No car parks
- The complete absence of amenity services, facilities cores & shops while existent ones are simply not found suitable to the community that it serves according to more than 70% of the citizens.
- Almost 80% of The citizens complain about flood issues although it's a semi-arid climate, and for that matter, they are requiring special drainage and water network structures
- The people are not satisfied with the housing and residential accommodation finding it unsuitable for the variety of types of residents, culturally and physically.
- The bousaadiens are an authentic society that's aware and proud of its city's possession of a rich and diverse heritage including; the natural wealth and patrimonial buildings

- They demand private accommodations and public urban spaces taking in consideration social, Cultural, and religious rules.

Some statistical summary diagrams examples to support what we have concluded:

1. Rate the municipality from 0 to 5 (average to very good)

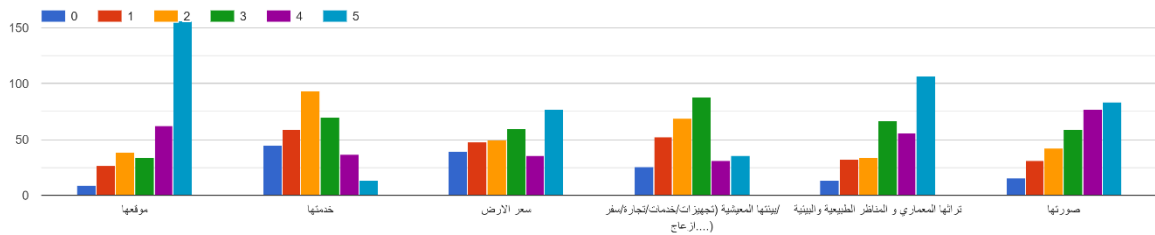


Figure 42: Social survey chart
source : authors.

2. In your opinion, what are the elements that embody the image of the municipality? What do you put forward when speaking and describing the city?

358 réponses

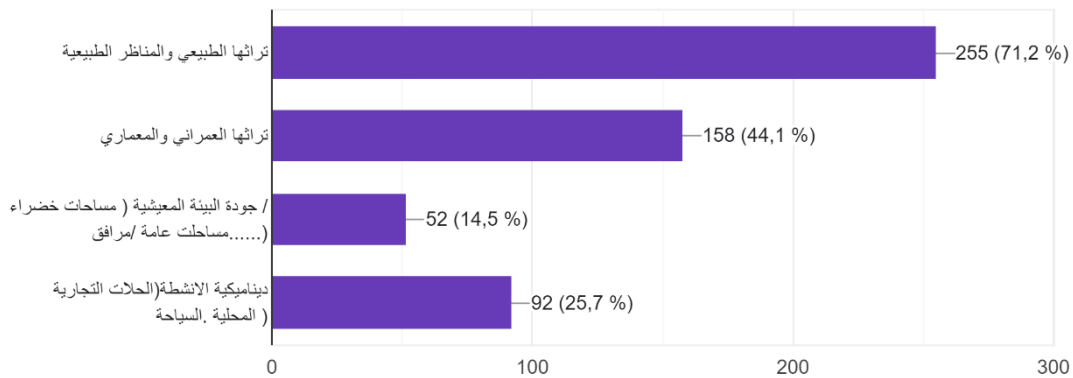


Figure 43: Social survey chart
source : authors.

3. Does the current availability of public facilities seem suitable to you?

340 réponses

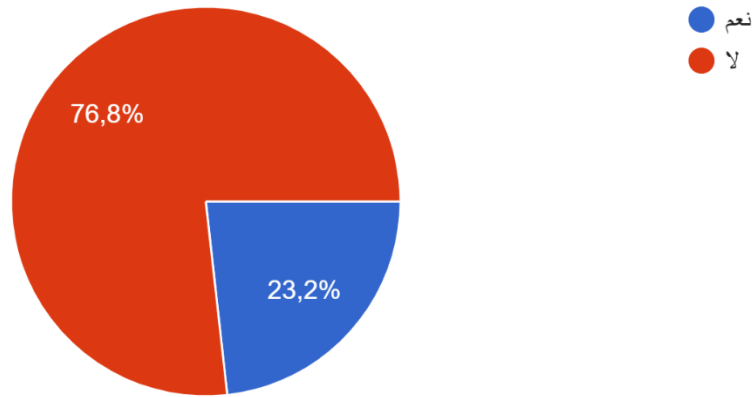


Figure 44: Social survey chart
source : authors.

4. What activities can we imagine on the squares of the city to promote living together?

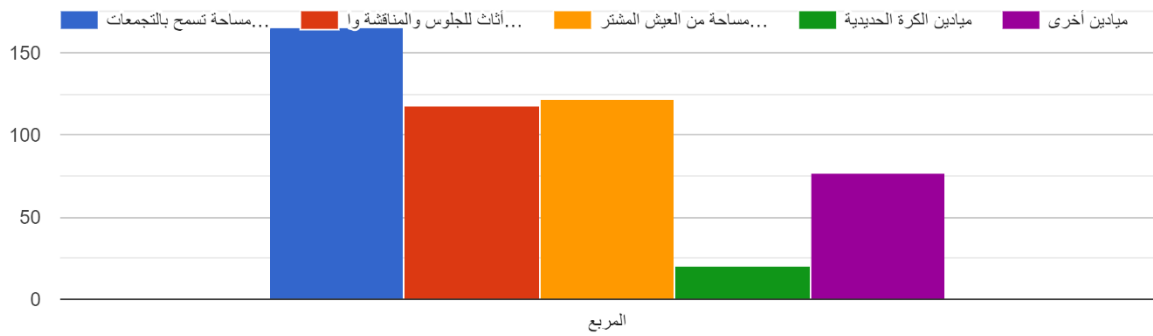


Figure 45: Social survey chart.
source : authors.

6. What are the most important developments that seem to you a priority in the city of Bussaba (rank your choice according to priority from 1 to 9)



Figure 46: Social survey chart
source : google docs

2. Master plan genesis:

2.1. Step 01: marking traces

Our intervention intentions consisted of assuring the three-axis; sustainable planning, achieving Islamic value principles, and creating a highly efficient city, for our actions were measured based on these three aspects.

2.1.1. fundamental fractal and sustainable planning :

Our first intention was to define the zone of intervention within the parameter of Bou Saada, the factor number one o vitality is water, as it can build but at the same time destroy whatever crosses its path, in order to reassure that this factor was on our side we had decided to opt in for a generative factor

- 1) Starting by defining the blue and green veins with the help of a DEM background.

Figure 47: Bleu & green veins map
source : authors

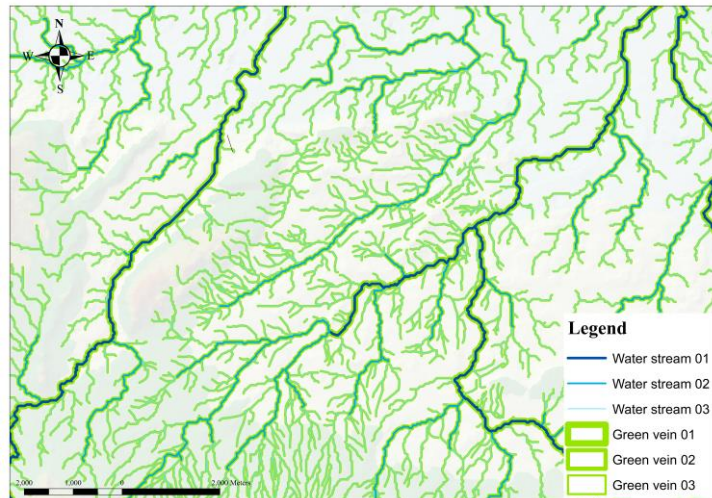
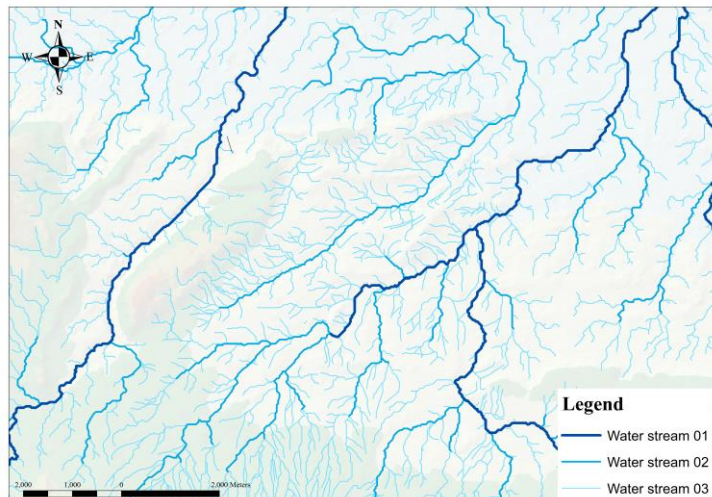


Figure 48: blue veins map.
source : authors



2) we extracted 6 water streams classes (A, B, C, D, E & F) of the water veins based on their width and flow, where we also come to a realization that Bousaada's old city river is a class B.

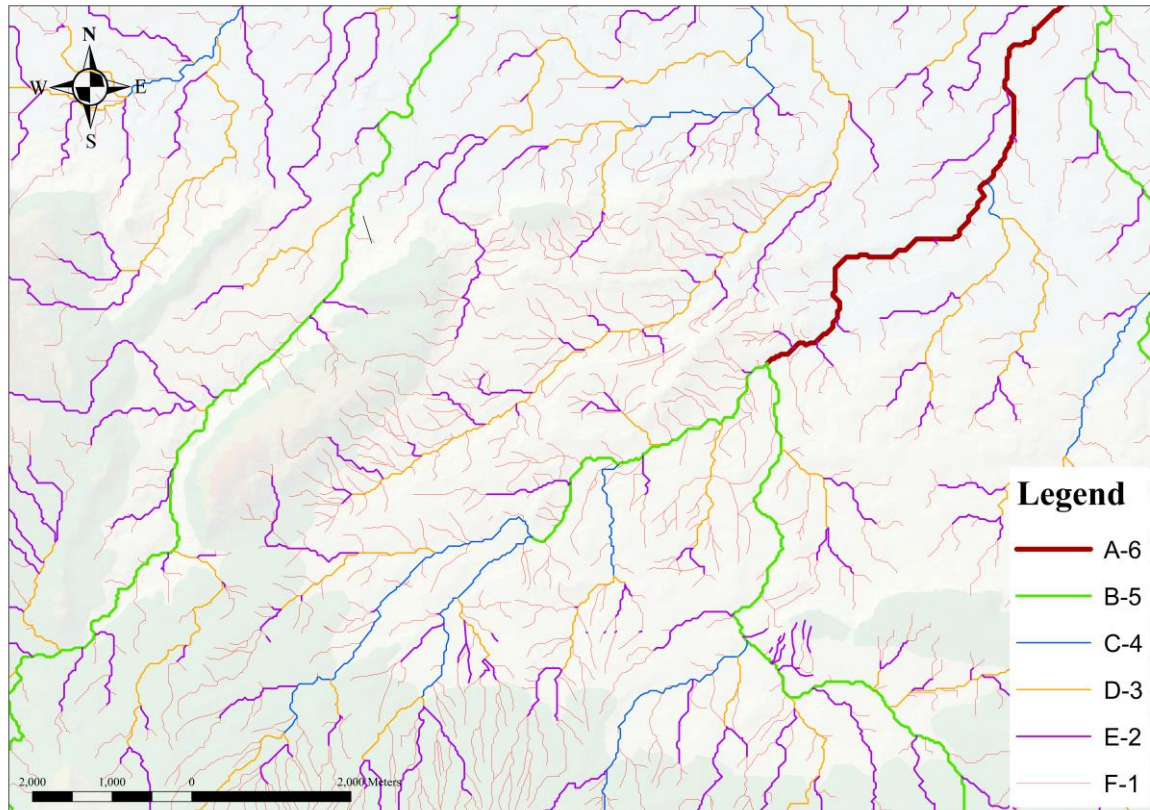


Figure 49: water streams classification A, B, C, D, E & F
source: authors

3) 2nd act was to define the intersection between different blue veins and determine the all knots and the veins that it combines, and that led to the making of a matrix of over 2000 components (a part of it resides in the annexes).

