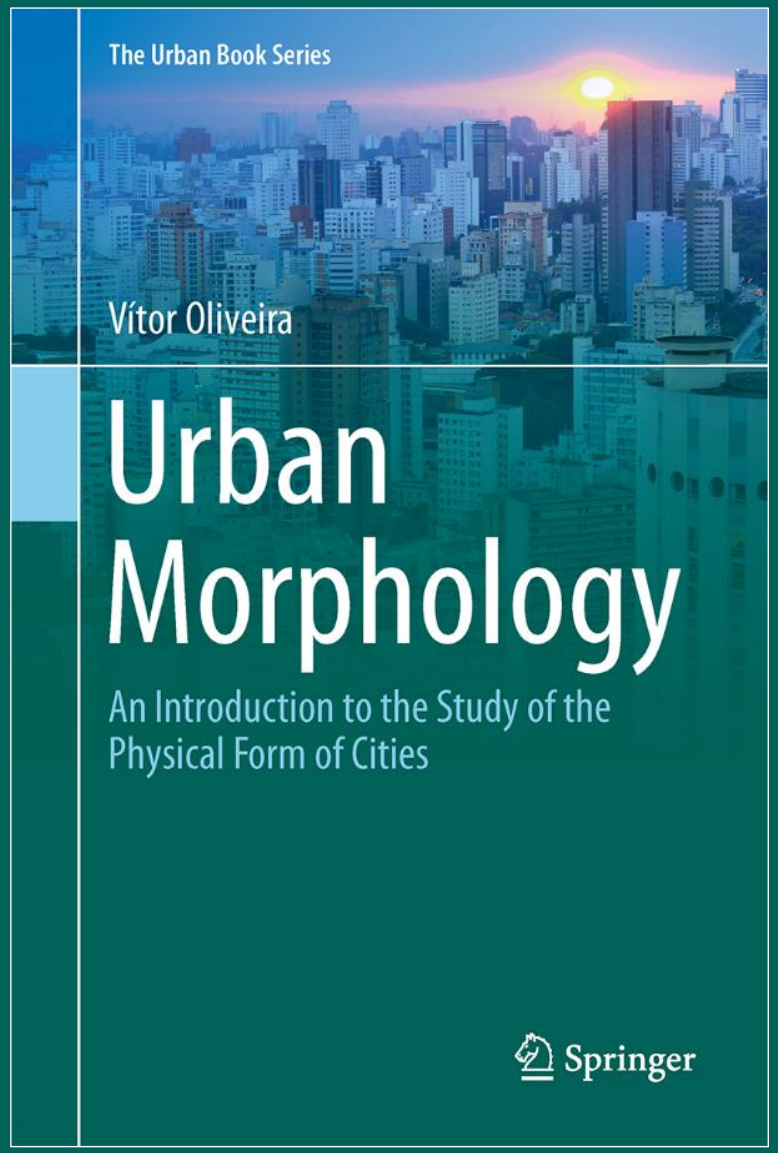
VITOR OLIVEIRA

URBAN MORPHOLOGY

MORFOLOGIA URBANA

AN INTRODUCTION TO THE STUDY OF THE PHYSICAL FORM OF CITIES

UMA INTRODUÇÃO AO ESTUDO DA FORMA FÍSICA DAS CIDADES



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SPACE SYNTAX

SINTAXE ESPACIAL

1. Theory and concepts
2. Methods and software
3. Exercise

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1. Teoria e conceitos
2. Métodos e software
3. Exercício

THEORY AND CONCEPTS

TEORIA E CONCEITOS

ORIGINS AND FUNDAMENTAL DEVELOPMENTS

1970s. Beginning of this line of research at Unit for Architectural Studies, **University College London**.
1984. Publication of the book **The social logic of space**, by Bill Hillier and Julienne Hanson, proposing a theory of space as a dimension of social life.
1996. Publication of Bill Hillier's book **Space is the machine** (http://eprints.ucl.ac.uk/3881/)
1997. Realization of the first **International Space Syntax Symposium** in London (http://www.spacesyntax.net/symposia/)
2010. Publication of the first issue of **The Journal of Space Syntax** (http://joss.bartlett.ucl.ac.uk/journal/index.php/joss)

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ORIGENS E DESENVOLVIMENTOS FUNDAMENTAIS

Anos 70. Início desta linha de investigação na *Unit for Architectural Studies,* ***University College London****.*
1984. Publicação do livro ***The social logic of space***, de Bill Hillier e Julienne Hanson, propondo uma teoria do espaço enquanto dimensão da vida social.
1996. Publicação do livro ***Space is the machine*** de Bill Hillier (http://eprints.ucl.ac.uk/3881/)
1997. Realização do primeiro ***International Space Syntax Symposium*** em Londres (http://www.spacesyntax.net/symposia/)
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Bill Hillier, Julienne Hanson, ‘The social logic of space’, ‘Space is the machine’.

SPACE AND SOCIETY

The way how space syntax relates space and society is one of its distinctive characteristics.
To understand space, space syntax removes the focus from ‘surfaces’ and seeks to perceive the void, the space (urban/exterior or architectural/interior) or the way in which space is organized.
When analyzing urban space, space syntax focuses on the city's street system.
It's a paradigm shift. For architecture, the proposal is to change from ‘form’ to ‘space’.
-

ESPAÇO E SOCIEDADE

O modo como a sintaxe espacial relaciona o espaço e a sociedade é uma das suas características distintivas.
Para compreender o espaço, a sintaxe espacial retira o enfoque das ‘superfícies’ e procura perceber o vazio, o espaço (urbano/exterior ou arquitetónico/interior) ou o modo como o espaço é organizado.
Ao analisar o espaço urbano, a sintaxe espacial coloca o enfoque no sistema de ruas de uma cidade.
Portanto, é uma mudança de paradigma. Para a disciplina de arquitetura, propõe-se uma mudança da ‘forma’ para o ‘espaço’.

Jamaa-el-Fna, Marrakech (Vítor Oliveira)

This involves realizing that a space with a poorly defined geometry, or with a set of poorly qualified surfaces, can be a successful space due to the space itself and to the way it relates to the other spaces in the system.
To understand the role of society, space syntax analyses, first, the way people use / travel in space and, second, how they organize their activities in that space.

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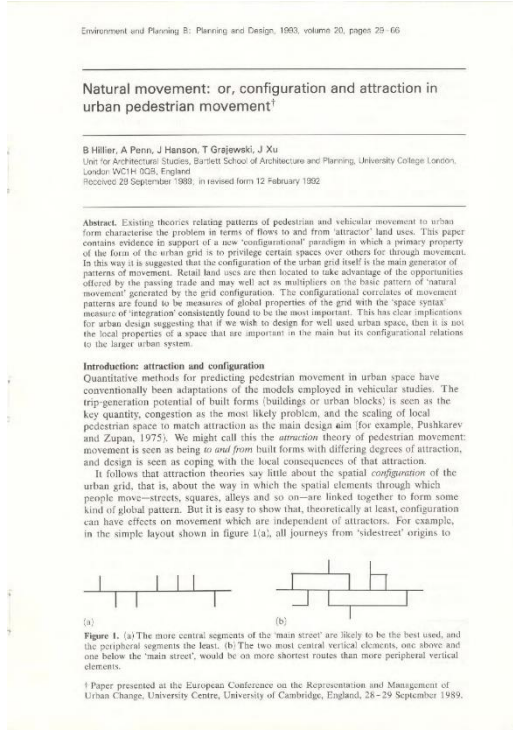
Isso implica, perceber que um espaço com uma geometria mal definida, ou com um conjunto de superfícies pouco qualificadas, pode ser um espaço de sucesso pelo próprio espaço e pelo modo como se relaciona com os outros espaços no sistema.
Para compreender o papel da sociedade, a sintaxe espacial analisa, em primeiro lugar, o modo como as pessoas usam / viajam no espaço e, em segundo lugar, como organizam as suas atividades nesse espaço.

NATURAL MOVEMENT

What cities do we want?
Cities that are ‘lived’; cities with people; cities as ‘spatialized societies’.
What criterion for assessing whether we are producing the characteristics / attributes that we want for our cities?
The movement of people as an evaluation criterion (a space/street with people is a successful space).

MOVIMENTO NATURAL

Que cidades queremos?
Cidades vividas; cidades com pessoas; cidades como ‘sociedades espacializadas’.
O que pode ser um bom critério para avaliar se estamos a produzir as características / atributos que queremos para as nossas cidades?
O movimento das pessoas como critério de avaliação (um espaço / rua com pessoas é um espaço de sucesso).



Environment and Planning B: Planning and Design, 1993, volume 20, pages 29–66

Natural movement: or, configuration and attraction in urban pedestrian movement[1]

B Hillier, A Penn, J Hanson, T Grajewski, J Xu
Unit for Architectural Studies, Bartlett School of Architecture and Planning, University College London, London WC1H 0QB, England
Received 28 September 1989, in revised form 12 February 1992

Abstract. Existing theories relating patterns of pedestrian and vehicular movement to urban form characterise the problem in terms of flows to and from 'attractor' land uses. This paper contains evidence in support of a new 'configurational' paradigm in which a primary property of the form of the urban grid is to privilege certain spaces over others for through movement. In this way it is suggested that the configuration of the urban grid itself is the main generator of patterns of movement. Retail land uses are then located to take advantage of the opportunities offered by the passing trade and may well act as multipliers on the basic pattern of 'natural movement' generated by the grid configuration. The configurational correlates of movement patterns are found to be measures of global properties of the grid with the 'space syntax' measure of 'integration' consistently found to be the most important. This has clear implications for urban design suggesting that if we wish to design for well used urban space, then it is not the local properties of a space that are important in the main but its configurational relations to the larger urban system.

Introduction: attraction and configuration
Quantitative methods for predicting pedestrian movement in urban space have conventionally been adaptations of the models employed in vehicular studies. The trip-generation potential of built forms (buildings or urban blocks) is seen as the key quantity, congestion as the most likely problem, and the scaling of local pedestrian space to match attraction as the main design aim (for example, Pushkarev and Zupan, 1975). We might call this the *attraction* theory of pedestrian movement: movement is seen as being *to and from* built forms with differing degrees of attraction, and design is seen as coping with the local consequences of that attraction.

