Master's Thesis 2023/24

MBArch Urbanism

Gonzalo Díaz Correas

Supervisor

Álvaro Clua Uceda

After updating

Spatial impact assessment of urban regeneration projects for mass-housing states

UNIVERSITAT POLITÈCNICA DE CATALUNYA BARCELONATECH

ETSAB Escola Tècnica Superior d'Arquitectura de Barcelona

dutp Departament d'Urbanisme Territori i Paisatge

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resumen

Los procesos de regeneración de los polígonos de vivienda se han convertido en uno de los ejes principales de las políticas urbanas a nivel nacional e internacional, deviniendo una de las acciones transformadoras más utilizadas para revertir ciertas desigualdades sociales.

Estos procesos suponen habitualmente una considerable asignación de recursos financieros, sociales, tecnológicos, etc. pues deben tratar de manera integral aspectos multivariables y complejos, entre los que se incluyen factores sociales, económicos, medioambientales y, por supuesto, arquitectónicos. No obstante, si bien es cierto quedichos proyectos tienen por objeto impactar en última instancia en la realidad socioeconómica de estos barrios, la dimensión morfológica es también clave, ya que dichos proyectos acaban impactando en mayor o menor medida en la estructura espacial, su garante de gran parte de los comportamientos humanos.

Pese a lo relevante de la condición espacial, es cierto que gran parte de los estudios urbanos han reducido el análisis a métricas centradas en la edificación -como podría ser la edificabilidad, las condiciones de habitabilidad, el número de viviendas o variedad tipológica-, o bien desde métricas vinculadas a la movilidad -flujos de peatones, ejes de viario. Pero son pocos aquellos que han explorado métricas que permitan evaluar el espacio libre per se, desde sus cualidades morfológicas propias.

Este trabajo se centra en el desarrollo y testeo de una serie de métricas basadas exclusivamente en el estudio en profundidad de los parámetros geométricos, topológicos y perceptivos que se derivan del plano fondo-figura de dichos barrios antes y después de los proyectos de regeneración.

Esta metodología, que busca ser fácilmente replicable y tiene por objeto último no solo comprender los valores de cada proyecto sino también dotar de conocimiento empírico a la correlación existente entre las transformaciones propuestas y los impactos espaciales resultantes, con el fin de ofrecer datos cuantitativos que permitan evaluar el impacto mayor o menor que determinados proyectos han tenido en relación a los recursos o magnitud de la transformación

abstract

Housing estate regeneration has become a central axis of urban policy, both nationally and internationally, as one of the most widely used strategies for addressing social inequalities.

These processes typically involve a significant allocation of financial, social, and technological resources to comprehensively address multivariable aspects, including social, economic, environmental, and architectural factors. Although the ultimate goal of these projects is to improve the socio-economic conditions of affected neighbourhoods, their morphological impact on spatial structure is equally critical, as space significantly influences human behaviour.

Despite the importance of spatial considerations, urban studies have often limited their analysis to metrics related to buildings—such as density, habitability, number of dwellings, or typological variety—or to mobility metrics, including pedestrian flows and road networks. However, few studies have explored metrics that evaluate open space based on its own morphological characteristics.

This work seeks to fill that gap by developing and testing a series of metrics focused exclusively on the geometric, topological, and perceptual qualities of the figure-ground relationship in these neighbourhoods, both before and after regeneration.

The proposed methodology aims to be easily replicable and strives not only to assess individual projects but also to generate empirical knowledge on the correlation between proposed transformations and their spatial impacts. By providing quantitative data, it offers a way to evaluate the effectiveness of regeneration projects in terms of their spatial outcomes relative to the resources invested and the scale of transformation

This first chapter explores the motivations and aims of this thesis, both personal and academic, and provides an initial introduction to some of the issues that will become the main discussion of this thesis. its purpose is therefore to provide the reader with a context for the issues that will be discussed in the rest of the thesis.

In this second part, the concepts to be analysed were defined in more detail. A literary exploration of the three main themes of this work is carried out and a reflection is developed with the aim of establishing the basis for the analysis to be carried out in the following part of the work.

In this third part, the concepts developed in the previous chapter are used to analyse a series of case studies that help to clarify the main hypothesis described in the first chapter. A methodological analysis is then presented in which a series of methodologies are used to attempt to quantify the concepts presented in the previous section.

This last part reflects on the results of the previous analysis in relation to the main theme of the thesis. it is then explored at several levels, firstly in relation to the specific analyses and the trends presented by the sum of the totals, and secondly in relation to the trends presented in each case study, in order to reach an overall conclusion on the hypothesis. The section ends with a brief reflection on the importance of continuing this type of research.

Abstract

1. Introduction

1.1 Context

1.2 Hypothesis

1.3 Goals

1.4 Methodology

2. Framework

2.1 Urban regeneration

- Background
- Definition
- Approaches

2.2 Mass Housing Estates

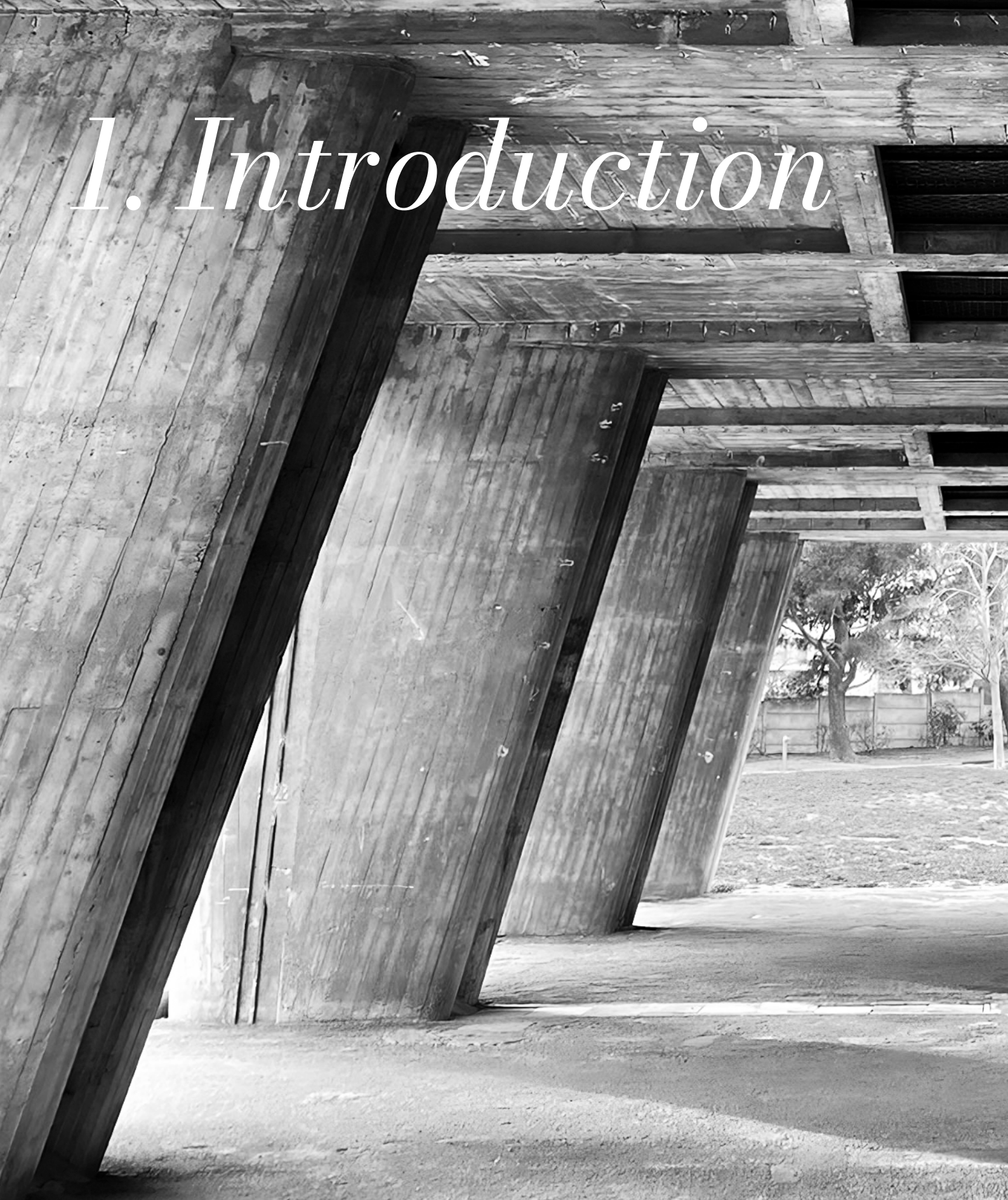
- Origin
- Definition
- Decay process
- Regeneration processes

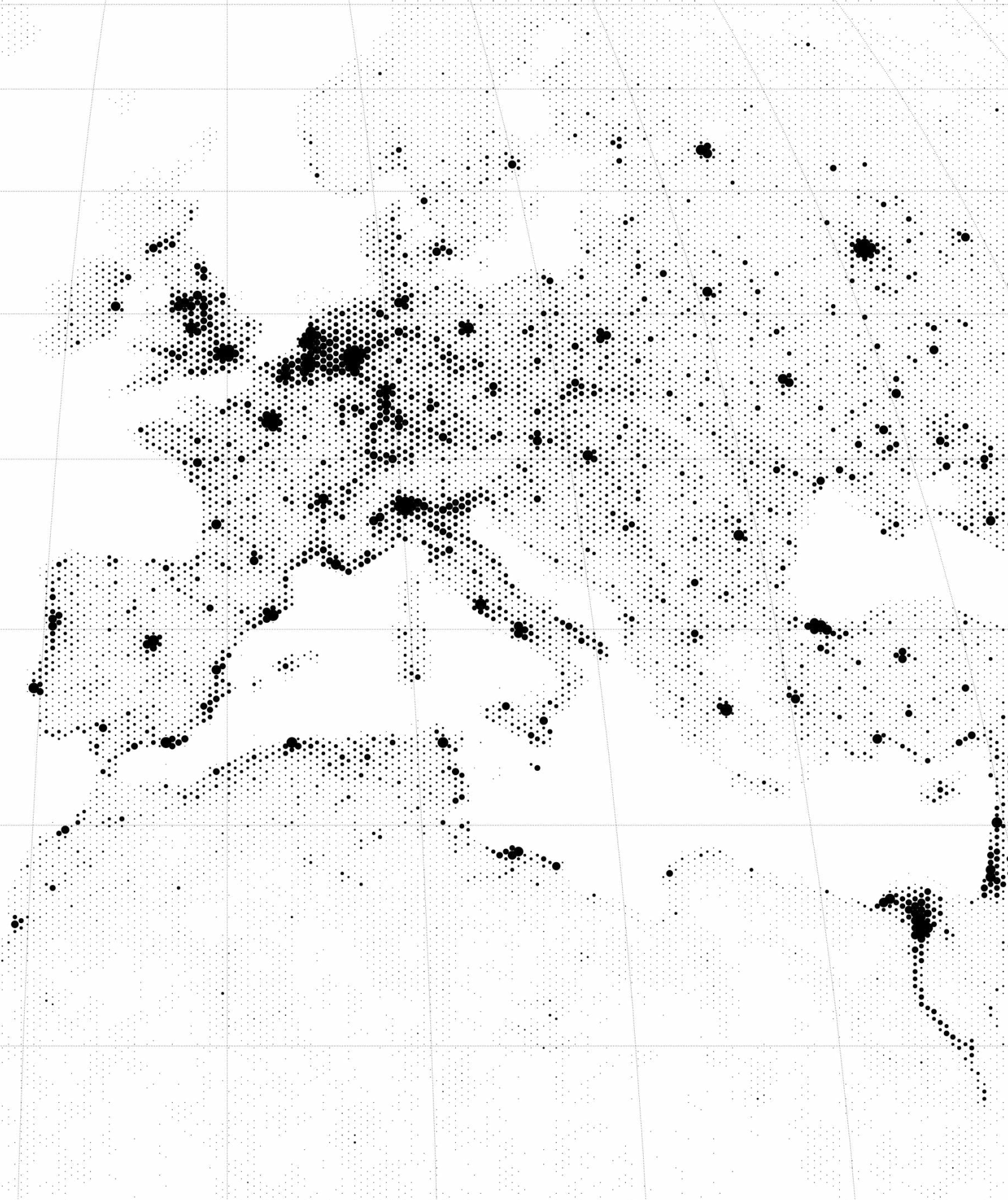
2.3 Learning to measure space

- Geometry
- Perception
- Structure

3. Measuring space

1. Introduction





1.1 Context

Figure 1. [left]. Volume surface in 2020, 1km detail. Note the concentration in certain urban areas. Source: Author with Global Human Settlement Layer Data.

1. "Urban-Rural Europe – Introduction."

2. With increases in the number of people working from home or a recession in household size from 2.4 to 2.2 persons, which increases the precision in the housing market and, at the same time, puts the city's existing typologies in crisis. "Household Composition Statistics".

3. As at least 75% of the housing stock is in need of an energy improvement European Commission. Joint Research Centre., Accelerating Energy Renovation Investments in Buildings.

Cities are subject to a constant and pervasive pressure, both internal and external, which drives them to remain in a state of constant evolution, both in a physical and functional manner. This series of circumstances has resulted, in most modern urban areas, in the emergence of areas with a profound alienation between the physical conditions of their environment and the functions required of them to promote the well-being of their users.

Moreover, there are a wide range of reasons for this functional evolution to happen. In the context of Europe, a highly urbanized area, where almost 75% of the population resides in urban areas[1] -that represents less than a 4,3% of the European territory-, the pressure over the urban environment is particularly evident. Secondly, the demographic changes taking place in a post-pandemic Europe that is immersed in changes in the composition of housing and the relationship with the working environment[2]. In addition, the increasingly evident effects of climate change are confronted with a building stock in great need of renovation[3].

This growing awareness has underscored the necessity of a coordinated and comprehensive approach to the adaptation of urban environments and infrastructures. As a result, a wide range of urban policies have been introduced at both national and European levels, aimed at aligning the physical urban environment with its functional requirements. Among these, the European Commission has placed significant emphasis on retrofitting the built environment to reduce energy consumption and mitigate the effects of climate change. The European Green Deal, adopted in 2019, prioritises the goal of "renovating buildings for greener lifestyles" and allocates substantial funding to ensure its implementation, particularly for the most vulnerable citizens across Europe.

Traditionally, efforts to reform urban environments began by addressing the challenges of the historic city centres. Following the industrial revolutions and the gradual transformation of cities into industrial cities, these areas began to experience problems of over-concentration and compactness, leading to a range of issues, including health and hygiene concerns, diminished quality of life, and various social problems for their inhabitants. In response to these challenges, a series of initiatives emerged in the 19th century, aimed at promoting urban transformation as a solution. Two major approaches can be identified: the first focused on transforming the existing city, with notable examples such as the opening of Carrer Ferran in Barcelona, Baron Haussmann's renowned transformation of Paris, and the creation of the Ringstrasse in Vienna. These efforts were contemporaneous with significant events highlighting the impact of the urban environment on public health, such as Dr. John Snow's mapping of cholera outbreaks in London.

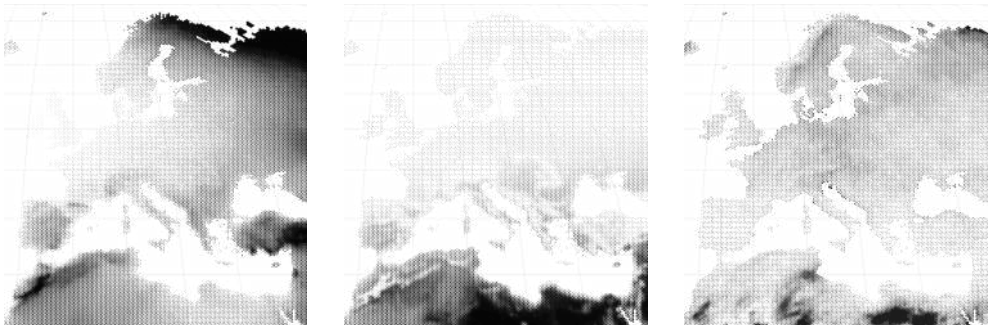
The second approach sought to address urban issues by creating entirely new urban fabrics designed to ideologically improve societal quality of life. Early examples of this include Ildefons Cerdà's Eixample expansion in Barcelona, Arturo Soria's linear city, and Ebenezer Howard's Garden City.

Over time, these two currents of urban development evolved in parallel, eventually converging in the mid-to-late 20th century. By this time, these newly created urban fabrics, due to the changing nature of urban life and the demands placed on these environments, began to require regeneration. Among these new developments, the open city or modern city—one of the predominant forms of urban expansion in the 20th century—gained particular relevance. This model, heavily influenced by the principles of the CIAM (Congrès Internationaux d'Architecture Moderne) and enshrined in the Athens Charter[4], was characterised by medium-rise buildings and monofunctional urban layouts that prioritised residential areas. These developments aimed to provide a high volume of dwellings, offering quality of life through expansive open spaces intended for social interaction, exposure to sunlight, and access to fresh air, contrasting sharply with the densely populated historic city centres.

However, despite these aspirations, certain limitations became evident. The monofunctional nature of these developments, coupled with their peripheral location, often resulted in isolation from the rest of the city. Furthermore, the quality of the buildings was frequently substandard, making them particularly vulnerable to degradation and limiting their capacity to adapt to changing circumstances over time.

Figure 2. [right] Lemiracle des arbres et des parcsrétablit l'echelle humaine. Source: Le Corbusier, La Ville Radieuse.

4. "Sun, space, greenery; these are the essentials. through the four seasons the trees stand; friends of man. large blocks of flats cross the city. what does it matter? they are behind the screen of the trees. nature is included in the lease"."Principios de Urbanismo : La Carta de Atenas - Universitat Politècnica de Catalunya."



This widely criticised urban model has resulted in the development of areas where 10-40% of the population in European cities now reside[5], underscoring the urgent need for their regeneration on multiple levels. This urgency has prompted the introduction of various policies, both at national and local levels, aimed at the renewal of these urban environments. The heterogeneity of these strategies largely reflects the diversity of the urban fabrics themselves, which, while following general principles, have been adapted to the theoretical and practical contexts of the regions in which they were implemented.

As a result, distinct trends have emerged, often shaped by national policy frameworks. In France, for instance, the association of mass housing with social housing necessitated significant state intervention. Although these efforts initially focused on large-scale demolitions, the prohibitive costs of such actions led to the adoption of more socially-oriented initiatives, which, however, have had limited impact on improving the quality of these urban fabrics[6]. In contrast, Italy, where approximately 25% of the housing stock is located within these developments, experienced later growth, with expansion continuing into the late 20th century. Italian regeneration strategies have consistently emphasised the social and economic upliftment of these neighbourhoods, combining urban renewal with modest increases in built-up areas.

In Spain, and particularly in Barcelona, there is a long history of responding to these urban challenges, especially in the face of increasing climate-related events in recent years, alongside significant economic and demographic shifts. These changes are transforming the functions that the city provides for its inhabitants. To address these shifts, public administrations have been tackling an issue that much of Europe may soon face: the lack of available land due to Barcelona's surrounding topographical constraints. Consequently, these administrations have focused on adapting existing urban environments as the primary response. areas, and the impact of globalisation on urban environments.

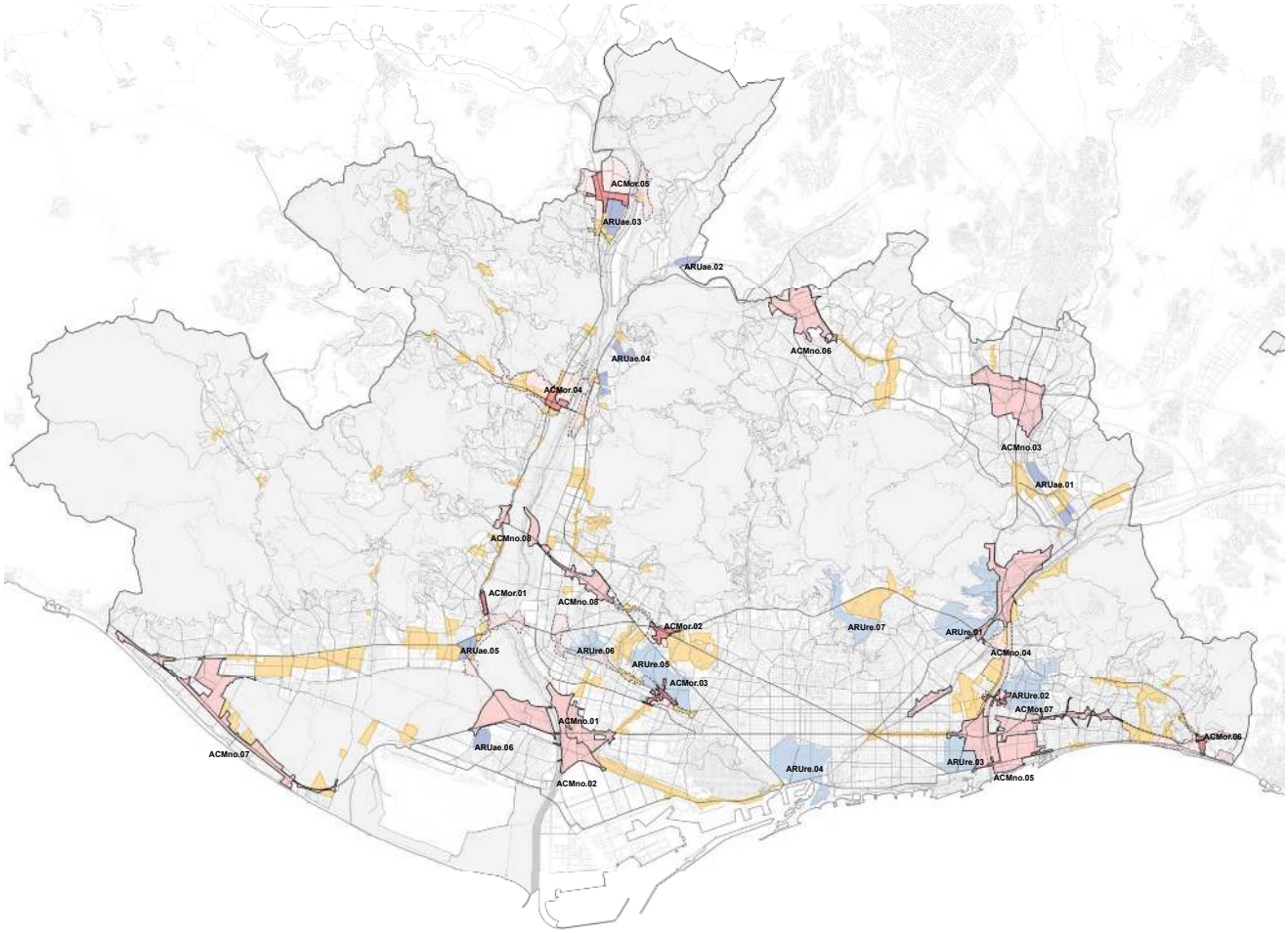


Figure 3. [up right] Priority areas for urban regeneration interventions in Barcelona. Source: PDU AMB

Figure 4. [up left] In order from left to right: temperature projection, future increase of heat waves and precipitation evolution according to IPCC Panel. Source: author with 'Atlas. In Climate Change 2021' dataset

5. Kempen et al., "Restructuring Large Housing Estates in Europe."

6. Turkington, van Kempen, and Wassenberg, "High-Rise Housing in Europe."

A substantial body of literature addresses interventions in existing urban fabrics in response to demographic and economic changes, including rural-to-urban migration, spatial inequalities between historic city centers and peripheral areas, and the impact of globalization on urban environments. However, there is a noticeable gap in studies that focus specifically on the evolution of the spatial configuration of these fabrics.

In recent years, the Barcelona City Council has made significant strides toward adopting a more integrated approach to interventions in existing urban fabrics, addressing the complexity of emerging challenges. This initiative has been largely driven by a collaborative effort with the Local Urbanism Office (IMU) to explore potential strategies for implementing these interventions. While the IMU has developed a comprehensive strategy aimed at improving conditions in the city's vulnerable areas through an integrated framework, certain aspects still require further refinement.

The first axis, focused on enhancing the urban environment, presents a key opportunity for greater integration. This approach aims to expand the concept of urban quality beyond physical conditions, emphasizing the interaction between various urban elements to foster a more holistic approach to urban regeneration.

1.2 Hypothesis

When designing and constructing cities, architects and urban planners employ a wide range of tools, from basic spatial arrangements—such as creating axes, living areas, and corners—to more complex strategies involving materiality, symbolism, and functionality. However, we often overlook the impact these design strategies have on the built environment and on both individual and surrounding spaces. For instance, the creation of an axis may sometimes divide areas and at other times revitalise them. In the current context, regeneration strategies have gained significant importance as a method for revitalising specific parts of the city, making them more efficient both environmentally and economically. Yet, a lack of understanding of the diverse spatial impacts of design strategies complicates our ability to predict the spatial outcomes of regeneration projects.

It might seem intuitive to assume that interventions in the physical environment have a direct, linear effect on both its configuration and perception, corresponding proportionally to the investment made. However, this paper seeks to explore and demonstrate that the relationship between investment and spatial impact is not only non-linear but also reveals certain trends whereby significant impacts can be achieved with moderate resources.

The relevance of this research lies in its focus on identifying the most resource-efficient strategies for urban interventions, aiming to maximise impact while minimising costs. Interventions in the physical environment are intended to enhance the direct functions they provide to users. For example, improving the permeability of both public and private spaces can foster urban encounters, thereby promoting social integration. Similarly, rehabilitating building façades and enhancing energy efficiency can improve residents' quality of life by reducing the effort required to maintain thermal comfort. Moreover, the demolition of certain areas can facilitate the development of new urban structures, reshaping the perception of a neighbourhood and altering its role and identity within the wider city.

Nevertheless, there remains a lack of clear methodologies for empirically determining the optimal placement of these interventions. Such decisions are generally based on a combination of the economic cost of the intervention and the complexity of the issues being addressed, rather than on an established empirical framework for assessing their spatial and social impact.

This previous approach assumes that in areas with high urban complexity, demolition and reconstruction represent the most effective solutions. Conversely, in less complex urban environments, thematic interventions may prove more appropriate. Despite the diversity of urban regeneration policies and their corresponding projects, resource efficiency is often a key consideration. However, this is typically achieved by implementing strategies that require minimal resources, rather than by identifying critical spaces where such interventions could yield the greatest impact. As a result, it is these strategic, intermediate-scale solutions that often strike the best balance between effort and impact.

Within this broader framework, this research will focus on evaluating the efficiency of changes made to the physical environment in regeneration projects on mass housing estates. It will do so by examining various case studies where spatial configuration has been central to the intervention. Specifically, it will investigate how different spatial strategies—such as creating axes, densifying, or demolishing—directly influence the spatial structure of urban fabrics, and consequently, how they affect users' perceptions of these spaces. The underlying assumption is that many spatial interventions lack a data-driven methodology to assess the development of various design strategies, often leading to the overuse of resources in creating specific spatial categories that could be achieved more efficiently. By increasing resource efficiency, this approach would also ensure the greater preservation of existing elements in the city, thereby promoting better protection of 20th-century heritage.

In essence, attempting to demolish and rebuild entire urban fabrics is an impractical solution. First, it would simply replace one set of problems with another, and second, it would displace the very residents intended to benefit from the intervention. Similarly, undertaking extensive modifications, such as adding elevators or new facades, while improving residents' quality of life, fails to transform the urban structure in a way that meaningfully alters the internal and external dynamics of the area.

1.3 Goals

The primary aim of this study is to provide empirical evidence, regarding the spatial consequences of various strategies and instruments used for transforming the built urban environment, with a particular focus on mass housing estates. This will be accomplished through a quantitative analysis of geometric, topological and perceptual parameters, enabling more efficient resource utilisation in the restructuring of these spatial configurations

To support this main objective, the study also seeks to fulfil several secondary goals. The first is to establish a clear and data-driven working methodology for understanding the structure of different urban fabrics, thereby providing insights into the changes resulting from these transformation processes. This methodology will serve two purposes: firstly, it will standardise the analysis to enable comparison across different urban fabrics; secondly, it will allow for the replication of the analysis in a wider range of regeneration projects, and, with methodological adjustments, its application to other types of urban fabrics.

Finally, by standardising this process, the study aims to identify a series of best practices, leading to the development of a toolkit for interventions in high-rise housing estates. These interventions would not only improve the physical conditions of the estates but, when combined with social and economic strategies, would also enhance their adaptability to changing dynamics and improve overall living conditions.

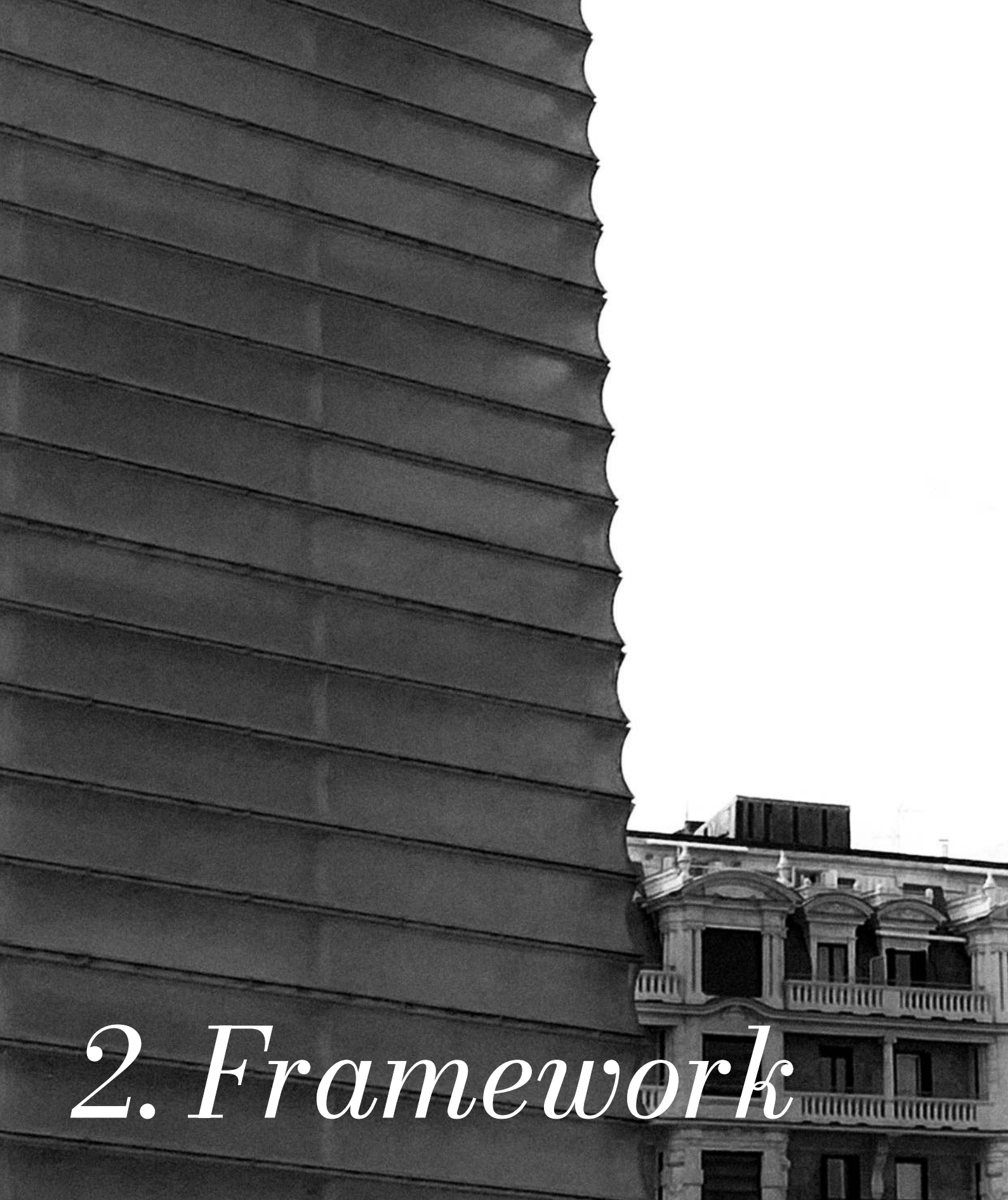
1.4 Methodology

To achieve the objectives, the methodology of this study is divided into three key phases.

Firstly, a comprehensive literature review will be conducted, focusing on three main themes: urban regeneration, housing estates, and methods for geometric and topological quantification of space. The literature on urban regeneration and housing estates will provide the foundational context necessary for understanding the environments in which this research is situated. Meanwhile, the review of geometric and topological quantification methods will offer the conceptual framework and tools for the spatial analysis that underpins the study.

Secondly, a series of comparative cartographic analyses will be undertaken, using the aforementioned indicators to quantify the evolution of spatial parameters such as geometry, topology, perception, and the formation of centralities. These analyses will be performed using advanced Geographic Information System (GIS) tools and Visibility Graph Analysis (VGA). The comparative cartographies will focus on selected case studies, specifically regeneration projects in mass housing estates, encompassing interventions completed from the late 1990s to the present. In addition, the analysis will include several contemporary projects that are still in the planning phase, in order to assess their potential future impact and success.

Finally, to test the hypothesis of this research, a comparative analysis of the case studies will be conducted. This will involve examining the relationships between the various indicators and the spatial strategies employed in each project, with the aim of identifying and understanding the trends and patterns that emerge across different cases. Through this comparative approach, the study seeks to determine how different strategies affect spatial outcomes and the efficacy of regeneration efforts.



2. Framework

2 Framework

One of the consequences of the European context of the second half of the twentieth century, characterised by the reconstruction after the Second World War, the high demand for housing due to the rural exodus or the influence of the Modern Movement, was the emergence of different housing policies that led to the creation of massive housing projects clearly influenced by the criteria of the Modern Movement[7].

The result is an 'urban' fabric with very specific characteristics, in many cases close to the statements of the Athens Charter. Tissues that in many contexts are considered problematic and vulnerable, unable to provide decent urban conditions for their inhabitants[8].

This has led to the regeneration attempts that have taken place throughout these fabrics in Europe. These efforts, promoted by different urban policies, generally of a national character, have been disparate in defining regeneration strategies for these spaces, creating different cultures of intervention. From the less interventionist policies found in housing estates in Northern Europe to policies of indiscriminate demolition, such as the strategies promoted by France's National Urban Renewal Plan in 2003[9].

However, an intuition is leading to a series of new strategies in which demolition is becoming an occasional and strategic tool, rather than a starting condition, in order to achieve the various objectives of urban restructuring, diversification etc[10]. Anyways, increasing urbanity has become a constant goal in urban renewal operations[11].

7. Brossa and Sotoca García, After the Project.

8. Krantz, Öresjö, and Priemus, "Large Scale Housing Estates in Northwest Europe."

9. Hernández León, Criterios de Intervención En El Patrimonio Arquitectónico Del Siglo XX.

10. Masboungi, Gravelaine, and França Direction générale de l'urbanisme, Régénérer les grands ensembles.

11. Brossa and Sotoca García, After the Project.

But despite all these efforts, not much attention has been paid to the spatial perception of these spaces, usually simplified as homogeneous "open block" fabrics, in contrast to the fabrics of the traditional compact city, trying to bring the criteria of the latter closer to the mass housing estates, without understanding the perception of these spaces as a whole.

In this regard, it is true that this tissue brought the characteristic of "open space" as an alternative to the relation of streets and squares to relate the built environment. It is important to recognize the opportunities that this open space and its configuration provides for the renewal of this estates.

This chapter will therefore examine, in turn, the three topics that seem relevant to discussing these issues. First, urban regeneration, in order to understand why these processes occur and what their objectives are. Next, it examines mass housing estates as an urban typology, in order to understand their emergence and early development, as well as their current situation. Finally, the most appropriate metrics for understanding the evolution of the spatial configuration of these estates will be explored in order to construct a set of indicators that will allow us to analyse the case studies that follow.

2.1 Urban regeneration

Background

The interaction between social, demographic, economic or political trends at local and global level causes a constant evolution in the urban environments in which they take shape, and it is precisely the management of conflicts that determines the capacity of these conflicts to deploy or not improvements at the urban level[12]. These processes have resulted in two major types of intervention on the territory, on the one hand the expansion of urban areas and, on the other hand, intervention in existing areas, in order to adapt urban environments to these driving forces.

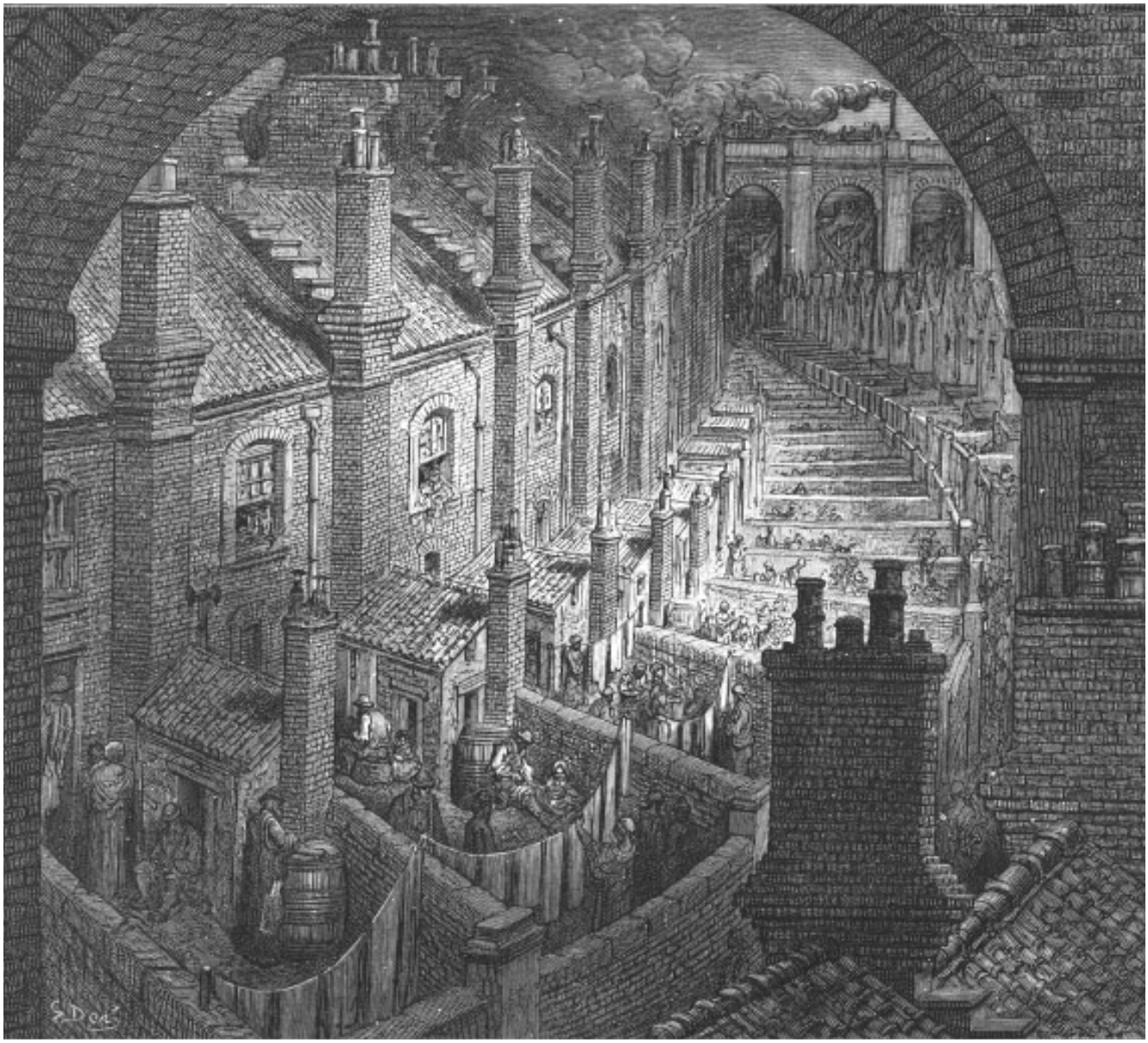
Particularly at the beginning of the 19th century, due to the social and political trends in Europe, as well as the physical conditions triggered by the emergence of the industrial city, characterised by an increase in density in city centres, a series of urban renewal policies began to appear. Despite the diversity of problems to which these policies proposed to respond, they had in common the need to provide an adequate housing environment, as well as the general improvement of health and the relationship with the natural environment[13].

These needs were, however, the great driving force behind suburban development in the 19th century. From the expansion of the Ensanche model, whose greatest representative at this time was undoubtedly Idelfons Cerdà with the Ensanche de Barcelona (1860) to models of medium and low-density suburban expansion, such as the linear city proposals of Arturo Soria (1885) or the garden city of Ebenezer Howard (1898), the responsibility for presenting viable solutions to the situation of urban centres was placed on the expansion of the city.

Figure 5. The situation in the XIX Century in the centre of the cities, illustrated in: Over London - By rail. Gustave Doré. Provided by The British Library

12. In the city, remote forces and influences intermingle with the local: their conflicts are no less significant than their harmonies' Mumford, The Culture of Cities.

13. Roberts, Sykes, and Granger, Urban Regeneration.



It is then that the transformation of city centres became subject to the political and social trends of the moment, as can be seen in the Napoleonic renovation of Paris in the mid-19th century, or the obsolescence of a series of spaces, such as the city walls, which led to interventions such as the Ringstrasse in Vienna. However, the massive use of this model leads to a series of attempts to, on one hand, limit the expansion of the city (with the green belt movement for example) and the redevelopment of the existing urban areas.

The arrival of the twentieth century, the new ideologies and, especially after the Second World War, the focus of interventions in the built environment was drastically shifted towards the reconstruction of an Europe that was, on the one hand, devastated and, on the other, with a whole series of new social and demographic dynamics to which it had to respond. Then, following the Anglo-Saxon movement showed in the Victorian era, a series of interventions lead to the demolish and posterior rebuild of huge areas of the core of the city, with the main hypothesis that these new buildings would provide with new functions and would be more suitable with the new infrastructure developments[14].

As can be seen in table 1, it is then that in the first two decades the interventions took advantage of the situation of destruction to replace the fabrics with those considered more modern, focusing on cleaning up the housing slums and replacing them with new building typologies: the mass housing estates.

Period	1950s	1960s	1970s
Policy Type	Reconstruction	Revitalisation	Renewal
Major strategy and orientation	Reconstruction and extension of older areas of towns and cities often based on a 'masterplan'; suburban growth.	Continuation of 1950s theme; suburban and peripheral growth; some early attempts at rehabilitation.	Focus on in situ renewal and neighbourhood schemes; still development at periphery
Spatial level of activity	Emphasis on local and site levels	Regional level of activity emerged	Regional and local levels initially; later more local emphasis
Physical emphasis	Replacement of inner areas and peripheral development	Some continuation from 1950s with parallel rehabilitation of existing areas	More extensive renewal of older urban areas

But then, the continuous depletion of resources, the displacement of residents and the urbanisation of the periphery provoked a series of demands on a social level and on the value of the built environment both as heritage and as a social space, which generated a series of adjustments in regeneration policies, which tried to respond to the growing social discontent with these policies.

This social awareness and the development of practices like the renewal of the Bologna urban centre led to the sign of the declaration of Amsterdam, in the Congress on the European Architectural Heritage of October, 1975 were, among others, there were some statements signed in order to ensure the protection of these older areas:

> *"(…) f. The rehabilitation of old areas should be conceived and carried out in such a way as to ensure that, where possible, this does not necessitate a major change in the social composition of the residents, all sections of society should share in the benefits of restoration financed by public funds."* [15]

Table 1. [down] Evolution of Urban Regeneration. Based on table 2.1 in Roberts, Sykes, and Granger, Urban Regeneration.

Period	1980s	1990s	2000s
Policy Type	Redevelopment	Regeneration	Regeneration in recession
Major strategy and orientation	Many major schemes of development and redevelopment; flagship projects; out of town projects	A more comprehensive form of policy and practice; emphasis on integrated policy and interventions.	Restrictions on all activities with some easing in areas of growth
Spatial level of activity	In early 1980s focus on site; later emphasis on local level	Reintroduction of strategic perspective; growth of regional activity and interventions.	More localist initially with developing sub-regional activity
Physical emphasis	Major schemes of replacement and new development; 'flagship schemes'	Initially more modest than 1980s and then increasing scale; heritage emphasised	Generally smaller scale schemes, but larger projects returning

14. Gregorio Hurtado, "Políticas urbanas de la Unión Europea desde la perspectiva de la planificación colaborativa."

15. "The Declaration of Amsterdam - 1975 - International Council on Monuments and Sites."

Furthermore, the 80s and 90s along Europe bring huge social changes: the aging of the population of the cities, the rise in the social diversity of their inhabitants conduct to the development of new social conflicts, which some of the occidental European countries respond with the development of a series of urban policies, that conduct to the establishment of National Regeneration Urban Policies[16].

Dissatisfaction, however, with the new fabrics that had been rapidly erected to serve the new demographic needs of the mid-century led these regeneration policies to focus on the periphery, where social problems began to concentrate, and to establish a whole series of policies that followed the same "bulldozer" model. This strategy, as with the interventions in the city centres, provoked a high level of social discontent and led to a reduction in "hard" interventions, replacing them with a series of strategies that were more focused on both social and economic aspects.

Then a last shift has happened along Europe that, with the development of the different urban policies, ends with the development of the Urban Agenda for the European Union introduced by the Pact of Amsterdam which, signed in 2016, place the urban environment in the core of the future sustainable development. In doing so, it considers urban regeneration as a tool that need to address the urban challenges in a holistic and integrated approach:

> *"(…) Urban regeneration, including social, economic, environmental, spatial and cultural aspects, also linked to the brownfield redevelopment with the objective of limiting greenfield consumption."*[17]

16. Jacquier, "politiques integrees de developpement urbain durable et gouvernance urbaine en europe : quelles relations mutuelles ?"

17. SERRENHO, "Pact of Amsterdam – The Urban Agenda for the EU."

Togards a definition for urban regeneration

Although the focus of the urban regeneration processes is constantly evolving and placing the focus points on different themes, answering to the social and political requirements, (Roberts, Sykes, and Granger 2017) defines it as:

> *"A comprehensive and integrated vision and action which seeks to resolve urban problems and bring about a lasting improvement in the economic, physical, social and environmental condition of an area that has been subject to change or offers opportunities for improvement".*

Despite providing a politically correct definition, the definition in question leaves a great deal of detail unresolved. The initial definition of improvement is not sufficiently clear, which could lead to the unintended consequence of replacing existing inhabitants in some instances. This is evident in major regeneration projects across Europe. Alternatively, it could be interpreted as the development of social strategies that enhance educational attainment, the labour market, and other aspects of urban life.

Furthermore, the emphasis on changes and opportunities does not necessarily imply an integrated approach to adapting the city to the needs of its inhabitants. An integrated definition should include this as a fundamental aspect, but in the actual context, it should also include the need to implement these interventions in an efficient manner, in order to address these interventions in a context of scarcity of resources, while aiming to achieve radical improvements in the areas of intervention.

Urban regeneration strategies

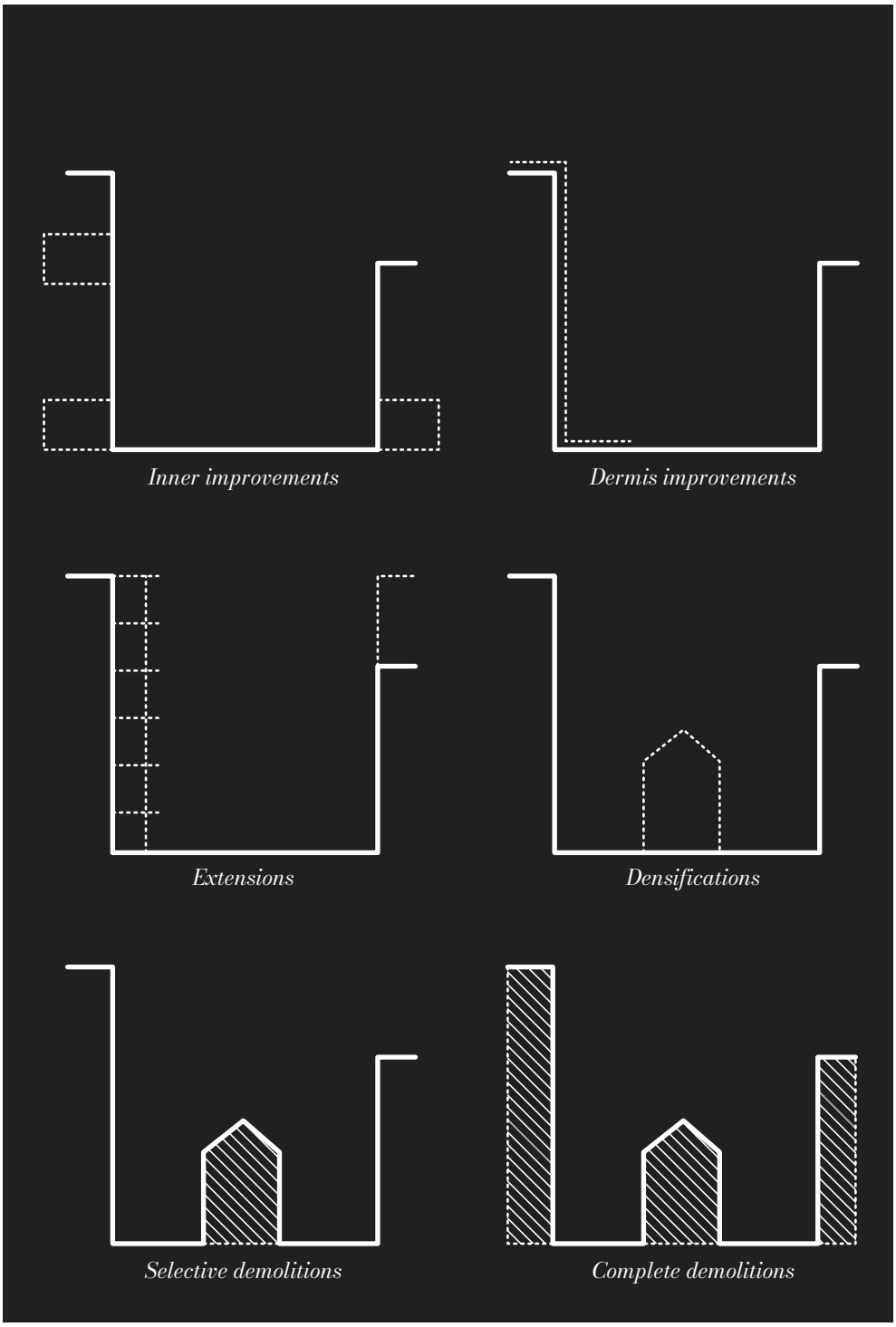
For the analysis carried out in this work, a whole series of urban regeneration strategies have been recognised which operate at various levels and which range from actions in relation to the territorial or urban integration of urban fabrics to the management of regeneration processes. However, in order to narrow down and pursue the objectives of this work, a filtering of the regeneration strategies has been carried out to establish a categorisation of those that have an impact on the physical environment of the fabrics in which they intervene. These strategies are ordered from those with a lesser impact on the spatial configuration of the tissues to those with a greater impact, in an incremental manner, i.e. the later ones can include the earlier ones:

In the first place, those strategies that act on the surface layer of the physical environment, but promote structural changes in the spatial organisation, are positioned. This category includes both energetic renovations that modify the façades of buildings and redevelopment interventions or the improvement of open space.

To continue, the strategies that increase the density of the surroundings through different actions, modifying the configuration of the built environment, are located. This series of strategies includes both those that increase density through the use of vacant spaces and those that extend existing buildings. It is in the latter that we find the actions to improve accessibility that affect the configuration of the free space with the annexation of lifts or actions to extend the building's centrelines. Also appearing here is the whole series of strategies that affect the provision of facilities and services through the incorporation of new parts in the existing fabric.

Finally, there are those strategies that modify the configuration of the built environment by either removing or replacing built parts of the fabric. This range of strategies will be divided into two parts. Firstly, those which cause the substitution of small parts of the fabric due to constructive or structural pathologies and, on the other hand, the substitution of large or small percentages of the fabric as a solution to a problem which is not architectural, but of the social, demographic, or economic situation.

Urban Regeneration Strategies



2.2 Mass housing estates

Housing estates are usually understood as a direct product of the Modern Movement and a break with the previous form of city building that has led to the creation of socially and economically disaggregated neighbourhoods. The then middle-class neighbourhoods have become, in a large number of European cities, marginal environments, far removed from the ideals with which they were developed, at least initially. This chapter will briefly describe the evolution and current state of housing estates and, through an extensive bibliographical review, will give a brief overview of their development and their consequences for the structure of open space.

Origin

The origin of housing estates can be dated back to the end of the 19th century and the beginning of the 20th century, and although their beginnings are influenced by different movements, they coincide in their spirit of responding to the degrading housing conditions that existed in city centres after the first industrial revolution. Residential congestion and poor quality of life, as well as the expansion of the use of new methods of transport made it possible to develop new ways of living, to expand cities by providing higher quality buildings, with greater access to open spaces, clean air and sunshine to ensure the health of their inhabitants[18].

It was after the Second World War, however, that the expansion of housing estates as a building typology spread throughout Europe on a massive scale and, in order to understand this typology, it is first necessary to understand the models that were proposed to resolve the crisis of the post-industrial city, or the "eighteenth-century" city. While there are a wide range of models, design strategies can be classified into two main groups: the garden city model and the concentrated city model.

The garden city model, understood as the heir to Howard's ideas, is understood as a model of expansion and diffusion of the city, of reduced densities and based on the use of new transport models and a more direct relationship with the natural environment. This model, characterised by low-density residential typologies (mostly single-family dwellings), evolves conceptually and moves to the centre of Europe, where siedlungs appear rejecting the separation with the compact city and are defined by the incorporation of existing urban structures.

18. The functional city model of the CIAMs and the Athens Charter must be understood as a response to a diagnosis focused on the idea of congestion and unhealthiness that characterised the urban fabrics of the time. Faced with this diagnosis, which denounced the failure of the traditional city, the response was committed to the design of the open city: an alternative model of healthy, sunny and egalitarian cities". García Perez et al., "Regeneración urbana de polígonos de vivienda masiva. Criterios para la evaluación y diagnóstico de la calidad de los espacios libres."

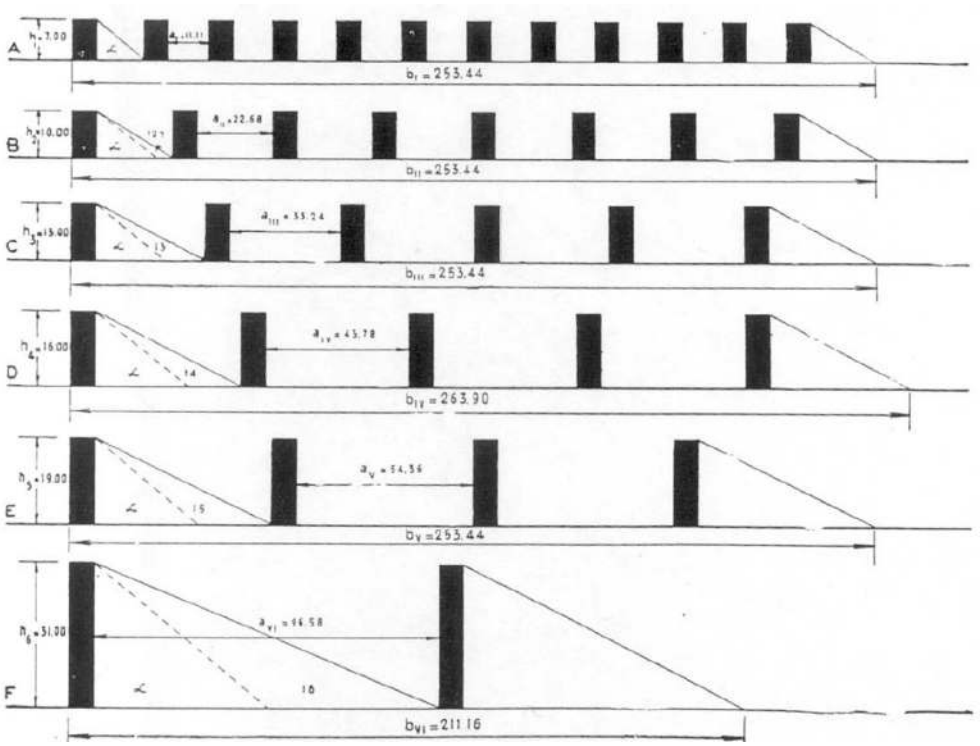


Figure 6. [left] *Diagrams illustrating the Development of a Rectangular Building-Site with Parallel Rows of Tenement-Blocks of Different Heights*
Source: Gropius et al., The New Architecture and the Bauhaus.

Figure 7. [right] Buildings classified by age of construction.
Source: EU housing stock observatory.

19. Martí Arís and Alegre, Las Formas de la residencia en la ciudad moderna.

20. Castex, Formes urbaines.

21. Kempen et al., "Restructuring Large Housing Estates in Europe."

22. Aernouts, Maranghi, and Ryckewaert, "The Regeneration of Large-Scale Social Housing Estates. Spatial, Territorial, Institutional and Planning Dimensions."

Meanwhile, the concentrated city is understood as that which, while establishing new relations with the existing city, understands it in continuity. As Martí Arís[19] explains, two paradigmatic proposals that explain this model are, on the one hand, Le Corbusier's contemporary city of 3 million inhabitants, and Ludwing Hilberseimer's Vertical City. In these, the industrial city appears but purified of the negative consequences of uncontrolled development, roads, uses, etc. are ordered. But in direct response to the existing city. In short, both are models that try to rationalise the way of living by establishing new relationships between the building and the open space.

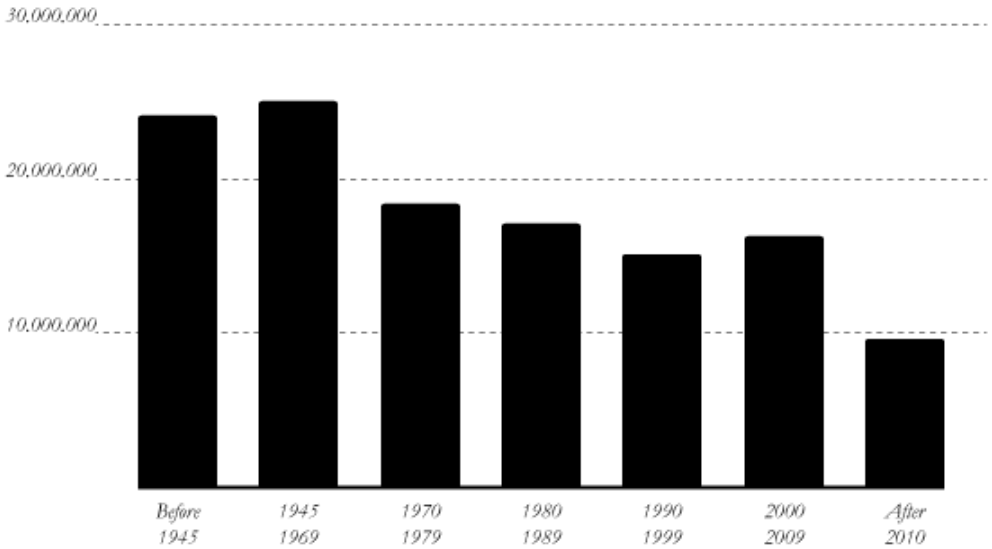
This rationalisation is accompanied by a typological exploration from which we can extract a new paradigm represented by the linear form or the building in line. This linear form is synchronised with the new models of the city thanks to the absence of hierarchy implied by its configuration, becoming one of the fundamental models.

The conjunction of in-line building and the new models of city expansion evolve conceptually, approaching a single model. The siedlung evolves with the use of the linear form and, after Walter Gropius' lecture "Low, medium or high building?", an intermediate model is consolidated, with linear high-rise building, following the relationship with the free space of the garden city but with the incorporation of the structures and densities of the compact city.

Expansion

Although it is already in the inter-war period that mass housing estates are presented as the technical tool for the expansion of the city that accompanies economic prosperity and technical advances[20], it is after the Second World War that the expansion in the use of these models becomes evident. Their conceptual relationship with assembly lines and the speed of their construction made them one of the main responses to the necessary reconstruction of Europe to replace the parts of the cities that had been destroyed, and especially to respond to the subsequent demand for housing resulting from the extensive natural growth of the population[21].

This situation, coupled with migratory movements, both internal and external, throughout Europe, necessitated an accelerated expansion of the residential stock in the cities. This, on the one hand, could not have been done without the support of central governments, which developed a series of national housing policies that chose this typology as the main one, conceptually resembling social housing with the linear high-rise typology[22].



Beyond the moment directly after the Second World War, Turkington et al.[23] have identified the high rise solution as the primary solution to housing problems in the early second half of the 20th century for a variety of reasons: from technological development to the reliance on modern architecture as a tool to promote a more just and egalitarian society, including the need to reduce urban sprawl and increase density in cities, protecting the productive rural environment from mass development.

Either way, the major development of the mass housing estates happened after the second World War, at first being part of the reconstruction efforts to replace the damaged or destroyed dwellings, but it was especially relevant as it provide with a solution for the demand of housing that happened in the posterior years of natural growth of the population.Already in the between war period, the mass housing estates present themselves as the material resolution for the economic prosperity and the advanced technical possibilities that allow for the development of a huge amount of social housing.

They seem to share some characteristics, which have been influenced by a generation of pre-war modernists that range from Le-Corbusier to Max Taut and can be observed, among others, in the statements develop by the CIAM, like the use of multi-storeys buildings:

> *"(…) high structures were a form of habitation more responsive to the individual and collective needs of men. The utilization of the third dimension to liberate generous areas of ground presents many (…)"*[24]

Furthermore, they seem to have more similar features: they are planned developments and not the result of the natural expansion of an historical city, they are not located in rural areas, but on mostly urban peripheral spaces. They also look similar in appearance, which is a consequence and logic after the first feature and the short building period in which they were used to be developed. They are also similar in the sense that they are mostly focused on residential functions, providing with dwellings and basic facilities, lacking productive or economical activities[25].

Despite this values, that follow the principles of Modernism, they were an answer that aims at constructing a new and egalitarian society by providing high quality housing and drastically better environmental conditions to the working class[26].

23. Turkington, van Kempen, and Wassenberg, "High-Rise Housing in Europe."

24. Corbusier and Eardley, The Athens Charter.

25. Wassenberg, "Housing Estates."

26. Turkington, van Kempen, and Wassenberg, "High-Rise Housing in Europe."

Definition

As mentioned above, the influences on the development of what we now know as housing estates are wide and diverse, which, applied in each particular context and under particular influences, has resulted in a wide heterogeneity in their design, as will be observed in the following case studies. For this reason, it is necessary to establish a definition of what a housing estate is and how it is defined.

To this end, we will start with the definition proposed by Turkington, van Kempen, and Wassenberg[26] who state that, despite the differences between different contexts, they can be defined as distinct and discrete geographic housing areas which are dominated by residential blocks of five storeys or more. To this definition, for the purposes of this paper, certain nuances will be added. Firstly, that their first construction took place between 1950 and 1980, in order to observe conceptually already developed examples of this typology. On the other hand, they will be defined as those spaces with a proportion of free space greater than 50%. Finally, the location with respect to the compact city will be added to the definition: housing estates emerge on the periphery of cities, both because of the need to find large modifiable spaces and to find land at a lower price.

In summary, housing estates could be defined, according to the needs of this work, as those residential areas that, once built on the periphery of the consolidated city, are characterised by being made up of residential blocks with a height of more than five storeys and by being configured with a large area of open space.

Decay process

Figure 8. *The second, widely televised demolitions of a Pruitt-Iggoe buildings that followed the March 16th demolition.* April 1972. Source: U.S. Department of Housing and Urban Development.

Once the origin and characteristics that made it the development model of choice have been understood, it is necessary to understand the reasons for its decline and, today, housing estates, in much of Europe, represent some of the most decadent areas of cities.

The decline of housing estates as a model is first determined by a series of theoretical criticisms that see the indiscriminate expansion of this model as a mistake that is not capable of supplying urban functions such as the compact city, where ideas of repetition prevent the development of urban facts as in a traditional city.

This is reinforced by a series of events, such as the demolition of Pruitt-Igoe in 1976, which were used to blame the physical configuration of these spaces for the social decay in which they sometimes found themselves.

The reality is that, although conceptually this model was based on egalitarian ideas, as opposed to the previous bourgeois style, as the housing market became less congested, it became clear that the housing stock in the mass housing estates did not meet the individual preferences of the population, who, with a more relaxed housing market and an increasingly developed mobility infrastructure, developed and diversified demand.

This process, together with the evolution of housing estates in each particular urban fabric, has led to the development of a series of problems that appear to be common. Firstly, their disconnection from the urban fabric is due to the decision to promote the development of these residential areas on the outskirts of the city, which, in the case of a limited expansion of the city, has led to the isolation of the housing estates.

They are also born in a complex situation, being mostly mono-functional, which has made it more difficult for shops and services to thrive in these environments. In summary, the processes in which these areas are framed develop a series of common problems[27]:

I. Physical decay. Because of shoddy construction work, rapid attrition, and dereliction, as the quickly decrease in the quality of the open spaces, that has triggered a series of insecurity problems, with visible anti-social behaviour.

II. Concentration of households with low incomes. Due to the low demand and abandonment of dwellings, among others, like the increasing unemployment taking place along Europe.

III. High turnover leading to partial breakdown of social cohesion and reduced resident activity, with social and racial tensions that lead to conflicts and the deterioration of the local services.

Regeneration processes

These characteristics have caused them to become the focus of different urban renewal or regeneration policies, ranging from intervention actions in the physical environment, with demolitions and subsequent reconstruction, constructive updates and rehabilitation of pathologies, to a series of comprehensive actions that seek not only to act on the physical environment, but to understand it as an opportunity to act socially and economically in the neighbourhood.

However, it is in the open space that regeneration projects have been least successful, failing to recognise the structure and opportunities it represents[28]. How to approach and what expectations to give to the regeneration of these spaces is a debate that has generated some literature in which two lines can be distinguished. The first, which supports that the manipulation of the physical environment provokes a direct reaction in social behaviours, supported by a series of literature on recommendations on urban safety, etc.

This, together with the difficulty of providing functional complexity and a greater diversity of uses due to the rigidity of the typology, means that these processes are still under experimentation and, after a first round of regeneration at the end of the 20th and 21st centuries, very heterogeneous results have been obtained. What is clear is that, as Solà-Morales[29] would say:

"the recuperative or redeeming attitudes of the peripheries are not, in any case, a starting point from which a serious peripheral project can begin".

27. Kempen et al. Kempen, Ronald, Karien Dekker, Stephen Hall, and Iván Tosics. 2007. "Restructuring Large Housing Estates in Europe," January.

28. García-Pérez, Monclús, and Medina, "Intervention Follows Diagnosis."

29. Solà-Morales, De cosas urbanas.

2.3 Learning to measure space

Measurements in architecture have traditionally been the critical element that relates built elements to the human body. Pythagoras said that 'the human body is the measure of all things', even elevating the scale and proportion of the human body to the world of the divine[30]. Measuring space in relation to the human body was the method of elevating architecture to the representation of the divine.

In the course of history, these abstractions were displaced in their conceptual basis: the human body was no longer a representation of the divine, but a physical object, which reduced it to geometric forms and proportions: scale, geometry, etc. These were translated into a technical conception of architecture. These are translated into a technical conception of the dimensions of space, into a geometrization of lived "space".

At this point, architecture begins to behave as a technical discipline in which the characteristics of space must be measurable and therefore standardised.

This method of observing architecture as the sum and measure of the different objects of which it is composed. From the second half of the 20th century onwards, however, there was a recovery of the understanding of architecture not as the sum of the physical objects, but of the spaces they generate, experienced by the human body, since it is the human body that, moving and occupying the space between the physical objects, gives it value and meaning[31].

However, the problem of measurement remains: how do we define space? The problem is, Hillier would say, that it is easier to talk about the consequences of space than about space itself. In his work, Hillier tries to define space as a series of relationships, configured in ways that can influence, or be influenced by, social processes[32]. He does this by developing a system of recognisable signs and symbols, a language to define (and delimit) the different configurations of space.

Figure 9. *The Modulor in La Unitè d'habitació, Marseille*. Source: author.

30. Vidler, The Architectural Uncanny: Essays in the Modern Unhomely.

31. "What, then, occupies space? A body -not bodies in general, nor corporeality, but a specific body, a body capable of indicating direction by a gesture, of defining rotation by turning round, of demarcating and orienting space" Lefebvre, The Production of Space.

32. "Our initial aim has been to show how order in space originates in social life, and therefore to pinpoint the ways in which society already pervades those patterns of space that need to be described and analysed" Hillier, The Social Logic of Space.

The analysis of urban fabrics is always approached in a way that integrates a broad range of knowledge from different areas. Even when we are discussing urban form, we must begin with a formal logic and logical-mathematical structures, as described by Lefebvre. These structures enable us to understand urban form as the simultaneity of events, perceptions, and elements of a whole in the real.[33]

However, the central theme of this thesis is to understand the physical dimension of these fabrics and the spatial logics that encompass them. This will enable an evaluation of the relationship between architecture and the city as the physical elements in which space is produced. While this analysis does not exclude social, cultural or economic determinants, it aims to add value to them. The built environment is the physical reality, the superficial layer of a complex reality, which enables the establishment of a concrete point of view on which to base an objective and critical analysis and to establish a concrete point on which to verify the analysis of urban fabrics.[34]

This morphological analysis has been conducted using a variety of approaches, particularly since the second half of the 20th century. These approaches have primarily focused on the study of the different elements of the urban fabric and their classification for subsequent analysis[35]. What these series of analyses have in common is the study of the relationship between the different elements that make up the fragments of the city under study. This establishes the importance of form, function, etc. Nevertheless, on a few occasions, these analytical approaches have coincided with the spatial perception of the urban environment. But if we take into account that, according to Lefebvre, who posited that it is the body that occupies space as it is capable of indicating direction, rotating, delimiting and orienting space[36].

The analysis on the perception of the spaces, as the relation between the observer an its environment should be added to understand and categorize the different open spaces within the city.

33. As described in Lefebvre, El derecho a la ciudad.

34. Rossi, La Arquitectura de la ciudad.

35. For example by the methodology developed by Saverio Muratori: "inductiva y basada en la observación, descripción, comparación, evolución y clasificación, para comprender y radiografiar la ciudad como tal y descubrir su estructura más profunda" in Clua, "La Condición Intersticial En Los Proyectos de Articulación Urbana : Del Slussen al Estocolmo de Tage William-Olsson En Cuatro Tiempos."

36. Lefebvre, The Production of Space.

37. Fraga, "From the 'city of blocks' to the recovery of the urban block."

38. Solà-Morales, De cosas urbanas.

From the outset, the morpho-typological analysis of urban fabrics has been accompanied by a critique of the urbanism espoused by the Modern Movement and its vision of a "city made out of blocks". This critique has led to calls for the recovery of the traditional way of constructing the city or, at least, the retention of certain elements of them[37] .A critical evaluation will also be conducted on the implementation of traditional elements such as streets and blocks, as well as the emergence of new "peripheral spaces," which Solà-Morales defines as a "sequence of aggrupation" constructed by "induction and dialogue," and regulated by the law of inner distances.[38]

This work will then propose the integration of different methodologies of morpho-typological analysis at the outset, with the objective of obtaining fundamental elements with which to comprehend the studied fabrics. This will be followed by a series of analyses based on the visual perception of the open space. The final objective of the work is to obtain the necessary information to understand whether the evolution of housing estates is the one sought with the consequent urban regeneration projects. This will enable the morpho-typological analysis of these spaces to be brought closer to their integration in the perceived space and, by doing so, provide with a toolbox on how to evaluate the physical reality of the regeneration projects.

geometry

Ground coverage

The initial analysis will concentrate on the most traditional analytical object for the identification of open spaces, as well as for the definition of their limits and their general form: the buildings. This section will then focus on the direct relationship between the buildings and the void they form, a relationship that will be dissected in two approaches, qualitatively and quantitatively.

Firstly, we will analyse the percentage of the land of the studied fabric occupied by buildings. This will provide us with an initial indication of the fabric's compactness, given that there appears to be a consensus that the low compactness of housing estates is one of the reasons for their obsolescence.[39] The benefits of a compact urban form have been the subject of much debate, but it seems clear that the evolution of the fabrics under consideration will be positive when their compactness increases.

Secondly, not only will the quantitative evolution of compactness be analysed, but also the qualitative relationship between the voids generated by changes in compactness. The diagrams will analyse how the location and orientation of the buildings have modified the structure of the open spaces. However, the evaluation of these terms will be carried out in later sections, in which the visual perception of these spaces will also be taken into account.

In order to carry out this analysis, a series of background-figure cartographies will be generated that will allow us to understand as clearly as possible the way in which the different elements of the urban environment studied are structured, as well as to give some initial comments on the evolution of their hierarchy, both of the built elements and of the free space and, like Collin Rowe[40], to find the objets trouvés, the main elements of the urban collage.

Figure 10. Extract of the Noli Map. Source: Interactive Noli Map Website

39. García-Pérez et al., "UR-Hesp."

40. Rowe, Ciudad collage.


PIAZZA
NAVONA
PANTEON
MONTE CITORIO
Piaz Colonna
PIAZZA DI PIETRA
S. Ignazio
MINERVA
COLLEGIO ROMANO
Palazzo Panfilj
Pal. di Venezia
S. Marco
S. Carlo
S. Andrea
S. Marcello

Critical distances

Repetition has been a fundamental design principle in the creation of housing estates. The concepts of unlimited urbanisation and geometric concatenation have emerged from the development of certain architectural typologies that establish a separation from their immediate urban surroundings and prescribe a minimum distance to ensure the correct functioning of the urban fabric. This distance has resulted in the creation of empty spaces where conflicts are simplified and the creation of the unexpected is prevented. Nevertheless, this distance has resulted in the creation of empty spaces, where conflicts are simplified and the creation of the unexpected is prevented[41].

As Solà-Morales posits, this distance can be divided into two distinct aspects: the distance between streets and buildings and the distance between buildings themselves; and the distance between neighbourhoods and motorways and the distance between different neighbourhoods. In this section, we will examine the relationship between buildings and empty spaces, focusing on the former since the latter is addressed in the urban integration section, which examines the relationship between the fabrics and their surrounding environment. With regard to the first section, it is necessary to understand that the traditional nature of space lies precisely in the diversity and concatenation of distances[42].

Consequently, it is necessary to explore whether there is a maximum distance – as opposed to the minimum distances found in these fabrics – for these empty spaces to improve their functionality. In order to achieve this, it is proposed that two concepts be cumulatively explored: continuity and contiguity. This will allow us to understand the alienation of buildings from the public realm through their geometry (their spatial promiscuity) and to understand how these distances facilitate the linking of a series of urban elements.

Figure 11. [up]. Note the repetition of buildings and the large voids that characterised the Empalot fabric on its origin [1952] Source: Conseil départemental de la Haute-Garonne

41. As noted in the essay about Alexanderpolder and the interesting distances in (Solà-Morales 2008).

42. Following the concepts develop in Galindo González and Moro Domingo, "Distancias críticas. Crecimiento residencial contemporáneo en ciudades medias españolas.".

In contrast to these fabrics, the historic centres, characterised by a more organic appearance, exemplify how urbanity is represented by the superposition of uses and activities, the lack of formal sectorisation and the concatenation of a high diversity of voids, which ensures a capillary urbanity through streets, corners and different spaces that are in tension with each other and which, furthermore, are in contiguity and at short distances, allowing for the multiplicity of links. It is crucial to recognise these open spaces as public spaces and, as such, they must exhibit the defining characteristics of urbanity, including the capacity to facilitate the encounter of the unexpected.

It appears that urban regeneration projects are increasingly adopting a model that involves strategies of densification or modification of the fabric's grain. In order to gain a better understanding of the impact of such projects, it is necessary to study the distances that characterise the free spaces of the fabric in its original state and after the regeneration project has been completed.