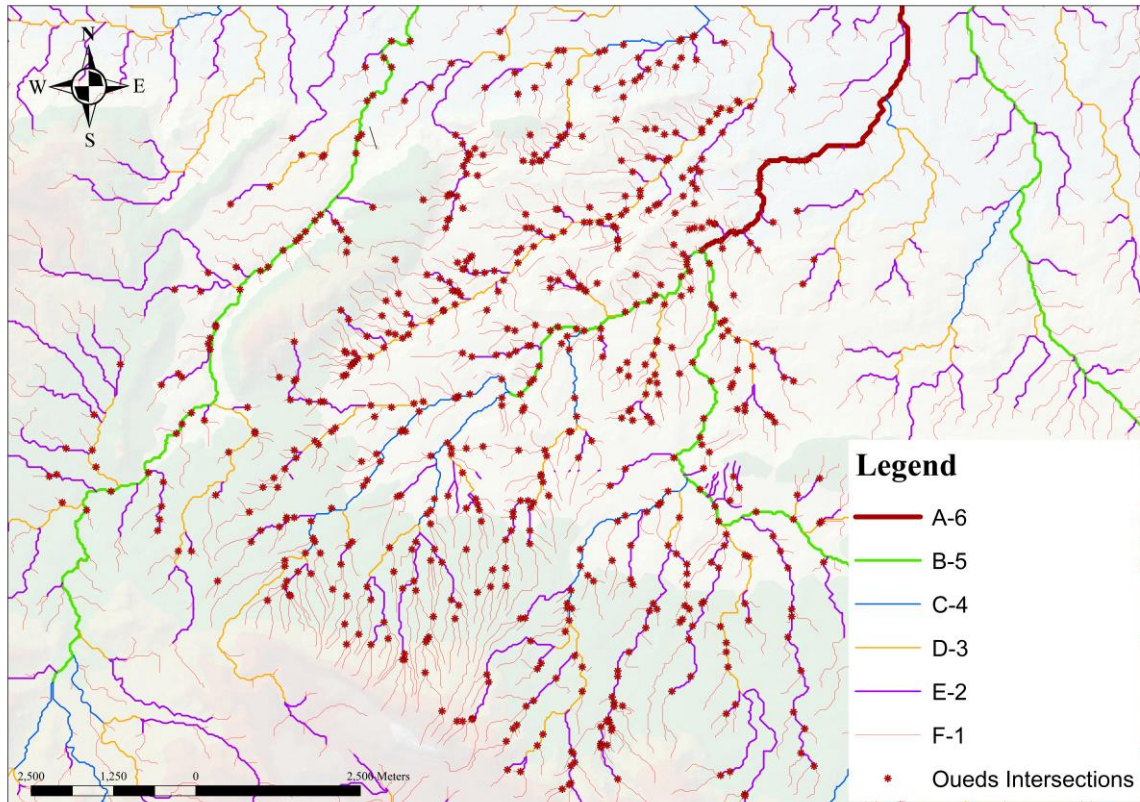


Figure 50: water streams intersection points
source : authors

4) 3rd we suggested 05 intervention areas scenarios by implanting the knots that combine the major veins as a center for the future urbanized areas.

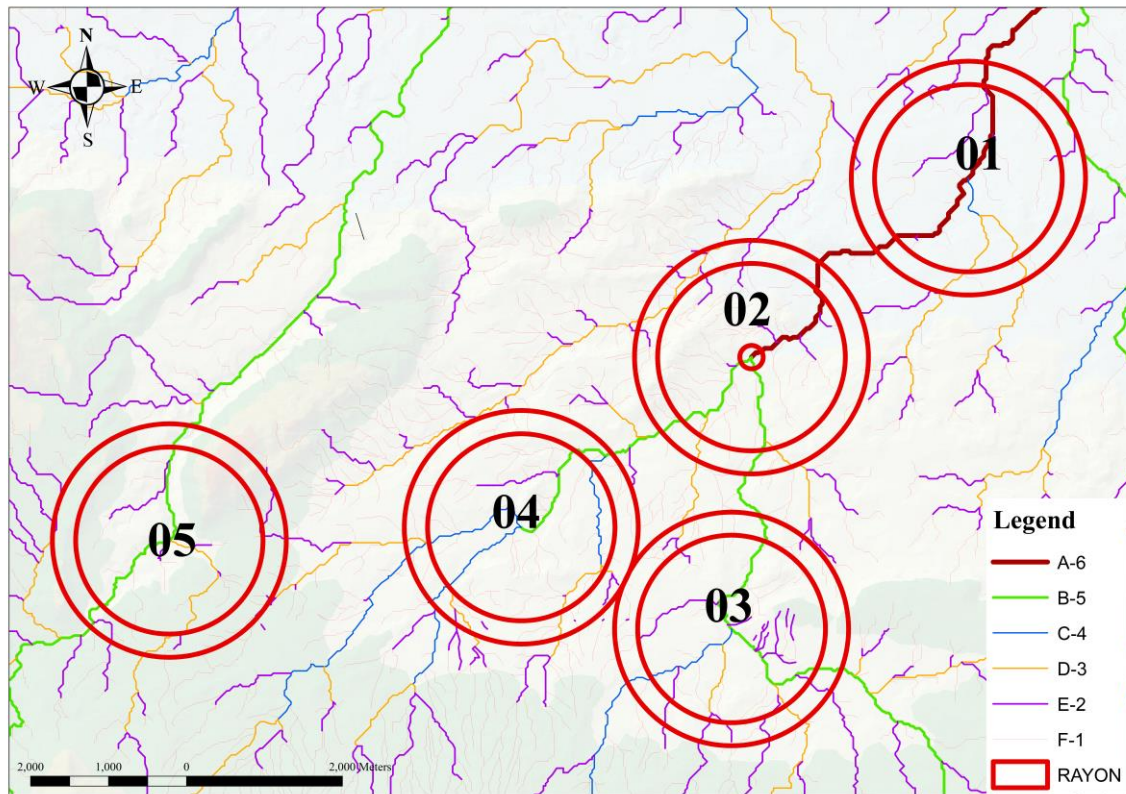


Figure 52: 05 proposed zones for the futur intervention.
source: authors

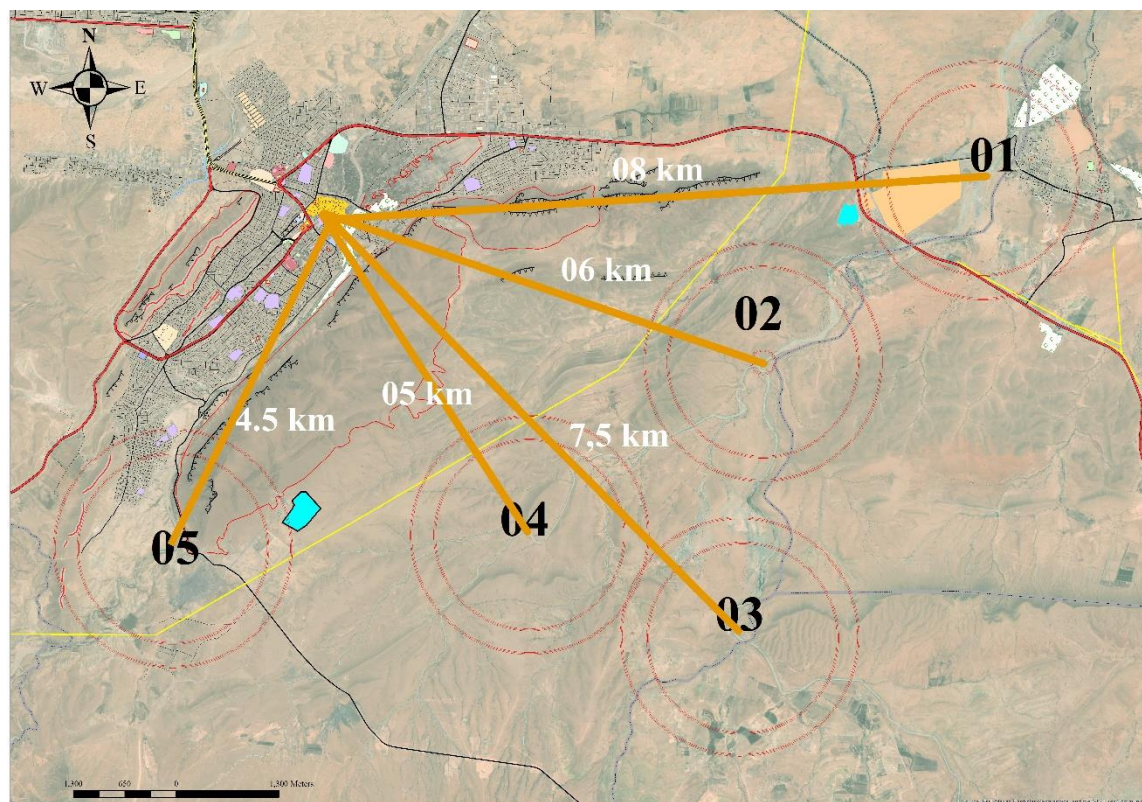


Figure 51: distance from propre city "Medina" to the center of each suggested zone.
Source: authors.

5) 4th as we are to choose Area n°05 for urban layout for our model intervention, at first we opted for the one that was the most approximate to the old city and that is to reassure the continuity of the city however after consulting the latest issue of PDAU and the supervising architects and urbanists of Bou Saada, the area was already reserved for a S.U.F (future urbanization sector) zone and was not an available site.

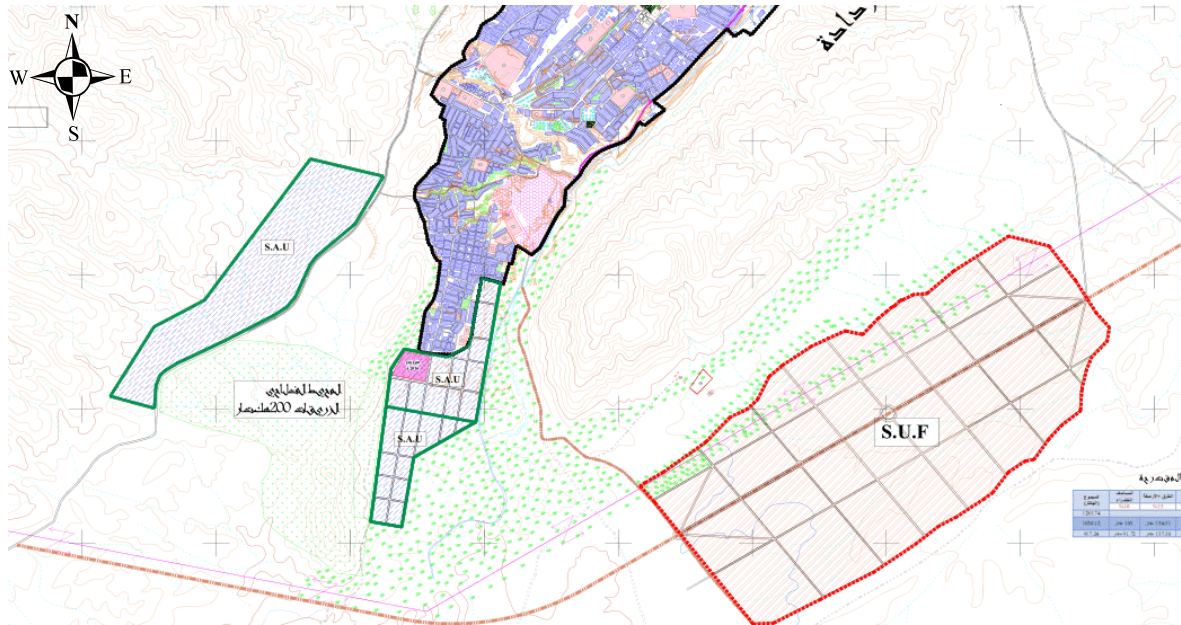


Figure 53: zone 05 approximate position ith its occupation.
source : PDAU 2019.

6) So we prioritized the water factor another time and for that, we chose our 2nd best scenario which for this case it was area N°02, the center knot of this site combines the 04 main streams A & B.

