The Town-plan as a Unifying Concept

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Abstract

How to address something so complex as the physical form of cities? The question has been at the centre of morphological debate in the last decades. Many theories, concepts, methods and techniques have been proposed to scientifically describe, explain and prescribe urban form; some of these offering a thorough understanding of the main agents and processes responsible for shaping that form over time. This paper proposes a reinterpretation of the town-plan as a unifying concept to address different scales, different kinds of landscape, and different periods of formation, and also to relate the physical form of cities with urban life, and scientific research with professional practice. The town-plan is addressed through the Morpho methodology. Porto Metropolitan Area, in Portugal, is used as an example to illustrate the main arguments of the paper.

Keywords

Urban Morphology, Urban Form, Town-plan, Morpho Methodology, Porto.

Introduction

Urban morphology is the study of the physical form of cities and of the agents and processes that continuously shape and re-shape that form over time (Oliveira, 2016; Kropf, 2017). The origins of urban morphology are in urban geography, in Central Europe in the turning from the 19th to the 20th century (Whitehand, 1981). Over more than one century, this field of knowledge has been formulating, developing and refining a number of theories, concepts and methods to capture the main aspects of the physical form of cities and their transformation.

Criticism on morphological theories, concepts and methods has many times focused on their 'ability to do something in particular, and the inability to do it in a different situation'. Critics have addressed, for instance, the capacity to effectively address a small town and the incapacity to grasp a whole metropolitan area; the skills to understand a 'planned' landscape and the incapability to deal with a settlement whose form results of many individual actions; and, also, the ability to capture the physical characteristics of an historical kernel and the inability to morphologically characterize a 21st century area. In addition, these theories, concepts and methods have been many times described as having an exclusively physical focus, with no apparent utility for the life of ordinary citizens, and as being too difficult to implement in the daily routines of planning practice.

Whitehand (1967) and Serra and Pinho (2013) offer evidence of the ability of morphological tools that have been formulated, or redefined, in small towns – Alnwick and Gassin – to address metropolitan areas (or even entire countries as proposed by Serra and Hillier, 2019). Amato (2017) and Iovene (2018) explore the use

of concepts formulated in the analysis of consolidated Italian cities in the study of informal settlements of Latin America. Dibble *et al.* (2017) demonstrate the use of the same morphological characteristics to analyse different parts of cities of different time periods and to explain an evolutionary process of urban form. Talen (2018) and Silva *et al.* (2017) offer comprehensive reviews on the impact of urban form on two crucial aspects of our daily life, social segregation and energy consumption. Oliveira (2020) gathers a number of contributions on how to effectively apply scientific morphological research into professional practice on planning, urban design and architecture.

This paper addresses these critics as a whole by proposing a reinterpretation of the town-plan as a unifying concept, capable of relating these different perspectives. The town-plan has been originally proposed by M.R.G. Conzen as part of the tripartite division of the urban landscape (Conzen, 1960). The town-plan is made of streets (including squares and gardens), plots and the block-plans of buildings. The other two elements of the tripartite division are the building fabric and the land and building utilisation. The potential of the concept is fully illustrated in the seminal book of Alnwick, which despite Conzen's original intentions has remained a study on town-plan analysis (Monteiro, 2017). The concept offers the stage for the creation and development of other concepts that address the way urban form elements are combined on the ground and how they evolve over time, notably the morphological region (Conzen M.R.G., 1975; Whitehand, 2009; Oliveira and Yaygin, 2020) and the fringe belt (Whitehand, 1972, 2019; Conzen M.P., 2009; Ünlü, 2013). Conzen (2018) offers a notable synthesis on town-plan analysis as a method for understanding the physical evolution and the present character of cities.

In this paper the town-plan concept is reinterpreted and developed through the Morpho methodology. Morpho has been originally proposed as a methodology to address the physical form of cities and first applied at the street scale in the city of New York (Oliveira, 2013). It has been subsequently developed and applied at the city scale (Oliveira and Medeiros, 2016) and later in the comparison of a large number of cities (Oliveira, Medeiros and Corgo, 2020).