It follows that attraction theories say little about the spatial *configuration* of the urban grid, that is, about the way in which the spatial elements through which people move—streets, squares, alleys and so on—are linked together to form some kind of global pattern. But it is easy to show that, theoretically at least, configuration can have effects on movement which are independent of attractors. For example, in the simple layout shown in figure 1(a), all journeys from 'sidestreet' origins to

(a) (b)

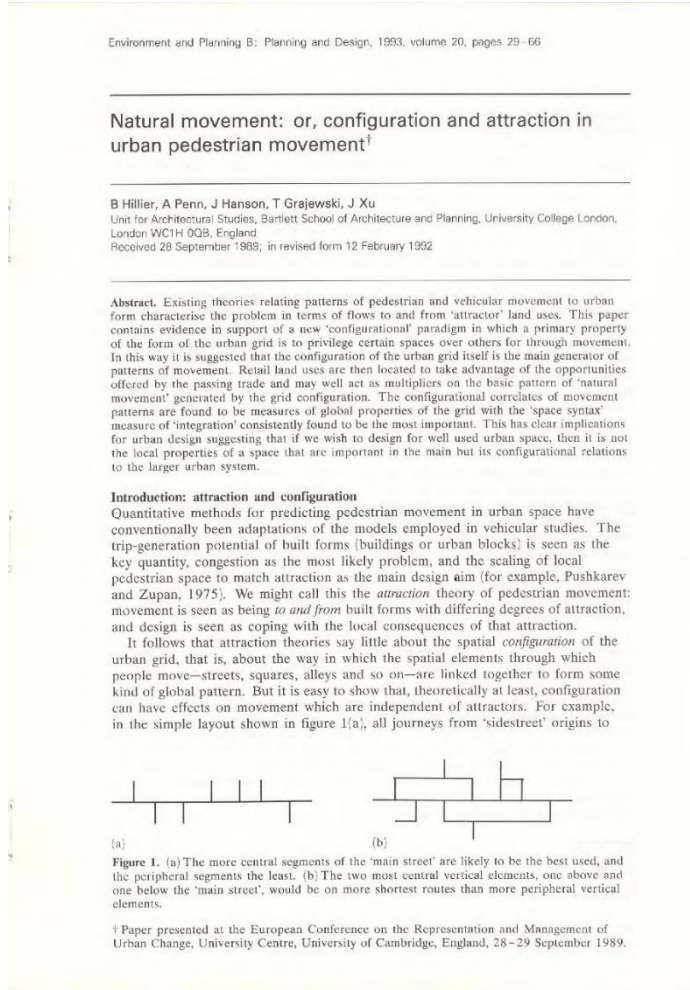
Figure 1. (a) The more central segments of the 'main street' are likely to be the best used, and the peripheral segments the least. (b) The two most central vertical elements, one above and one below the 'main street', would be on more shortest routes than more peripheral vertical elements.

† Paper presented at the European Conference on the Representation and Management of Urban Change, University Centre, University of Cambridge, England, 28–29 September 1989.

Natural movement (Hillier et al., 1993).

These ideas are clearly expressed in the influential paper 'Natural movement' published in 1993.
The paper argues that, in a city, the accessibility of the street system (and not the land uses, as proposed by many theories) is the main generator of movement patterns.

Estas ideias são claramente expressas no influente artigo 'Movimento natural', publicado em 1993.
O artigo argumenta que, numa cidade, a acessibilidade do sistema de ruas (e não os usos do solo, como proposto por muitas teorias) é o principal gerador de padrões de movimento.



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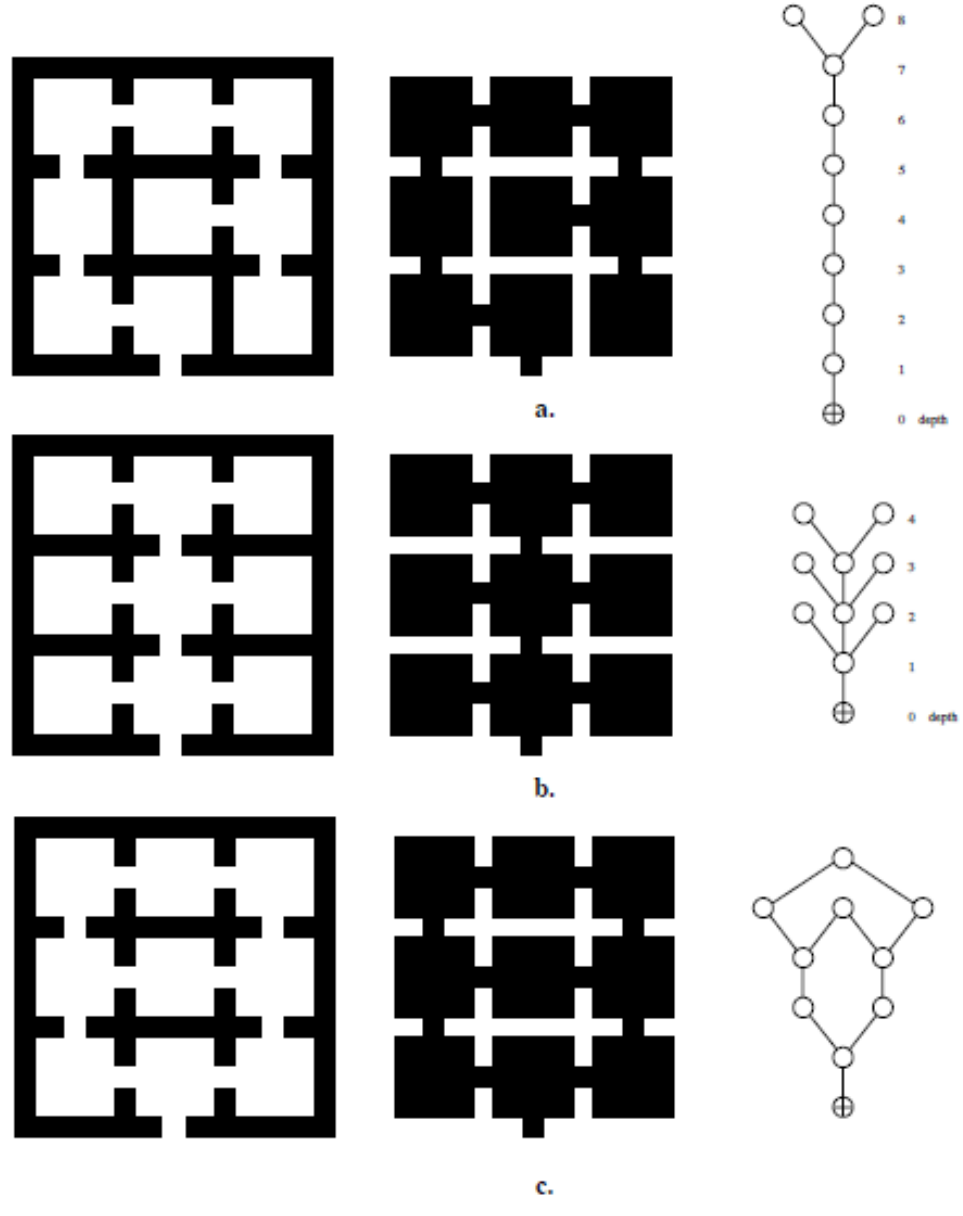
SPATIAL CONFIGURATION



Three spatial configurations a. b. c.: from a segregated to an integrated pattern.
The only variation is the location of doors (Hillier, 1996).

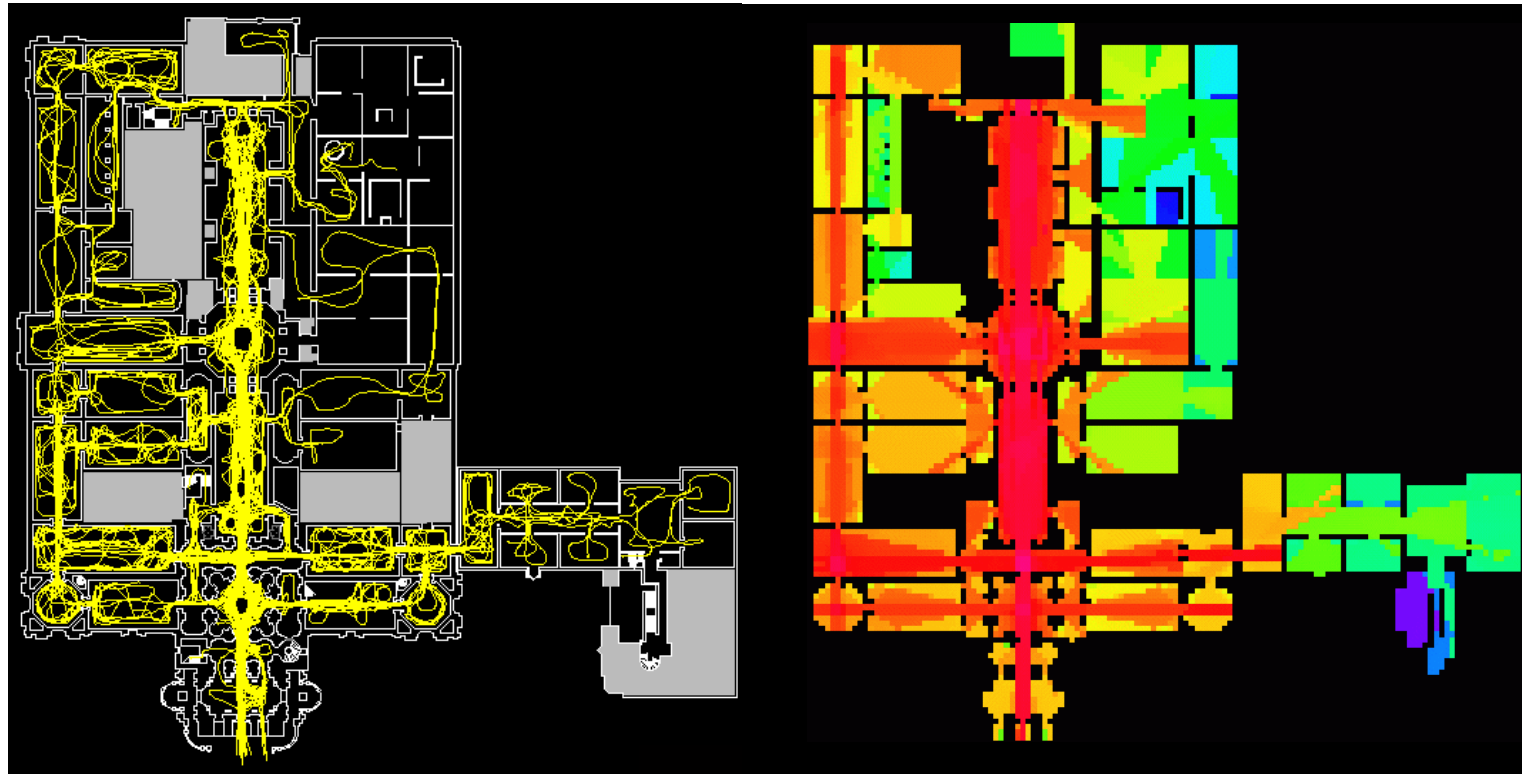
Três configurações espaciais a. b. c .: de um padrão segregado para um padrão integrado. A única variação é a localização das portas

THE REPRESENTATION OF MOVEMENT

Movement in space (or streets) plays a central role in space syntax.
As such, it is necessary to represent the movement potential of each space.
This potential is determined by the position of that space and the way it relates to other spaces in the system.
The potential can be verified in loco.