In order to quantify the evolution of the distance in the different tissues, an analysis will be applied which results will be divided into three parts, which will characterise and qualify the aforementioned evolution. Firstly, the basic structure of the tissue, as previously explained in sections, will be used and different points will be extracted from it. Firstly, the vertexes, which represent the variety of meeting spaces, and secondly, the midpoints of each segment of the structure, which allow us to understand the relationship of continuity of these axes with the existing buildings.

Once all the points have been extracted, the distance between the points and the nearest building perpendicularly is calculated. This will permit an understanding of the key evolution of two aspects: the average of this distance, which will speak to these densification strategies, the grain, etc.; and the standard deviation of these distances, which will represent whether the different projects have increased diversity within the fabric. Although in this case the relationship between the distance calculated and the height would also be an interesting value, in order to simplify the calculation and to maintain a methodology based on two dimensions, height is excluded from this metric and, from this point onwards, densification processes will be understood in this work as those that increase the land occupation of the fabric.

Finally, with this distance, which has permitted a comprehensive examination of the fabric, a graph will be constructed, in which circles will be drawn with their centres at the various points and whose radius are equal to the distances calculated at each of the points. This will enable us to comprehend the interrelationship between the two values and will serve as a framework for analysing the evolution of the fabric's structure in terms of the contiguity of the free spaces.

Urban Grain

Continuing with the previous analysis, and in a similar way, the urban grain will be analysed. This becomes a fundamental tool for understanding the relationship between the built elements and the basic characteristics of the fabric as a function of them[43].

The definition of the grain, its size, is essential to determine the quality of an urban environment and has been related both to its social capacity and its capacity to promote habitable environments. . While in the traditional compact city fabrics this coincides with the blocks, the rupture of the alignment of the buildings with the roads typical of these fabrics makes it necessary to incorporate a methodology for analysing this grain.

What seems clear is that it becomes a fundamental indicator to understand the porosity of the fabric, since the smaller the size, the greater the possible connections within the same fabric. Observations have also been made on the importance of taking into account the diversity of the urban grain as an indicator of urban diversity, considering this as a positive element in an urban fabric, which allows the insertion of diverse typologies and thus multiplies the capacity of the environment to accommodate different activities[44].

To carry out this analysis, the same "skeleton" of the previous analysis has been used, but, since the focus is placed on the surface of which the building is the element of greatest weight, the polygons are represented and a colour gradient will indicate the surfaces of the same. The use of this gradient will allow, in a visual way, to understand the distribution of the grain and its diversity, since the greater the diversity of colour, the greater the diversity of grain and, therefore, the greater the urban diversity.

43. "A building cannot be a human building unless it is a complex of still smaller buildings or smaller parts which manifest its own internal social facts " Alexander, A Pattern Language: Towns, Buildings, Construction.

44. Bentley et al., Responsive Environments.

perception

Urban integration

Some of the definitions of the mass housing estates (chapter 2.1.1 of this document) lay out the importance of the location and the interaction of the fabrics regarding their urban and natural context. Most of them were built in the outskirts of the city due to different reasons: economical, as the land were cheaper on these places, ideological, which range from the relation between the city and the nature to the will of developing autonomous units[45] and were facilitated by the development of large mobility infrastructures. In some cases, where the expansion of the urban environment has not solve some of the previous topics, this peripherical nature has led to a severe isolation from their metropolitan and urban context, whose effects, as García-Pérez et al. mentions, have been extensively studied following different approaches, from the architectural determinism to the social aspects. In the studies cited in the paper, it is clear that the more integrated an urban fabric is, the better their conditions will be in social and economical terms.

It is also important to consider the physical conditions of the area, as the new developments require a functional connection with the traditional city in order to develop their own urban functions properly. In most cases, the connection is made through large, empty spaces, such as avenues without activity or huge green spaces. In the majority of cases, the connection is established through expansive, unoccupied spaces, such as avenues devoid of activity or expansive green areas. It is therefore necessary to assess whether urban regeneration projects have contributed to a reduction in the distance that provokes isolation, thereby improving the physical, social and economic conditions of the area.

In order to evaluate the integration of the different estates, this research is going to put the focus majorly on two scales that are related to the two reasons of the isolation of these estates. Firstly, the metropolitan context will be analysed, in order to understand the evolution of their locations in regard the metropolitan contexts. In a second place, the local scale will be studied, in order to understand how the physical environment, both the buildings dispositions and the infrastructure locations, improve or decrease the permeability within their direct urban and natural context.

45. García-Pérez et al., "UR-Hesp."

46. Borgatti and Everett, "Models of Core/Periphery Structures."

47. Hillier, "Centrality as a Process: Accounting for Attraction Inequalities in Deformed Grids."

48. Christaller, Central Places in Southern Germany.

49. Hillier, The Social Logic of Space; Hillier, "Centrality as a Process: Accounting for Attraction Inequalities in Deformed Grids."

50. Developed by KTH School of Architecture, Chalmers School ofArchitecture (SMoG) and Spacescape AB. Alexander Ståhle, Lars Marcus, Daniel Koch, Martin Fitger, Ann Legeby, Gianna Stavroulaki, Meta Berghauser Pont, Anders Karlström, Pablo Miranda Carranza,Tobias Nordström.

51. Stavroulaki et al., "PST (Place Syntax Tool) Documentation v3.2.4-3.2.5_20230110."

Metropolitan context

The relation between the cities and their peripheral spaces are complex and lot of studies have been developed and focused on this topic. Despite there are different definitions of what periphery means [46], in this work the understanding will be that the peripheral spaces are those located further to the centre than other spaces. And by centre the meaning is not only related to the historical core of the cities, but to understand the hierarchy of centres and subcentres that appears through the city while it growth, which are defined by the spatial factors that play a critical role in their development [47] [48].

The measure of this situation, focused on their physical characteristics, will be realised by the approach offered by the Space Syntax methodology[49] and the tools for GIS: PST[50]. This methodology, focused on the linear networks abstracted from the spatial configuration of the city, will evaluate the degree of spatial integration, understanding by it how many turns have to be made from each line to reach all the other lines in the networks, using the shortest paths[51]. The formulation of this analysis in a metropolitan context should show the topological centre of the urban contexts, which is usually located in the historical fabrics.

However, if instead of analysing the interaction with *all the other lines in the network*, the analysis selects all the lines within a radius, the analysis will show the hierarchy of centres and sub-centres that have appeared throughout the expansion of the city. Then, for the local analysis the radius chosen will be the distance from the fabric to the historical centre of the city and, for the local analysis, the distance selected will be the average length of the fabric studied.

Furthermore, at this point it is important to note that centre in this context means the highest values of the analysis, who will be showing the more accessible spaces within a network. For a more complete analysis, it is necessary to understand that the main centralities of the cities are shaped by a combination of different variables, which, according to Torra et al.[52] are:

> *"social density and a diverse composition, an accumulation of functions with a reasonable complementarity of time, the presence of a trigger for social and productive innovation, (spatial) contiguity and (temporary) simultaneity of local and metropolitan elements, efficient accessibility by public transport and a value as a reference point for a wide range of citizens."*

But, in addition to those values, the movement economy theory also explained that the movement patterns, which are shaped by the spatial configuration of the network, are the main basis for the land use distribution choices, the local grid adaptation and the intensity of use, most of the values previously pointed. This theory does not predict the success of the centrality but it analysed the requirements of the network to develop centralities, which mainly are referred as a global position in the settlements (regarding the integration measurements) and compact and interaccesible local layout conditions[53].

This analysis will therefore focus purely on the network analysis. The interventions that have evolved the network, constructing new relationships or closing old ones, should be the ones that show more changes in this analysis, especially in the local layout, noting that the local grid conditions, mostly the size and the intersections, are key elements that allow the improvement of the analysed values.

Figure 12. [right]. Angular Integration at 20kms radious. Note how the pink colors represent the highest values and, then, how they represent the center of Paris. In black,some of the case studies that are going to be abalysed. Source: author.

52. Torra et al., "Col·lecció QUADERNS_PDU Metropolità DIRECTRIUS URBANÍSTIQUES," n.d.

53. Hillier, "Centrality as a Process: Accounting for Attraction Inequalities in Deformed Grids."


La Courneuve
Les Courtillieres
Agrocitè Gagarine

Permeability

The different regeneration policies have usually tended to deploy "internal-looking" interventions, providing an answer to the inner nature of the fabric which, in terms of physical interventions, usually means the poor housing stock, the disconnection between the urban design and the needs of their users, physical barriers, and some more develop in (Hall 1997)[54], and have lack an approach that take into account the position of the estate in the whole urban area. In order to solve this situation, the new regeneration policies are also inserting an "outward-looking" approach, which is trying to improve the position (social, economical,…) of the estates regarding the city. Therefore, in order to improve this position, in physical terms, the policies are deploying interventions that improve the permeability of the fabrics.

Furthermore, permeability is considered an important quality in urban design, as it means to which extent an environment allows a choice of routes through it. There is also a differentiation between visual and physical permeability, as the first one is related to the ability to see the routes, while the physical one refers to the ability to walk through those routes[55]. Both of them can be translated and used in order to understand the sense of security within an urban context, as more permeable, integrated urban fabrics would lead to clearest visual relations, and will enhance the use of these streets, which are key elements in the feeling of security in urban spaces[56].

Hence, in order to measure the permeability of the fabrics studied, there is a need of understand both, the physical and the visual relations that exist on the edges of the fabrics. Therefore, the first step is to define the boundaries of the fabric, before and after the urban regeneration projects, which will define the impact of the intervention in open the physical fringes of the boundary. In order to develop this analysis, first a viewshed from key spaces in the fabric will be conducted. These key points will be located first by basic online research, focused on finding the main spaces of the fabric and, secondly, selecting the topological centres of each fabric.

Figure 13. [down left]. Sequence of revelations. Source: Cullen, Concise Townscape.

54. Hall, "Regeneration Policies for Peripheral Housing Estates."

55. Carmona, Public Places, Urban Spaces.

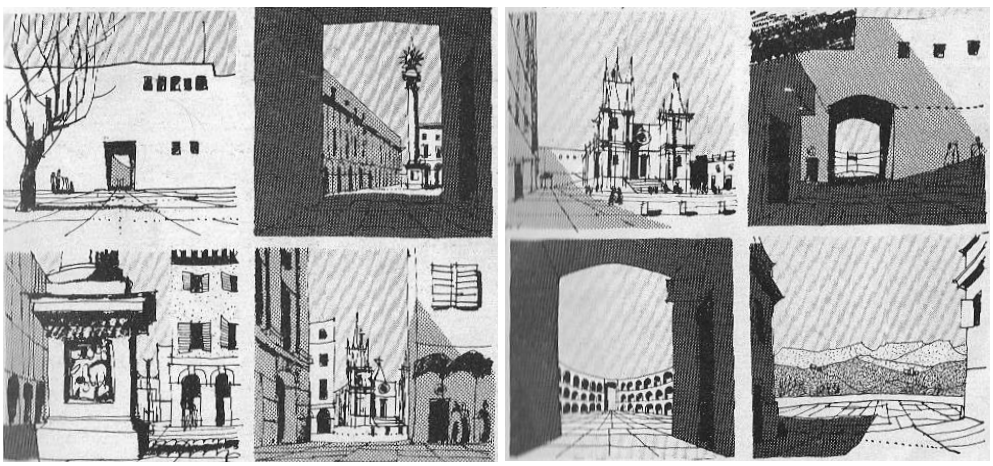
56. Gehl, Cities for People.

The resulting viewshed will be corrected then by considering the physical barriers that, despite they allow a visual relation, they don't easily allow a physical connection.

Examples of this elements would be infrastructural elements like highways, railways, natural components like a step topography, dense vegetation, etc. or lastly, special elements like big facilities, compounds, etc.

Once the boundaries are defined, the main entrances to the fabrics will also be defined. The first comparison will be the measurement of the quantity of entrances, as more entrances implies more interaction and therefore a greater permeability. Furthermore, in order to understand the visual connections, the viewshed from the main entrances will be analysed.

The focus here will be first the percentage of open space seen from the different points, as a bigger percentage would implied a more visible urban space and, in order to understand if the quantification has a meaning in the sense of security, also the composition of the hidden spaces (from the entrances) will be analysed, as the smaller the hidden space is, the better the sense of security will be.



Integration

One of the most recurrent problems in housing estates is the lack of a perception of safety. The large open spaces are combined with reduced pedestrian space and a relatively low presence, which together with the lack of maintenance and spatial appropriation have produced spaces that are positioned in the collective mentality as dangerous.

As has been observed, some of the solutions to this lack of safety have been radical to say the least, including the demolition of the most problematic environments. At other times, densification and selective removal have sought to promote greater activity and activate elements of co-presence, the passive surveillance of space.

It is precisely this latter value that this section will seek to analyse. Understanding the capacity of the spatial configuration to promote continuous presence in an amorphous environment is essential to establish a hierarchy that allows us to understand the vocation of each space. To this end, an analysis is carried out using Visual Graph Analysis (Isovist2.4), the context of which has demonstrated the relationship between spatial configuration and pedestrian movements.

The basic question in this section is then to understand whether the changes brought about by the regeneration projects have promoted the creation of spaces of co-presence or whether, on the contrary, they have reduced them. In this process, the variation of intermediate values will be looked for as positive, i.e. an increase of intermediate values will be considered positive, while an increase of negative values will be considered negative, since low values will show environments with few opportunities to promote pedestrian movement and, as has been shown in some literature[57], high values also seem to show safety problems.

57. Laouar, Mokrane, and Claramunt, "Do Urban Renewal Programs Make Suburbs Safer?"

58. Gehl, Cities for People.

59. Ching, Architecture.

60. Benedikt, "To Take Hold of Space."

61. Turner et al., "From Isovists to Visibility Graphs."

Large & visible square-like spaces

The buildings that compose the different fabrics have a direct relation with the open spaces that are framing, because of their location, orientation, etc. But also because of the quality of this spaces. Despite hierarchy in urban planning in often related to network analysis, a clear hierarchy of spaces in an urban environment is recognized as one of the qualities that urban spaces need to have in order to encourage lively environments[58].

Firstly, in order to comprehend the spaces delineated by the location and orientation of the built environment, an analysis will be conducted through the delineation of the voids left by the built environment's location. Furthermore, the hierarchy of the spaces defined by the built environment will be analysed, with the understanding that the concept of hierarchy in this context implies an understanding of the differences between the forms and elements of the different spaces, differences that induce an order of the topological and functional order that these spaces hold.

As explained by Ching[59] three characteristics can be identified that define the hierarchy of elements within an architectural composition. Firstly, the size of an element can be considered, as those that deviate from the average will be more prominent in comparison with all the other elements. Secondly, the shape of key elements can be observed, whereby those that differentiate themselves from the rest of the elements could be perceived as more important within the composition. Finally, the positioning of the element can also be a significant factor in determining its importance within the composition. If the element is placed in a way that draws the viewer's attention and is visually connected to other elements, it can become more prominent.

Therefore, in order to measure the three characteristics, the methodology develop by Benedikt[60] will allow to obtain a set of measurements of spatial properties that, on one side are related to the previous characteristics and, furthermore, seem to be related with the spatial perception of the environment[61]. So, the measurement is going to consider the open spaces, those that are not occupy by buildings, as the canvas where to develop a visibility graph analysis.

This type of analysis will be first based on the "Isovist", that Benedikt[62] described as "the set of all points visible from a given vantage point in space", and who defines a field of vision that allow to calculate a diverse range of geometrical properties[63].

Therefore, in order to understand the relationships between the different open spaces, this work will make use of the visibility analysis, which is going to provide with the morphological properties of the built environment. In the first place, in order to understand the hierarchy of open spaces through their size, it is necessary to measure the "size" of the different open spaces. This will be conducted through the analysis of the "average radial" area seen by the Isovist analysed in the fabrics. This methodology, calculated with the Isovist_App develop by McElhinney[64], would show those open spaces in the fabric which, by average, host more line of vision[65].

Practically, this will show the most compact, square-like spaces. Furthermore, as the values are represented in the same range, it will also show where are the larger compact spaces, providing with a first hierarchization of open spaces. The same analysis would help to understand the "shape" of the open spaces, relating with the second characteristic, as it is not only the size of those spaces what is calculated, but also their perceived shape.

62. Benedikt, "To Take Hold of Space."

63. Batty, "Exploring Isovist Fields."

64. McElhinney, Isovist App UserGuide V1–7.

65. Turner, "To Move through Space."

structure

Space configuration

This second part of the analysis will concentrate on elucidating the fundamental structure of free space. In the context of this work, free space can be defined as the area that is not occupied by buildings, as illustrated in the ground coverage section, and its structure can be conceived of as the minimum linear elements that define it.

This is where the notion of visibility graph analysis emerges as an extension of the network graph analysis discussed in previous sections. While the latter enables us to comprehend the interrelationships between a set of graphs, the construction of these graphs is inextricably linked to geometry. This particular analysis will investigate the construction of the graph comprising those lines that contain a greater number of compact spaces. For that, the analysis constructs a set of axial lines, which are defined as the longest line representing the maximum axial extension of any point in a straight line. An axial map would represent the least set of axial lines which pass through each convex space. The key principle of drawing an axial map is to minimise the number of lines and the angular change between any pairs of lines[66].

However, the utilisation of visibility graph analysis in this study is due to the necessity of incorporating geometrical parameters into the analysis, as an alternative to syntactic ones[67]. This approach, which attempts to describe architectural form[68] and employs a series of isovist or viewsheds to explore a range of spatial characteristics, is becoming increasingly prevalent in the analysis of open space at the urban level due to its relevance in providing detailed information on the visual perception of spaces, their integration with the surrounding environment and their hierarchy[69].

Figure 14. [down left] Axial map of G. Source: Hillier, The Social Logic of Space.

66. "Representations of Space Space Syntax – Online Training Platform."

67. Any point in the structure of space(…) can be seen to be a part of a linearly extended space (…) which represents the maximum global or axial extension of that point in a straight line. But the point is also part of a fully convex of space. Hillier, The Social Logic of Space.

68. "Set of isovists and isovists fields form an alternative description of environments. The method seems relevant to behavioural and perceptual studies in architecture (…) and spaciousness judgements. Benedikt, "To Take Hold of Space."

69. Clua, Crosas, and Parcerisa, "An Approach to Visual Interaction Analysis of Urban Spaces. Central Barcelona as a Case Study."

70. Beuf, "Centralidad y policentralidad urbanas."

71. Christaller, Central Places in Southern Germany.

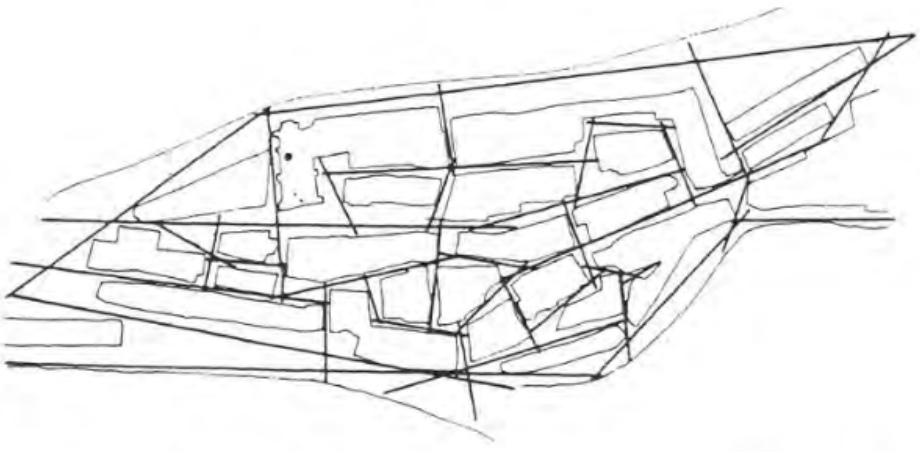
72. Torra et al., "Col·lecció QUADERNS_PDU Metropolità DIRECTRIUS URBANÍSTIQUES," n.d.

Centric corners

By now, the different approaches have helped to understand first how the tissues analysed are integrated in their environment and, secondly, the hierarchy of these spaces in relation to their physical attributes, but this order does not provide with all the conditions that define the most important open public spaces, the central spaces of the fabrics.

The studies about central spaces have a larger background, which concept was first develop by Walter Christaller in 1933 in his theory of the central places[70] where he defined the centrality as the ability of a city to provide with goods and services to the citizens of the adjacent regions[71].

This definition have been further develop through the XXth Century in order to take into account the new mobility, social and economic dynamics and, lately,is defined by Torra et al.,[72] as "areas which stand out from their environment because they are a focus of more social interaction, with a concentration of activities, movement and meaning and which generate a diffuse polarity of boundaries".



Narrowing the scale to the urban fabrics, Manuel de Solà-Morales[73] defines the corners as the spaces that provide with the better conditions for encounters, superposition and conflicts, which main characteristics range from the physical intersection to the different exchanges happening The main characteristics of these spaces is that, despite they are physical intersection, the exchanges happening on them are as important as the physical features.

Therefore, the corners are placed as the prime areas for the commercial exchanges, as they are a highly accessible space, where movement is concentrated. The concentration of corners are, Solà said, the attribute which defines urbanity. The opposite, the anti-corners, are nor only responding to their physical composition but to the diversity of their urban context:

"Anti-corners occur where there is uniformity without admixture, monotony without difference, density without interchange"

Hence, to measure the spatial conditions that make feasible the development of central spaces within an urban environment, there is a need of understanding where the corners are located.

Nevertheless, the need is not only to understand where the physical encounters are, which analysis would help to understand the structure of the fabric, but to understand where those locations where the physical conditions for a corner are present, are also places where the visual relations, and by that, the control wield by them, are

73. Solà-Morales and Fòrum Universal de les Cultures- Barcelona, Ciudades, esquinas = Cities, corners.

74. McElhinney, Isovist App UserGuide V1-7.

more present. In order to measure this control, the analysis will be developed again through a visibility graph analysis, first by understanding where the places are that control de most, understand as the locations that are able to see a higher number of other locations. To carry this out, the "overt control" field will be evaluated, which is defined by McElhinney[74] like:

> *"The visual 'linking' dominance of any location; the options each space offers for its immediate neighbours as a junction, or where movement may provide access to multiple restricted visual fields".*

In addition, in order to narrow the places, the analysis would keep through the understanding of the "choice" field, which is defined as:

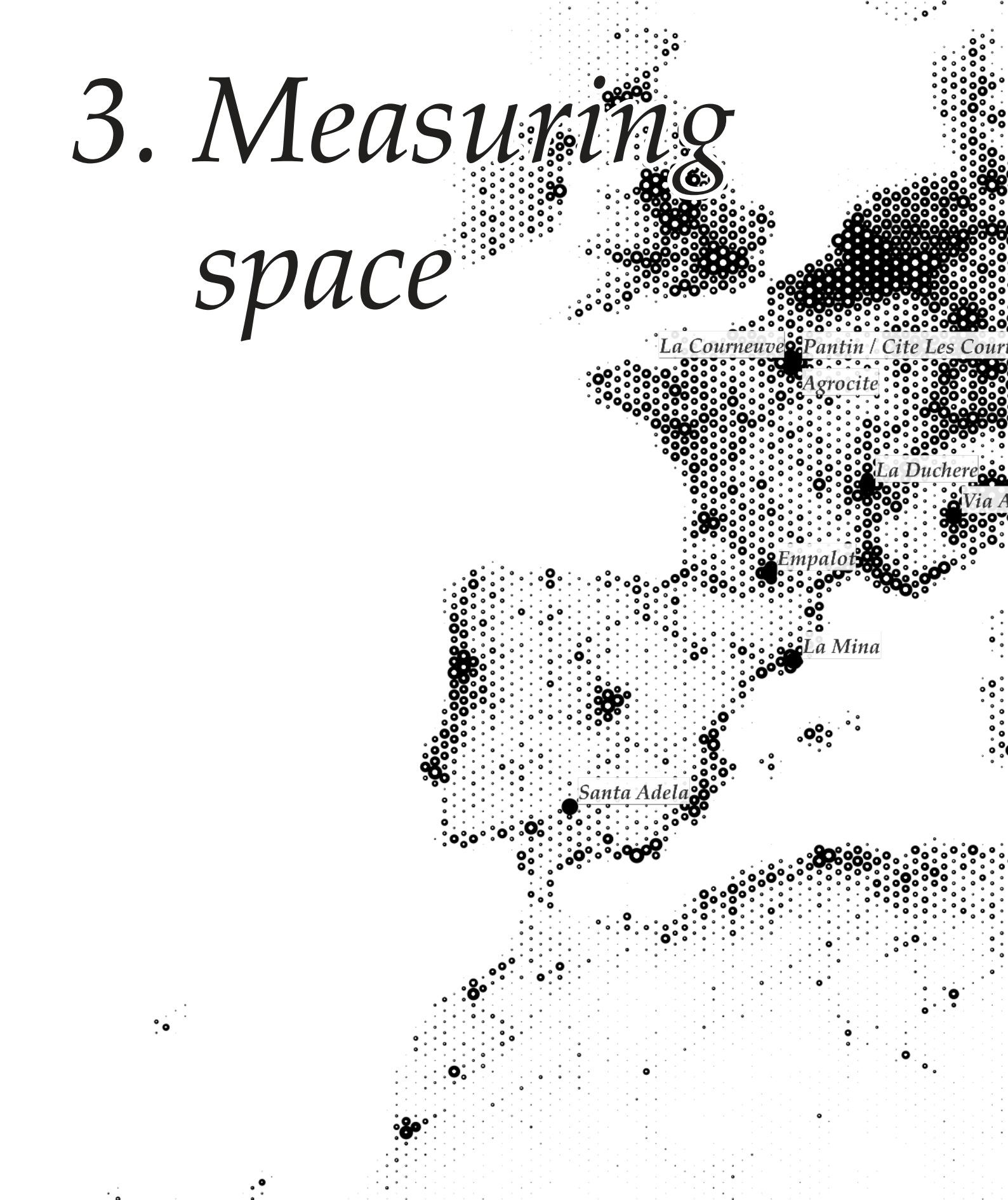
> *"How likely it is for any location to be seen on all shortest routes from all spaces to all other spaces".*

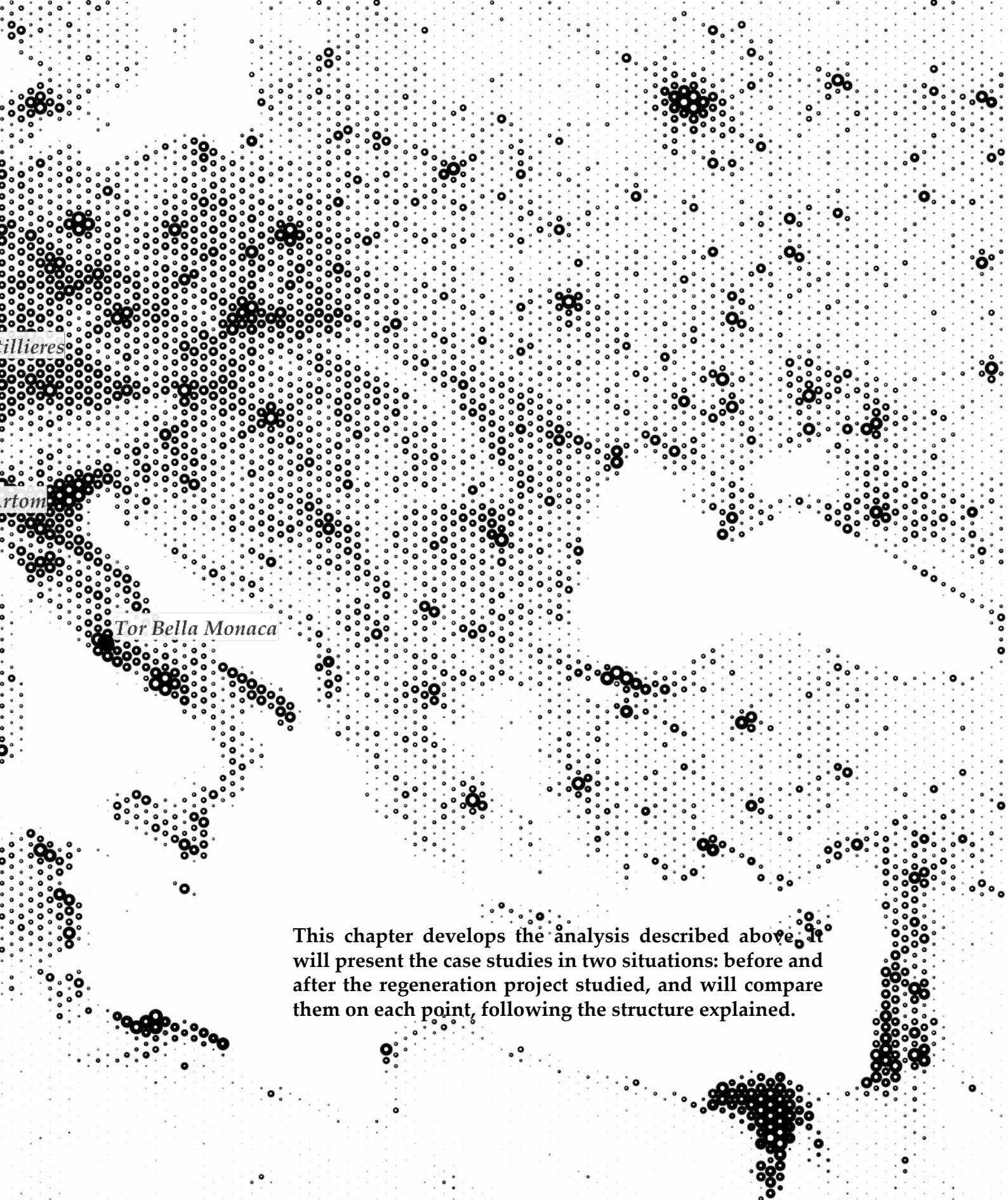
To put in another words, is going to highlight the places where is more possible for a path that is starting and ending in the analysis area to go through, which is going to be useful to classify what places control the most and have the greatest potential. This will develop another hierarchy of spaces, this time focus not only on the physical conditions, but on the perceived and potential space for encounters. The crossing of them both would provide meaningful relations to understand the location of the central spaces of the fabric.

However, it is not possible to select one place above another if the criteria is only related with the size and location of the high values. Until this point, the analysis have brought out the spaces where it is possible to develop a thriving central space and, in order to understand the ability of the fabric to make this spaces become central, the activities happening in the fabric are going to be analysed by overlapping both, the activities happening in the ground floor of the buildings, and the location of public facilities and other amenities.

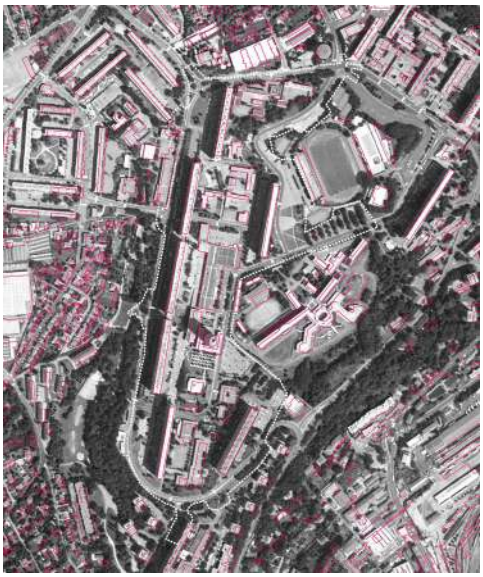
If the regeneration project is to be successful, it must not only provide the optimum physical conditions, but also be accompanied by a range of social and economic interventions that facilitate the engagement between citizens and their built environment, a relationship that should be most evident in these central areas.

3. Measuring space





This chapter develops the analysis described above. It will present the case studies in two situations: before and after the regeneration project studied, and will compare them on each point, following the structure explained.









3.1 Case studies selection

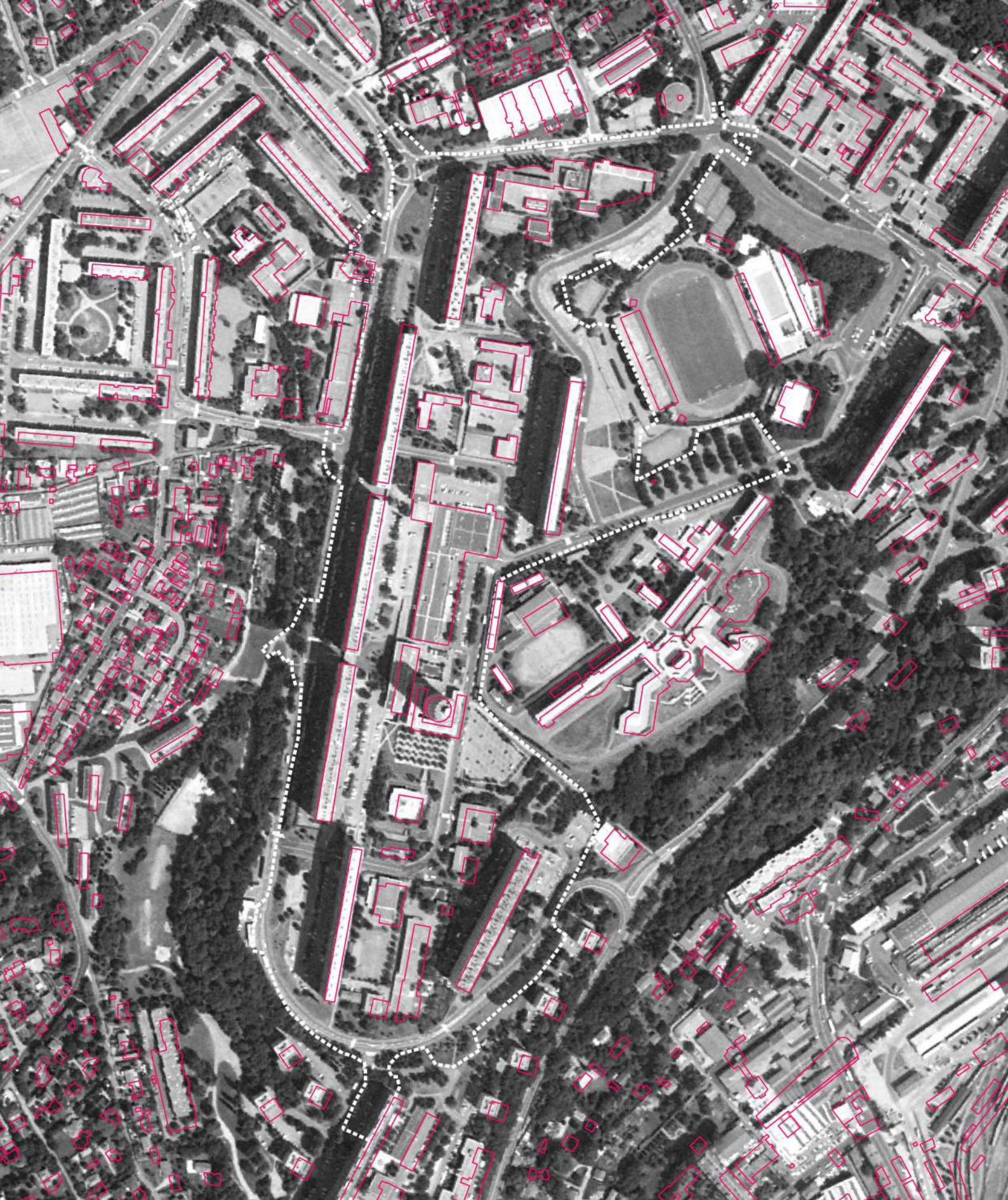
The selection of the case studies has been conducted following multiple criteria. First by locating projects that have tried to redevelop or regenerate high-rise housing estates along Europe. Between the different projects encountered, the selection has focused first taking into account the availability of data of the different projects, published by their authors, being public administrations, or private developers. There is an intensive searching for quantitative data, so the correlation is based on confirmed data.

Then the selection has prioritise projects in the Mediterranean context, but in order to have a wider selection and to find more representative interventions, some projects out of the Mediterranean context, but located in Europe, have been selected. And about the territorial location of the projects selected, there has been an intention to territorially balance the selection, as it have been easier to find projects in certain regions than others.

Furthermore, the selection has filtered those projects within a limited scale that encompass a content expansion of the city and that have not altered the city's underlying dynamics. This analysis considers projects with a surface area of less than 80 ha, but greater than 10 ha. This allows the study to focus on intermediate-scale projects that, despite their role in facilitating urban growth, are not sufficiently large to alter the existing urban soul.

Finally, an attempt has been made to select projects that represent different typologies of interventions. This implies that the selection has endeavoured to identify projects e ranging from minor physical interventions, such as the installation of elevators or enhancements to urban accessibility, to significant physical interventions, such as the demolition and reconstruction of entire urban structures.

The result has been the analysis of eight case studies, with four located in France: La Duchère in Lyon, La Courneuve and Les Courtillières on the outskirts of Paris, and Empalot in Toulouse. Two case studies were conducted in Italy: Via Artom in Turin and Tor Bella Monaca in Rome. One case was from Spain: La Mina in Barcelona. Additionally, the Agrocité Gagarine-Truillot project was included to test the methodology on a project that has not yet been implemented.



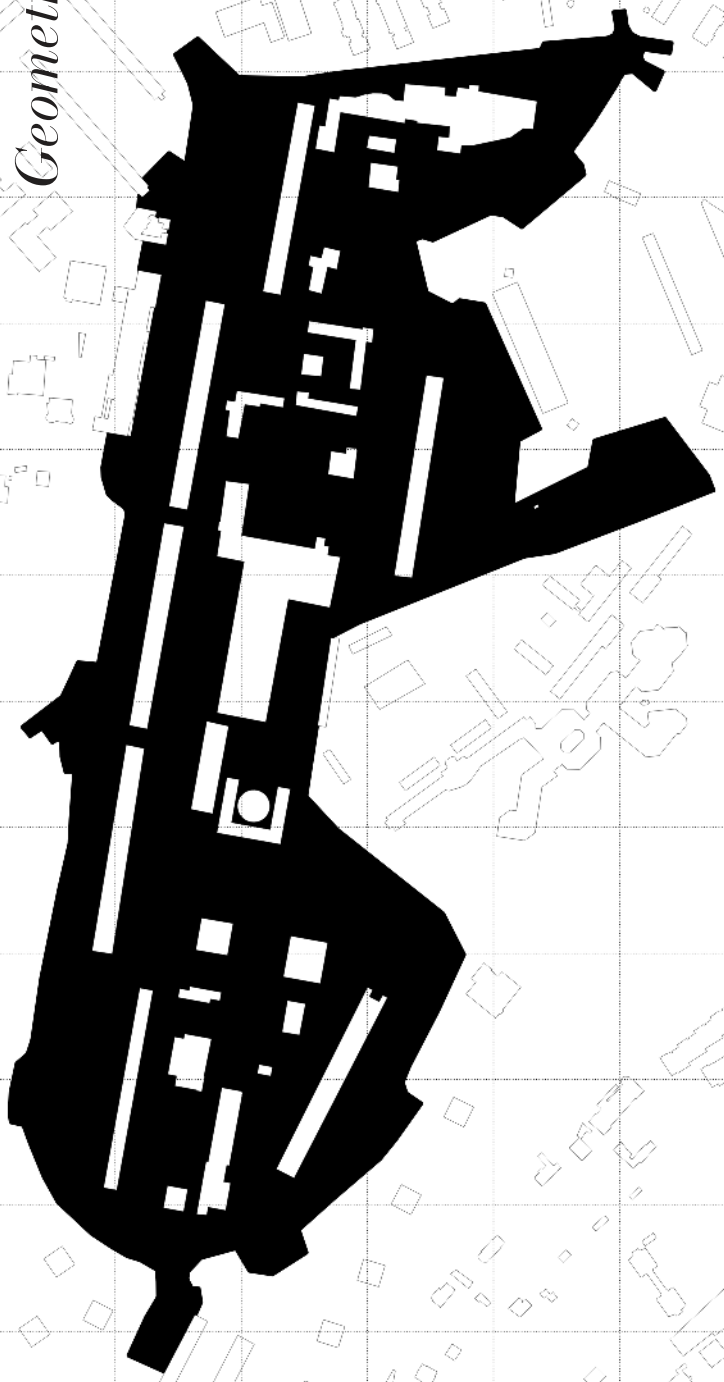
La Duchère, Lyon

Surface	**27 ha**
Year or construction	**1960**
Year of renovation	**2002**
Built surface [%]	**15.4 %**
Budget	**228,121,000.00 €**

Located in the northwest of Lyon's historic centre, it is a neighbourhood conceived as a suburban housing project and inserted in the urban expansion that Lyon suffered on 1960s. Its built environment represents the ideas of the Modern Movement with high-rise residential complexes interspersed with green and open spaces.

It quickly became one of the most sensitive neighbourhoods in France until a major regeneration project was launched in 2002, which did not prevent it from being classified as a priority area in 2012. Nearly 2,000 social housing units were demolished and numerous facilities were inserted. However, this on the one hand has led to the displacement of residents, with the reduction from 85% to 55% of social housing and the demolition of numerous dwellings displacing the original inhabitants.

The project, which required an investment of 228M€, was based on the complete destruction of the central part and its reconstruction with a smaller scale residential typology, in a semi-open block format, establishing new relationships and small spaces.



1:6000

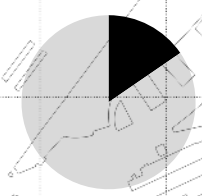
Figure Ground

The objective of this initial analysis is to represent the evolution of the geometry of the free space of the fabrics through the use of a figure-ground map. This representation facilitates a comparative analysis of the previous and subsequent states, both in terms of their geometric characteristics and their dimensional properties.

The first step in the development of this map is the selection of the boundary, which is different before and after the project. The location of the buildings, in conjunction with the aerial image, serves to define the limits of the fabric under investigation. As the present analysis and subsequent ones are based solely on geometric and visual considerations, the characterisation of the boundary has been informed by elements of both.

Once this boundary has been established, the precise location is determined through the encounter with those elements that represent a barrier to visual perception.

In other words, as can be observed in the cartographic representations, the western edge of the fabric is clearly delineated by the infrastructure, including the road and the green areas, which generate a geometric separation between the neighbourhood and its surroundings.



15,4 %
Surface occupied by buildings [%]

The edge has therefore been delineated by the buildings situated on the opposite side of the road infrastructure (which does not impede visual perception) and by the periphery of the green zone (which is vegetated and thus acts as a visual barrier). In order to represent the existing buildings, polygons have been obtained from open databases and verified against the most recent aerial images. In order to represent the buildings in their original state, a variety of resources have been employed, including historical aerial images and plot plans of a certain age.

Once the methodology has been elucidated, the cartographies unambiguously demonstrate the locations of the most significant alterations to the fabric and illustrate how the regeneration project has augmented the land cover, replacing the central areas with buildings of smaller size.

The result shows a 5.8% increase over the original solution. However, this change should be interpreted in conjunction with other metrics to better assess its impact on the resulting structure. This broader analysis will provide a more comprehensive understanding of the transformation's effects.

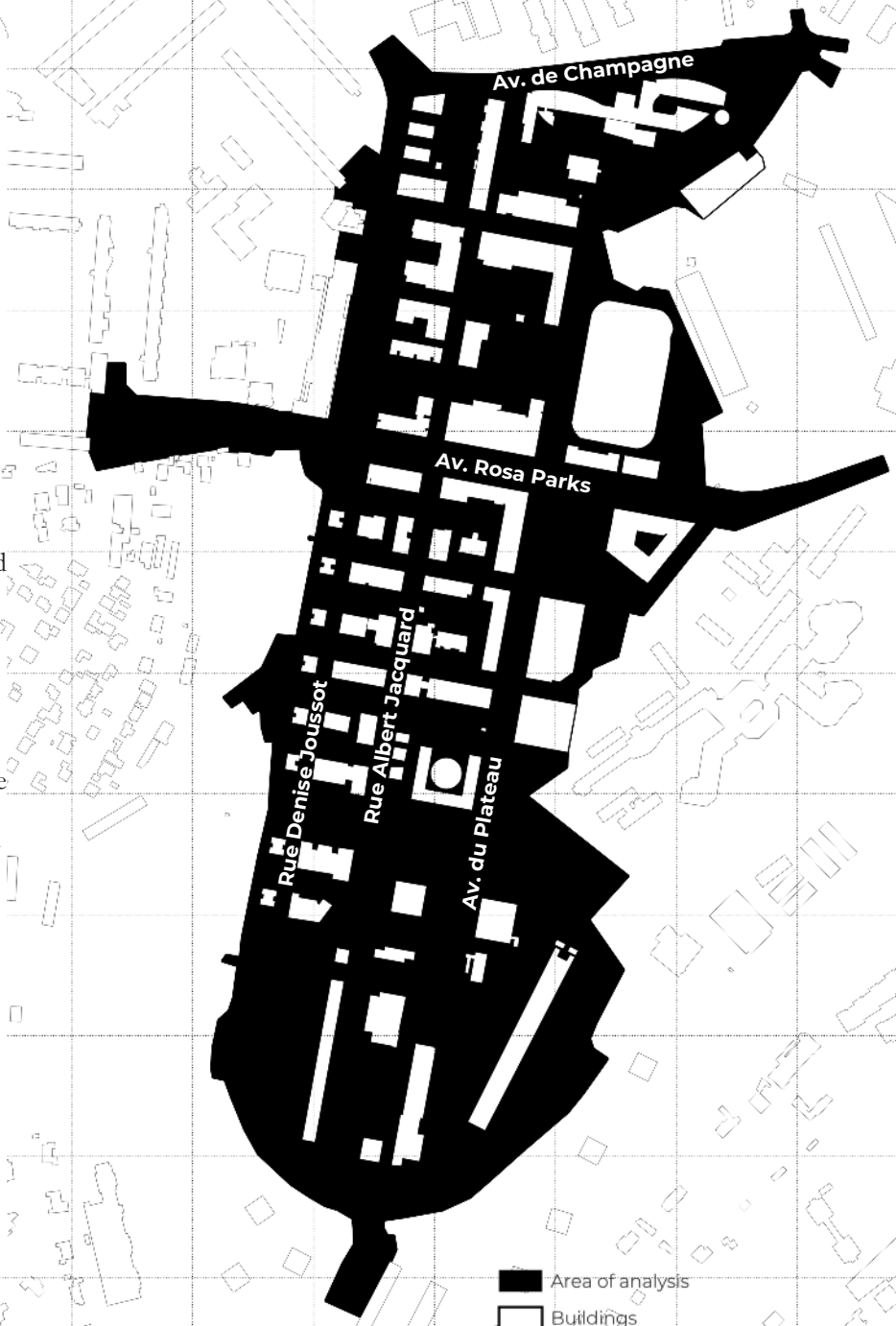
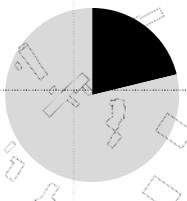
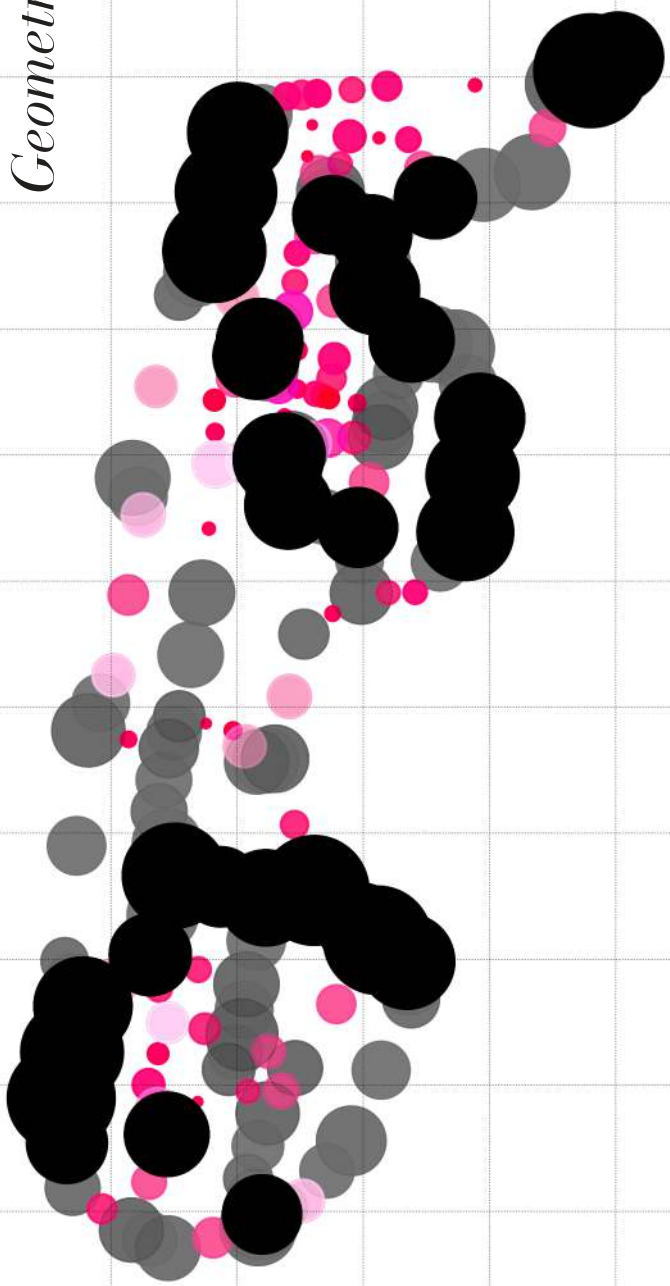


Figure 15. [left]. Figure-ground map,representing in black the space not occupied by buildings in the original state of La Duchère. Source: Author.

Figure 16. [right]. Figure-ground map,representing in black the space not occupied by buildings in the present state of La Duchère. Source: Author.



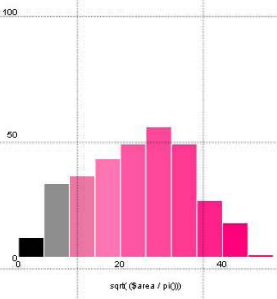
21,2 %
Surface occupied by buildings [%]



In-between distances

In order to conduct this analysis, the initial step was to build the skeleton of the free space within the tissue, based on a Voronoi diagram. To this end, the black surface derived from the preceding analysis was utilised and processed with the BecaGis Tools add-on in QGIS version 3.34.1. The initial skeleton was then processed manually, with any connections that were in contact with the buildings, due to the construction of the skeleton, being eliminated. Subsequently, the skeleton was simplified using the Douglas-Peucker algorithm and the simplify tool. Subsequently, the extreme and intermediate vertices were extracted, and the distance from each vertex to the building was calculated. The aforementioned distance was then used to plot circles with their centres at the vertices and with a radius equal to the aforementioned distance.

This process, which is discussed in greater detail in the second chapter of this work, allows us to ascertain the dimensions of the built space.



23.3 m
Average radius

1:6000

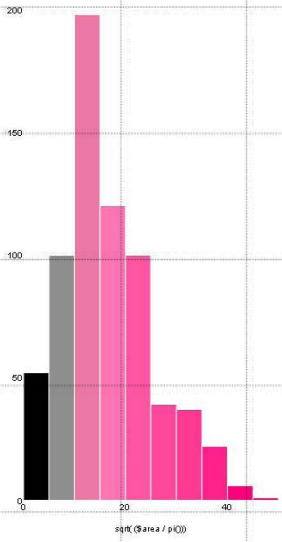
When applied here, it enables us to identify the following trends.

A reduction in the quantity and size of free space is observed. The average radius has decreased from 23.3 metres to 16.64 metres.

This is also evident in the cartographic representations, wherein the lowest values are depicted in deep red, while the highest are represented in black, following an intermediate gradient. It can then be observed that in the current situation, a series of intense reds appear in the central part of the fabric, while on the northern and southern edges, some of the large spaces have been maintained.

Conversely, the methodology employed in the construction of this metric results in a variation in the number of circumferences due to alterations in the built environment.

This is evidenced by the distribution of the lower histograms, which demonstrate a reduction in distances and a narrowing of the distribution at the upper end of the graph.



16.64 m
Average radius

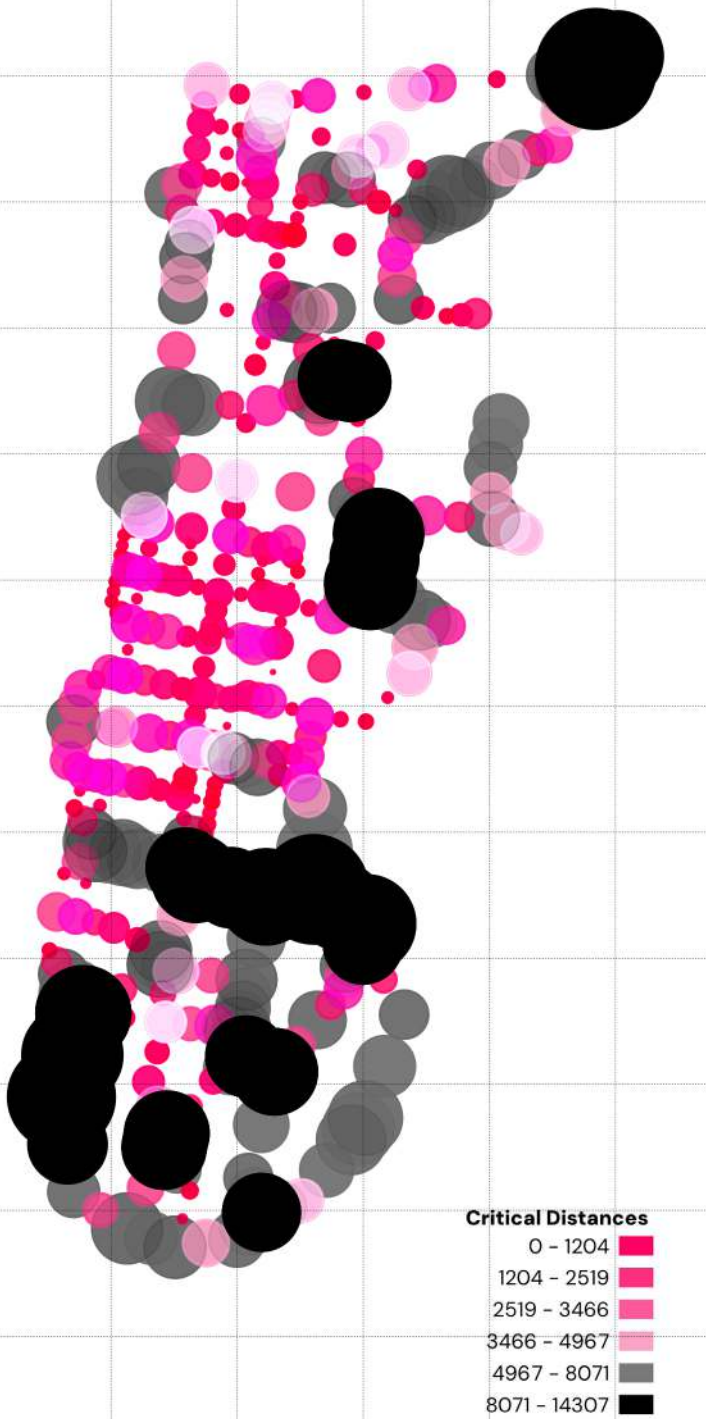
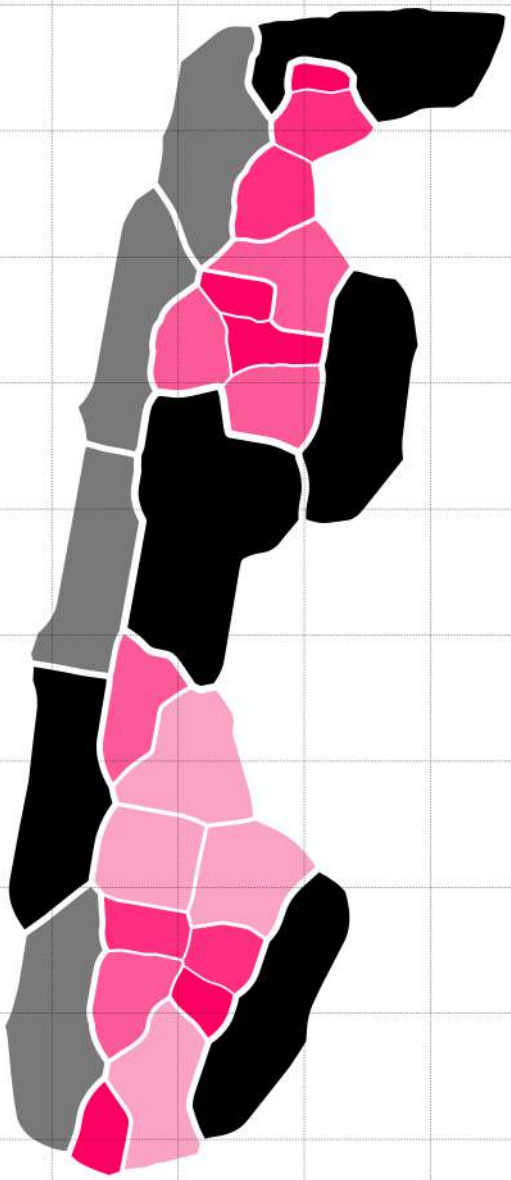


Figure 17. [left]. Critical distances of the open spaces around the original La Duchère fabric. Source: Author.

Figure 18. [right]. Critical distances of the open spaces around the actual La Duchère fabric. Source: Author.



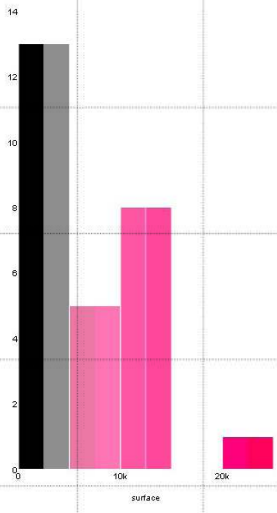
1:6000

Urban Grain

This measure aims to provide a precise interpretation of the distribution of block sizes in open urban fabrics, where streets do not always align with building fronts.

Therefore, the construction of this metric was initiated with the skeleton configuration described in the preceding analysis. This approach was adopted because the process entails the delineation of lines traversing the open area between the built structures at their midpoints. This allows the transition from the skeleton (lines) to the observed surfaces in cartography (polygons), thus enabling the calculation of their dimensions. The colour gradient, analogous to that observed in the preceding analysis, represents the gradient of surfaces, ranging from the larger "blocks" (represented in black) to the smaller-scale ones (observable in the central part of the current fabric, represented in intense pink).

Conversely, the thickness of the perimeter of these polygons is precisely determined by their length.

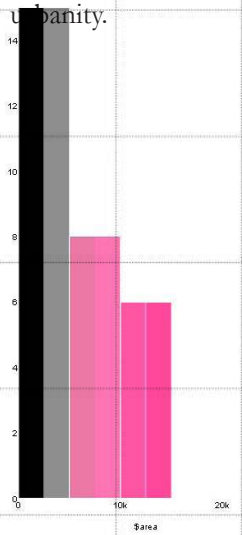


7,000 m²
Average surface

Thus, the thicker the edge, the longer the perimeter, which allows for the exploration of not only their surface but also their geometry in terms of compactness.

This construction allows for a clear observation of the conjunction of the two previous analyses: the tension and multiplicity appear to move from the ends to the centre of the fabric. The drastic reduction of the grain in the central part, combined with the non-modification of the ends, seems to reduce the average surface area of the grain, which goes from 0.7 ha to just under half a hectare. This is demonstrated in the graphs below. Furthermore, a reduction in the diversity of the grain is evident, as indicated by a decrease in the standard deviation of both the surface area and perimeter.

The reduction in grain size suggests an effort to downscale the overall structure, aiming to create conditions more akin to the compact fabrics of historic cities. This approach appears to be grounded in the notion that a finer grain fosters a greater sense of urbanity.



4,658 m²
Average surface

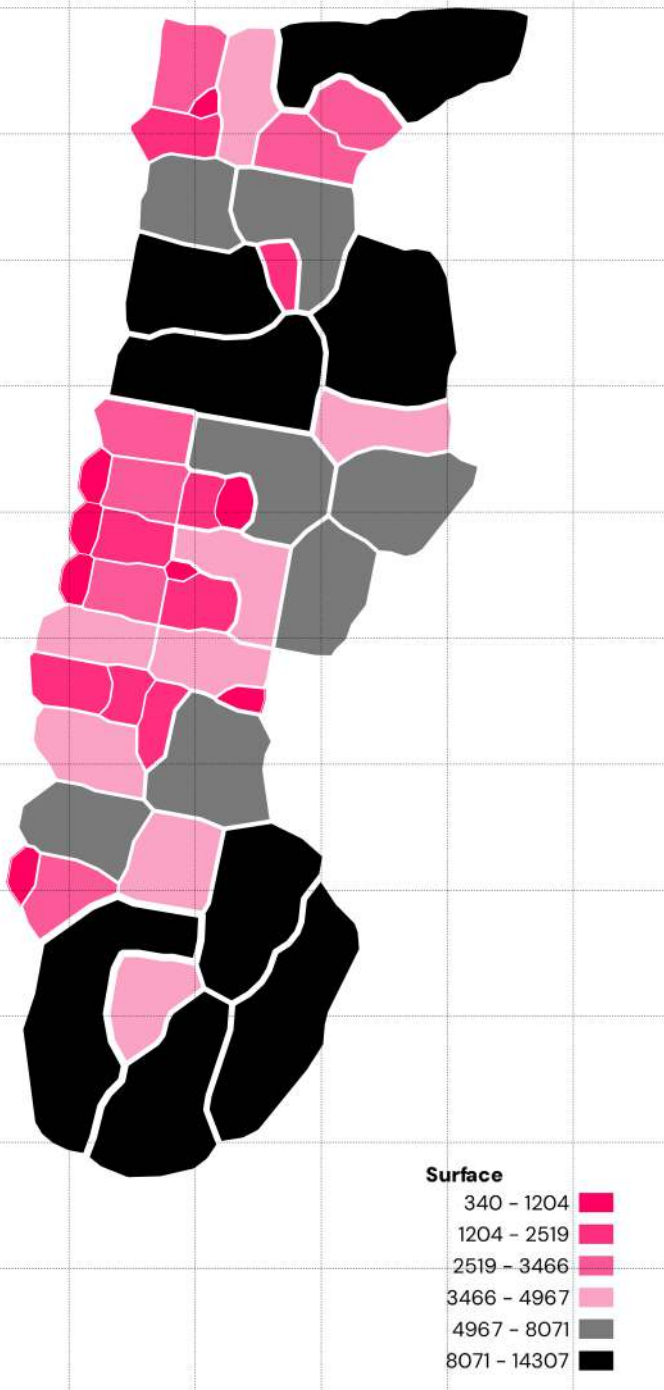


Figure 19. [left]. Basic grain and skeleton of the original La Duchère fabric. Source: Author.

Figure 20. [right]. Basic grain and skeleton of the present La Duchère fabric. Source: Author.

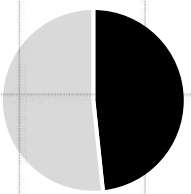
1:6000

Exterior Permeability

These maps illustrate the permeability of the housing complexes from the outside, specifically indicating how much of the interior is visible from external viewpoints.

The representation is then centred on the viewshed from a point situated at the main access point to the fabric. The initial measure is the number of access points, or points of measurement (6), and the relationship between them. Of the six points of observation, only one is focused on pedestrian mobility. Consequently, the remaining visual relations are altered by the speed of the mean of transport. In addition, the viewshed analysis identifies two primary considerations: firstly, the opacity of the fabric, which arises from the distribution of buildings that prevent the perception of what lies within from the boundaries. This resulted in a greater degree of privacy in the central area of the neighbourhood, which has subsequently given rise to security concerns and is directly related to the perception of security.

As a result of this analysis, the viewsheds are rarely related to one another (with the exception of the west exterior axis), which increases the feeling of uncertainty due to the lack of visual relations not only between the interior and the exterior, but also between the various paths that cross the fabric.

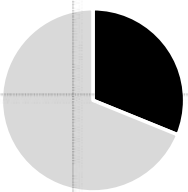


48,3 %
Surface visible [%]

Conversely, the revised configuration not only enhances the number of points of access to the structure but also markedly increases its permeability. The primary reason for this is the introduction of new openings, which facilitate the emergence of novel visual relations between the interior and exterior of the fabric, as well as between access points. This enhances the clarity of travel through the environment and, consequently, the perception of security.

Furthermore, although the total area of the hidden zones is greater than that of the previous configuration (72% of the total area is now hidden, compared to 49% in the previous state), the average size of these zones is smaller. This could potentially alter the perception of insecurity into one of privacy, which is reinforced by the increase in built surface area. This could result in a sense of a more controlled space, with a greater sense of surveillance.

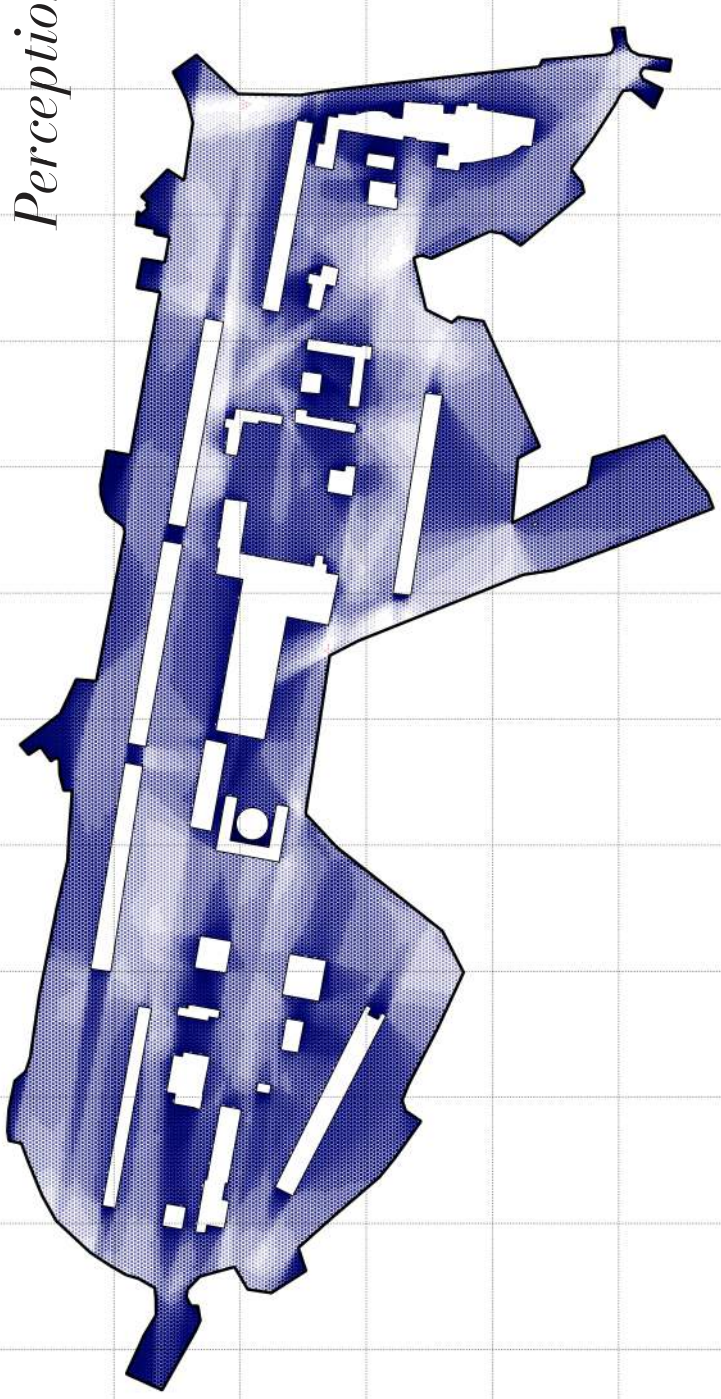
In other words, while the visible surface area is reduced, it is strategically organised to enhance the perception of the core structure from the outside. This deliberate arrangement maximises the visibility of key elements, creating a stronger visual connection between the exterior and the interior.



31,1 %
Surface visible [%]

Figure 21. [left]. Visual sheeds from the main entry points to the original La Duchère fabric. Source: author.

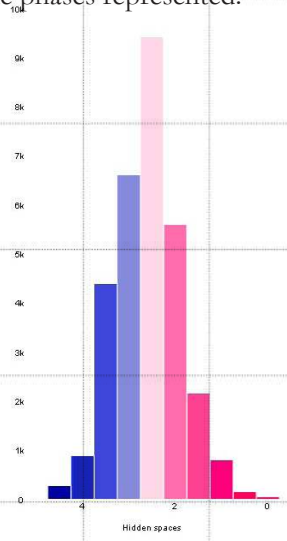
Figure 22. [right]. Visual sheeds from the main entry points to the present state of La Duchère fabric. Source: author.



1:6000

Hidden places

A key objective in urban regeneration projects is the elimination or reduction of hidden, invisible, and segregated spaces. In visibility graph analysis, this aspect can be assessed through the parameter known as Integration. To calculate this, the study employed Isovist.app (version 2.4), a tool that enables the computation of various properties of isovists generated from the different pixels that compose the structure defined by the figure-ground plane.This analysis proceeds with an investigation of the spatial hierarchy, with a focus on identifying the most concealed spaces within the fabric. To this end, a visibility graph analysis of the fabric has been constructed and represented in a gradient from blue to pink, with the first representing the smallest values, which are understood to be the most hidden spaces in the fabric, and the second representing the largest values. As indicated in the legend, intermediate values are represented in white to facilitate a more discernible comparison with the extreme values. It should be noted that the colour gradients used in this analysis and in all subsequent analyses are consistent, both in terms of the values assigned and in terms of the phases represented.

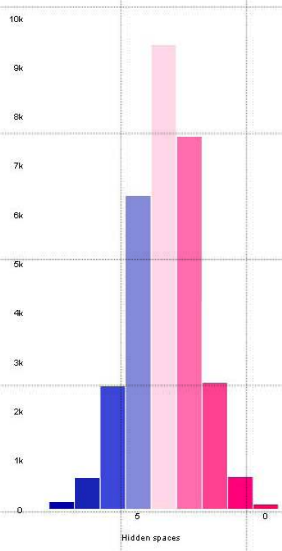


7.53
Median of the values indicating the hidden spaces

While this may result in a loss of relative information in each situation, it allows for a clearer observation of the evolution of the different values.

This is exemplified in the following case, wherein it is evident that the preceding situation (left) exhibits minimal values, indicative of greater concealment, in comparison to the subsequent situation (right), which also displays pinks representing elevated values. This allows for the expression of evolutionary trends, such as the observation that the regeneration process has reduced the occurrence of corners along the tissue. Furthermore, it is evident that the distribution undergoes a transformation from an amorphous and non-hierarchical configuration to a packet distribution. This also leads to the observation of the diversity of the spaces. While the previous state presented values with a standard deviation of 0.69, the current state presents a greater diversity with a standard deviation value of 1.29.

Together with the progression of the mean value, this indicates a general reduction in the number of corners, but with an increase in spatial diversity. This undoubtedly translates into greater spatial quality.



6.53
Median of the values indicating the hidden spaces

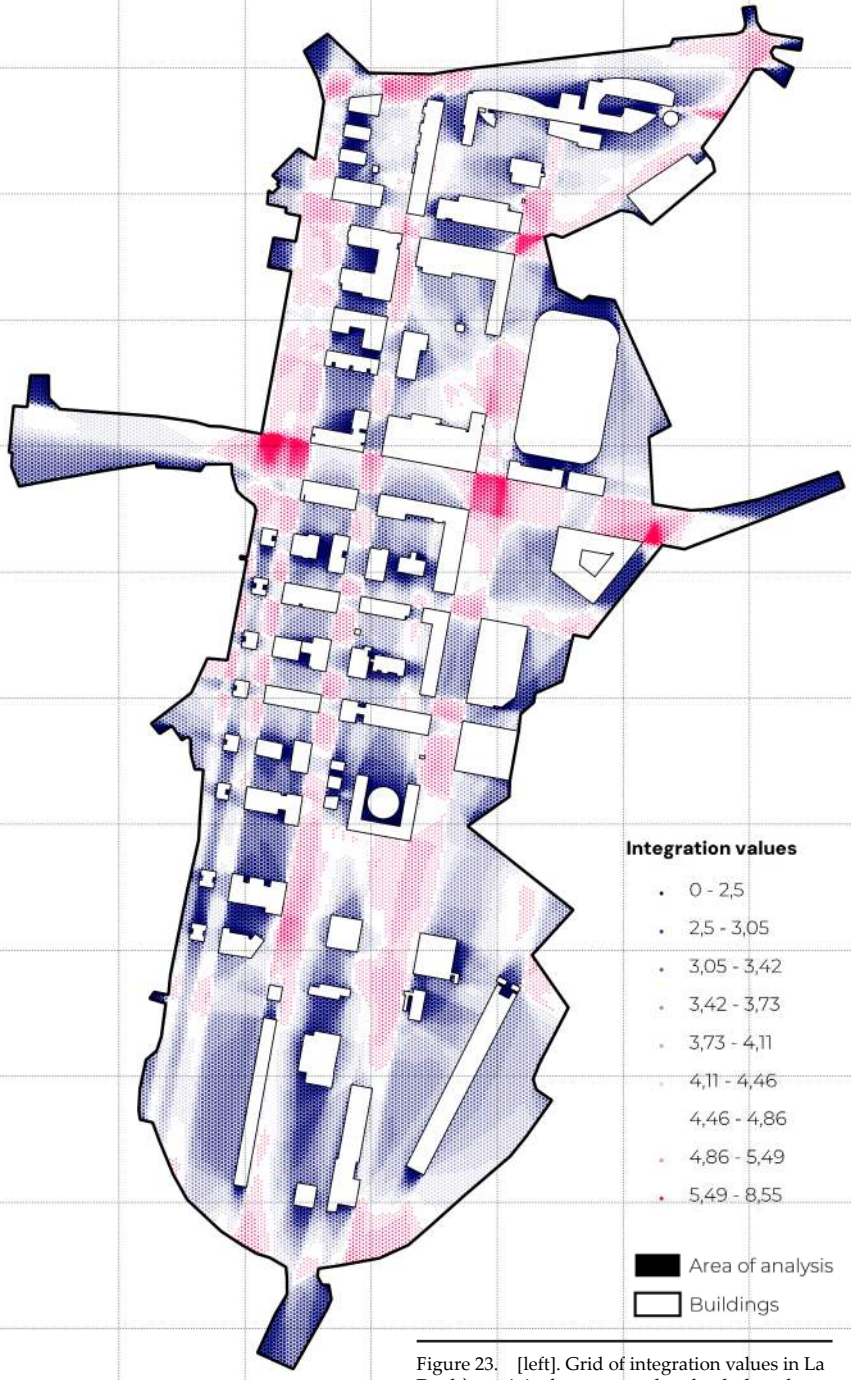


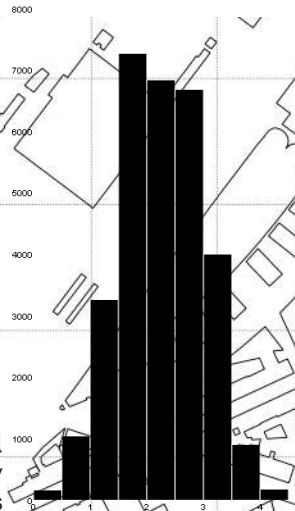
Figure 23. [left]. Grid of integration values in La Duchère original state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Figure 24. [right]. Grid of integration values in La Duchère present state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Perception

Large & more visible square-like spaces

These maps aim to identify the location and scale of large 'square' or 'esplanade' spaces that offer good visibility within the site. Although there may be some error from not accounting for small-scale elements that obstruct visual perception, this analysis effectively highlights prominent gathering areas and major public spaces. A visibility graph analysis was constructed using the outline of the buildings and the edge of the study area as a basis for the analysis. In order to conduct this analysis, as outlined in the second chapter, we proceeded to normalise and incorporate the values of "average radial", which emphasise those spaces that are "compact" and square-shaped. In order to gain insight into the visual hierarchy, the values of "visibility" were also considered, indicating the spaces that are most visible to other locations within the fabric. Subsequently, contour lines indicating the concentration of the highest values were generated using the "Contour Plugin" in QGIS version 3.34.1. The values were selected on the basis of their location in the upper quartile. The resulting contour lines are represented in a gradient of colours, indicating a transition from higher to lower values within the upper quartile.