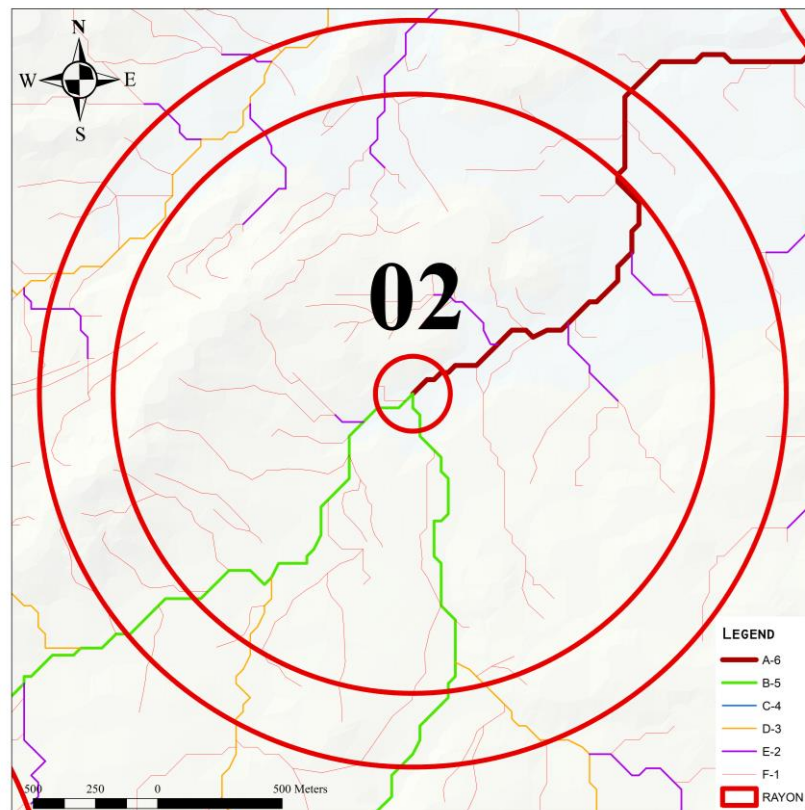


Figure 54: zone 02
source : authors

2.1.2. Urban layout principals:

After defining the intervention area we needed to define the approximate borders and surface bar for our layout, and in this case, we used boleslaw malisz's book The Formation of Housing Systems: Outline of Threshold Theory, as a theoretical base for our decision-making,.

as we used a combination of a few of the mentioned housing models plus the dynamic approach of the city implant and development to make an adequate form for our layout

- 1) the surface was defined by taking, for example, the radiometric models of Fritsh and Howards garden city, Which consisted of a diameter of 1km up to 1,5 km, and the distribution of the 04 main components of the city; industry, amenity, residency, and agricultural/natural fields.

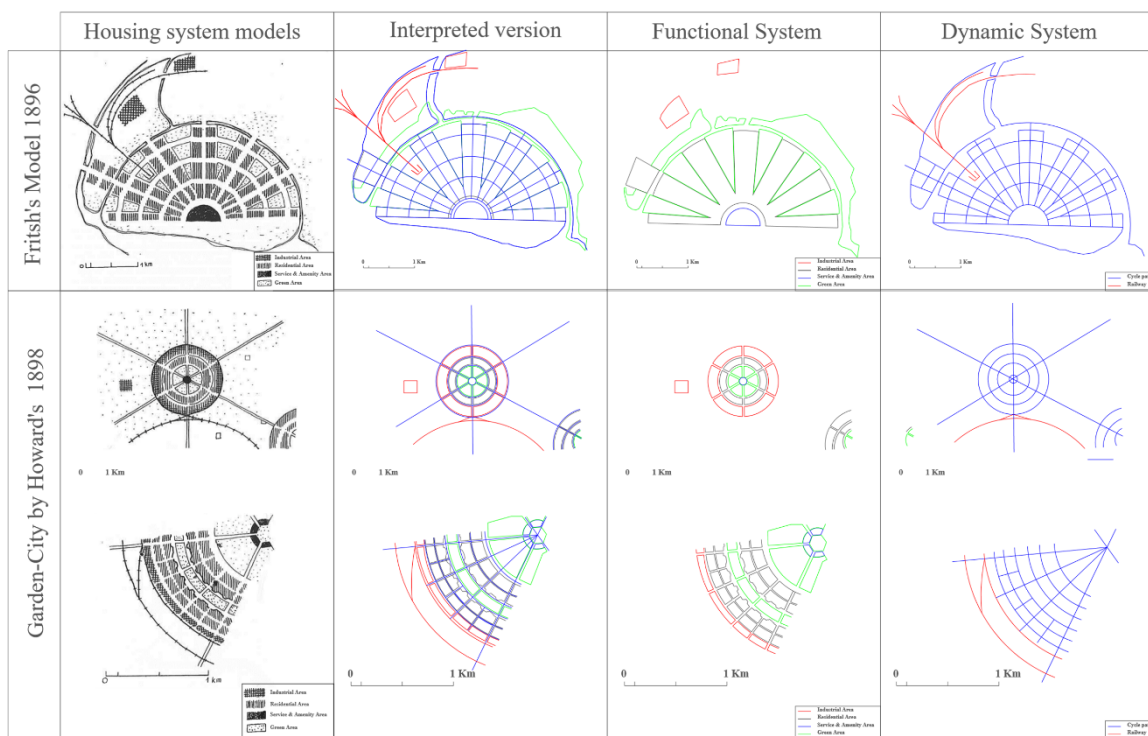


Figure 55: 02 housing systems models.
source : authors.

2) We divided the intervention field into 3 diameters going from the center to the outside as it follows; services, residential, and industrial.

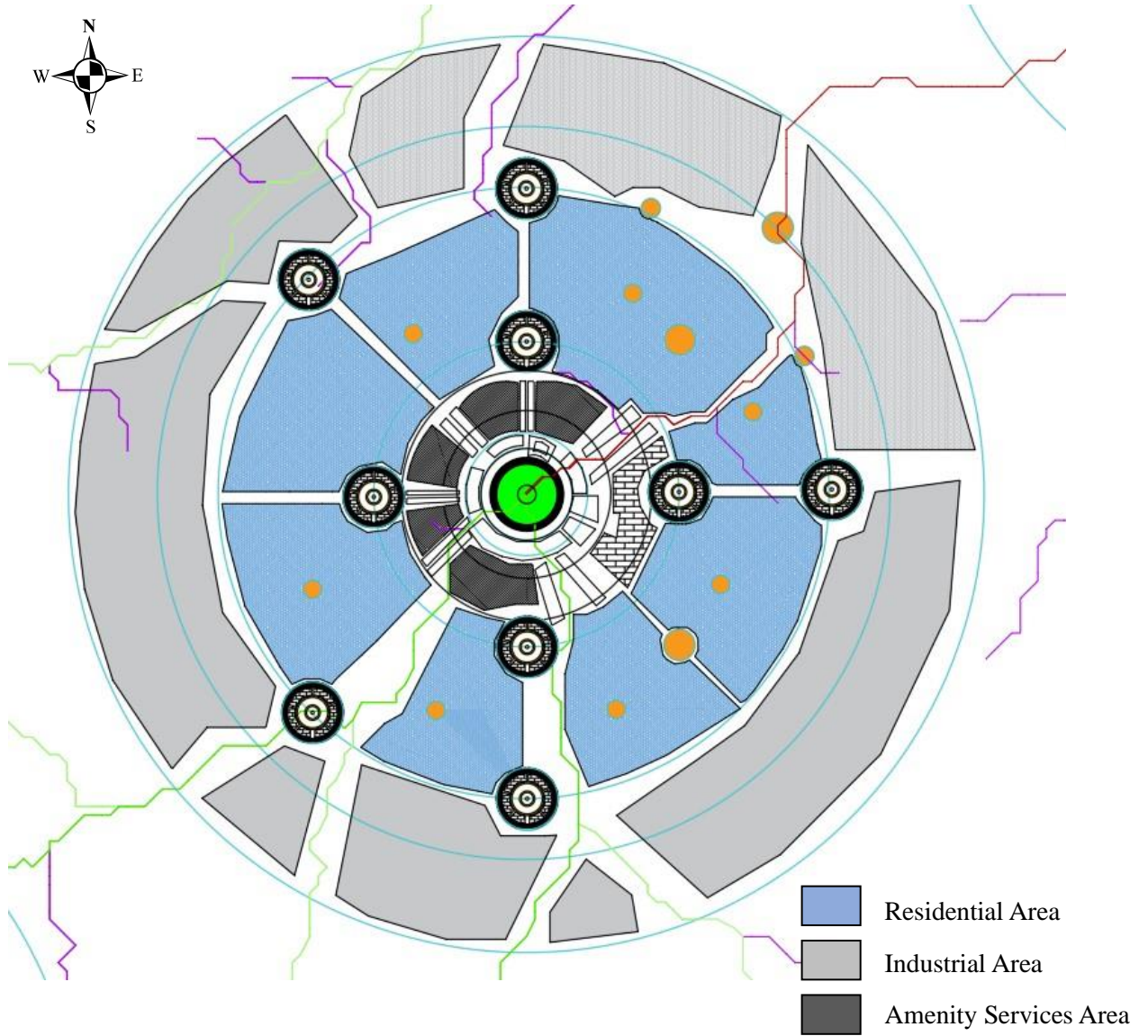


Figure 56: functional designation of zone 02.
source authors.

3) then we established the mechanical embracing structure which consisted of roads and that is by following his approach of dynamic establishment and generation, which also sorts out 03 types of centralities (primary, secondary & tertiary).

Figure 57: applied concept on our zone of intervention
source: authors

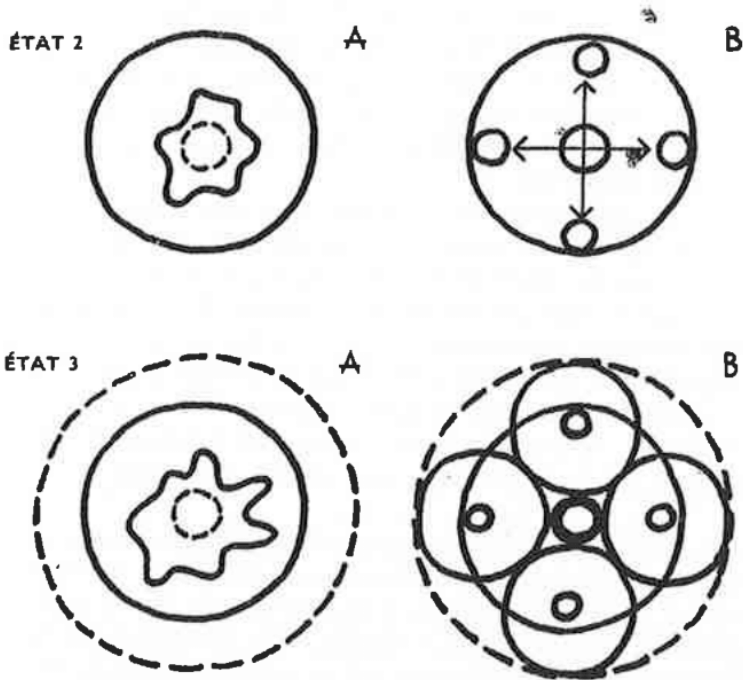
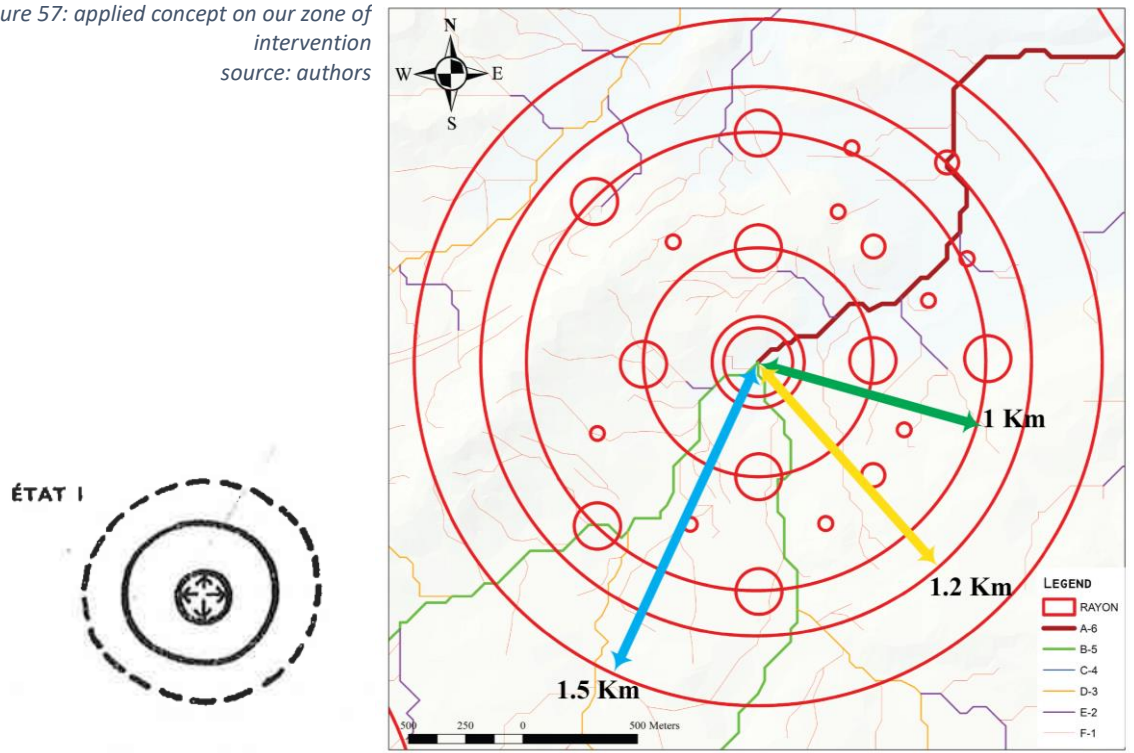


Figure 58: B. Malisz dynamic development approach.
source: Malisz, B., 1972. *The Formation of Habitat Systems: Outline of Threshold Theory*. Dunod, Paris.