A REPRESENTAÇÃO DO MOVIMENTO

O movimento nos espaços (ou nas ruas) tem um papel central na sintaxe espacial.
Como tal, é necessário ser capaz de representar o potencial de movimento que cada espaço possui.
Esse potencial é determinado pela posição daquele espaço e pelo modo como se relaciona com os outros espaços no sistema.
O potencial pode ser verificado por meio de contagens reais.



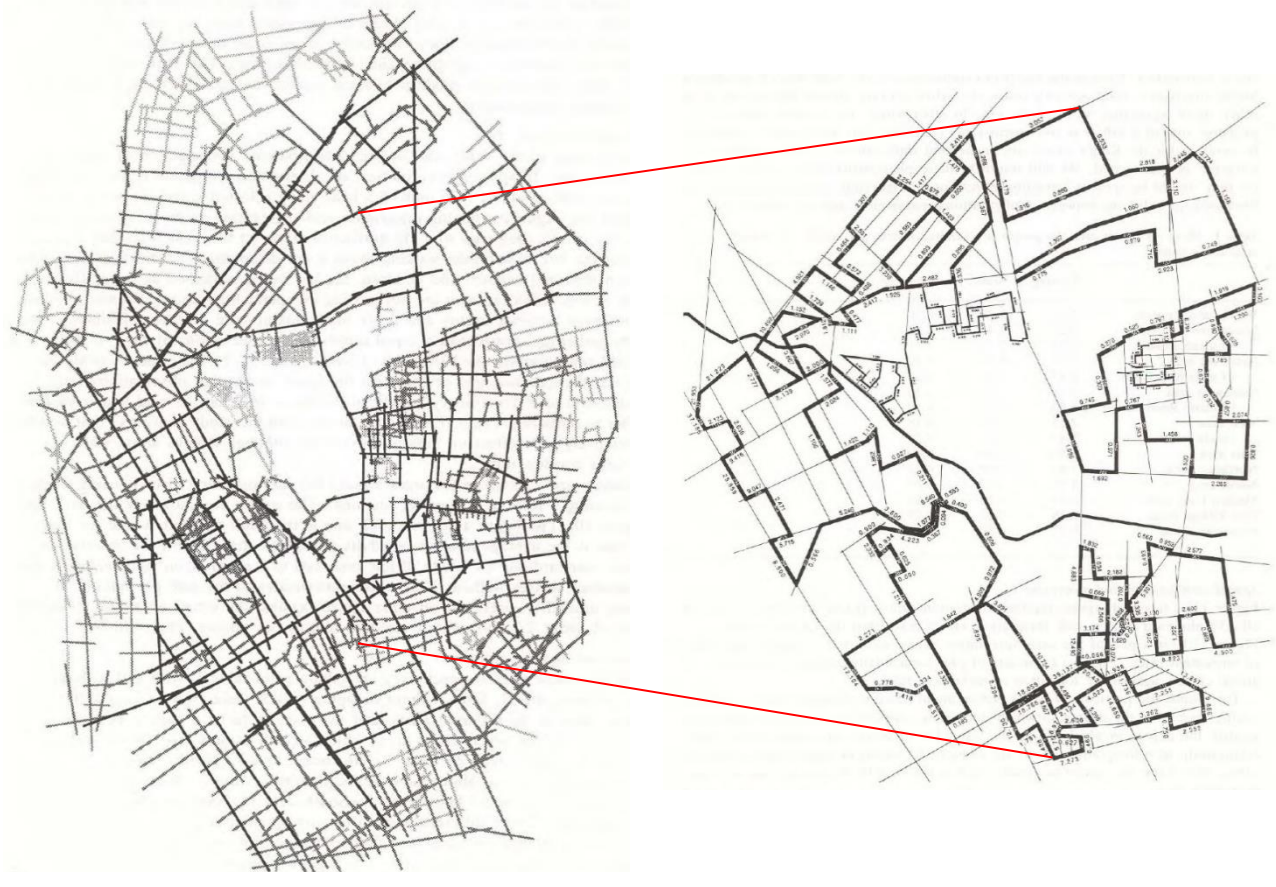
Tate Gallery: real movement (100 people) and simulation movement (Hillier, 1996).

QUANTITATIVE REPRESENTATION

This method of analyzing a building can be used in the city.
The representation of the movement potential is a visual and numerical representation.
Each of the streets in the left map (movement potential in gray) corresponds to a numerical value.
In the right map, in each street section, the number of moving adults per 100 m is represented.

UMA REPRESENTAÇÃO QUANTIFICADA

Este método de análise de um edifício pode ser extrapolado do edificio para a cidade.
A representação do potencial de movimento é uma representação visual, mas também é uma representação numérica.
A cada uma das ruas no mapa à esquerda (potencial de movimento a cinza), corresponde um valor numérico.
No mapa à direita, em cada troço de rua, é indicado o número de adultos que se movem por 100 m.

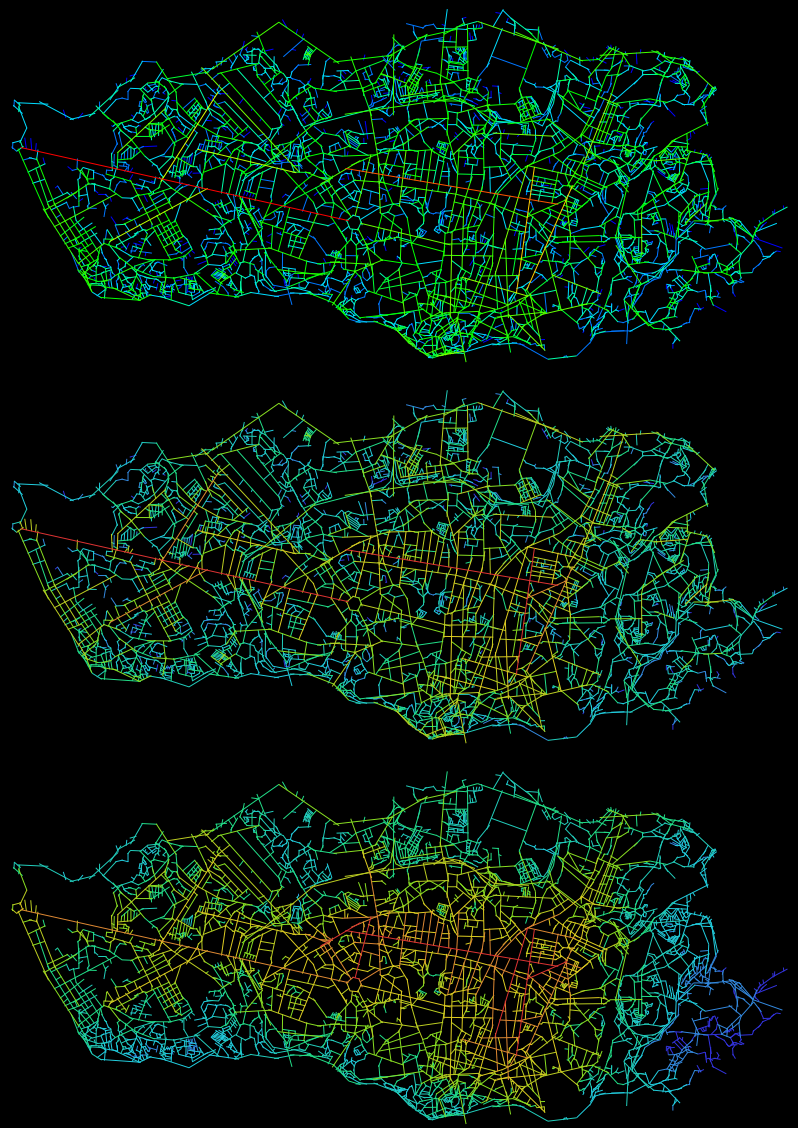


King's Cross, London: simulation movement and real movement (Hillier *et al.*, 1993).

SYNTATICAL MEASURES

MEDIDAS SINTÁTICAS

Variation of radius . Variação do raio



Porto. Potential of movement / system accessibility: variation of radius: 1, 3, *n*.

Space syntax also shows that the movement associated with each street can be divided into two types: **to-movement** and **through-movement**.
The first is associated with an idea of **centrality**, the second is related to an idea of **hierarchy**.

-

A sintaxe espacial também nos mostra que o movimento associado a cada rua pode ser dividido em dois tipos: **movimento de destino** e **movimento de percurso**.
O primeiro está associado a uma ideia de **centralidade**, o segundo está relacionado a uma ideia de **hierarquia**.

The street system of a city is a **dual network**.

On the one hand, there is a **foreground network**, which represents a main structure of the city, consisting of a reduced number of longer streets.

On the other hand, there is a background network, corresponding to a network of greater proximity, composed by many shorter streets.

-

O sistema de ruas de uma cidade é uma **rede dual**.

Por um lado, existe uma **rede de primeiro plano**, que representa a estrutura principal da cidade, composta por um número reduzido de ruas mais longas.

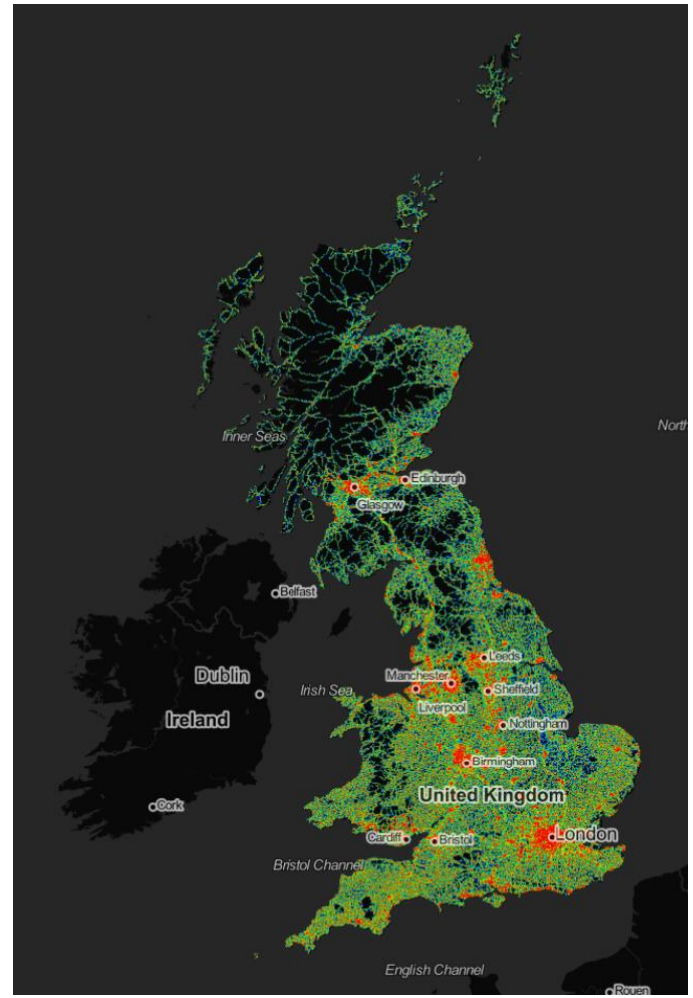
Por outro lado, temos uma **rede de fundo**, que corresponde a uma rede de maior proximidade composta por um grande número de ruas mais curtas.