The potential of the concept and method will be illustrated in Porto Metropolitan Area. Porto is the second most important city of Portugal and the centre of its metropolitan area. According to the last national census (2011), the city has about 237.000 people, while the metropolitan area has around 1.3 million people. This paper considers, not the so-called Greater Metropolitan Area of Porto with seventeen municipalities (which is mainly an administrative creation) but, the group of nine original municipalities that is more accurate to the extant situation. These are as follows: Póvoa de Varzim, Vila do Conde, Matosinhos, Maia and Valongo at north, Porto in the centre, and Gondomar, Vila Nova de Gaia and Espinho at south (Figure 1). The city of Porto and the metropolitan area have, respectively, approximately 101.000 and 490.000 families, meaning an average size of 2,4 and of 2,6 people per family. The city and the metropolitan area are made of about 44.000 and 273.000 buildings, consisting of around 138.000 and 625.000 dwellings – corresponding to an average size of 3,1 and of 2,3 dwellings per building.

The paper is in seven parts. After this brief introduction it sequentially addresses the five main topics identified above: different scales, different landscapes, different periods of formation, interaction between physical form of cities and urban life, and relation between scientific research and professional practice.

Figure 1. Porto Metropolitan Area.

Different Scales

Metropolitan scale

It is argued that the Morpho methodology is able to address urban form from the metropolitan to the city scale, and from this to the neighbourhood scale (Table 1). What should, then, be the most important urban form elements and characteristics to address at the metropolitan scale? It is claimed that the focus should be on the main stocks and flows of the metropolis.

Streets and plots – or buildings, if data on plots is not available – should constitute the elements of inquiry for this first layer of analysis. Furthermore, it is argued that the main variations of the physical form of the metropolitan territory would be justified by variations in the density of streets (or more specifically of nodes and segments) and in the density of plots (or buildings) per street-block. The former gives a potential of flows interaction and the later gives a potential of the diversity of urban actors and strategies. The analysis of the density of nodes (with a focus on 4-ways nodes) and segments can progress into an inquiry of the spatial accessibility of the street system (Hillier and Hanson, 1984; Hillier, 1996).

Figure 2 is the segment map of Porto Metropolitan Area, and represents integration at radius 25,000 (see also Table 2). Integration measures the distance from each segment of origin to all others in a given radius, highlighting the most important centralities. Figure 3 is the density of buildings per street-block, per hectare. Both maps make evident, with considerable detail, the central role of the city of Porto in the metropolitan area, and within the city, its central part limited by the inner ring road. Both maps highlight a number of axes (made of streets and buildings) leading to north, east and south. While in the segment map this is made of traditional and new streets (usually motorways), the map of buildings density reveals mainly the traditional structure, closer to what would be a map of integration calculated for a lower radius. Matosinhos, as a whole, and Gaia, in the northern part of the municipality have high values for both criteria. On the contrary, Vila do Conde (except for its central parish) has low values for both streets and buildings. The map of buildings density – but not the segment map at this scale, only at a lower scale – highlights the values of the central parishes (with the municipalities names) of Póvoa de Varzim, Vila do Conde and Espinho.

Table 1. The town-plan and the different scales of analysis

	Town-plan				Building fabric	Land utilization
	Streets	Street-blocks	Plots (or buildings)	Block-plans of buildings		
Metropolitan	Accessibility of streets, density of nodes	-	Density of plots (or buildings)	-	-	-
City	Accessibility of streets, density of nodes	Density of street-blocks	Density of plots (or buildings)	Coincidence plot / building frontages (density)	-	-
Neighbourhood	Accessibility of streets, density of nodes	Density of street-blocks	Density of plot (or buildings), width of plot frontages	Coincidence plot / building frontages (density)	Relation building height / street width	Land and building utilization

Table 2. Different scales: metropolitan, city and neighbourhood

	Integration of streets (r25,000)			Size of street-blocks (%)			Density of Buildings (%)			Coincidence building/plot front.	
	Max	Ave	Min	Sma	Med	Lar	Hig	Med	Low	C+MC	NC+MNC
Porto metropolitan area	8135.8	4136.6	172.5	31,1	21,4	47,5	20,0	22,8	57,2	-	-
Porto city	8135,8	6235.2	3858.5	47,8	23,5	28,7	38,1	24,7	37,2	48,3	51,7
Caxinas neighbourhood	2386.2	2096.9	1715.9	55,3	36,8	7,9	81,6	7,9	10,5	73,7	26,3

Accessibility of streets: Max – Maximum, Ave – Average, Min – Minimum
Size of street-blocks: Sma – Small, Med – Medium, Lar – Large
Density of buildings: Hig – High, Med – Medium
Coincidence between building and plot frontages: C – Coincident, MC – Mostly Coincident, MNC – Mostly Non-Coincident, NC – Non-Coincident.