4) we connected all the centralities together to extract the road traces between them.

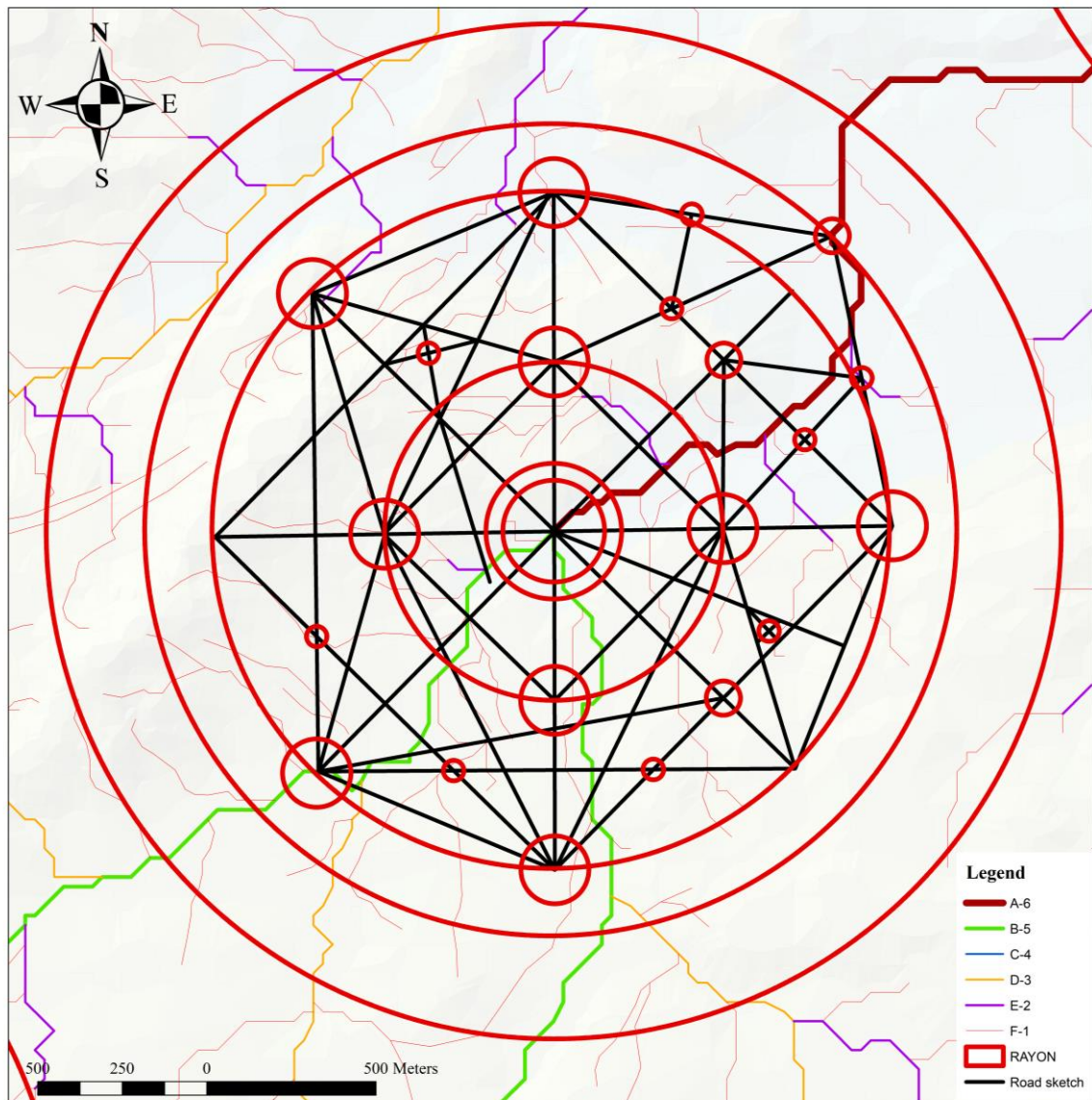


Figure 59: Raw road structure of the zone.
source: authors.

5) however we can't rely on geometrical and theoretical basis only especially on a crucial system like urban mobility, and for that matter, we tried rotating and adjusting the system until it aligned with the water veins minimizing its crossing, placed on the right side of the streams which is the higher side and that is to avoid any case of future flooding.

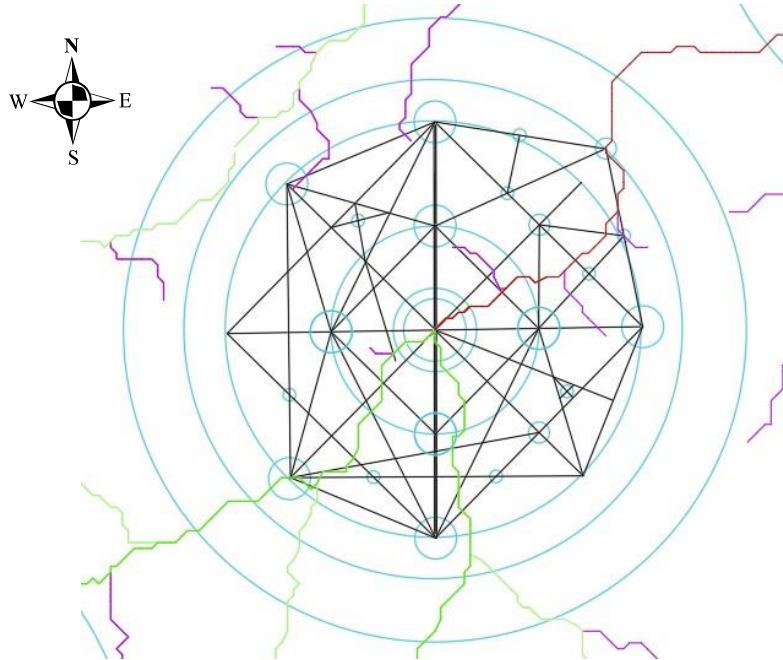


Figure 60: raw road structure.
source : authors.

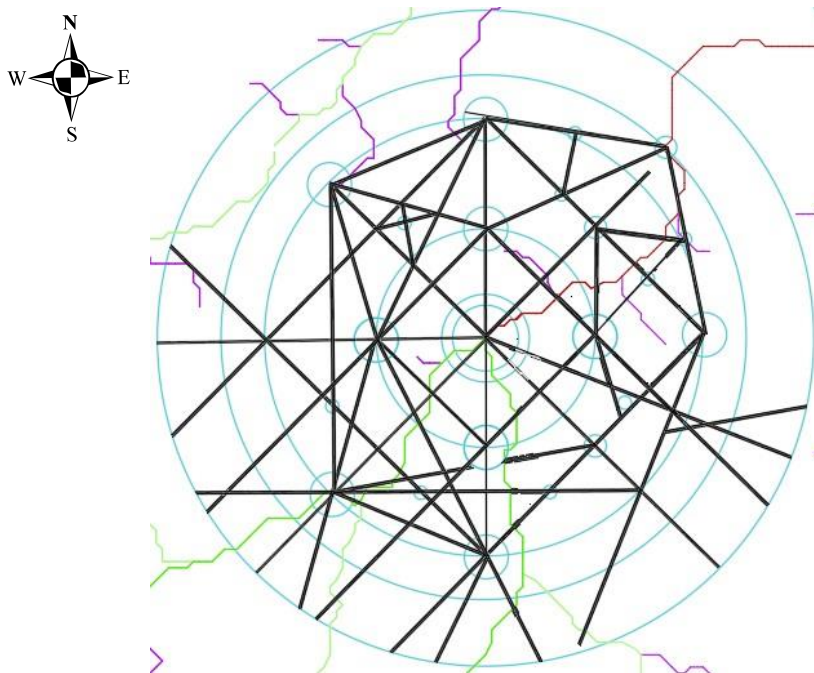


Figure 61: adjusted road structure proposition.
source: authors

2.1.3. Urban Programming:

the dynamic approach division of primary secondary and tertiary centralities aligned perfectly with the facilities theoretical grid supported by the annalise Gerard in order to provide the minimum of facilities needed within a city

- 1) and for that, we have to use the facility grid support made by the CNERU for future Algerian urban planning which also consisted of placing different services and areas based on different centralities levels (A, "B, C" combined, & D).
- 2) disposing of the surface of the intervention area we consulted the document and compared it to the different programs until we matched it with the city type: 35.000 citizens, valid from 25.000 up to 50.000 citizens. (provided in the annexes).

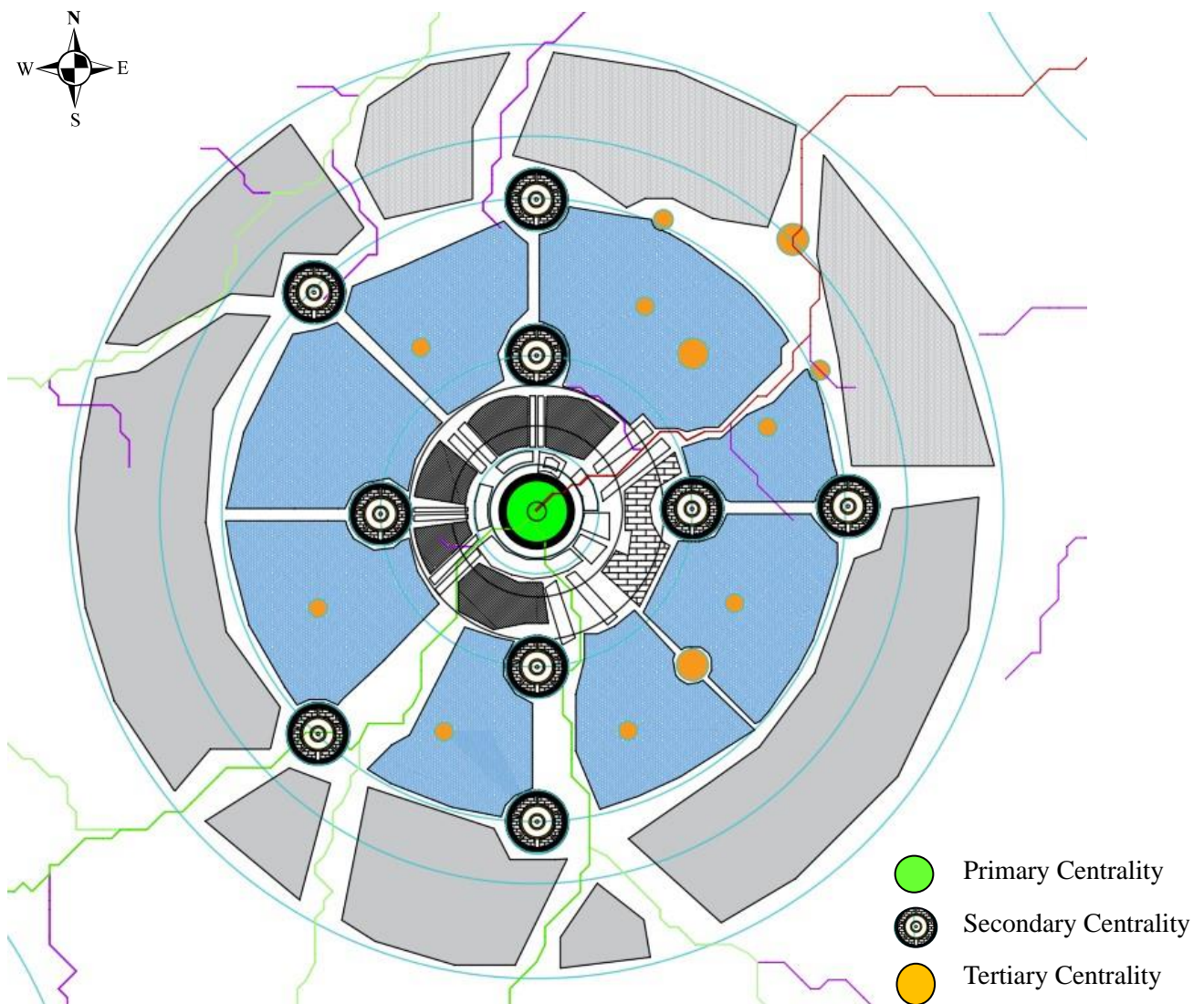


Figure 62: designated centralities hierarchy
Malisz, B., 1972. *The Formation of Habitat Systems: Outline of Threshold Theory*. Dunod, Paris.