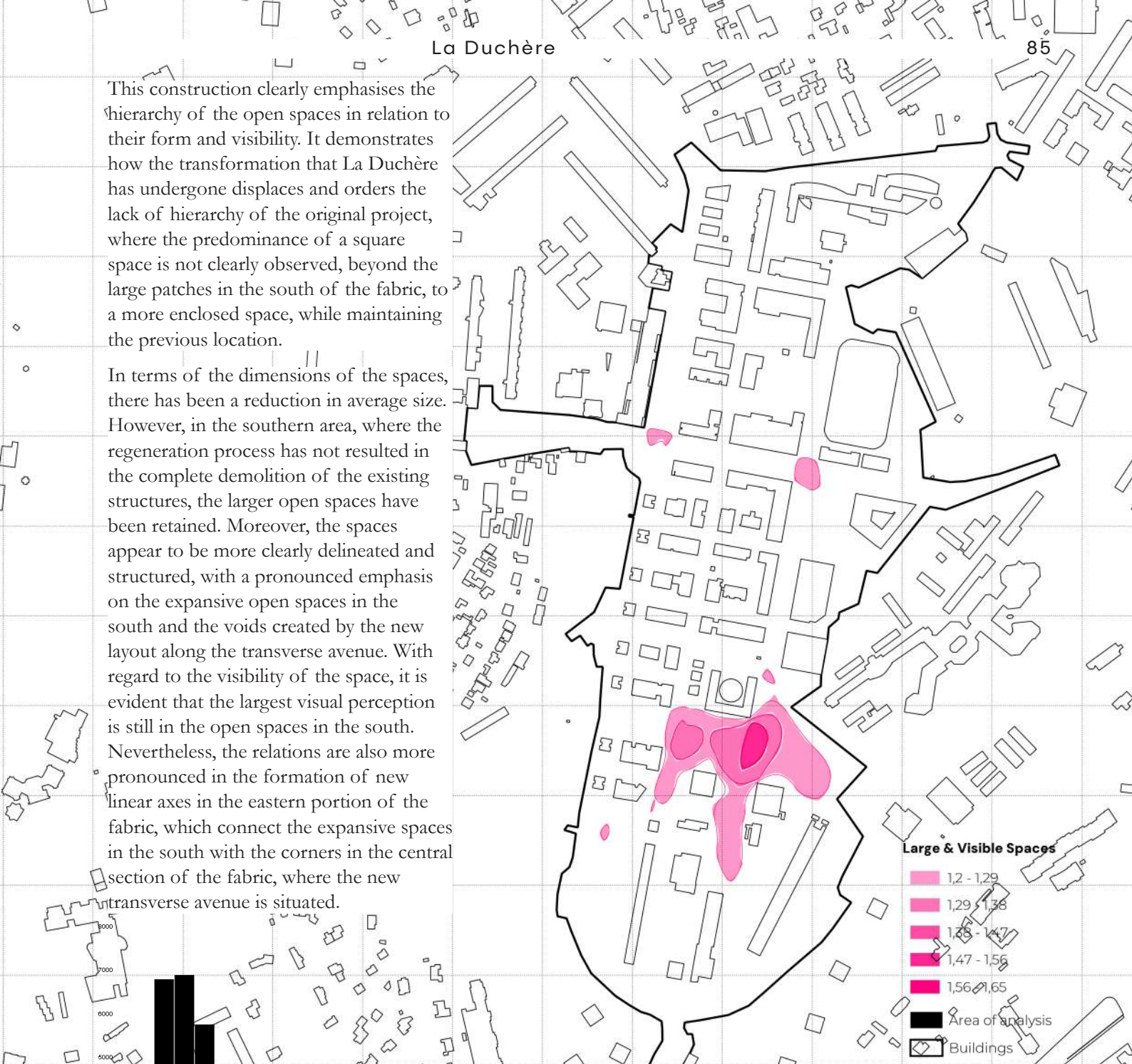
1:6000

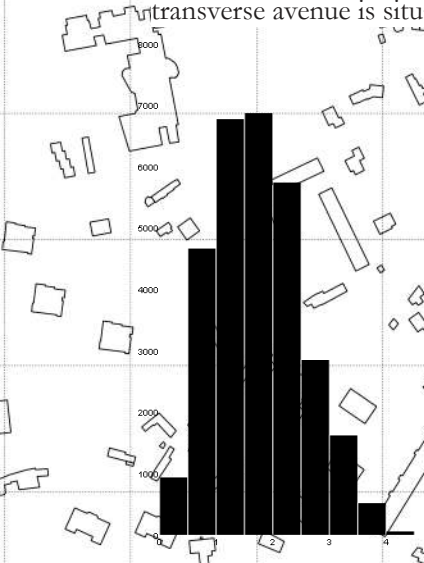
97.9 ha

Surface occupied by the highest values

This construction clearly emphasises the hierarchy of the open spaces in relation to their form and visibility. It demonstrates how the transformation that La Duchère has undergone displaces and orders the lack of hierarchy of the original project, where the predominance of a square space is not clearly observed, beyond the large patches in the south of the fabric, to a more enclosed space, while maintaining the previous location.

In terms of the dimensions of the spaces, there has been a reduction in average size. However, in the southern area, where the regeneration process has not resulted in the complete demolition of the existing structures, the larger open spaces have been retained. Moreover, the spaces appear to be more clearly delineated and structured, with a pronounced emphasis on the expansive open spaces in the south and the voids created by the new layout along the transverse avenue. With regard to the visibility of the space, it is evident that the largest visual perception is still in the open spaces in the south. Nevertheless, the relations are also more pronounced in the formation of new linear axes in the eastern portion of the fabric, which connect the expansive spaces in the south with the corners in the central section of the fabric, where the new transverse avenue is situated.

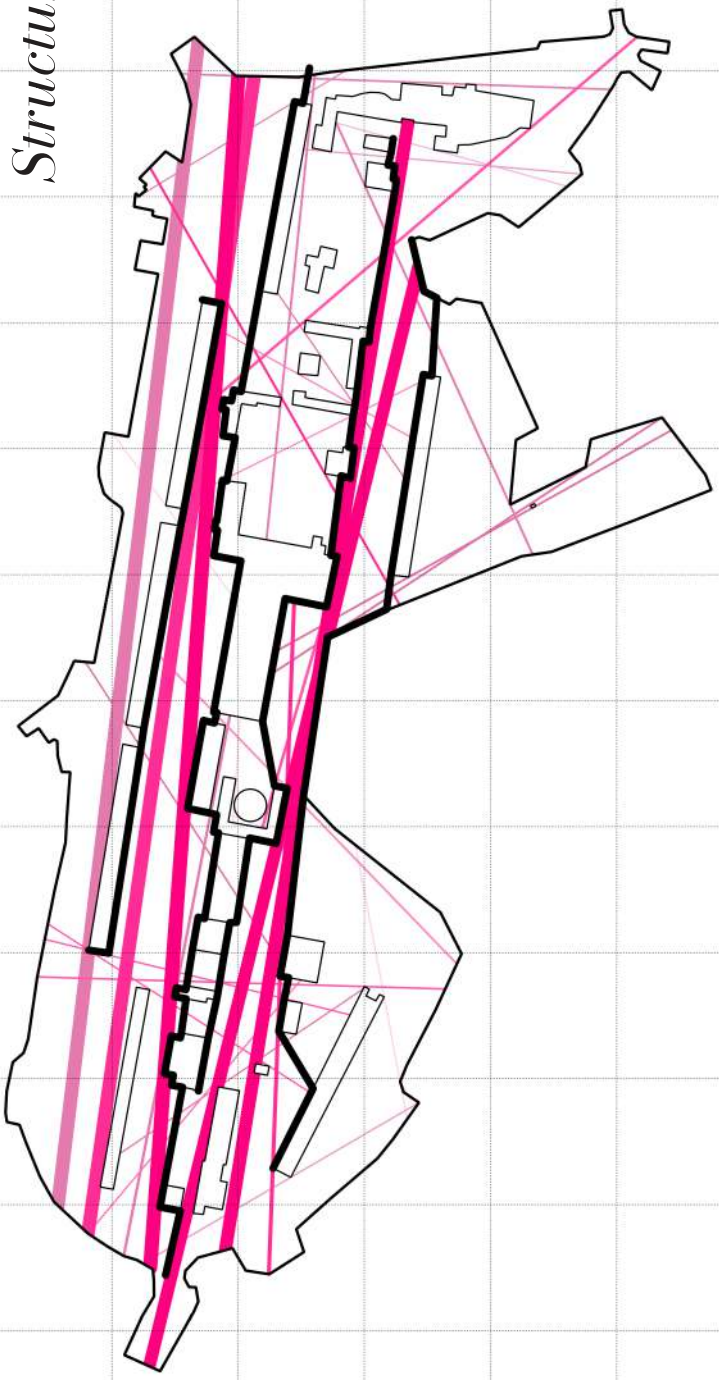




24.3 ha
Surface occupied by the highest values

Figure 25. [left] Contour lines representing the highest values of average radial in La Duchère original state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

Figure 26. [right] Contour lines representing the highest values of average radial in La Duchère present state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

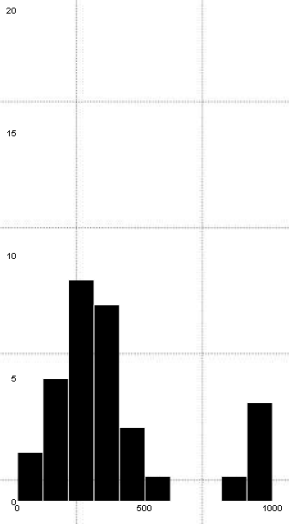


Basic Structure

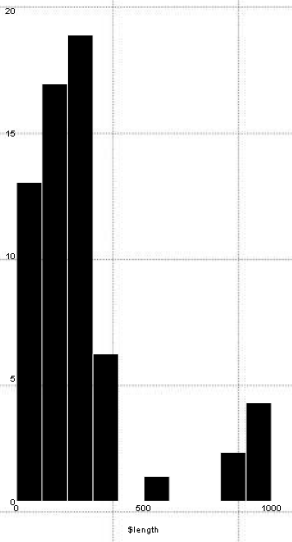
The housing estates of the open city often present challenges in identifying their basic structure or the underlying framework that organises open spaces. To better understand this, the metric traces the longest axial lines within the open space, revealing the primary skeletal structure that shapes the overall urban fabric. In order to achieve this, the area under examination and the outlines of the buildings have been processed with version 0.35 of the DepthmapX[net] program, thereby enabling the construction of the axial map in this program. In order to represent the aforementioned lines, the thickness of each has been modified according to its length. This is based on the premise that the longer the axis, the more structural role it plays in the construction of the spatial configuration of the fabric. Accordingly, a greater thickness has been applied to highlight this importance. This methodology generates a cartography that allows the basic structure of the fabric to be observed.

1:6000

381.6 m
Average length of the main structural axis



Moreover, the processing of the previous and subsequent situations enables the evolution of the same to be understood. In order to facilitate comprehension of the cartographies and provide a visual representation of the underlying geometric structure, the elements that define the physical and geometric limits of the axes have been highlighted. This construction allows for the slight diversification of the direction of the axes to be demonstrated, thereby illustrating a change in the spatial structure.
It is clear that the original fabric is oriented in a north-south direction. However, the spatial configuration of the regeneration project has resulted in the emergence of perpendicular spaces, particularly in the initial phase. As a result, the emergence of these shorter transverse axes leads to a reduction in the mean length from approximately 380 metres to 260. Despite the positioning of more extensive axes, which ostensibly enhance the connectivity of the fabric, in this instance it is not a reduction in connectivity but rather the multiplication of axes in a direction that is, in terms of dimensionality, smaller.



261.6 m
Average length of the main structural axis

Figure 27. [left]. Fewest-Line Map of the original La Duchère fabric. Source: Author.

Figure 28. [right]. Fewest-Line Map of the present La Duchère fabric. Source: Author.

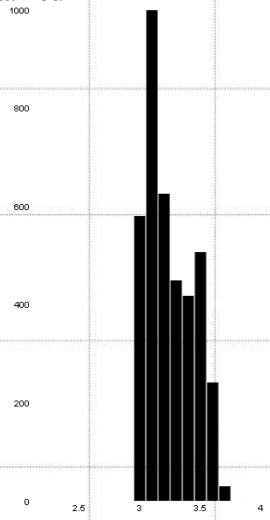
1:6000

Centric Corners

Corners serve as a fundamental expression of urbanity (Solà Morales, 2004) a quality easily identifiable in compact or historic cities. In contrast, corners in open urban environments often function merely as junctions or lack the vibrancy found in other urban fabrics. One common outcome of urban regeneration projects in mass housing estates is the emergence of a new, more rhythmic structure of corners.

To analyze this structure, we employed the same visibility graph analysis model has been processed, and the sum of the "choice" and "overt control" values have been normalised and represented. In order to facilitate comprehension of these maps, the façades that delineate the elevated values have been depicted in a gradient of thickness, whereby those with greater thickness occupy a more advantageous position for activities that require the presence of multiple individuals.

Following the implementation of the regeneration project, two principal dynamics can be discerned. Firstly, with regard to the 'corner' spaces, a clear differentiation is evident between the section of the fabric where the project has introduced a new layout in the north, and the south area where, despite some improvements, the existing layout has been maintained.



3.19

Median of the normalization of values indicating the centric corners

In the new layout, a structured grid of corners is evident, particularly at the intersection of the linear axes in the centre of the fabric.

The new layout has established a new grid comprising a greater number of corners, which are those exhibiting above-average control. This indicates that the most controlled spaces are not solely confined to corners, but also exist within wider spaces.

It is noteworthy that the values situated at the terminus of Denise Joussot Street in the southern section warrant particular attention. In this instance, a linear axis originating from the new layout is deflected in order to circumvent an existing high-rise structure, which is identified as the endpoint of the axis.

Moreover, with regard to the selection criteria, it is apparent that the higher values are more closely associated with the hierarchy measurements. It can be observed that the most prominent spaces are situated within the larger open areas located in the southern portion of the fabric. This can be attributed to the precise delineation of the choice field, which encompasses a more expansive area in close proximity to the geometric centre of the fabric, thereby underscoring its significance in relation to inner trails. Conversely, it can be considered a transition point.

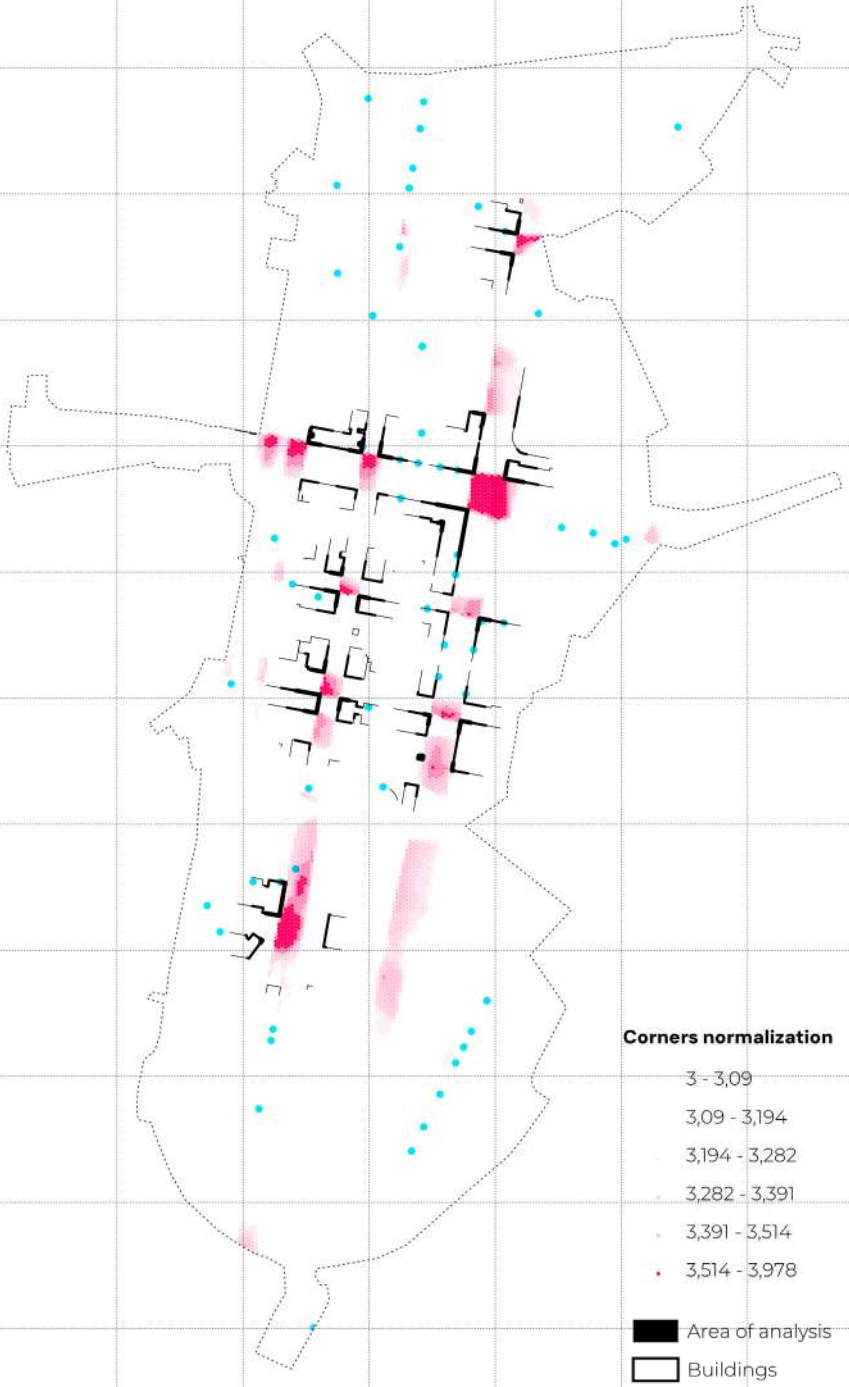
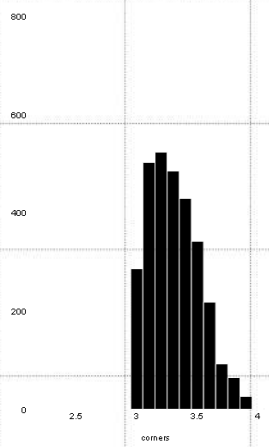


Figure 29. [left]. Grid of choice and overt control values in La Duchère original state, note that the more pinl the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Figure 30. [right]. Grid of choice and overt control values in La Duchère present state, note that the more pink the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.



3.28
Median of the normalization of values indicating the centric corners

Citè des 4000, La Courneuve

Surface	**21.3 ha**
Year or construction	**1980**
Year of renovation	**2019**
Built surface [%]	**16.3**

Budget	**280,000,000.00 €**

The Cité des 4000 in La Courneuve, an iconic social housing neighbourhood on the outskirts of Paris, has undergone a major regeneration process since 2004. Known for its high poverty and crime rates, this 1960s housing estate faced serious problems of decay and stigmatisation. The regeneration process has focused on the demolition of obsolete buildings, the construction of new housing and the creation of public spaces and green areas, seeking to revitalise the neighbourhood's image, and has also included the improvement of public services, such as schools and health centres, and the development of social programmes to promote inclusion and employment.

Despite these efforts, the neighbourhood still faces the challenge of dealing with marginalisation and negative perceptions, which complicates the integration of its residents into the wider context of the city. This case study will explore how changes in spatial configuration have affected its relationship with the urban context, as well as the evolution of internal relations.

Geometry

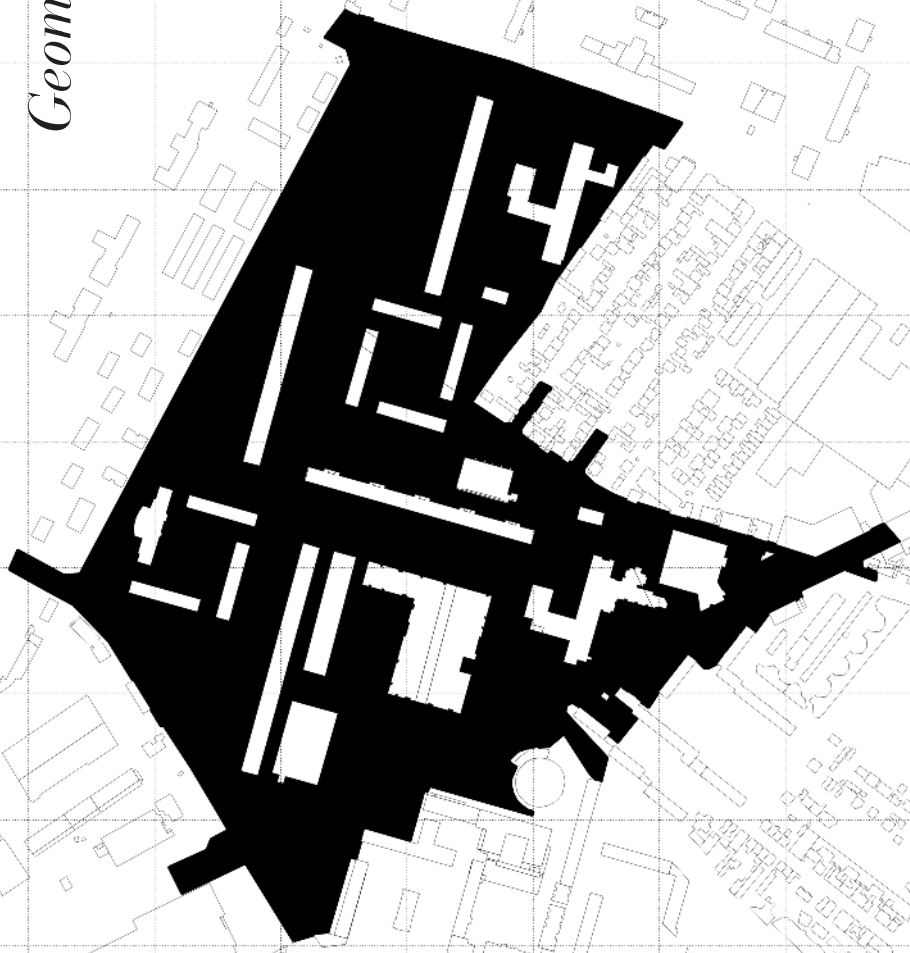
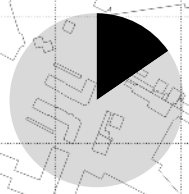


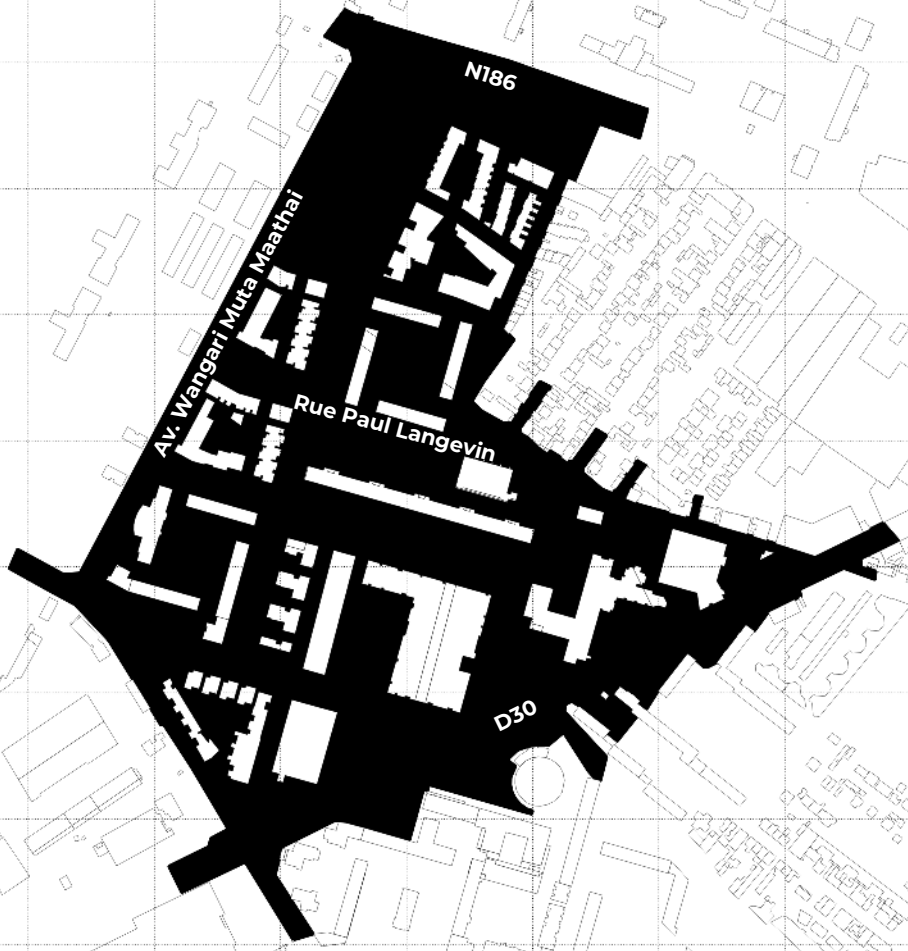
Figure Ground

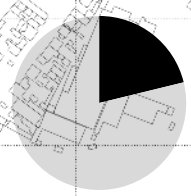
This initial analysis allows for the observation of the modifications implemented by the regeneration project, which entailed the demolition of both the northern and western sections of the structure for subsequent reconstruction. A notable increase in land use density is evident, with the proportion of occupied land rising from 16.3% to 19%. This represents an additional occupation of approximately 4,000 square metres. This initial analysis demonstrates a transformation in the spatial configuration, evolving from a fabric comprising linear blocks to one comprising associated blocks in the form of a block. However, the occupied land appears to be maintained in comparable areas. The implications of this for the spatial configuration of the fabric will be explored in subsequent analyses.



16,3 %
Surface occupied by buildings [%]

1:6000



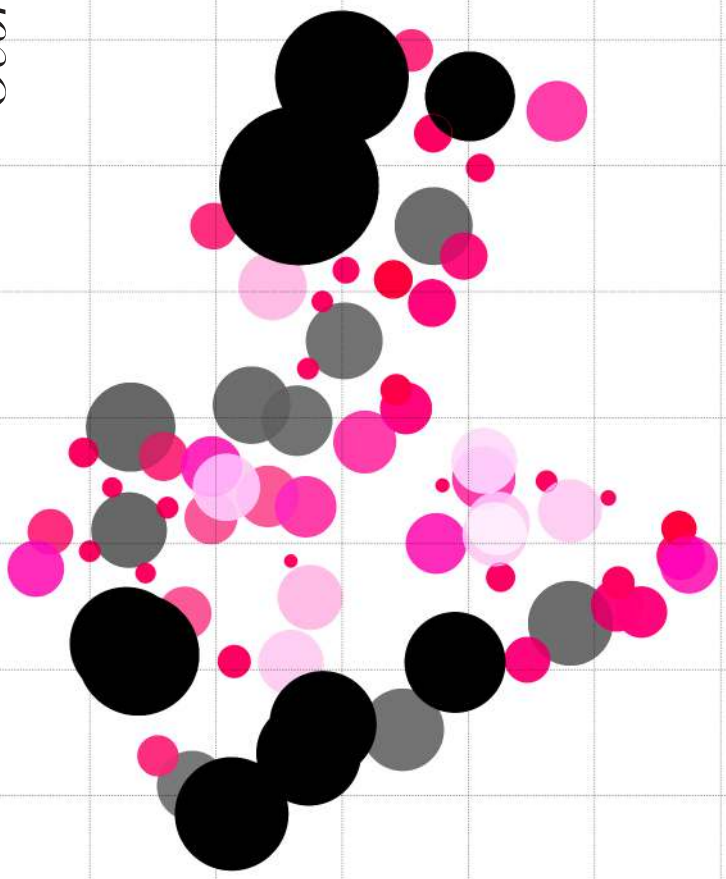


19 %
Surface occupied by buildings [%]

Area of analysis
Buildings

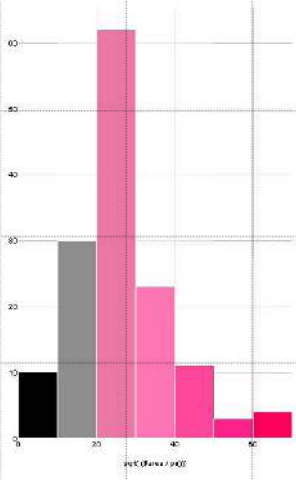
Figure 31. [left]. Figure-ground map,representing in black the space not occupied by buildings in the original state of La Courneuve. Source: Author.

Figure 32. [right]. Figure-ground map,representing in black the space not occupied by buildings in the present state of La Courneuve. Source: Author.



In-between distances

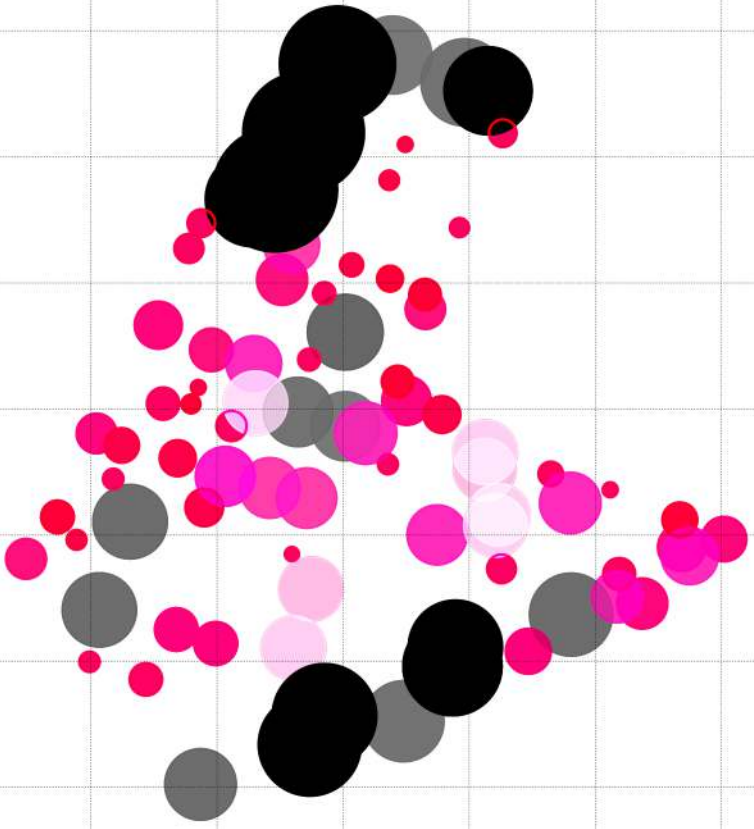
This third analysis serves to confirm and specify the observations made in the previous analyses. It demonstrates that the largest critical distances are consistently located at the edges of the fabric. It is evident that the regeneration project has not resulted in a direct transfer of the existing city to the fabric; rather, it has limited the spaces in the centre of the fabric, reducing the distances between the existing city and the fabric itself. The distances at the edges of the fabric have remained unresolved, exhibiting no significant changes that would modify the distances between the fabric and the existing city.

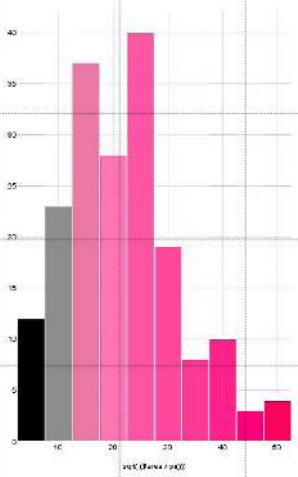


26.01 m
Average radius

1:6000

With regard to diversity, it is evident that the standard deviation of the radius has decreased from 11.89 metres to 10.35 metres, a seemingly minor change that is nevertheless accompanied by a reduction in the median from 24.7 metres to 20.98 metres. In conclusion, the regeneration project has narrowed the clearances, reducing their size while still allowing for a great diversity of spaces. However, the spatial dispersion of the high values, especially at the edges of the fabric, must be considered.





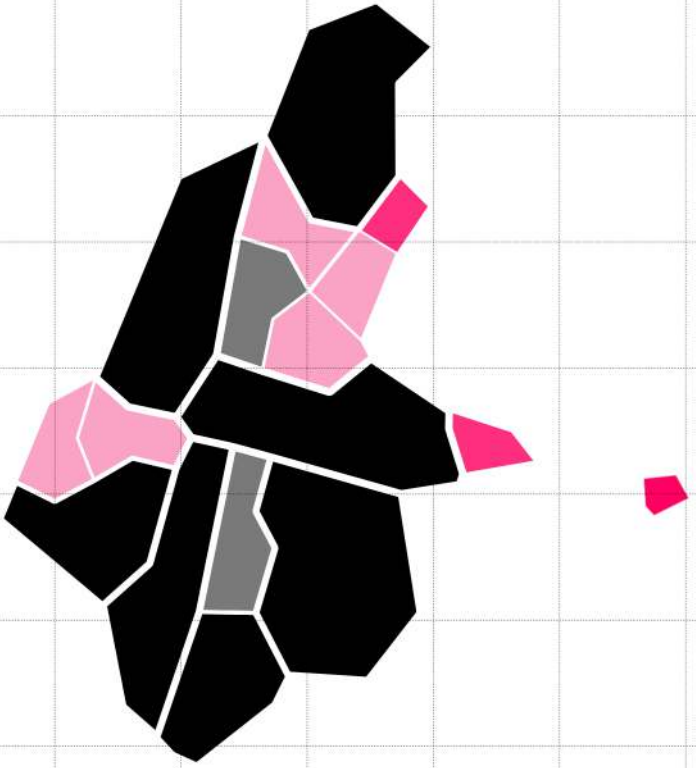
21.54 m
Average radius

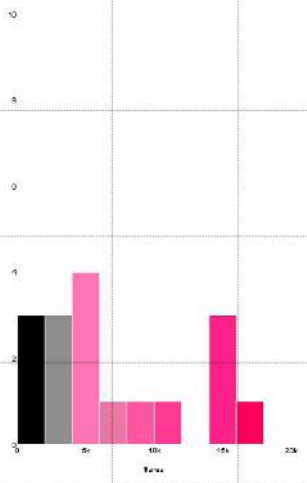
Figure 33. [left]. Critical distances of the open spaces around the original La Courneuve fabric. Source: Author.

Figure 34. [right]. Critical distances of the open spaces around the actual La Courneuve fabric. Source: Author.

Urban Grain

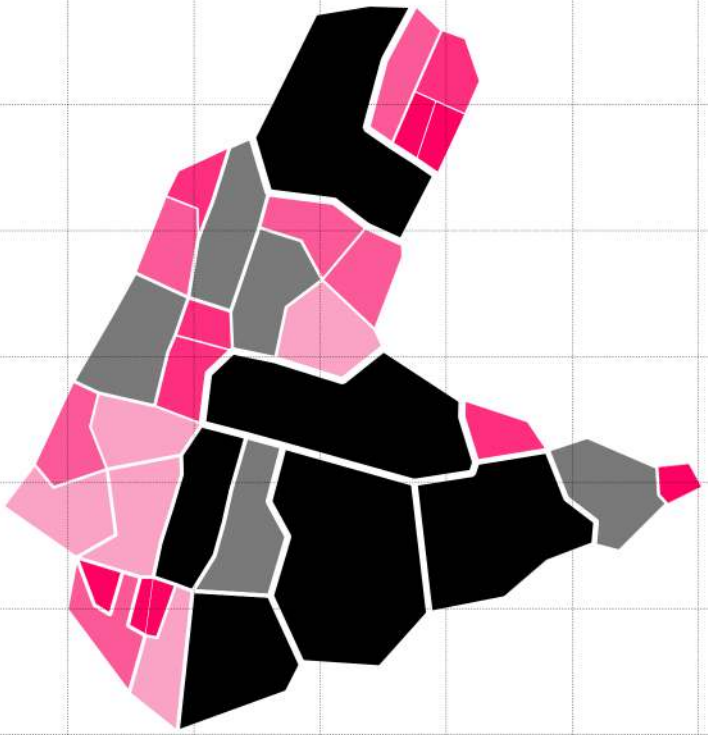
The regeneration project has resulted in the fragmentation of the built units, as evidenced by the observed changes. In instances where buildings have undergone renovation, the overall grain of the built environment has been reduced, thereby increasing the diversity of the built units and, consequently, the visual and architectural environment. This has resulted in an enhancement of the fabric and its visual component. Furthermore, it enables the discernment of areas where the spatial configuration of the fabric has been distorted or where the most significant alterations have occurred. However, due to the nature of the construction of the analysis, the polygons include the built units, rather than the spatial units or blocks of which they are composed. Consequently, in addition to the analysis of open spaces, there is less variation in diversity than in this case.

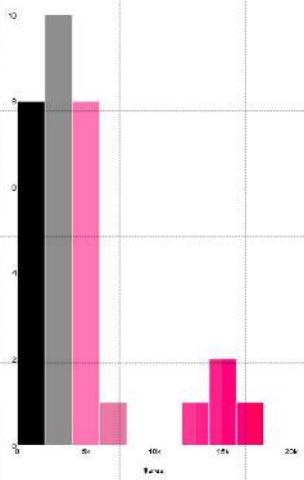




7,231 m²
Average surface

1:6000





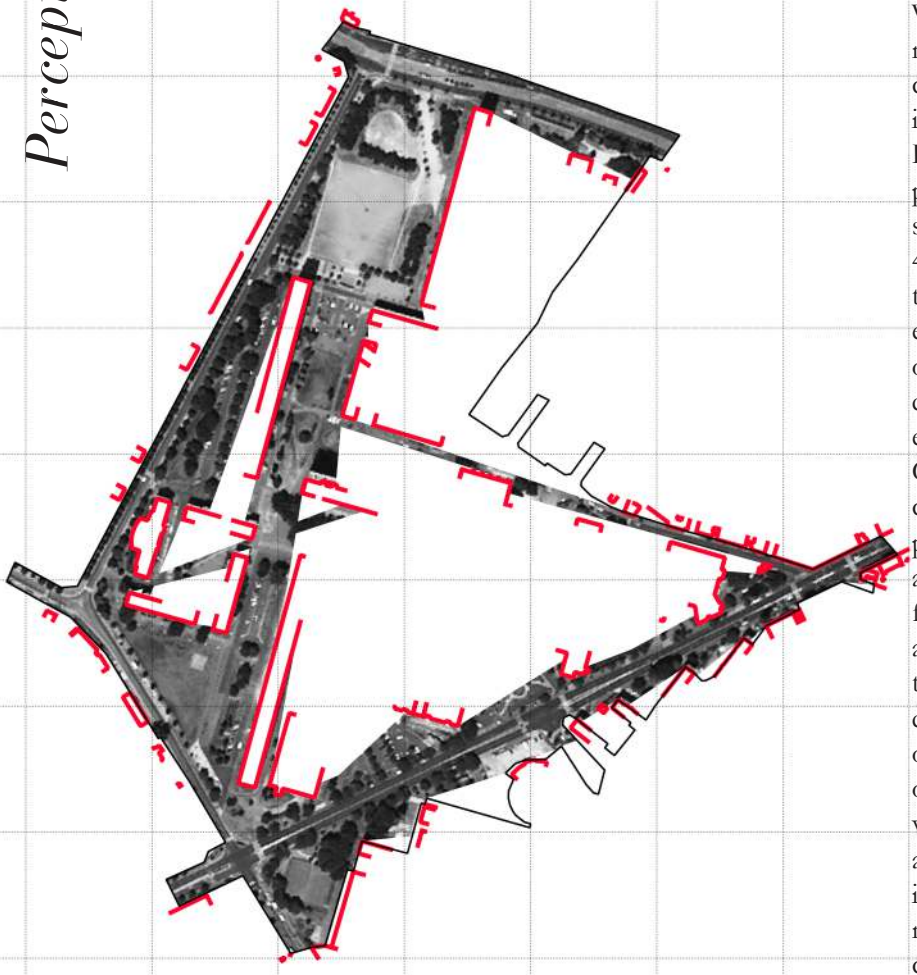
4,486 m²
Average surface

Grain surface

- 544 - 1191
- 1191 - 2483
- 2483 - 2979
- 2979 - 4387
- 4387 - 5327
- 18000

Figure 35. [left]. Basic grain and skeleton of the original La Courneuve fabric. Source: Author.

Figure 36. [right]. Basic grain and skeleton of the present La Courneuve fabric. Source: Author.



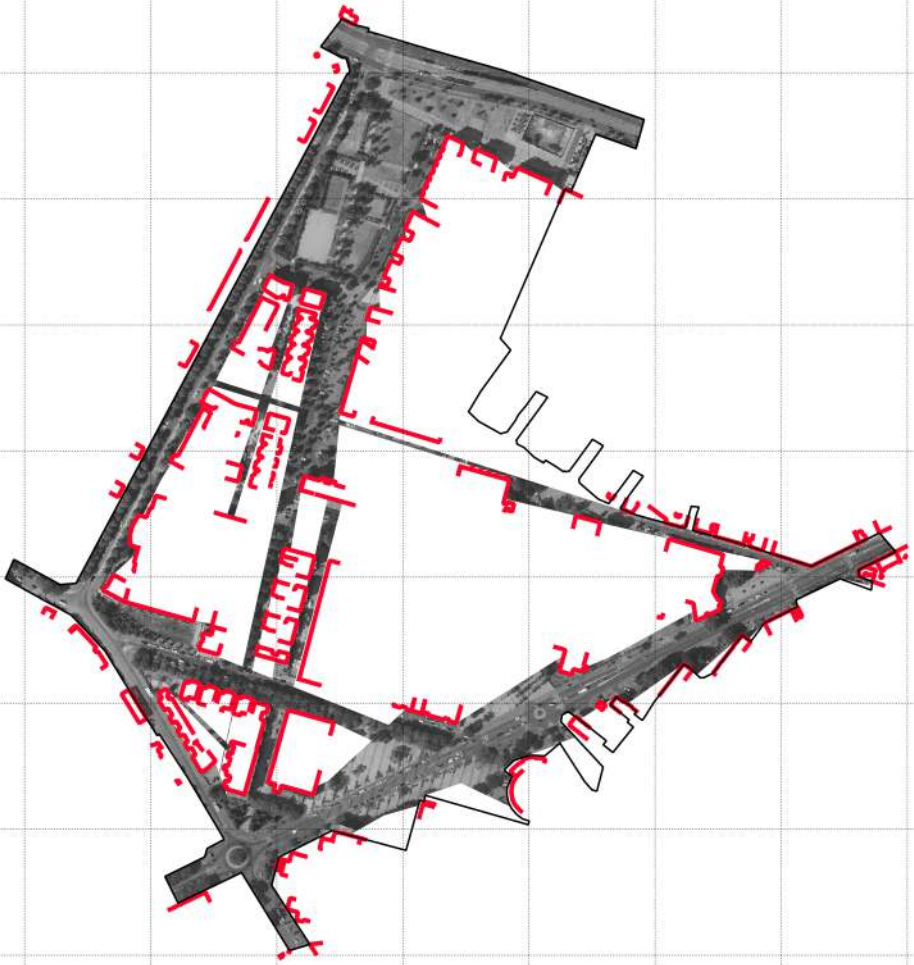
1:6000

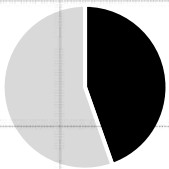
Exterior Permeability

With regard to tissue permeability, a number of noteworthy differences can be discerned, while in other instances, these are absent. Firstly, no increase in structural permeability is observed; the seen areas decrease from 51% to 44%. However, the structure of the surrounding areas allows new entrances to appear in these changes of structure, which, nevertheless, do not appear to significantly enhance the fabric's permeability. Conversely, the same structural configuration is evident as in the preceding analysis. Indeed, there is a striking resemblance between the fundamental structure of the tissue and the discernible regions of the tissue. Conversely, there are notable discrepancies in the characterisation of the visible areas. The structure of the free space indicates that the visible areas in the initial case have a larger section than those observed in the current project. It is also noteworthy that, although a kind of cross has indeed been generated, the cross-section of this indicates that the interaction is minimal and therefore of little relevance.

51.5 %
Surface visible [%]

In conclusion, although the overall permeability has increased, the section of the visible areas suggests that the relationship with the surrounding fabrics has not been enhanced, but rather maintained at a distance and in isolation.



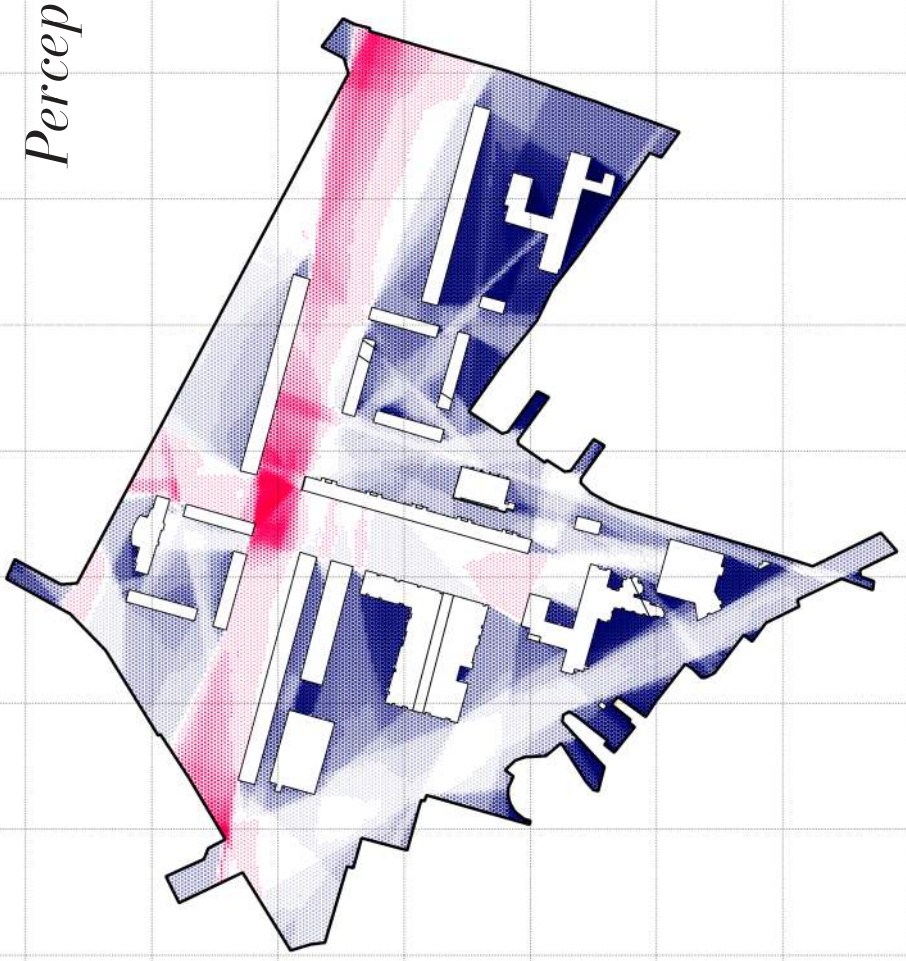


44.6 %
Surface visible [%]

Boundary delimiting the area of the analysis
Facade delimiting the viewshed

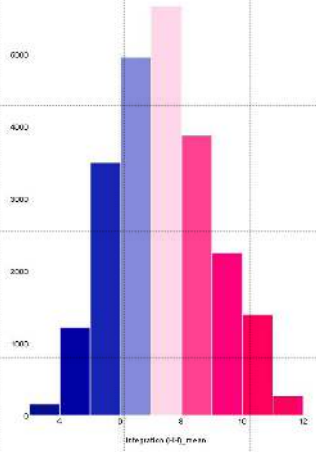
Figure 37. [left]. Visual sheeds from the main entry points to the original La Courneuve fabric. Source: author.

Figure 38. [right]. Visual sheeds from the main entry points to the present state of La Courneuve fabric. Source: author.



Hidden places

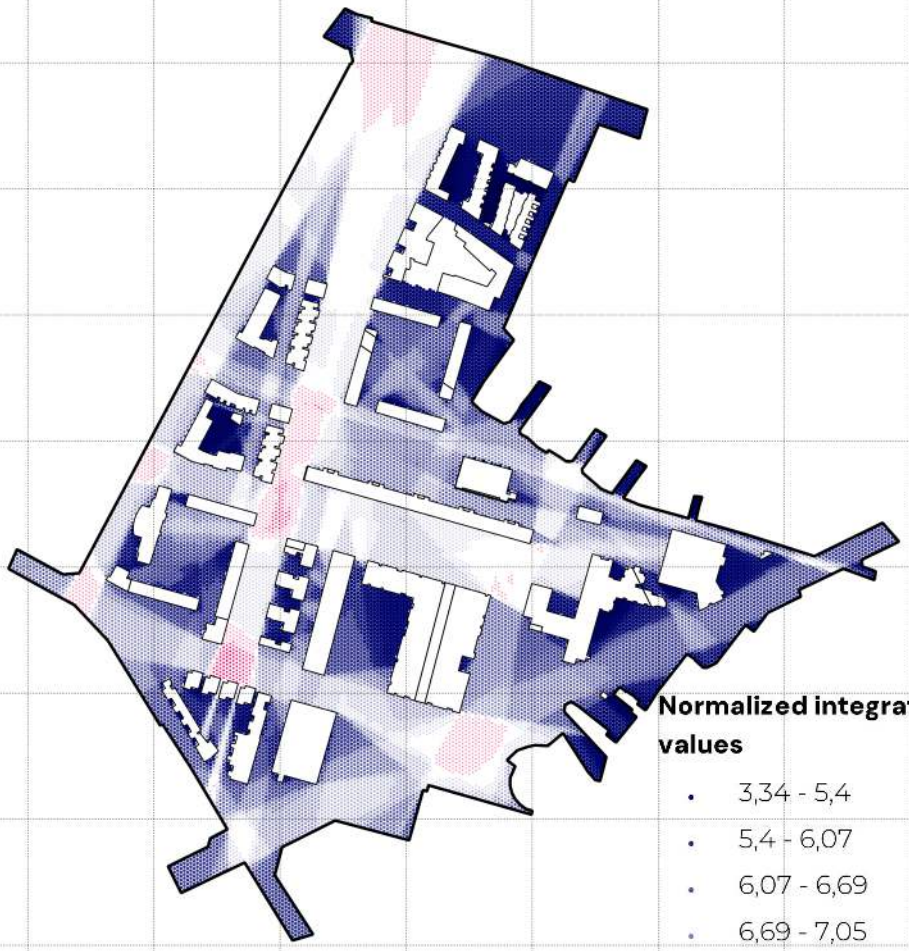
In terms of the distribution of hidden spaces, a clear trend can be observed: the reduction of the grain and the reduction of the average distance of the free space have promoted the appearance of a greater number of hidden spaces or corners. This indicates that the current fabric contains more hidden spaces than the previous fabric. This corroborates the preceding analysis and suggests the creation of a fabric with greater visual obscurity, both from external and internal perspectives. While this may result in the formation of spaces with a diminished sense of security, as discussed in the section 'Learning to Measure Space', the creation of expansive spaces can, at times, give rise to an enhanced perception of insecurity.

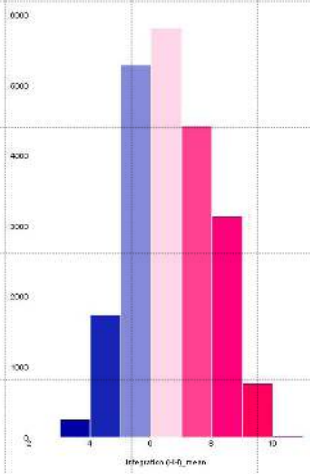


7.22
Median of the values indicating the hidden spaces

1:6000

This contradiction can be resolved through a more detailed analysis that considers both the materiality of the boundaries and a series of other environmental factors. However, this analysis will not elucidate the configuration of the space, which is undoubtedly more closed in the regeneration project than in the original fabric.





6.59
Median of the values indicating the hidden spaces

Figure 39. [left]. Grid of integration values in La Courneuve original state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Figure 40. [right]. Grid of integration values in La Courneuve present state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Perception

Large & more visible square-like spaces

The results of the second analysis are consistent with the hypothesis of densification of the fabric. The original configuration, characterised by a lack of hierarchy in the open spaces, exhibits a north-south continuity of open spaces with minor peaks at the perpendicular crossroads or in the wider spaces to the north of the fabric. In contrast, the second configuration demonstrates the dissolution of this continuity, giving rise to a different type of hierarchy. Here, the open spaces are dispersed in a more structured manner, reappearing at the main crossroads in the centre of the fabric, while the spaces at the edge of the fabric assume greater significance.

53.2 ha
Surface occupied by the highest values

1:6000

In conclusion, it can be observed that the regeneration project has resulted in a reduction of the continuity of the open spaces, with a subsequent limitation and, to some extent, relocation to the edges.

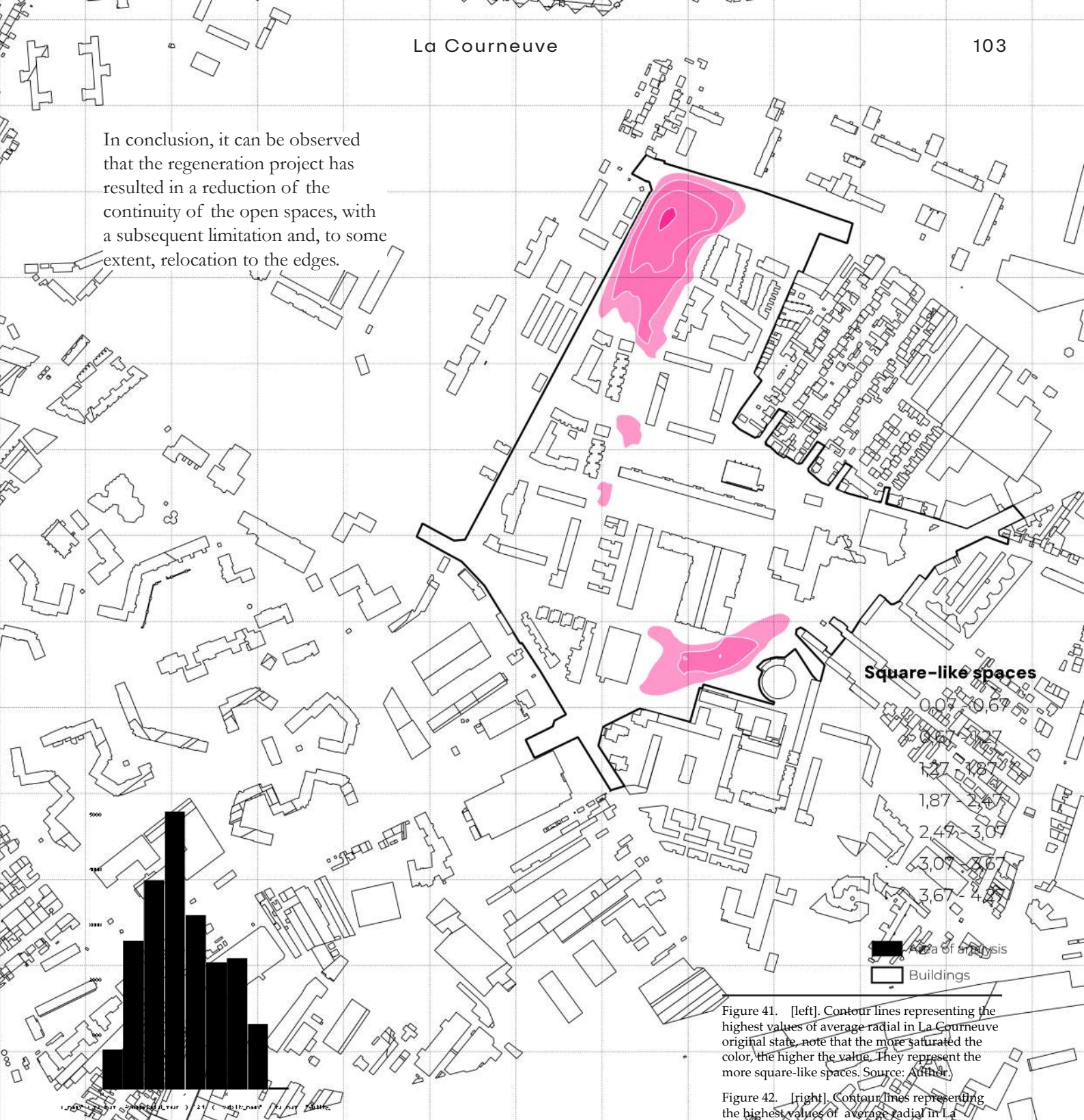


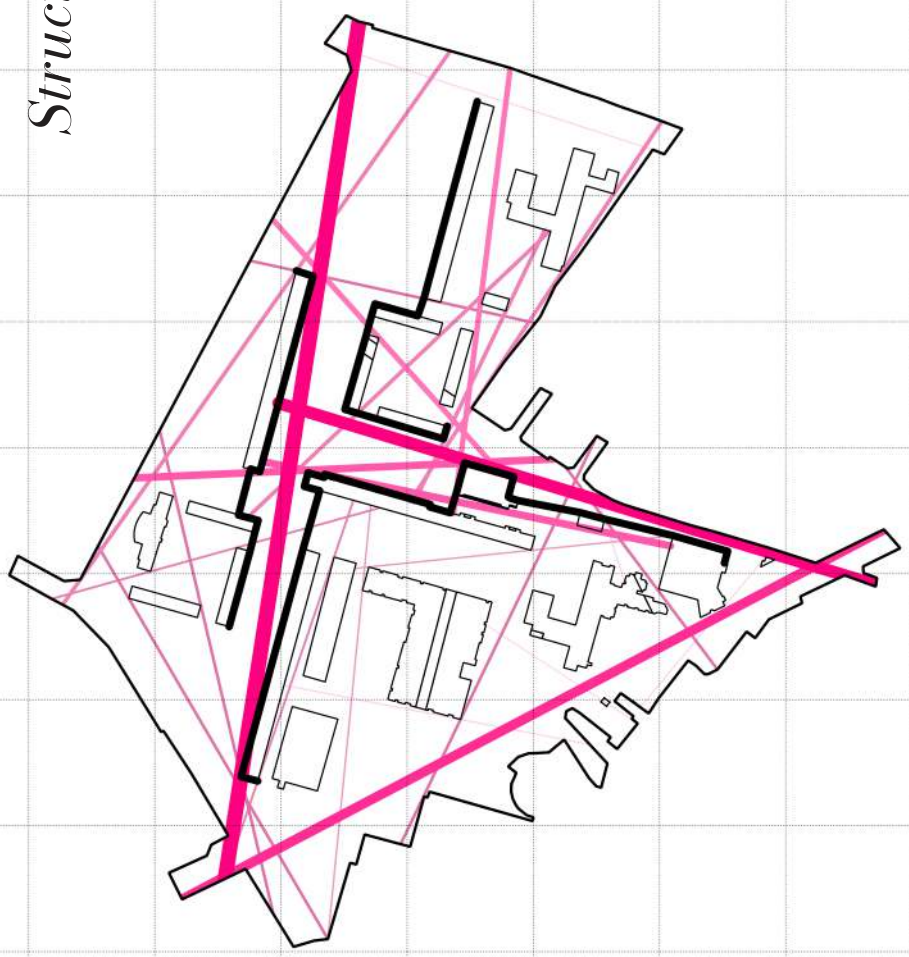
Figure 41. [left]. Contour lines representing the highest values of average radial in La Courneuve original state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

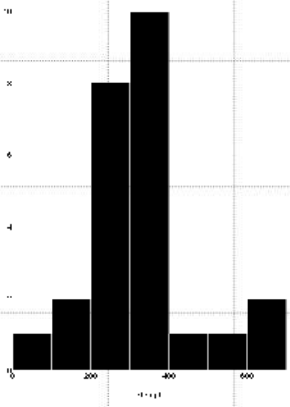
Figure 42. [right]. Contour lines representing the highest values of average radial in La Courneuve present state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

26.6 ha
Surface occupied by the highest values

Basic structure

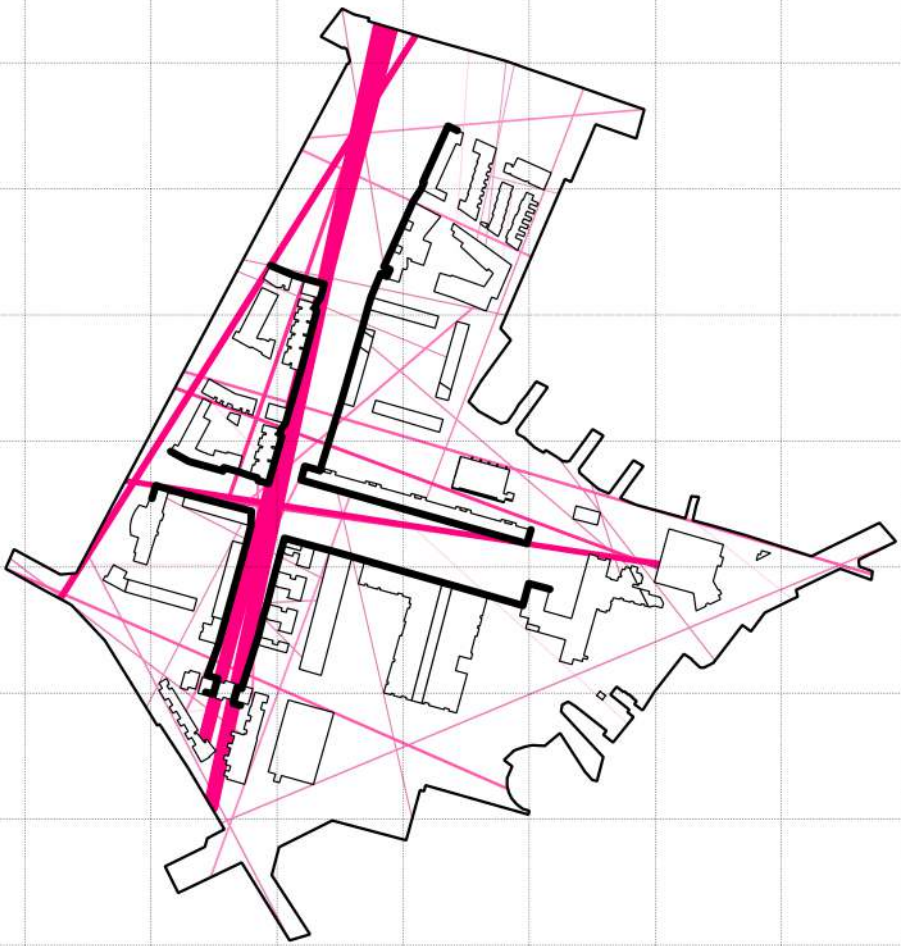
The regeneration project has resulted in a significant transformation of the original linear north-south structure, with the incorporation of a new axis that connects to the eastern part of the fabric. This has led to the creation of a crossing of axes, which appears to be establishing a new spatial centrality point in the centre of the fabric.

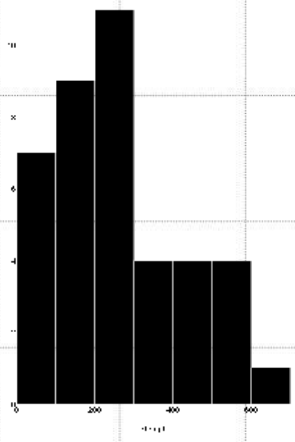




330 m
Average length of the axis

1:6000





213 m
Average length of the axis

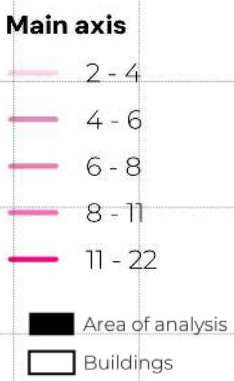
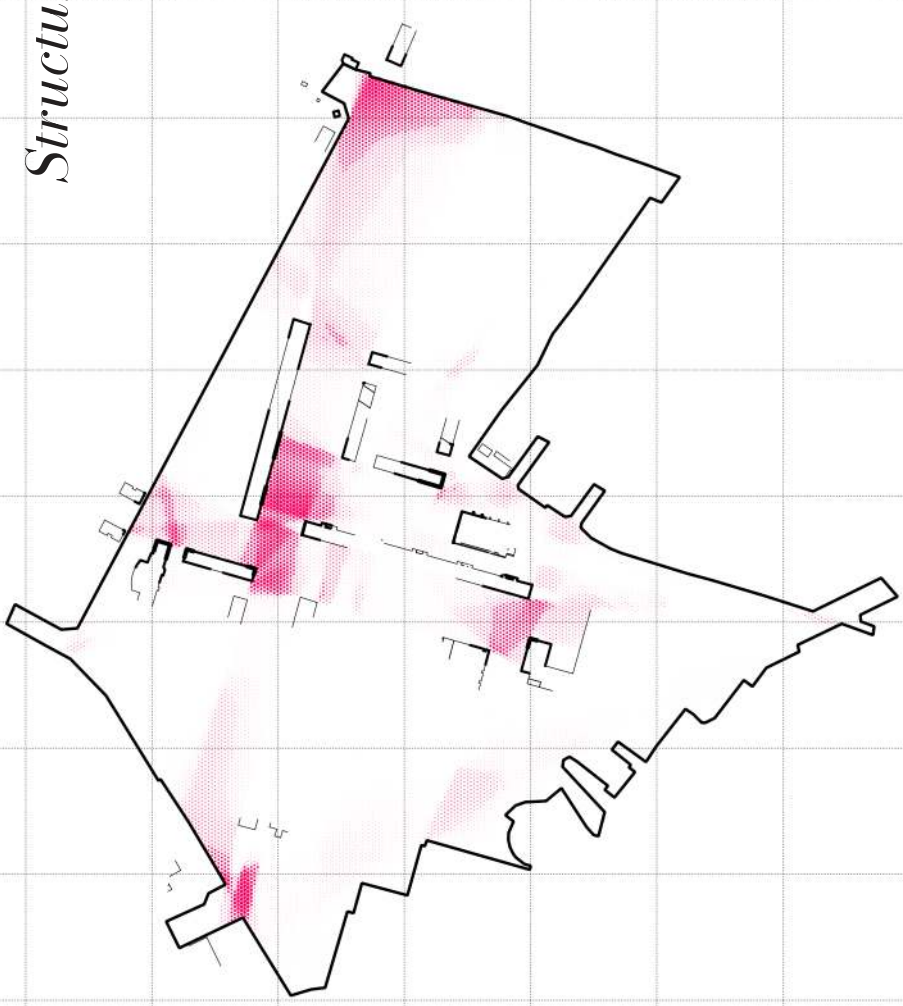


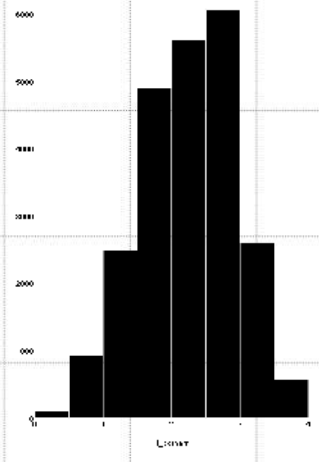
Figure 43. [left]. Fewest-Line Map of the original La Courneuve fabric. Source: Author.

Figure 44. [right]. Fewest-Line Map of the present La Courneuve fabric. Source: Author.



Centric Corners

Finally, the examination of the corners, understood as points of intersection, of encounter, and of co-presence, corroborates the process that has been identified throughout the analyses. The delineation of free spaces has permitted the multiplication of spaces of multiple presence, which manifest with greater intensity in the centre of the fabric. This is due to the greater multiplicity of relations that a smaller grain allows, which in turn increases the possibilities of meeting in the central environment. Consequently, the reduction in grain results in an increase in the diversity of potential routes, leading to a greater overall value, even in areas that have not been directly modified. This illustrates the far-reaching impact of the interventions on the entire fabric.



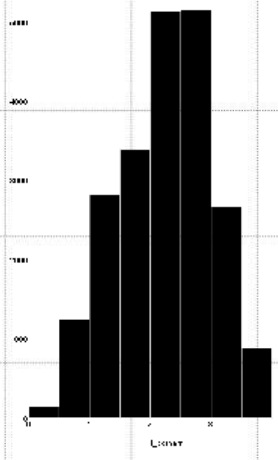
1:6000

2.27

Median of the normalization of values indicating the centric corners

Figure 45. [left]. Grid of choice and overt control values in La Courneuve original state, note that the more pinl the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Figure 46. [right]. Grid of choice and overt control values in La Courneuve present state, note that the more pink the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.



2.3
Median of the normalization of values indicating the centric corners

Empalot, Toulouse

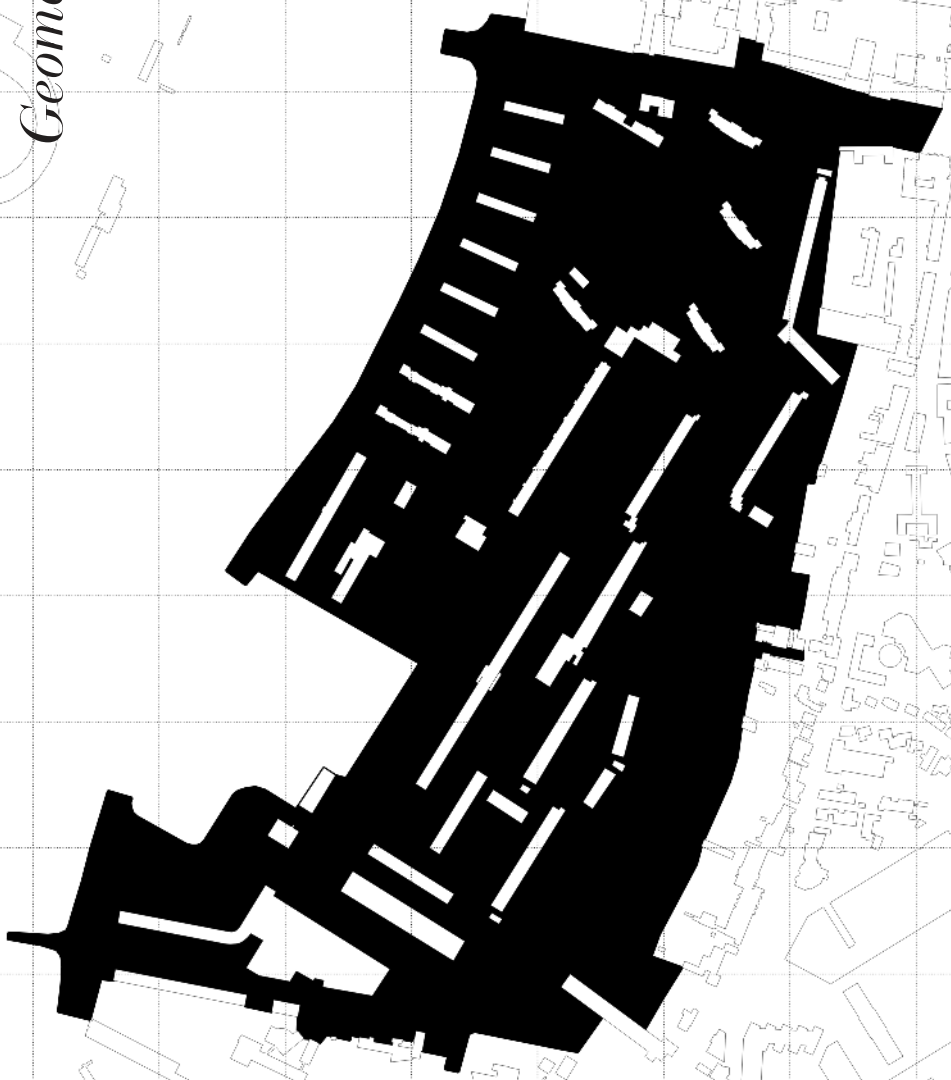
Surface	**27 ha**
Year or construction	**1948**
Year of renovation	**2009**
Built surface [%]	**18.5 %**
Budget	**100,000,000.00 €**

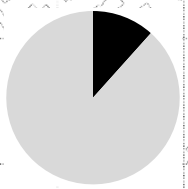
The Empalot neighbourhood is located in the southwestern part of Toulouse. It has a long and distinguished historical background, dating back to the industrial revolution. Originally characterised by factories and warehouses, it was established due to its location outside of the historic centre and next to the river. However, it suffered a significant economic and social decline in the late 20th century due to the relocation of some of the industries. This resulted in a lack of maintenance of the infrastructure, vacant buildings, and a decline in the population.

At the urban level, the Empalot regeneration project is characterised above all by its ability to localise and reinforce existing spatial dynamics. On the one hand, it locates the views and the relationship of the spaces to the surrounding fabric and arranges them in such a way as to create more linear and delimited spaces. However, this is not to the detriment of the free spaces, which become more concave and less linear with the new organisation, which favours their composition as central spaces, as can be seen in the cross-reference with the analysis of centralities, where this dynamic is clearly observed as a whole.

Figure Ground

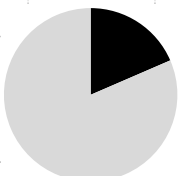
This analysis demonstrates how modifications have occurred, particularly in the southern and eastern regions of the fabric. Firstly, the linear blocks have been replaced by more compact typologies. Secondly, there has been a general densification of land cover, increasing from 11.6% to 18.5%. It is also noteworthy that modifications have been made on the east-west axis, approximately halfway through the fabric. This appears to have resulted from the demolition of some of the older linear blocks, which has created an opening in this direction. Conversely, the absence of intervention in the northern and western sections of the fabric is noteworthy, both in terms of their spatial and material configuration.





11.6 %
Surface occupied by buildings [%]

1:6000



18.5 %
Surface occupied by buildings [%]

Area of analysis
Buildings

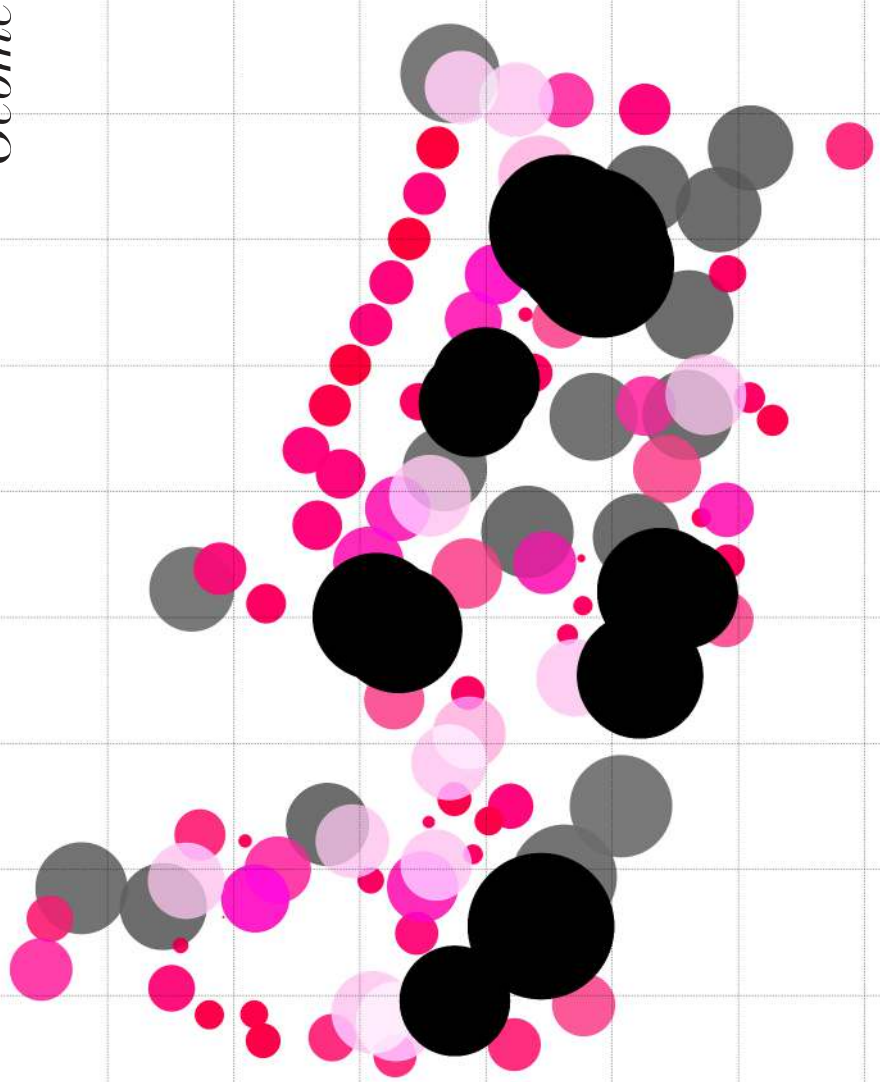
Figure 47. [left]. Figure-ground map,representing in black the space not occupied by buildings in the original state of Empalot. Source: Author.