MULTIPLE SCALES

The focus on a single urban form element and a single criterion, allows dealing with different scales with few methods. This simplification allows moving from the analysis of a small public space to the analysis of an entire country.

ESCALAS MÚLTIPLAS

O foco num único elemento da forma urbana e num único critério, permite lidar com escalas diferentes com poucos métodos. Esta simplificação da realidade permite ir da análise de um pequeno espaço público à análise de um país inteiro.



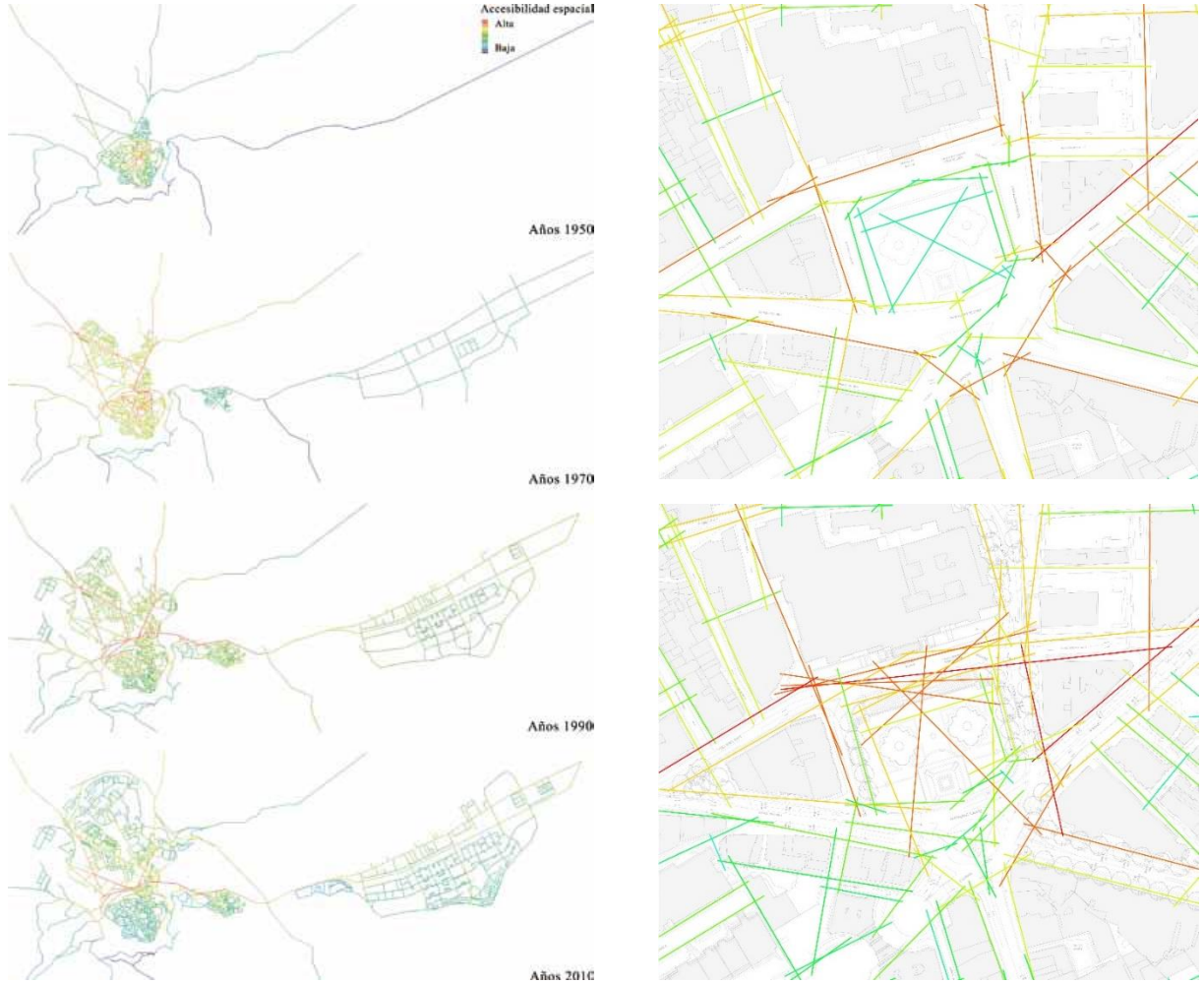
Nottingham Old Market Square (left), Great Britain (right) (https://spacesyntax.com).

PAST, PRESENT AND FUTURE

PASSADO, PRESENTE E FUTURO

The focus on streets (and the understanding of this element through historical cartography) allows space syntax to study the structure of a city in the past, or even to reconstruct its evolution over time.

O foco nas ruas (e a facilidade de compreensão desse elemento através da cartografia histórica) permite que a sintaxe espacial estude a estrutura de uma cidade no passado, ou mesmo reconstrua a sua evolução ao longo do tempo.



Evolution of Toledo (1950-2010). Trafalgar Square, London: before and after the intervention (Arnaiz et al., 2013; https://spacesyntax.com/).

On the other hand, the modeling of movement potential allows space syntax to evaluate different alternatives for future transformation of the street system.

Two aspects should be highlighted:

Space syntax does not ‘draw’ new proposals; proposals are drawn by architects or planners, and then evaluated using spatial syntax.

Spatial syntax is neither ideological nor normative; the framework for the evaluation of new proposals is given by the way each one relates to the existing city, whether in a closer or a wider spatial relationship.

-

Por outro lado, a modelação do potencial de movimento permite que a sintaxe espacial avalie diferentes alternativas para a futura transformação do sistema de ruas.

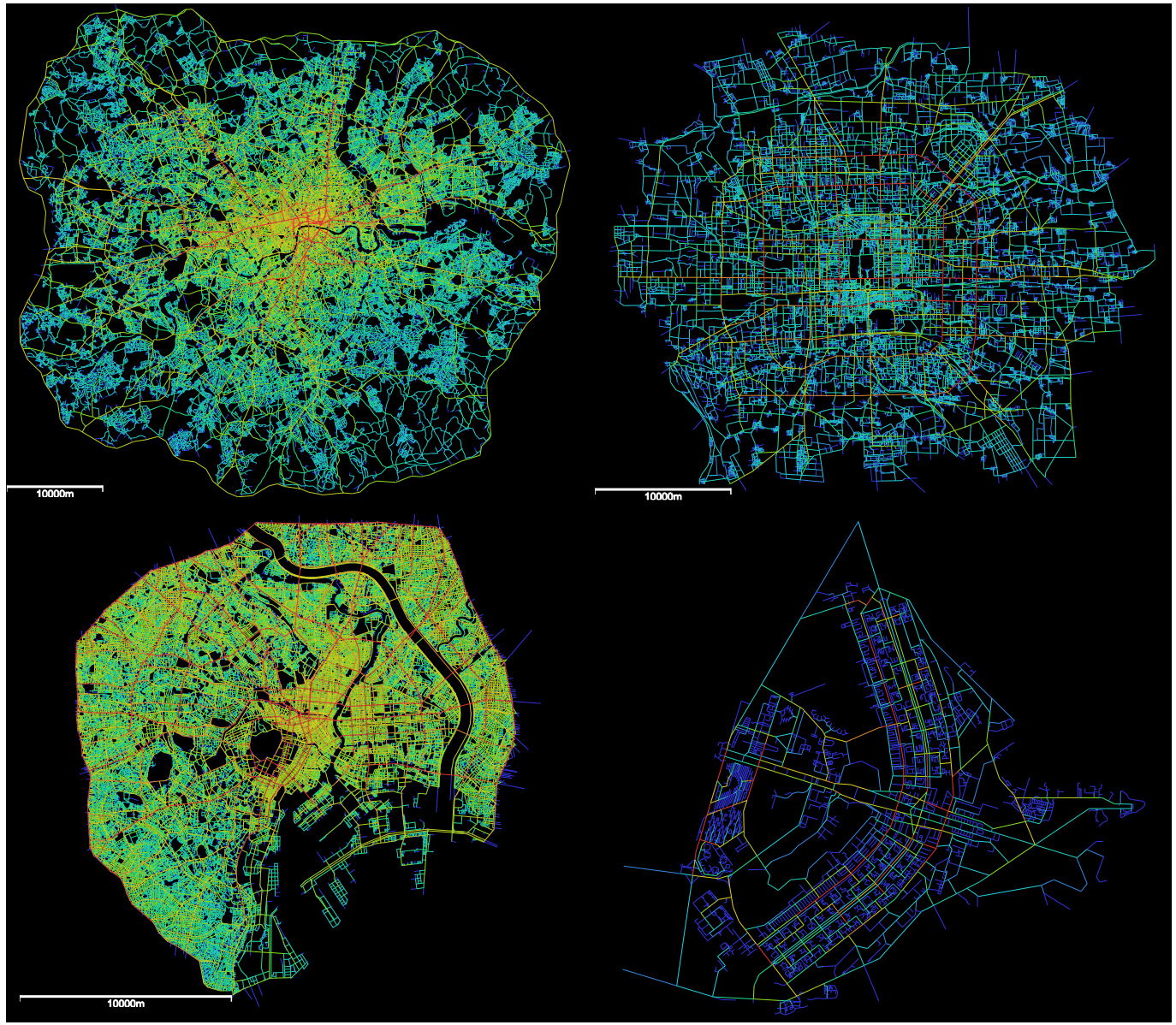
Dois aspetos a destacar:

A sintaxe espacial não desenha novas propostas; as propostas são desenhadas por arquitetos ou planeadores, sendo depois avaliadas através da utilização da sintaxe espacial.

A sintaxe espacial não é ideológica nem normativa; o enquadramento para a avaliação de novas propostas é dado pelo modo como cada uma se relaciona com a cidade existente, seja numa relação de proximidade ou mais abrangente.

COMPARATIVE STUDIES

ESTUDOS COMPARATIVOS



London, Beijing, Tokyo, Brasilia (Hillier, 2014).

Its clear and systematic method allows the use of spatial syntax in different geographical contexts and the subsequent comparison of results.
This allows: i. increasing the robustness of the method; and ii. increasing the knowledge on a case study in relation to others, realizing what is specific of that case, and what is common to others.

London and Tokyo have more balanced and less planned street systems:
in London, with a foreground network closer to a radial scheme;
in Tokyo, with a foreground network closer to a grid.
Beijing and Brasilia have more unbalanced road systems:
in both there is a very small number of streets with a high potential for movement, but it quickly moves from these streets to others with very low movement potential.
In Brasília, this is evident from the comparison of the two wings, north and south, with the various residential super blocks.