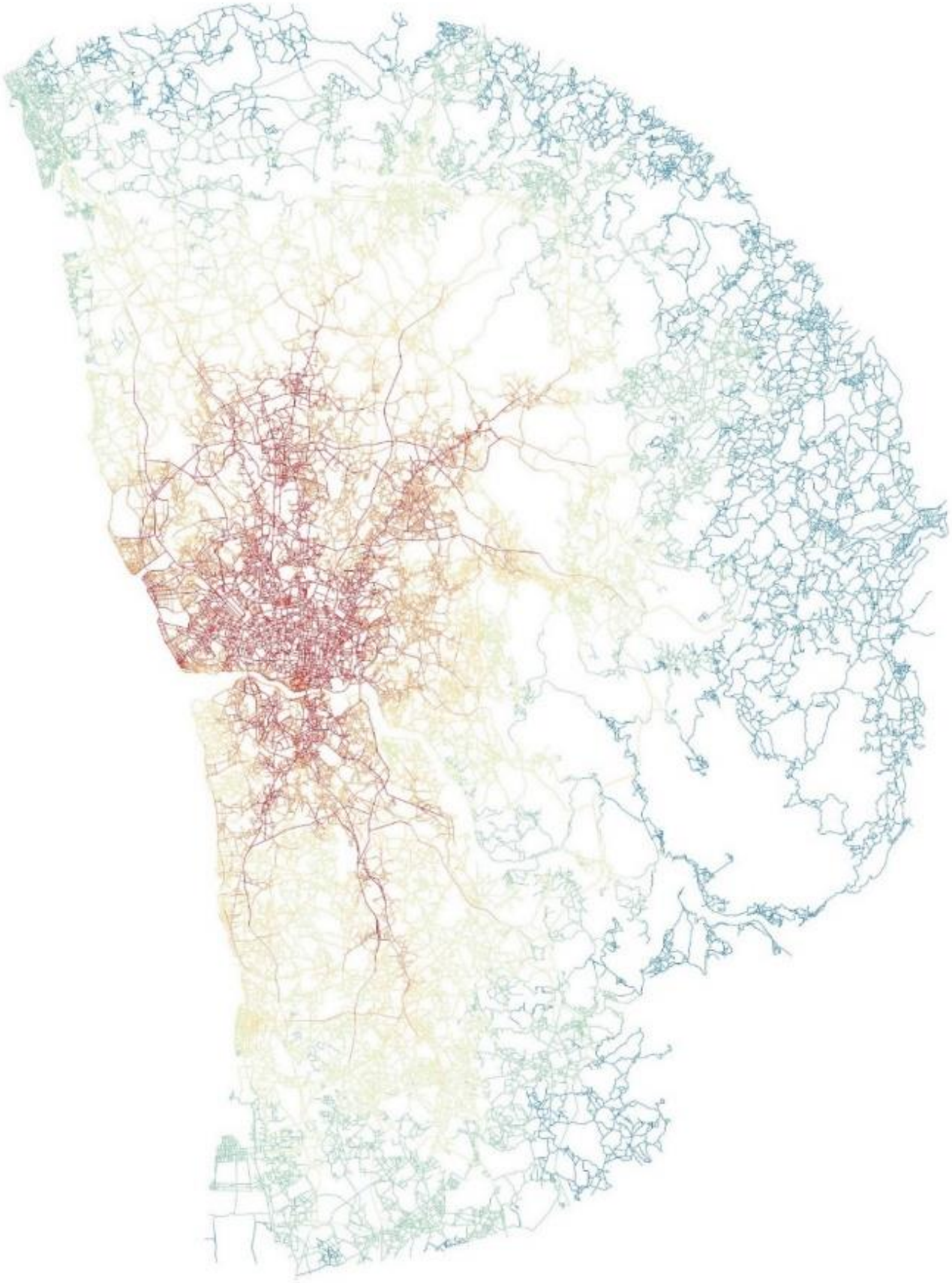

Figure 2. The segment map of Porto Metropolitan Area, and represents integration at radius 25,000 (see also Table 2).