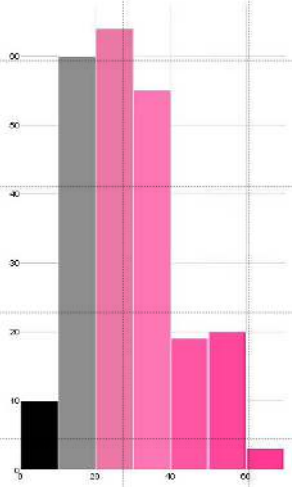
Figure 48. [right]. Figure-ground map,representing in black the space not occupied by buildings in the present state of Empalot. Source: Author.

In-between distances

This analysis corroborates and elucidates certain assertions posited in the preceding analysis. It is evident that the southern part of the fabric has undergone a process of densification and reduction of open spaces as a result of the increase in land cover that has occurred following the replacement of the original buildings. Moreover, the incorporation of new built-up areas to the east of the road, which previously functioned as a border, not only reduces the internal distances but also improves the continuity of the urban fabric.

It seems that the reduction of distances has resulted in an increase in both the density of the fabric and the potential for interaction within it.

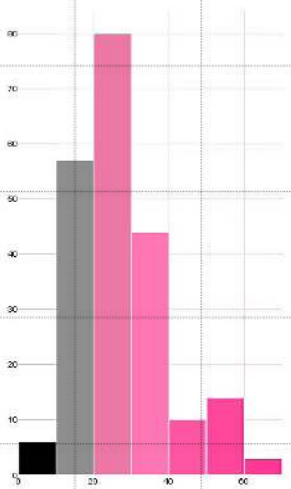




28.39 m
Average radius

1:6000

However, the structure of the free space still exhibits considerable distances at the edges, which may indicate a degree of isolation of the fabric with respect to the surrounding city, particularly in the middle and northern parts, due to the lack of interventions in this area. In general, there has been a reduction in diameter (due to the aforementioned densification) from 28 to 27 metres. With regard to diversity, the standard deviation has decreased from 13.05 to 11.8. This has resulted in a slight reduction in diversity in open space, particularly in the southern part of the fabric. Nevertheless, the sustained existence of extensive territories to the north endows the fabric with a spectrum of spatial configurations.



27.30 m
Average radius

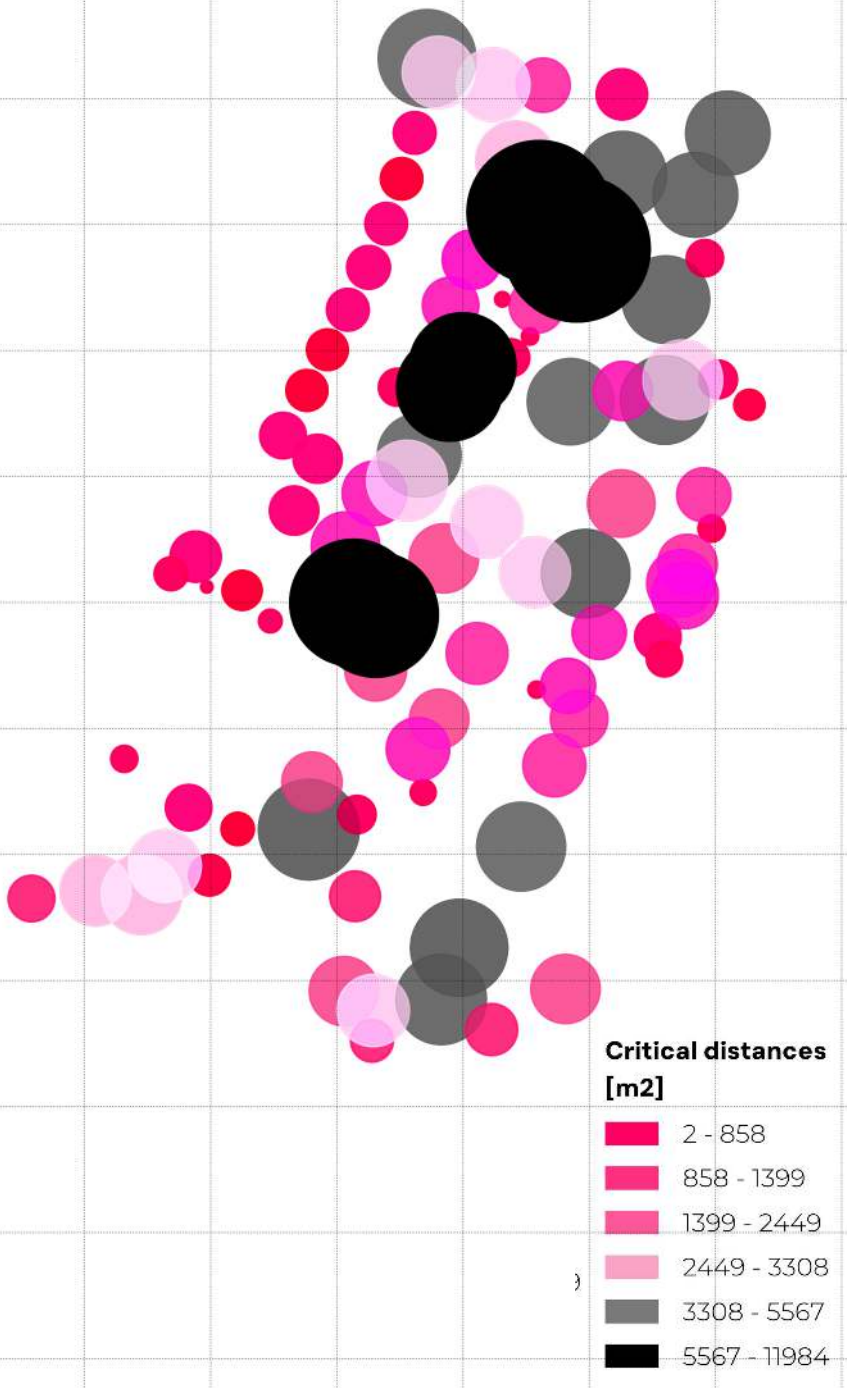
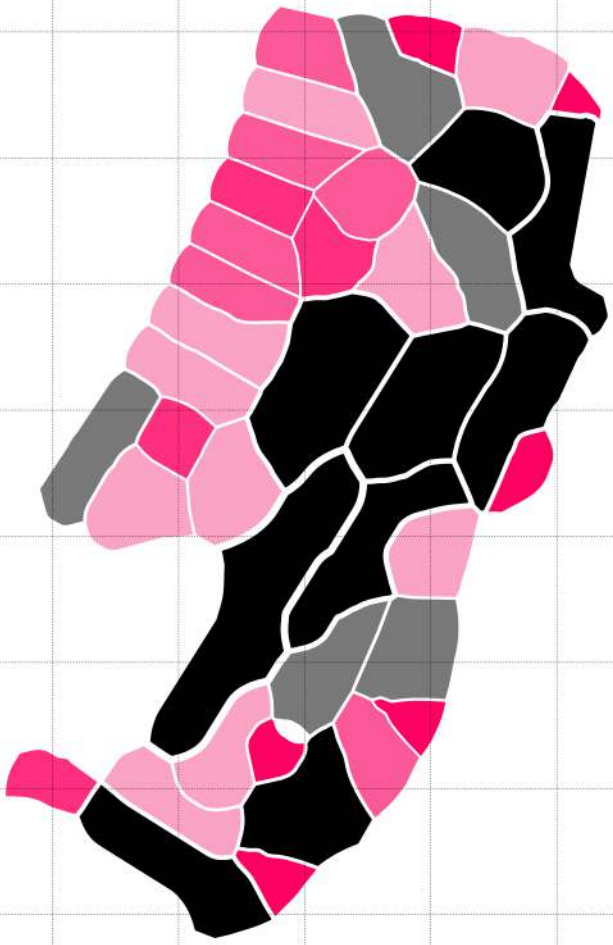


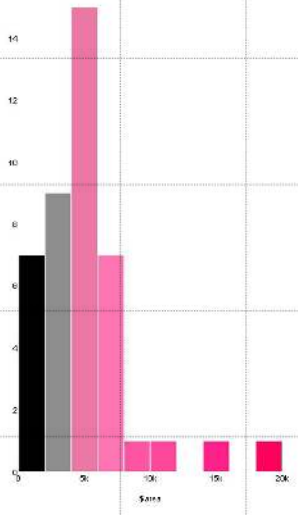
Figure 49. [left]. Critical distances of the open spaces around the original Empalot fabric. Source: Author.

Figure 50. [right]. Critical distances of the open spaces around the actual Empalot fabric. Source: Author.

Urban Grain

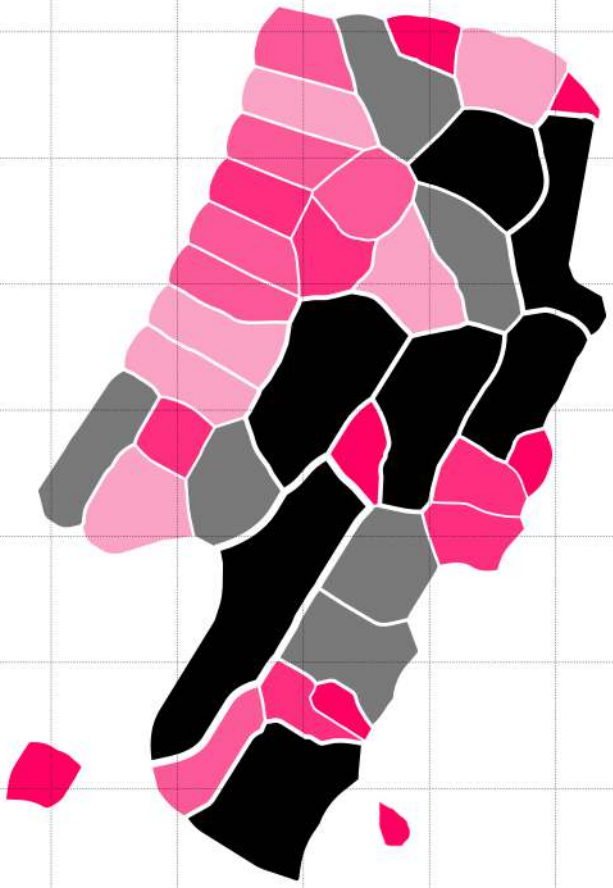


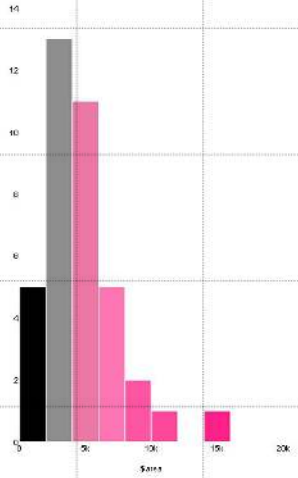
It is noteworthy that the representation of the spatial units in this analysis exhibits variation when observed in relation to the influence of the built elements. It is also noteworthy that the areas of the fabric that have undergone the most significant intervention or have undergone a complete transformation are observed. However, this analysis does not delve into how these changes have affected the rest of the fabric. It is noteworthy that the paths following the perimeters exhibit distinct characteristics. In the original project, the layout appears to be staggered along the central axis. However, the regeneration project has opted for a more orthogonal concatenation of the built elements.



5,140 m²
Average surface

1:6000





4,723 m²
Average surface

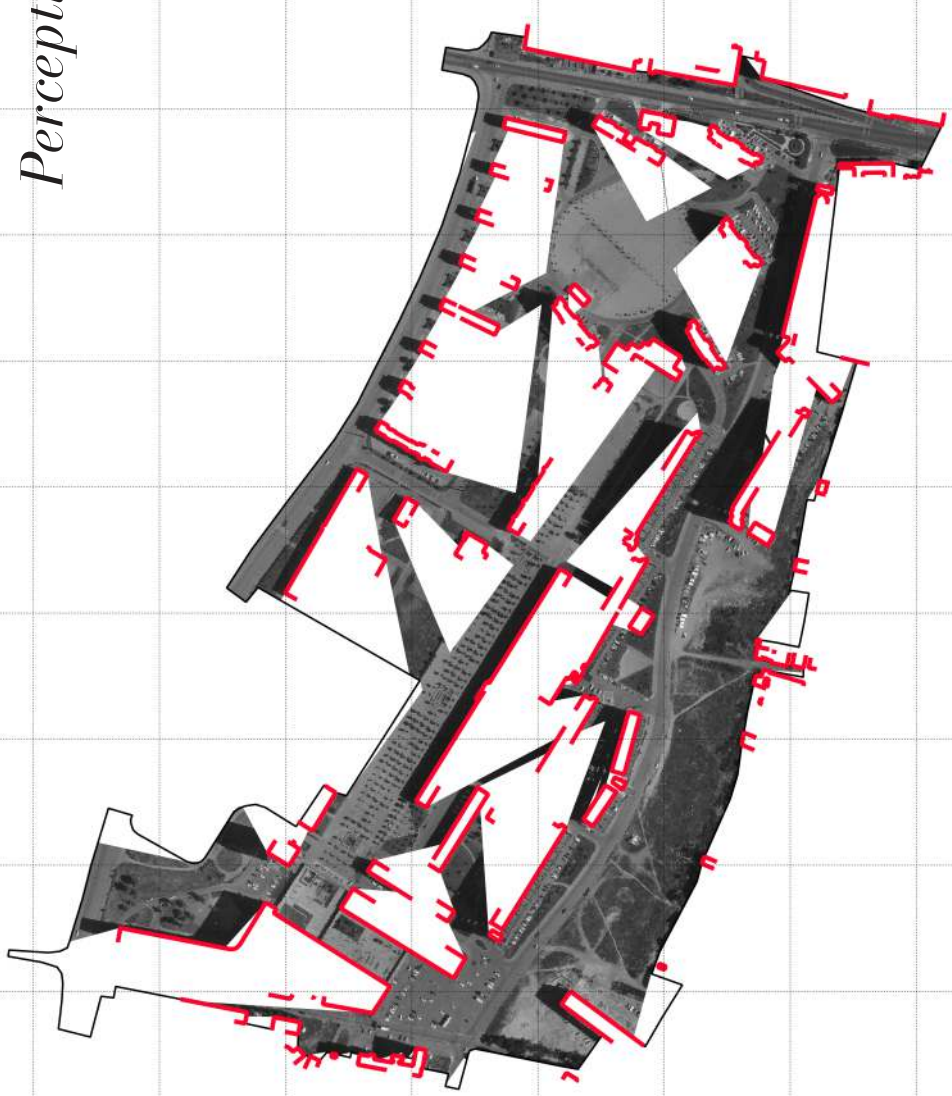
Surface

- 571 - 2431
- 2431 - 3370
- 3370 - 4091
- 4091 - 5208
- 5208 - 6503
- 6503 - 15309

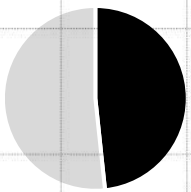
Figure 51. [left]. Basic grain and skeleton of the original Empalot fabric. Source: Author.

Figure 52. [right]. Basic grain and skeleton of the present Empalot fabric. Source: Author.

Exterior Permeability



In fact, this analysis demonstrates a synthesis of the preceding conclusions. The structure of the open spaces in the original project is notable for its lack of hierarchy, which, in terms of permeability, nevertheless translates into a widening of the visible section. This results in spaces that are not visible from the outside of the fabric being smaller than in the current situation. However, the lack of specificity of these visual basins may be a crucial factor to consider. In contrast, the current project has defined the visuals from the outside, resulting in visuals that appear to have a stronger relationship with one another. This is evidenced by the fact that, in a direct manner or with a relatively consistent section, it is possible to visualise the entrance and exit route.

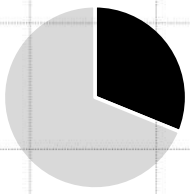


61.2 %
Surface visible [%]

1:6000

Boundary delimiting the area of the analysis

Facade delimiting the viewshed

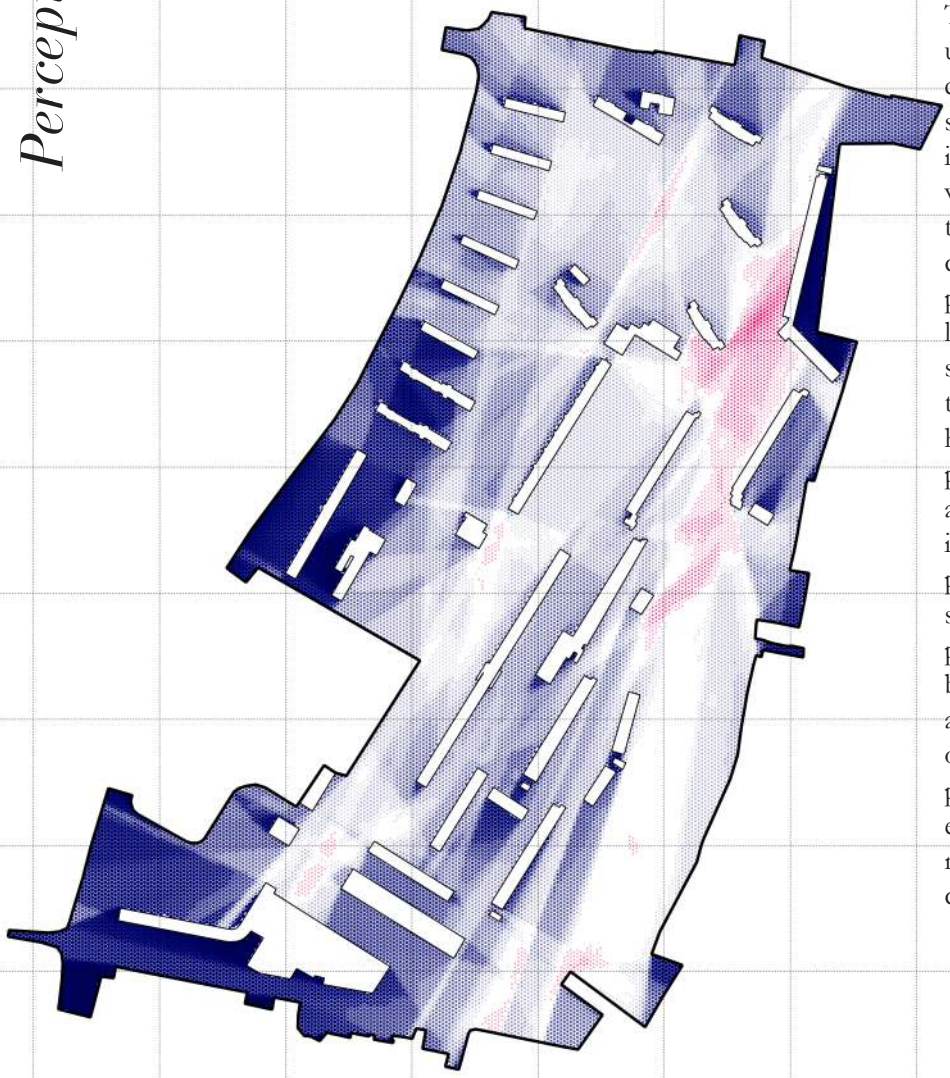


49.5 %
Surface visible [%]

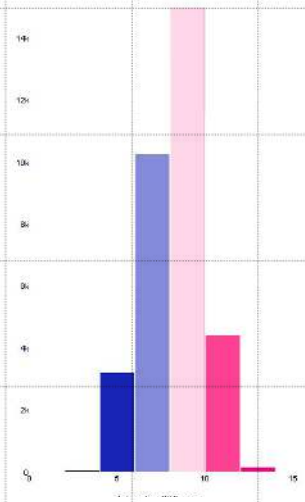
Figure 53. [left]. Visual sheeds from the main entry points to the original Empalot fabric. Source: author.

Figure 54. [right]. Visual sheeds from the main entry points to the present state of Empalot fabric. Source: author.

Hidden places



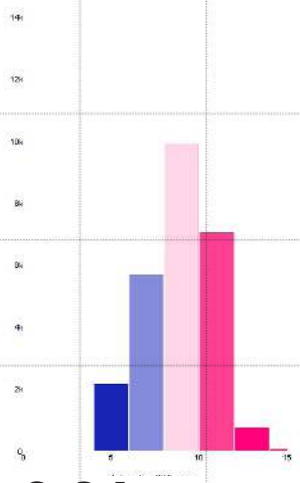
This series of analyses builds upon the preceding analysis by demonstrating how the current situation has resulted in a reduction in the number of hidden spaces within the fabric, while maintaining the existing configuration to a certain extent. In the original project, it can be observed that the largest hidden areas in terms of spatial configuration are located at the edges of the fabric. These areas have the least possibility of multiple presence, and hidden spaces also appear around the axes previously identified. It is evident that in the present circumstances, the hidden spaces persist in the peripheral areas, particularly in the interstitial spaces between buildings. These spaces appear to diminish in distance from one another, thereby creating "dark" pockets that then give rise to the emergence of the aforementioned new axes, which manifest as a concatenation of visible spaces.



8.41

Median of the values indicating the hidden spaces

1:6000



9.24
Median of the values indicating the hidden spaces

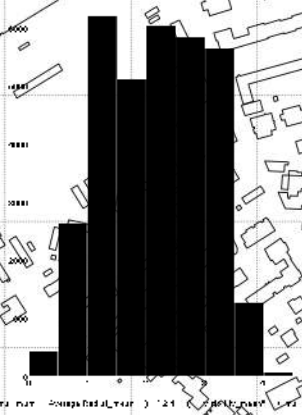
Figure 55. [left]. Grid of integration values in Empalot original state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Figure 56. [right]. Grid of integration values in Empalot present state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Perception

Large & more visible square-like spaces

The findings of the preceding analysis are now able to be interpreted in a meaningful way. Firstly, the extensive open spaces present in the south-eastern section of the original fabric have evidently been diminished as a consequence of the densification of the fabric. In contrast, the configuration of open spaces in the northern part has remained largely unaltered. Conversely, the configuration of the new densification has resulted in the emergence of additional peaks of open space, distributed more widely and concentrated at what appears to be the crossroads of axes, as will be observed in a subsequent analysis. Furthermore, the structure of the open spaces to the north, despite remaining essentially unchanged, exhibits variation in contour due to the effect of the reconfiguration of the open space to the south.



48 ha

Surface occupied by the highest values

1:6000

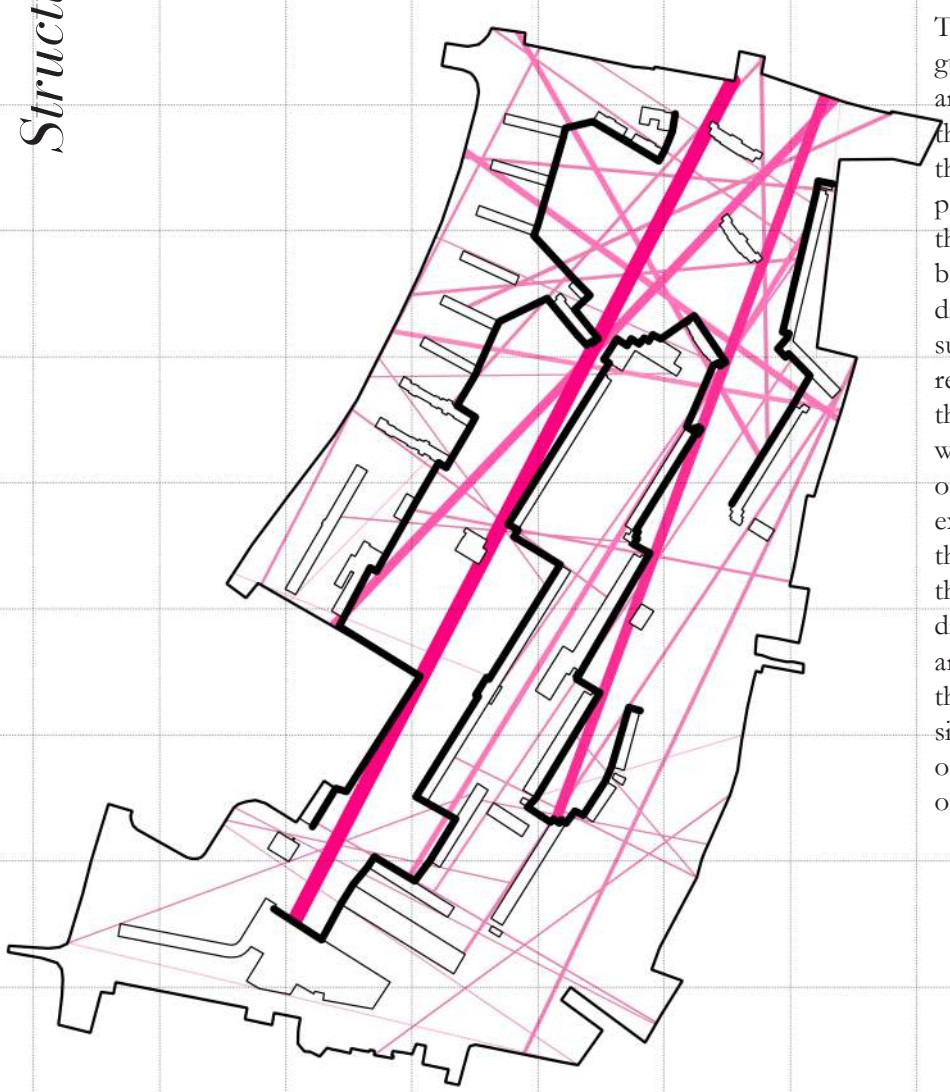
Figure 57. [left]. Contour lines representing the highest values of average radial in Empalot original state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

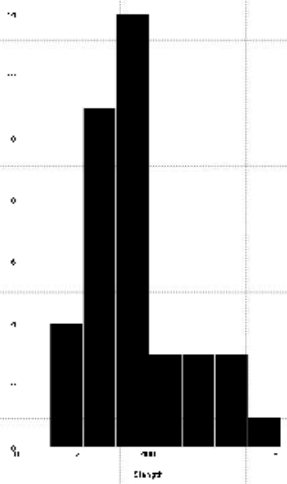
Figure 58. [right]. Contour lines representing the highest values of average radial in Empalot present state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

41.45 ha
Surface occupied by the highest values

Basic structure

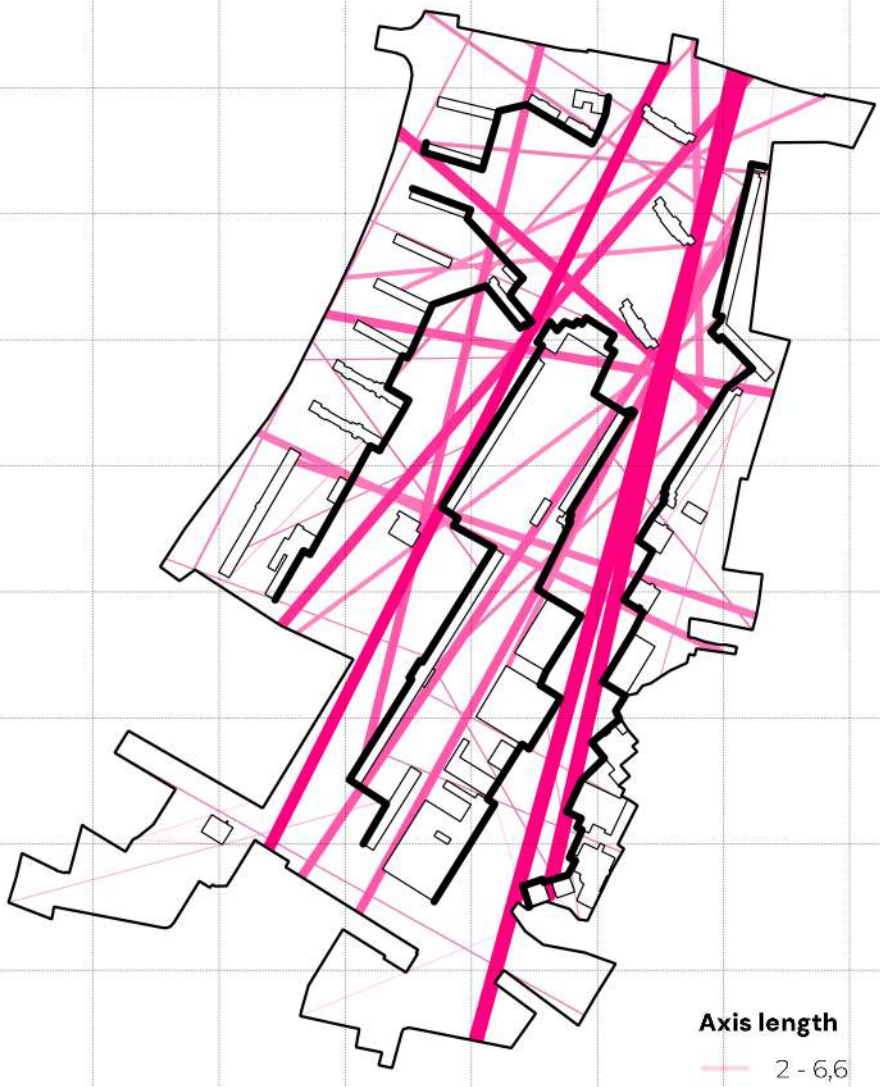
The advantages of the spatial configuration of the regeneration project are evident in this instance. Firstly, the original project demonstrates the concatenation of free spaces, particularly within the interior of the fabric, with what appears to be a significant axis. This will be discussed in greater detail in the subsequent analysis. In contrast, the regeneration project has facilitated the reorganization of built elements, which has resulted in the creation of new axes. The strengthening of existing axes is evident, including the greater relevance of the axis on the eastern edge of the fabric. Additionally, new axes appear and are arranged in a transversal manner to the fabric, with a particular emphasis on the axis situated in the centre of the fabric, which connects with one of the entrances.

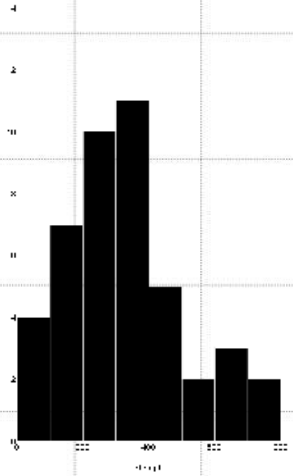




1:6000

312 m
Average length of the axis





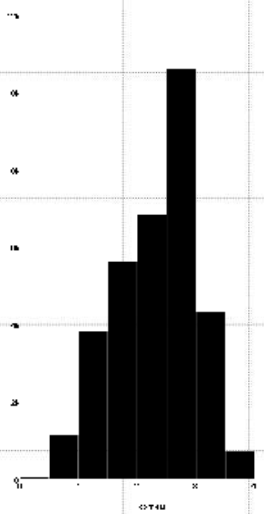
303 m
Average length of the axis

Figure 59. [left]. Fewest-Line Map of the original Empalot fabric. Source: Author.

Figure 60. [right]. Fewest-Line Map of the present Empalot fabric. Source: Author.

Centric Corners

Although the evidence suggests that there has been a significant spatial differentiation between the centralities of the original project and the current situation, it is evident that the vast free spaces in the northern part of the fabric have shifted the centre's focus towards the north, thereby diminishing the project's overall importance. It is evident that certain interventions have facilitated the emergence of new centres in the central part of the fabric, thereby reinforcing its centrality. Moreover, these centres may have established connections with the new areas to the south. However, the absence of a defined hierarchy in the original fabric results in the loss of potential multiple presence in spaces, particularly in the southern section of the fabric, which has received the majority of investment.



1:6000

2.45

Median of the normalization of values indicating the centric corners

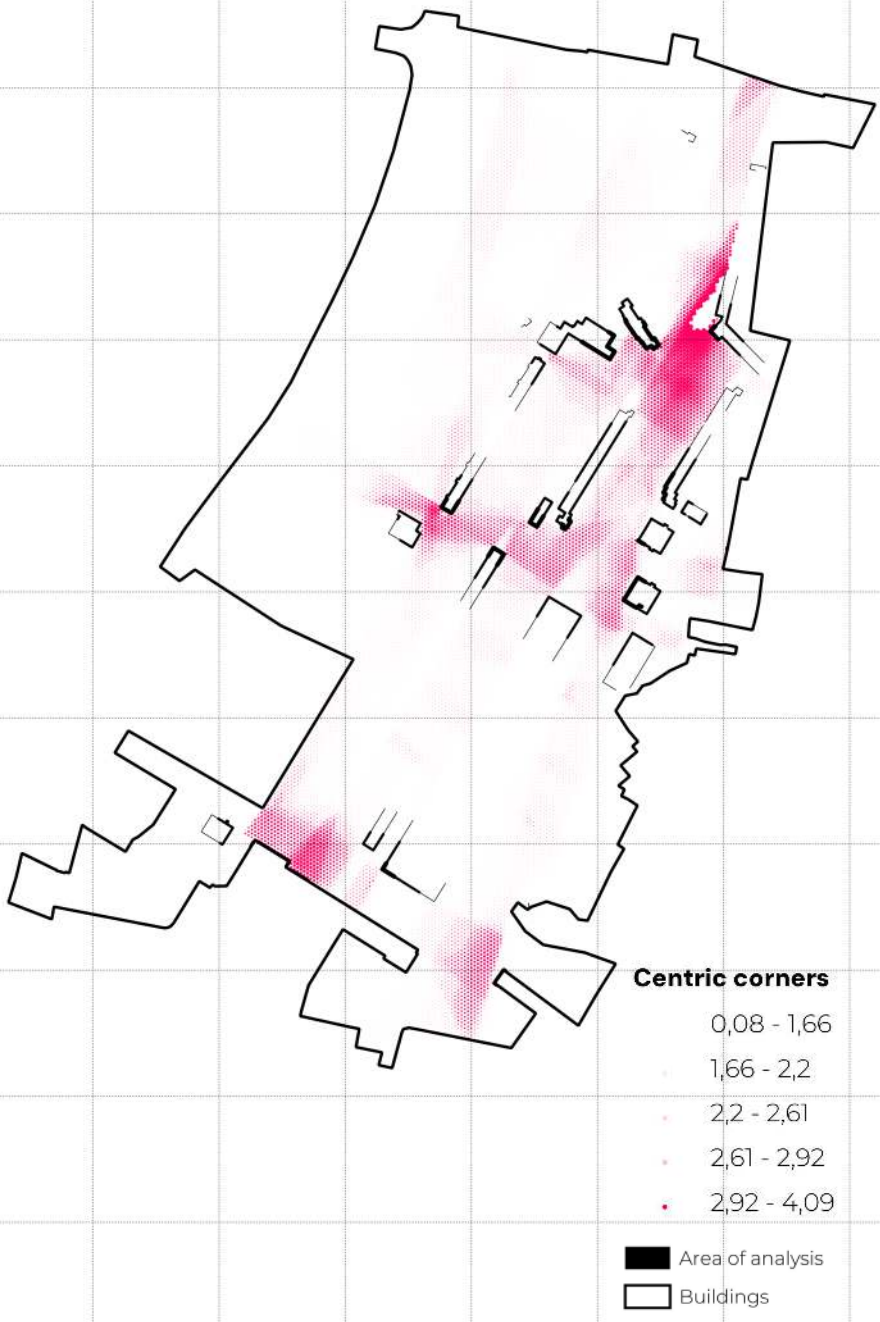
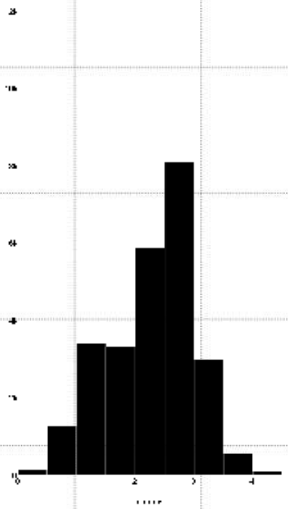


Figure 61. [left]. Grid of choice and overt control values in Empalot original state, note that the more pinl the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Figure 62. [right]. Grid of choice and overt control values in Empalot present state, note that the more pink the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.



2.3
Median of the normalization of values indicating the centric corners

Les Courtillieres, Ivry-Sur-Le-Seine

Surface	**27 ha**
Year or construction	**1956**
Year of renovation	**2007**
Built surface [%]	**22 %**

Budget	**44,671,000.00 €**

The neighbourhood of Les Courtillères in Pantin, near Paris, has undergone a significant regeneration process since the early 2000s. Originally conceived as a social housing estate in the 1960s, Les Courtillères faced problems of decay and a negative reputation associated with crime and poverty.

The regeneration process has included interventions ranging from the renovation of existing buildings and the construction of new housing, to the development of social programmes, with a focus on increasing diversification and improving the quality of life.

New public spaces and green areas have been created, promoting a more welcoming and dynamic environment. Although there has been progress, Les Courtillères faces the challenge of overcoming the stigma associated with the area and ensuring that the benefits of regeneration reach all residents, avoiding displacement of the original population. This case study will explore how the regeneration process has promoted the improvement of perception through the evolution of its spatial structure.

Geometry

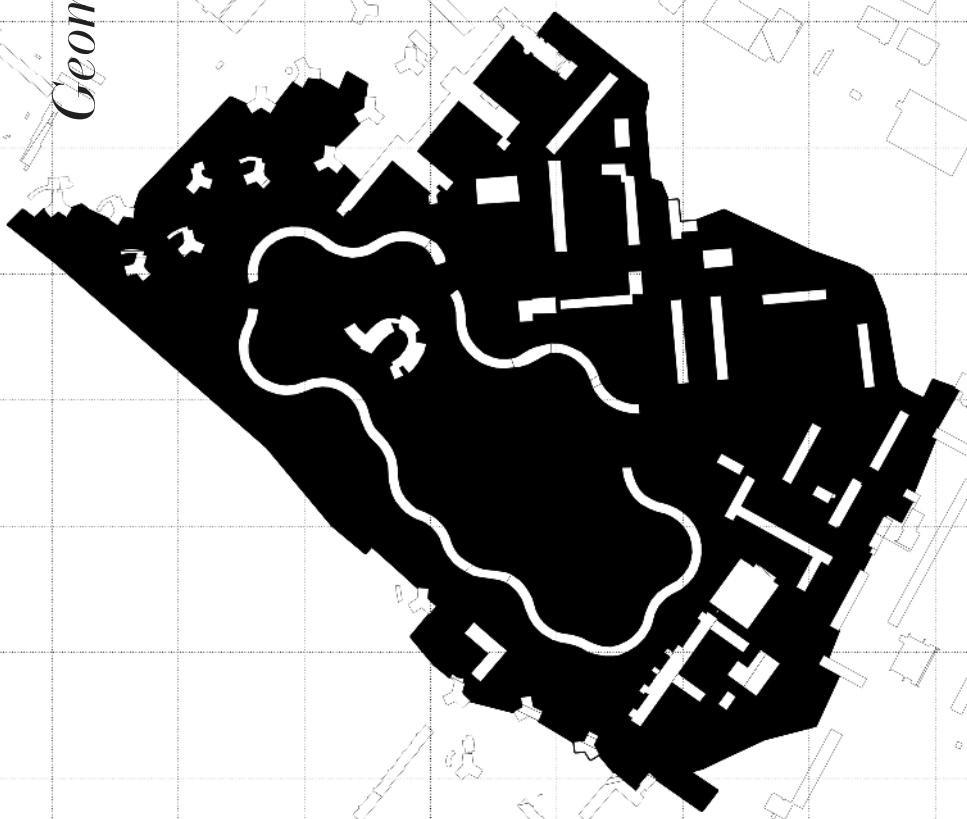
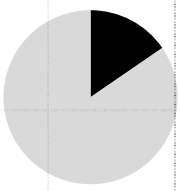


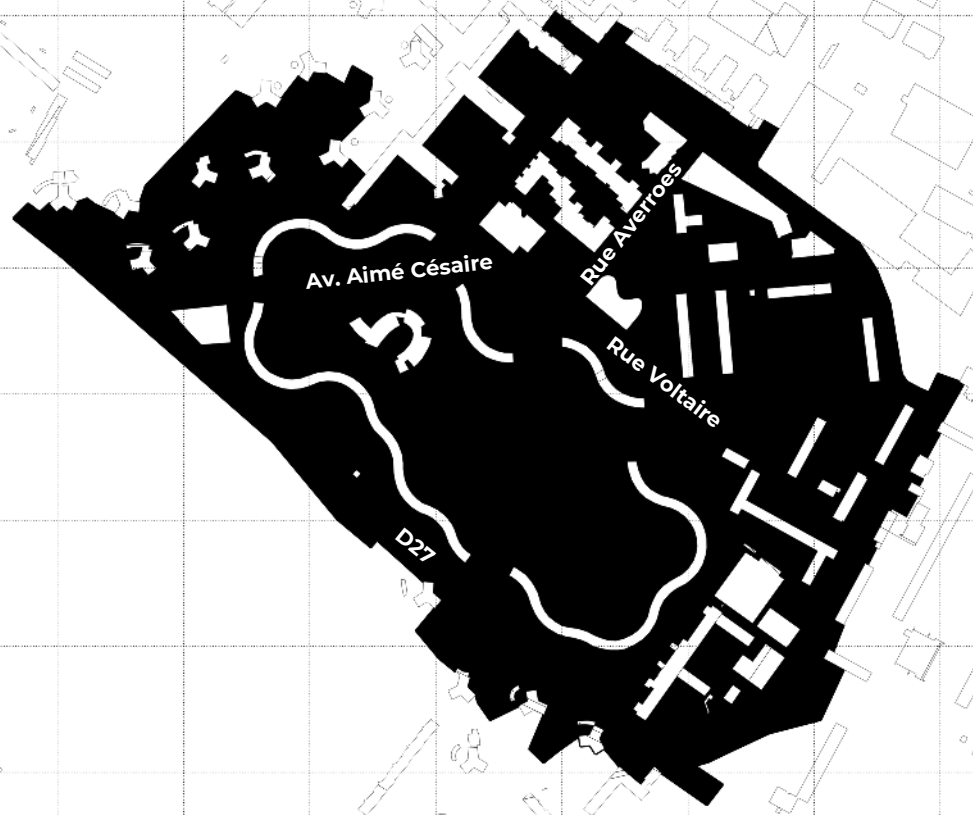
Figure Ground

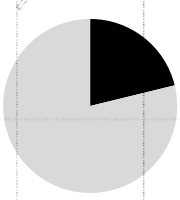
Two principal dynamics can be discerned in the regeneration process of Les Courtillieres. The initial and most apparent transformation is the substitution of the northern section's structural framework, which has also undergone a process of densification, with the replacement of the linear blocks by more compact typologies with a larger bay. This configuration deviates from the original orientation and instead aligns with the existing urban fabric surrounding it. However, it maintains the axis established by the opening in the great "serpentine" while introducing new openings. The second dynamic is the regeneration of the serpentine, the undulating building that occupies the majority of the fabric. This process is relatively more subtle. Despite undergoing a comprehensive regeneration process, the complex is notable for the selective extractions that have taken place, resulting in the creation of two new openings in both the southern and northern sections.



15,4 %
Surface occupied by buildings [%]

1:6000





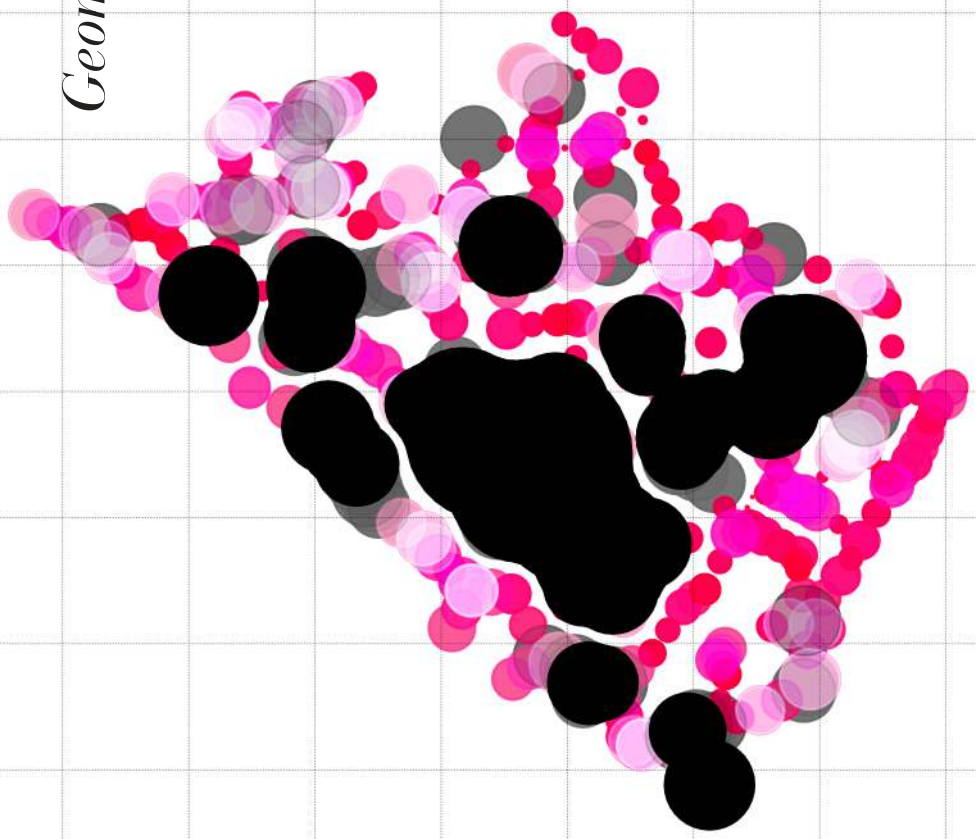
22 %
Surface occupied by buildings [%]

Area of analysis
Buildings

Figure 63. [left]. Figure-ground map,representing in black the space not occupied by buildings in the original state of Les Courtillieres. Source: Author.

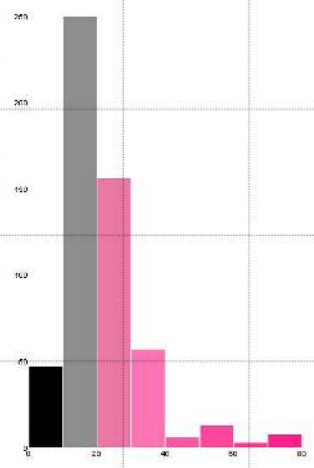
Figure 64. [right]. Figure-ground map,representing in black the space not occupied by buildings in the present state of Les Courtillieres. Source: Author.

Geometry



In-between distances

In this analysis, an examination of the "interior" of the complex reveals a paucity of discernible alterations. In any case, the configuration of the built space has undergone a process of simplification, whereby it has transitioned from an enclosed, undulating space to one constructed through the concatenation of undulating blocks. This has resulted in a reduction in the number of circumferences required to describe the space.

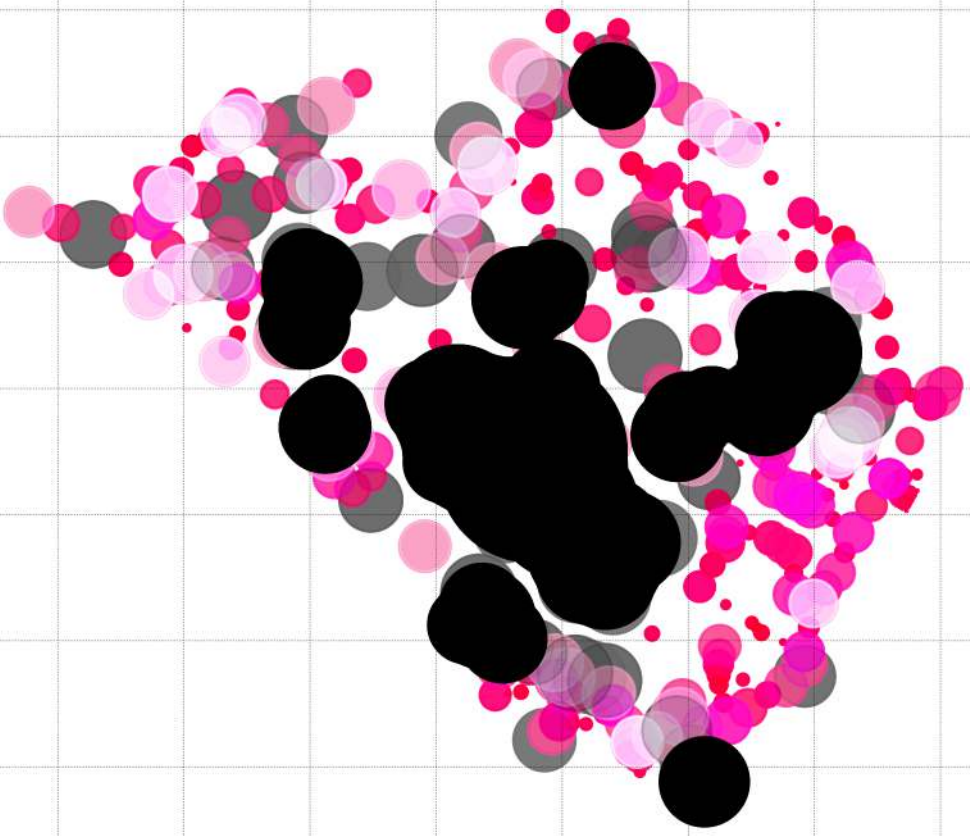


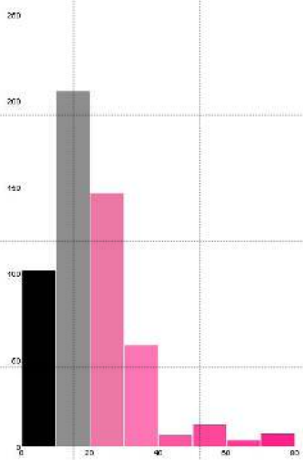
21.8 m
Average radius

1:6000

Conversely, the renovation of the space to the north of the complex appears to have constrained the free spaces that extended along the diagonal axis, relocating them to the south of the complex.

In contrast, the opening has facilitated a crossing of spaces in the southern part of the complex, resulting in a widening of the distance at the edge of the fabric. This could potentially lead to issues of isolation, which will be addressed in subsequent analyses.



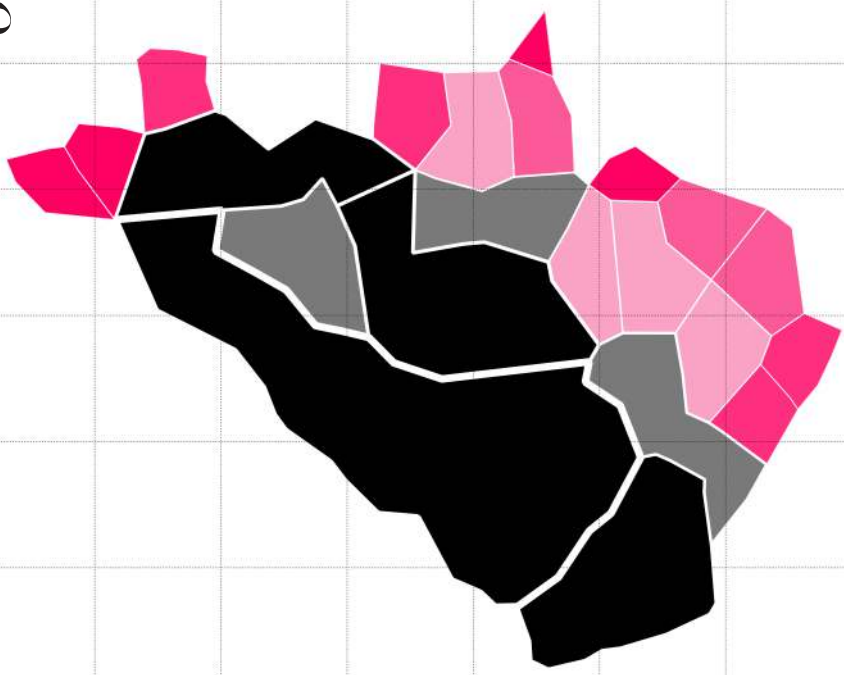


19.7 m
Average radius

Figure 65. [left]. Critical distances of the open spaces around the original Les Courtillieres fabric. Source: Author.

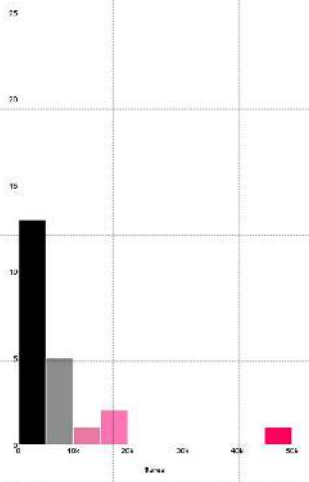
Figure 66. [right]. Critical distances of the open spaces around the actual Les Courtillieres fabric. Source: Author.

Geometry



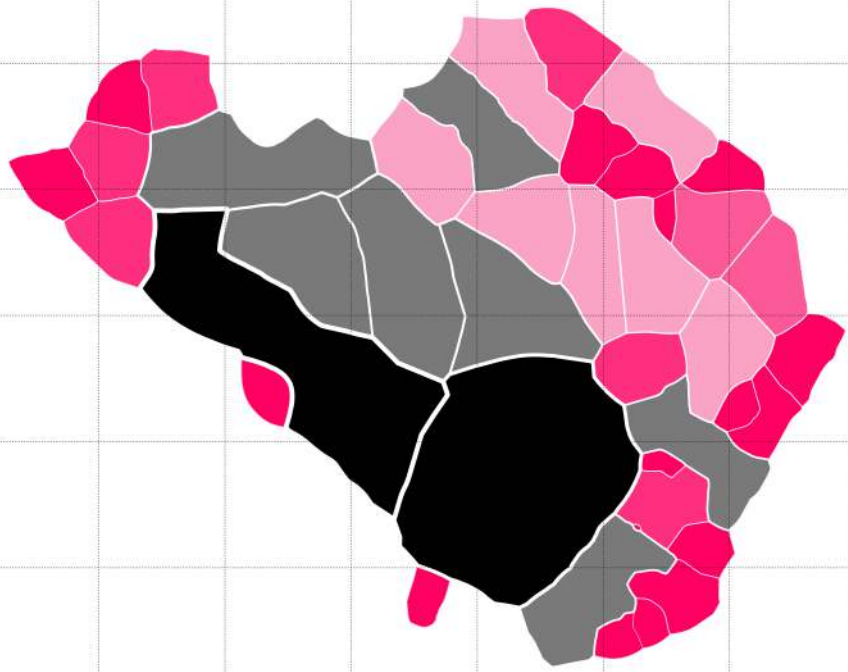
Urban Grain

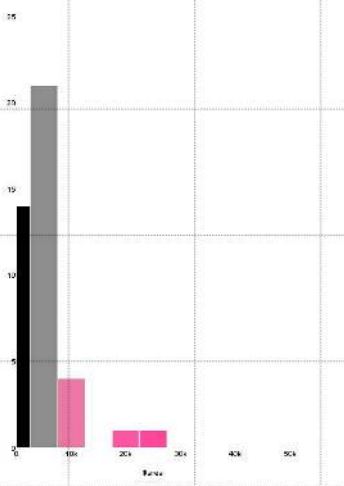
The principal alteration discernible in this analysis is the fragmentation of the primary complex. As previously indicated, the spatial configuration appears to undergo a transformation, shifting from a state defined by a singular, punctual opening to a fabric constituted by disparate elements sharing a similar typology. While the scale of these fragments persists in defining their importance, it is evident that they delineate the boundaries between interior and exterior spaces. Furthermore, the surface and perimeter of the resulting areas exhibit a reduction overall. The original project displays a median of 7,790 m², while the current situation presents 4,682 m². However, given the considerable standard deviation, it is challenging to discern a clear pattern of concatenation or continuity.



7,790 m²
Average surface

1:6000





4,682 m²
Average surface

Grain surface

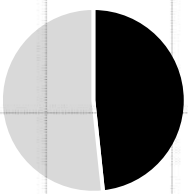
- 20 - 2733
- 2733 - 3814
- 3814 - 4406
- 4406 - 5423
- 5423 - 10767
- 10767 - 47903

Figure 67. [left]. Basic grain and skeleton of the original Les Courtillieres fabric. Source: Author.

Figure 68. [right]. Basic grain and skeleton of the present Les Courtillieres fabric. Source: Author.

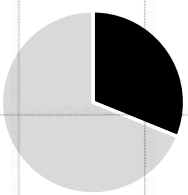
Exterior Permeability

It is interesting to note that the combination of interventions throughout the fabric has resulted in an increase in the number of points of interaction between the interior and exterior of the fabric. This appears to be immediately understood as an increase in the porosity of the fabric. In any case, this increase in porosity is not observed in the surface of the visible space, which undergoes a change from 47.4% to 37.5%. The structure in section in the part close to the complex remains similar, while the replaced part of the fabric narrows and defines the visuals.



47.4 %
Surface visible [%]

1:6000



37.5 %
Surface visible [%]

Boundary delimiting the area of the analysis

Facade delimiting the viewshed

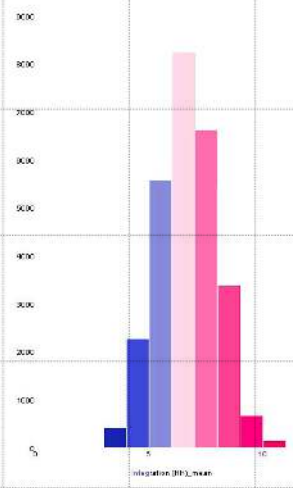
Figure 69. [left]. Visual sheeds from the main entry points to the original Les Courtillieres fabric. Source: author.

Figure 70. [right]. Visual sheeds from the main entry points to the present state of Les Courtillieres fabric. Source: author.

Perception

Hidden places

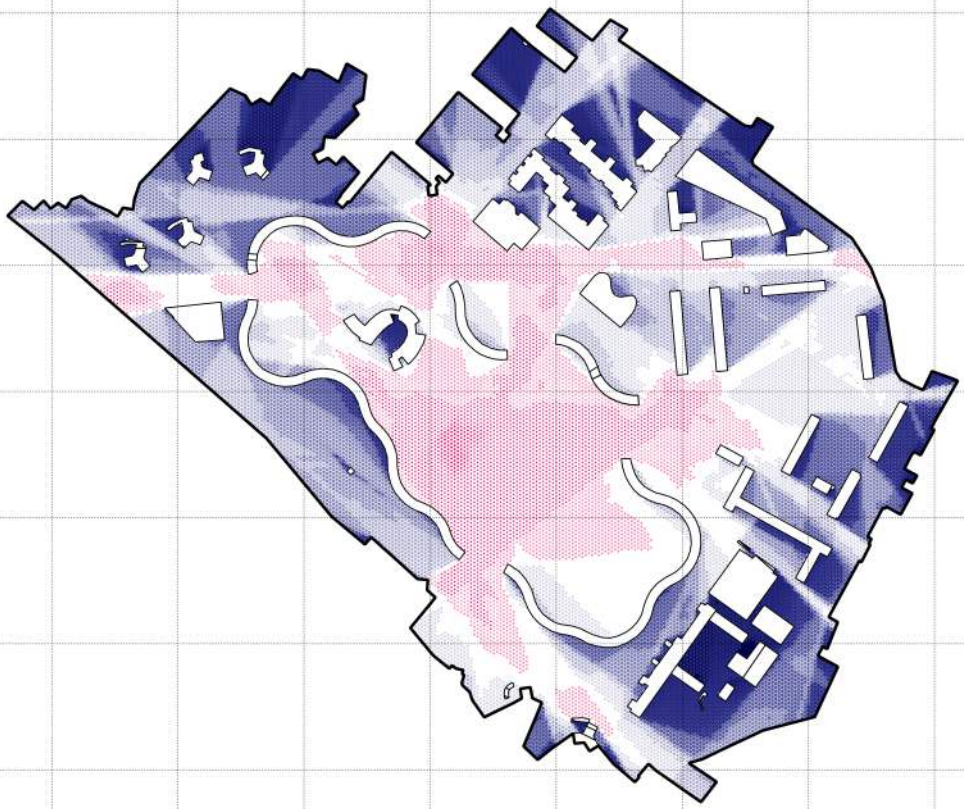
This analysis clearly demonstrates the trajectory of the regeneration project. The opening has had the effect of eliminating the few remaining concealed spaces within the complex. Furthermore, it has facilitated a comprehensive expansion of the visual field, particularly in the northern section, with ramifications that are discernible throughout the entire fabric. It is interesting to combine the conclusions of this analysis with those of the previous one, since while this one presents the internal perspective of the fabric, the previous one presents the external perspective.

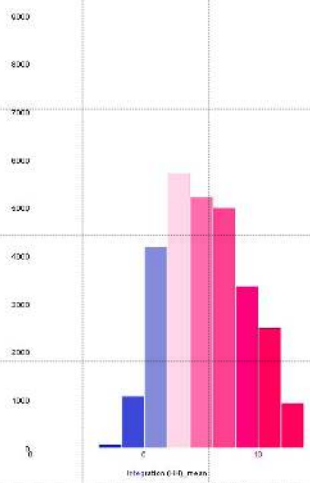


6.42
Median of the values indicating the hidden spaces

1:6000

In conclusion, it can be observed that the initial configuration of the site fostered the formation of a confined interior and exterior spaces, which, in conjunction with the existing structures, have served to impede the creation of an environment that is less structured and more permeable, visible from both the exterior and interior of the fabric.





7.2
Median of the values indicating the hidden spaces

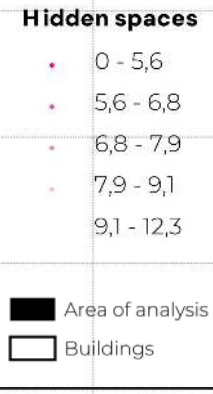


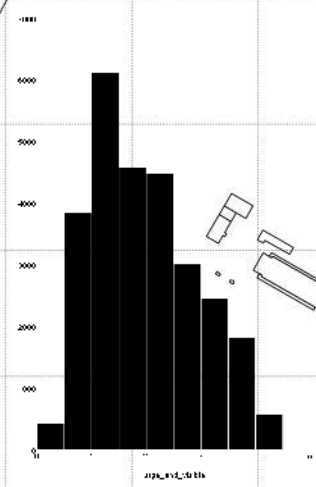
Figure 71. [left]. Grid of integration values in Les Courtillieres original state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Figure 72. [right]. Grid of integration values in Les Courtillieres present state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Perception

Large & more visible square-like spaces

It is evident that the focus of this analysis will be on the interior of the "serpentine." In light of the comprehensive renovation of the northern section, this study aims to elucidate the impact of selective serpentine removal on the configuration of the space. It can then be observed in the original fabric that the large free space is located in the interior of the complex and appears to extend into the areas adjacent to the openings. This is particularly evident in the opening situated to the east of the complex, which extends almost to the boundary of the complex. Furthermore, the positioning of a structure within the interior results in the emergence of additional peaks of open space at the points of convergence created

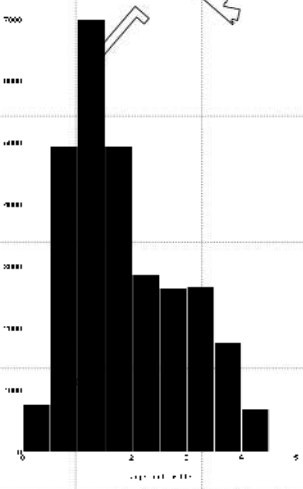


84.08 ha
Surface occupied by the highest values

1:6000

by the openings.

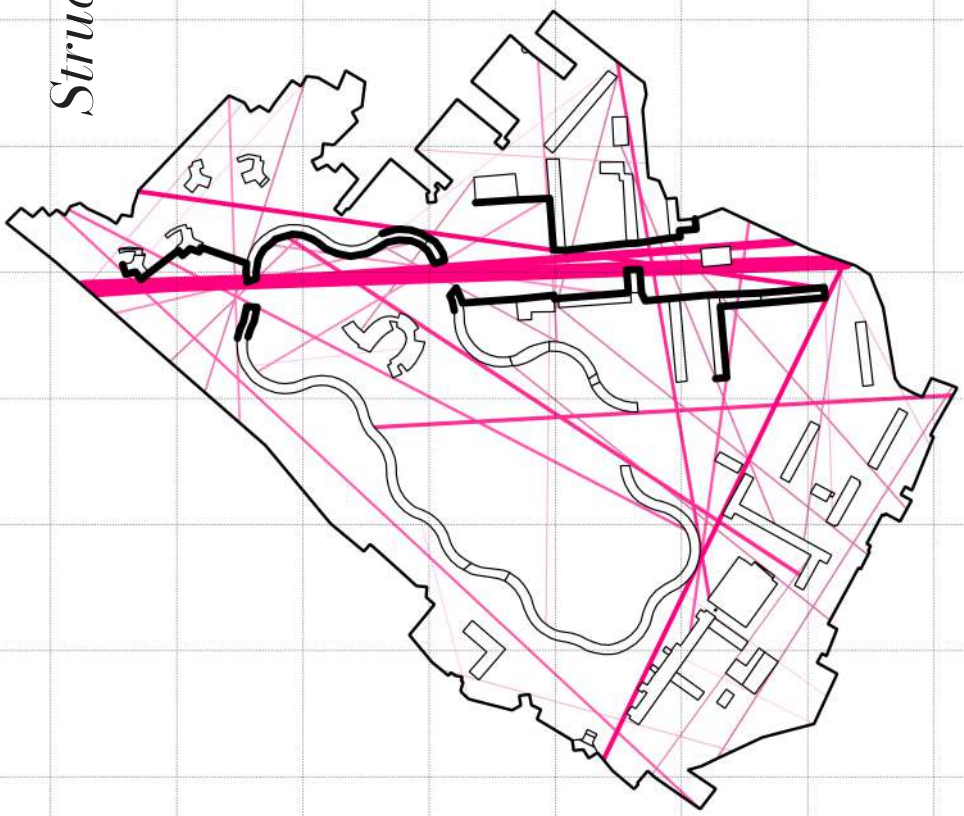
In the present situation, however, it can be observed that this colonisation is distributed more evenly towards the north, continuing the opening and generating a large space not only in the northern opening but also in its continuation. Furthermore, it can be seen that it opens up in the south, extending and generating a less compact and more extensive form.



89.6 ha
Surface occupied by the highest values

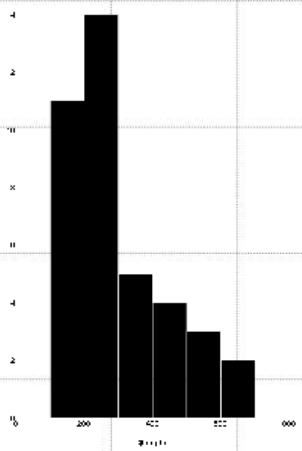
Figure 73. [left]. Contour lines representing the highest values of average radial in Les Courtillieres original state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

Figure 74. [right]. Contour lines representing the highest values of average radial in Les Courtillieres present state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.



Basic structure

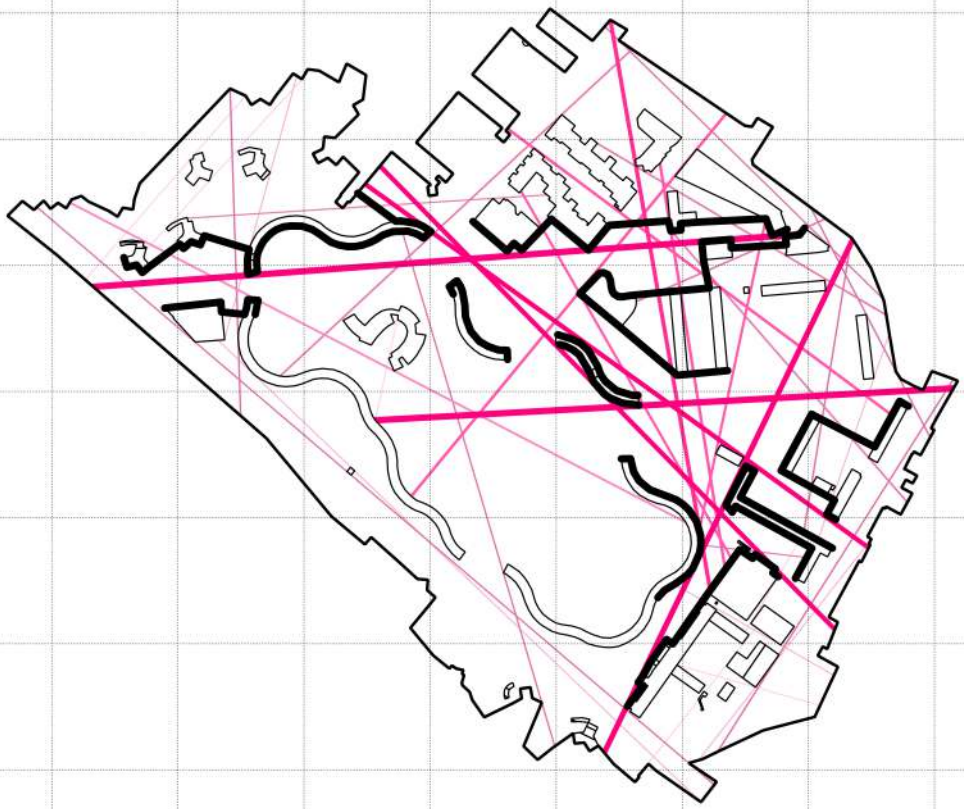
In order to facilitate analysis, it is necessary to filter the graphic information and focus attention on the changes in the intermediate values. In both cases, the principal axes are those which traverse the southern portion of the fabric and those which traverse the complex in a transverse manner. While the original project appears to ascribe greater significance to the latter axis, as it is the sole such axis, the regeneration project introduces new axes which traverse the complex, connecting the southern and northern portions. This improves the complex's permeability, which in the original situation acted as a boundary, although this will be verified in subsequent analysis.

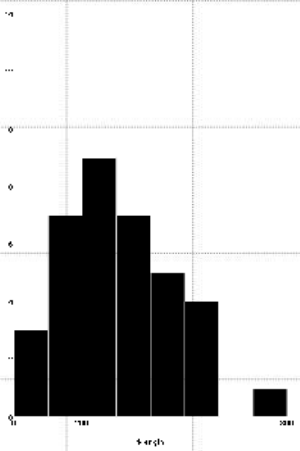


247 m
Average length of the axis

1:6000

The axes that cross the new opening in the south appear to be of particular relevance, as they not only connect with the northern openings, but also create new axes with the northern interior of the complex. It can also be observed that, in the northern part, both the openings and the replacement of the fabric have resulted in the open space becoming more orthogonal in structure. In conclusion, the structure of the free space has undergone a transformation with the introduction of new axes, facilitated by the opening to the south. This has led to the emergence of a more defined structure in the central area, resulting from the combination of the new opening in the north with the replacement of the fabric.





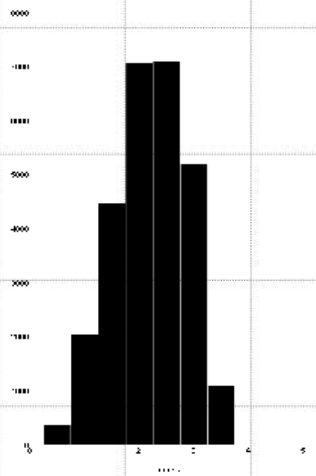
285 m
Average length of the axis

Figure 75. [left]. Fewest-Line Map of the original Les Courtillieres fabric. Source: Author.

Figure 76. [right]. Fewest-Line Map of the present Les Courtillieres fabric. Source: Author.

Centric Corners

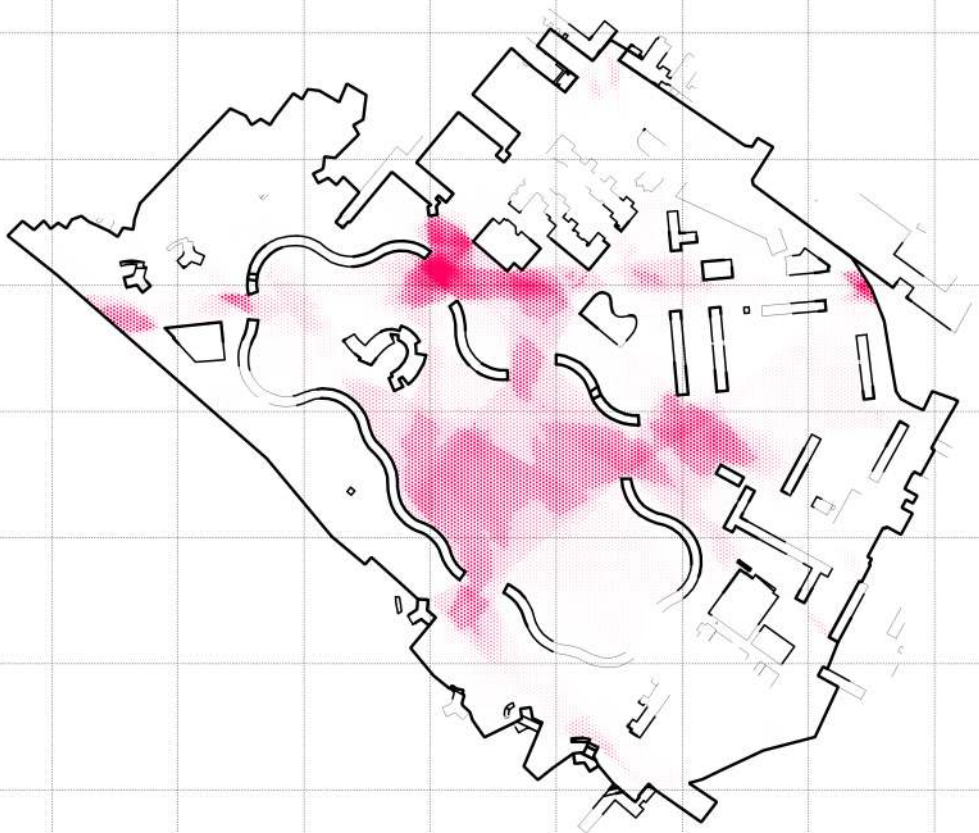
It can be argued that this analysis is not particularly relevant in this case, given that the evolution of the land occupation makes the changes in question too subtle to be discerned. It can be observed that the formation of openings leads to an increase in the number of corners. However, due to their dimensions, it is not accurate to categorise them as corners or even as spaces with multiple points of presence. It is evident that the analysis demonstrates that, in one of the existing openings, the orthogonalisation observed in the axial analysis and the small nuclei of free space have reinforced its presence, thereby defining a new centre in the spatial configuration of the fabric.



1:6000

2.13
Median of the normalization of values indicating the centric corners

This is an intriguing phenomenon that merits further investigation. Despite the intuitive appeal of attributing centrality to the expansive open space, the extant literature and prior studies suggest that the mere presence of a large open space, regardless of its definition, does not necessarily imply the emergence of centrality. Instead, it is the bounded spaces with multiple influences and interactions that are more likely to become central.



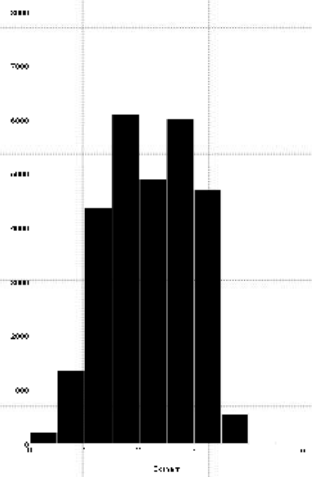


Figure 77. [left]. Grid of choice and overt control values in Les Courtillieres original state, note that the more pinl the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Figure 78. [right]. Grid of choice and overt control values in Les Courtillieres present state, note that the more pink the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

2.02
Median of the normalization of values indicating the centric corners

Via Artom, Torino

Surface	**27 ha**
Year or construction	**1963**
Year of renovation	**1993**
Built surface [%]	**18.5 %**
Budget	**145,529,807€**

The Via Artom neighbourhood in Turin has been the subject of an urban regeneration process focused on improving the quality of life of its residents and revitalising the area.