-

O seu método claro e sistemático permite à sintaxe espacial ser utilizada em diferentes contextos geográficos e a posterior comparação de resultados.
Isso permite: i. aumentar a robustez do método; e ii. aumentar o conhecimento de um estudo de caso em relação a outros, percebendo o que é específico do caso em análise e o que é comum a outros.

Londres e Tóquio têm sistemas de ruas mais equilibrados e menos planeados:
em Londres, com uma rede de primeiro plano mais próxima de um esquema radial;
em Tóquio, com uma rede de primeiro plano mais próxima de uma quadricula.
Pequim e Brasília têm sistemas viários mais desequilibrados:
em ambas há um número muito pequeno de ruas com alto potencial de movimento, mas rapidamente se passa dessas ruas para outras com potencial de movimento muito baixo.
Em Brasília, isso é evidente pela comparação das duas alas, norte e sul, com as várias superquadras residenciais.

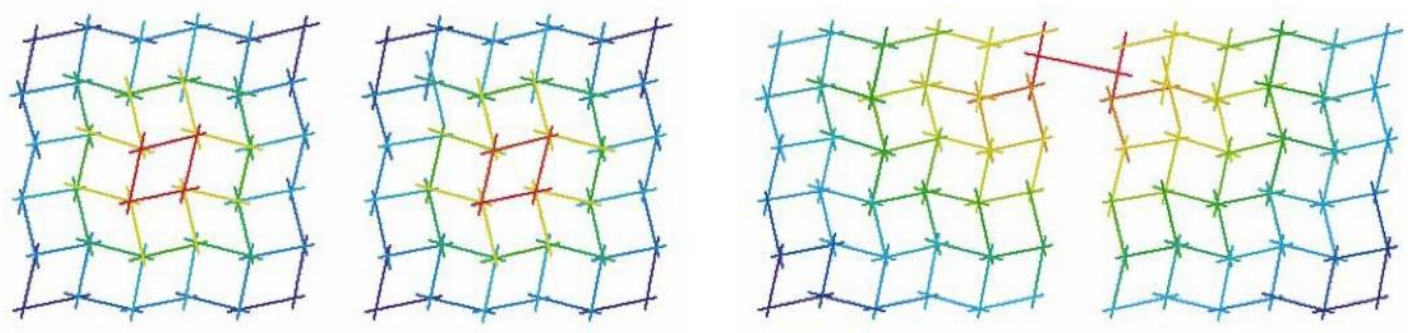
CRITICISM

The focus on a single element of urban form – excessive simplification.
The absence of three-dimensionality: topography and building volume.
The influence of limits on the results of analysis.
The predominance of form/space over function.
Domain of topological and angular measures over metric measures.
The process of construction of the axial map.

-

CRITICAS

O enfoque num único elemento da forma urbana - simplificação excessiva.
Ausência de tridimensionalidade: topografia e volume edificado.
A influência do limite nos resultados da análise.
A predominância da forma/espaço sobre a função.
Dominio das medidas topológicas e angulares sobre as medidas métricas.
O processo de construção do mapa axial.



Potential for movement in two urban systems, first considered as separate entities and then as one entity (Ratti, 2004).

RELATIONSHIPS WITH OTHER DIMENSIONS OF URBAN LIFE

Since its creation in the 1970s, addressing social problems in modernist housing estates, spatial syntax seeks to bridge the understanding of the physical dimension with other aspects of our urban life.

One of the most consistent lines of research, promoted by Laura Vaughan, has been gathering evidence on the relationships between patterns of spatial segregation and patterns of social segregation and poverty.

Another consistent line of research has been addressing the relationships between different types of spatial organization and different types of crime.

RELAÇÃO COM OUTRAS DIMENSÕES DA VIDA URBANA

Desde a sua criação nos anos 70, quando foi utilizada para compreender problemas sociais surgidos nos conjuntos habitacionais modernistas, a sintaxe espacial procura cruzar a compreensão da dimensão física com outros aspectos da nossa vida urbana.

Uma das linhas de investigação mais consistentes, promovida por Laura Vaughan, tem vindo reunir evidência sobre a relação entre padrões de segregação espacial e padrões de segregação social e pobreza.

Outra linha consistente tem vindo a abordar a relação entre diferentes tipos de organização espacial e diferentes tipos de crime.

Map of poverty in London, early 20th century, by Charles Booth, often used in Vaughan' s research (https://booth.lse.ac.uk/).

METHODS AND SOFTWARE

MÉTODOS E SOFTWARE

AXIAL MAP: Map made of the smallest set of axial lines that cover a system, in a way that each convex space is crossed by one of these lines.

AXIAL LINE: The longest line (representing visibility and movement) that can be drawn at one point in the system.

INTEGRATION (GLOBAL): Is the relative depth of each axial line to all other lines of the system.

INTEGRATION (LOCAL): Is the accessibility of each line up to three steps away.

CHOICE: Is the probability of a line to be used as the shortest path linking any pair of lines

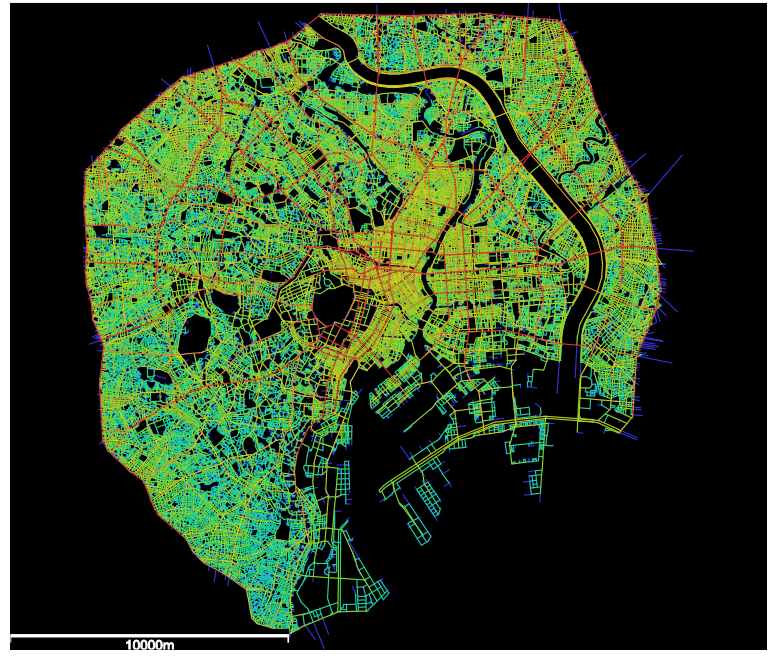
MAPA AXIAL: Mapa constituído pelo menor conjunto de linhas axiais que cobrem um sistema, de modo a que cada espaço convexo seja atravessado por uma dessas linhas.

LINHA AXIAL: A linha mais longa (representando visibilidade e movimento) que pode ser desenhada num ponto do sistema.

INTEGRAÇÃO GLOBAL: É a profundidade relativa de cada linha axial a todas as outras linhas no sistema.

INTEGRAÇÃO LOCAL: é a acessibilidade de cada linha até três passos topológicos.

ESCOLHA: É a probabilidade de uma linha ser utilizada como percurso mais curto entre qualquer par de linhas.



Tokyo axial map (Hillier 2014)

‘DEPTHMAP’ SOFTWARE

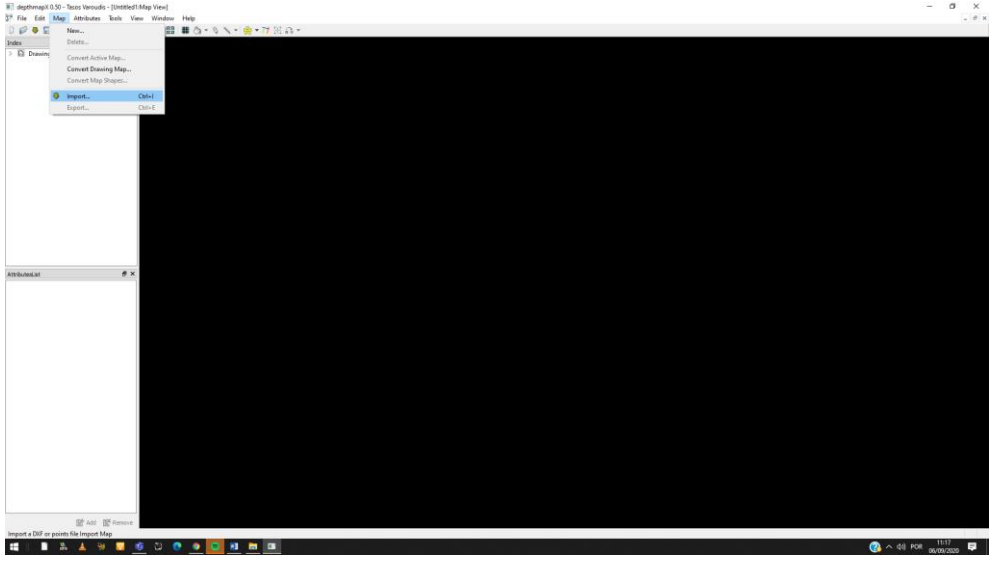
(https://varoudis.github.io/depthmapX/)