Figure 3. Porto Metropolitan Area: map of density of buildings, per plot per hectare. The colour range goes from black (highest values) to grey and to white (lowest values).

City scale

At the city scale, the analysis should encompass streets, street-blocks, plots and buildings (Table 1). Density continues to be the main characteristic under inquiry, in a direct or indirect way. Firstly, Morpho measures the accessibility of the street system, using again the method of angular segment analysis and the measure of integration. Secondly, Morpho addresses the density of street-blocks. It considers six classes of size: under 5,000 m², 5,000-10,000 m² (these two fall under Siksna, 1997, classification of 'small'), 10,000-20,000 m² ('medium'), 20,000-50,000 m², 50,000-100,000 m², and over 100,000 m² ('large'). Thirdly, Morpho focuses on the density of plots (or buildings, when data on plots is not available), considering the number of plots per street-block and dividing it by the area of the street-block (measured in hectares). Six classes are defined: fewer than 1, 1-5, 5-10 (low density), 10-20 (medium density), 20-50, and more than 50 (high density) plots per hectare in each street block. Finally, the coincidence between building and plot frontages is addressed. More particularly, in each street block, it measures the number of plots where building and plot frontage is coincident and expresses it as a percentage. Four classes are considered: Coincident / C, Mostly Coincident / MC (coincidence in more than 50% of plots in a street block), mostly non-coincident / MNC (less than 50%) and Non-Coincident / NC. In terms of measurement procedure, one building within one plot is considered aligned if more than 50% of the building frontage coincides with the plot frontage.

The application of Morpho to the city of Porto reveals that the integration core (considering the metropolitan area for calculation of a 3,000m radius) is made of a dense central area organised around two east-west axes (Constituição and Boavista) and a number of north-south axes – Figure 4. Both the western and (particularly) the eastern parts of the city have lower values of integration. There is a dominance of 'small' street-blocks – almost half of the total number of street-blocks (Table 2). Density of buildings is more balanced. Yet, almost 2/3 of the street-blocks has a high or medium density of buildings. Finally, considering the street-blocks that are mainly or exclusively residential, it can be said that the street-blocks with non-coincident or MNC is slightly higher than the street-blocks with coincident or MC building and plot frontages. Previous investigation (Oliveira, Medeiros and Corgo, 2020) shows that, against the background of the 20 main Portuguese cities, Porto holds, together with Lisbon and Beja (located in the Alentejo region) the highest results for these four criteria taken together.

Figure 4. Porto: segment map, integration at radius 3,000; map of density of buildings, per plot per hectare. Source: the segment map has been kindly given by Miguel Serra; it has been published in Serra and Pinho (2013).

Neighbourhood scale

At the neighbourhood scale, the analysis of the ground plan is complemented with an inquiry to the main elements of building fabric and of land and building utilisation. Caxinas illustrates the application of Morpho at the neighbourhood scale. Caxinas is a fishing settlement with a long urban history and a strong identity and character, located in the northwest part of the Vila do Conde parish, in the municipality with that same name (see Figures 1, 5 and 6). It is one of the places with the highest building density as illustrated in Figure 3.

The relief of this settlement has no significant variations. The spatial accessibility of Caxinas is very high, not only when considering it at a neighbourhood scale of analysis, such as a 500m radius, but also when considering it at an urban scale, such as a 3,000m radius. The area has 53 street intersections; 24 of these are 4-ways nodes, which reveals a certain balance between accessibility and privacy. The area is made of 38 street-blocks. More than half of these is 'small' and only three are 'large' street-blocks (Table 2). 4/5 of these street-blocks has a high density of plots; only four have a low density of plots. In many occasions plot width is less than 5m. Building and plot frontages are coincident, or mostly coincident, in ¾ of the street-blocks.

Most of the 1,500 buildings that make this area have one or two-storeys. ¼ has three or four storeys, and only a small minority has five or more storeys. Most streets have between 7,5 and 15m width. While 85% of the buildings have exclusively a residential use, only six of the 38 street-blocks are exclusively residential and two street-blocks remain empty.