Originally a social housing neighbourhood, the evolution of the social structure and the neglect of space maintenance promoted the emergence of this regeneration process, which included the renovation and replacement of buildings, the construction of new housing and the improvement of urban infrastructure, seeking to transform the physical environment of the neighbourhood.

Although significant progress has been made, Via Artom still faces challenges in terms of social integration and the need to maintain an inclusive approach. This analysis is undertaken in order to provide further insight into the evolution of the fabric and, in so doing, to promote the achievement of the regeneration process.

Geometry

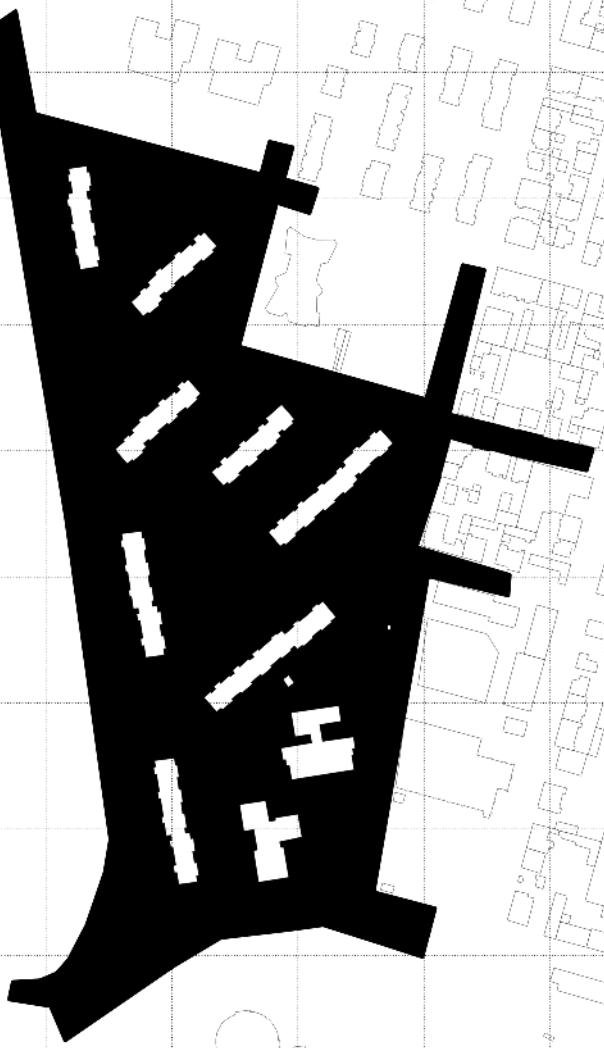
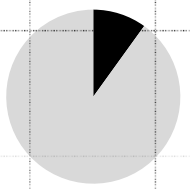


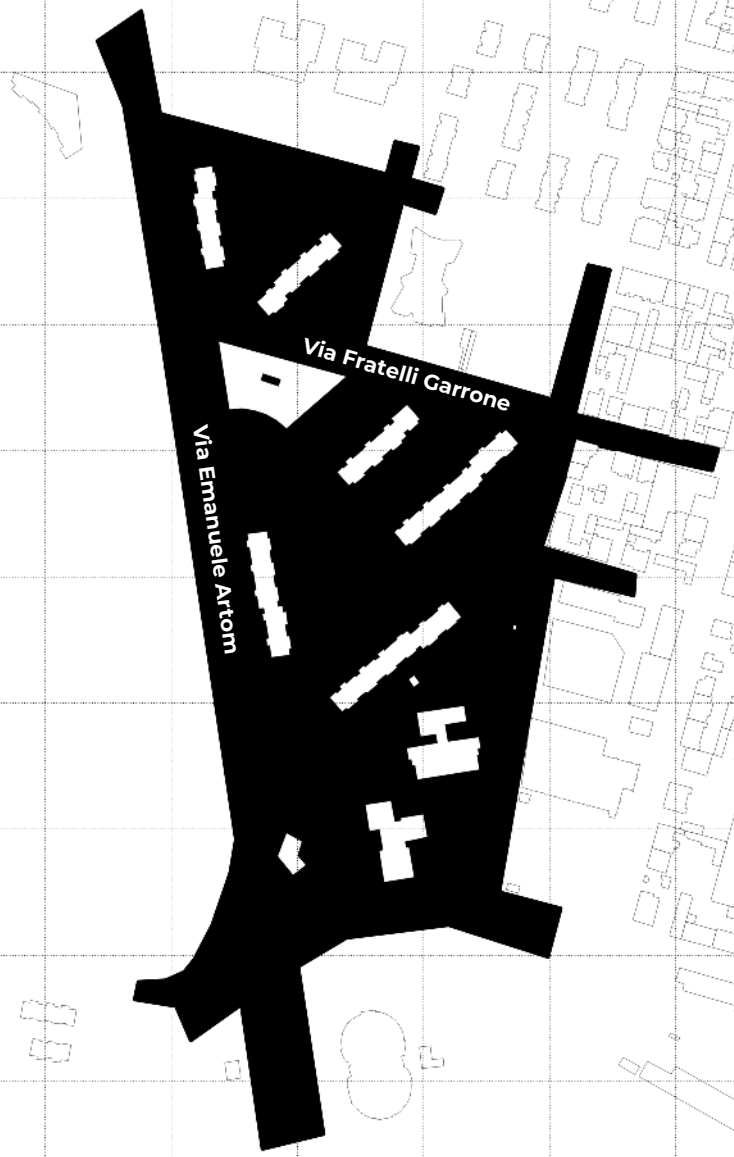
Figure Ground

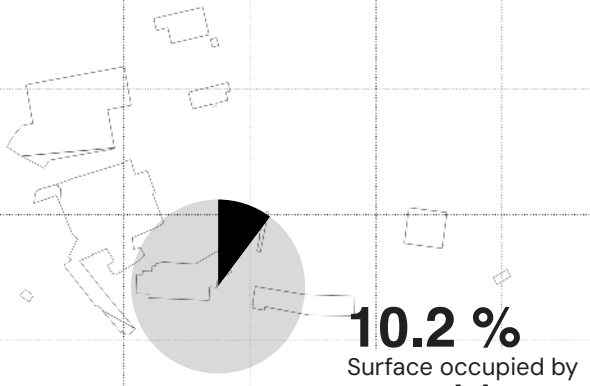
This type of analysis is of limited relevance in this specific fabric, as it fails to demonstrate the full extent of the alterations to the built structure of the space. On the one hand, we can observe the replacement of one of the buildings in the northern half with a new, closed complex that represents a departure from the existing typology. Furthermore, the demolition of another of the blocks in the southern part of the fabric, along with the substitution of a small piece in the centre of the previous construction, can also be observed. These seemingly minor changes have resulted in a relatively minor evolution of the ground cover of the fabric, which has increased from 9.9% to 10.2%. Nevertheless, it would be beneficial to observe and analyse the impact of such minor alterations. Such changes have had an impact on the spatial structure of the fabric.



9.9 %
Surface occupied by buildings [%]

1:6000





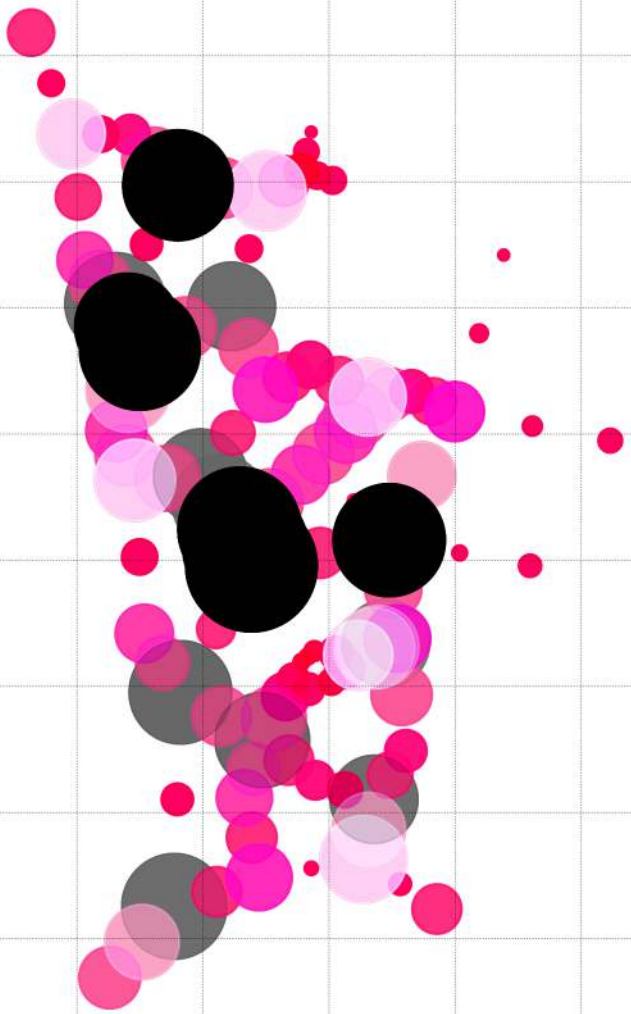
Area of analysis

Buildings

Figure 79. [left]. Figure-ground map,representing in black the space not occupied by buildings in the original state of Via Artom. Source: Author.

Figure 80. [right]. Figure-ground map,representing in black the space not occupied by buildings in the present state of Via Artom. Source: Author.

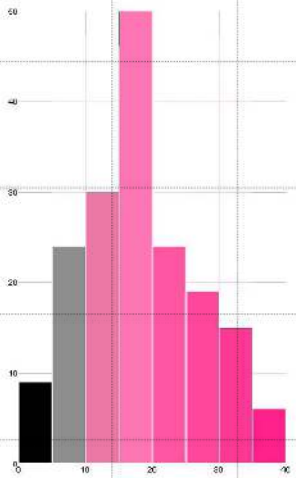
Geometry



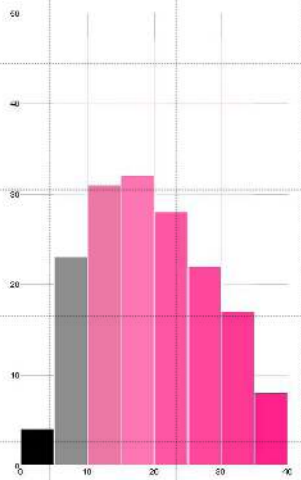
1:6000

In-between distances

The two maps illustrate the increase in distance and, consequently, the isolation of the southern section as a result of the formation of a significant void created by the demolition of the linear block. It is evident that, in this area, the average radius has increased from 18.5 to 19.7 metres. Conversely, this analysis demonstrates how the replacement of the linear block has facilitated the separation of the spaces situated to the north and south of the new complex. In conclusion, the interventions that have been implemented in this urban fabric have been particularly diverse. On the one hand, they have resulted in increased distances between the new construction and the existing city. On the other hand, they have led to an increase in spatial diversity and the emergence of enclosed spaces with a distinct hierarchy.



18.5 m
Average radius



19.7 m
Average radius

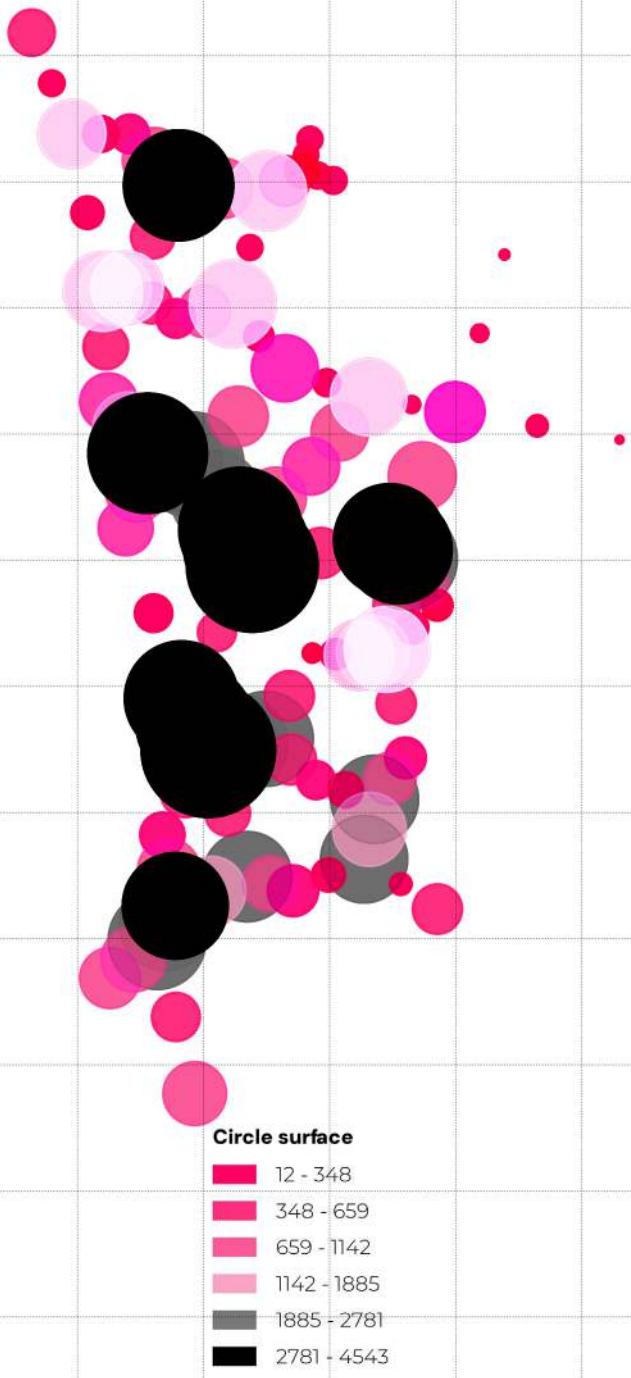
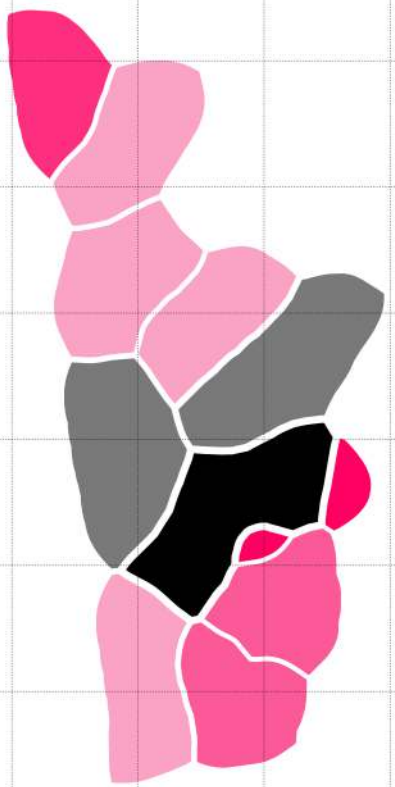


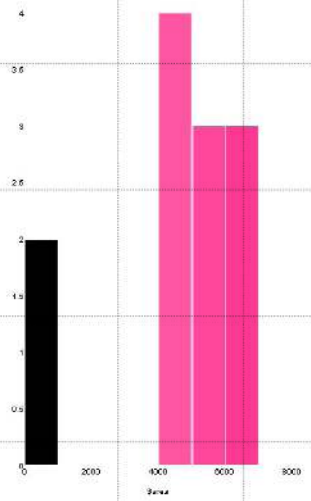
Figure 81. [left]. Critical distances of the open spaces around the original Via Artom fabric. Source: Author.

Figure 82. [right]. Critical distances of the open spaces around the actual Via Artom fabric. Source: Author.



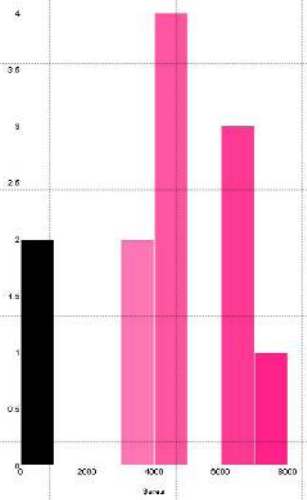
Urban Grain

It is not possible to make any further additions or highlight any further points in this analysis. The distribution and characterisation of the aforementioned blocks have undergone minimal changes. This will be a topic of interest in subsequent analyses, as it will be of value to understand how relatively minor alterations, without significant changes to the configuration of the built environment, can result in shifts in the structure of the surrounding open space.

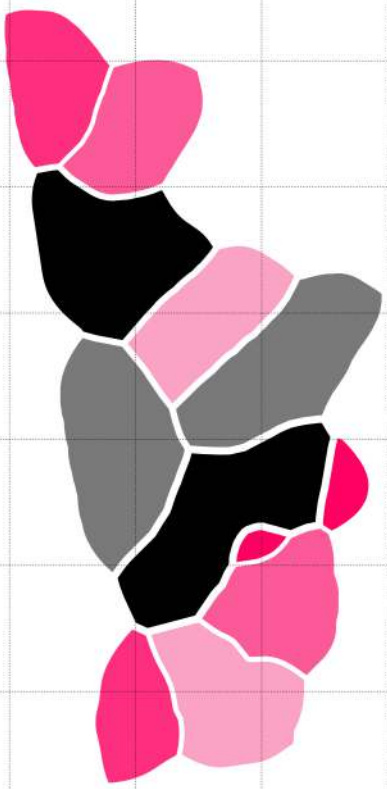


4,411 m²
Average surface

1:6000



4,428 m²
Average surface

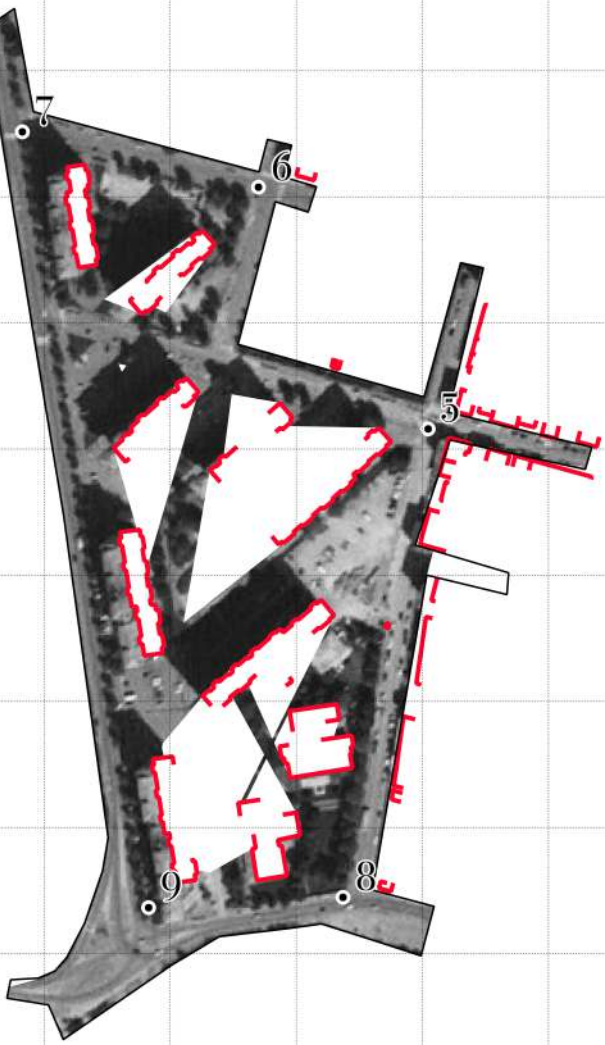


Grain surface

- 450 - 2739
- 2739 - 4162
- 4162 - 4352
- 4352 - 5458
- 5458 - 6528
- 6528 - 7192

Figure 83. [left]. Basic grain and skeleton of the original Via Artom fabric. Source: Author.

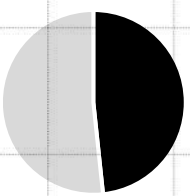
Figure 84. [right]. Basic grain and skeleton of the present Via Artom fabric. Source: Author.



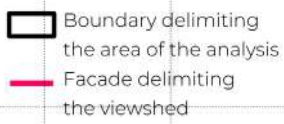
1:6000

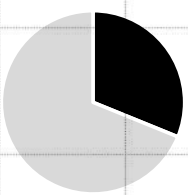
Exterior Permeability

In considering the permeability of the fabric, it is essential to take into account the boundary conditions. To the west of the fabric, there is no significant urban development, and therefore, for the purposes of analysis, only the northern, eastern, and southern parts of the fabric, in contact with consolidated urban plots, will be taken into account. Accordingly, the observed changes can be classified into two categories. The first category pertains to the upper part of the fabric, where the introduction of the new typology and its layout results in a reduction in the surface area visible from the exterior. Conversely, the lower section does not appear to have increased the visible surface area in proportion. In general, there has been an evolution in the visible surface area, which has decreased from 48.3% to 31.1%.



48,3 %
Surface visible [%]



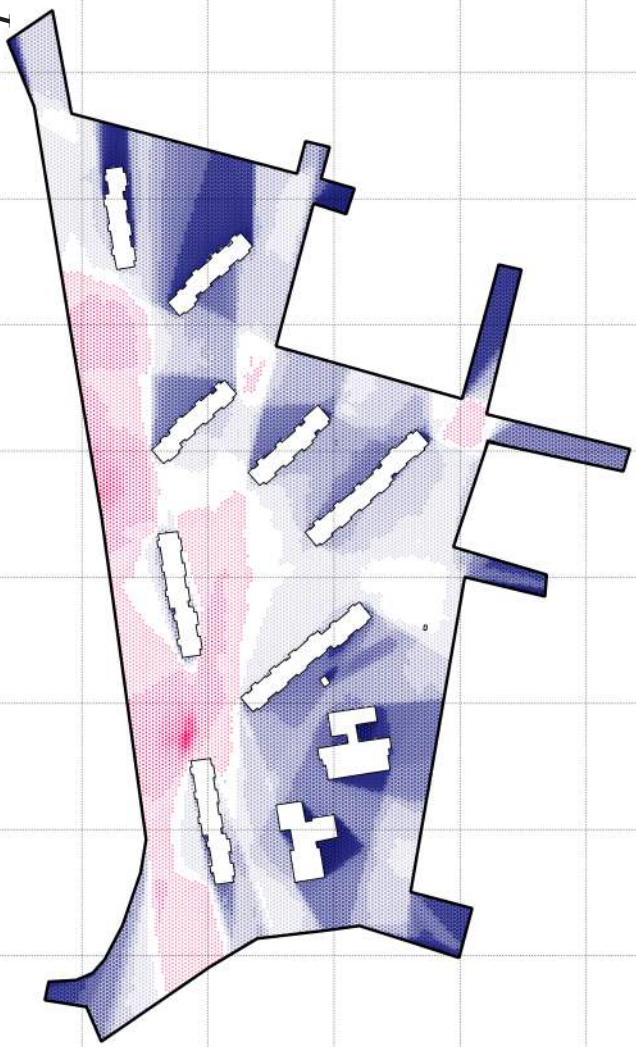


31,1 %
Surface visible [%]

Figure 85. [left]. Visual sheeds from the main entry points to the original Via Artom fabric. Source: author.

Figure 86. [right]. Visual sheeds from the main entry points to the present state of Via Artom fabric. Source: author.

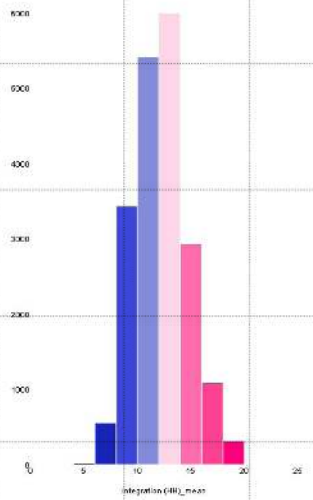
Perception



1:6000

Hidden places

This analysis reaches analogous conclusions to those of the preceding one. The upper section has introduced an augmented number of concealed spaces within the fabric, thereby creating novel areas that traverse one of the transverse axes. In contrast with the preceding analysis, the demolition of the block in the lower part has resulted in a modification of the configuration of the hidden spaces, as it has created a new opening, which has consequently reduced the hidden environments in the central part of the fabric. In general, the existing dynamics appear to be reinforced, although there are no discernible alterations in the spatial configuration.



11.83

Median of the values indicating the hidden spaces

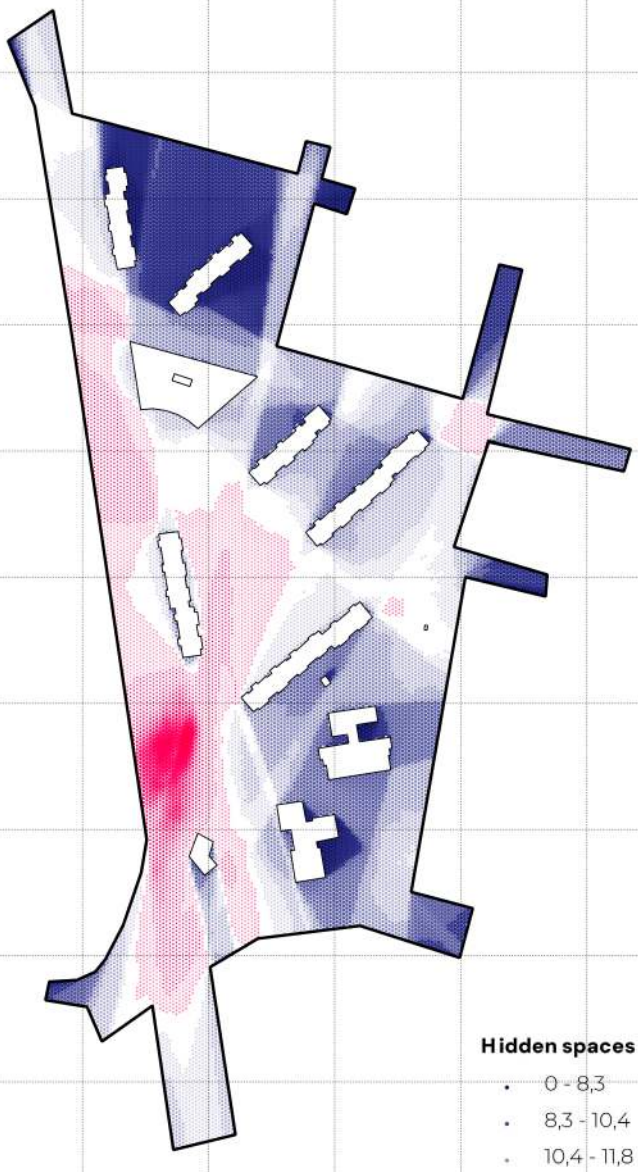
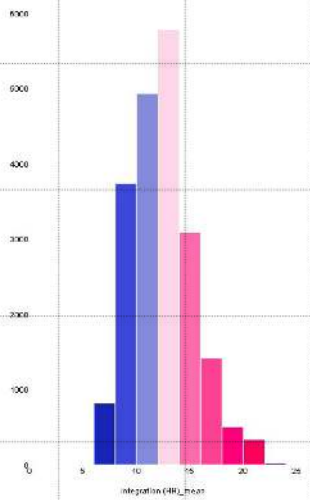


Figure 87. [left]. Grid of integration values in Via Artom original state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.



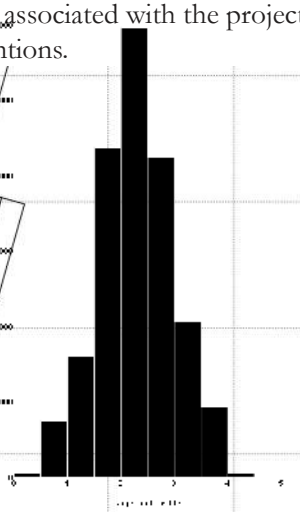
11.80
Median of the values indicating the hidden spaces

Figure 88. [right]. Grid of integration values in Via Artom present state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Perception

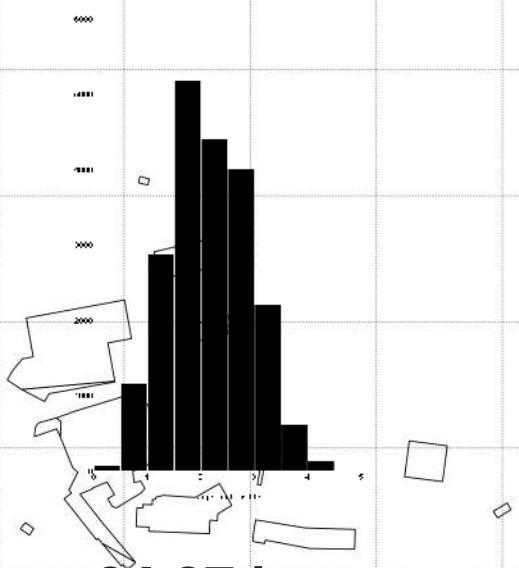
Large & more visible square-like spaces

Two significant alterations can be discerned in the configuration of the open space, reflecting the transformation of the built environment. While the continuity of open spaces in the western part of the fabric is maintained with the regeneration project, two main evolutions can be observed. In the northern half, it appears that the crossing itself and the southern part are delineated and distinguished from one another, in continuity. Conversely, the southern part has gained open space due to the demolition of the existing building, which has also reinforced the spatial continuity towards the geometric centre of the environment. Despite the fact that the fabric is delineated and the alterations implemented affect a significant portion of its surface area, no discernible changes are evident in sections of the fabric that are not directly associated with the project's interventions.



19.15 ha
Surface occupied by the highest values

1:6000



24.27 ha

Surface occupied by the highest values

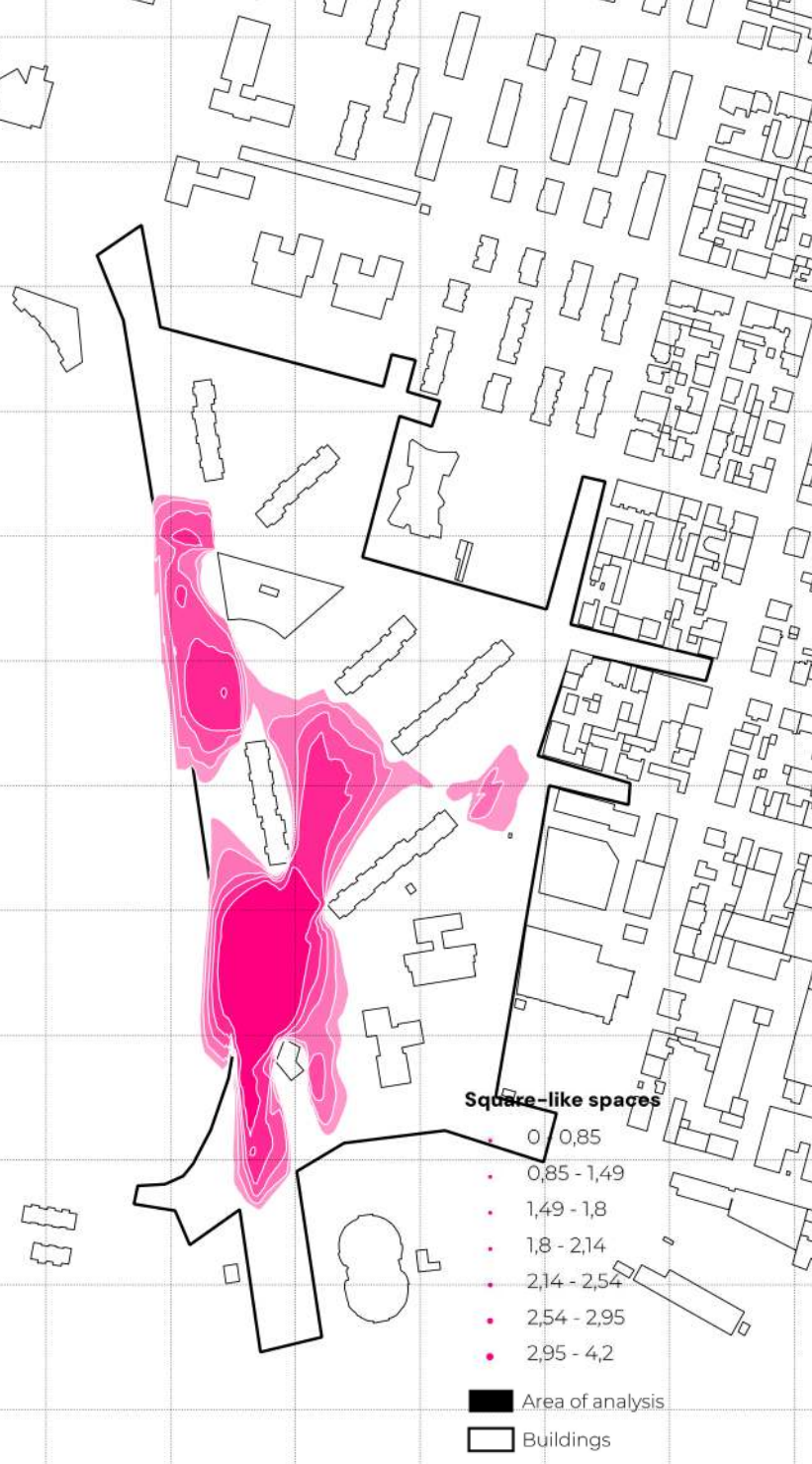
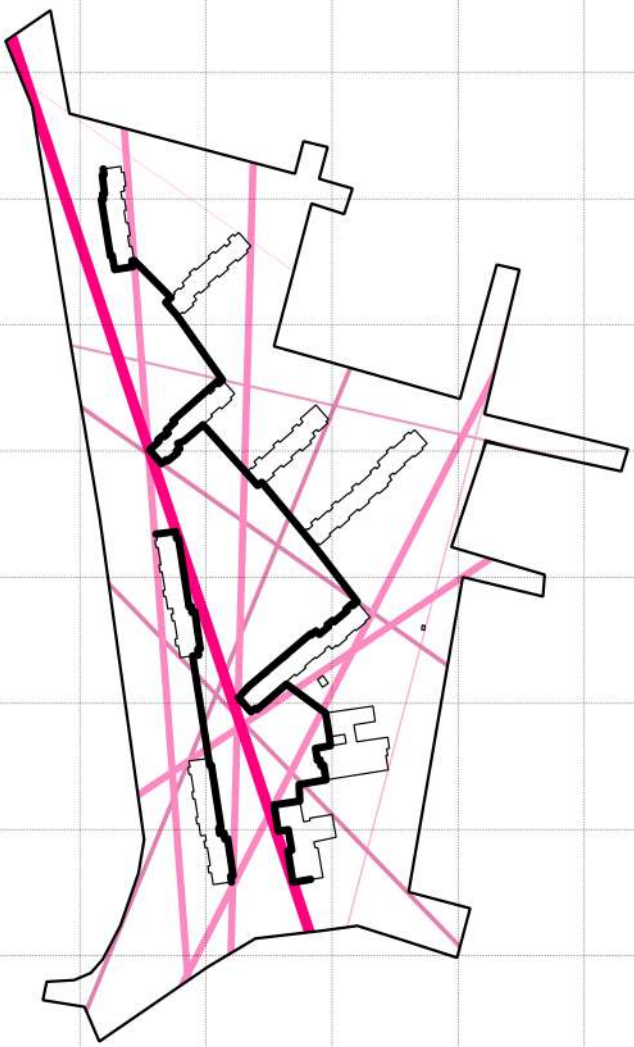


Figure 89. [left]. Contour lines representing the highest values of average radial in Via Artom original state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

Figure 90. [right]. Contour lines representing the highest values of average radial in Via Artom present state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

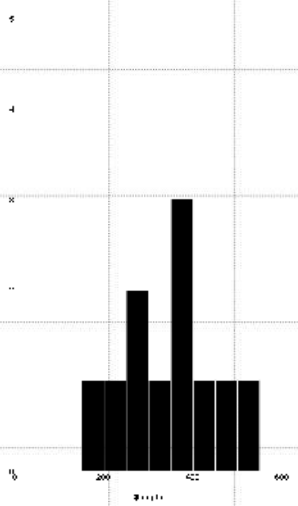
Structure



1:6000

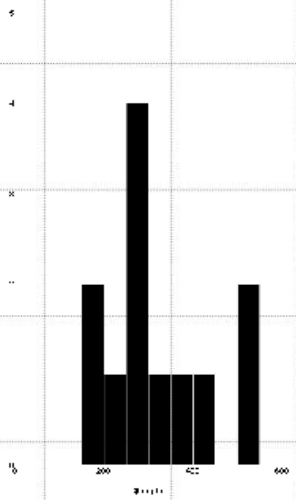
Basic structure

With regard to the continuity of the spaces and their representation in these axes, it is notable that, in contrast to other case studies, no significant alterations or additional axes are observed in the southern part of the fabric. However, it is intriguing to observe how the axes appear to diverge and converge in this area in a more pronounced manner. This can be attributed to the demolition of the linear block, which has resulted in these axes converging in silhouette. Conversely, the transverse axes are more conspicuous in the present context, and their eastward displacement in conjunction with the longitudinal axes results in the initial differentiation of the spatial structure, which is directly attributable to the interventions. This gives rise to the formation of an orthogonal structure in the upper right quadrant of the fabric.



380 m

Average length of the axis



282 m
Average length of the axis

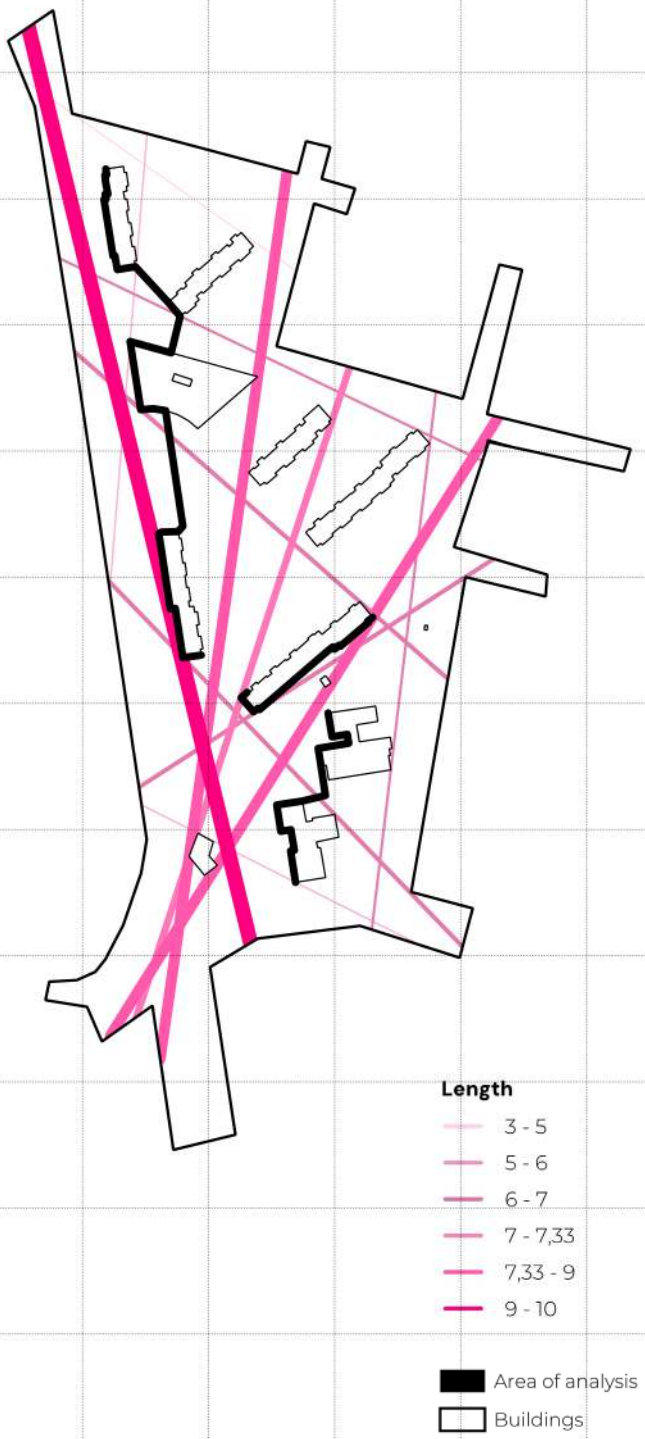
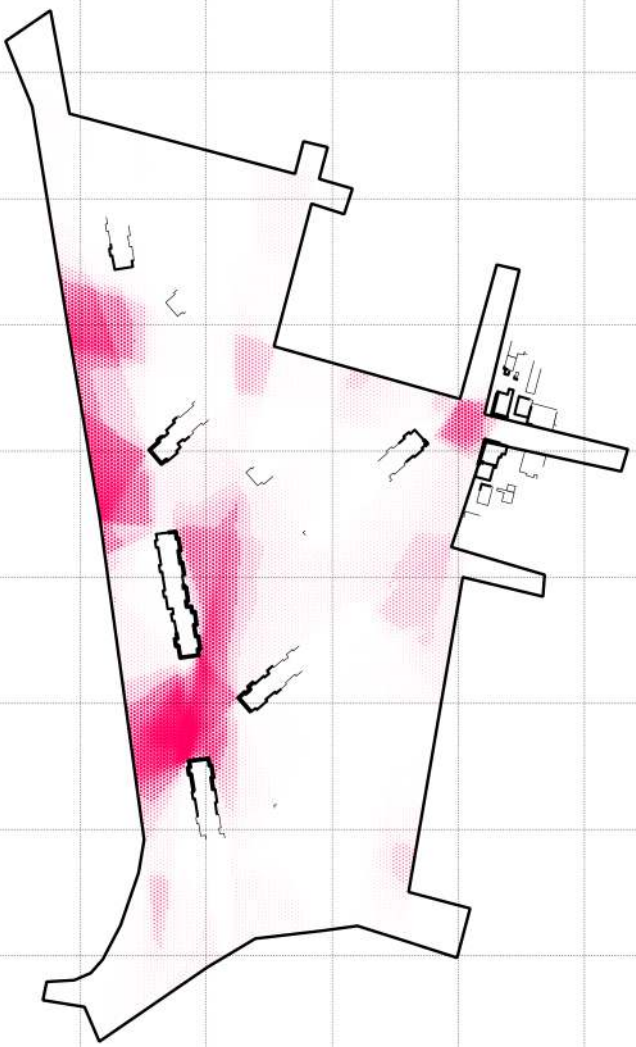


Figure 91. [left]. Fewest-Line Map of the original Via Artom fabric. Source: Author.

Figure 92. [right]. Fewest-Line Map of the present Via Artom fabric. Source: Author.

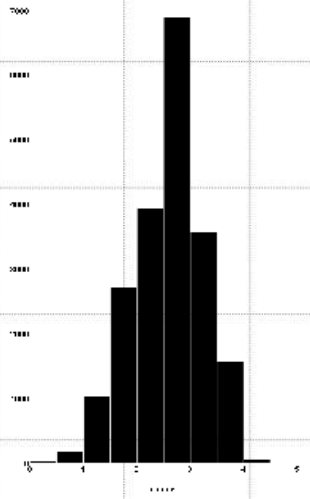
Structure



1:6000

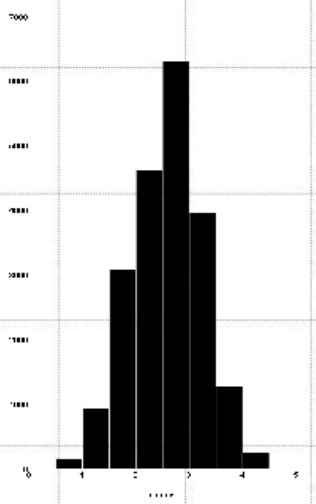
Centric Corners

This analysis demonstrates that the points of spatial centrality are situated on the outer axis, which is not in contact with any urban fabric. Furthermore, this phenomenon is accentuated in the lower part of the fabric, while the upper part remains relatively unchanged. Conversely, while the second analysis indicates that the open spaces extend towards the centre of the fabric, this does not appear to affect the areas where multiple presences are probable. Similarly, the slight displacement of the basic fabric structure does not seem to have altered the direction of expansion from this central point to the south.



2.57

Median of the normalization of values indicating the centric corners



2.51

Median of the normalization of values indicating the centric corners

Figure 93. [left]. Grid of choice and overt control values in Via Artom original state, note that the more pinl the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Figure 94. [right]. Grid of choice and overt control values in Via Artom present state, note that the more pink the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Tor Bella Monaca, Rome

Surface	**24.2 ha**
Year or construction	**1978**
Year of renovation	**2026 (predicted)**
Built surface [%]	**18.5 %**
Budget	**21,939,869.23 €**

The neighbourhood of Tor Bella Monaca, on the outskirts of Rome, has been the focus of an urban regeneration process that seeks to address problems of social marginalisation, decay and criminality.

Originally built in the 1970s as part of a social housing programme, the neighbourhood showed rapid and widespread deterioration, affecting the perception of the fabric at the metropolitan level. To this end, a regeneration process has promoted interventions to replace buildings and improve public space, in order to improve the quality of life of its inhabitants and change its location in the residents' imaginary.

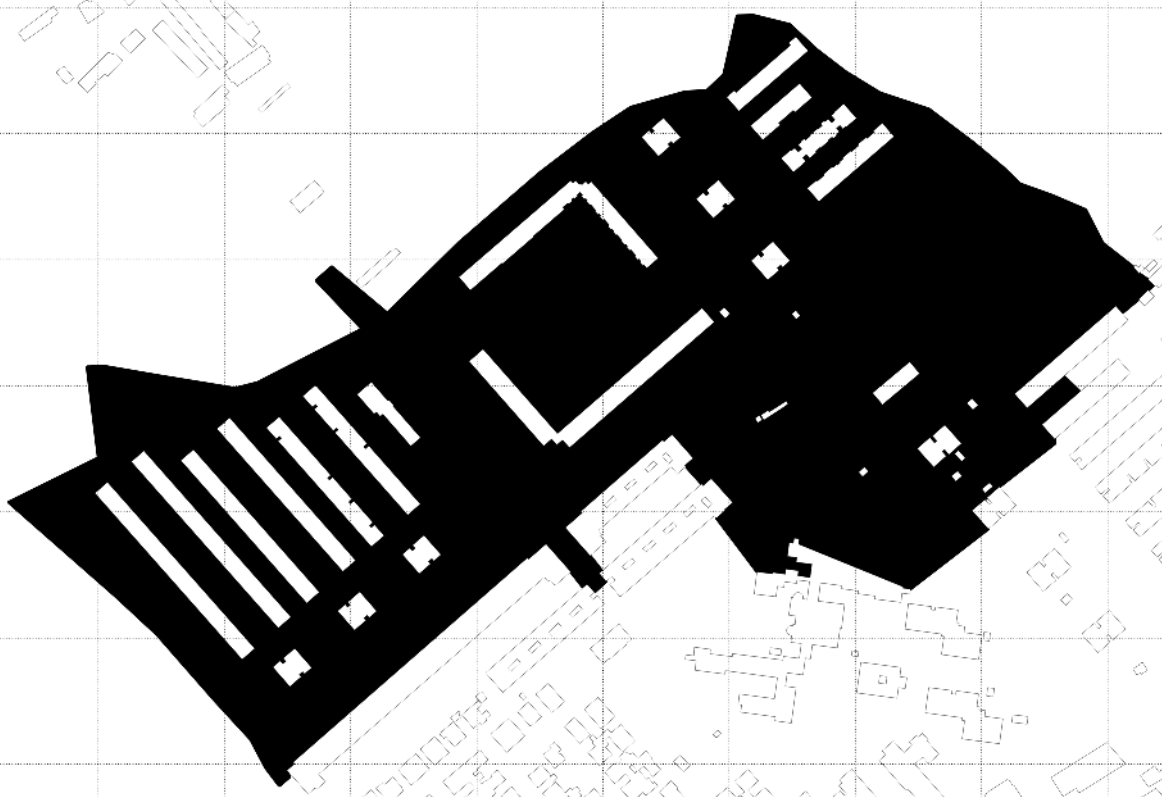
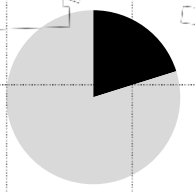


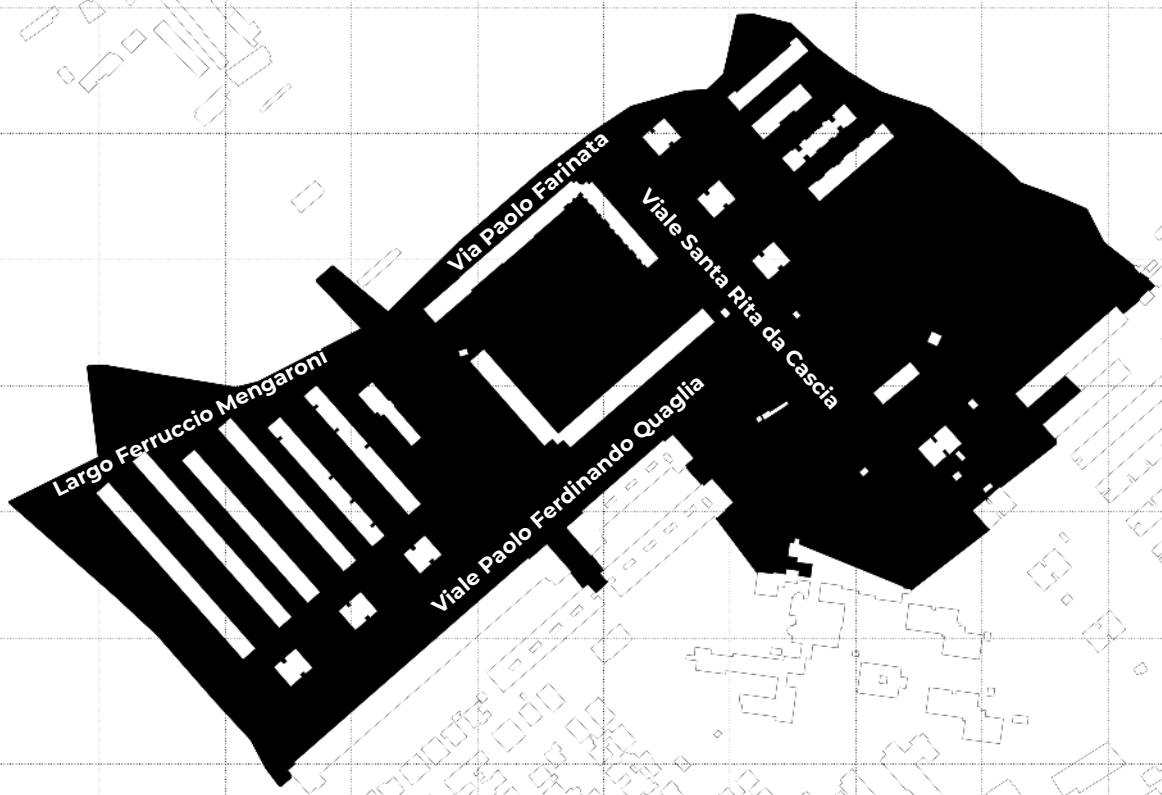
Figure Ground

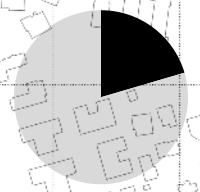
In accordance with the preceding case study, it is essential to consider the impact of incremental alterations to the built environment on the spatial configuration of the surrounding free space. In this instance, a regeneration project has been developed that has focused, among other things, on the rehabilitation of the existing buildings. This has entailed the addition of a small block that seems to complete the square in the central part, limiting the western opening. This alteration results in a negligible alteration in land cover, which shifts from 20.2% to 20.4%.



20.2 %
Surface occupied by buildings [%]

1:6000

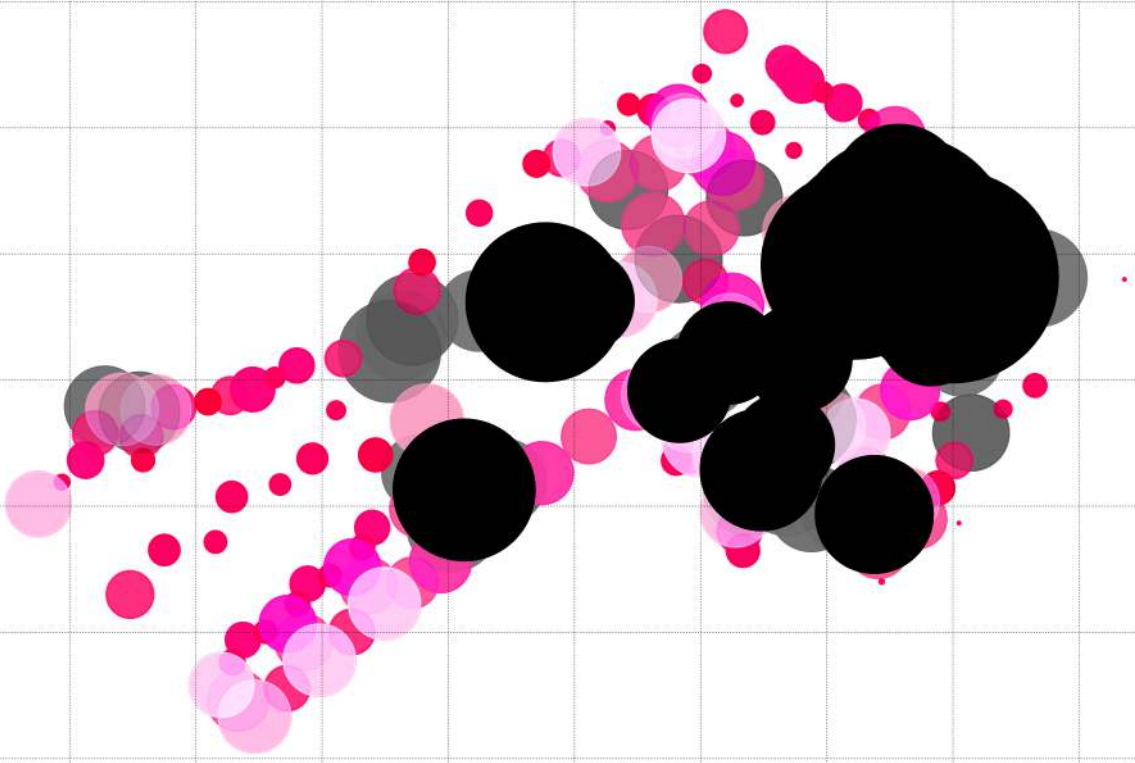




20.4 %
Surface occupied by buildings [%]

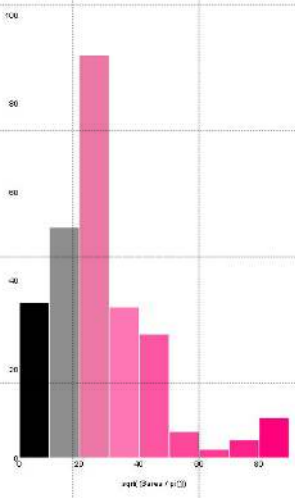
Figure 95. [left]. Figure-ground map,representing in black the space not occupied by buildings in the original state of TorBella Monaca. Source: Author.

Figure 96. [right]. Figure-ground map,representing in black the space not occupied by buildings in the present state of TorBella Monaca. Source: Author.



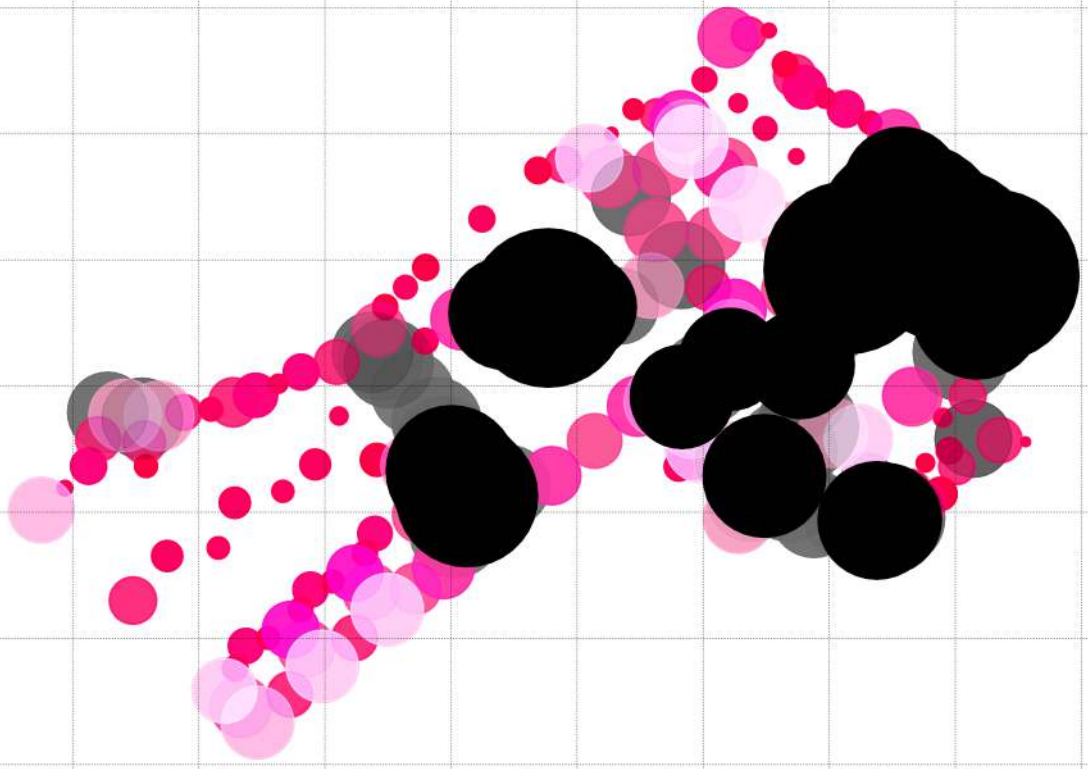
In-between distances

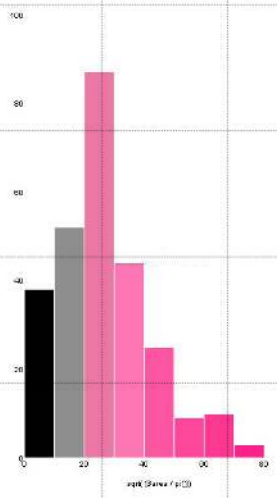
The initial evident alterations in the configuration of the space are evident here. In contrast to the original project, where the distances of the free space in the central part appear to exhibit a disorganized variety, the current situation demonstrates a discernible orderliness. This is evidenced by the linear concatenation of these spaces, which is continued by the spaces in the center of the complex and culminates in the sequence of free spaces in the east of the fabric. Conversely, this does not appear to have a significant impact on the overall diversity or mean.



27.8 m
Average radius

1:6000





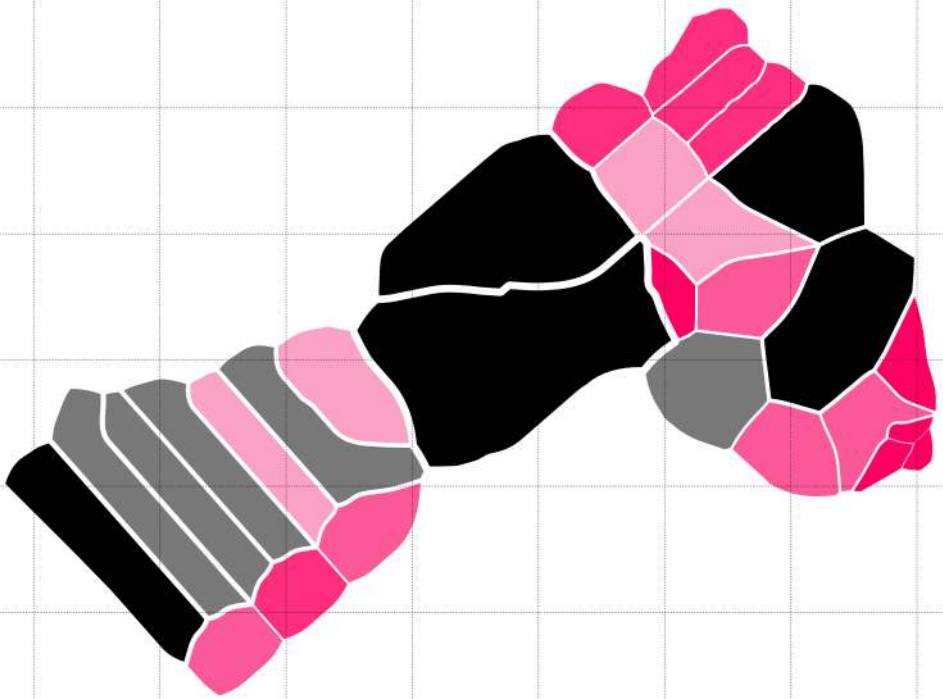
27.15 m
Average radius

Critical distances

- 1 - 524
- 524 - 1213
- 1213 - 1976
- 1976 - 2810
- 2810 - 5173
- 5173 - 24001

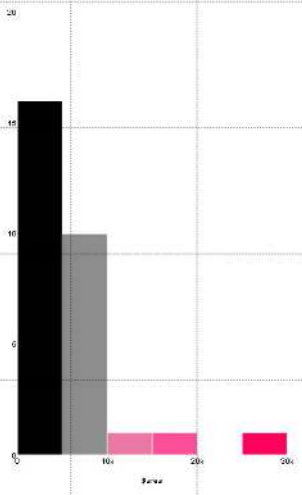
Figure 97. [left]. Critical distances of the open spaces around the original TorBella Monaca fabric. Source: Author.

Figure 98. [right]. Critical distances of the open spaces around the actual TorBella Monaca fabric. Source: Author.



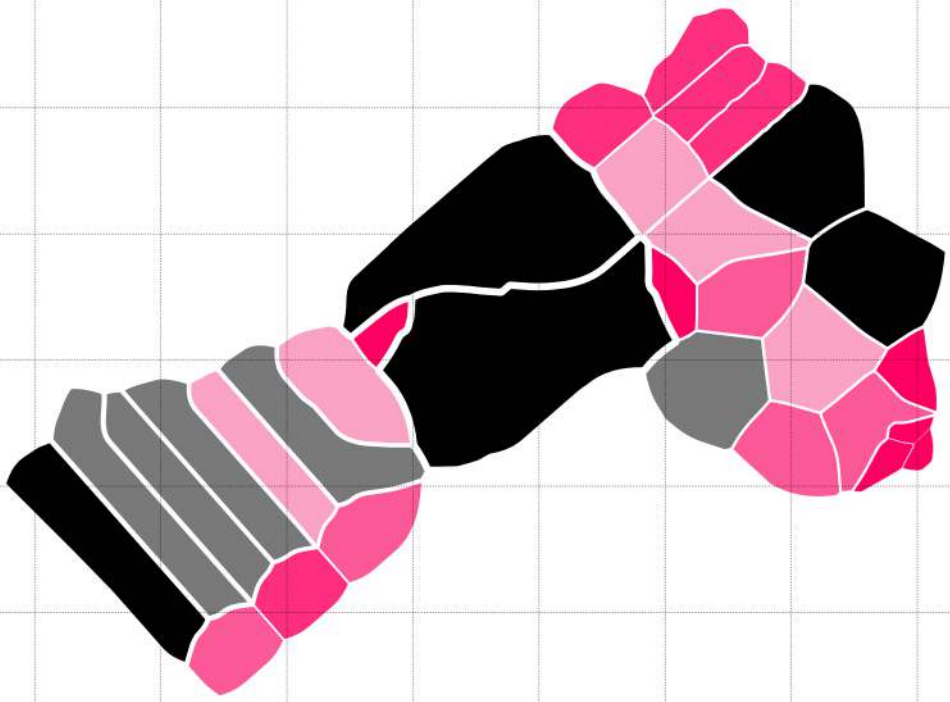
Urban Grain

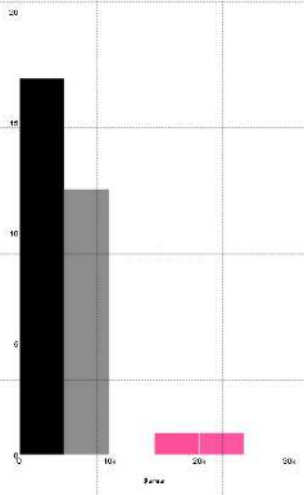
This analysis reveals a virtually imperceptible shift. The mean surface area of the grain in the original project is 5,919, while that of the present project is 5,632. There is no significant change between the two. It is noteworthy that the complex, which is bisected by two L-shaped buildings, exhibits a larger surface area than the polygons in the eastern section, which represent the expansive open space.



5,919 m²
Average surface

1:6000





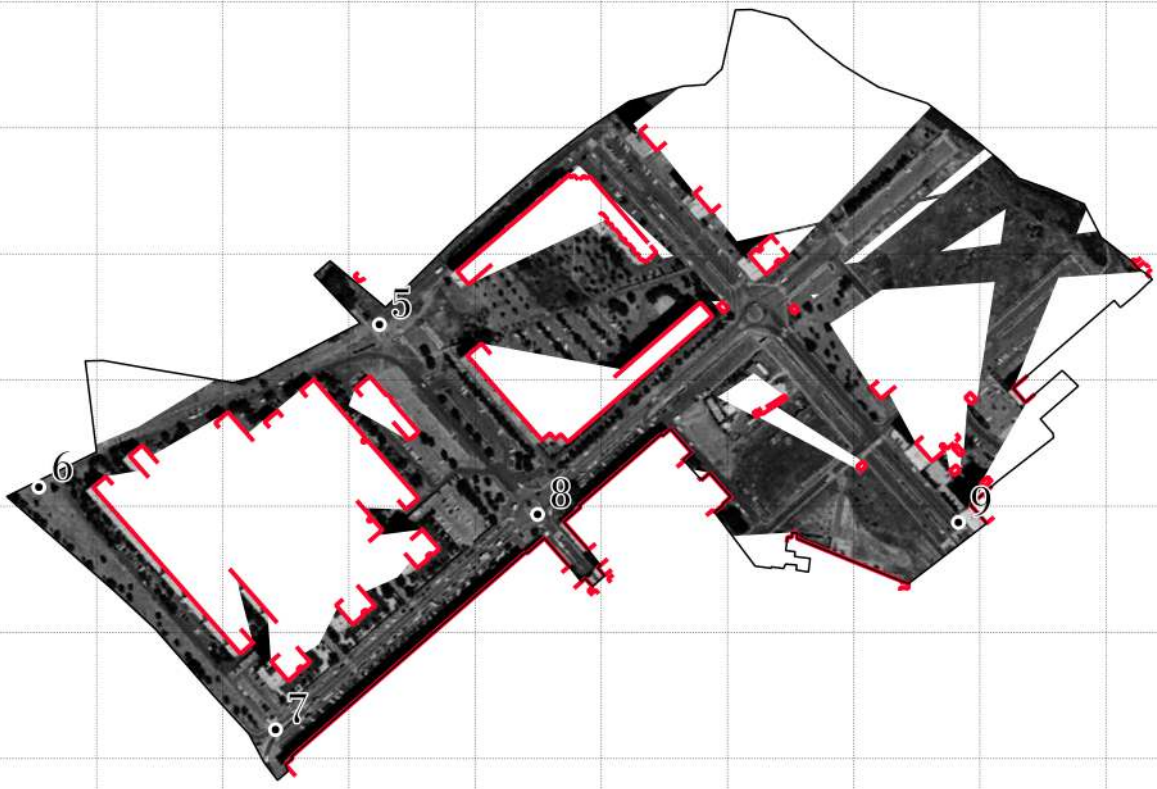
5,632 m²
Average surface

Grain surface

- 460 - 2774
- 2774 - 3493
- 3493 - 4657
- 4657 - 6298
- 6298 - 8201
- 8201 - 25195

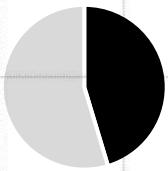
Figure 99. [left]. Basic grain and skeleton of the original TorBella Monaca fabric. Source: Author.

Figure 100. [right]. Basic grain and skeleton of the present TorBella Monaca fabric. Source: Author.



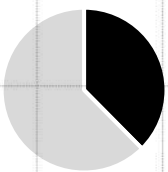
Exterior Permeability

With regard to the permeability of the fabric, the alterations resulting from the construction at points 5 and 11 are especially noteworthy. It is evident that, in the original fabric, the interior of the complex is largely visible from the entrance. However, following the implementation of the regeneration project, this visual basin has become more restricted. The remaining fabric exhibits minimal alterations. It is noteworthy, however, that the diagonal formed by point 5 intersects with other visual basins, a feature that is no longer evident in the current configuration.



45.3 %
Surface visible [%]

1:6000



37.6 %
Surface visible [%]

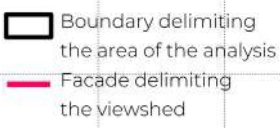
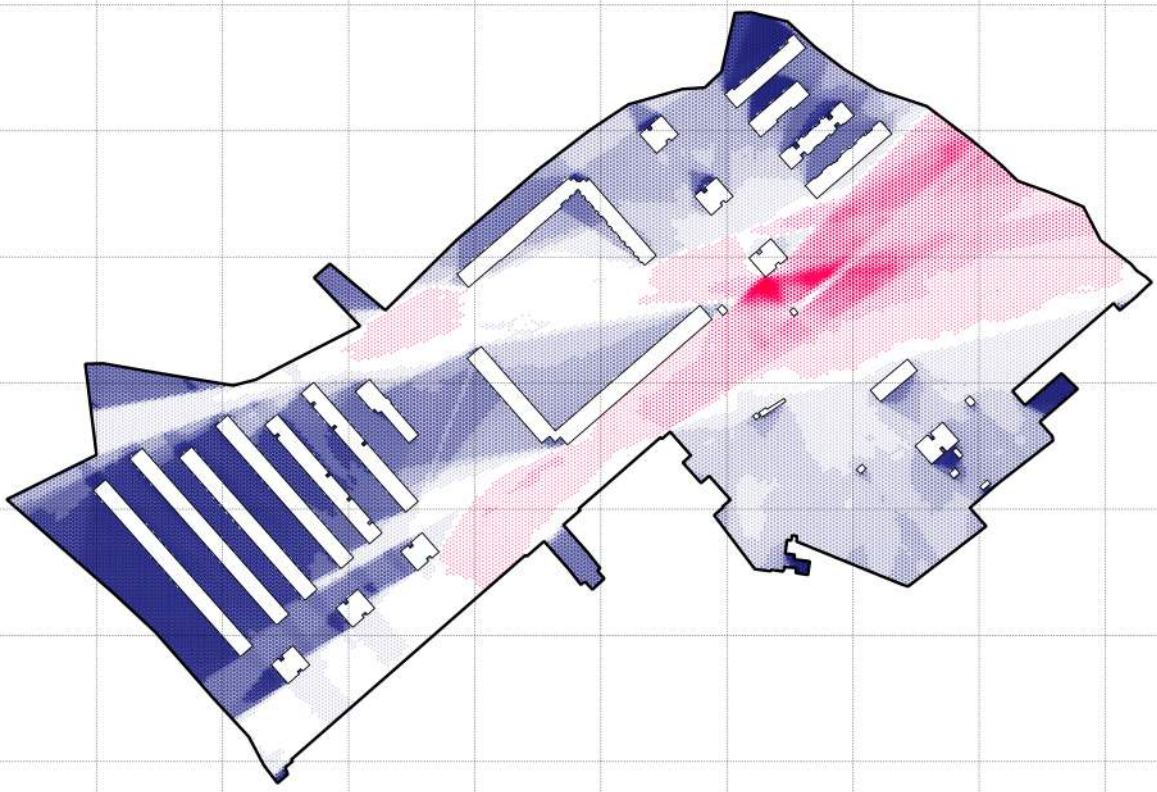


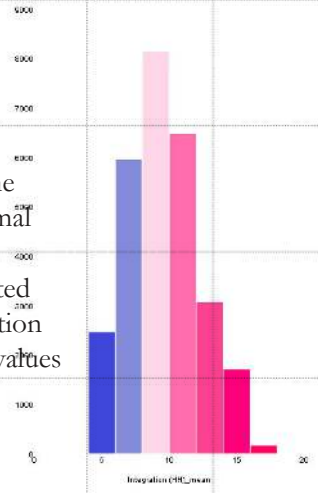
Figure 101. [left]. Visual sheeds from the main entry points to the original TorBella Monaca fabric. Source: author.

Figure 102. [right]. Visual sheeds from the main entry points to the present state of TorBella Monaca fabric. Source: author.



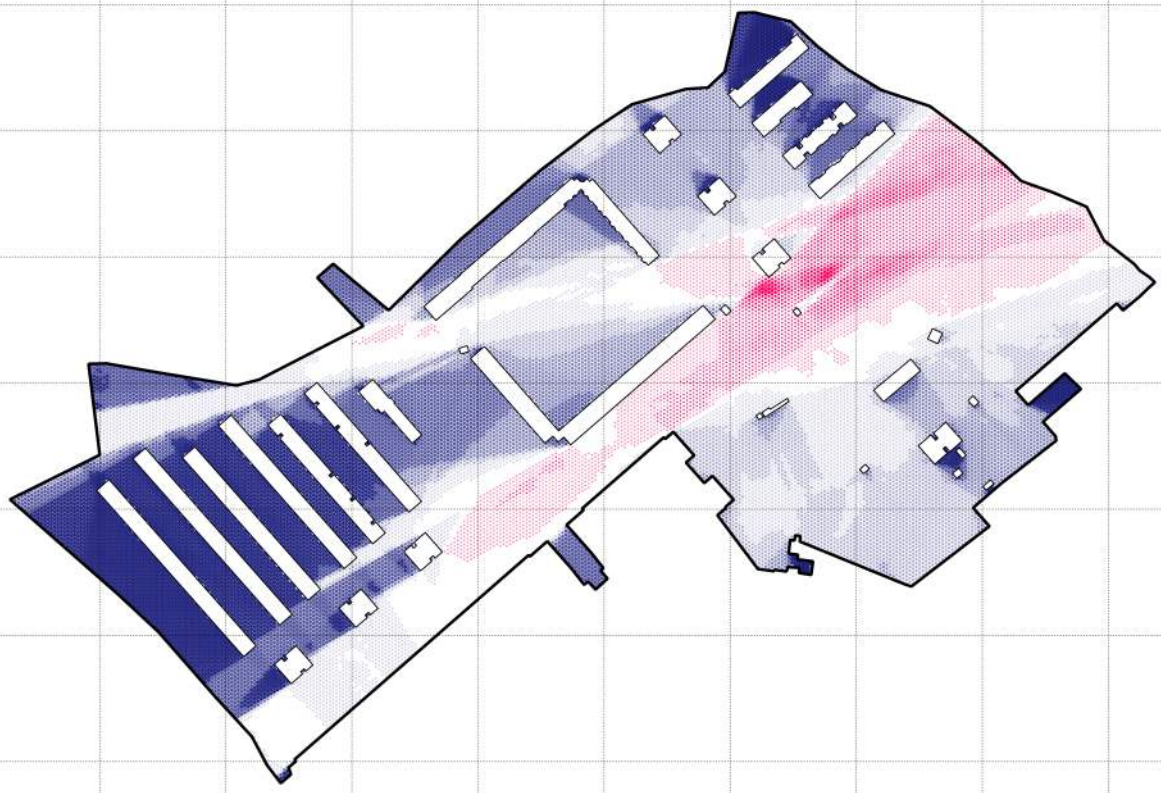
Hidden places

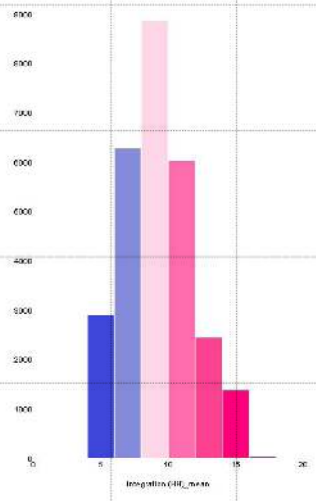
It is noteworthy that this analysis has not identified any changes in the spatial configuration of the fabric, including in the vicinity of the new extension. In the original fabric, the hidden spaces appear to align with the areas exhibiting minimal distances and situated at the periphery. However, the central complex and the southern axis remain active spaces. Although the regeneration project has resulted in a reduction in the values observed, these are not as high as in the eastern section of the complex or along the southern axis. However, the distribution of these values remains unchanged.