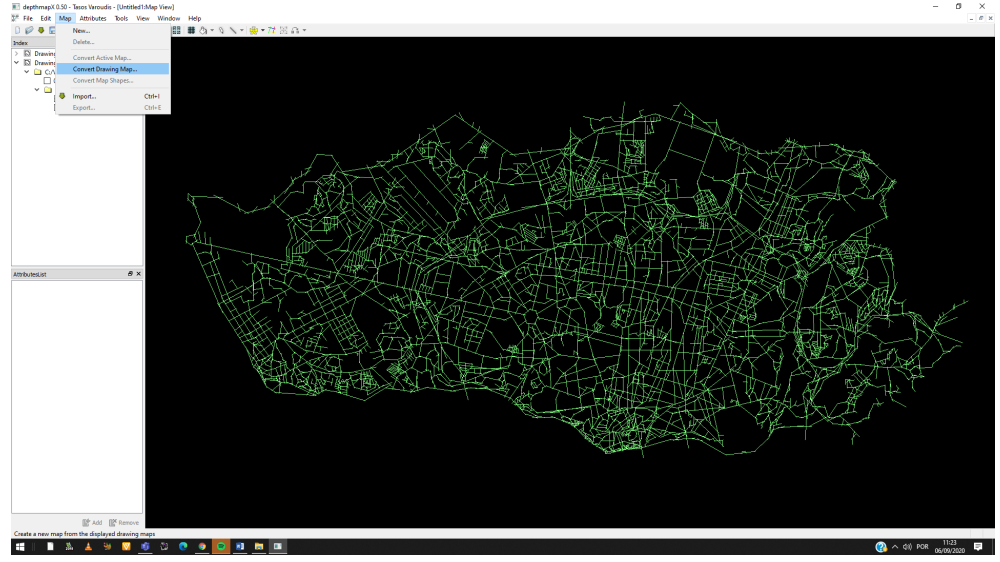
CONSTRUCTION OF THE AXIAL MAP

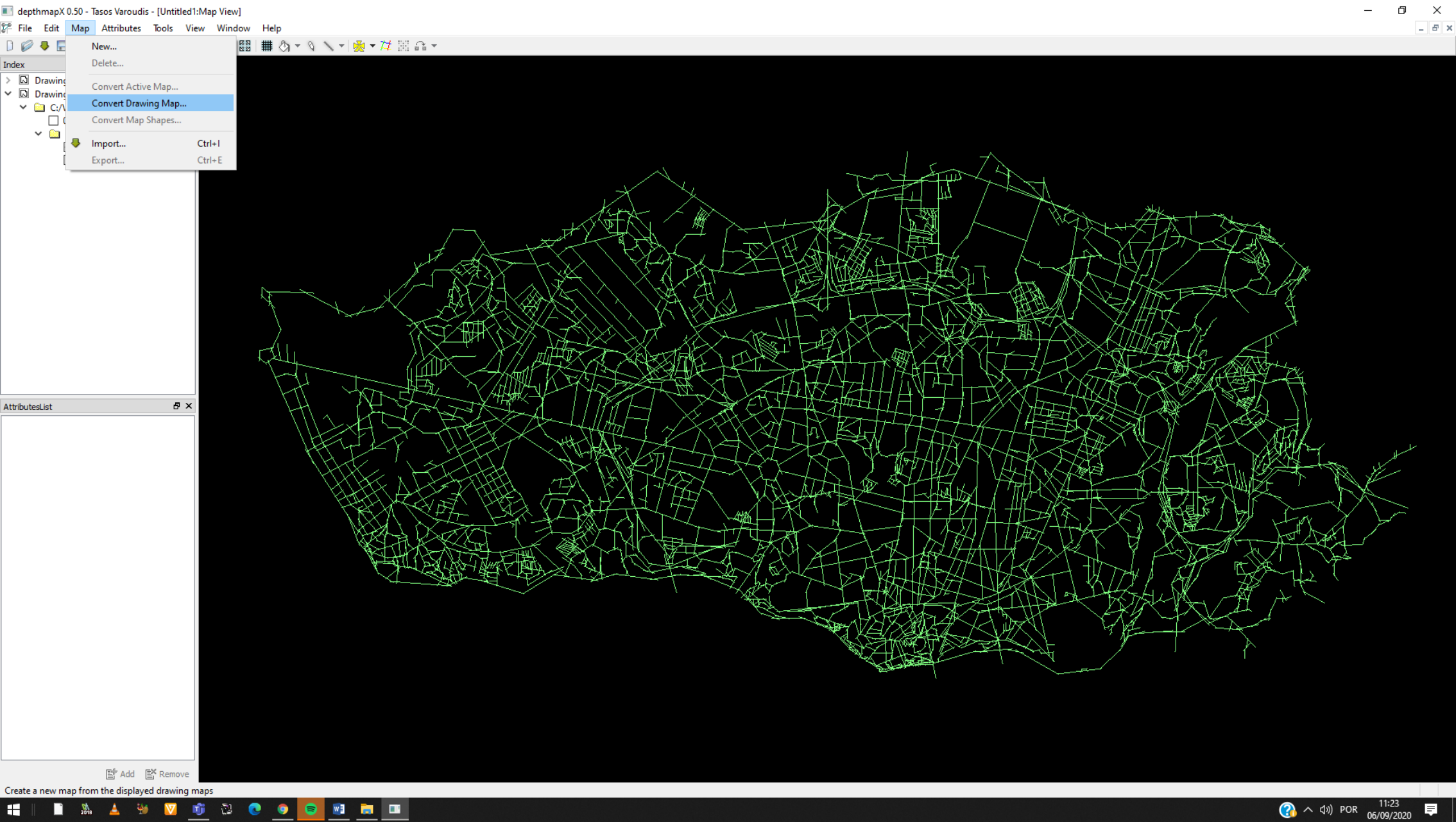
i. designing the axial lines over a map of streets, in Autocad; saving as dxf. files;
ii. import the drawing in Depthmap;
iii. **convert drawing map** into an **axial map (new map type)**;

CONSTRUÇÃO DO MAPA AXIAL

i. desenhar as linhas axiais sobre um mapa de ruas, no Autocad; salvar como arquivo dxf.;
ii. importar o desenho no Depthmap;
iii. converter o desenho num mapa axial;






depthmapX 0.50 - Tasos Varoudis - [Untitled1:Map View]
File
Edit
Map
Attributes
Tools
View
Window
Help
New...
Delete...
Convert Active Map...
Convert Drawing Map...
Convert Map Shapes...
Import... Ctrl+I
Export... Ctrl+E
Index
AttributesList
Add
Remove
Create a new map from the displayed drawing maps
POR
11:23
06/09/2020

‘DEPTHMAP’ SOFTWARE

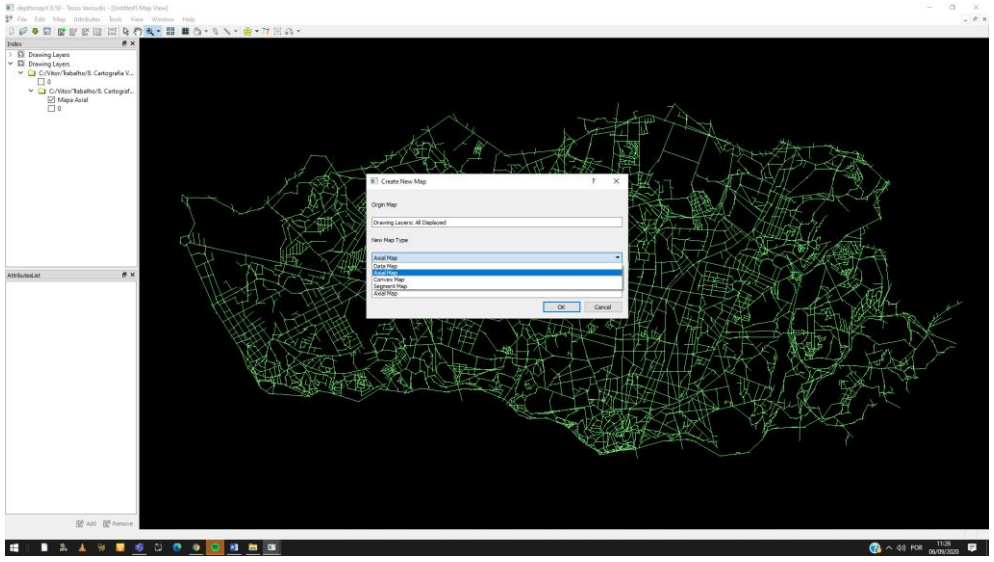
(https://varoudis.github.io/depthmapX/)

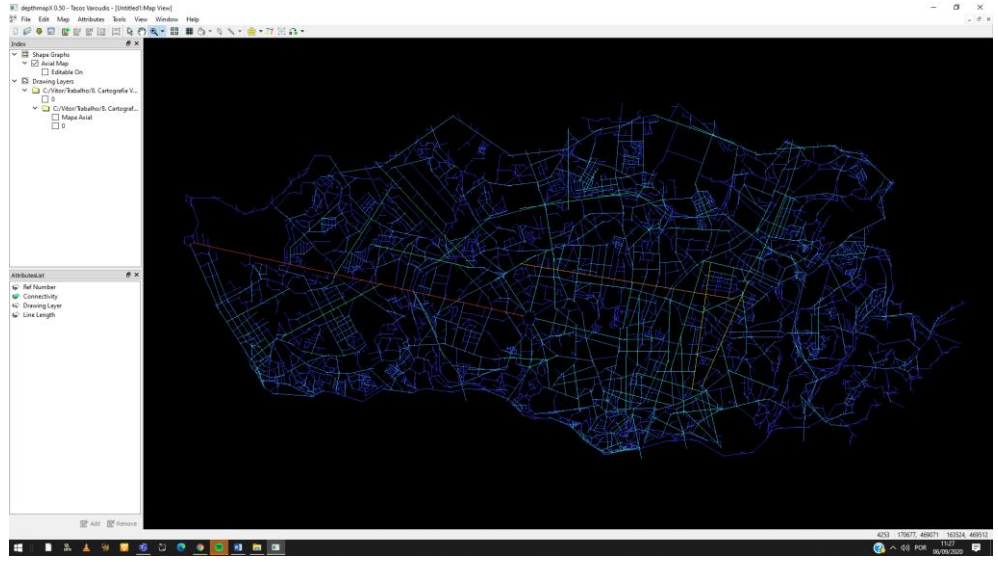
CONSTRUCTION OF THE AXIAL MAP

i. designing the axial lines over a map of streets, in Autocad; saving as dxf. files;
ii. import the drawing in Depthmap;
iii. **convert drawing map** into an **axial map (new map type)**;
iv. the new axial map as the following measures: connectivity and line length;

CONSTRUÇÃO DO MAPA AXIAL

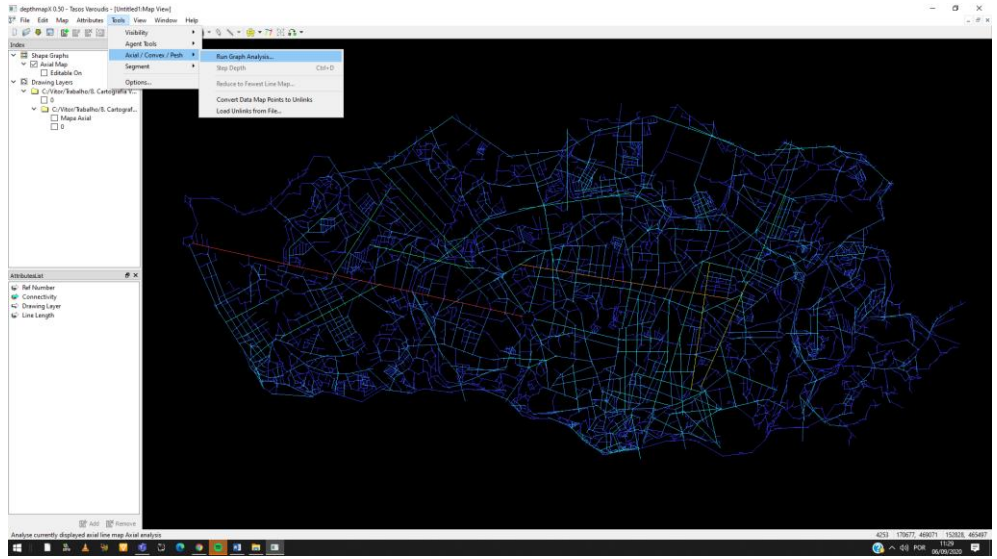
i. desenhar as linhas axiais sobre um mapa de ruas, no Autocad; salvar como arquivo dxf.;
ii. importar o desenho no Depthmap;
iii. converter o desenho num mapa axial;
iv. o novo mapa axial tem as seguintes medidas: conectividade e comprimento da linha;