2.1.4. plot and urban block assigning:

- 1) stratifying our current sketch and the topography of that area, we extracted the unable-to-construct zones which were the fields that lay on a topography above 25% based on Ian Macharg recommendations.

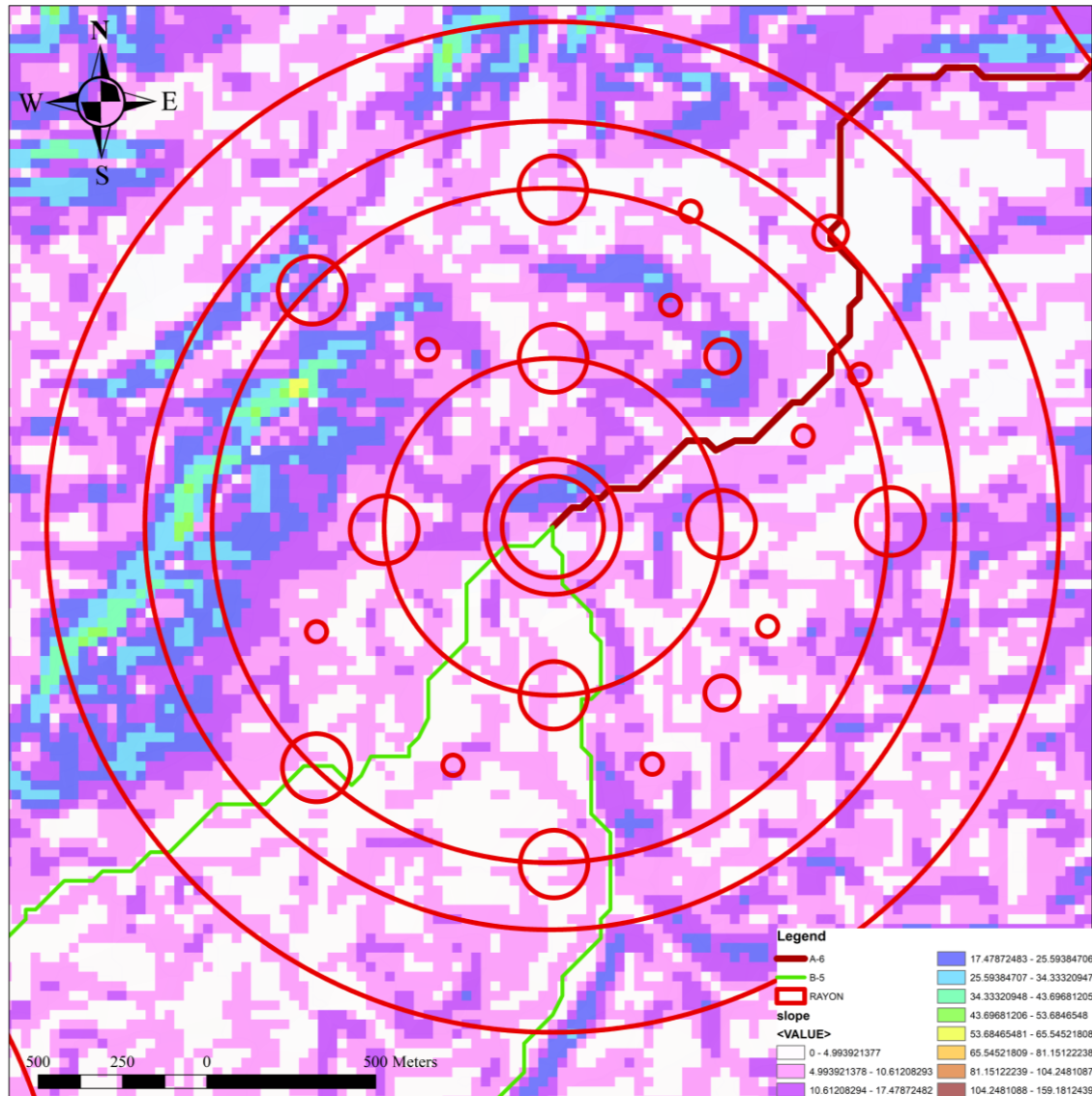


Figure 63: topography and slope percentage of the zone.
source: authors.

2) We've also searched for agricultural capacity within the area but unfortunately not only it was minimal its production capacity didn't allow many species to develop nor a considerable amount of production can be retained from it.

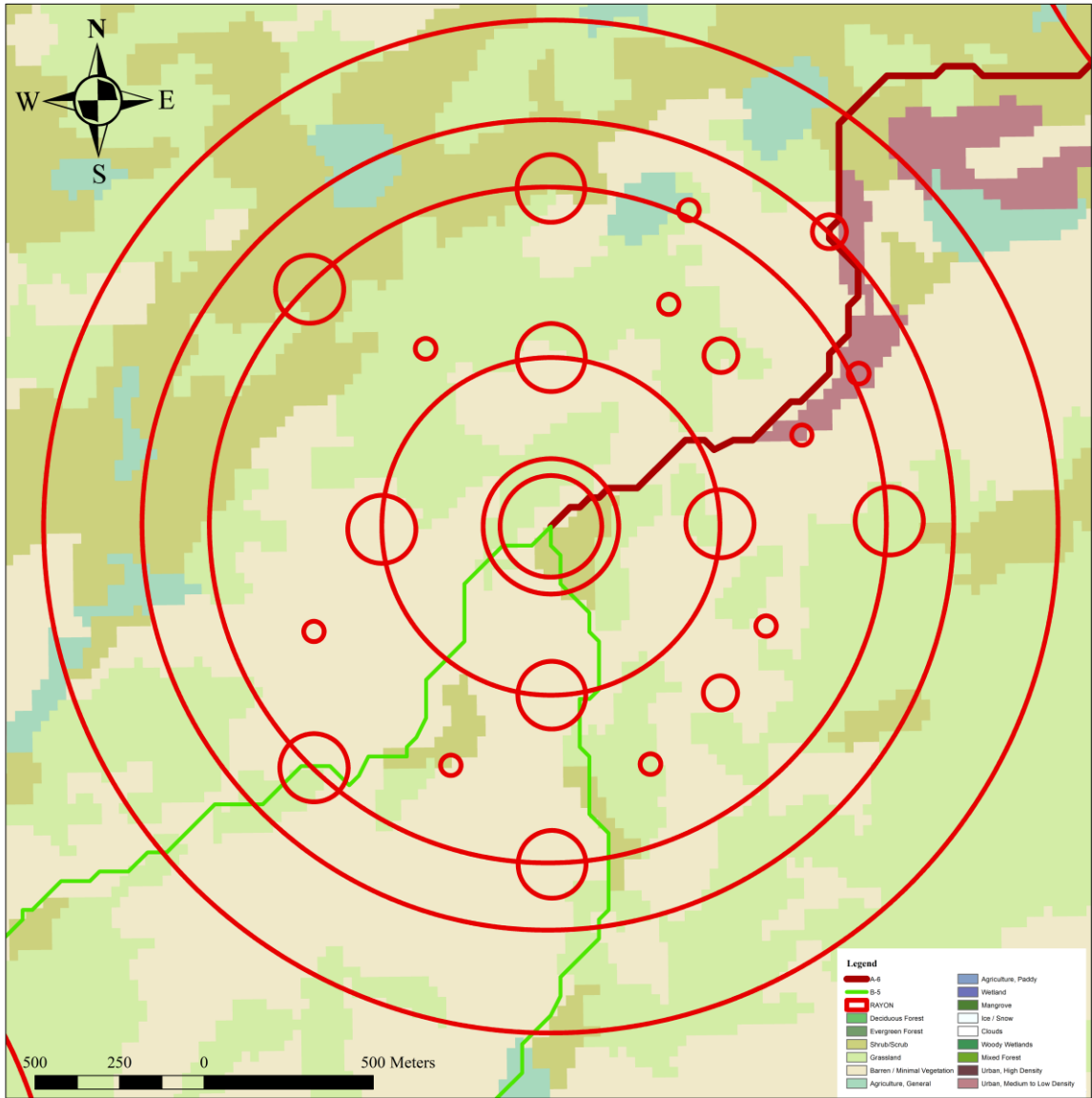


Figure 64: land properties of the zone.
source: authors.

3) We've zoomed in and focused on one slice of the area as a model of how the rest of it should follow.

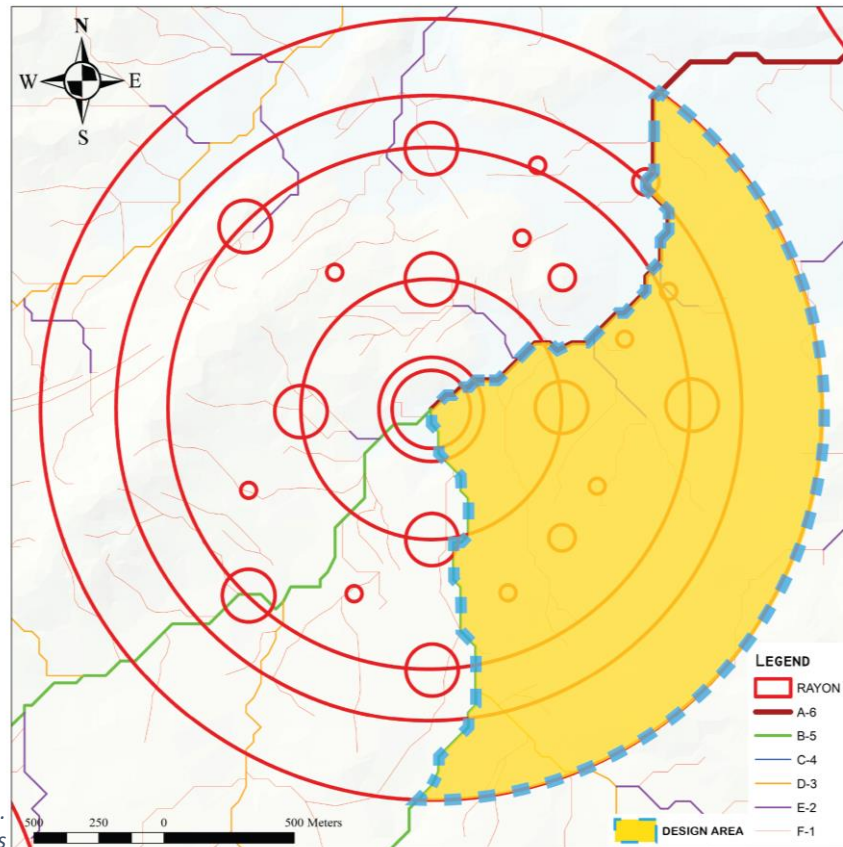


Figure 65: the defined design area.
source: authors

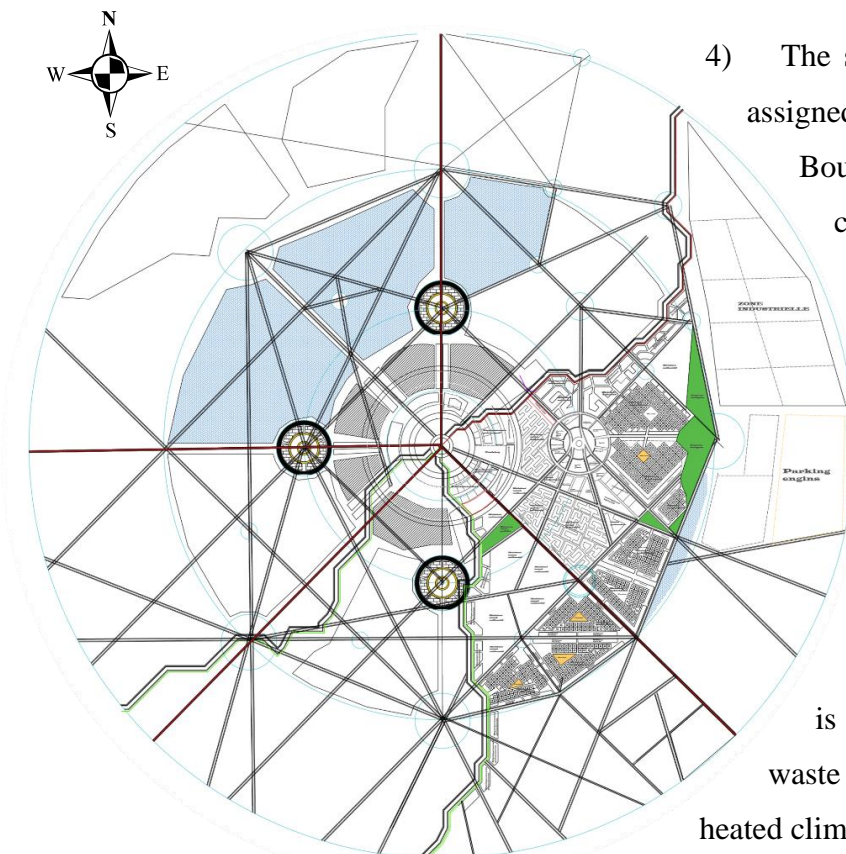


Figure 66: first sketch of the design.
source: authors.