1:6000

8.68
Median of the values indicating the hidden spaces





Hidden spaces

- 0 - 6,1
- 6,1 - 8,1
- 8,1 - 9,5
- 9,5 - 11,5
- 11,5 - 18

Area of analysis

Buildings

Figure 103. [left]. Grid of integration values in TorBella Monaca original state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Figure 104. [right]. Grid of integration values in TorBella Monaca present state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

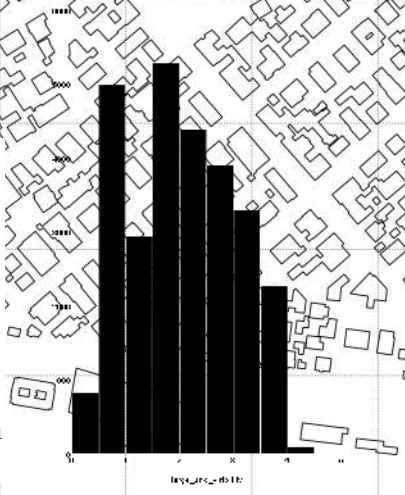
8.64

Median of the values indicating the hidden spaces

Perception

Large & more visible square-like spaces

The scale of the open space in the north-eastern part of the fabric necessitates a focus on the nuances of the intermediate and lower values in this analysis. Firstly, it appears that the spaces to the south of the complex, which are formed by two l's, expand and assume the character of a larger plaza. This is consistent with the material description of this new axis. Conversely, it appears that the structure of the open space is gradually encroaching upon the interior of the complex through the western entrance. Furthermore, it extends slightly further to the south. In conclusion, however, there are no significant alterations to the configuration of the open space.



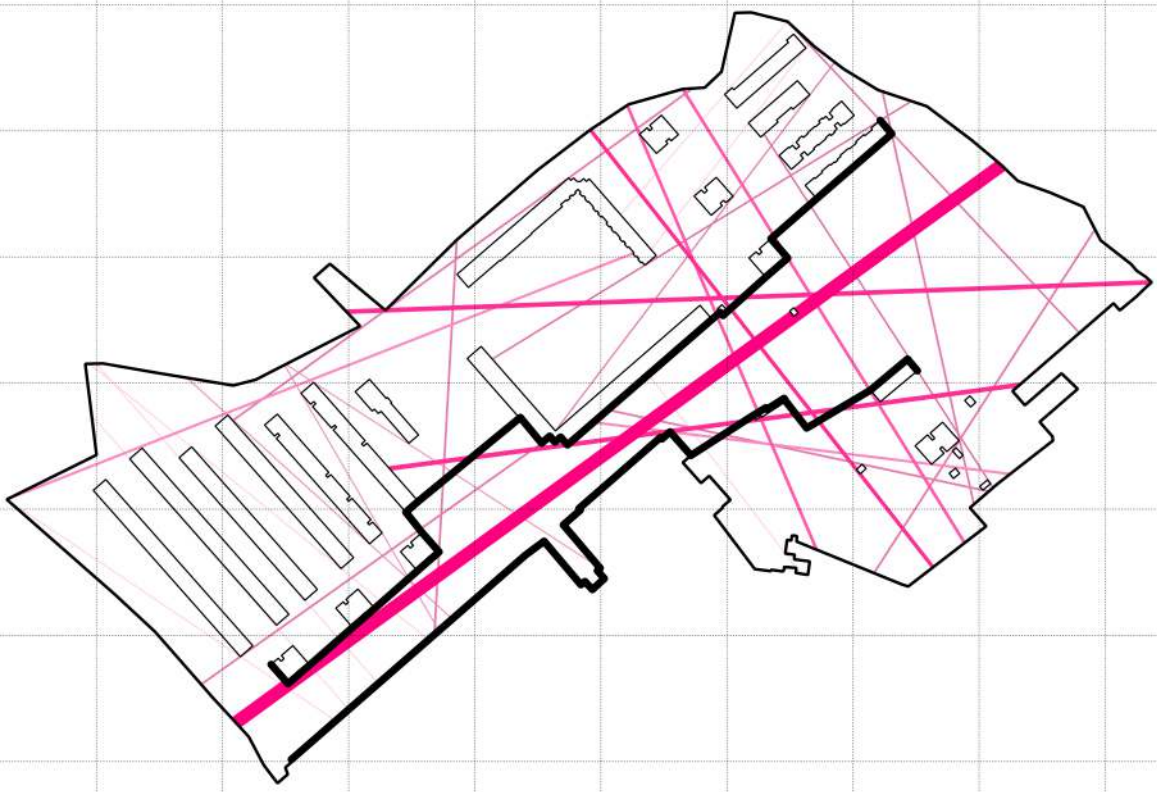
1:6000

100.1 ha

Surface occupied by the highest values

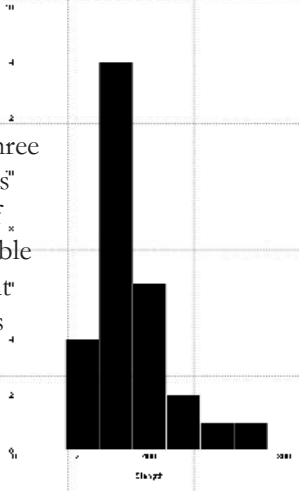
Figure 105. [left]. Contour lines representing the highest values of average radial in TorBella Monaca original state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

Figure 106. [right]. Contour lines representing the highest values of average radial in TorBella Monaca present state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.



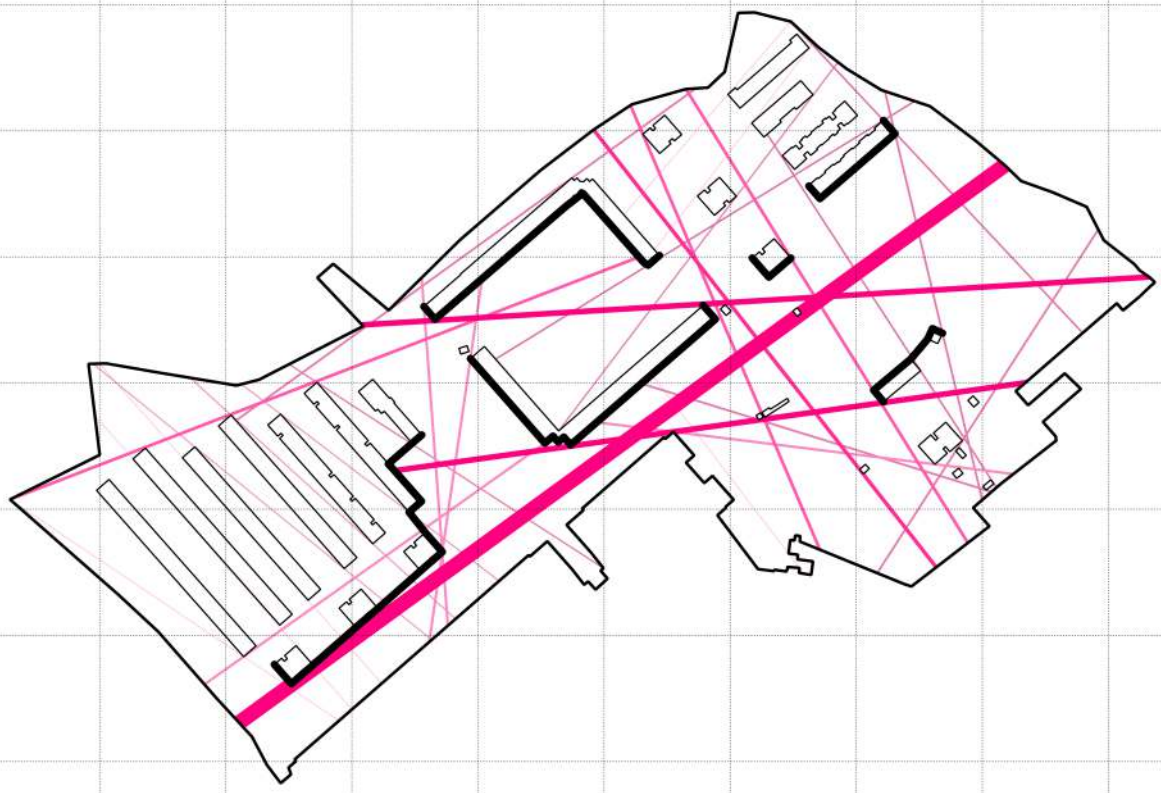
Basic Structure

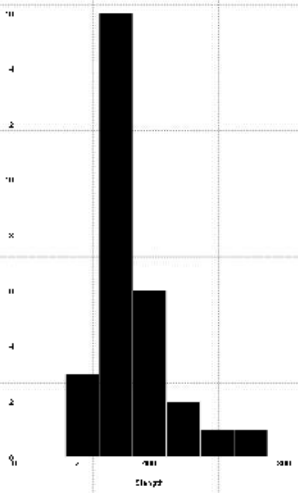
The analysis does not indicate any evolution; however, the development of the three main axes is worthy of note. The axis running to the south of the complex serves to connect the entire fabric, functioning as the backbone of the concatenation of blocks and spaces. Conversely, there is an axis that, although it appears to be double and is represented as such, is in fact understood as a continuity that finds its point of rotation in the opening of the complex. Despite a reduction in its section, this opening maintains its function as the backbone of this axis.



337 m
Average length of the axis

1:6000

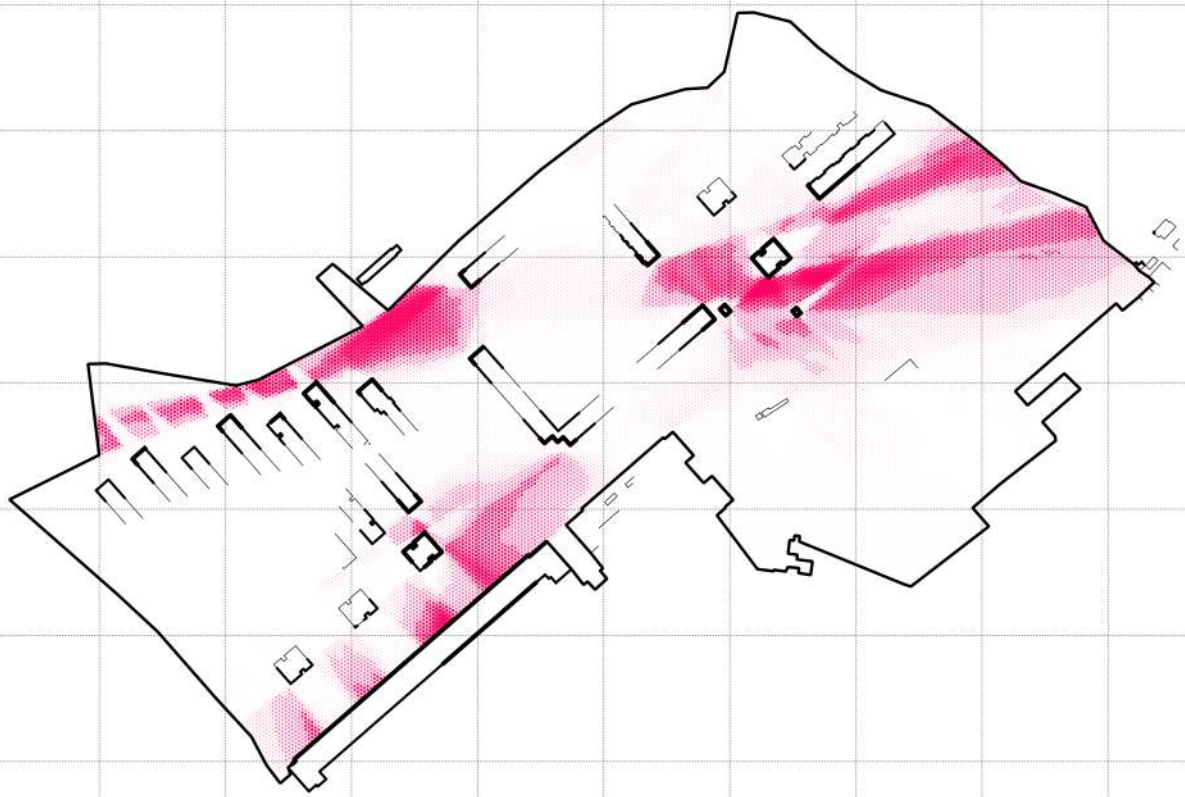




334 m
Average length of the axis

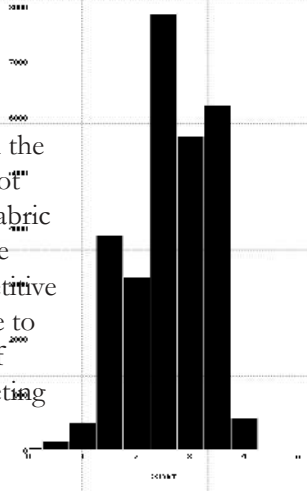
Figure 107. [left]. Fewest-Line Map of the original TorBella Monaca fabric. Source: Author.

Figure 108. [right]. Fewest-Line Map of the present TorBella Monaca fabric. Source: Author.



Centric Corners

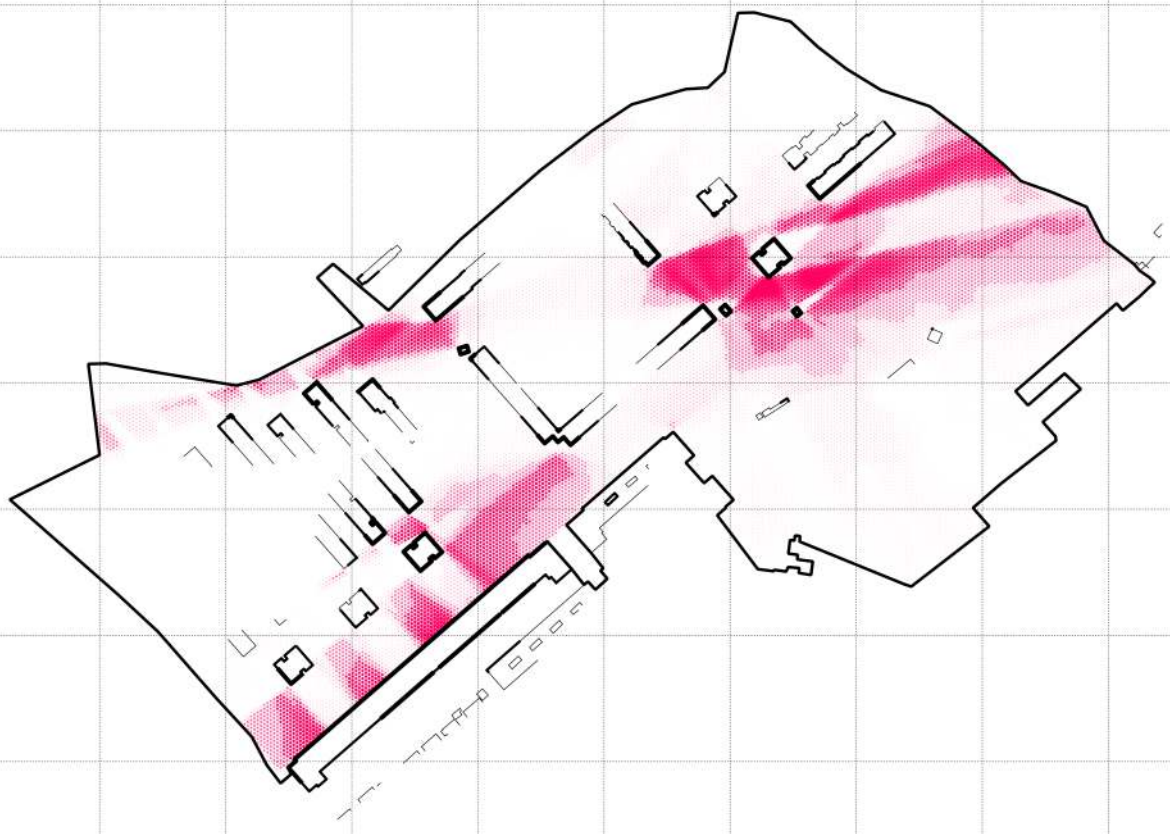
The logical progression of the preceding analyses is evident in this instance. On the one hand, there are slight alterations to the overall structure, though these are not significant. It would appear that there are no corners in the original or current fabric as such, but rather a spatial configuration that indicates a lack of hierarchy in the free space, with continuities of spaces and relationships that are not clearly repetitive or interactive. This is, on the one hand, a positive outcome, as the project is able to maintain the character of the fabric. However, without clearly locating spaces of multiple presence, other types of intervention will be necessary to generate meeting spaces within the fabric.

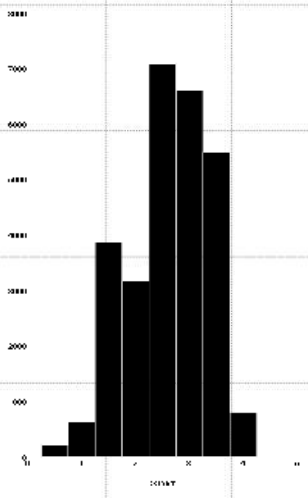


1:6000

2.51

Median of the normalization of values indicating the centric corners





Centric corners

0 - 1,9

1,9 - 2,45

2,45 - 2,85

2,85 - 3,33

3,33 - 4,13

Area of analysis

Buildings

Figure 109. [left]. Grid of choice and overt control values in TorBella Monaca original state, note that the more pinl the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Figure 110. [right]. Grid of choice and overt control values in TorBella Monaca present state, note that the more pink the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

2.55

Median of the normalization of values indicating the centric corners

La Mina, Barcelona

Surface	**23.5 ha**
Year or construction	**1969**
Year of renovation	**2002**
Built surface [%]	**16.8 %**
Budget	**173,300,000 €**

The La Mina neighbourhood of Sant Adrià de Besòs has been undergoing a significant regeneration process since the early 2000s. Originally designed as a social housing estate in the 1960s, La Mina faced serious problems of poverty, marginalisation and crime.

The current urban regeneration process involves the demolition of dilapidated blocks of flats, the construction of new buildings and the improvement of infrastructure and public spaces.

This project, which is still underway, has gone through several phases and its regeneration process has been highly controversial, and as the project continues to evolve, it is necessary to analyse and determine how the spatial structure has evolved from its inception to its current situation and, if necessary, modify the project in order to promote the most comprehensive project possible.

Geometry

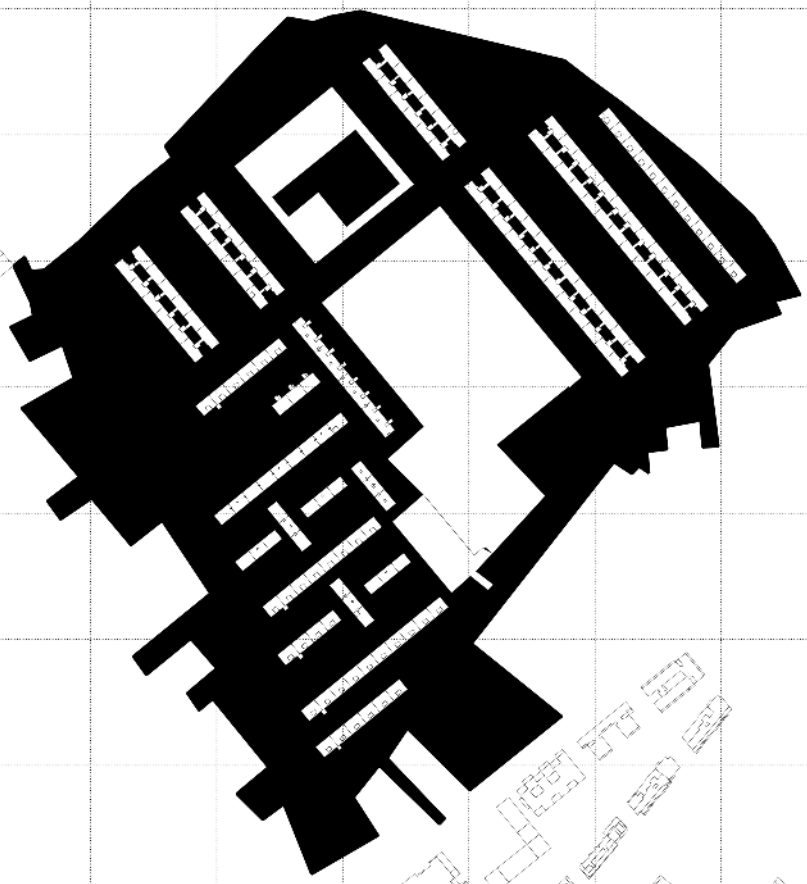
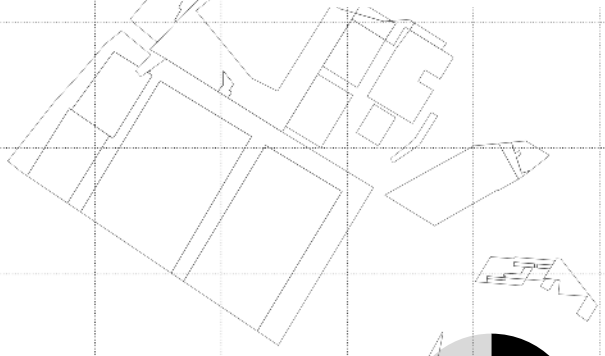
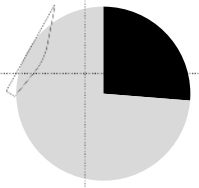


Figure Ground

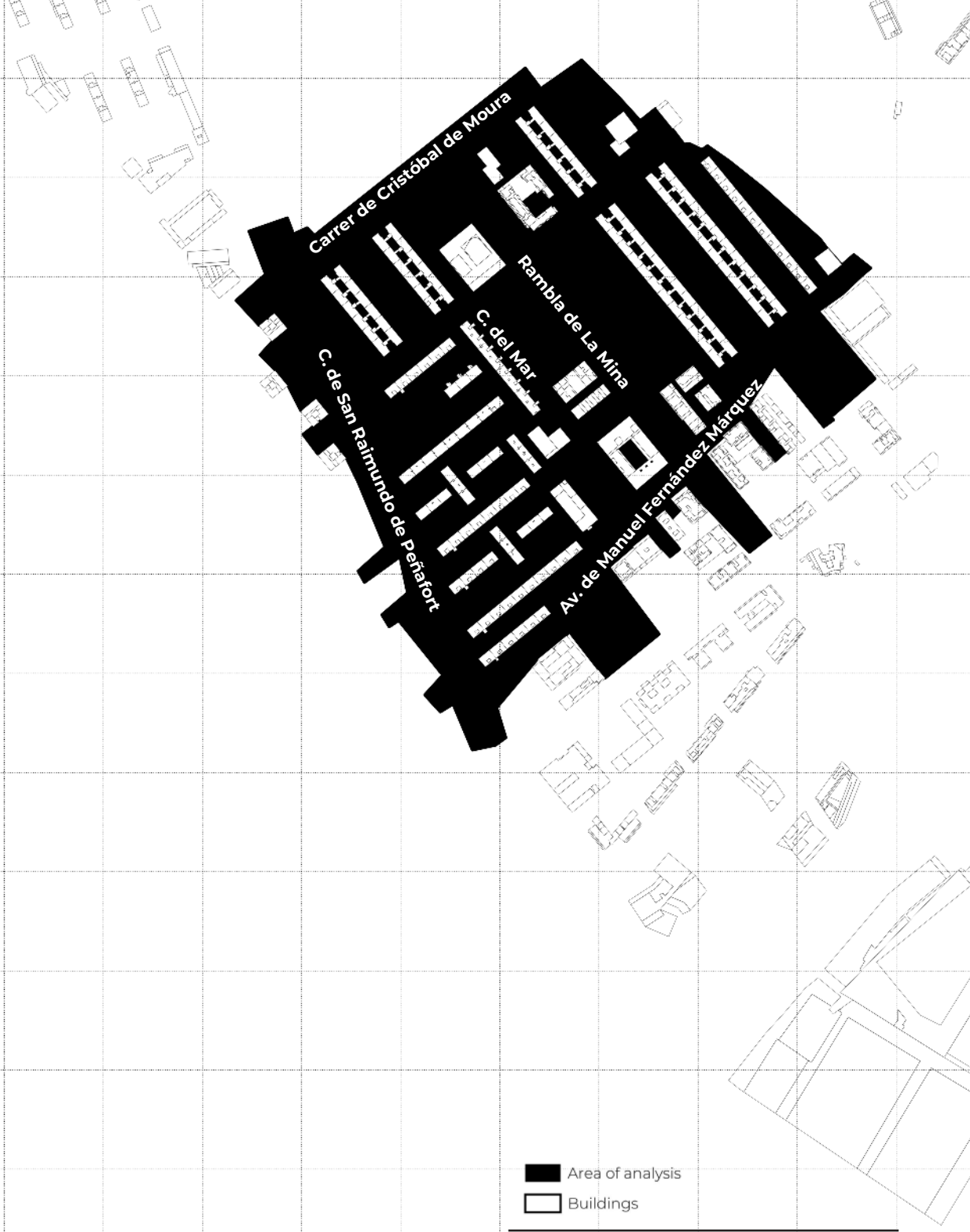
As has been previously stated, the subject of this analysis is an unfinished project that, due to its extended temporal scope, serves as a paradigmatic example of a regeneration project as a temporal expansion of a project that is typically conducted in phases. Each phase of the project may extend sufficiently in time to function as an independent unit, rather than exhibiting an increase in spatial quality in the final project, as is often the case. Instead, the substantial improvement observed in this project can be attributed to a notable enhancement in the previous situation. In this particular instance, it is evident that the enclosure (1), which was situated within the interior of the fabric, has been partially replaced and largely removed in order to facilitate the creation of a new axis and, consequently, a new structure that encompasses a surface area ranging from 26.3% to 16.8%, with notable typological alterations in this central section.

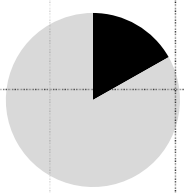




26.3 %
Surface occupied by buildings [%]

1:6000

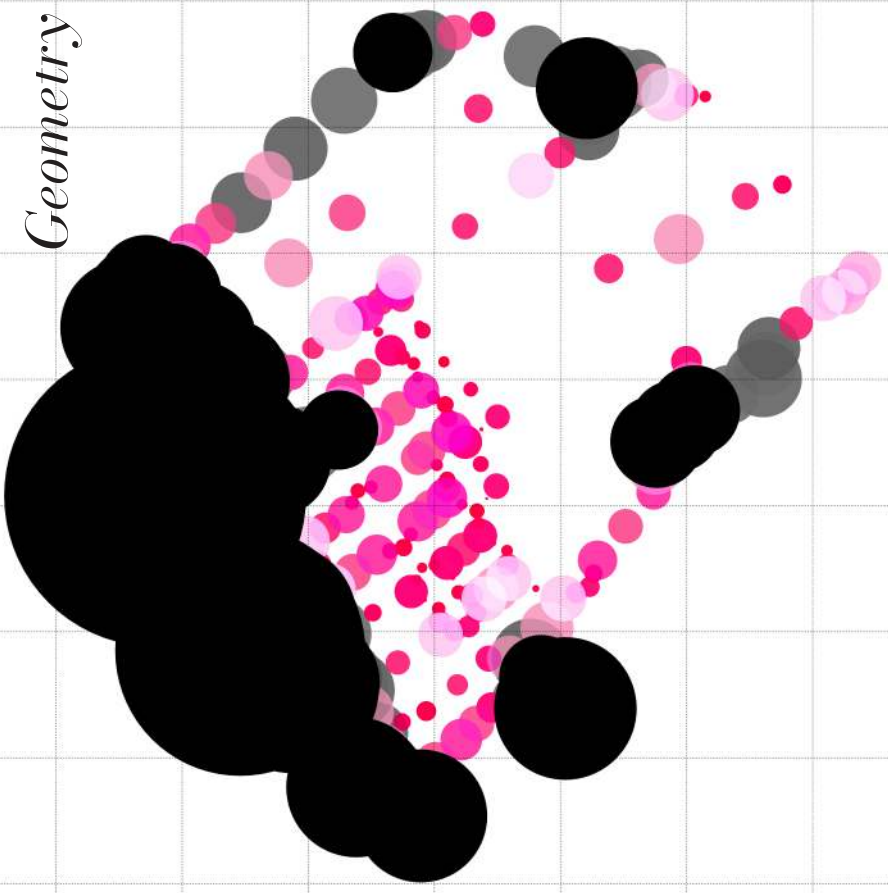




16.8 %
Surface occupied by buildings [%]

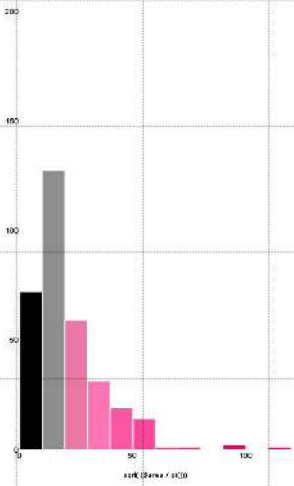
Figure 111. [left]. Figure-ground map,representing in black the space not occupied by buildings in the original state of La Mina. Source: Author.

Figure 112. [right]. Figure-ground map,representing in black the space not occupied by buildings in the present state of La Mina. Source: Author.



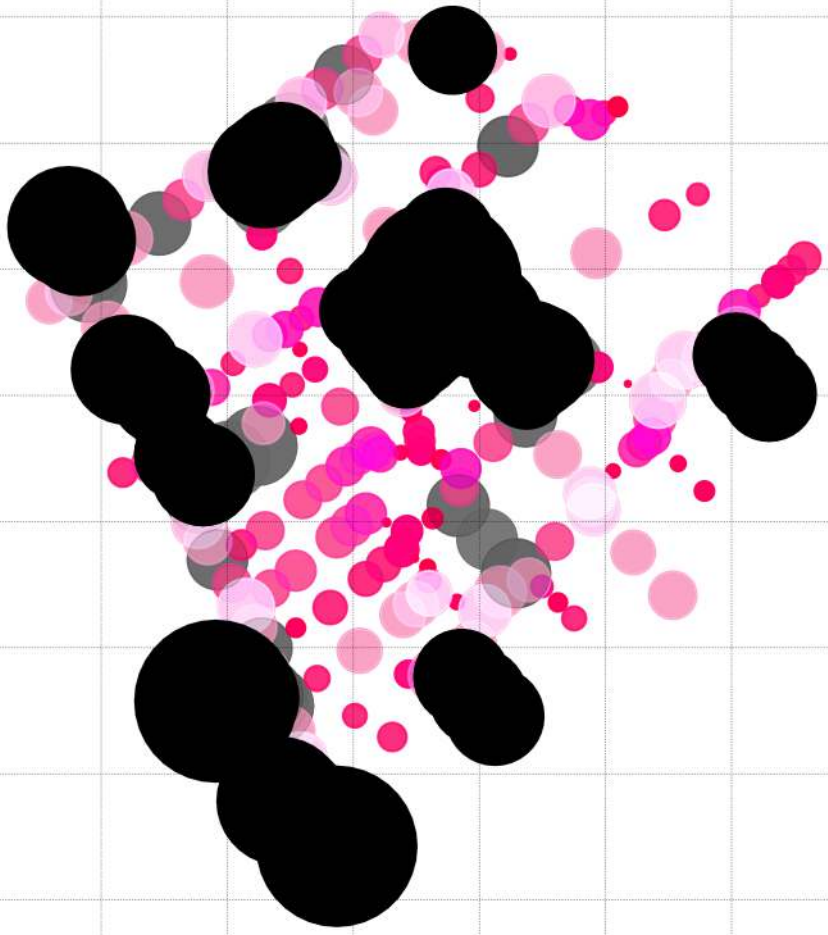
In-between distances

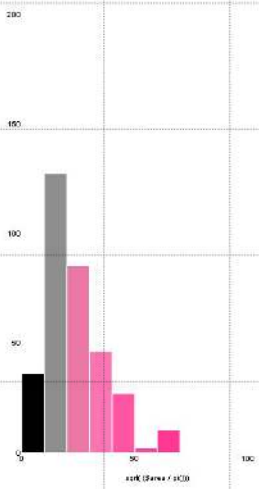
The findings of the preceding analysis are corroborated by those presented here. At the central point where the main opening has taken place (1), the average distance has increased substantially, resulting in a shift of the greatest distances from the perimeter of the enclosure to its inner part. This has led to the formation of a new empty urban environment, which has been observed to entail a number of problems. This process of emptying, though only temporary, has resulted in the formation of a new edge in the centre, which is in contrast to the new buildings in the southern part (2). These buildings appear to perpetuate the existing distances between the free space and the built environment, which are reasonable in relation to the existing built fabric. There is a slight increase in these distances, which allows for an increase in the diversity of the free space.



21.05 m
Average radius

1:6000





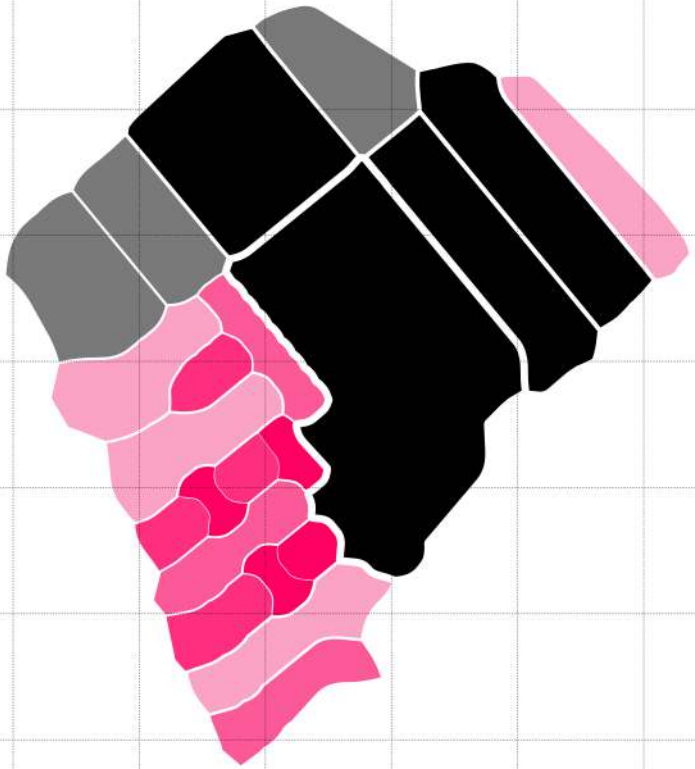
23.26 m
Average radius

Radius [m]

- 1,9 - 11,7
- 11,7 - 15,5
- 15,5 - 20,3
- 20,3 - 24,4
- 24,4 - 36,3
- 36,3 - 64,5

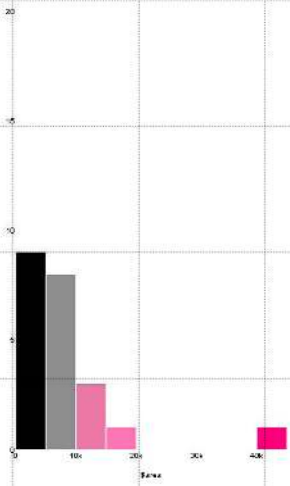
Figure 113. [left]. Critical distances of the open spaces around the original La Mina fabric. Source: Author.

Figure 114. [right]. Critical distances of the open spaces around the actual La Mina fabric. Source: Author.



Urban Grain

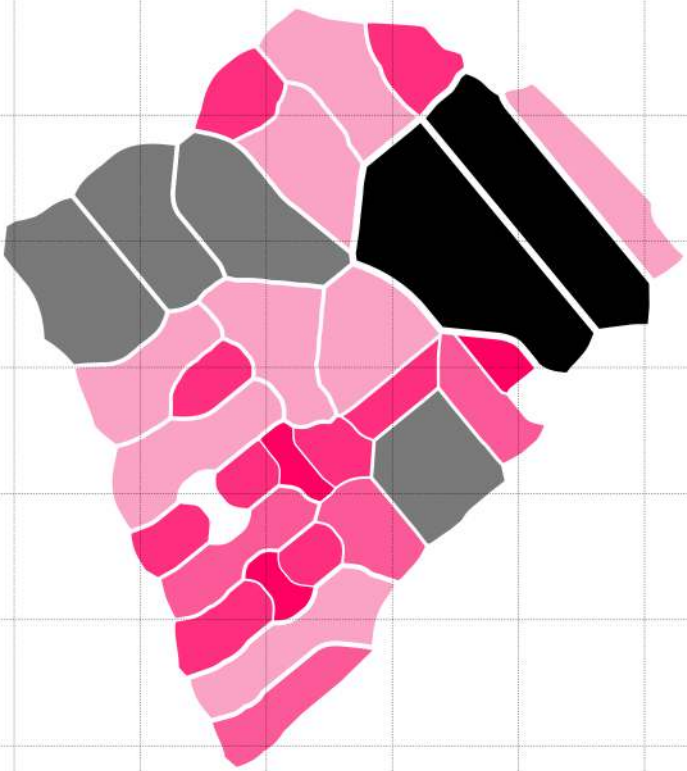
The principal dynamics of the intervention are evident in this analysis. On the one hand, the evolution and diversification of a medium-sized grain in the southern part of the fabric (1) and the appearance of new divisions in the space in the central part affect the new relationship between the built environment and the free space in this environment, promoting a more central structure, observable in the confluence of the different polygons in the central part. Conversely, this phase of the project exhibits a gradation in grain size from west to east. In the west, the grain is smaller, while in the east, it is larger. This generates a linear gradation, which contrasts with the more radical and central gradation observed in the original project.

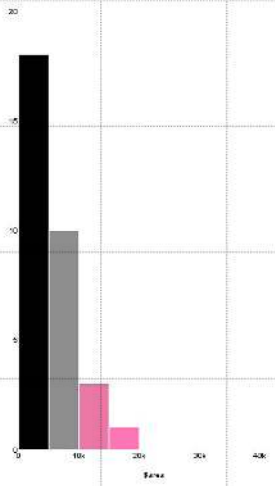


8,015 m²
Average surface

1:6000

In general, this process has permitted a reduction in the average grain surface area of approximately 2500 square metres, accompanied by a reduction in the standard deviation of almost double, approximately 5000 square metres. This explains the reduction in the size of the large surfaces present in the original state.





5,490 m²
Average surface

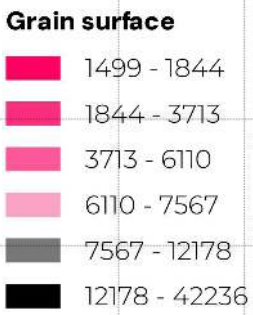
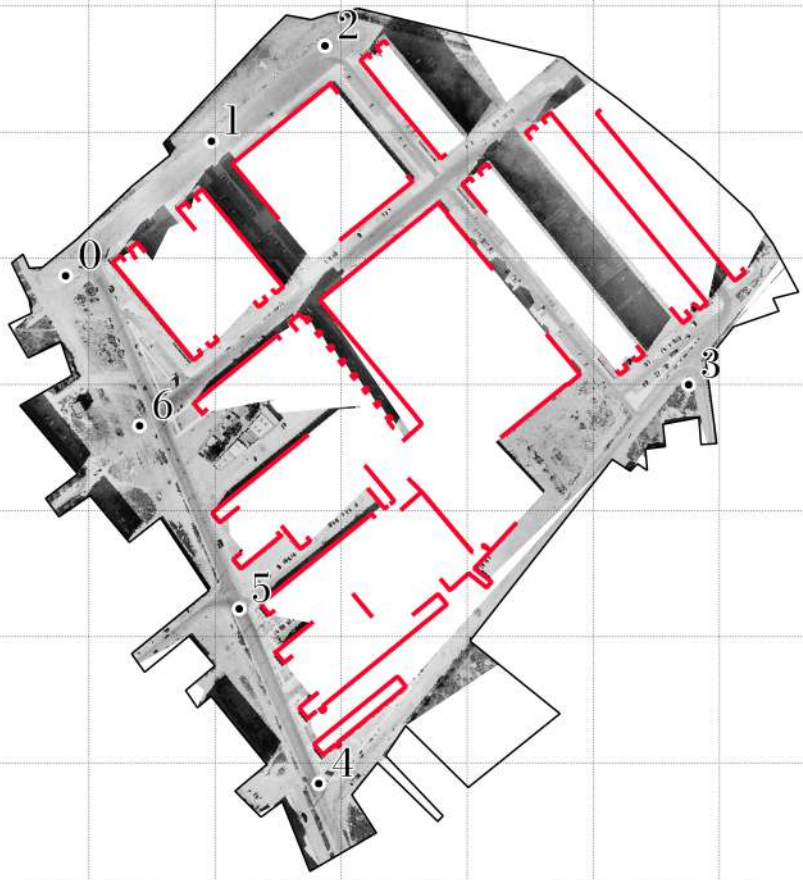


Figure 115. [left]. Basic grain and skeleton of the original La Mina fabric. Source: Author.

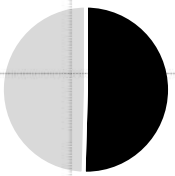
Figure 116. [right]. Basic grain and skeleton of the present La Mina fabric. Source: Author.

Perception



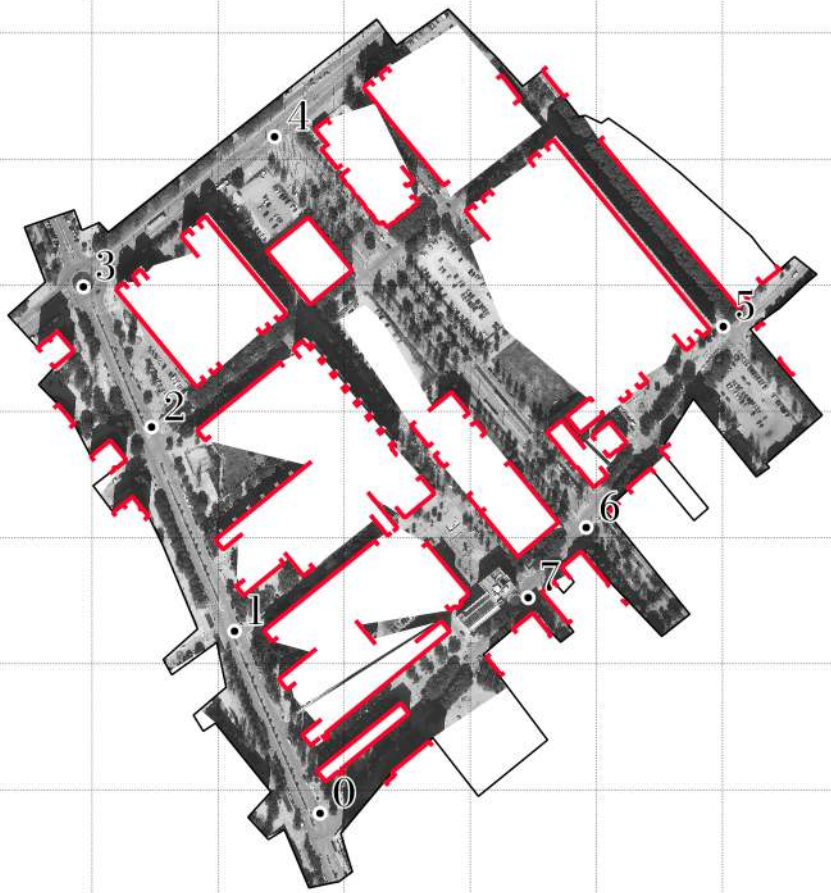
Exterior Permeability

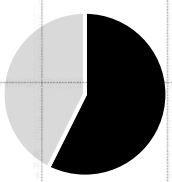
In terms of the porosity of the fabric, a notable enhancement can be observed, with an increase of 7% in the visible area, which, in absolute terms, equates to an expansion of 16 hectares. However, apart from the evident increase in the area visible from the outside, the topology of these changes is noteworthy. The location of the new areas visible from the outside ensures a new spatial configuration perceived from the entrances to the neighbourhood. The establishment of a new axis within the central space and the modification of the urban environment at the periphery result in a more fragmented perceived configuration, characterised by clusters with a smaller average surface area than in the original case. Furthermore, in addition to the primary axis (1), the establishment of a secondary axis (2) that appears to be relatively well-established in its southern section, indicating a visible section of a similar magnitude to those observed in the original project, also merits attention. This secondary axis also communicates with the surrounding urban structure.



50.5 %
Surface visible [%]

1:6000



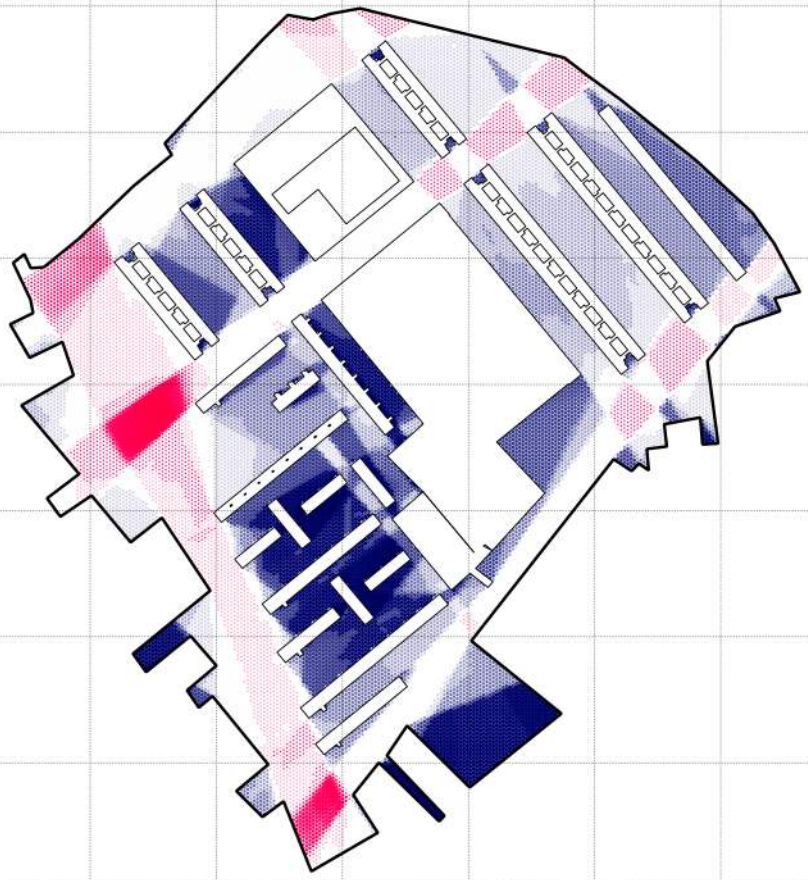


57.4 %
Surface visible [%]

Boundary delimiting the area of the analysis
Facade delimiting the viewshed

Figure 117. [left]. Visual sheeds from the main entry points to the original La Mina fabric. Source: author.

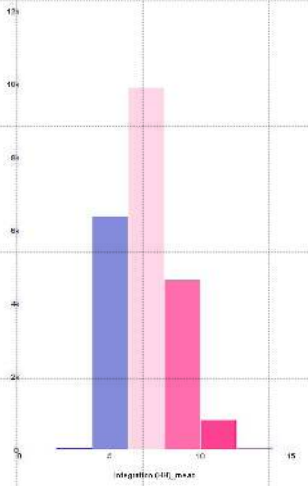
Figure 118. [right]. Visual sheeds from the main entry points to the present state of La Mina fabric. Source: author.



Hidden places

In addition to the preceding analysis, it is evident that there is a distinction in spatial configuration in relation to the spaces that are, on the one hand, more concealed and, on the other hand, have a lesser capacity to accommodate multiple presences within the open space.

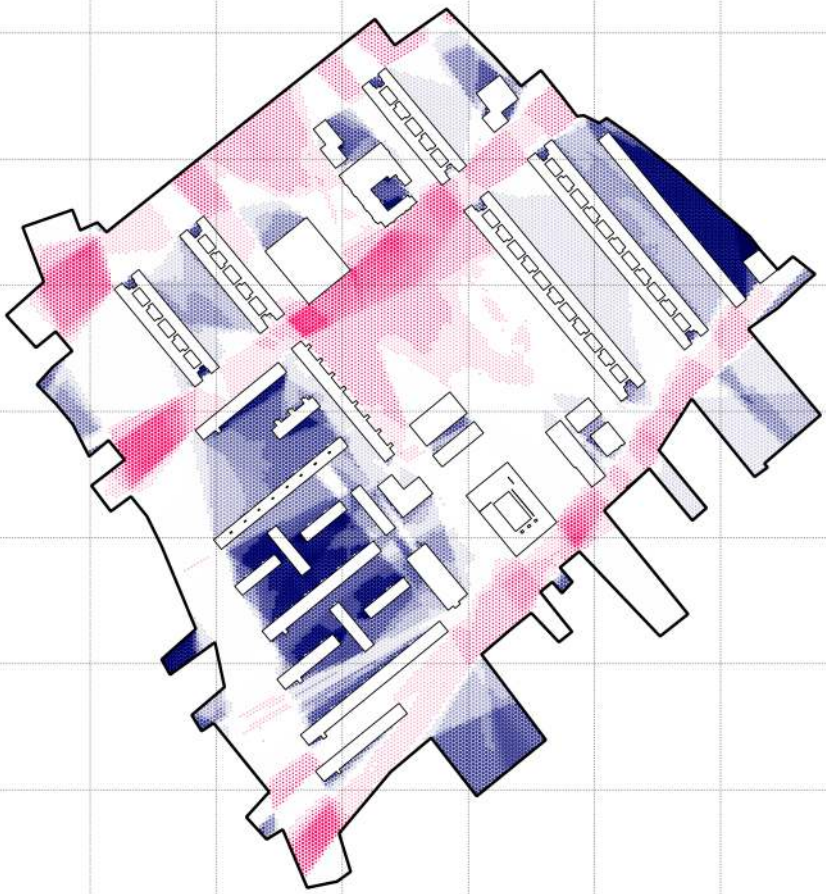
It is notable that both cases exhibit a paucity of high values in this fabric, which may be attributed to the considerable heterogeneity in the surface area of the open spaces. The hidden spaces are located in the south-western part of the fabric (1), which undergoes a transformation in the part closest to the centre of the fabric. Furthermore, no significant alterations are evident in the north-eastern section.

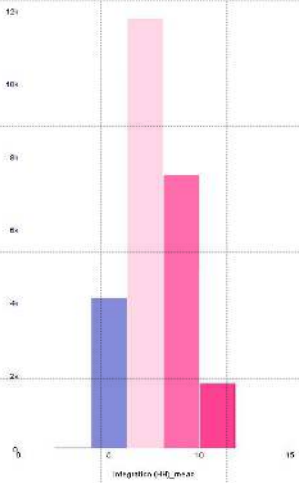


1:6000

6.6
Median of the values indicating the hidden spaces

In conclusion, the new structure, which involves the creation of a central axis and the opening of new visual relations with the exterior, does not appear to have affected those areas that are not in direct contact with the modifications of the built environment.





7.44
Median of the values indicating the hidden spaces

Hidden places

- 3,67 - 6,12
- 6,12 - 7,03
- 7,03 - 7,83
- 7,83 - 8,74
- 8,74 - 11,17

Area of analysis
Buildings

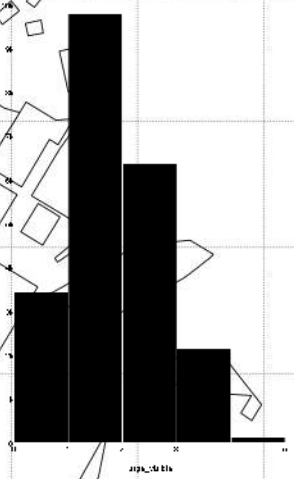
Figure 119. [left]. Grid of integration values in La Mina original state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Figure 120. [right]. Grid of integration values in La Mina present state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Perception

Large & more visible square-like spaces

With regard to the aforementioned square-like spaces with high visibility, the same dynamics that have been observed in previous analyses are clearly evident, with some new nuances. Firstly, it appears that the greatest incidence of large open spaces shifts from the edge of the fabric (1) to the central region, although the high values observed at the edge remain. Conversely, when the focus is shifted to the intermediate values, which are present in small clusters along the weave, it is in these areas that the most significant contrast can be observed.

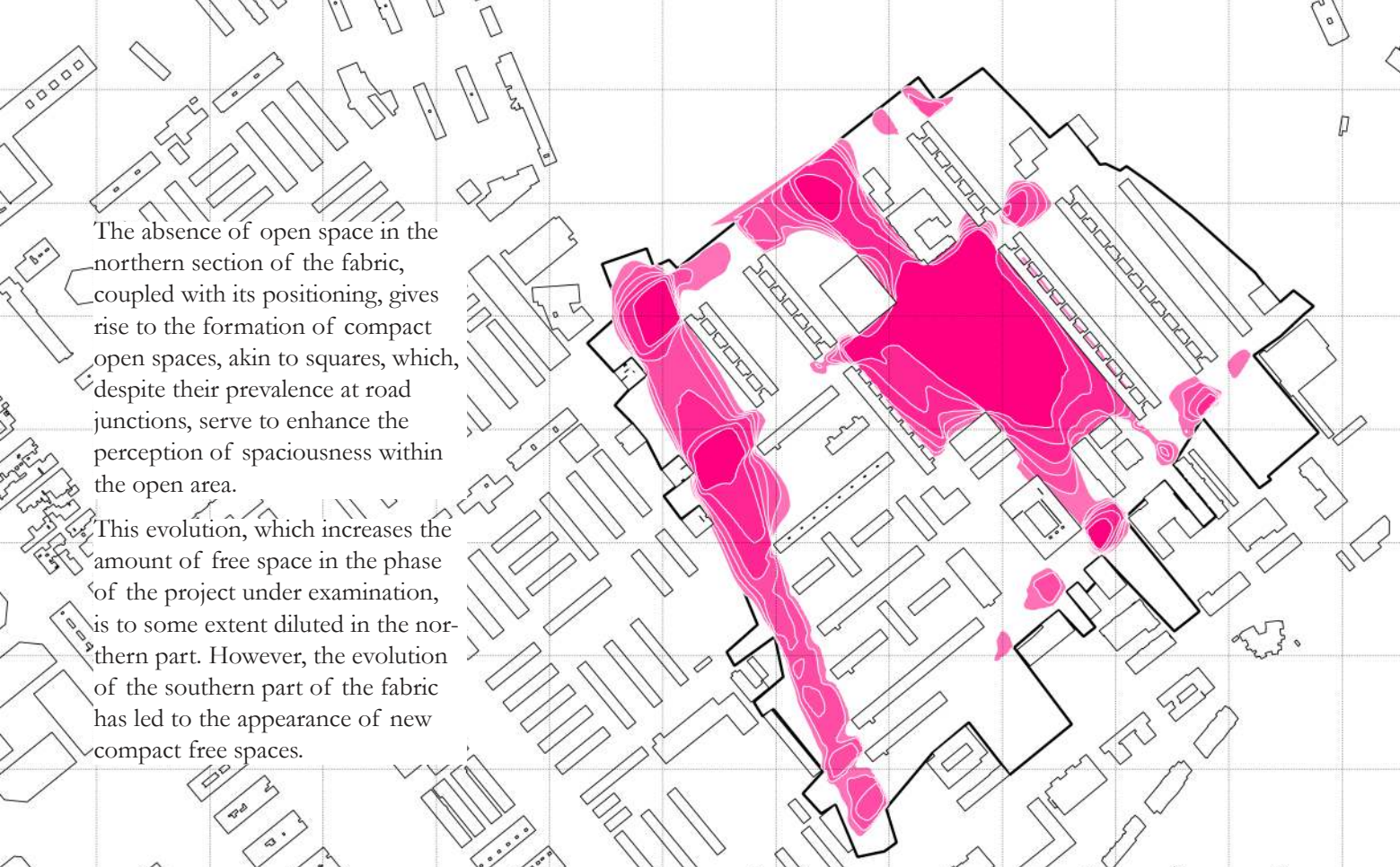


58.8 ha
Surface occupied by the highest values

1:6000

The absence of open space in the northern section of the fabric, coupled with its positioning, gives rise to the formation of compact open spaces, akin to squares, which, despite their prevalence at road junctions, serve to enhance the perception of spaciousness within the open area.

This evolution, which increases the amount of free space in the phase of the project under examination, is to some extent diluted in the northern part. However, the evolution of the southern part of the fabric has led to the appearance of new compact free spaces.



80.5 ha
Surface occupied by the highest values

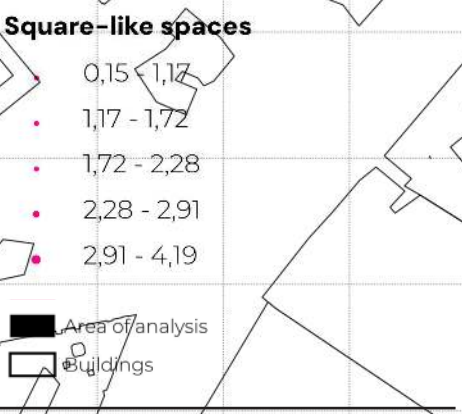
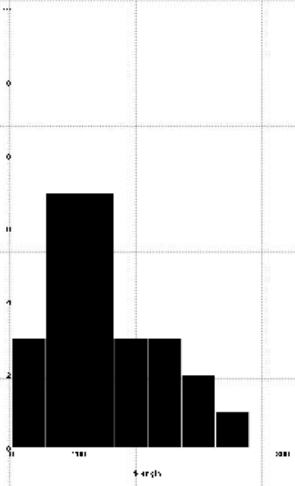


Figure 121. [left]. Contour lines representing the highest values of average radial in La Mina original state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

Figure 122. [right]. Contour lines representing the highest values of average radial in La Mina present state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

Basic structure

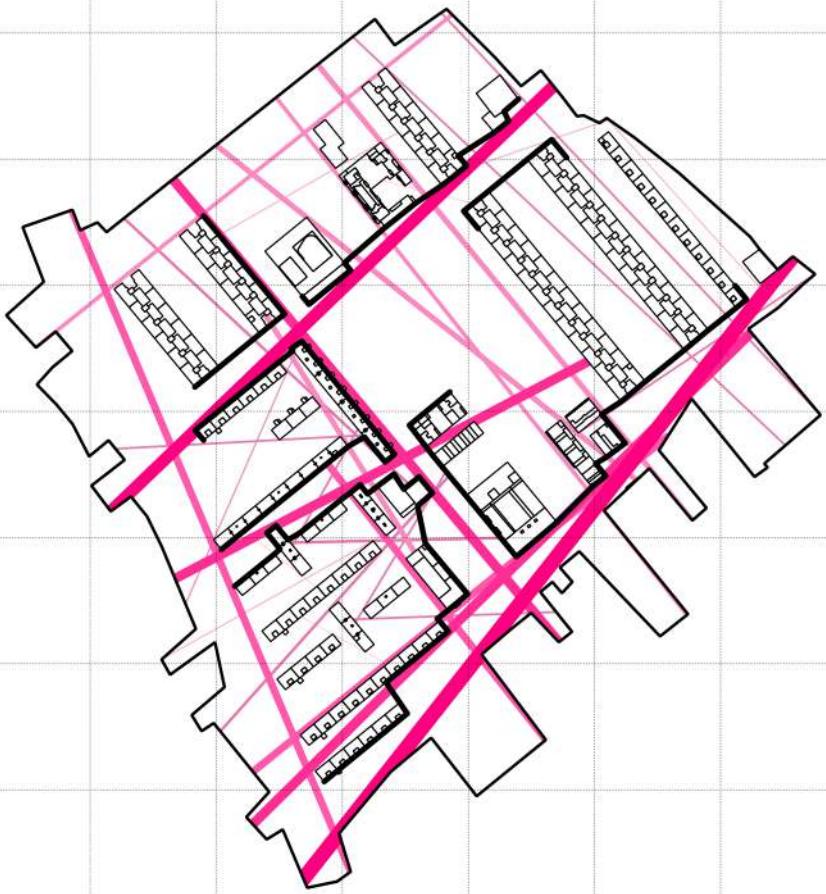
The modification of the spatial configuration, as a consequence of the removal of the central complex, can be observed in this particular area in a most striking manner. Firstly, the formation of axes can be observed, which originate in the eastern section and extend towards other areas, primarily along the edge of the fabric. Additionally, the original fabric exhibits the emergence of several minor axes that intersect in the central region, though their significance is comparatively diminished. Conversely, the current phase has witnessed two significant alterations in this regard.

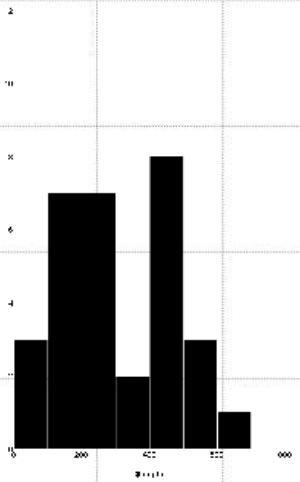


238 m
Average length of the axis

1:6000

Firstly, the consolidation of the transversal axis, which, due to the opening up of the central area, assumes greater relevance in the connection of the spaces of the fabric and, therefore, becomes central in the configuration of the free space of the neighbourhood. The modification of the southern edge also results in the formation of a new central axis in the spatial configuration, which is oriented in parallel with the initial axis and is connected by perpendicular axes.





273 m
Average length of the axis

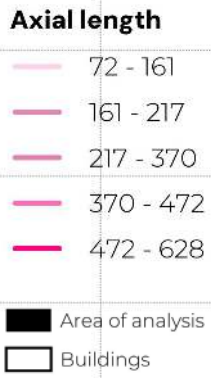
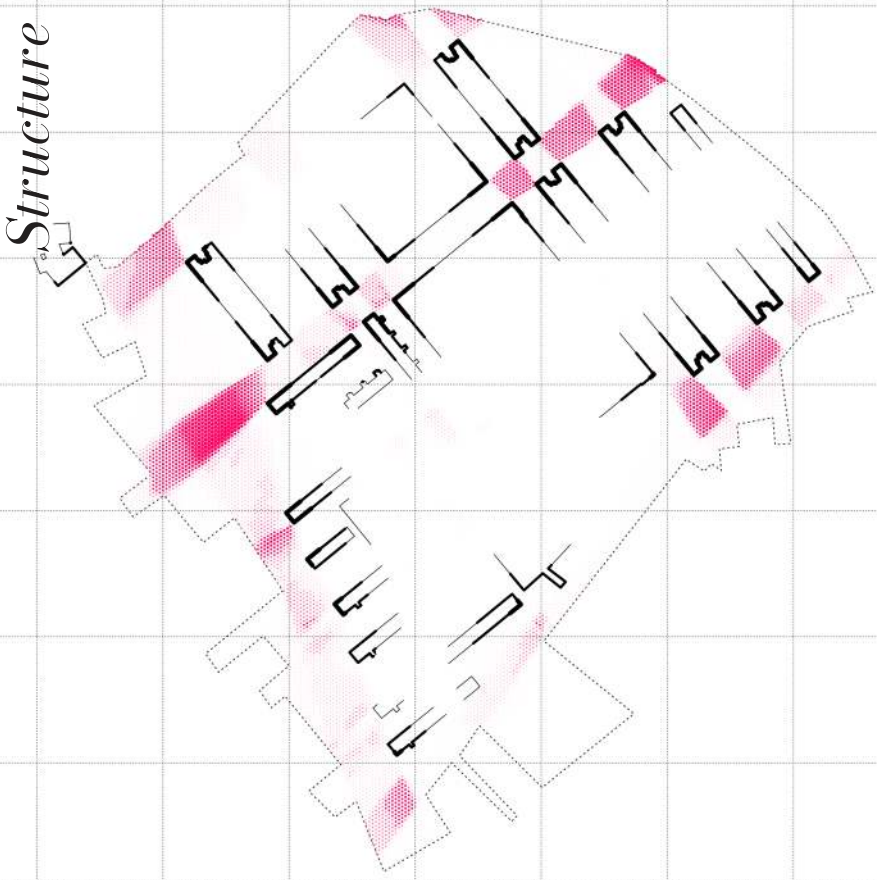


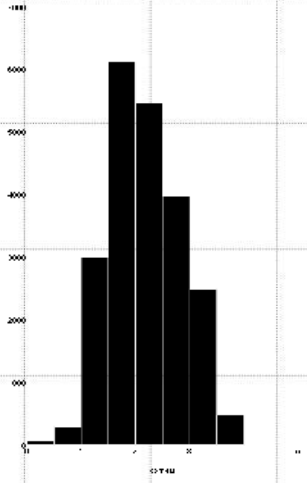
Figure 123. [left]. Fewest-Line Map of the original La Mina fabric. Source: Author.

Figure 124. [right]. Fewest-Line Map of the present La Mina fabric. Source: Author.



Centric Corners

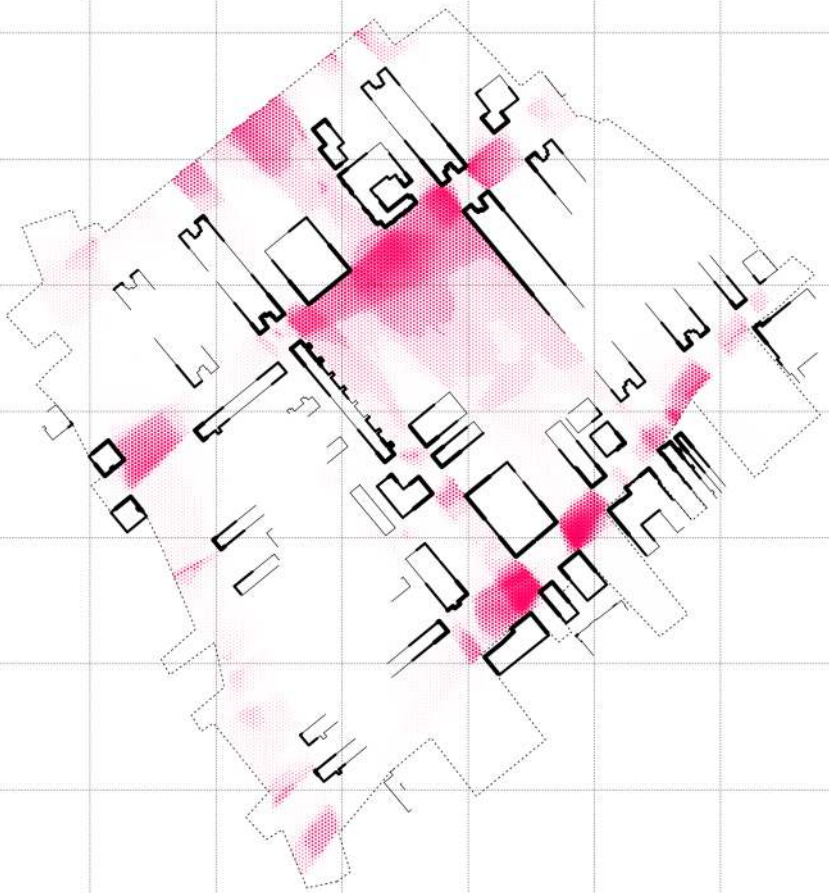
Prior to undertaking a comparative analysis, it is essential to highlight the similarities between this analysis and that of square-like spaces. Although the two spaces employ different graphical languages, a relevant similarity can be observed in their current state. It is noteworthy that these spaces, which are characterised by high overt control and choice, are situated in the largest open areas. This is a phenomenon that has been observed in the literature and is often indicative of spaces that are perceived as insecure and degraded. Despite their central location, these spaces are often avoided.

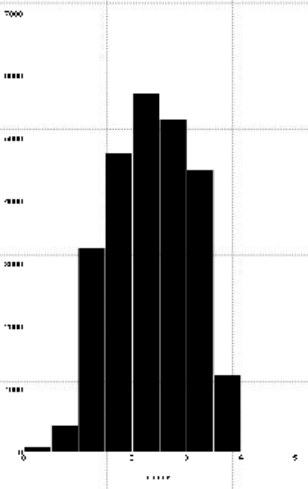


1:6000

2.11
Median of the normalization of values indicating the centric corners

In the original fabric, however, two tendencies can be observed, which have also been identified previously. The first of these is the importance of the western axis and the relationship with that part of the urban context. The second is the creation of corners in the north-eastern part, at the intersections of the blocks with the perpendicular axes. In the current situation, however, there is a notable increase in heterogeneity and a reduction in the perceived hierarchy, which in turn increases the complexity in defining the configuration of the free space. This appears to be balanced between the northern part of the central space and the new axis in the southern part, the latter of which seems to have become the backbone of the spatial configuration of the fabric.





2.31
Median of the normalization of values indicating the centric corners

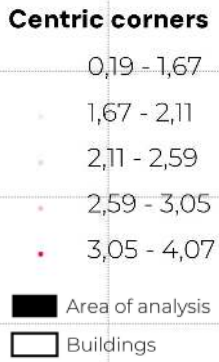


Figure 125. [left]. Grid of choice and overt control values in La Mina original state, note that the more pinl the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Figure 126. [right]. Grid of choice and overt control values in La Mina present state, note that the more pink the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Agrocite Gagarine Truillot

Surface	**27 ha**
Year or construction	**1963**
Year of renovation	**2010 - 2029**
Built surface [%]	**48.4 %**
Budget	**16,600,000 €**

The Gagarine-Truillot neighbourhood, located in Ivry-sur-Seine, initially built in the 1960s as an expansion of social housing on the outskirts of Paris, the neighbourhood has faced a significant process of deterioration that ended, in 2004, with the demolition of the emblematic Gagarine building.

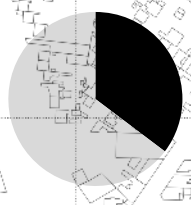
In order to reverse this process, multiple initiatives have been launched, including the major intervention 'Agrocitè Gagarine Truillot', designed by the Archikubik studio, which seeks to radically transform the neighbourhood through densification and the creation of a new relationship with the open space through the incorporation of productive spaces. Given the relevance of this project (winner of the Spanish national urbanism prize), it is chosen as a case study in order to understand not only interventions already carried out and studied, but also to understand future trends in regeneration processes.

Figure Ground

The following cartographies provide a clear indication of the location of the physical intervention in this fabric. Although this is an unbuilt project that has sought to enhance the relationship with the free space and to promote the free space as a productive space, the project has focused on densifying and filling in, as can be observed from the spatial perspective. On the one hand, the extensive vacant area at the centre of the fabric, adjacent to the railway line, has been reinforced. In contrast, the remainder of the fabric has undergone a process of selective extraction, whereby the larger blocks have been replaced by a series of smaller buildings. This approach has resulted in a denser and undoubtedly more porous overall structure, which will be subject to further investigation in subsequent analyses.

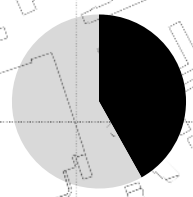
Geometry

1:6000



35.3 %
Surface occupied by buildings [%]

Furthermore, it can be observed that a series of new axes are emerging from the limits of the fabric towards the current large void. It seems pertinent to note that the process of densification has resulted in a 6.6% increase in land occupation. This appears to foster a relationship with environments that are not primarily productive, but rather serve as sites for productive leisure and social interaction.

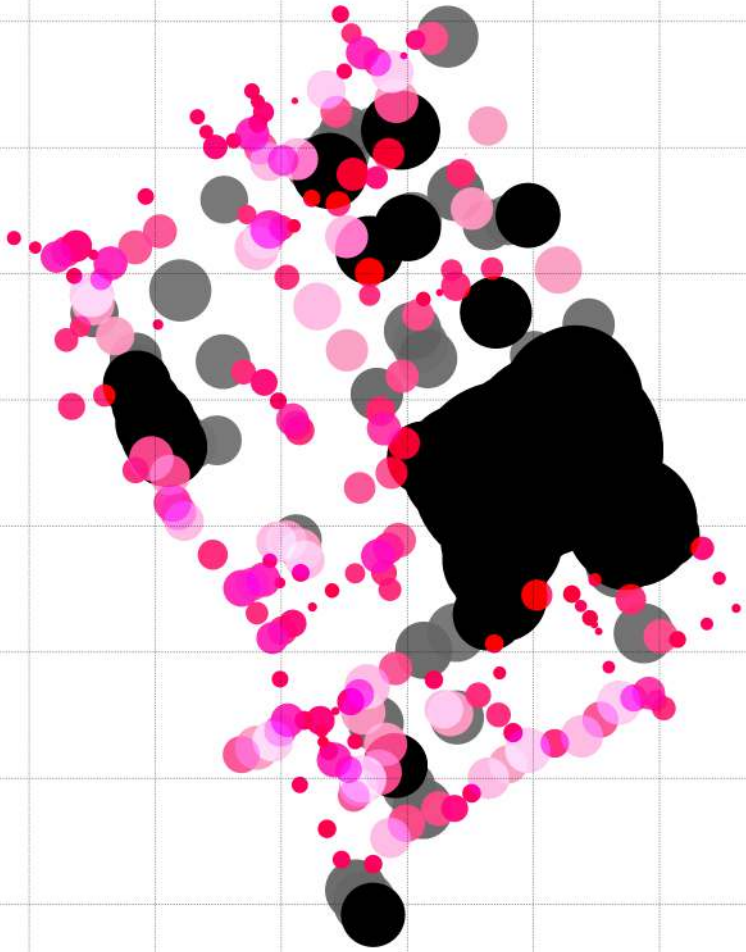


41.9 %
Surface occupied by buildings [%]

Area of analysis
Buildings

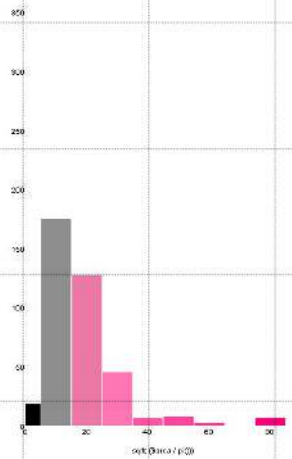
Figure 127. [left]. Figure-ground map,representing in black the space not occupied by buildings in the original state of Agrocité Gagarine Truillot. Source: Author.

Figure 128. [right]. Figure-ground map,representing in black the space not occupied by buildings in the present state of Agrocité Gagarine Truillot. Source: Author.



In-between distances

The observed densification subsequently results in a significant reduction of distances within the fabric's inner region. The large open spaces in the centre of the fabric, along with the location of certain voids at the edges of the fabric, resulted in an average radius of 21.8 metres. This has now been reduced to 19.7 metres. This suggests the resolution of the extensive void and the development of smaller spaces, which permits interaction between the elements within the fabric. However, the voids, which may impede the relationship with the surrounding urban environment, appear to be maintained in the project.