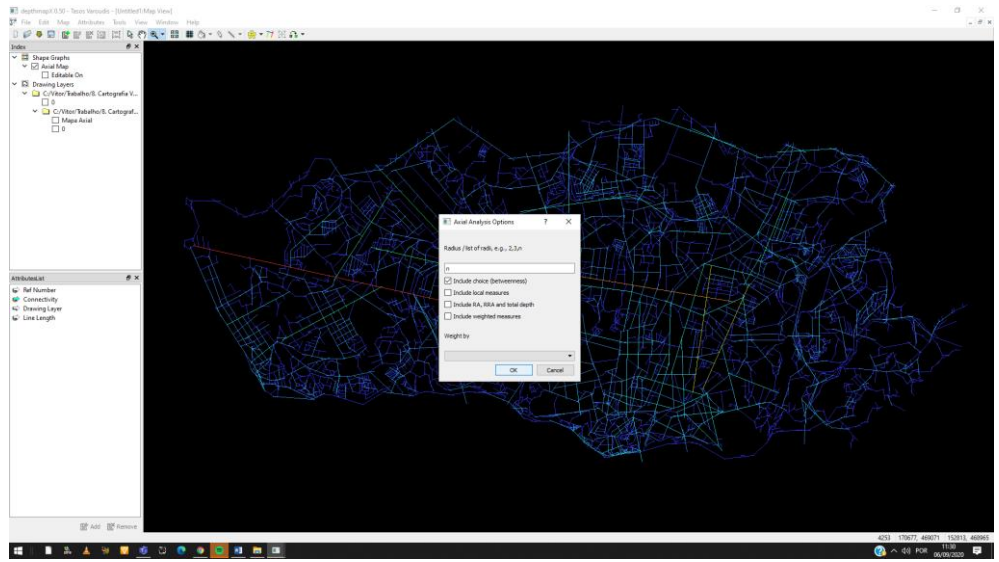


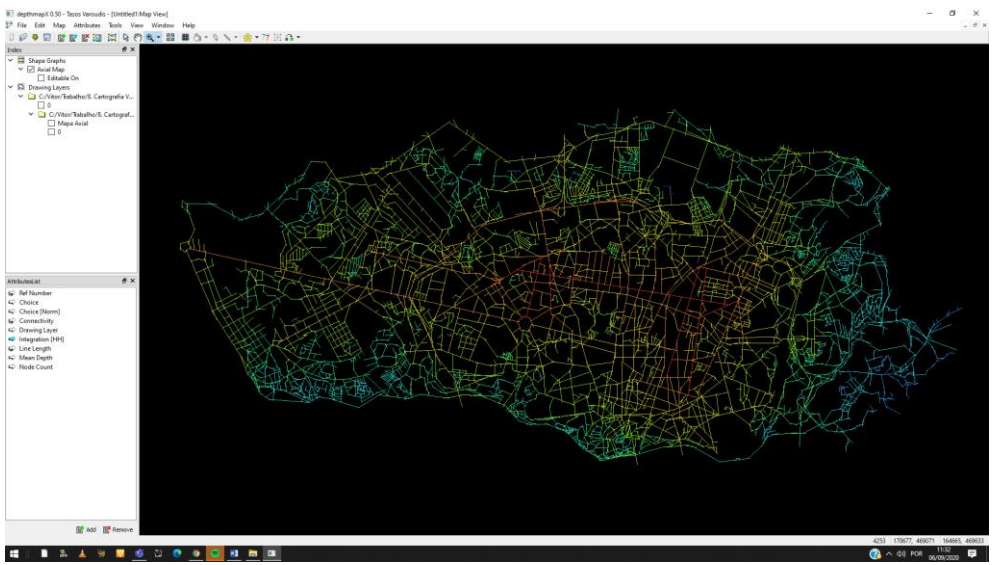


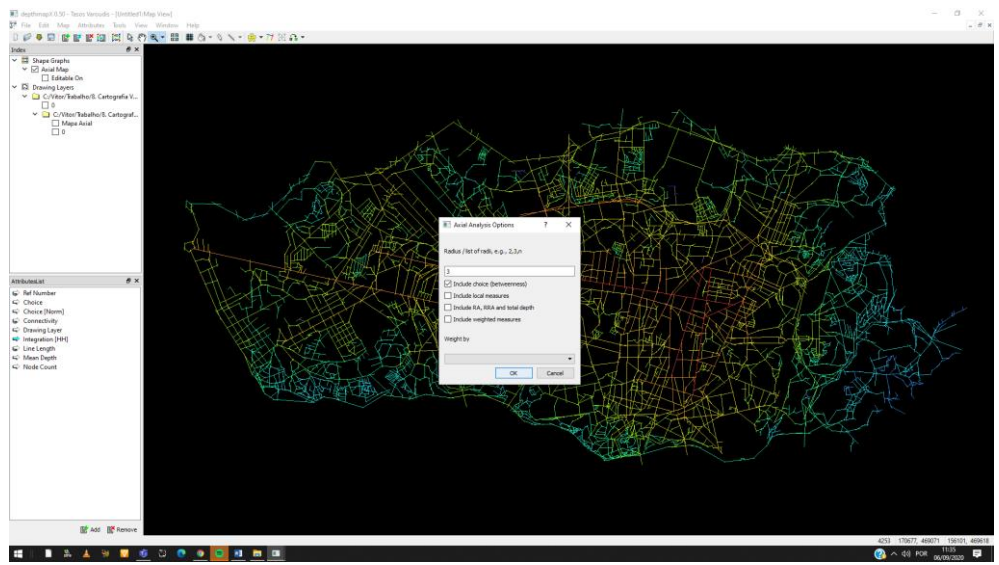
v. calculate the following measures (radius n): ‘integration’ and ‘choice’ (**tools – axial/convex/pesh – run graph analysis**)
vi. Calculate integration for a lower radius – example r3

v. calcular as seguintes medidas (raio n): ‘integração’ e ‘escolha’ (**tools – axial/convex/pesh – run graph analysis**)
vi. calcular a integração para um raio menor – por exemplo, r3



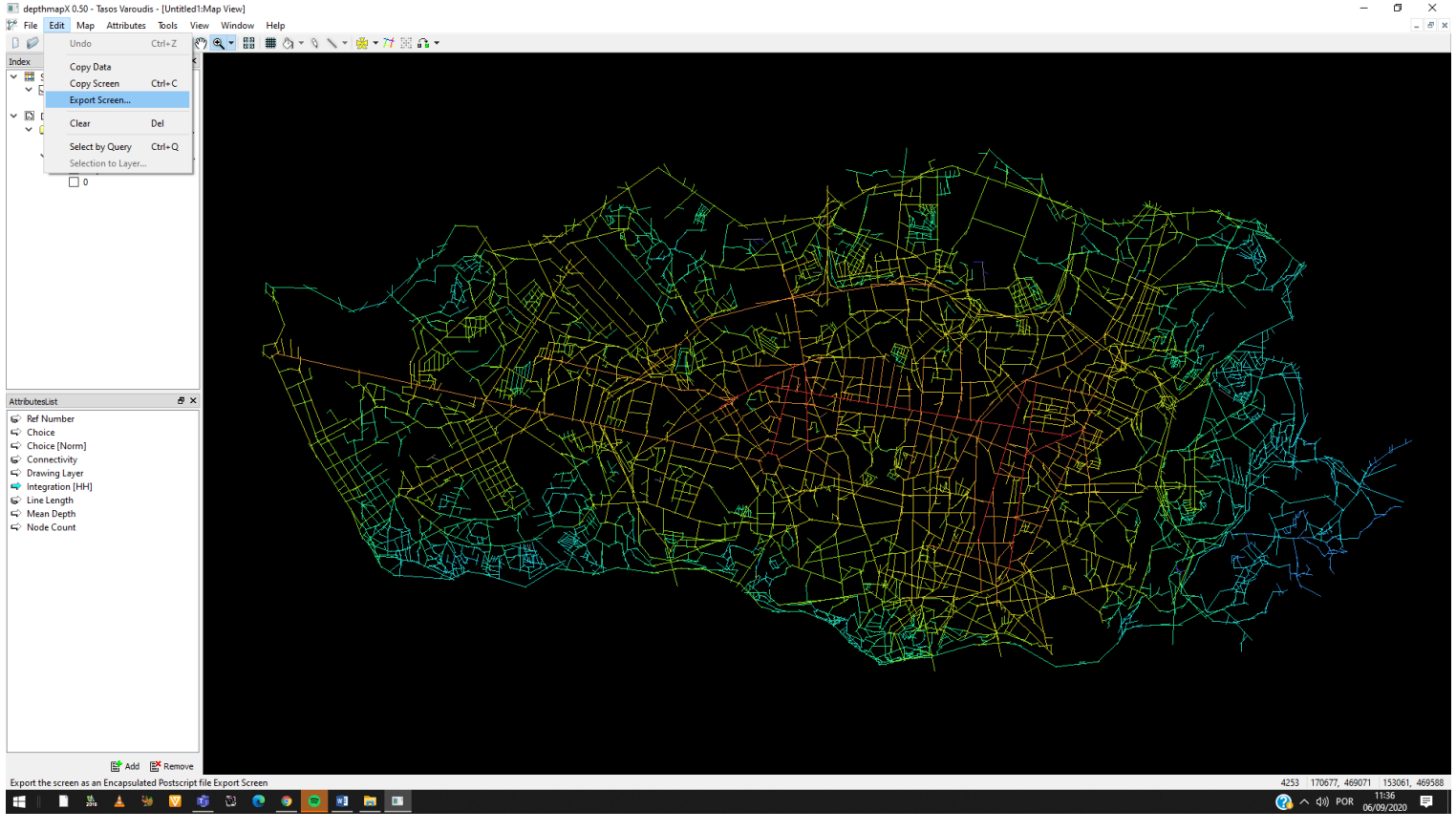






vii. **export screen** (map).

vii. exportar imagem (mapa).