The two most vibrant streets of Caxinas are the seafront and the first parallel street – Dr. Carlos Pinto Ferreira. The latter is 1,000m long. The west and the east sides of the street are made of, respectively, 108 and 130 buildings, opening their doors directly into the street – including single-family houses, multi-family houses, restaurants and coffee shops, supermarkets and fruit shops, hairdressers, banks, to name the most important. This means that on average, and one each side of the street, there is one new building each 8m (as mentioned before many buildings have less than 5m width, with a two 'bays' façade – two doors or one door and one window in the ground floor, and two windows in the upper floors).

Figure 5. Caxinas aerial view (source: Google Earth).

Figure 6. Welcome to Caxinas (photograph by the author).

Different Landscapes

'Planned' landscapes

It is argued that, because of its focus on the most structural aspects of urban form, Morpho can be applied in the description of very different urban landscapes, from 'planned' to 'unplanned' (adopting a simplistic duality). One of the most successful planning cases in the urban history of Porto has been the construction of a number of streets outside the 14th century city walls, in the second half of the 18th century. The Junta das Obras Públicas was responsible for the opening of these new streets and for the regularization of existing paths, designing a street network that would be able to structure the process of urban development of the city until the end of the 19th century. The most iconic of these streets is Almada (which has the name of the first president of the Junta) – Figures 1 and 7.

Rua do Almada is 800 m long and 10 m wide. It links two different squares, Loios in the south and República in the north (República located 50m higher than the former). The street is part of the integration core of the street-system at the neighbourhood, city and metropolitan scales (Table 3). The street has six intersections, four 4-ways nodes and two 3-ways nodes, somehow reflecting the adaptation of the street structure to the rugged relief. Almada is made of ten street blocks and of 344 buildings. Street-blocks are mainly small or medium, and have medium- to high-density of buildings per hectare. Building and plot frontages are coincident in all plots.

2/3 of the buildings in Almada are three or four storeys high. The largest street block of this set includes 121 buildings. 58 of these face the Almada street (the other facing the surrounding streets). In a significant part of these buildings, frontage is about 5m and depth ranges between 20 and 90m. Over more than two centuries in the 'life' of these plots, buildings were conserved recurring to small maintenance works. Yet, eight buildings erected in the last decades of the 20th century can be found in these 58 plots. However, even in this set of eight buildings, seven were built in the original plots of the 18th century, and only one building was erected on a plot resulting from plot amalgamation (of two different plots). In Rua do Almada the establishment of a particular type of plot, long and narrow, led to the emergence of a particular type of building. Due to the reduced dimension of the plot frontage, the building type had to adopt an in-depth organization, usually with more than 15m depth. This in-depth organization of the building has led to the location, in each storey, of one (or two) room (s) near the two facades and of a staircase, and of one (or more) rooms in the interior of the building.

There is a high mixture of utilization, with predominance of mainly non-residential buildings (almost 2/3). There is also a mix between traditional (including a large number of hardware and cutlery shops, some hotels and one cinema) and new establishments (comprising restaurants and coffee shops, and clothing stores).

Unplanned landscapes

Gens is a small settlement in the parish of Foz do Sousa, in Gondomar (Figures 1 and 7). While the settlement size has been considerably small until the 1950s – only 20 buildings of the period remain – the major stage of development took place in the 1970s and 1980s. The relief has a significant variation, between 70m in the south-west limit and 130m in the east limit. The streets of the settlement are segregated, particularly at the city scale. The only exception, when analysed at the neighbourhood scale, seems to be the triangle formed by Castanheira and Central de Gens streets, at the centre of Figure 7b. The street system is made of more than forty 3-ways nodes and only three 4-ways nodes, revealing a high discontinuity of streets – framed by relief constraints and by the original rural structure – being now overlapped by motorways and their accesses (down left, Figure 7b). Street width varies between 5 and 10m. Fifteen street-blocks have been identified; almost half of it being large street-blocks. About half of these street-blocks have low density of plots. While building and plot frontages are non-coincident or mostly non-coincident is all street-blocks, there is some coincidence in the two streets of higher integration (referred to above). Almost all 400 buildings have one to two storeys high (and 5% have three to four storeys). Gens is a residential area; almost all its buildings are exclusively residential.