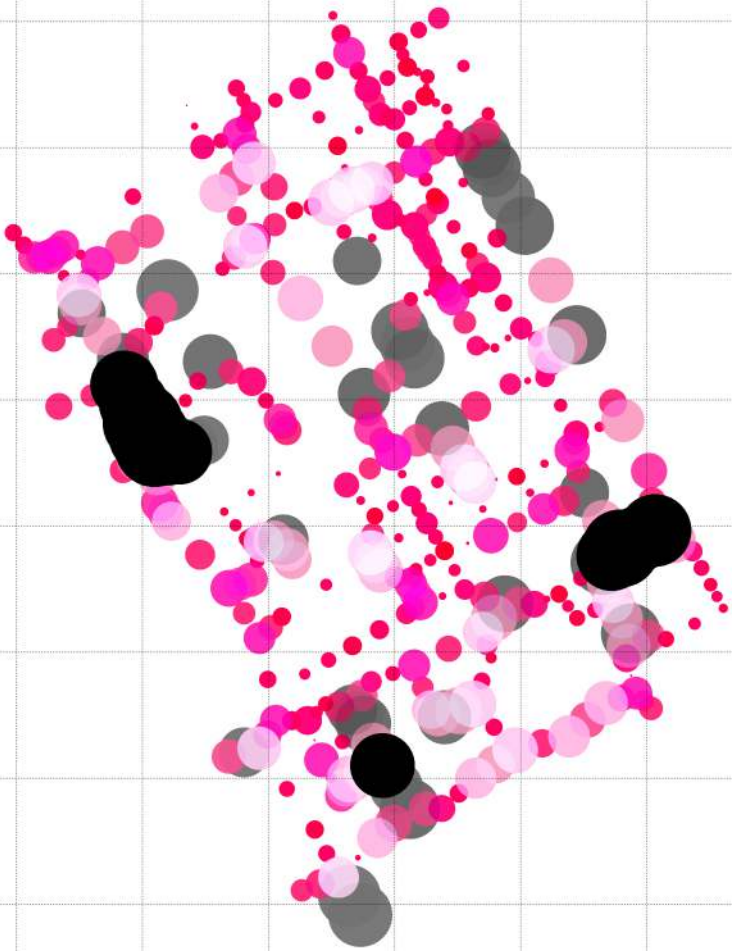


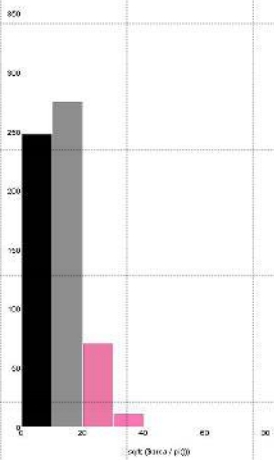
15.15 m
Average radius

Geometry

1:6000

It is also noteworthy that the diversity of spaces, characterised by varying dimensions, has been reduced. This is evidenced by a decline in the standard deviation from 12.4 metres to 9.02 metres. This may suggest a loss in urban diversity; however, this may be an inaccurate representation due to the elimination of the large free space that was the central space.





12.61 m
Average radius

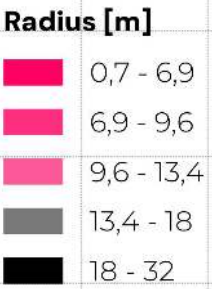
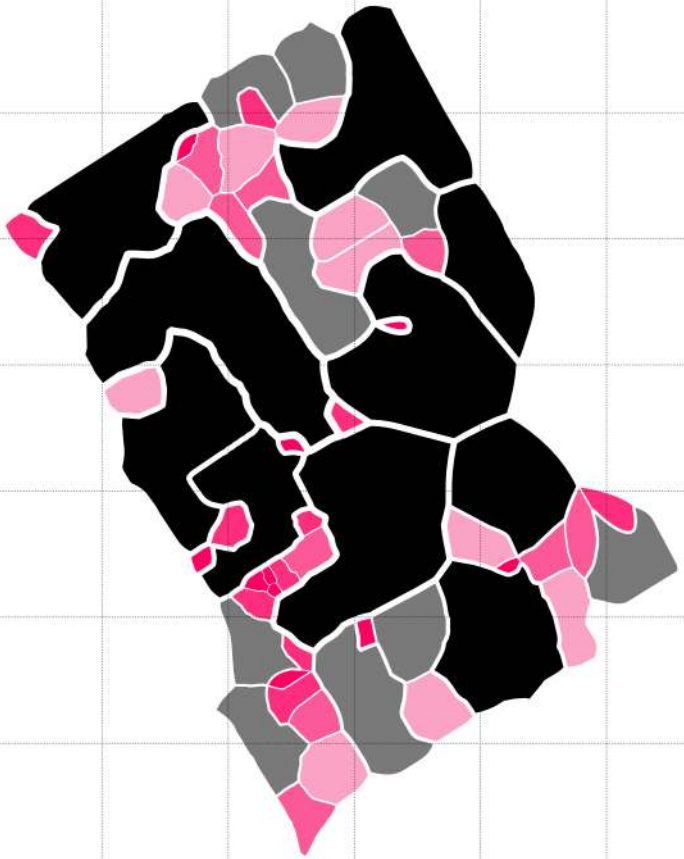


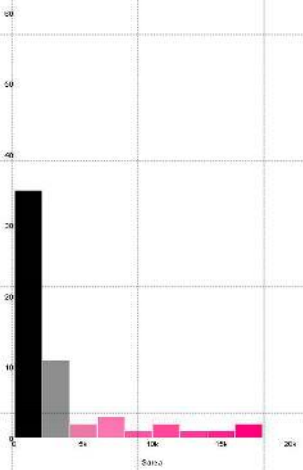
Figure 129. [left]. Critical distances of the open spaces around the original Agrocitè Gagarine Truillot fabric. Source: Author.

Figure 130. [right]. Critical distances of the open spaces around the actual Agrocitè Gagarine Truillot fabric. Source: Author.

Urban Grain



Conversely, an examination of the urban grain reveals that the preceding analyses are validated. On the one hand, the replacement of edge buildings and the densification of the central area with smaller units has resulted in the multiplication of polygons, as observed in the analysis of distances. This has led to a reduction in the average surface area of these polygons, which has decreased by approximately 1500 square metres. This reduction also appears to be concentrated along two axes that converge in the extensive central void of the current state (1, 2). Conversely, there are also areas that have not undergone physical intervention, resulting in the maintenance of their surface area.

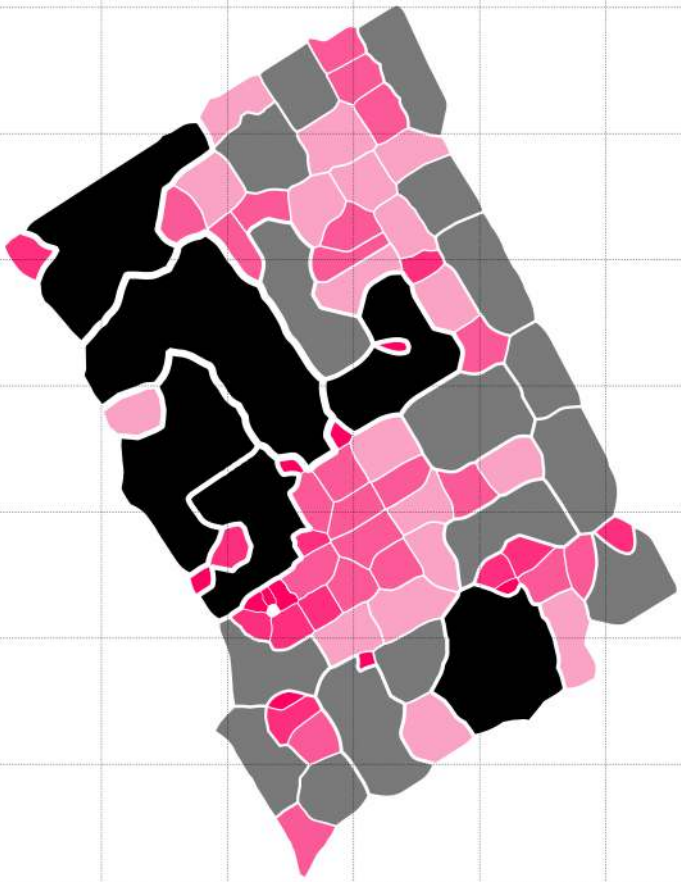


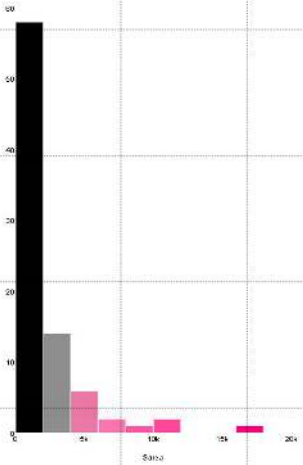
3,128 m²
Average surface

Geometry

1:6000

It is also noteworthy to observe that even at the outset, the fabric exhibited areas with a relatively small grain, which ensured a fairly high standard deviation. However, this has been reduced, possibly indicating a similarity in the typologies employed in the regeneration process and, therefore, a loss in the urban diversity of the fabric.





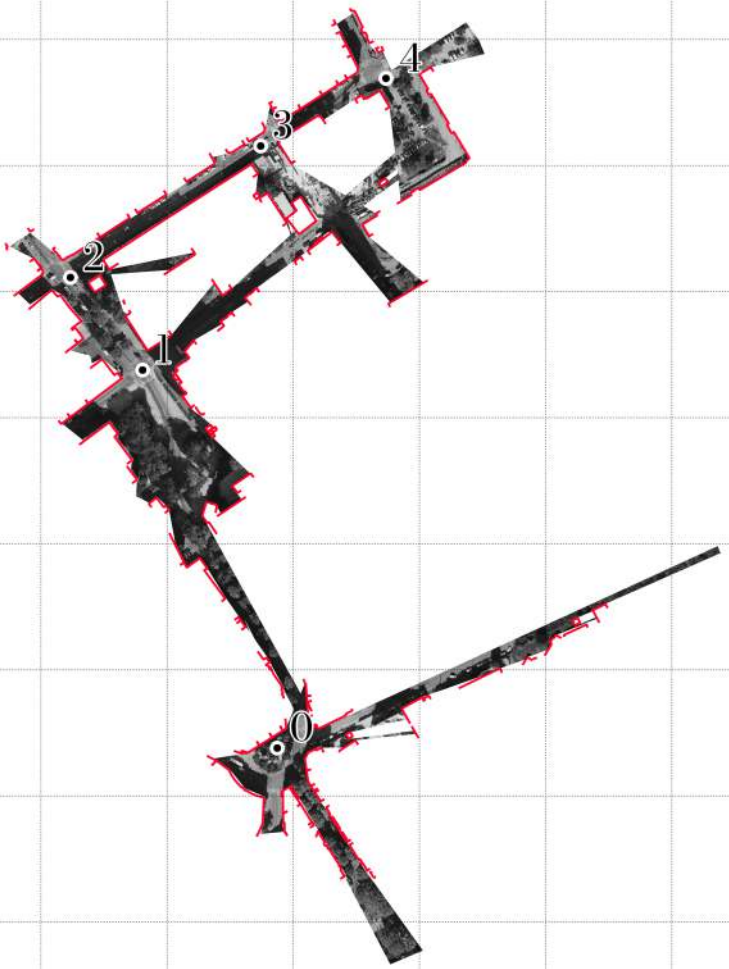
2,253 m²
Average surface

Grain surface [m2]

- 77 - 778
- 778 - 1140
- 1140 - 1612
- 1612 - 2954
- 2954 - 17706

Figure 131. [left]. Basic grain and skeleton of the original Agrocitè Gagarine Truillot fabric. Source: Author.

Figure 132. [right]. Basic grain and skeleton of the present Agrocitè Gagarine Truillot fabric. Source: Author.



Exterior Permeability

As can be observed in the cartographic representations that follow, the surface area visible within the project area is greater than that of the current situation, with an expansion of 8.4%. This has been achieved by maintaining the porosity of those parts of the fabric which already appear to be permeable, particularly in the north (1), while simultaneously consolidating the existence of some minor axes of visibility in the southern part (2). This has been done by first increasing their section and, in addition, doubling the existence of this axis. It is also worth noting that the creation of new axes, both in the northern part and in a southerly direction, and the crossing of these axes in the central part, appear to ensure a complete visual transition through the fabric. However, this will be confirmed in subsequent analyses. In conclusion, it can be stated that the project has enhanced the permeability of the fabric, with an optimal selection of the access axes and an effective multiplication of them, thus improving the overall porosity.

Boundary delimiting the area of the analysis

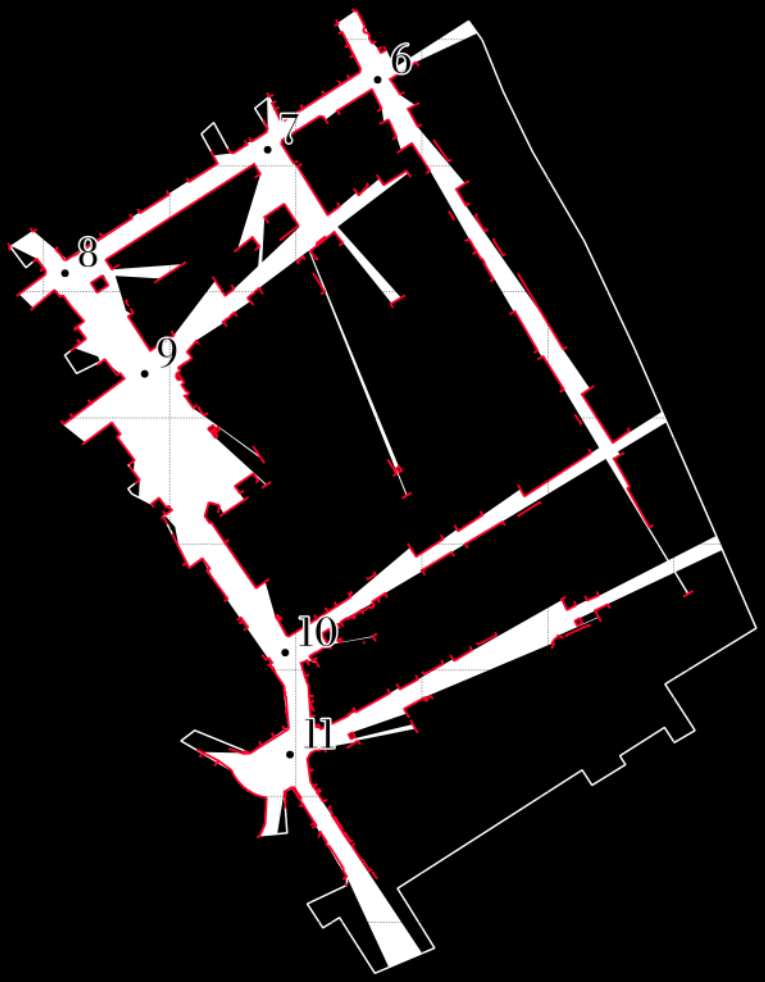
Facade delimiting the viewshed

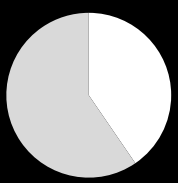
Perception

1:6000

48,3 %

Surface visible [%]

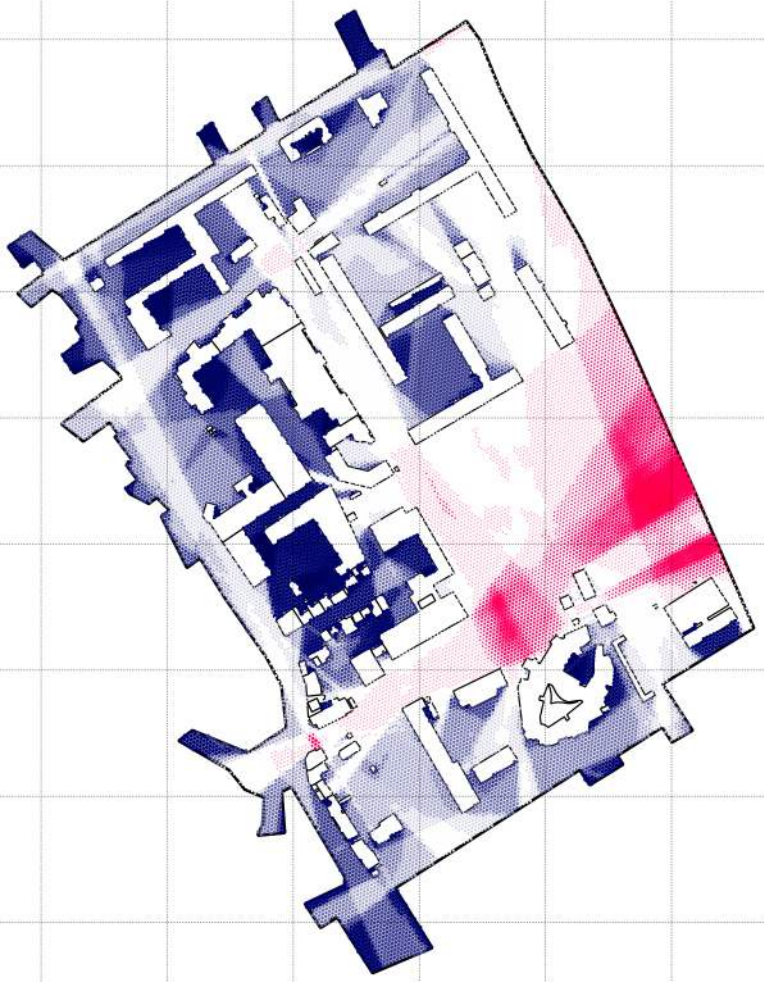




31,1 %
Surface visible [%]

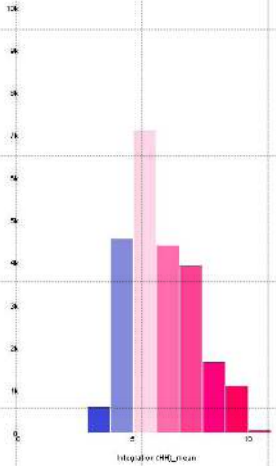
Figure 133. [left]. Visual sheeds from the main entry points to the original Agrocitè Gagarine Truillot fabric. Source: author.

Figure 134. [right]. Visual sheeds from the main entry points to the present state of Agrocitè Gagarine Truillot fabric. Source: author.



Hidden places

This analysis suggests that the observed increase in the less integrated surface area of the fabric is a logical consequence of the observed phenomena. Although it appears that the scale of the expansive central space may distort the final result, it seems logical that the larger the space, the greater the potential for crossing or generating a multiple presence. However, the scale of the space may have the opposite effect, acting as a barrier. However, it is noteworthy that the multiplication of the grain and the reduction of distances, which might be expected to increase the opportunities for promoting encounters, has been drastically reduced.



5.88
Median of the values indicating the hidden spaces

Perception

1:6000

This may be attributed to the utilisation of an insufficiently granular scale, which has resulted in an exponential multiplication of relationships, thereby reducing the overall density in specific areas. However, a hierarchy is observed in the project, whereby certain spaces expand their section and are thus able to accommodate and encourage a greater number of meeting spaces, thereby establishing spatial relations that order a clear structure.

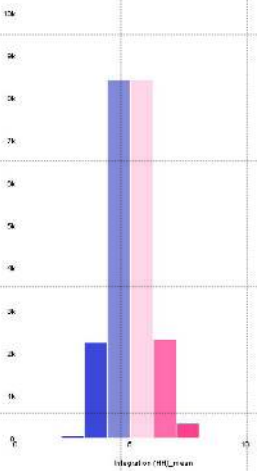


Figure 135. [left]. Grid of integration values in Agrocitè Gagarine Truillot original state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

Figure 136. [right]. Grid of integration values in Agrocitè Gagarine Truillot present state, note that the darker, the lower the value. They represent the hidden spaces of the studied area Source: Author.

5.02

Median of the values indicating the hidden spaces

Geometry

Perception

Large & more visible square-like spaces

The configuration of the expansive central space within the existing structure, which exhibits a relatively compact form and a scale that ensures extensive visibility, unambiguously positions it as the central space within the current spatial hierarchy, both in terms of its physical form and its visual perception. It is evident that the influence of this expansive space extends to the surrounding areas, akin to a spider's web. Conversely, the subsequent densification appears to have resulted in a loss of spatial hierarchy at the level of compact spaces. It can be observed that a clear hierarchy has been created with the formation of new axes, a phenomenon that can also be seen in this analysis. However, the shape of these spaces indicates a lack of compact spaces, specifically squares, which are essential for the creation of high-quality public spaces.

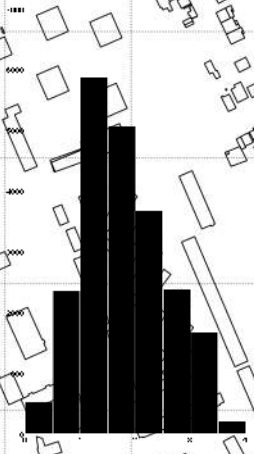
74.1 ha

Surface occupied by the highest values

1:6000

Instead, it appears that at the cross-roads of certain axes, higher values emerge, suggesting the presence of a road crossing rather than a square space.

In conclusion, despite the low spatial quality of the original large central space, it established a clear hierarchy that is not evident in the project. The plan transitions from a central structure to one based on axes.



54.1 ha
Surface occupied by the highest values

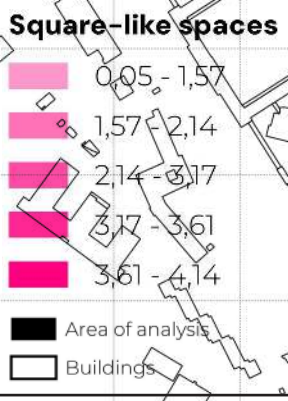
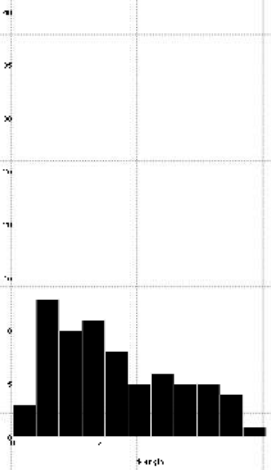


Figure 137. [left]. Contour lines representing the highest values of average radial in Agrocité Gagarine Truillot original state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

Figure 138. [right]. Contour lines representing the highest values of average radial in Agrocité Gagarine Truillot present state, note that the more saturated the color, the higher the value. They represent the more square-like spaces. Source: Author.

Basic structure

The preceding analysis indicated a shift from a central structure to one based on axes. This analysis serves to reinforce that observation. Firstly, it can be observed that the disorganisation of the lines indicated in the current situation gives way to an ordered structure, with a clear hierarchy between the axes. While there are some main ones (highlighted), a whole series of new axes cross them in an orderly fashion, establishing a new, ordered structure. Furthermore, a comparison with the analysis of permeability is required, as while certain similarities can be observed in the case of the project, several differences can be observed in the current situation.

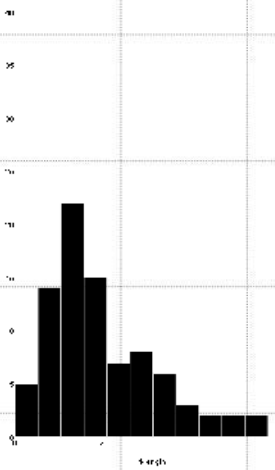


194 m
Average length of the axis

Structure

1:6000

Firstly, the largest visible spaces in the current state are located in the northern part, while the major axes are situated in the southern part. This results in a clear disconnection with the surrounding urban environments, which is further exacerbated by the distance of the space at the edges. In contrast, the project demonstrates that the primary axes align closely with the axes that define the fields of vision, suggesting a structural framework based on axes that are distinctly connected to the exterior, integrating seamlessly with the surrounding urban environment.



151 m
Average length of the axis

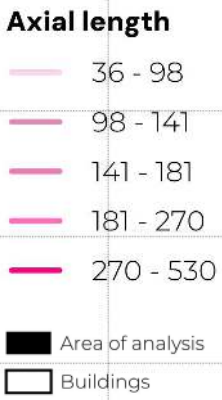
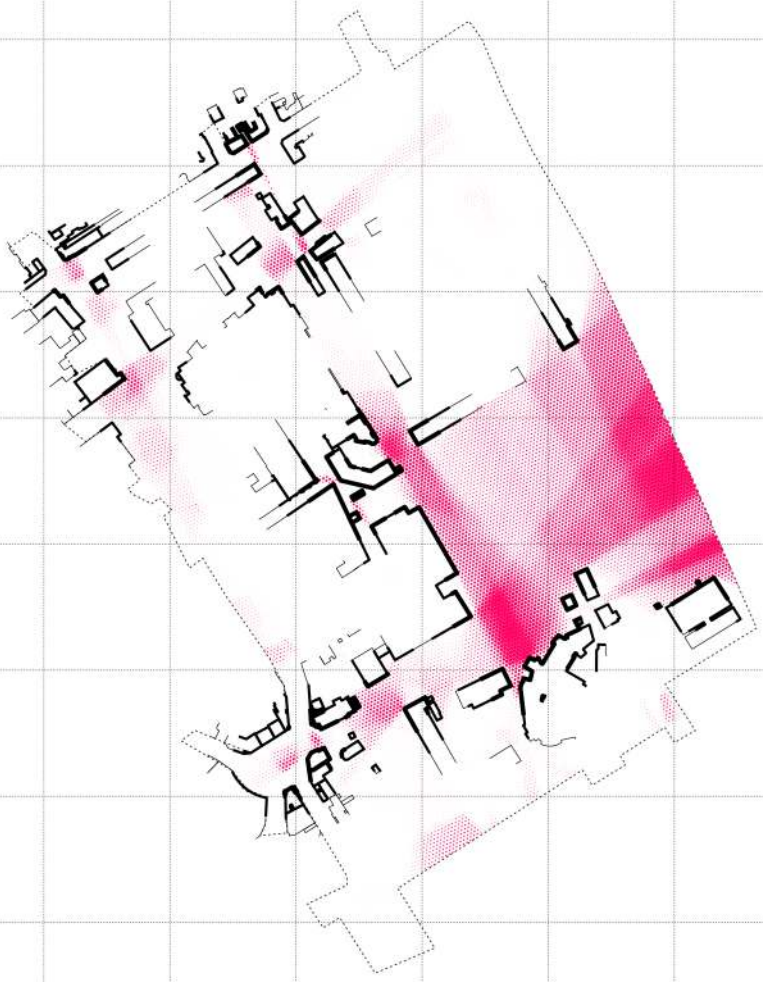


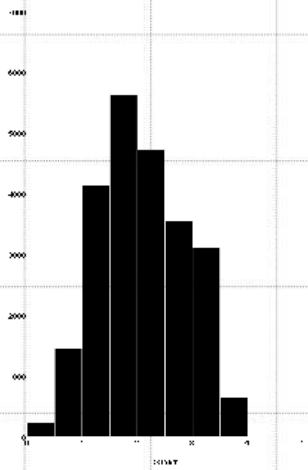
Figure 139. [left]. Fewest-Line Map of the original Agrocitè Gagarine Truillot fabric. Source: Author.

Figure 140. [right]. Fewest-Line Map of the present Agrocitè Gagarine Truillot fabric. Source: Author.



Centric Corners

The preceding conclusions are thus validated. On the one hand, there is a densification, a multiplication of the grain and a reduction of distances that promote a multiplication of corners and, therefore, of meeting and co-presence spaces. However, the lack of a clear hierarchy in the free space, as well as a greater diversity of spaces, means that the distribution of these corners is quite homogeneous, reducing urban diversity and, consequently, the quality of the space. Nevertheless, it can be argued that this homogenisation facilitates greater access to spaces of co-presence, which could be translated into enhanced interaction along axes that are now connected not only with the rest of the fabric, but also with the surrounding urban fabric, thus increasing the potential for chance encounters.

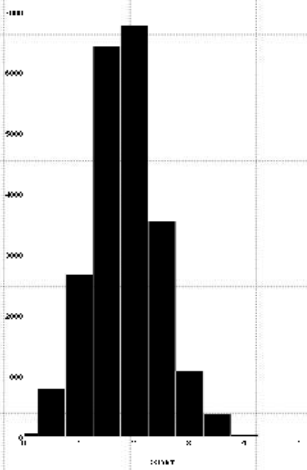


Structure

1:6000

2.02
Median of the normalization of values indicating the centric corners

However, it appears to expand the surface area of spaces that do not facilitate encounters, both by increasing the built surface area and by increasing the number of concealed spaces, which could potentially result in a negative hierarchical structuring of space. This is to say that the axes are imposed as the central space, while the interior spaces are denied. It is evident that the alterations implemented have significantly influenced the spatial configuration of the fabric.



1.81
Median of the normalization of values indicating the centric corners

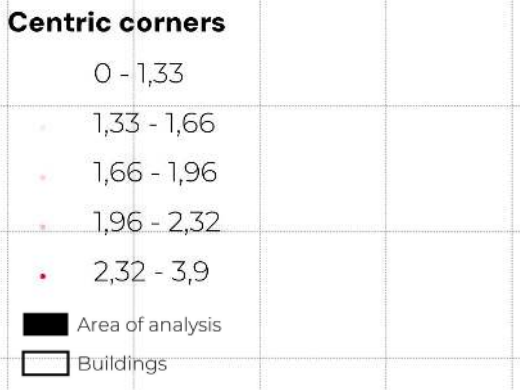


Figure 141. [left]. Grid of choice and overt control values in Agrocitè Gagarine Truillot original state, note that the more pinl the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

Figure 142. [right]. Grid of choice and overt control values in Agrocitè Gagarine Truillot present state, note that the more pink the colour of the circle, the higher the value. They represent spaces that visually control more area of the analysed area. Source: Author.

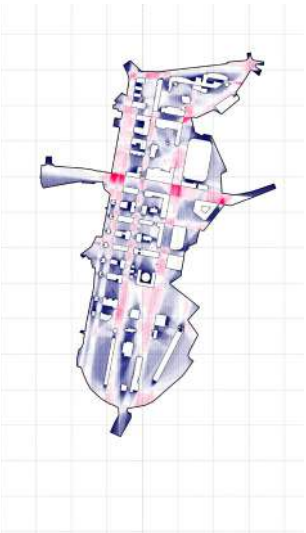
4. Conclusions

In this last section the conclusions will be divided into two parts. Firstly, common conclusions will be drawn from the different case study analyses and common trends across the different projects will be observed. A second part of these conclusions will try to clarify the original hypothesis, with some considerations.

Lights and shadows of the studied projects

Based on the comparative analysis of the various case studies, this section provides a concise summary of the key findings related to their spatial configuration.

La Duchère

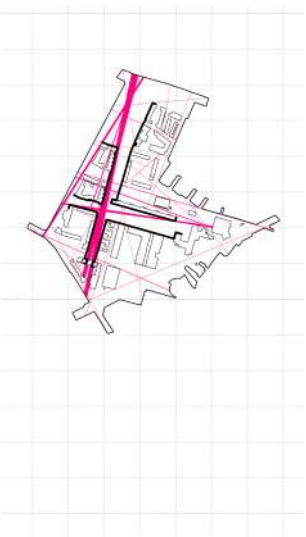


The project in La Duchère, Lyon, is a paradigmatic case, as the process of demolition and subsequent replacement has not yielded the expected results, despite the significant resources invested.

However, with regard to the spatial configuration, it is evident that the regeneration project has successfully implemented a series of interventions that have altered the structure of the open space as a whole, particularly in the central area.

This has been achieved by the creation of new axes and areas of multiple presence, facilitated by a densification and reduction of critical distances, particularly within the fabric. The project has resulted in a more defined spatial hierarchy, which initially led to an increase in activity on the ground floor. This raises the question of the appropriate scale for such interventions, particularly in terms of the potential impact on the existing structure and the removal of symbols, heritage, and important landmarks in the local landscape. Future projects will explore the possibility of achieving similar changes in spatial structure through less destructive means.

La Courneuve

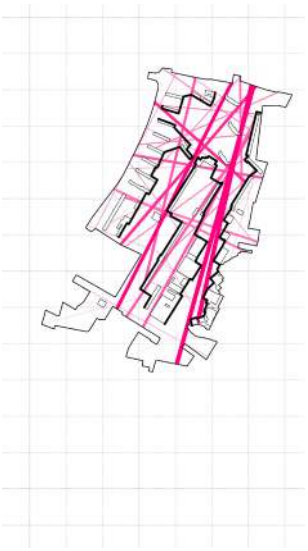


The regeneration project of Le Cite des 4000, Le Courneuve, which has been characterised by the replacement of the western and northern part of the fabric, has promoted a small densification which, although it has substantially varied the form of the built environment and, therefore, the geometric values of the construction of the free space, does not seem to have had a great effect on the variation of the spatial configuration of the fabric.

However, there have been certain interventions, design decisions which seem to have promoted a positive evolution in the topology of the space and which could undoubtedly have been made with less use of resources. These include the opening of a new axis which, transversally, promotes the appearance of a large intersection point in the centre of the fabric.

However, the reduction in the size of the free space, grain, etc. does not seem to have promoted major changes in the topology, hence in the spatial structure, although some, such as the reduction of the grain, promote greater porosity and the creation of an environment with a more human scale.

Empalot

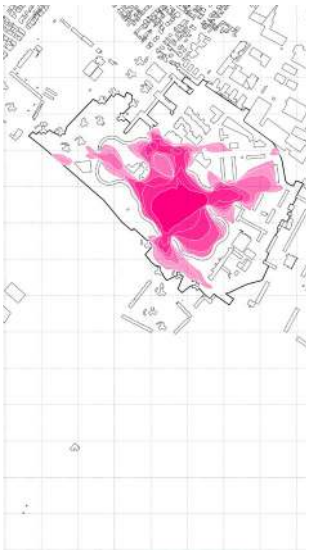


The analysis of Empalot in Toulouse reveals a smaller percentage of modified surface area compared to the previous cases, with changes localized to a specific section of the fabric. Despite the absence of interventions affecting the broader physical environment, these modifications still impact the organization of the spatial structure as a whole.

In terms of spatial configuration, the most noteworthy observation is the continuity of the majority of values. While there is an increase in land occupation, the changes in other indicators appear to be relatively minor. A significant development is the introduction of a new transversal axis in the central area, which seems to enhance local values related to corners, even though the overall number of corners has decreased.

In conclusion, although the interventions have not dramatically altered the spatial configuration, the actions in the southern part of the area have reorganized and established a new hierarchy concerning the northern spaces. This shift increases the relevance of wide, visible spaces and facilitates the creation of new corners in the central section of the fabric.

Les Courtillieres

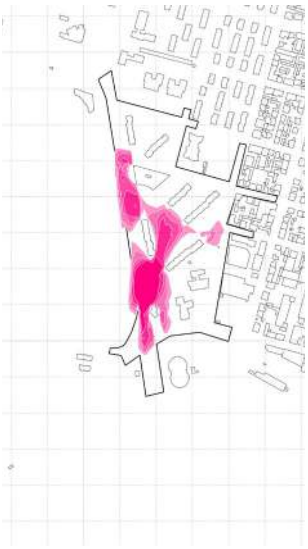


In the case of the regeneration project of Les Courtillieres, Paris, the intervention in such a particular complex as the Serpentine is remarkable on the one hand, but also for the fact that, with relatively small interventions, major changes in the configuration of the spatial structure have been achieved.

The key to the process, however, has not been in the simple opening up, but in the understanding of the environment and the cutting of areas that have ensured the evolution of the spatial configuration. On the one hand, and seemingly the most relevant, is the transformation of the complex into a concatenated series of blocks, united typologically and visually, but generating a new whole on a spatial level.

This causes a series of consequences, from the appearance of a new central system, orthogonal to the existing north opening, reinforced by the new opening, to the enlargement of the porosity, reducing the hidden spaces, or the creation of new axes.

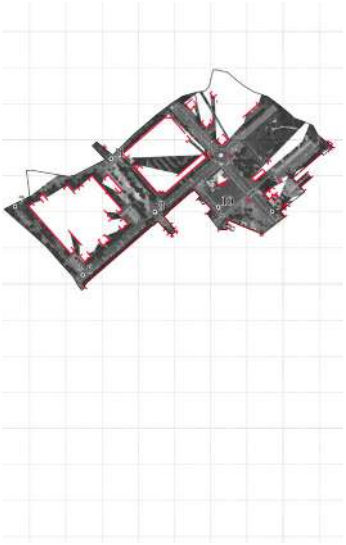
Via Artom



The interventions that have taken place in Via Artom, Torino, appear to describe somewhat confusing developments. On the one hand, the interventions appear to be entirely distinct in form and concept. On the one hand, the demolition of a linear block allows for the construction of sports facilities, which extend the open spaces and improve their continuity and visibility. However, this also results in a confusing alteration to the hierarchy of open spaces, making it challenging to determine the centre of the fabric. Conversely, the replacement of the upper block with a new typology appears to adhere to a disparate logic. Firstly, its orientation serves to reinforce the Francesco Rimondo axis, while simultaneously facilitating the expansion of uninterrupted open spaces in the southern sector.

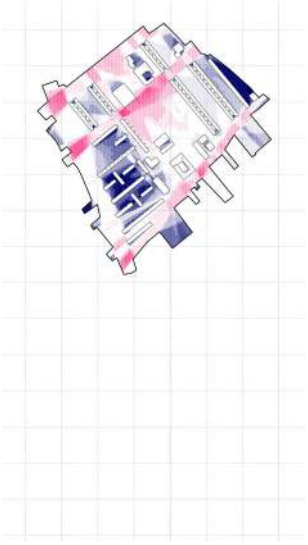
Nevertheless, these alterations, which entail the replacement or demolition of a single element within the fabric, have not significantly altered the configuration of the space. However, it appears that the displaced mass may have the potential to bring about significant changes. This raises the question of whether this is the critical displaced mass required to effect changes to the configuration of the space, and further study of the location of this effort is required. It can be hypothesised that had the demolition of certain parts of buildings in the central environment occurred with the same displaced mass, the impact and spatial arrangement would have been significantly more pronounced.

Tor Bella Monaca



The interventions carried out in this area of the Tor Bella Monaca neighbourhood in Rome are characterised by promoting lower densification in the central part of the fabric and it would appear that the regeneration interventions in this case have not resulted in any significant alterations to the configuration of the open space. This, in conjunction with the preceding case study, prompts reflection on the significance of the transformed mass. In other words, it appears that there is a specific critical mass that, when situated in an optimal location, can significantly alter the characteristics of an open space. However, when these changes occur in marginal environments, as in this case, they do not result in a modification of the spatial configuration. This does not imply that the regeneration process has been unsuccessful. For a definitive conclusion, further analysis of additional variables would be required. However, it is evident that the spatial character of the fabric has not been enhanced.

La Mina

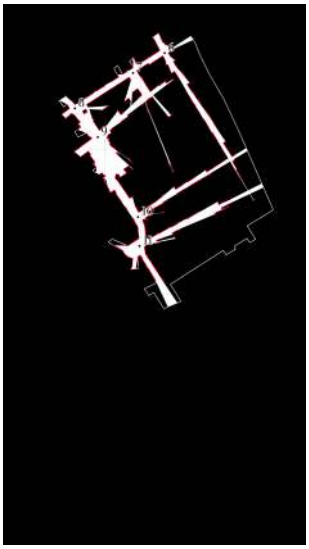


The La Mina regeneration project in Barcelona is marked by the creation of a central axis and the enhancement of associated infrastructures. This initiative has significantly transformed the configuration of open space within the neighborhood, revealing two key trends.

Firstly, the establishment of the central axis has generated a substantial urban void at the core of the fabric, a feature that was previously lacking, resulting in the emergence of a new internal edge.

Secondly, the repositioning of the vertebral axis in the western part of the fabric, oriented from south to north and situated at a considerable distance from the urban environment, has led to the formation of two parallel axes. One of these axes structures the center of the fabric, while the other, located along the southern edge, plays a crucial role in creating spaces that encourage multiple forms of interaction. This development is further underscored by the emergence of corners in this area, as well as insights derived from an analysis of critical distances.

Agrocite



The unrealized regeneration project for the Gagarine Truillot neighborhood in Paris is notable for its emphasis on densification and the incorporation of productive spaces within the open areas. In terms of spatial structure, the proposed project suggests a significant transformation of the neighborhood's configuration. The current layout features a distinctly isolated structure that overlooks a central void. In contrast, the project introduces a new structure based on axes and a fine-grained grid that integrates harmoniously with the surrounding urban fabric.

This new framework effectively enhances the number of natural gathering spaces, which could foster the development of central and communal areas within the neighborhood. However, it is essential to conduct a more detailed analysis of the hierarchy of square spaces and to facilitate interactions between areas situated outside the axes and those along them. This could be achieved by introducing secondary axes or by increasing the diversity in the design of the urban grain.

Metrics evaluation

This chapter presents an analysis of the various metrics used throughout this work, evaluating their suitability and potential for improvement. Firstly, it is necessary to reflect on the metrics used in the successive analyses and to understand their usefulness in **defining the geometry of the open spaces, their topology and, therefore, their spatial configuration and, finally, the visual perception of these spaces.**

Throughout the execution of this work, a question of scale has also been identified. The scale used in this work, which is largely urban, has enabled an understanding of the relationship between the built elements and the surrounding open space, as well as their relationship with the adjacent urban fabric. However, the use of this scale, with the level of detail that it implies, has resulted in the omission of certain elements that could be fundamental when describing the three groups of indicators.

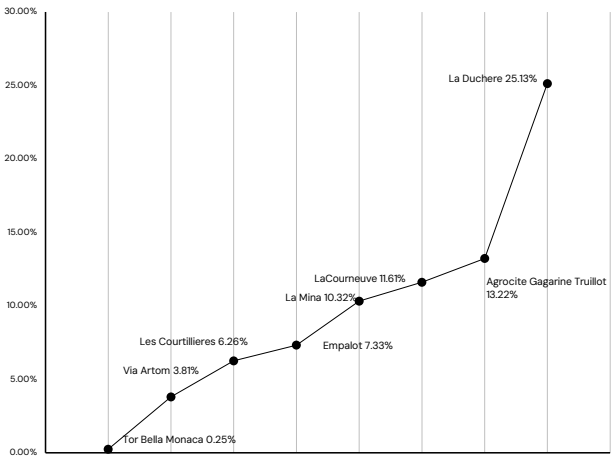
In terms of **geometric** description, the three analytical methods employed—figure-ground, critical distances, and urban grain—have proven effective in accurately representing both the geometry of free space and its evolution. The **figure-ground** cartographies, in particular, have provided a concise means of observing changes in the built environment and the corresponding transformations in free space. This method has offered valuable insights into the significant changes brought about by demolitions and expansions within open spaces. As emphasized in Rowe and Koetter's work, this fundamental factor not only highlights an initial effort to create spaces of intensity rather than mere quantity, but also serves as a reference point (in terms of modified surface area) for assessing the impact of the various metrics discussed throughout this paper.

The **critical distances** analysis has revealed a clear trend toward reducing the "safety distances" that once dominated the design of many polygons. Meanwhile, the **urban grain** analysis has been instrumental in assessing improvements or deteriorations in the porosity of these polygons, offering deeper insights into how spatial permeability has evolved over time.

In describing the fabric in relation to **visual perception,** the three methodologies employed—permeability, hidden spaces, and square-like larger visible spaces—have proven essential in understanding the hierarchy of visual perception derived from the fabric's geometric structure. First, the analysis of **permeability** has emerged as a key factor, as many of these fabrics, despite their "open" spatial structure, are often disconnected from the wider urban context, leading to segregated urban environments. This analysis has been crucial in highlighting the evolving relationship—whether open or hermetic—between the fabric and its immediate urban surroundings.

The **hidden spaces** analysis has complemented this by revealing how projects handle the positioning of invisible spaces, which are critical in influencing the perception of safety. Interestingly, while it might seem logical to reduce the number of convex corners, the analyses indicate that this is not always the case.

Lastly, the analysis of **square-like large visible spaces** has identified the locations of expansive areas with square-like configurations. This has proven particularly relevant in understanding trends related to palace-like central spaces and their role in urban centrality. Future research will need to address the apparent contradictions between these findings and the factors of land urbanization, which fall outside the scope of this study.



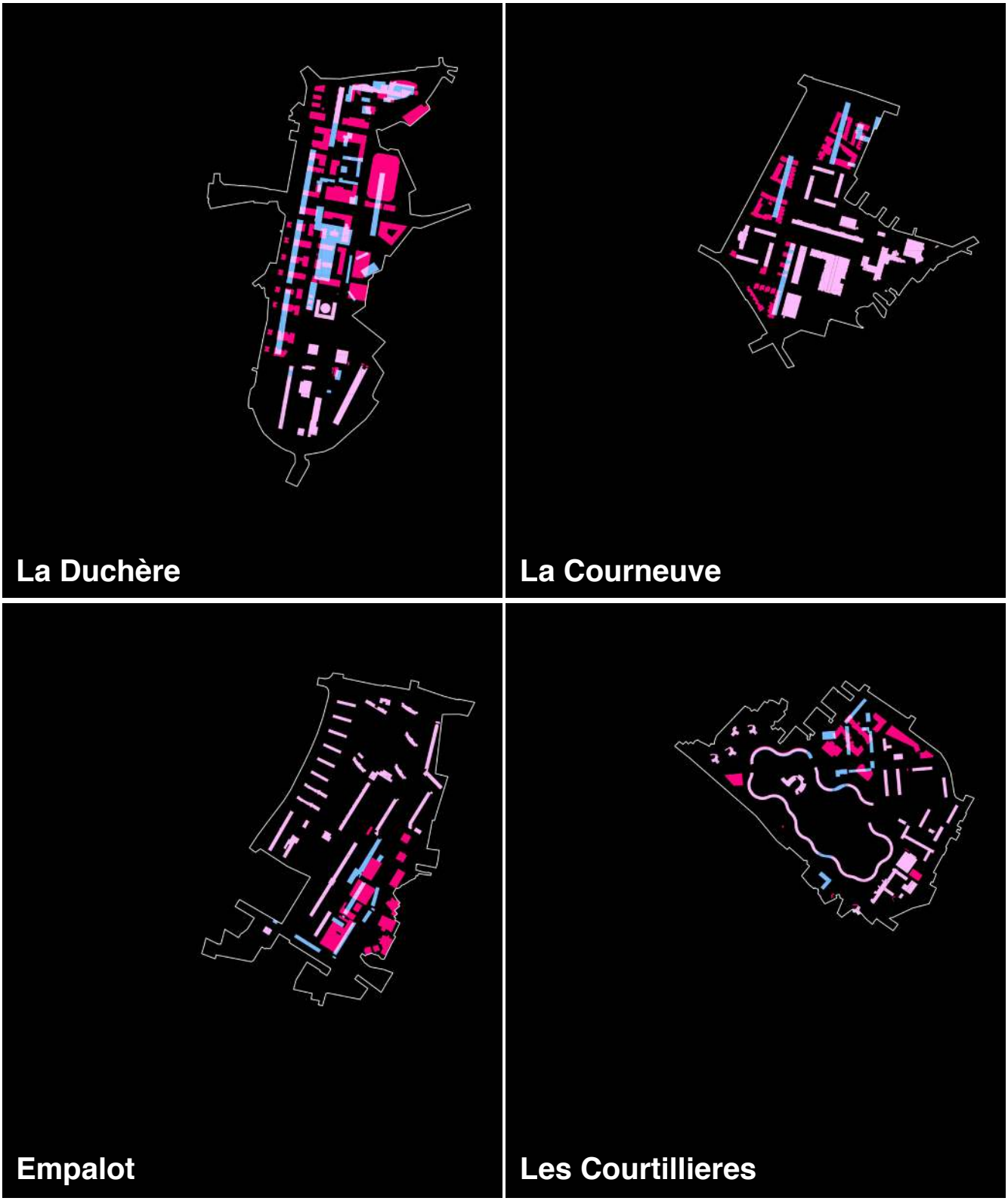
Surface modified in relation to the boundary of the fabric

Finally, in relation to the analysis of the s**ynthetic structure** of the fabric's free space, the two methodologies proposed have been key to understanding both its construction and its evolution. Firstly, the calculation of the **basic axial structure** has made it possible to highlight the basic guidelines (or lines of force) that organise the fabric. In an urban typology where the alignment of the buildings is not responsible for the organisation of the space, promoting the existence of a wide and shapeless free space, the visual axes are perhaps the elements that best synthetically describe this space. The comparison of the two temporary situations has allowed us to discover the insistence on a pre-existing axis, its multiplication or the change of direction (rotation) in order to promote network structures.

Next, the location of **centric corner**s was not automatic in this type of urban fabric due to the low intensity of its free space. This is why in this metric we have developed a calculation of those points that control other points that are not visible to each other and that, in addition, have a high centrality value. This complex calculation has made it possible to observe the consolidation of pre-existing corners, the proliferation and distribution of new ones (sometimes in relation to the intersections of the previous analysis) and, in the case of the project already built, to draw possible conclusions about the location of commercial activities on the ground floor, although this is not the main purpose of the work.

The following pages present a detailed description of the results of each metric, with a particular focus on their comparison between the different case studies. This is accompanied by an analysis of the relationship between the evolution of the metrics and the surface modified by the interventions.

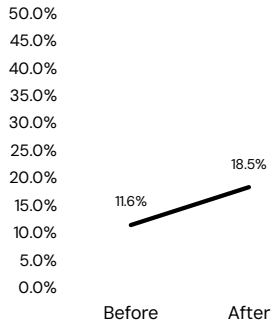
Old buildings New buildings Overlap



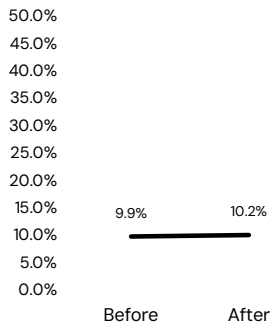
Ground coverage

La Duchère

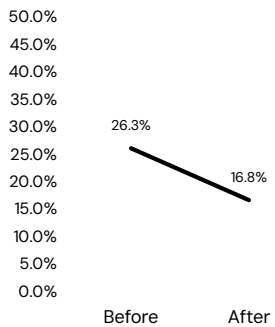
La Courneuve



Empalot

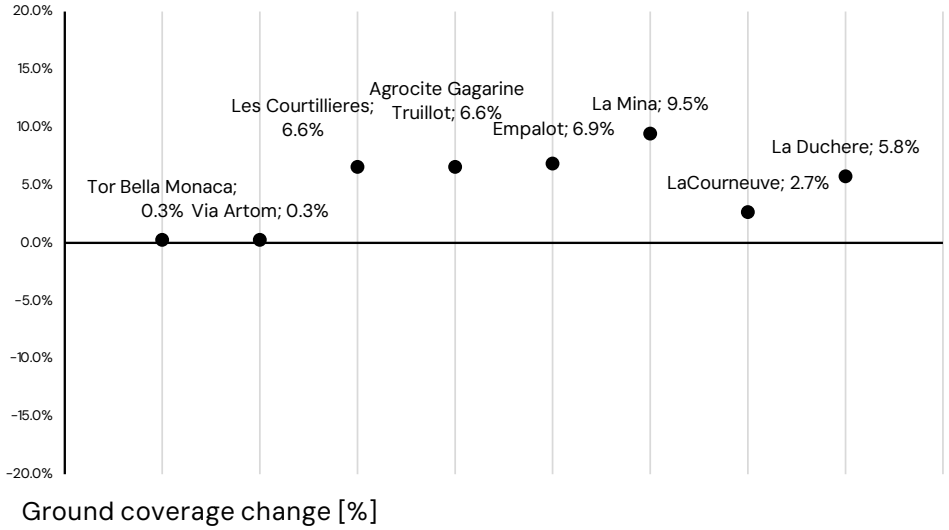


Les Courtillieres

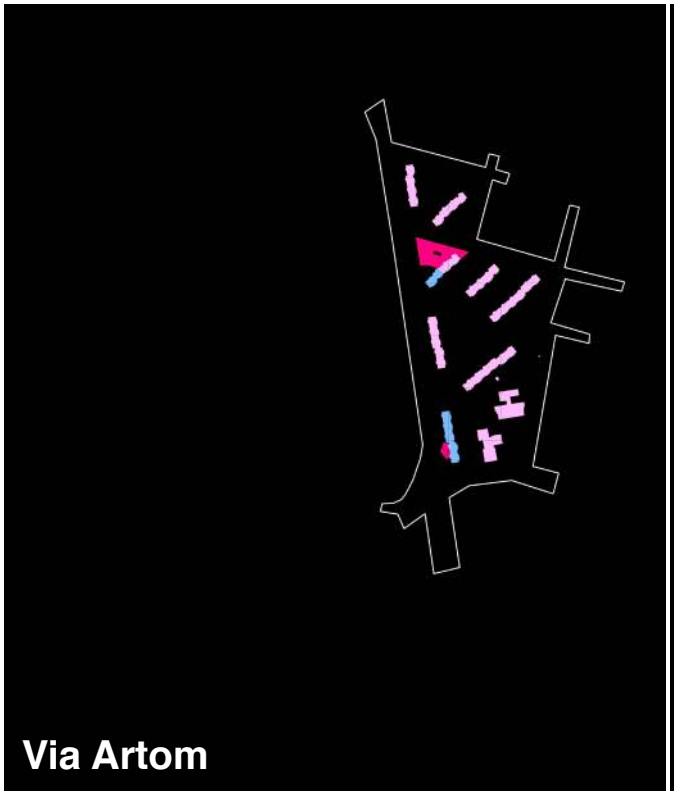


Regarding ground coverage, it is evident that regeneration processes have primarily focused on expanding the built environment, resulting in a notable reduction of free space. Overall, the proportion of space occupied has decreased from 80.2% in the original configurations to 78.7% in their current state. This trend confirms the inclination of urban fabric modification processes toward more compact, traditional models of the city.

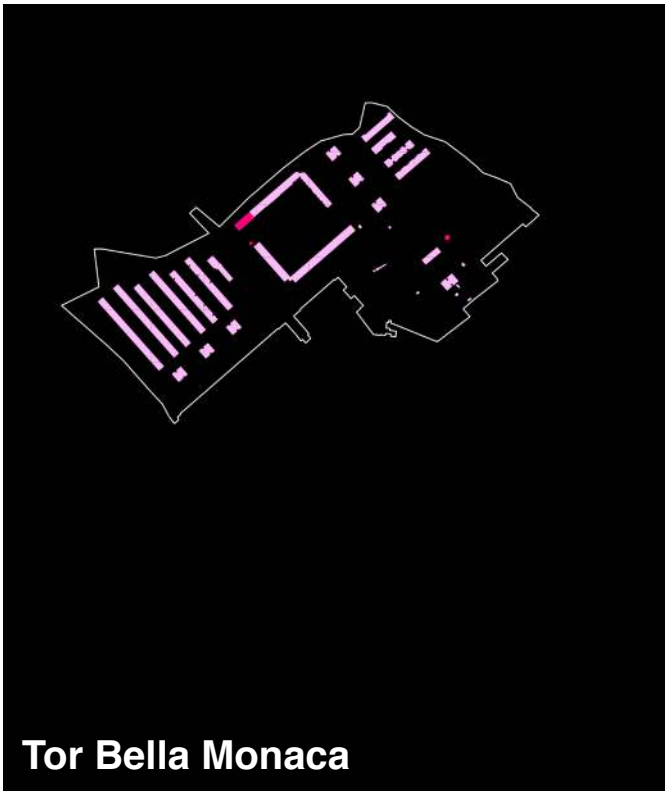
This land-covering strategy, while aiming to slightly increase fabric density, often leads to the fragmentation of larger areas, promoting the development of urban fabrics characterized by smaller components. However, distinct trends emerge within the case studies analysed. In several instances, particularly in the French cases—both completed and planned—there is a clear trend toward increased ground occupation. This densification often occurs either after significant demolition of existing fabric, as observed in La Duchère and La Courneuve, or through the occupation of vacant spaces, as seen in Agrocité.



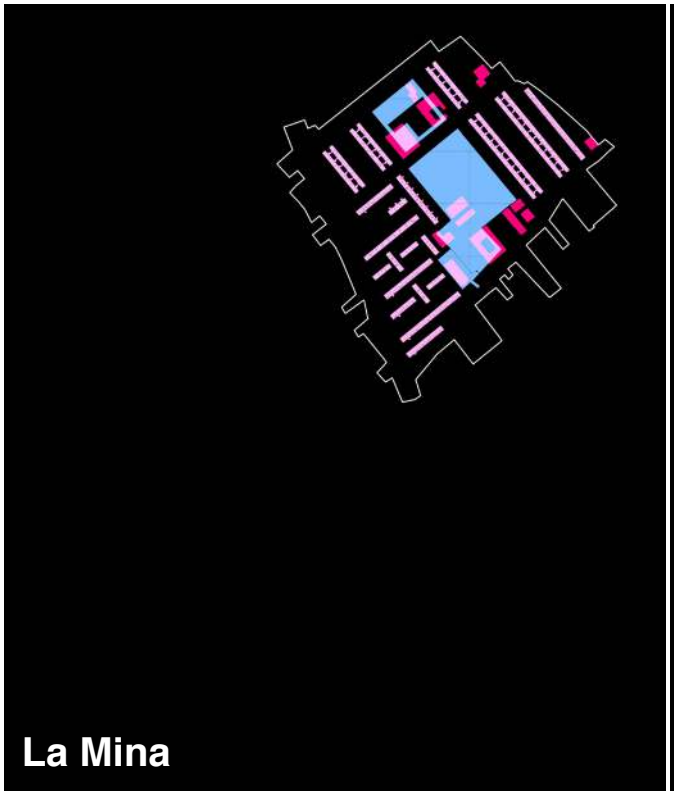
Old buildings New buildings Overlap



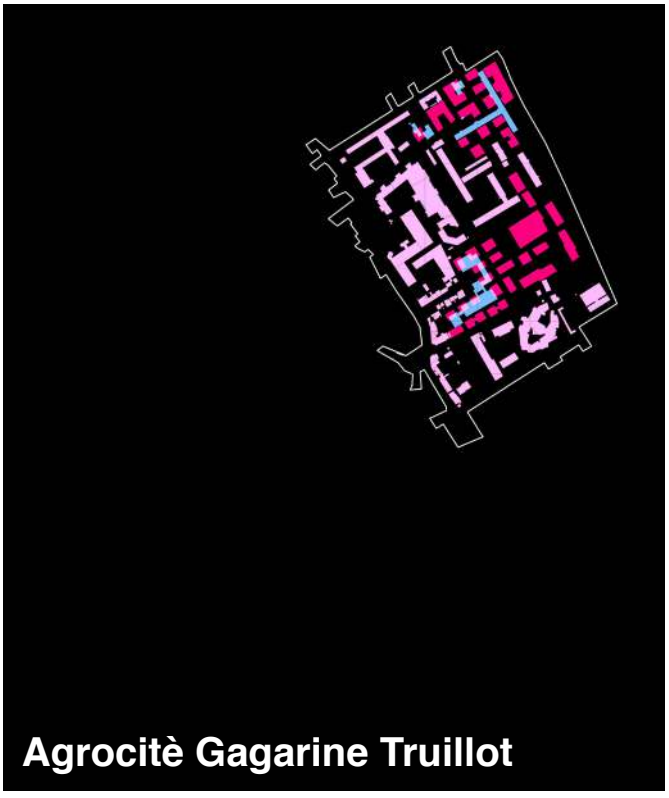
Via Artom



Tor Bella Monaca

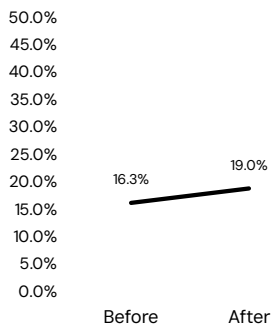


La Mina

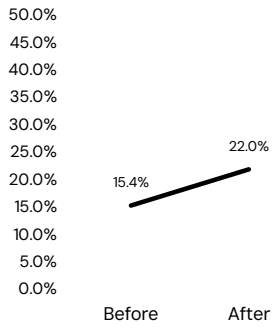


Agrocitè Gagarine Truillot

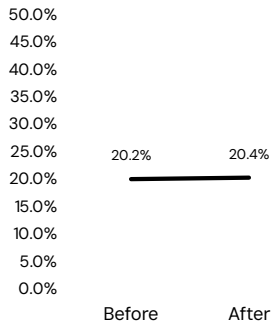
Via Artom



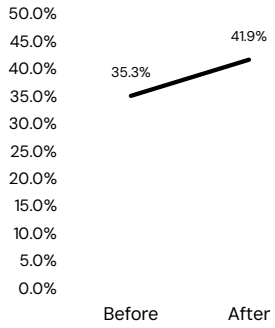
Tor Bella Monaca

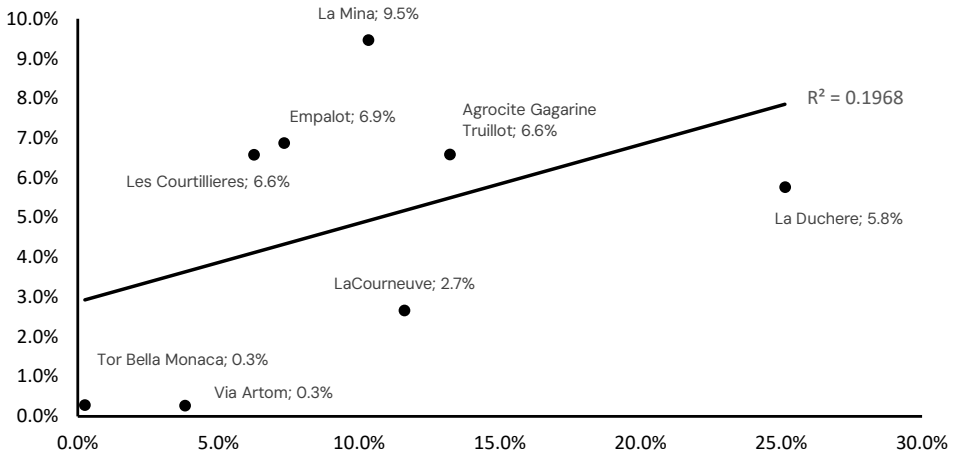


La Mina



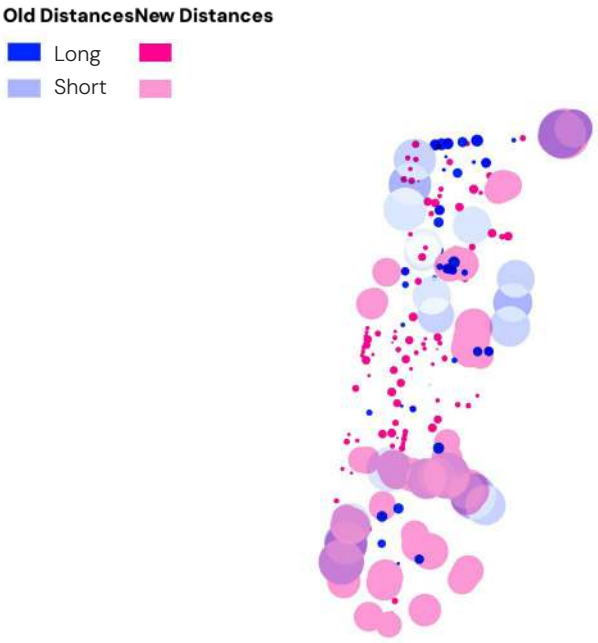
Agrocitè Gagarine Truillot



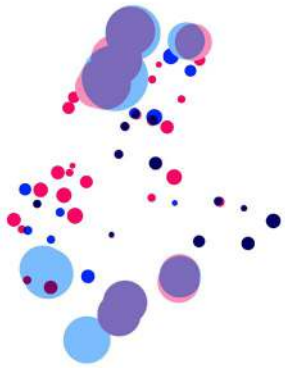


Relation between ground coverage change and percentage of modified built surface

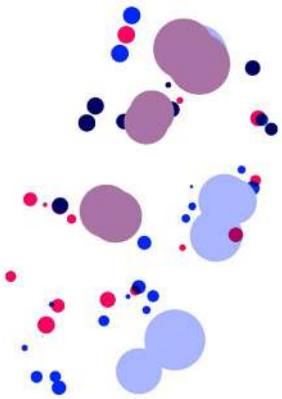
Conversely, the Italian cases demonstrate a different trajectory. With minor interventions—including instances of replacement (as in Via Artom) and densification (such as Tor Bella Monaca)—the land occupation remains largely unchanged. Notably, in La Mina (Barcelona), there is even an increase in free space. These observations suggest that national trends, or cultural group influences, may play a significant role in shaping the evolution of mass housing estates, leading to the emergence of distinct spatial configurations across different environments.



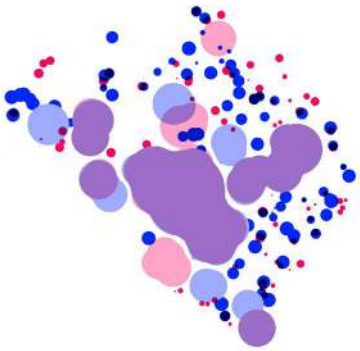
La Duchère



La Courneuve

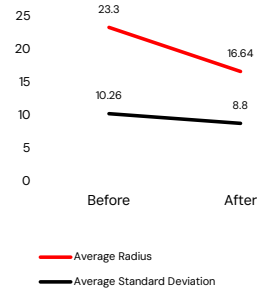


Empalot

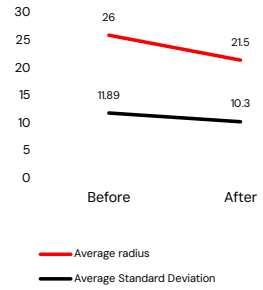


Les Courtillieres

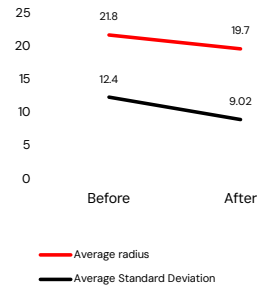
La Duchère



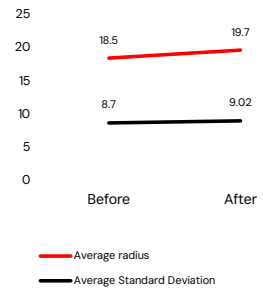
La Courneuve



Empalot



Les Courtillieres

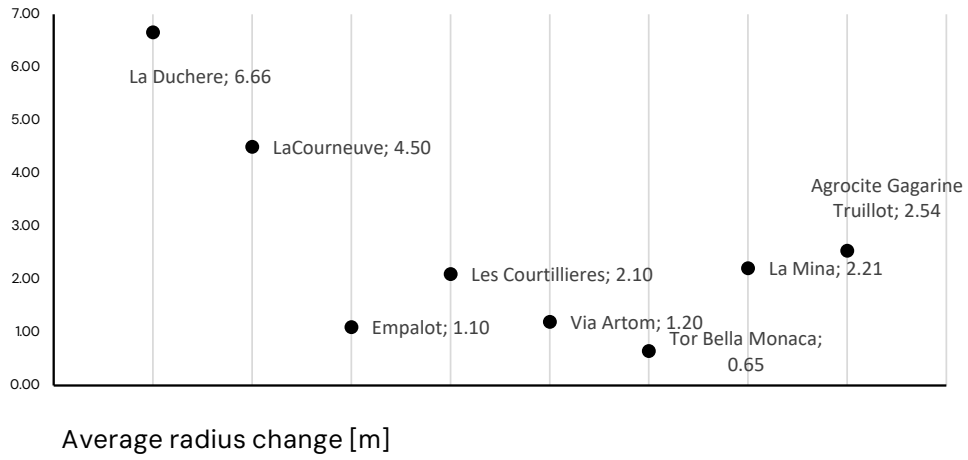


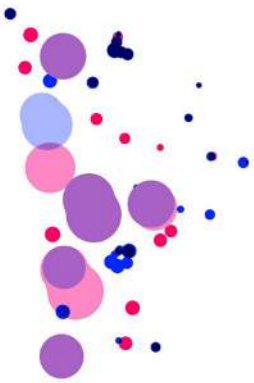
With regard to the examination of critical distances, it is necessary to consider two distinct categories of factors.

The first of a topological type indicates the location of the critical distance and, as has been explored in the literature, whether the issue pertains to the contiguity or continuity of urban fabrics. In this context, and building on the preceding analysis, it appears reasonable to conclude that contiguity is a primary objective in urban fabrics, with a general reduction in distance, the radius of which has been reduced to approximately 3 metres.

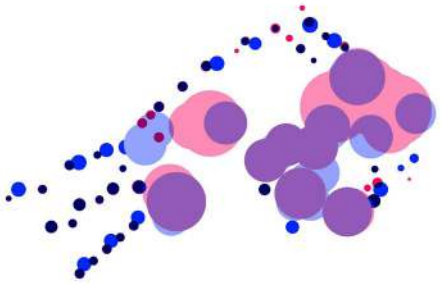
Topologically, however, the results are largely ambiguous, and the casuistry of cases does not immediately yield a clear result. Nevertheless, certain discernible trends can be identified. Firstly, in interventions such as those observable in Les Courtillieres, Via Artom or Tor Bella Monaca, the critical distance is not considered as such, and its scale is framed in the interior, in large open spaces that do not appear to require resolution due to their limited scale. Conversely, in instances such as Agrocitè or La Mina, the critical distance does not vanish entirely but is relocated from one part of the fabric to another. This is particularly evident in the case of La Mina, where the interventions have resulted in the creation of a substantial interior void (the Rambla de la Mina, with a tramway line).

The second category of considerations pertains to dimensional aspects, specifically the measurement of variables. It has been observed that the successive densification and increase in land cover, as identified in the previous analysis, has resulted in a reduction in the average distance of the free space. This naturally results in a reduction of the critical distance, which can be defined as the median plus or minus the standard deviation. However, it can be observed that the standard deviation of the radius undergoes variations that are not parallel to the evolution of the mean radius.

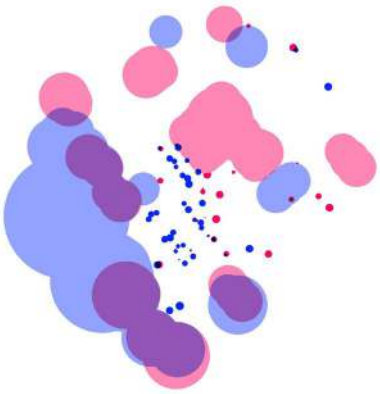




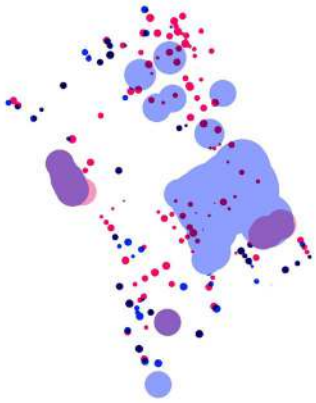
Via Artom



Tor Bella Monaca

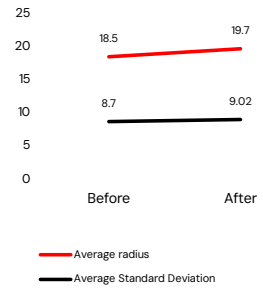


La Mina

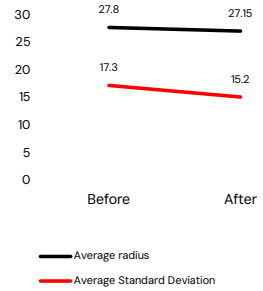


Agrocitè Gagarine Truillot

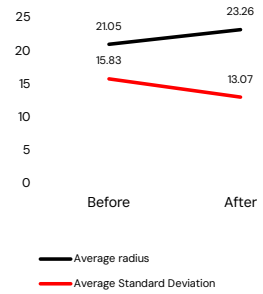
Via Artom



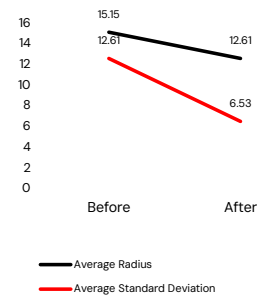
Tor Bella Monaca

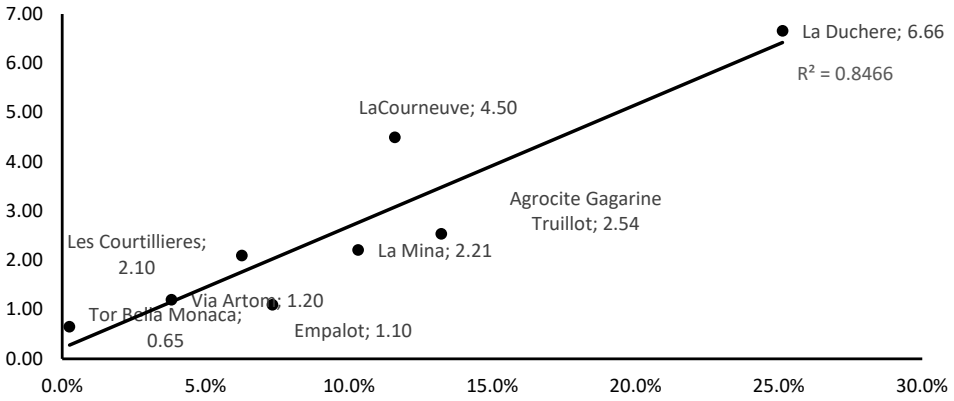


La Mina

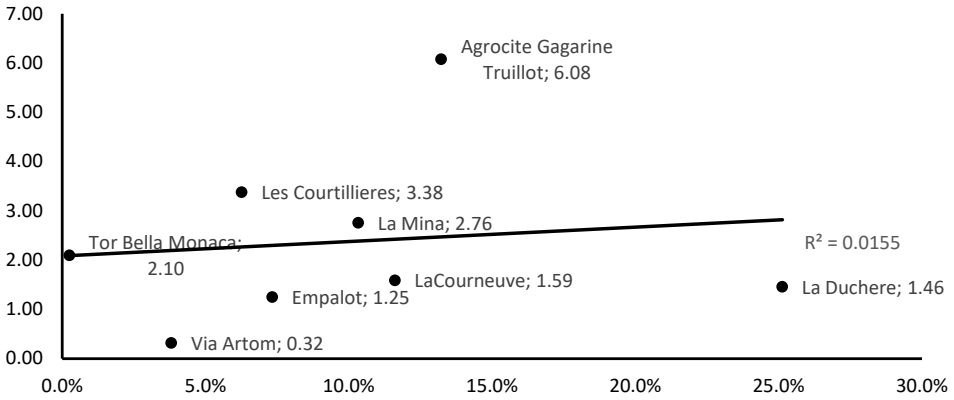


Agrocitè Gagarine Truillot





Relation between average radius change and percentage of modified built surface

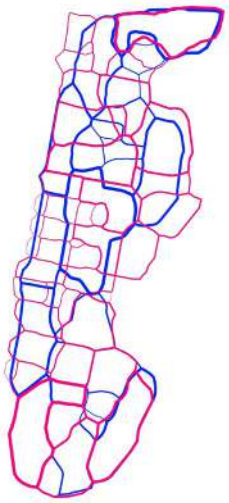


Relation between the change of the standard deviation of the radius and the percentage of modified built surface

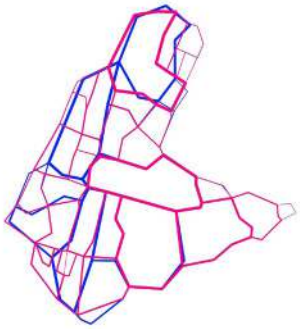
This indicates that when the reduction in standard deviation exceeds that of the mean radius, there is a notable decline in the diversity of open spaces in terms of their size, as evidenced by La Courneve and La Duchère. Conversely, when the distance between the mean and standard deviation increases, as observed in the other cases, it can be posited that urban diversity increases.