4) The single urban block surface was assigned according to the old town of Bousaada specifically the proper city based on typo-morpho analysis, the urban block of that area consisted of 02 hectares and thus we've also used the surface as a measurement tool

5) In terms of building implants we assigned the closed island approach and that is to insure intimacy, reduce land waste and protect the users from the

heated climate .

6) Functional Landuse:

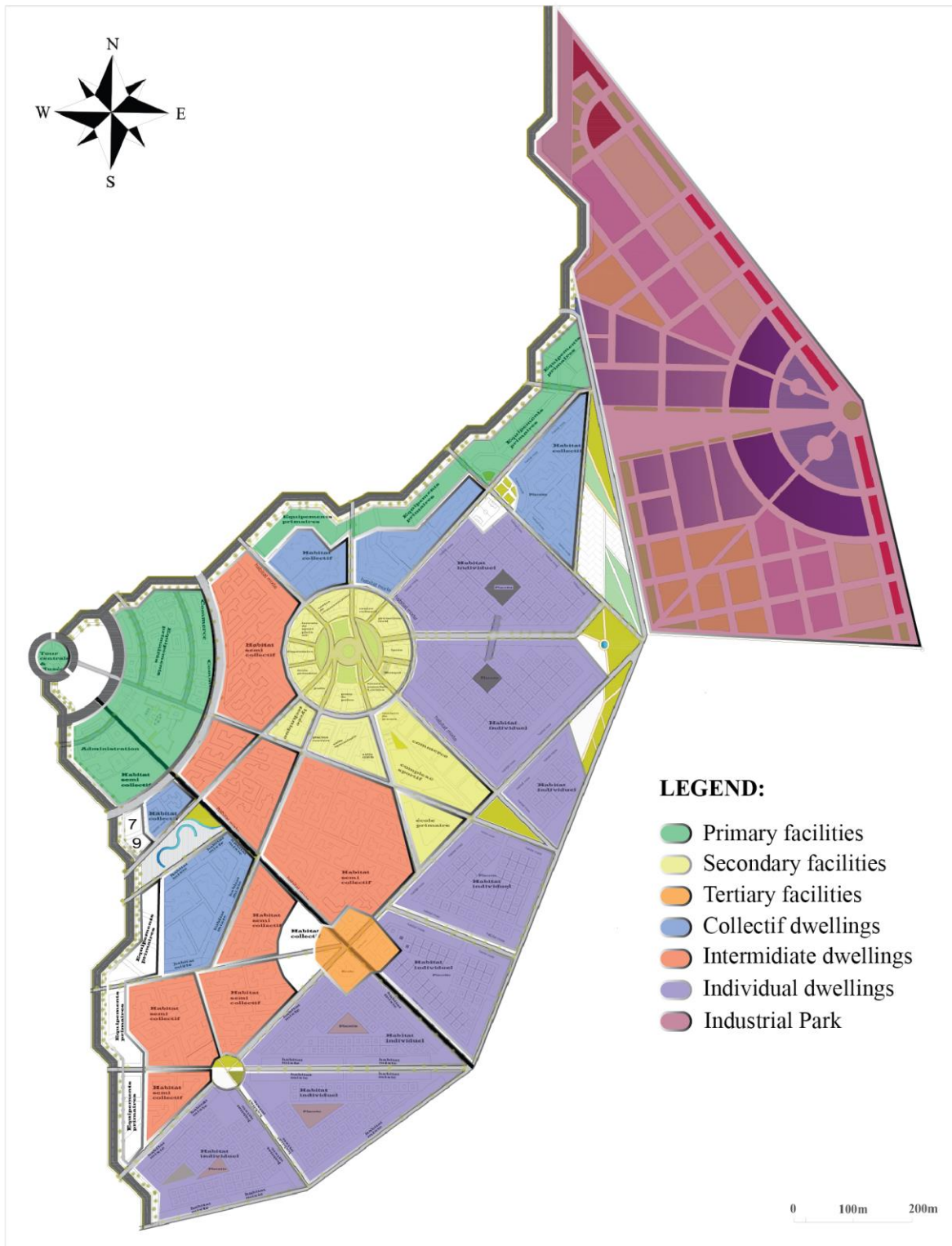


Figure 67: functional Landuse of the new suggested city expansion.
Source: Author

- 7) Compacting and aligning the buildings such as the individual residential blocks while designing them with the same form is to ensure protection against climate and heat leakage but also to check the modesty and social diversity of its tenants.



Figure 69: individual dwelling blocks -01-.
source: authors.

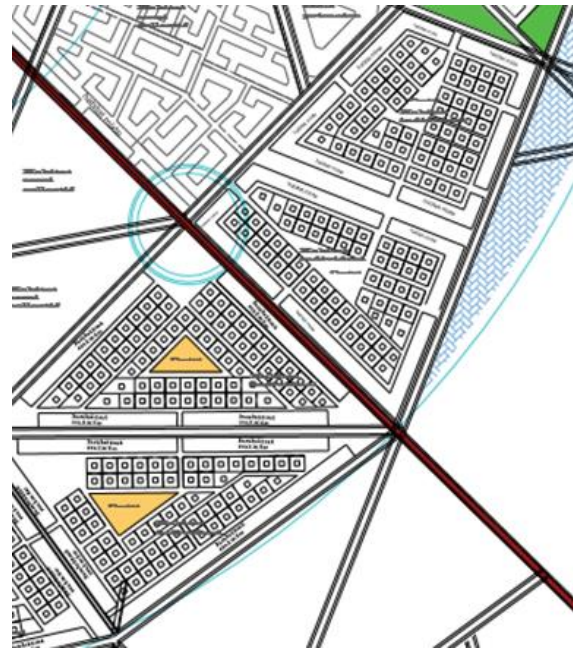


Figure 68: individual dwelling blocks -02-.
source : authors.

- 8) Also, the use of low building heights within the same range if they were under the same functional category was meant for environmental issues as the residential part was to also ensure the rights of neighbors.

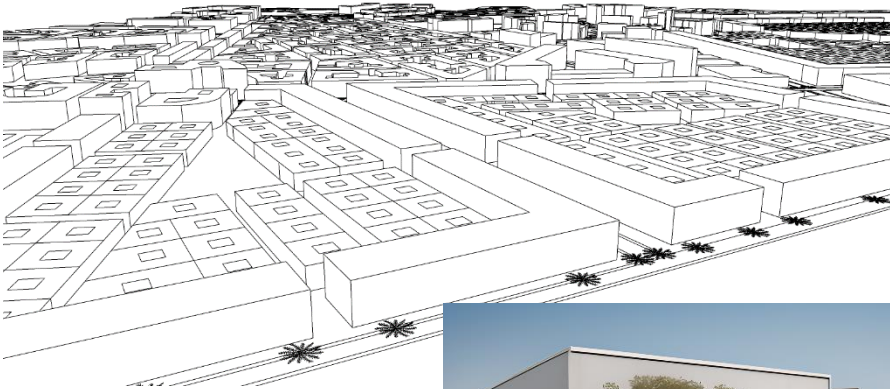


Figure 70: generated 3D
model of the layout.
source: authors.



Figure 71: rendered housing area within the
design.
source: authors.

- 9) The industrial was actually assigned as an industrial parc although the diversity of functionality that it contains it relies mostly on light industry and that is to ensure the health of the citizens but also encourage them to have their own approach and explore different working fields in all sizes, as it can also be considered as a leisure and touristic area.

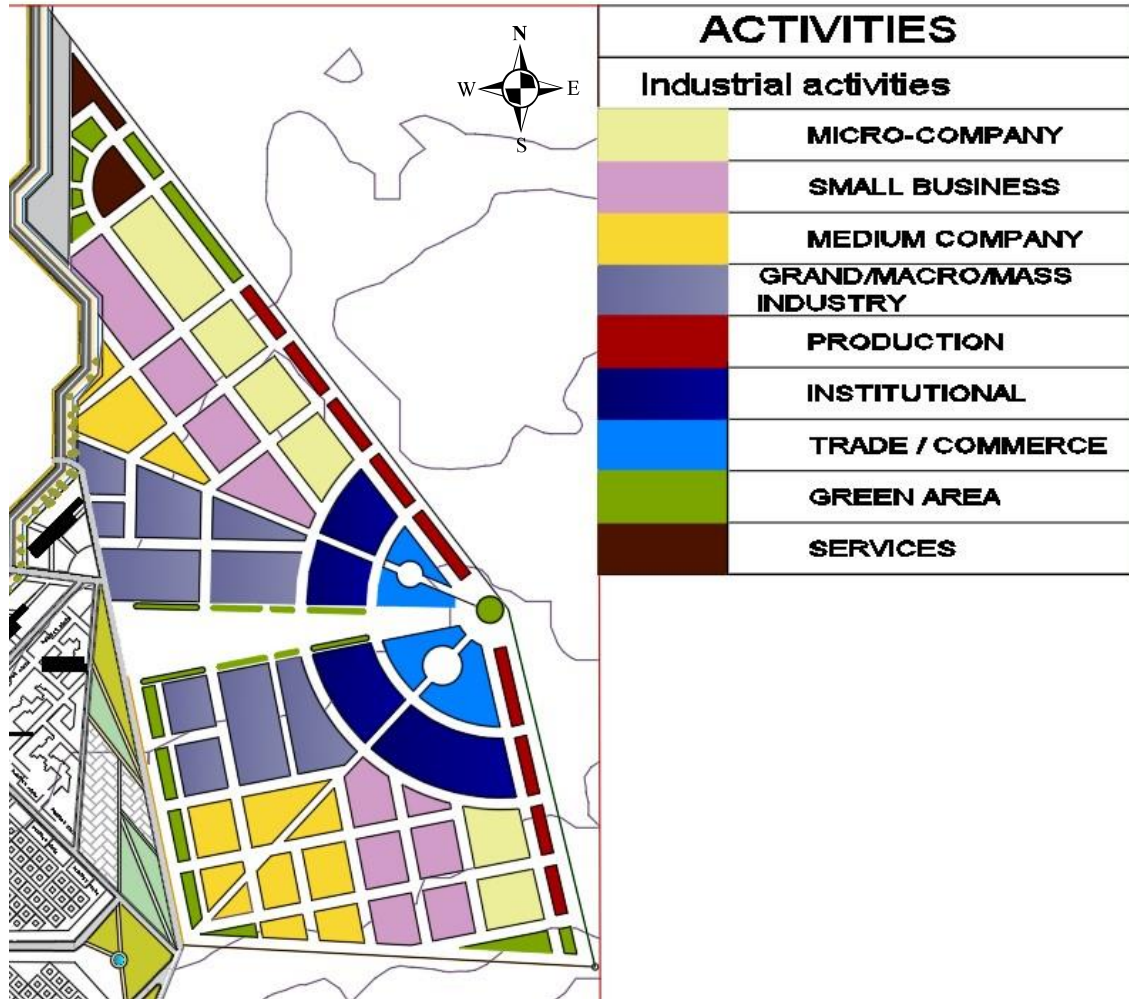


Figure 72: Suggested industrial park.
source : authors

10) Residential areas in their three types (individual, intermediate & collectif blocks) are surrounded and protected by mixed-use housings while the rest resided within the block and that is for social protection and community-bounding reinforcement.