Different Periods of Formation

Historical areas

Historical areas are different from new urban areas. The strengths, weaknesses, opportunities and threats each one has are singular. Yet, in physical terms, historical and new areas are made of the same elements – streets, street-blocks, plots and buildings. This sub-section focuses on the historical kernel of Porto. The first definition of the city, through a built wall (with four gates) was probably made in the sixth century. It comprised a church, a residential building for the clergy, a small market and a number of small houses. Outside the wall the land had mainly agricultural uses. In the fourteenth century, a new city wall (with sixteen gates) was built, including an overall area that was twelve times superior to the former. Contrarily to the former, built on the top a hill, the new walled area was in direct contact with the Douro river, that offers a notable setting for this urban landscape.

This analysis focuses on the area that was once contained by the second city wall (most of it demolished in the turning to the 20th century) – Figures 1, 8 and 9. Relief of this area, in a valley structure, has significant variations, ranging from the water level to 90m in the northeast part. The integration of these historical streets in the whole street system is high at the three scales of analysis considered in this paper, being slightly higher at the metropolitan and city scales than at the neighbourhood scale. The 'walled area' is made of 80 street-blocks and around 1,400 buildings. More than 4/5 of the street-blocks are 'small'– Table 4. 2/3 of the street-blocks have high density of plots; less than 1/5 has low density of plots – mainly made of open spaces and institutions, part of the 'inner fringe-belt' associated to the city wall 'fixation line', using historico-geographical terminology (Whitehand, 1981). Building and plot frontages are coincident, or mostly coincident, in all street-blocks (Table 4).

More than half of the 1,400 buildings is three or four storeys; 30% is one or two storeys, and 16% has five or more storeys. Street width is quite variable, being narrow in medieval streets and large in 19th and 20th century streets. Building height is usually higher than street width, creating the usual 'canyon' section of medieval cities. Mixture of uses exists in more than ¾ of the street-blocks; 14% is exclusively residential and 9% is exclusively non-residential.

While the tension between conservation and transformation should be seen as something that is not exclusive of historical areas, and should be framed by a coherent strategy for the whole territory, built heritage concerns should be higher in these areas (as in Rua do Almada addressed in the last section). It is argued that built heritage concerns should first focus on the town plan, maintaining streets, street-blocks, plots and the block-plans of buildings. Secondly, it should focus on building fabric promoting not only the conservation of facades but the elements that make the identity and authenticity of the building. The theme of prescription will be amplified in the sixth section of the paper.

Table 3. Different landscapes: 'planned' and 'unplanned'

	Integration of streets (r25,000)			Size of street-blocks (%)			Density of Buildings (%)			Coincidence building/plot front.	
	Max	Ave	Min	Sma	Med	Lar	Hig	Med	Low	C+MC	NC+MNC
Rua do Almada (Porto)	7113.7	6469.9	5856.4	40,0	30,0	30,0	40,0	40,0	30,0	100,0	0,0
Gens (Gondomar)	4185.3	3146.3	2528.5	40,0	13,3	46,7	26,7	26,7	46,6	0,0	100,0

Accessibility of streets: Max – Maximum, Ave – Average, Min – Minimum
Size of street-blocks: Sma – Small, Med – Medium, Lar – Large
Density of buildings: Hig – High, Med – Medium
Coincidence between building and plot frontages: C – Coincident, MC – Mostly Coincident, MNC – Mostly Non-Coincident, NC – Non-Coincident.

Table 4. Different periods of formation: historical and new areas

	Integration of streets (r25,000)			Size of street-blocks (%)			Density of Buildings (%)			Coincidence building/plot front.	
	Max	Ave	Min	Sma	Med	Lar	Hig	Med	Low	C+MC	NC+MNC
Porto historical kernel	7373.6	5928.8	4664.2	83,8	13,7	2,5	67,5	18,8	13,7	100,0	0,0
South Vila do Conde	2405.9	2175.5	1870.3	38,5	46,1	15,4	7,7	30,8	61,5	30,8	69,2

Accessibility of streets: Max – Maximum, Ave – Average, Min – Minimum
Size of street-blocks: Sma – Small, Med – Medium, Lar – Large
Density of buildings: Hig – High, Med – Medium
Coincidence between building and plot frontages: C – Coincident, MC – Mostly Coincident, MNC – Mostly Non-Coincident, NC – Non-Coincident.