Finally, regarding the relationship between the area modified by the intervention and the evolution of critical distances, the trend appears to be a clear correlation: the more transformation is done in the ground coverage (%), the less are the in-between distances provided.. However, several intermediate interventions demonstrate a more pronounced evolution of the indicator relative to their surface area. Notable examples of this phenomenon include the projects in La Courneuve and Agrocité Gagarine Truillot

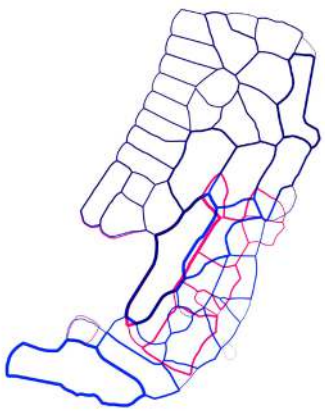
Old Urban Grain New Urban Grain



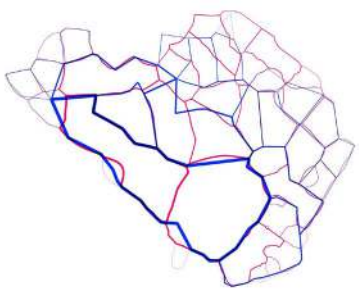
La Duchère



La Courneuve

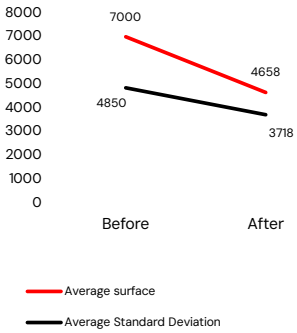


Empalot

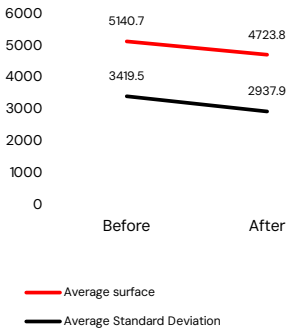


Les Courtillieres

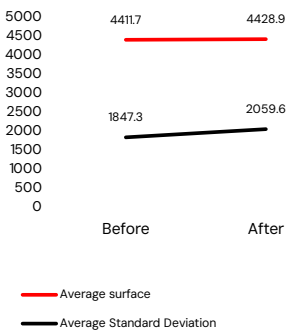
La Duchère



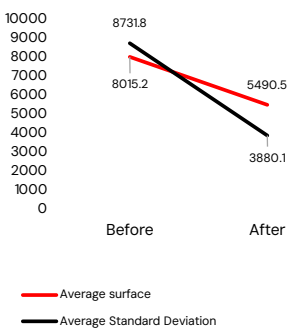
La Courneuve



Empalot



Les Courtillieres

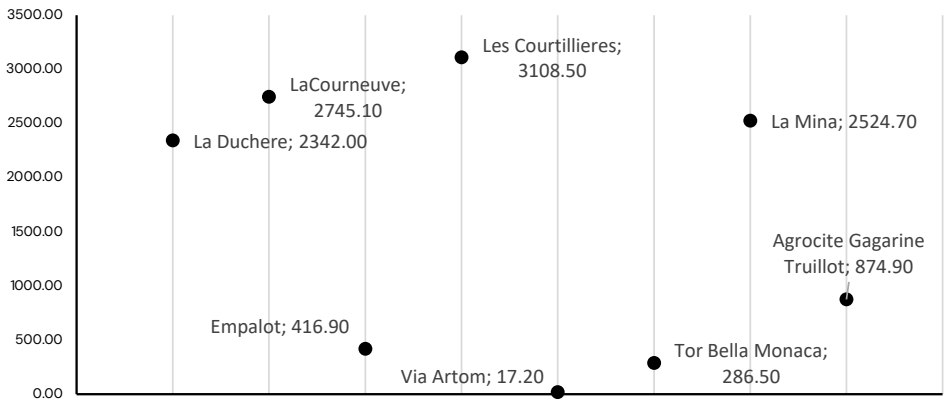


The analysis of the urban grain has reinforced the trends observed in the previous analysis. On the one hand, it can be observed that, in general, the densification of the fabrics takes place with smaller pieces than the existing ones and, in the case of the replacement of the pieces, it is carried out with pieces of a dimension, both in surface and in linear distances, smaller than the original ones. This seems to show a tendency towards specific architectural typologies, on the one hand, and a rejection of the existing ones on the site, seeking a revision towards more compact forms, which can be seen in the general relationship between surfaces and perimeters.

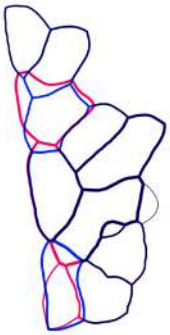
This is determined by the general assimilation that a smaller grain generates more porous and therefore more walkable urban fabrics. However, to put some of the values defined here into context, while a block in the Eixample of Barcelona has a surface area of approximately 1 hectare, the average surface area of the grain in the original fabrics is around 0.6 hectares. This may be an indicator that the focus, when talking about the urban grain, is not on the dimension, but on its geometry.

On the other hand, the urban grain seems a great indicator of the changes at a general level in the fabric since, in the different case studies, there seemed to be a correlation between the changes in tonality of this analysis and the location of the main changes in the spatial configuration of the free space, showing the direct relationship with the built environment.

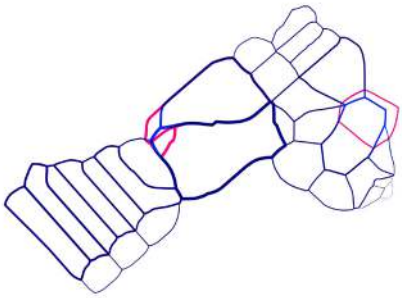
Equally noteworthy is the comparison between the average values and the standard deviation of the set of values, which for the most part follow a similar trend of reduction, where again the evolution of the difference between the average value and the standard deviation indicates a loss of diversity, as in La Duchère, La Courneuve or Les Courtillieres.



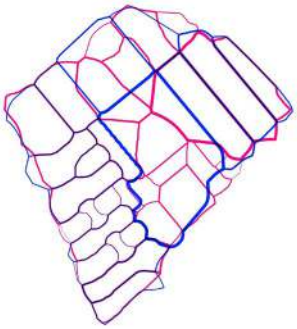
Old Urban Grain New Urban Grain



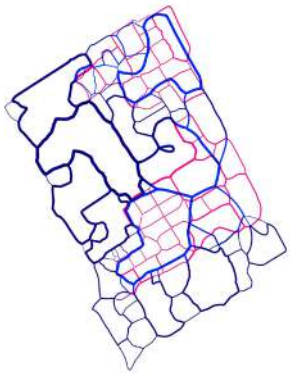
Via Artom



Tor Bella Monaca

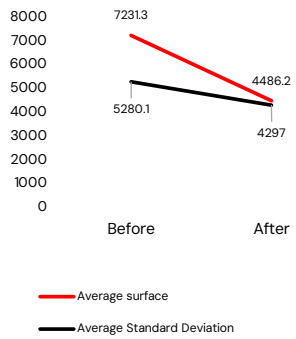


La Mina

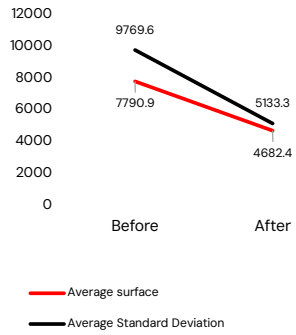


Agrocitè Gagarine Truillot

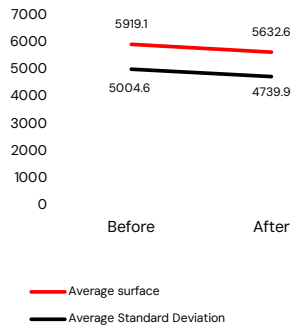
Via Artom



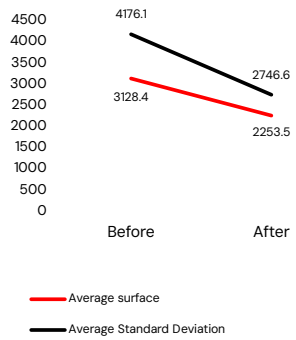
Tor Bella Monaca

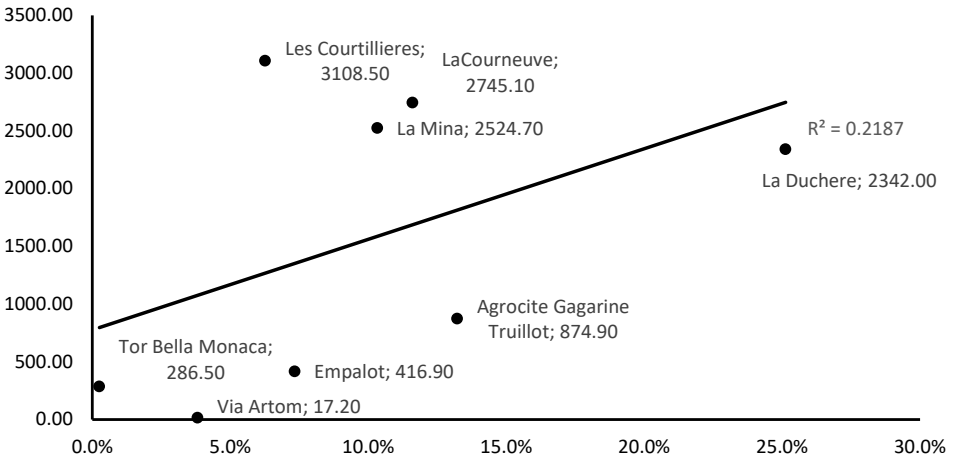


La Mina

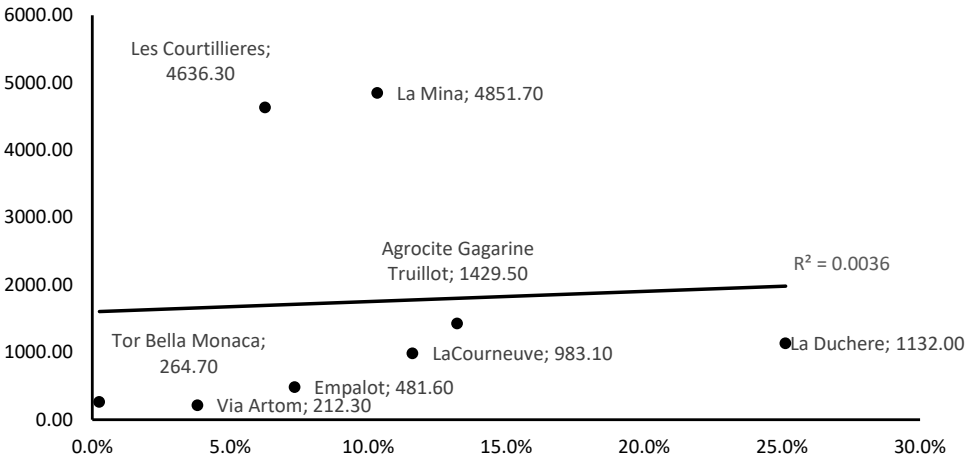


Agrocitè Gagarine Truillot





Relation between average surface change and percentage of modified built surface

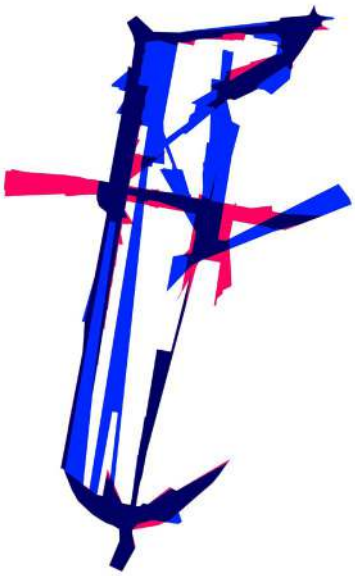


Relation between the change of the standard deviation of the surface and the percentage of modified built surface

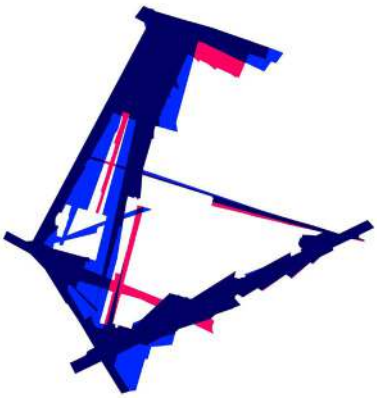
When, despite a reduction in the average surface area, as in the case of La Mina, the standard deviation is maintained and its relationship with the modified surface area is positive. This indicates that the variations in the background-figure representing the free space now show a greater diversity of spaces.

When analysed in relation to the required percentage of built-up area, the ratio effort (surface area) / result or present-day configuration at La Courneuve, as well as at Les Courtillieres, stands out when it comes to modifying the standard deviation, which in this specific case means a loss of diversity, as this indicates that the range of values is reduced from the median and, given that the median value has been maintained, it is the range that is reduced and, therefore, the diversity.

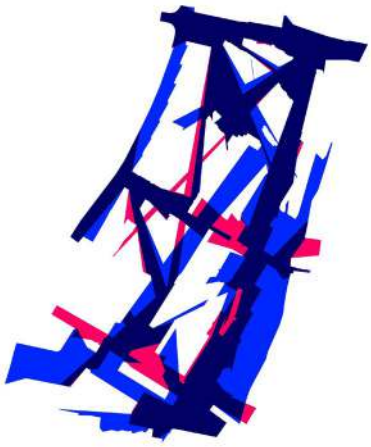
Old viewshed New viewshed



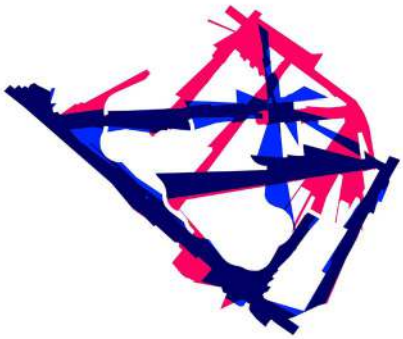
La Duchère



La Courneuve

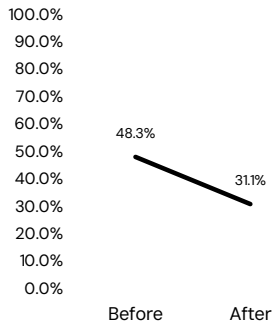


Empalot

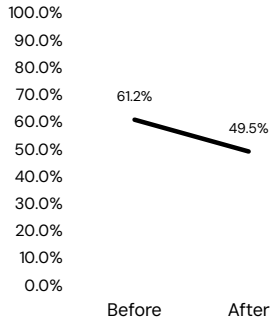


Les Courtillieres

La Duchère



La Courneuve



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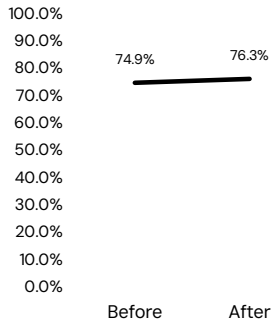
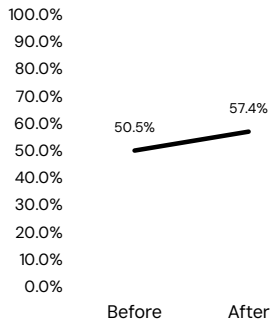
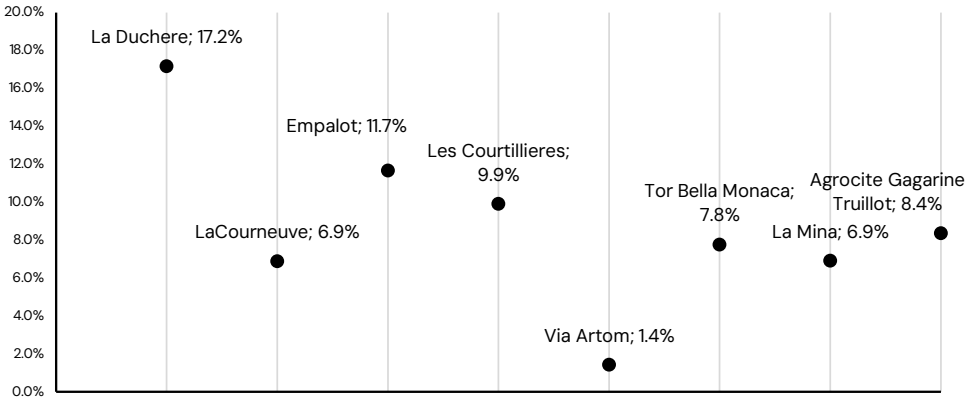


Les Courtillieres



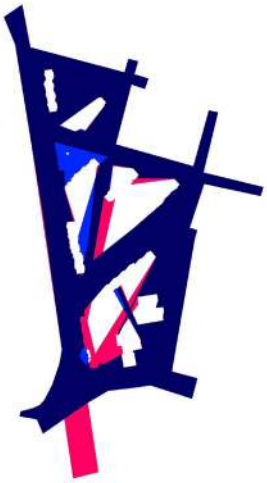
In general terms, the urban permeability from the outside is manifested in the significant reduction of the interior open spaces. However, in order to gain a full understanding of the permeability and porosity of the fabrics in question, it is necessary to recall some of the cases analysed individually.

It is evident that in all the case studies except Via Artom and La Mina, the visible surface area has diminished. This initial observation suggests a reduction and, consequently, a negative trend. However, when specific examples are recalled, such as La Duchère, Les Courtillieres or the Agrocité, it becomes evident that this reduction in surface area is produced by a densification and a reduction in the visible section (also observable in the analysis of the critical distances). This occurs while the number of points of entry is multiplied and new axes are generated that structure the space in a clearer and more hierarchical way, establishing visual crossroads and complete routes, as is the case of La Duchère. This means that, although the surface area visible from the outside has been reduced, the location of the visible areas, as well as their conformation, with a smaller visible section, means that these areas are more distributed and, therefore, sweep more space. As in the case of La Duchere, rather than a reduction, it is a more strategic permeability.

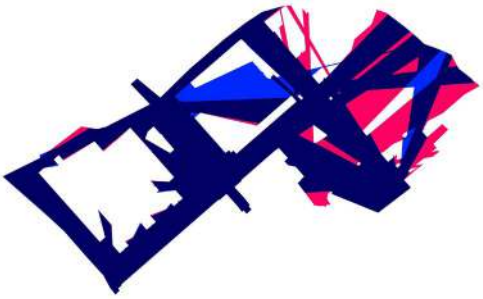


Visible space from outside [% of absolute values]

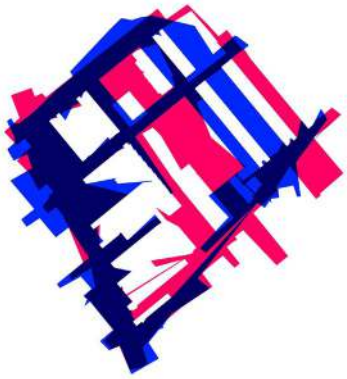
Old viewshed New viewshed



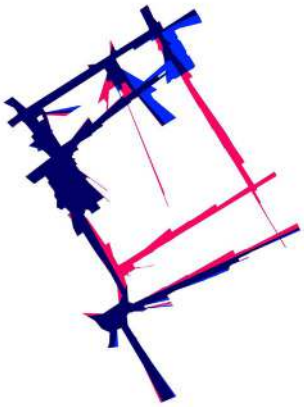
Via Artom



Tor Bella Monaca

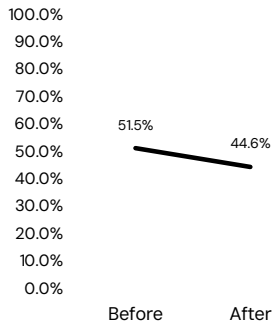


La Mina

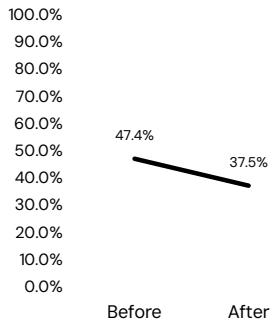


Agrocitè Gagarine Truillot

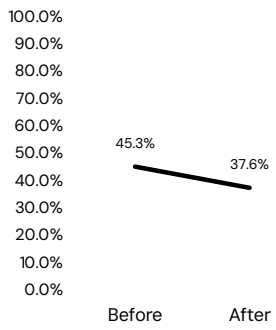
Via Artom



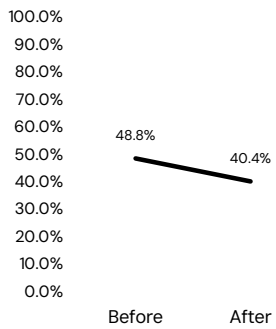
Tor Bella Monaca

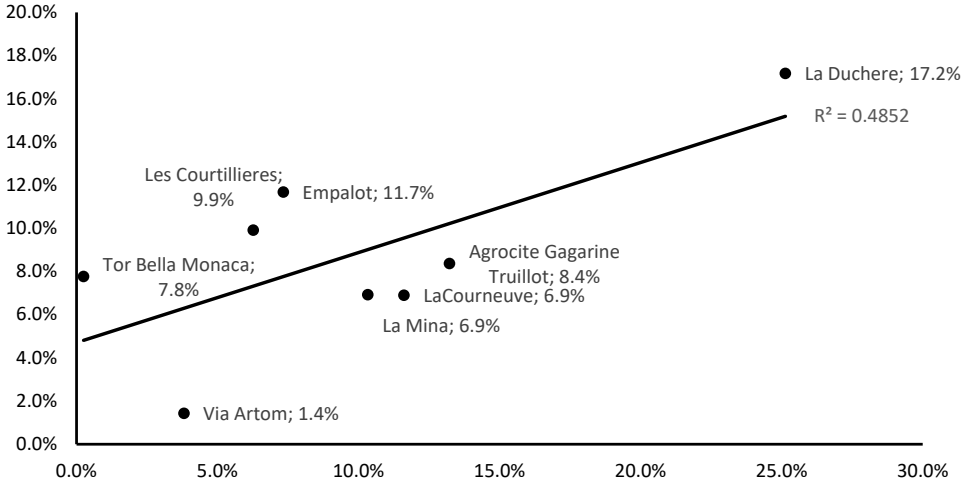


La Mina



Agrocitè Gagarine Truillot





Correlation between visible surface and modified surface [%]

Although this analysis presents some contradictions in general, it is noteworthy that Tor Bella Monaca has become a relevant case study in terms of defining the impact on surface area. The introduction of a small piece has significantly reduced the porosity of the fabric. It is therefore pertinent to pose the inverse question and pursue the identification of case studies wherein the excision of a minor component engenders a comparable constructive outcome. One potential exemplar could be Les Courtillières, were the analytical lens to be directed (or had the intervention been oriented) towards the southern entrance of the complex.

Moreover, the correlation with the modified built surface is particularly noteworthy, as it generally shows that larger interventions do not necessarily result in higher fabric permeability. While, in some cases, this "loss" of permeability is implemented strategically, certain interventions, such as those in Les Courtillières, Empalot, and Tor Bella Monaca, stand out for breaking this trend. These projects achieve a more favorable impact-to-surface ratio, enhancing permeability despite relatively modest surface modifications.

Old hidden spaces New hidden spaces

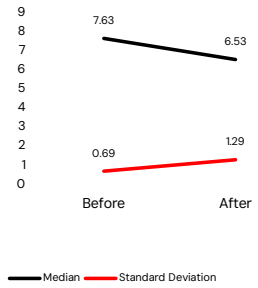
La Duchère

La Courneuve

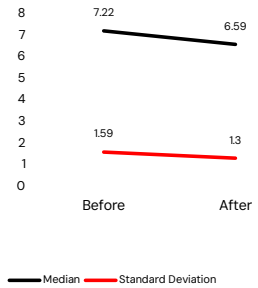
Empalot

Les Courtillieres

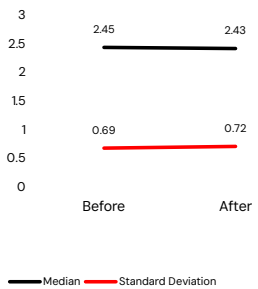
La Duchère



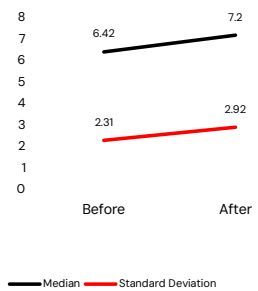
La Courneuve



Empalot



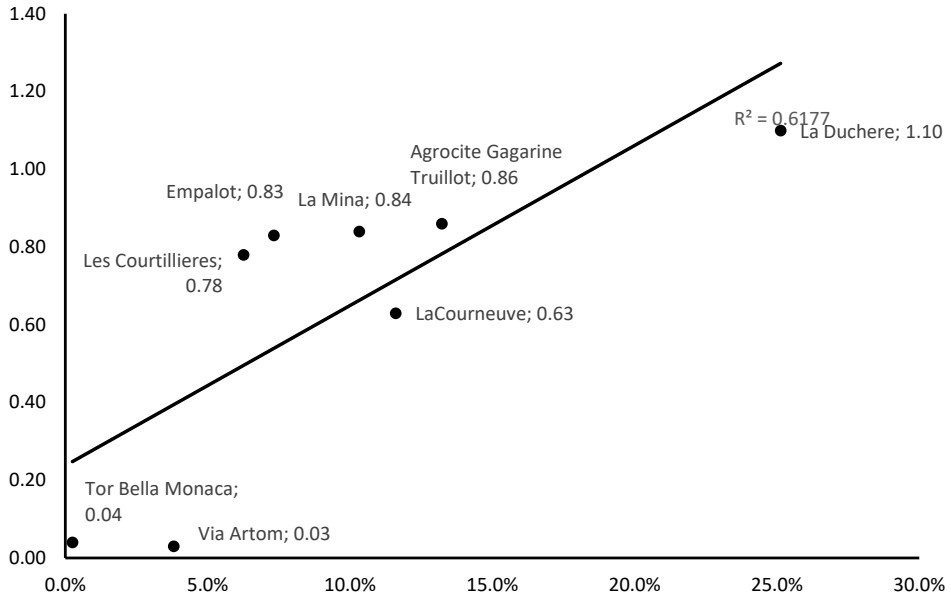
Les Courtillieres



The maps clearly indicates that the implementation of densification with a smaller grain of regeneration projects tends to facilitate the emergence of hidden spaces in a more consistent manner than in the original fabrics. This can be quantified by an increase in the standard deviation, which represents a greater range of values in the analysed interventions. Ultimately, it is the location, material characteristics, and functional attributes of these spaces that will determine their quality. For the purposes of this work, an increase in the number of hidden spaces is generally considered a negative factor. However, a detailed examination of each case will reveal that the location of these hidden spaces may not necessarily be detrimental; instead, it could reflect a variation in the spatial structure of the fabric.

The source of this analysis makes the interpretation of the resulting values somewhat complex, as an increase in the standard deviation signifies a broader range of values. This implies that, while there are higher values, there are also clearly lower values.

Conversely, when this increase in the standard deviation is accompanied by an increase in the median, it appears to indicate that the spatial structure becomes more clearly hierarchical. This is exemplified by Les Courtillieres and La Mina, where the rise in high values and either the maintenance or reduction of low values suggests the generation of spaces of significant importance within the hierarchy, accompanied by the emergence of numerous hidden spaces.



Relation between average change and percentage of modified built surface

Old hidden spaces New hidden spaces

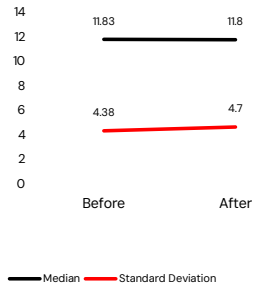
Via Artom

Tor Bella Monaca

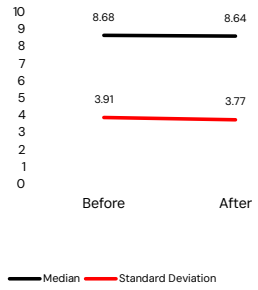
La Mina

Agrocitè Gagarine Truillot

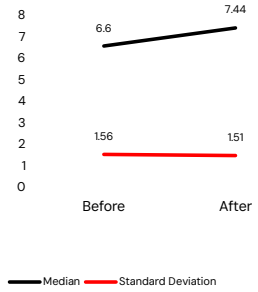
Via Artom



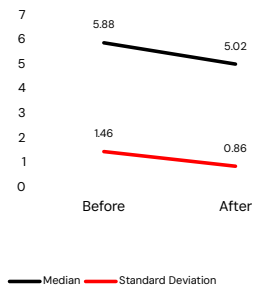
Tor Bella Monaca

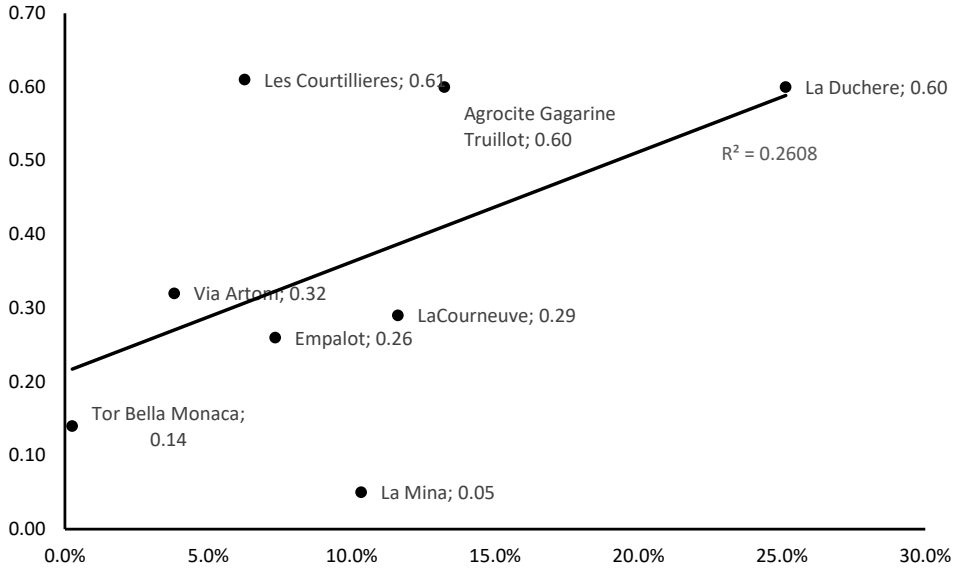


La Mina



Agrocitè Gagarine Truillot



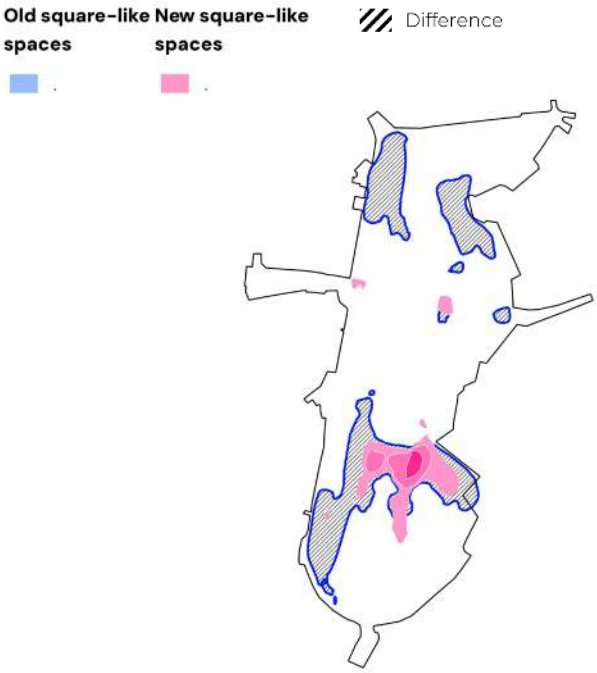


Relation between the change of the standard deviation and percentage of modified built surface

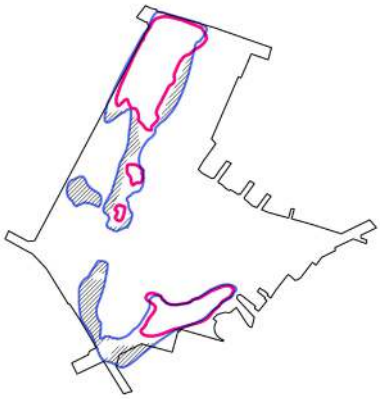
For instance, in La Courneuve, it is evident that the pinks (representing the current situation) exceed the blues (representing the original situation). Furthermore, these are concentrated in the vicinity of the new developments, as well as in the interior regions. A comparable phenomenon can be observed in the case of Agrocitè.

It is noteworthy that actions initially intended to reduce these hidden spaces, such as the intervention in La Mina and the creation of the axis, have not fully addressed the persistence of corners in the southern part (as evidenced by the overlap between the blue and pink zones). In relation to the modified surface, the Duchère site stands out as a surprising example of successful visual hierarchy and improved porosity of the fabric, despite its apparent negative evolution. However, the definitive best examples in the correlations are those with intermediate values, such as Les Courtillieres or Gagarine Truillot.

Finally, when examining the correlation between the development of hidden spaces, a mostly linear pattern emerges, with some interventions, such as La Mina and La Courneuve, showing a decline in this relationship. In these cases, significant surface interventions did not lead to an improvement in hidden spaces. What is particularly striking is the comparison with the standard deviation, where projects like Les Courtillières and Agrocité stand out. Despite utilizing fewer resources, these interventions succeeded in enhancing the spatial diversity of the fabric, demonstrating a more efficient use of resources to achieve greater complexity and variety in the urban layout.

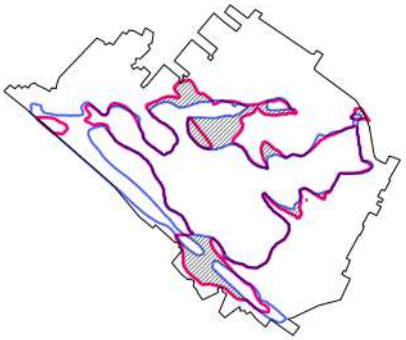


La Duchère



La Courneuve

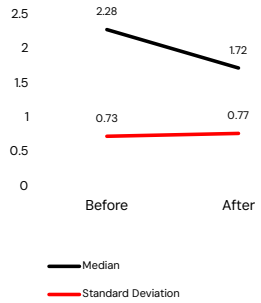
Empalot



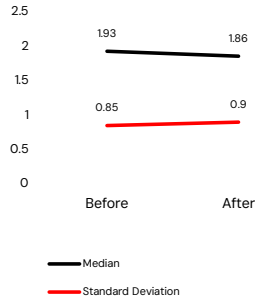
Les Courtillieres

Large & more visible square-like spaces

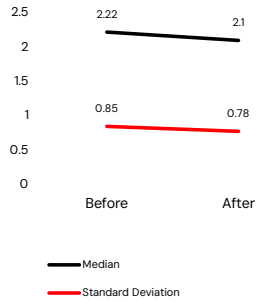
La Duchère



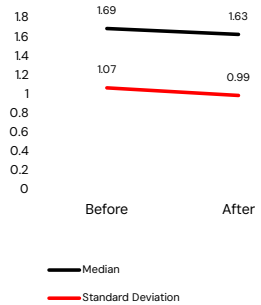
La Courneuve



Empalot

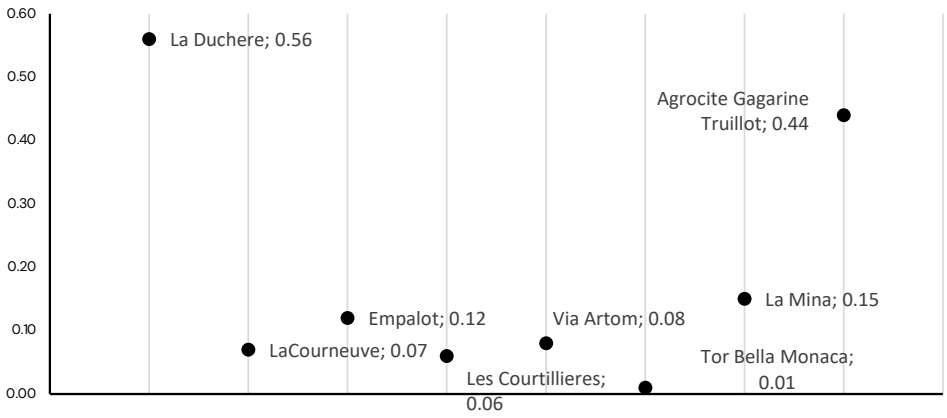


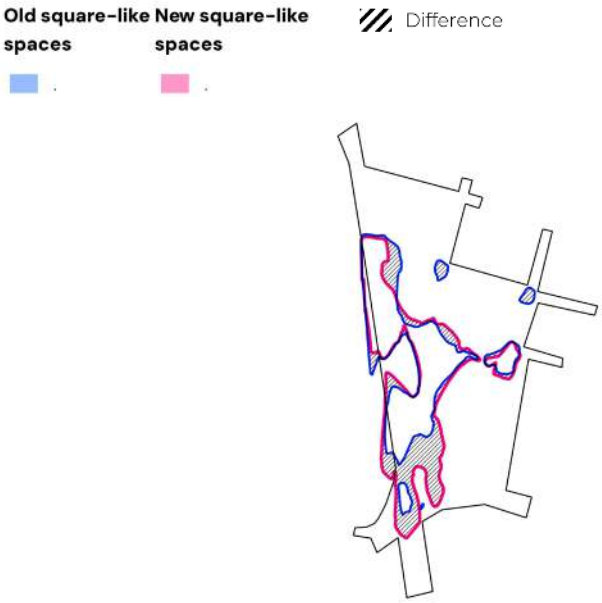
Les Courtillieres



In regard to the configuration of compact open spaces or squares, a predominant trend is evident: a general reduction in size that coincides with an increase in the occupation of space. Conversely, the evolution of their location is notable, progressing from a lack of hierarchical continuity to the formation of a network of compact open spaces. This enables the creation of relationships between spaces that are no longer defined by indeterminate open space, but rather by well-defined elements. Furthermore, when considered alongside the analysis of critical distances, it enables the identification of instances where the scale of open space is unsuitable for the continuity of urbanity, either within the fabric itself or at its periphery. The latter analysis also permits a more detailed definition of the evolution of the configuration of open space due to changes in the built environment. La Duchère is a notable example in both analyses, exhibiting an evolution of free space and a corresponding increase in its hierarchical configuration. However, this trend is also evident, to varying degrees, in the projects of La Courneuve, La Mina, and the Agrocite Gagarine Truillot.

Nevertheless, the analysis reveals a minimal variation in the values, which appears to diverge from the dynamics observed in the cartographies. This is undoubtedly due to the normalisation carried out in the analysis process, which was implemented to enable comparison of the different case studies. The radial average values, representing compact free spaces, and the visibility values, representing the most visible spaces, were normalised to a range between 0 and 4.2 for the sum of the two. This enables the observation of dynamics in the dimensions that are not evident in the mapping. To illustrate, while the Agrocitè displays a reduction in compact spaces, the introduction of internal axes results in a notable enhancement in visibility, which subsequently leads to an increase in the average value.





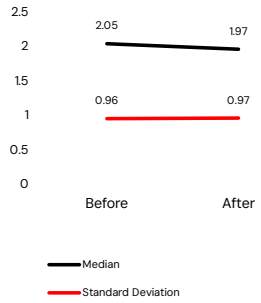
Via Artom

Tor Bella Monaca

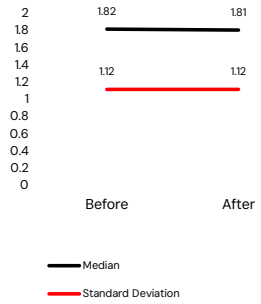
La Mina

Agrocitè Gagarine Truillot

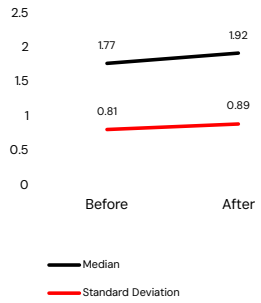
Via Artom



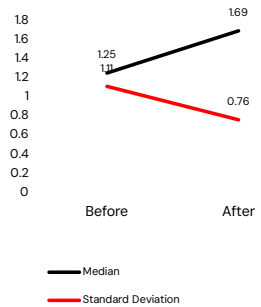
Tor Bella Monaca

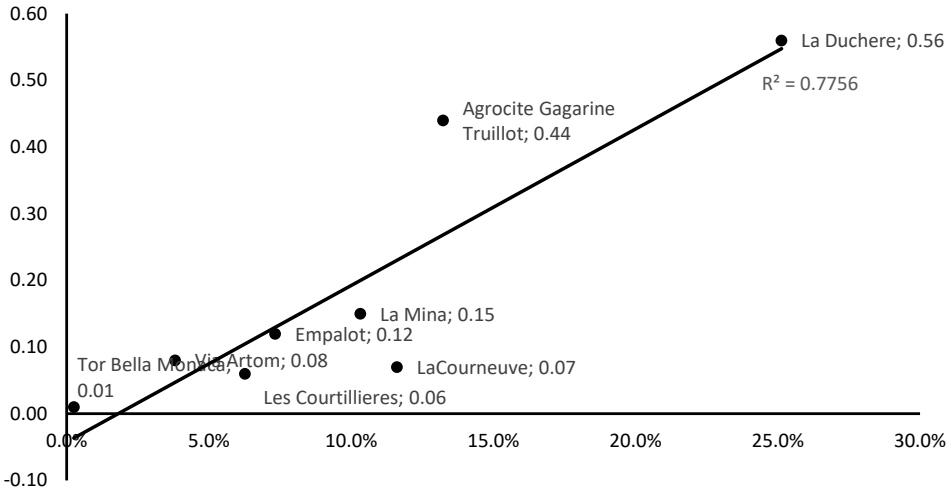


La Mina

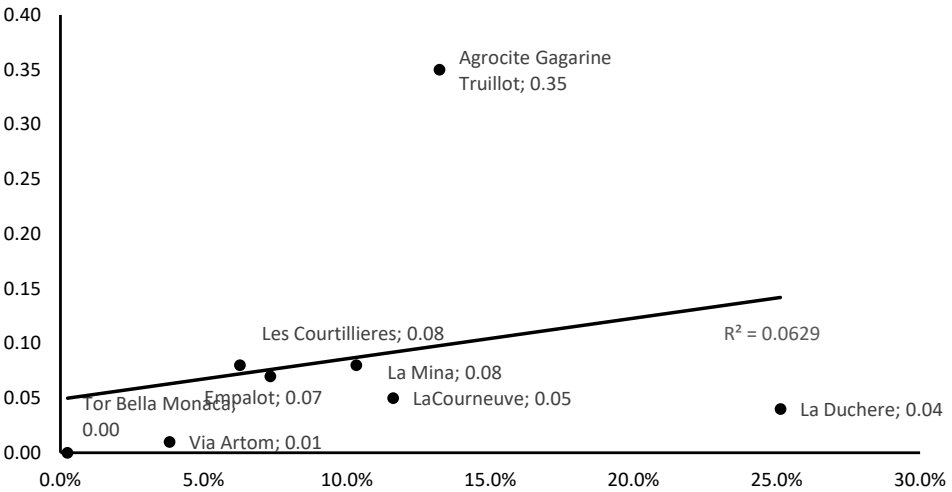


Agrocitè Gagarine Truillot



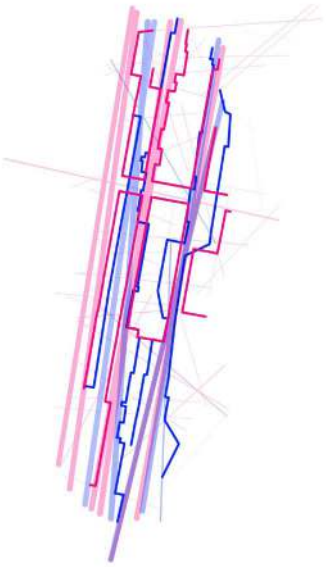


Relation between average change and percentage of modified built surface

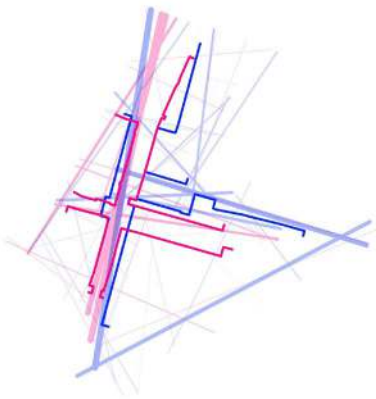


Relation between the change of the standard deviation and percentage of modified built surface

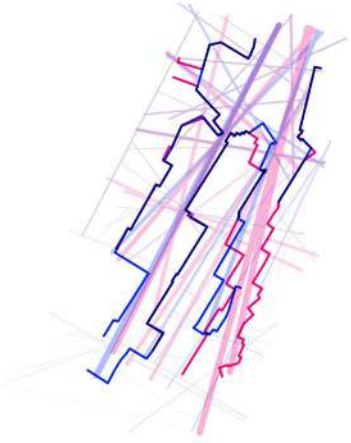
It is also noteworthy that a previously unobserved trend has emerged, namely a reduction in the standard deviation in correlation with the modified surface. This suggests that as the modified surface area increases, the diversity of these spaces tends to decrease. In other words, a larger modified surface area does not necessarily lead to a broader range of values; rather, it may indicate a shift towards a more defined dimensional model of free space.



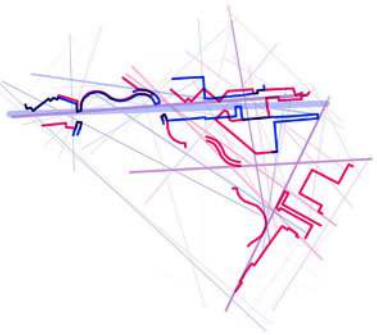
La Duchère



La Courneuve

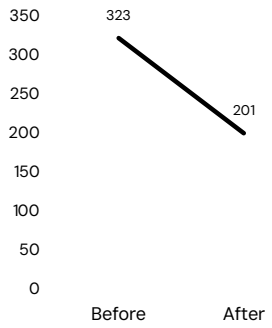


Empalot

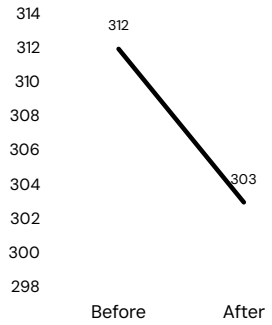


Les Courtillieres

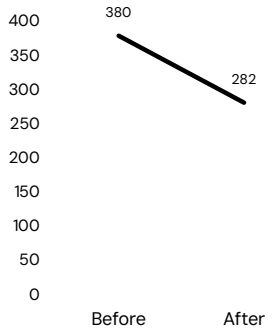
La Duchère



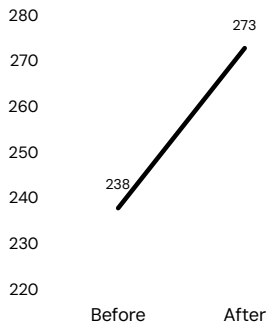
La Courneuve



Empalot



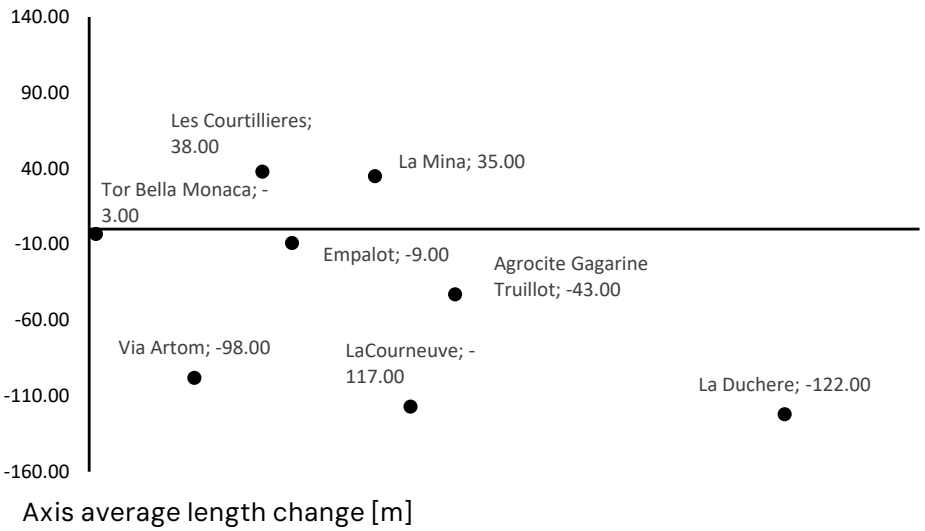
Les Courtillieres

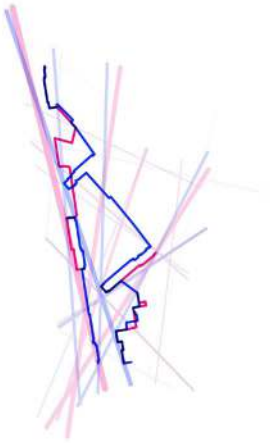


The analysis of the basic structures is perhaps too particular to elucidate general conclusions. However, there seems to be a relationship between the configuration of the large and visible spaces and the appearance of the axes in those cases where the hierarchy of this analysis is relatively poor. In areas where the hierarchisation of space is more evident, the appearance of axes is not related to the relationship between the different areas. Conversely, in parts where there is an evident continuity in this analysis, the axes seem to be built in the same environment.

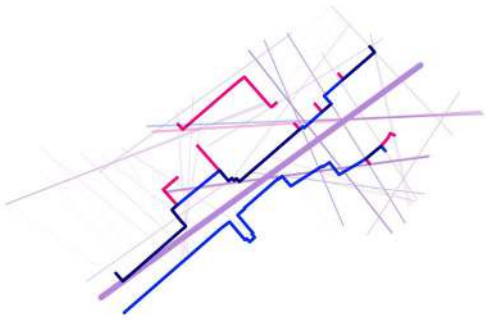
This tool can be further utilised, taking advantage of the densification techniques that are sometimes employed without sufficient consideration to enhance the definition of specific axes of interest. Conversely, it can be employed as a diagnostic instrument to identify instances of fragmentation within a built environment characterised by a variable quantity of constructed elements. This approach enables the identification of new spatial directions, as exemplified by Les Courtillieres, the emergence of new axes, as observed in Empalot, or subtle shifts in orientation, as evidenced in Via Artom.

In contrast, two principal trends emerge with regard to the average length of the axes, contingent on the nature of the intervention. In areas where the strategy was based on densification, there is a general reduction in the average length. In contrast, in the fabrics La Mina and Les Courtillieres, where the intervention, despite a slight densification, has promoted the creation of axes through the selective extraction of parts of the fabric, this average length has increased.

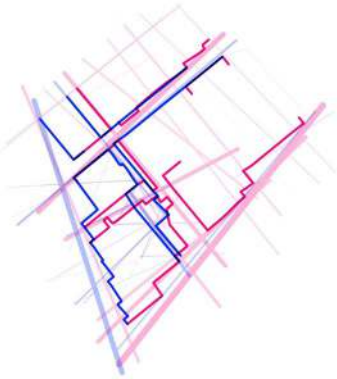




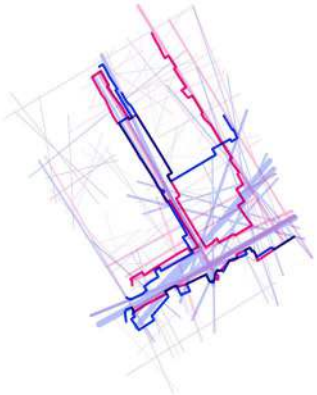
Via Artom



Tor Bella Monaca

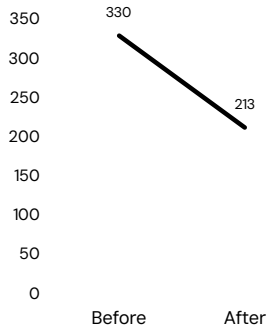


La Mina

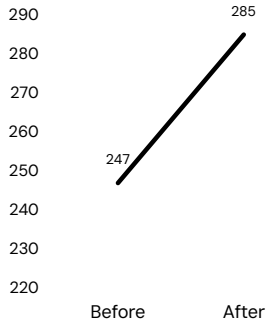


Agrocitè Gagarine Truillot

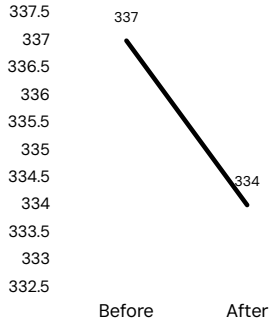
Via Artom



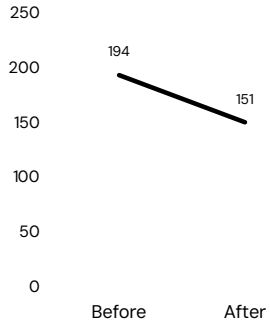
Tor Bella Monaca

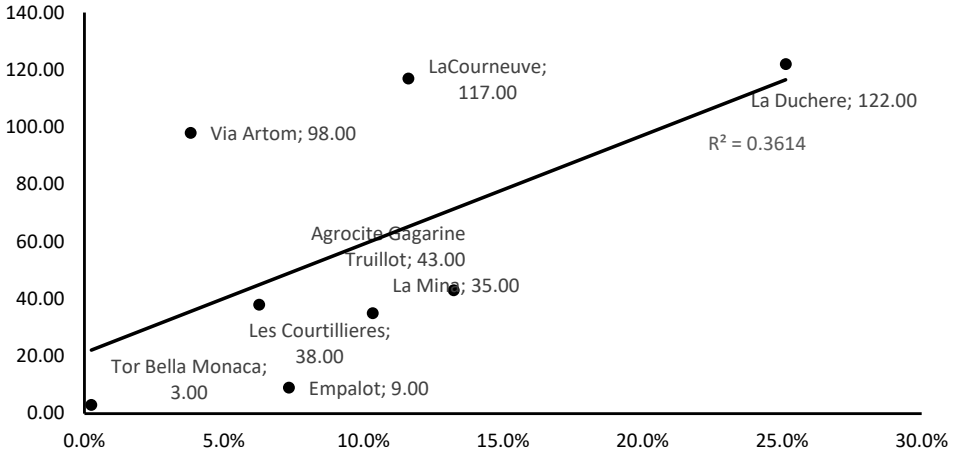


La Mina



Agrocitè Gagarine Truillot





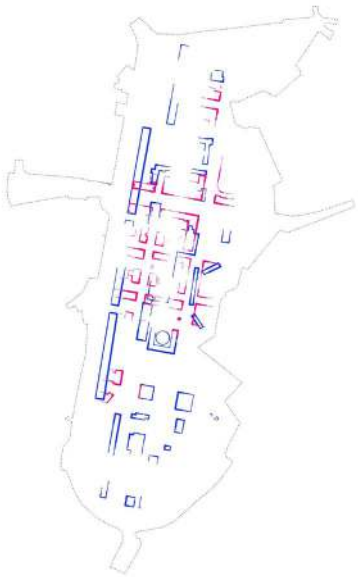
Relation between axis average length change and percentage of modified built surface

The construction of these lines, apart from providing a clear visualisation of the basic structure of the fabric, also makes it possible to understand the straight lines that connect the most spaces. Therefore, the increase in average length implies the possibility of a greater number of spaces being connected from a single axis.

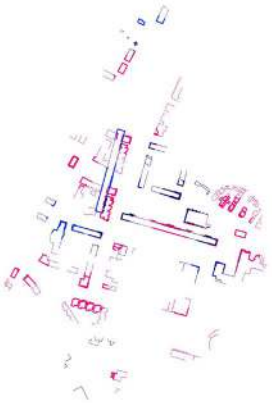
It is also noteworthy that these axes often undergo a transformation in their location and structure. Initially, they may appear amorphous and lack a discernible hierarchy. However, through the implementation of strategic interventions, they can be effectively ordered and organised into a coherent system. This is evident in the French cases, where the creation of main crossroads and grids, as observed in La Duchère and Agrocitè, demonstrates a clear intention to establish a structured and systematic approach to the organisation of axes.

As with the other analyses, when relating the metric to the surface area of each intervention, projects with moderate surface use, such as La Courneuve and Via Artom, stand out for achieving a similar impact to larger interventions like La Duchère, but with a fraction of the resources. Conversely, interventions like Empalot, despite their moderate resource usage, have shown minimal progress in this regard, highlighting that greater resource efficiency does not always equate to significant spatial improvements.

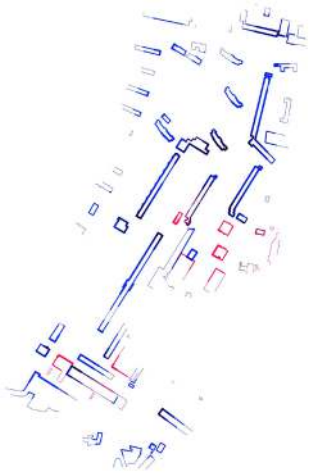
Old centric corners New centric corners



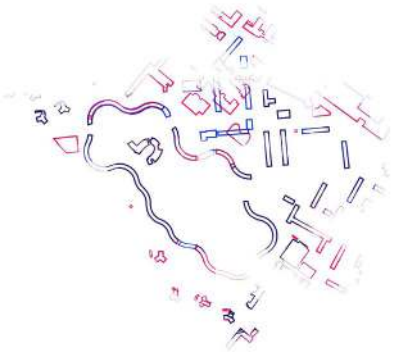
La Duchère



La Courneuve

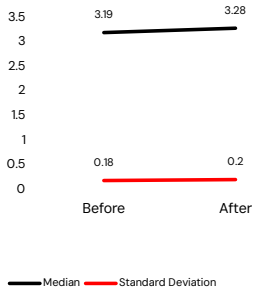


Empalot

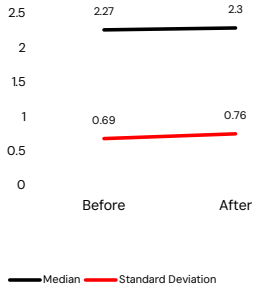


Les Courtillieres

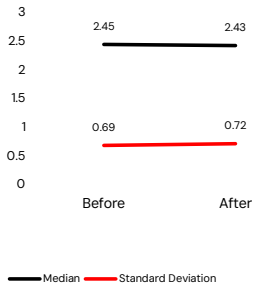
La Duchère



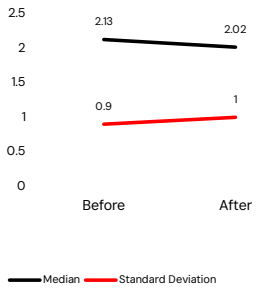
La Courneuve



Empalot



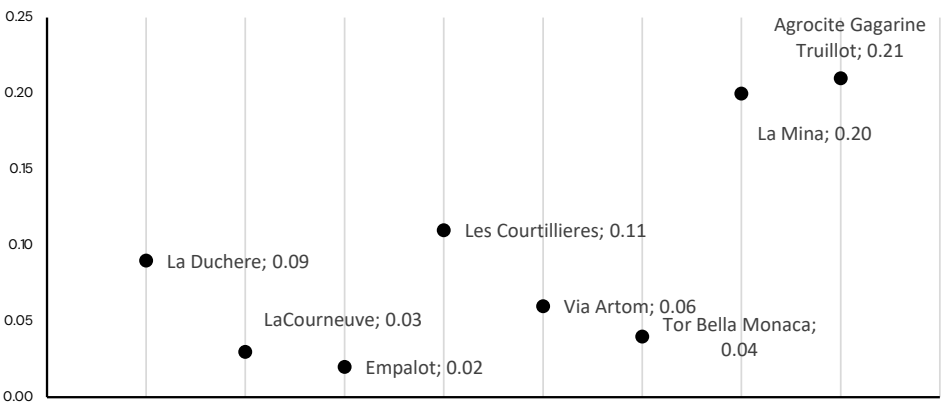
Les Courtillieres



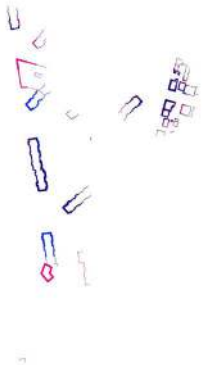
Finally, the study of the corners has proved to be a good general summary of the spatial configuration of the open spaces in the fabric on several levels. Firstly, it clearly shows the scope of the project and that if the evolution of the configuration has been extensive, this is also the evolution of the corners in the current fabric, while if the changes have been of an intensification or of a subtle expansion, this has meant partial changes in the configuration of the open space. Although there does not appear to be a direct correlation with the values discussed above, the conclusions drawn from this analysis in general could embody many of the above.

Particularly relevant is the relationship with the modified surface area, where the intermediate cases, which did not need to intervene on a large percentage of the surface area, are those which have managed to promote the appearance of these corner spaces, where opportunities are increased and which offer the best conditions for promoting casual encounters.

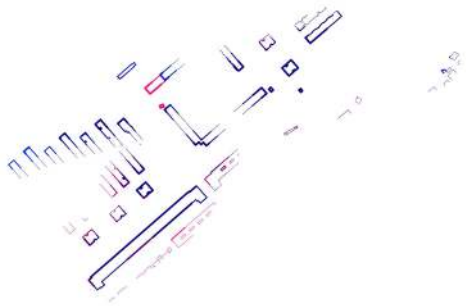
In this respect, Les Courtillieres stands out, which, with a limited intervention, has managed both to increase its capacity to generate these spaces, and therefore to modify their spatial configuration, and to increase their standard deviation, and therefore to increase the diversity of open spaces in the fabric.



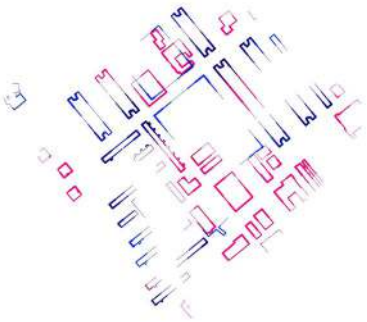
Old centric corners New centric corners



Via Artom



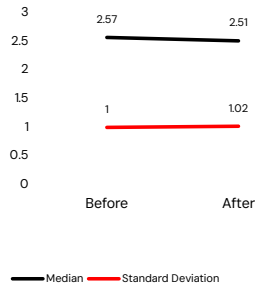
Tor Bella Monaca



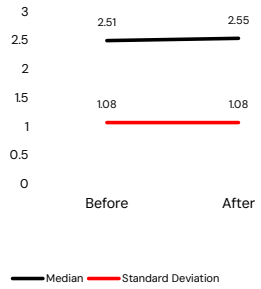
La Mina

Agrocitè Gagarine Truillot

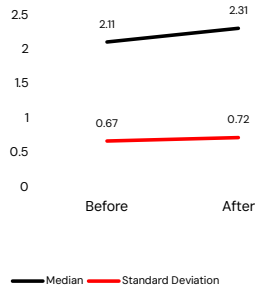
Via Artom



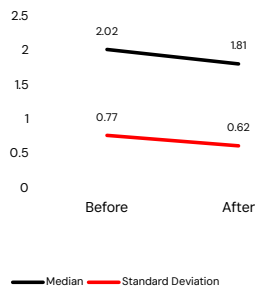
Tor Bella Monaca

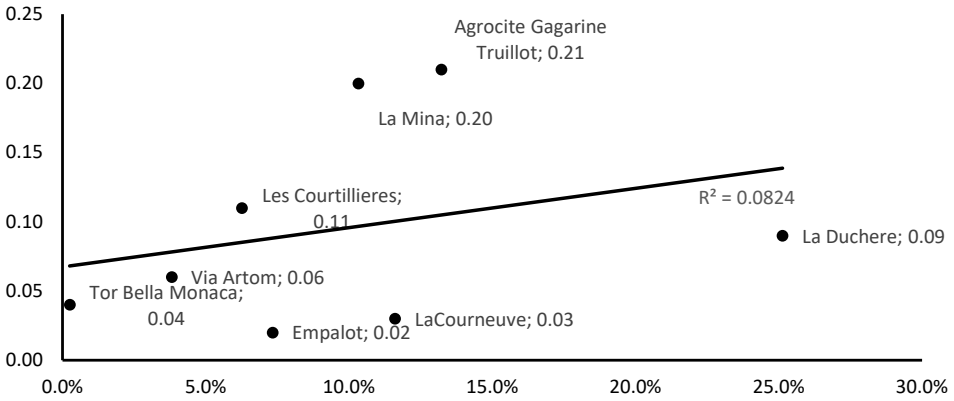


La Mina

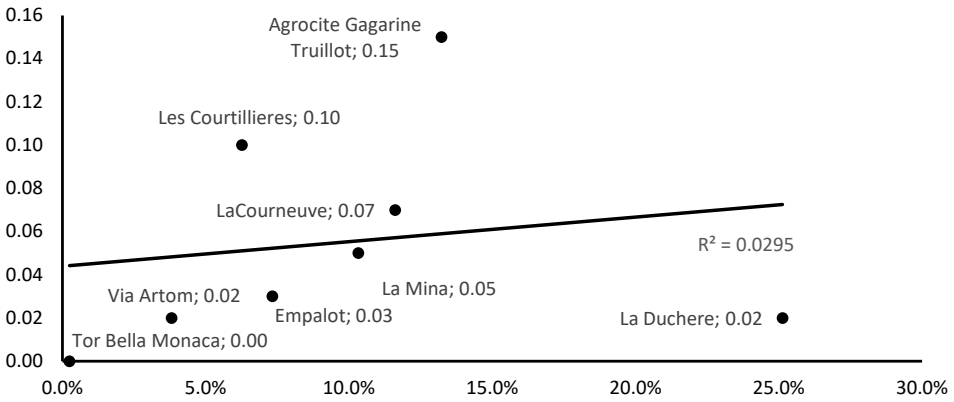


Agrocitè Gagarine Truillot





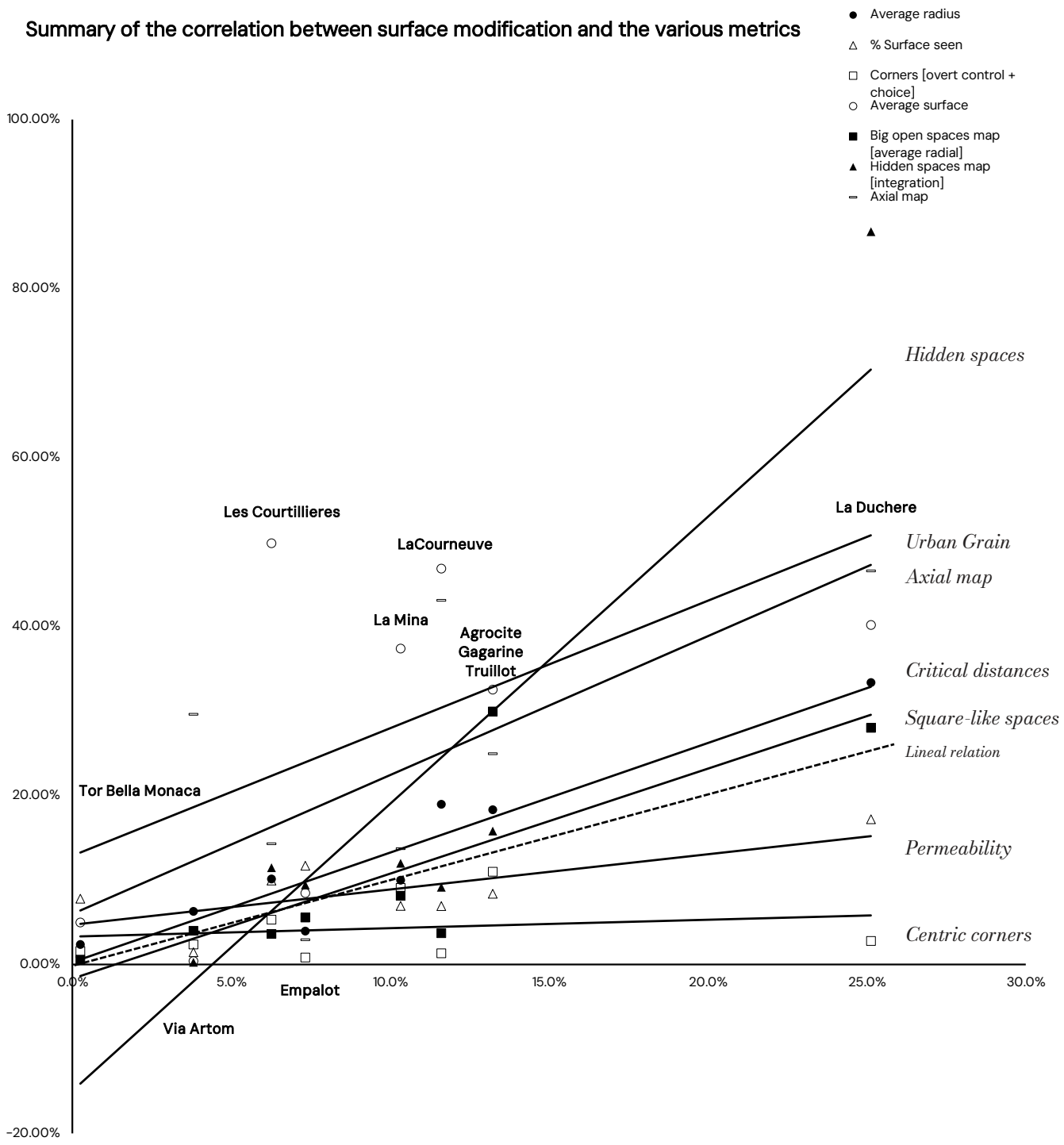
Relation between average change and percentage of modified built surface



Relation between the change of the standard deviation and percentage of modified built surface

In any case, understanding where the point of spatial centrality of the fabric is has been particularly useful in evaluating the general structure, but it would be even more interesting to analyse the different situations that take place at these points of spatial centrality: is it the corner between two urban motorways or an intersection full of activity? In short, to understand whether, if they meet the spatial conditions to become a centrality, the economic, material, etc. conditions that allow the creation of a micro-spatial centre should be taken into account. As will be shown in the section on future work, it is particularly important to understand the relationship between the hierarchies established with this indicator and the experimental reality. That is to say, to understand the type of activities that take place in these spaces, not only to understand whether they are central or not, but also to detail their categorisation and thus to understand the conditions that the urban physical environment must provide in order to achieve a certain density of activities.

Summary of the correlation between surface modification and the various metrics



Do urban interventions and open space transformation correlate?

One of the primary hypotheses of this work has been to determine whether the resources invested in the regeneration of mass housing estates—measured by the percentage variation of the modified built surface relative to the total fabric—are proportionate to the spatial impacts generated by these interventions. However, as previously mentioned, the relationship between surface modification and spatial impact is not linear. In many cases, **interventions that modify an intermediate percentage of the surface area (ranging from 6% to 7%) have a larger effect on the spatial configuration,** as reflected in the percentage evolution of the metrics analyzed.

A review of the graph on the left, which correlates the modified built surface (on the horizontal axis) with the evolution of various metrics (on the vertical axis), reveals two main trends. First, there are instances where small surface modifications result in significant spatial impacts, particularly regarding hidden spaces. Additionally, the variation in urban grain stands out, especially in intermediate interventions. Les Courtillières is a prime example of this, where a modest intervention has resulted in a notable shift in the average grain size, fostering a more porous fabric with a more human scale.

In contrast, the relationship between the creation of central corners and spatial impact is more complex. Despite substantial resource investment, this approach has not significantly advanced the indicator. In order to comprehend these trends, and despite the limited number of case studies, a comprehensive examination of the various cases reveals several distinctive actions that have been repeatedly identified as contributing factors to the evolution of the spatial configuration of the fabric.

First, the creation of axes emerges as one of the most frequently used design strategies, yielding varied results. **Axes that connect** urban spaces to interior areas, **enhance permeability,** and establish a **clear spatial hierarchy** tend to have a positive effect on the regeneration of urban fabric.

Notable examples include the transversal axis of Empalot and the diagonal axes formed through the openings in Les Courtillières. However, when axes are created on too large a scale, as seen in La Mina, or are left incomplete, as in Agrocité and La Courneuve, t**he spatial evolution is less pronounced.** Similarly, when specific elements obstruct the continuity of existing axes—such as in Tor Bella Monaca and, to a lesser extent, in the longitudinal axes of La Duchère—**the resulting spatial configuration tends to be less favorable**, with spaces developing relationships akin to those seen in the pre-intervention phases.

A variety of densification strategies have also been observed. Although these do not appear to generate significant trends, the resulting free space from this densification the resulting free space from densification **offers insights into the evolution of urban typology, and consequently, the evolution of the structure of open space.** his is especially evident in the analysis of urban grain. Case studies that demonstrate clear shifts in spatial configuration, such as La Duchère, La Courneuve, La Mina, and Agrocité, stand out in this regard. However, these findings must be contextualized with an analysis of open-space distances. For example, reductions in the average grain size, as seen in Les Courtillières, are largely due to selective openings that fragment the grain while preserving the relationships between free spaces.

In conclusion, this work has raised some knowledge on the existence of a series of interventions that **develop a new spatial configuration with an intermediate use of resources.** These interventions foster new spatial relationships, which, over time, will lead to evolving patterns of behaviour in the urban environment. When combined with additional interventions, these strategies can contribute to the comprehensive regeneration of urban peripheries, ultimately improving the quality of life and use within these urban fabrics.

Future research

In the development of this thesis, a series of themes have been observed, which although they have been central to the conceptual development of the thesis, in the future they will have to be expanded and nuanced. In this section, possible future lines of research will be developed, as well as some possible outputs from the direct implementation of this research.

Firstly, and with regard to one of the central themes, all the research has been carried out by closing the scope of the study to physical characteristics and, specifically, to dimensional characteristics, those that define the size of spaces. This has been done assuming, and referencing existing literature, that these physical characteristics have an impact on the social structure of urban fabrics. It is necessary, however, to promote similar research, which relates the efficiency of these interventions not only to their capacity to develop a new spatial structure, but also to the capacity of these spatial structures to generate changes (improvements) in social structures. This, it is expected, will present great nuances in the results and conclusions of this work, modifying the importance and, especially, the ranges to be highlighted of each one of the indicators. In other words, understanding how the different ranges of the different indicators generate a positive or negative impact on social behaviour, so that the ranges of the indicators on spatial structure are narrowed down.

Secondly, although following a similar scheme, it seems necessary to incorporate this research into others with a focus on housing estates, but with a different specialised subject matter. It should be noted here that indicators of urban form do not ensure the quality of spaces; it is necessary to broaden the range of research and incorporate demographic, economic, environmental or heritage values, among others, in order to really understand the evolution of regeneration processes. In the end, this work seeks to contribute empirical knowledge to current research on urban regeneration, improving its capacity to measure changes in spatial configuration.

In this sense, it also presents the opportunity to adapt the methodology of this work to other urban typologies. It seems necessary, once this work has been completed, to establish a comparison of regeneration processes in more compact environments, as well as in even less dense spaces. On the other hand, and also in relation to the methodology, the incorporation of values in three dimensions has been intentionally avoided due to their apparent lack of relevance in certain values. However, it would be necessary to explore a deeper incorporation of three-dimensional variables, as well as to increase the detail of certain analyses.

Conversely, in regard to certain decisions made during the development of this work, potential inclusions emerge that enhance the intricacy and, consequently, the understanding of the spatial configuration of these tissues. Firstly, elements of closure, encompassing both compact and porous forms, which have the capacity to alter the geometry of the analysed spaces, have been excluded. Furthermore, the integration of specific elements of street furniture into the analysis would have facilitated a more detailed comprehension of the topology of the examined spaces, as well as their associated visual perception. In other words, the incorporation of elements such as vegetation or minor variations in elevation could provide valuable insights, thereby bringing these analyses closer to the reality of the spatial configuration of these fabrics.

This prompts another consideration regarding the metrics employed, namely the exclusion of the third dimension in the analysis, not merely at a higher level of detail. The incorporation of the third dimension (for example, the heights of the buildings) would not have provided additional information regarding the fabric's geometry or topology. However, it would have facilitated the construction of a more comprehensive image and a more realistic series of analyses on the visual perception of the different fabrics. This is particularly evident in fabrics such as La Duchère or Empalot, where the height of the new buildings contrasts enormously with the average height of the original fabric. While this may appear to have been accompanied by a reduction in some of the values described here, the urban grain, the critical distance, and their inclusion in the analysis would facilitate a more natural linkage between the series of geometric descriptions and those of a perceptive nature.

Finally, the conclusions of this work have shed light on those interventions with greater efficiency; however, the number of case studies does not allow the abstraction of recommendations at a general level, so it would be interesting to incorporate a certain mass of case studies that would allow us to find macro trends and, with this, establish a series of less particular recommendations.

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Housing estate regeneration has become a central axis of urban policy, both nationally and internationally, as one of the most widely used strategies for addressing social inequalities. These processes typically involve a significant allocation of financial, social, and technological resources to comprehensively address multivariable aspects, including social, economic, environmental, and architectural factors. Although the ultimate goal of these projects is to improve the socio-economic conditions of affected neighbourhoods, their morphological impact on spatial structure is equally critical, as space significantly influences human behaviour.

Despite the importance of spatial considerations, urban studies have often limited their analysis to metrics related to buildings—such as density, habitability, number of dwellings, or typological variety—or to mobility metrics, including pedestrian flows and road networks. However, few studies have explored metrics that evaluate open space based on its own morphological characteristics.

This work seeks to fill that gap by developing and testing a series of metrics focused exclusively on the geometric, topological, and perceptual qualities of the figure-ground relationship in these neighbourhoods, both before and after regeneration. The proposed methodology aims to be easily replicable and strives not only to assess individual projects but also to generate empirical knowledge on the correlation between proposed transformations and their spatial impacts. By providing quantitative data, it offers a way to evaluate the effectiveness of regeneration projects in terms of their spatial outcomes relative to the resources invested and the scale of transformation.