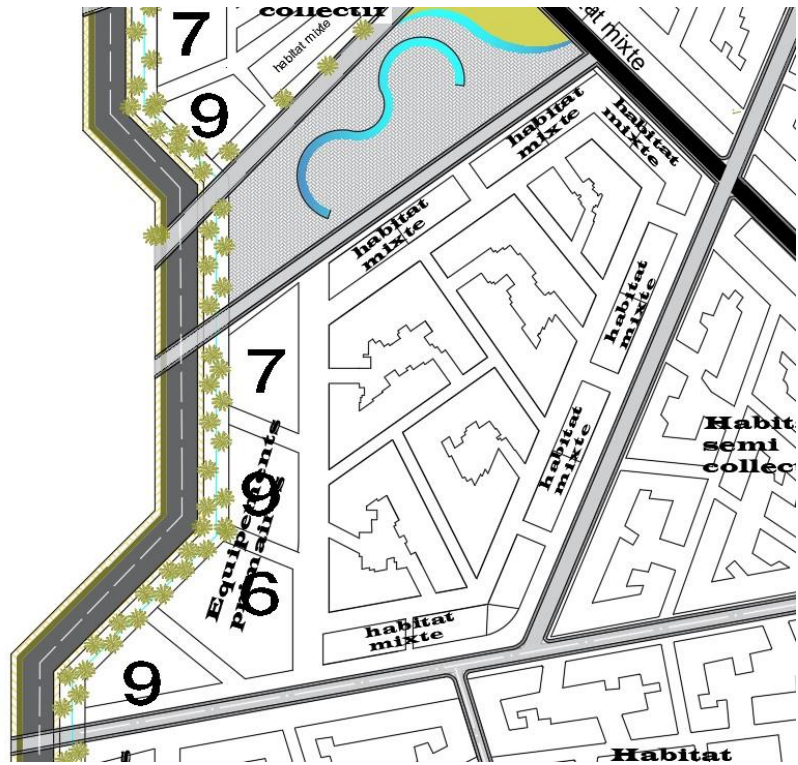


Figure 73: collectif housing urban block.
source: authors

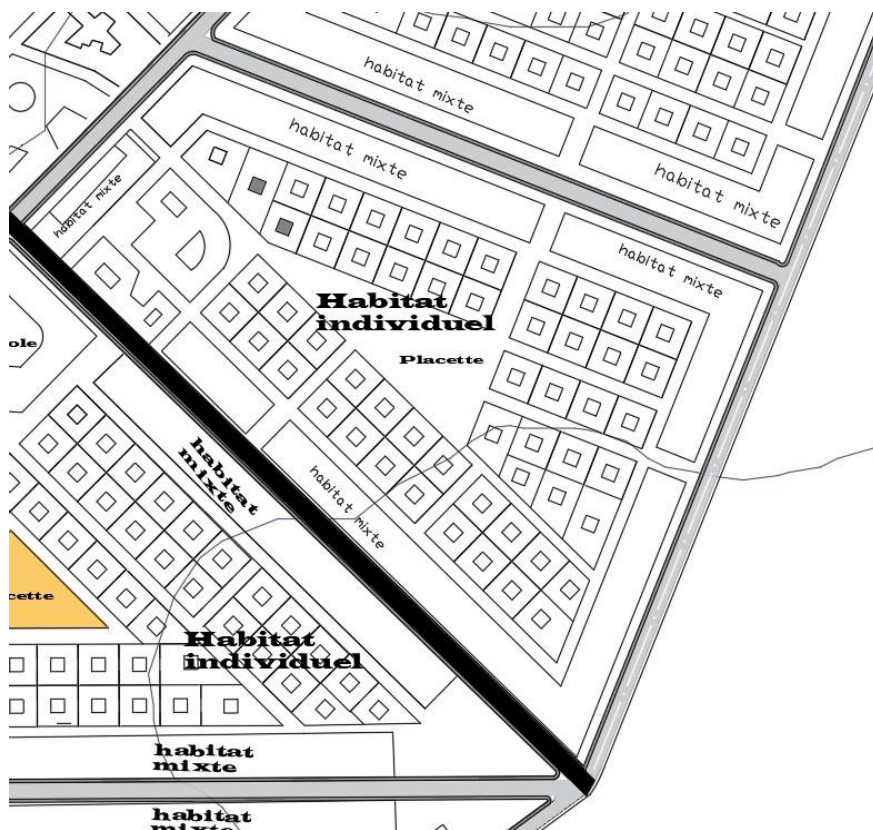


Figure 74: individual dwelling blocks -02-.
source : authors.

11) Urban and public areas are mainly present within each block to ensure semi-public contact for tighter hold of the security situation and avoid the no man land inconvenience however other forms of public areas were provided accordingly.

12) We suggested a tramway path to enhance public transport and urban mobility efficiency as we also provided protected lanes to encourage the citizens on using more sustainable and health maintenance means.

13) Trees such as Saharan cypress, Algerian fir, and oak are trees that require little to no water whereas in our case we have implemented them all along the urban mobility traces to protect the people and the city from the aggressive climate and more sustainable purposes .



Figure 76: an image of Saharan cypress.
source: https://encrypted-tbn0.gstatic.com/licensed-image?q=tbn:ANd9GcSj-c6NQUgettNzIG4WoZWPNxyRGprA6w1_Dhu3ajPAOOjaOrn6GksTRxrIDVWvGiAGXT6ahA0a17b65E



Figure 75: an image of Algerian Fir.
Source:
<https://www.biolib.cz/en/image/id380708/>

Master Plan: The Bousaada City Extension

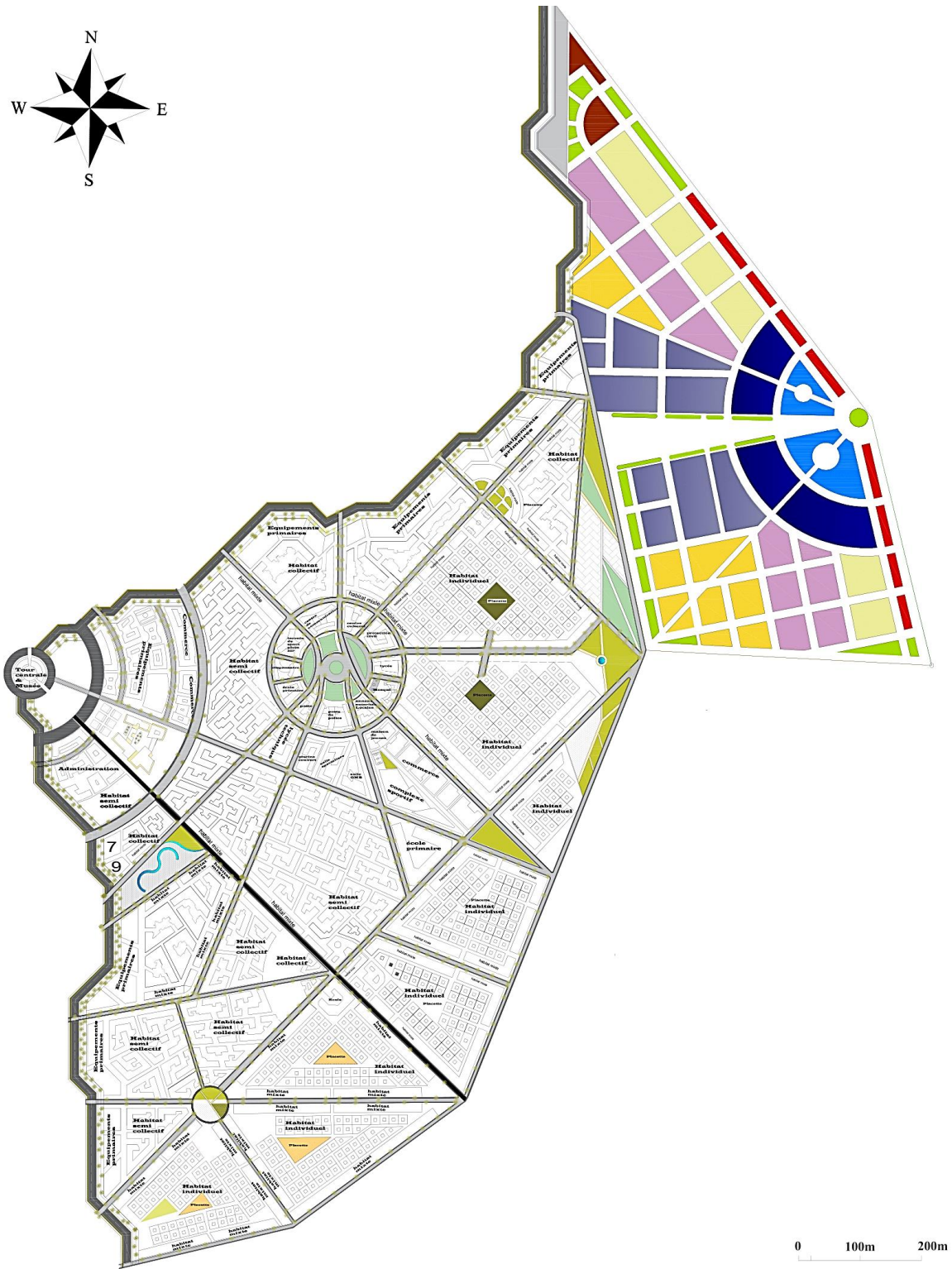


Figure 77: urban composition of the new Bousaada city extension. source: authors

3D elevation and rendered model



Figure 80: industrial zone rendered image.
source : athors.

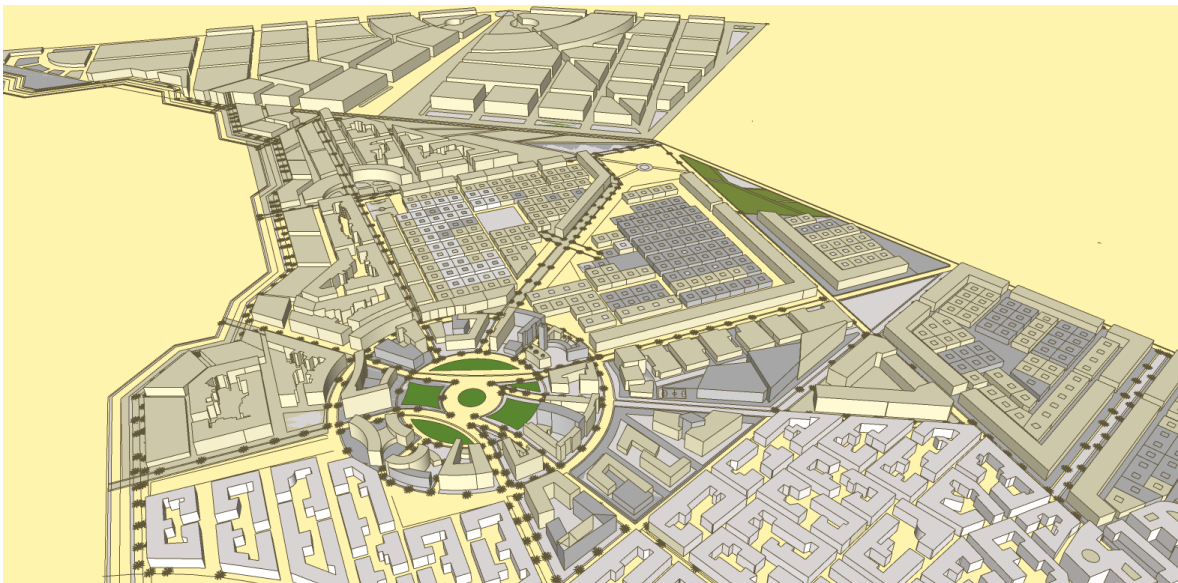


Figure 79: eye bird perspective of a part within the urban composition.
source: authors.



Figure 78: pedestrian perspective within an individual vicinity.
source: Authors.



Figure 82: Secondary amenities render.
source : authors.

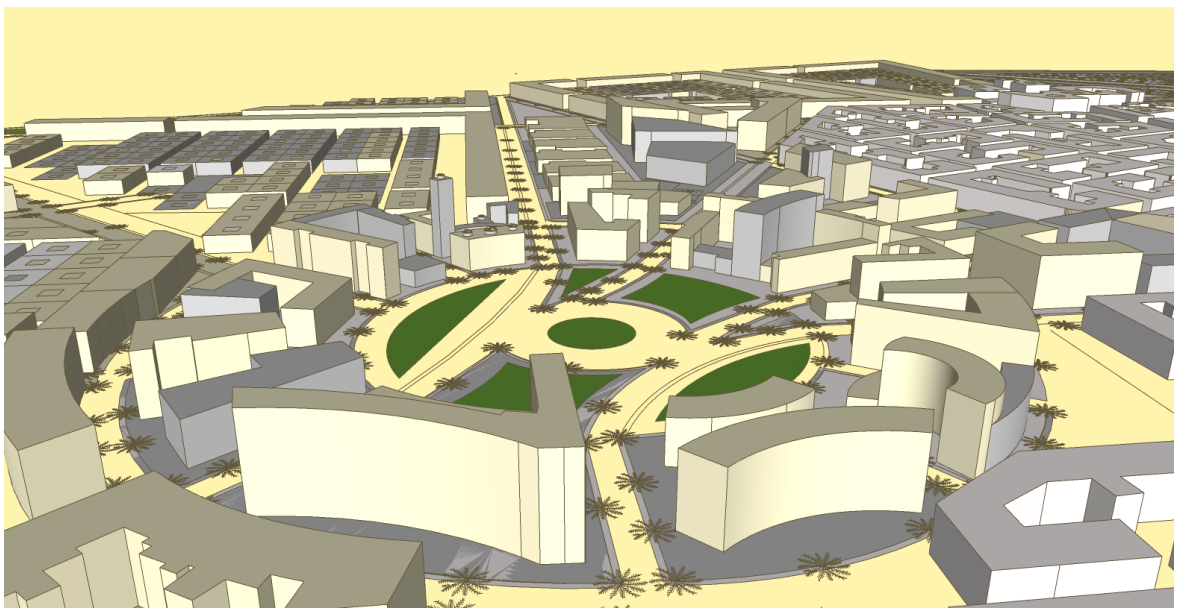


Figure 81: Secondary centrality 3D model.
source: authors.