Figure 7. Rua do Almada / Porto (a) and Gens / Gondomar (b) – aerial views, approximately at the same scale (source: Google Earth).

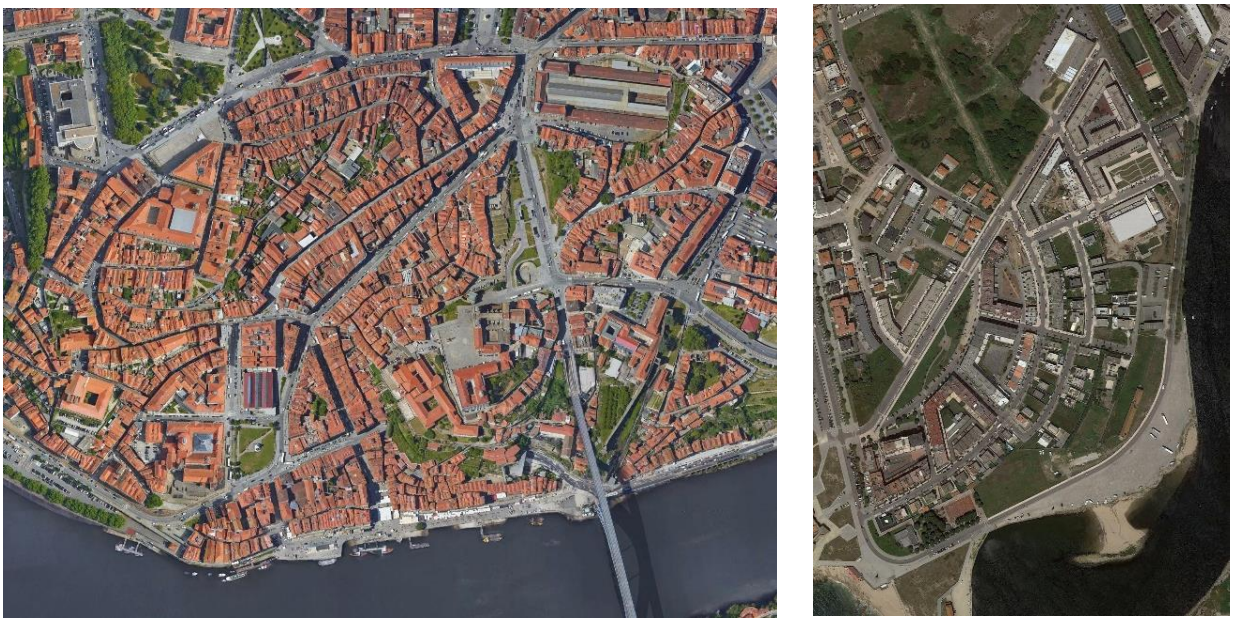

Figure 8. Historical area in Porto and new area in south Vila do Conde – aerial views, approximately at the same scale (source: Google Earth).

Figure 9. Historical kernel of Porto (photograph by the author).

Figure 10. Case studies 1, 2, 3 and 4 in Porto, from left to right: street views (photographs by the author).

New built-up areas

Porto Metropolitan Area is made of 130 parishes. In the most recent period covered by the national census, the parish with the higher number of new buildings was Vila do Conde. The analysis focuses on the southern part of this large parish, particularly at south of the diagonal axis Avenida do Castelo, developed in the two last decades (Figures 1 and 8). The natural setting for this urban landscape is exceptional, being at the river mouth of the Ave; relief is almost flat. Despite the close distance to Caxinas (a place of high integration), presented in the second section of this paper, the streets that make this area are poorly integrated in the whole street system in all three scales of analysis, particularly at the metropolitan scale (Table 4). The area is made of 26 street intersections, including only two 4-ways nodes, revealing the fragmented nature of the street layout. The area is made of thirteen street-blocks. More than 4/5 of these street-blocks are small- or medium-size. Almost 2/3 of these street-blocks have low density of plots. In more than 2/3 of the street-blocks buildings step back from the street.

More than half of these buildings are three or four storeys high; 30% have five or more storeys and 15% are one or two storeys. Street width is usually large, varying from 12 to 25m (in addition to the step back of buildings). Accordingly, street width is larger than building height, creating an 'open' section. In addition to the overall low number of plots, there is also a low number of building promoters creating a monotonous landscape. The area is almost exclusively residential. Only two of the 121 buildings have mixture of uses.