EXERCISE

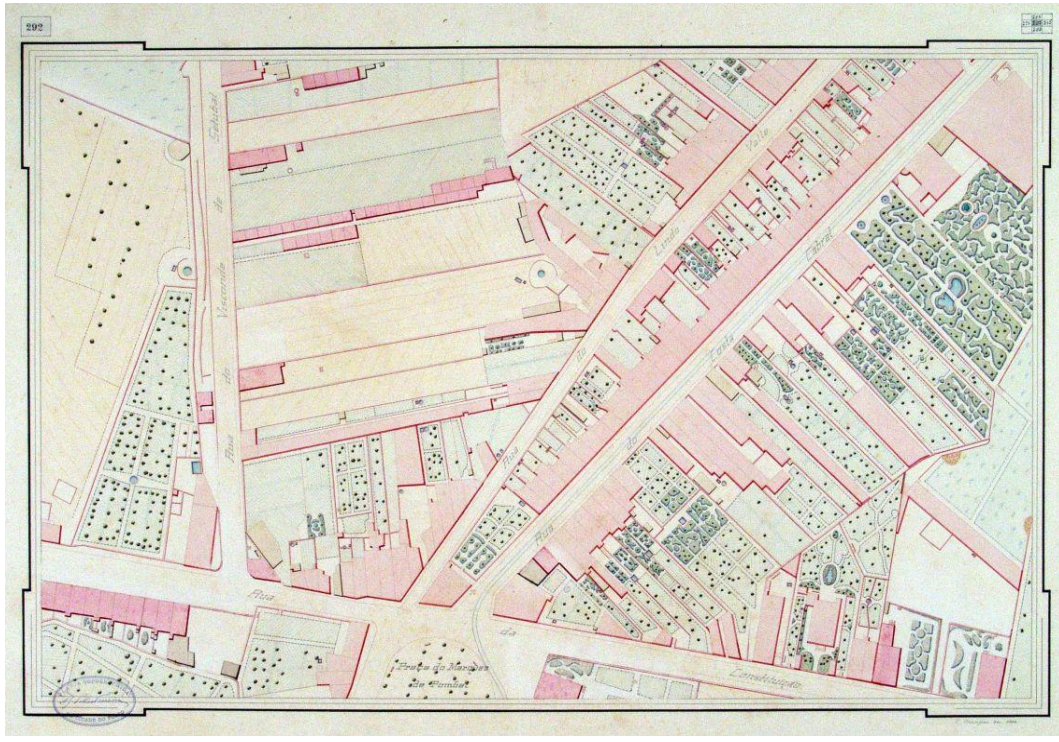
EXERCICIO

SPATIAL CONFIGURATION

CONFIGURAÇÃO ESPACIAL

A. Definition of the case study area (Rua de Costa Cabral, Porto – *Oliveira et al*., 2015)

A. Definição do estudo de caso (Rua de Costa Cabral, Porto – *Oliveira et al*., 2015)



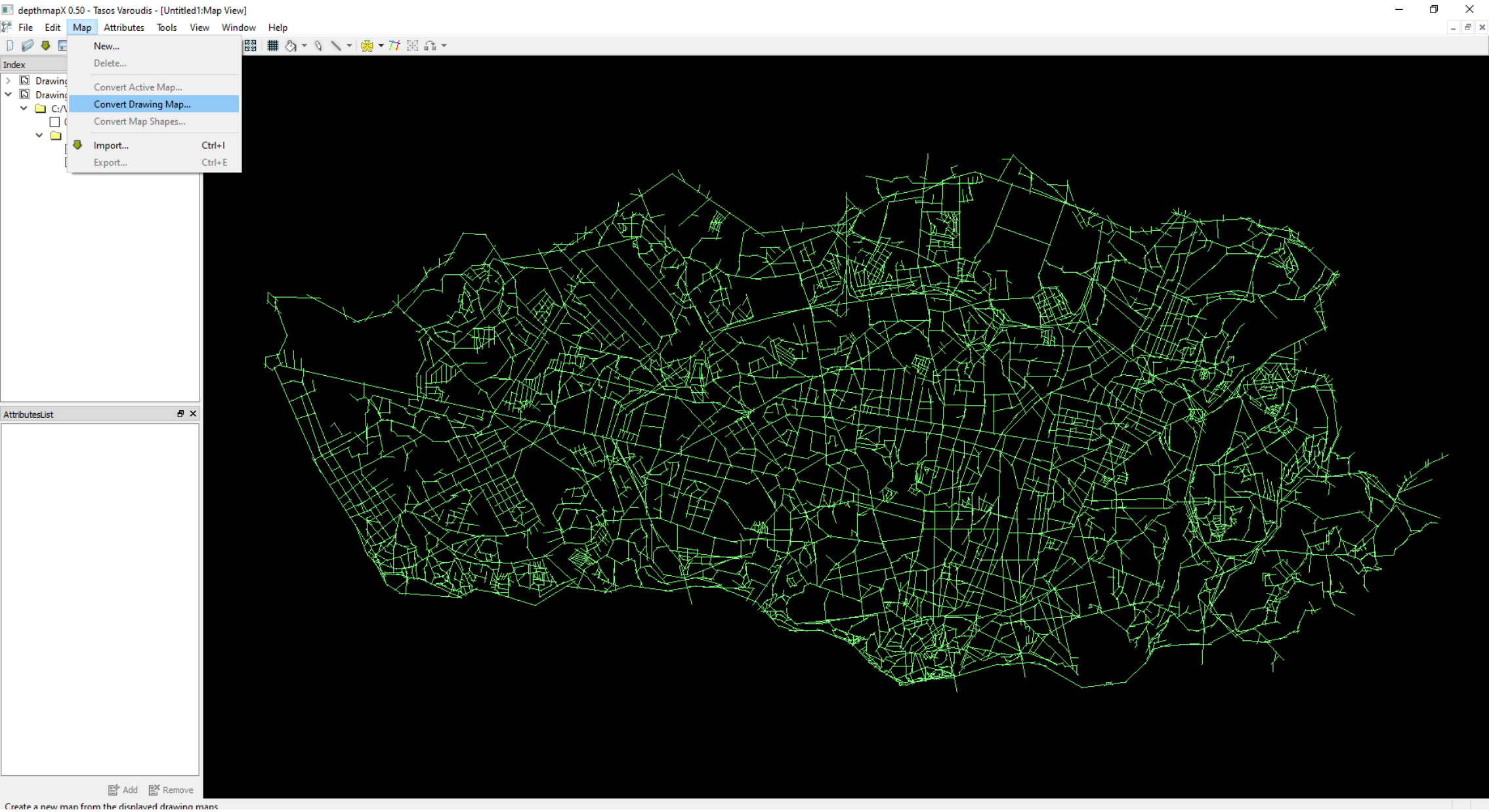
1892

Cartography

1892 *Planta Topográfica da Cidade do Porto* - Telles Ferreira
1903 *Planta da Cidade do Porto* - STCMP
1932 *Planta Topográfica da Cidade do Porto* - STCMP
1937 *Planta Topográfica da Cidade do Porto* - STCMP
1948 *Carta Militar de Portugal* - IGE
1960 *Planta Topográfica da Cidade do Porto* - STCMP
1978 *Levantamento Aerofotogramétrico* - DGPU
1992 *Cartografia Digital* - STCMP
1997 *Carta Militar de Portugal* - IGE
2010 *Planta da Situação Existente* - STCMP

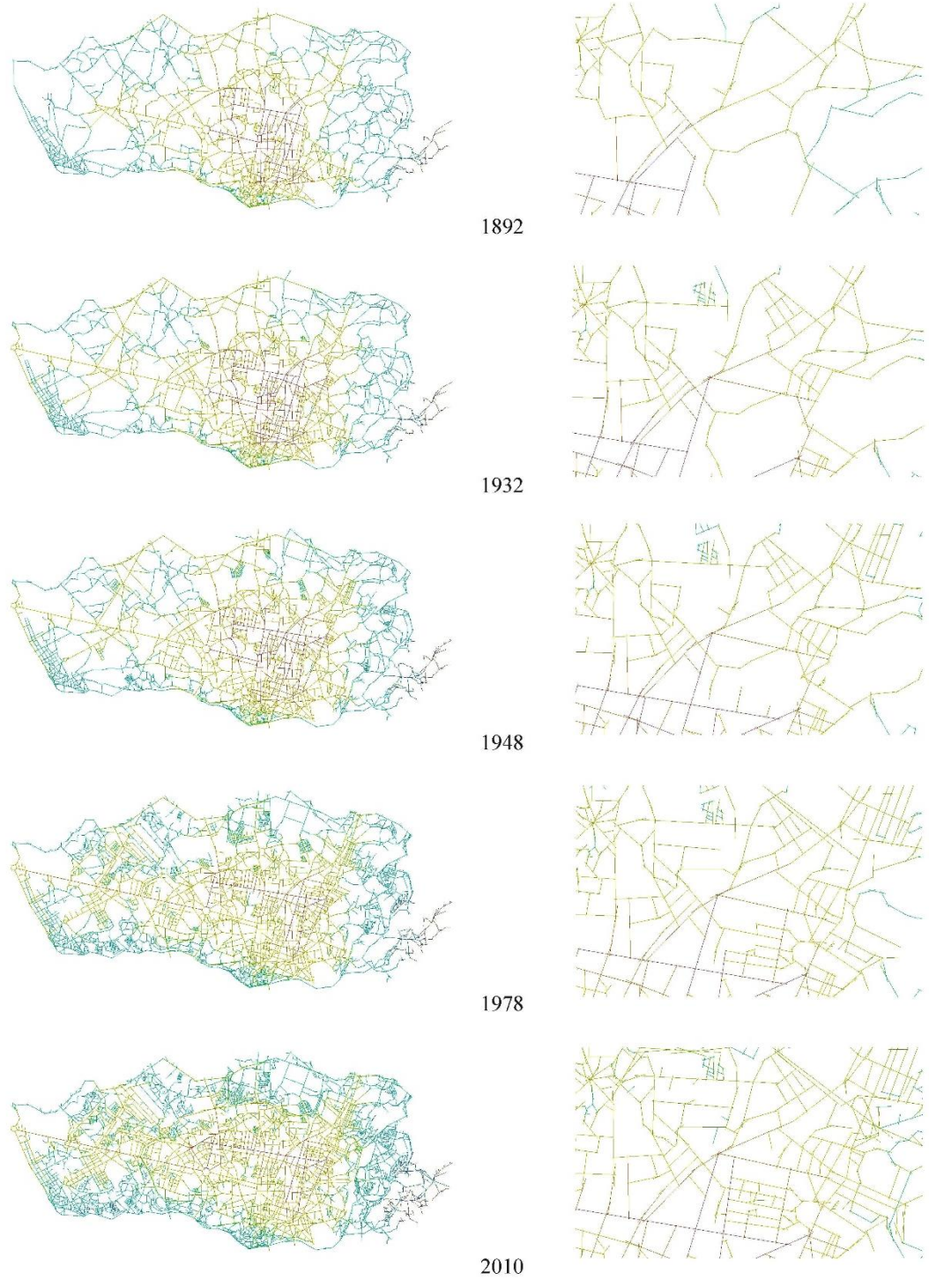
B. Identification of available material

B. Identificação de material disponível



C. Construction of the maps for the different time periods

C. Construção dos mapas para os diferentes periodos temporais


1892
1932
1948
1978
2010