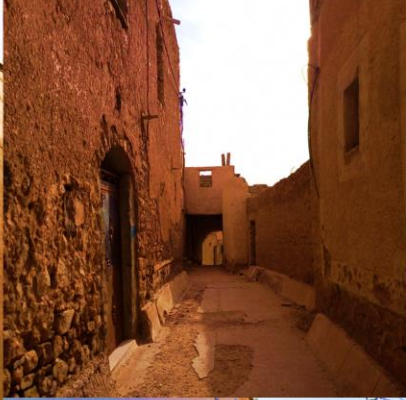
3. Synthesis:

“There is no justification for present existence other than its expansion into an indefinitely open future.” (Simone de Beauvoir)

Theorizing a living containing zone can be more than a challenge for science is still in the pursuit of doing such in many fields, however and in like every scientific equation, a variability modulus is required to ensure the control handle of the situation when it gets out of hand and when the unexpected course of events reassures, and thus our study and project really embraced the social interaction, nature, and fractal growth and imposture, to answer yesterday's, today's and tomorrows needs and requirements, the result or the product can still meet short ends by the end of day

Following the same rhythm as the design plot the circle or zone can be completed while another simultaneously starts, dividing these zones into different centralities will reassure that the source of services will not be exhausted from the citizen's density increase however once the zone starts to grow out of its designated area it will meet another zone's expansion, both relying on their center's supplement providing without causing the city to break apart.

This approach changes the definition of expansion, for have we always tried to attach a new layout area to the existing one without acknowledging the insufficiency of the center in maintaining the current situation let alone taking on a new responsibility. Maybe we've been doing it wrong all along and maybe this can open doors to a new vision of urban planning perspective we only hope for both scenarios to achieve the highest quality of life for each individual and its community.



1. Summary:

Through witnessing the life of a city, the main core always seems to grow prosperously at first, until it reaches a certain degree where its resources are exhausted and can't provide nor invest in any future growing parts and that's why we notice the edges of cities always being outcasted compared to the city headquarters, as a result of this act, suburbs start surfacing, by the citizens, in a detached and an unplanned behavior, causing imbalance to the main system since the city ends up claiming it as a part of it is growing on its territory.

as the main core barely survives while the suburbs grow even further, the city loses its definition as a unit and acts as broken fragments unable to manage the main core nor its surrounding areas, which leads to the death of the city itself, a topic portrayed by Jane Jacobs in her book "the death and life of great American cities" which proves the heavy weight this problem has brought to the table

The main objective of the work is to predict future agglomeration heads while making a system that will link these tissues to allow the city to grow in a balanced, attached, and healthy way translated and represented in the shape of math equations and vectors which will facilitate the conversion into computer coding language and its insertion into a software

As many have tried before to create an inflexible system dismissing the urbanist and architect's role, their impulses were rejected as the humanitarian impact; mainly the constant change and time factor has not been taken into consideration.

The different approach of this initiative is that the habitants are to be portrayed as the main characters, meaning creating a city that perfectly fits its own citizens as a glove and that will allow every city to have its own unique pattern, shape, and look

This technique is yet to be called "the city's own digital fingerprint" It also keeps the city always updated on the changes occurring at every moment, preventing the waste of effort and time traditional urbanists suffered from by the time the city layout reaches the execution phase, but also plans out for the long-term efficiency of the program.

Bou Saada like many other cities, has witnessed many attempts to resuscitate the city back to life, unfortunately, it only increased the gap between the existing town and the future layout, even in the citizens' speech we noticed them referring to the proper city as the old town and the new constructions as the new city which was the number one sign that the previous actions were absolute failures, nevertheless, the great increase in the unemployment rate, the decrease in the water pressure and quantity running in the oasis hence the death of the surrounding farming lands and the fast urbanization of a fertile area, all of these facts required immediate intervention in order to prevent the death of a city that was once appointed as the first capital of the country for the immense amount of potentials that it held in it

Launching a startup or opting for one requires us to check many factors in order for you to succeed or at least assure longer longevity.

The five most important factors to take into consideration are: the idea, the team/execution, the business model, funding, and saving the best for the last: timing one of the best

companies always tries to display the fact that their startup launched full rounded in terms of these factors while in fact, the top three elements were: timing, execution/team and the idea coming at third place in that order

A small market with a high growth ratio is the way to go when rolling your dice for a startup.

This idea can also eliminate the Metaverse trend that is growing aggressively with a big community completely dismissing its necessity to exist as it is unsafe fictional and delusional world and that explains the facts that people prefer running away from their current issues than confronting them.

As metaverse is considered a luxury nowadays yet it's trying to make its way through the different social categories as a plague, real-life community, and the world is suffering from a demographic explosion, water, and edible elements shortage, pollution, and the running out of occupational space, Yet the time seems to be passing as quickly as thunder, changes keep occurring during the study and data collection phase that by the time the design phase starts the data has already flipped upside down making your effort completely useless to the current adjusted reality.

As urban life is expanding relentlessly and spontaneously our idea comes in handy for the local authority to skip the study phase and apply the design catalog immediately on the targeted urban fragment, not only that, but the software has a generating engine that can detect possible future centers for human agglomeration while proposing a system that can link the old and new fragments within the same area

Pros :

- this software/application/extension will save the time and effort made during the design phase
- that usually takes 80% of the urban operation, minimizing the data change in that time and
- allowing immediate execution
- It scans and organizes the data of that fragment in order to propose the best system to apply to the intervention site
- It allows interaction and the involvement of the citizens by providing them with different models and allowing them to choose the one that suits them the best

Cons:

In order to focus on the system inserting and making the design generator engine we need to eliminate the data collection programming part, this con can be reversed into a selling opportunity to a data collection and analysis company as an extension such as ArcGIS and depthmapx and many other urban and natural data collection companies that have been experiencing extremely slow growth if not at all in terms of their usage and services. An option often seen on the SketchUp software where many users create different extensions and sell them to other users in order to have a smoother experience on SketchUp and that allows Sketshup to grow and encourages many opportunity makers to be involved which diversifies the customers' persona and interaction which by the end of the day all translates into more money to be earned

Basically, along with providing services to users as a B2C form and the government aka local authorities that plays on two threads being identified as a user we by turning the tables for this can have added a B2B service.

But this only presents itself as a con for the mere fact of the execution time that we want to frame ourselves into which is of 6 months in order to show our first operating model.

In terms of financial impact aka what the investor or sponsor is required to take care of financially is the simple local new launching company requirement which is an office workspace, internet, and basic work environment conditions since the procedures focus on the programming and generating the software

This facility can play a major role in creating a strong attachment between the old town and the new proposed extension of the city perceiving their cultivated history as a setting stone to a more promising future in the media industry.

The main problems that this innovative action will be solving. Reducing the ridiculous amount of time spent on the data collection and the study phase for a more efficient design

Detection of future agglomeration center appearance while assuring a connected harmonious design

Using Malisz book and embodying it as an extension is a method or a process used by the students of Iam Maccarth when they themselves embodied the book into a computer system called ArcGIS, then launched a serie of software that supported this system that presents in the ArcGIS server

Following their footsteps is a successful debuting key to launching this plugin The book content emphasizes the fact that with the development of math and cyber science, this should be taken as an opportunity to help the Planifier to focus on the design act and to replace its critical role within the process

The required experts that will show the most efficient help are cybernetics experts, economists, and applied mathematicians.

2. Business Model Canvas “BMC”:

<p>KEY PARTNERS</p> <ul style="list-style-type: none"> The government Urban planning and design corporates and companies Local authorities, institutions, universities, and research institutions Aiming for the international scale 	<p>KEY ACTIVITIES</p> <ul style="list-style-type: none"> predict future agglomeration heads while making a system that will link the tissues to allow the city to grow in a balanced, attached, and healthy way keeps the city always updated on the changes occurring at every moment, preventing the waste of effort and time traditional urbanists suffered from by the time the city layout reaches the execution phase, but also plans out for the long-term efficiency of the program. eliminate the Metaverse trend that is growing aggressively with a big community completely dismissing its necessity to exist as it is unsafe fictional and a delusional world 	<p>VALUE PROPOSITIONS</p> <ul style="list-style-type: none"> this software/application/extension will save the time and effort made during the design phase that usually takes 80% of the urban operation, minimizing the data change in that time and allowing immediate execution It scans and organizes the data of that fragment in order to propose the best system to apply to the intervention site It allows interaction and the involvement of the citizens by providing them with different models and allowing them to choose the one that suits them the best. This facility can play a major role in creating a strong attachment between the old town and the new proposed extension of the city perceiving their cultivated history as a setting stone to a more promising future in the media industry. 	<p>CUSTOMER RELATIONSHIP</p> <ul style="list-style-type: none"> Online/phone communication channels and built-in support channels on the official site 	<p>CUSTOMER SEGMENTS</p> <ul style="list-style-type: none"> <u>Business to government B2G:</u> Local authorities, urban planning services, companies <u>Business to business B2B:</u> Geographic Information System (GIS) and urban planning & analysis companies: (ArcGIS, QGIS, Depthmapx, Autodesk... etc) engines <u>Business to customer B2C:</u> Every individual involved in the urban sector: (students, urban planners & designers... etc)
<p>COST STRUCTURE</p> <ul style="list-style-type: none"> cost optimization strategies Staff maintenance and experts' interventions for managing and upkeeping the servers and the plugin 60% Large investment costs to expand the plugin to international corporates and governments to fixate an inner cell within their grounds (Capital investment) Well-scaled and efficient local provided by a high-tech work environment. 	<p>KEY RESOURCES</p> <ul style="list-style-type: none"> GIS (Geographic Information System) database Servers for the official site and cloud servers for plugin data 	<p>CHANNELS</p> <ul style="list-style-type: none"> Social media Official website Online/phone customers services Digital marketing and advertising platforms 	<p>REVENUE STREAMS</p> <ul style="list-style-type: none"> High-profit margin streams from governments, advertising, and subscription services. Investors and sponsors such as companies and corporates adopting the plugin in their systems. 	

Conclusion :

This study represents an agenda or a practical diary that beholds all the produced or introduced references, related to my 2nd-year master's degree graduation where we attempted to answer the following problematic:

Can we provide a system that will allow us to design future cities that are adaptive and adaptable at the same time? Is it possible to tame chaos?

Followed up by many other demanded explanations making us question a lot of the classic ways to handle an urban project and how the current parameters came to be in the first place.

Our intervention approach consisted of 02 scales: architectural and urban scale. Based on three base holders, sustainable urban planning, Islamic urban principals, and fractal interpretation of the city layout but most importantly this study involved the citizens in making decisions and expressing their desires and requirements towards the city they aspire to occupy, which privileged this study to the point where we were not required to walk on the classic urban planning path, rather it spread our spirit on focusing on the human contact.

As we explored the different theoretical concepts and approaches while also performing different urban analyses on the city, our choice of site, urban composition, and architectural project occupation were strengthened and fairly justified

In the process of diving into, what is fairly called, adventure, we took two trips to Bou Saada city where we were taken in in the most hospitable manner, got involved with the community's diverse individuals, and even had the chance to conduct a survey of almost 900 questionnaires, That particular social interaction and involvement with civilians and between them not only awakened a sense of duty from our behalf to the people, but the people also reciprocated the feeling towards their city and themselves, we witnessed the encouragements and actions to show their commitment to the bettering of their homes.

Our project is a product of our effort in combining all the beneficial parts of a variety of urban intervention approaches highlighting the 03 fundamental principles: society, nature, and economy. And for this matter, this urban layout proposal that we are delivering right now is an opening model or a new conduct product for future urban planning.

In the lookout journey for the people's best interest is where the architectural project choice resides, a center that beholds and eliminates any future stress built up that can convert into an occupational disease that could've been avoided if it were taken care of earlier, we have to admit that practicing a certain act repeatedly on the long run, especially labor ork will fade out the part it usually operates with, so in order to avoid these scenarios a complex center between occupational healing and community services was found adequate to this problem, this combo was made to ease the people and accept this new healing concept through different regular life activities

An architect or an urbanist has to be aware of the amount of responsibility he beholds once he merges himself into this field, once he realizes the amount of influence he can project on people's lives, behavior, mindset, and even happiness, he will feel the burden that falls on his shoulders, but not the kind that exhausts, but more likely the one that will teach you dedication

Whether this model is a success or a failure can only be determined by the people that will reside in it in the long run, however, we will always remain in the pursuit of providing the people with the best quality of life through architecture urban planning urban design, and landscaping.

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