Physical Form of Cities and Urban Life

This section addresses the relation between urban form and daily life, based on the results of recent research (Oliveira, 2021). In particular, Oliveira (2021) focuses on the relation between the town-plan concept and a number of indicators of social and economic diversity and of environmental sustainability. Four small-scale case studies in the city of Porto have been selected for this exploratory analysis (Figure 10). Each case has a high homogeneity of urban form, and the four cases have a similar area, of about 16 ha. These cases have different patterns of urban form, and have been erected in different time periods – medieval (included in the historical area addressed in the last section), 19th century, first half of the 20th century, and second half of the 20th century.

Firstly, similarly to the previous sections, these cases have been described by a set of characteristics of town-plan elements – streets, street-blocks, plots and the block-plans of buildings. Secondly, the social and economic diversity and the environmental sustainability of the case studies have been investigated through the analysis of eight relevant indicators: diversity in education, employment and dwelling sizes; diversity in economic activities measured in terms of companies and workers; and consumption of land and energy. It was found that case studies 1 (medieval origin) and 2 (19th century formation), have higher values than cases 3 and 4, for both town-plan's criteria and social and economic diversity's and environmental sustainability's criteria. This exploratory research identifies this coincidence; it does not establish a causal relationship. To better realize the relation between physical form and urban life research needs to be extended to different scales and to different geographical contexts. Yet, these preliminary results encourage the development of this line of investigation, bearing in mind the understanding of the role of urban form in the promotion of sustainable places and communities.

Scientific Research and Professional Practice

It is argued that the elements applied in the description of different areas (in terms of scale, content and time formation), presented in the last sections, can be used in the prescription of their future transformation. Over the last decades, spatial planning has been mainly addressing land uses and some aspects of building volumes. Although these are important aspects, it is argued that these should not be the focus of planning practice. On the contrary, the focus should be on the most structural and persistent elements of urban form – streets, street-blocks, plots and the block-plans of buildings.

It is important to clarify that this two-dimensional view is far from the generic modernist 'plan' composition, usually simplistic, abstract and building-centred. On the contrary, this view recognizes the full complexity of the urban phenomenon. Firstly, in terms of the three-dimensionality of the natural support and of the plan influence on the building fabric and land uses. Secondly, in terms of the continuous accumulation of historical layers. All this is expressed with high permanence in the town-plan.

The way the system of streets, squares and gardens is organized in a city, as well as the density of its elements and its intersections, allowing more or less spatial accessibility, and thus favouring or hindering the flows of movement of its residents, workers and visitors, is a decisive factor in structuring a territory and in promoting effective urban cohesion. Each transformation of this system, given its high permanence in time, must be correctly evaluated. In the assessment of a new transformation, spatial accessibility should not be dependent of the regularity or the orthogonality (as opposed to curvilinear) of the

new streets, but on the way in which the new streets are proposed to be articulated with the existing system, reinforcing or weakening it. In addition, street design must change the focus from vehicles to people.

The definition of a street system is always associated with the conformation of a block system. In a way, the two systems correspond to the 'full' and 'empty' of the same object. The first system guarantees urban flows, the second provides support for the construction of building stocks. It is argued that urban stocks and flows should have high density. The smaller these blocks are (within certain limits), and the smaller the 'segments' defining the blocks are, the higher the possibility of spatial interaction is.

In each street-block, a high density of plots potentially corresponds to a high presence of agents and, as such, to a high diversity of urban strategies. The increase in plots size and the reduction in the number of agents has been one of the most significant changes that occurred in the 20th century in the physical form of Portuguese cities, with consequent losses in different aspects of urban life (Oliveira, 2020). In this sense, low density of plots per block should be avoided. On the contrary, the definition of small- and medium-width of plot frontages along a street corresponds to an effective valuation of each linear meter of contact between public (street) and private space (plot).

Each building to be erected on each of these plots will confirm its diversity potential. It should also actively contribute to the formal definition of the street as an attractive place for different modes of transport, particularly the pedestrian mode. In this sense, building and plot frontages should be as close as possible, or should be coincident. Additionally, this particular position of the building on the plot is the most advantageous option in terms of the definition of background open space.

After the definition of the main focus, it is important to identify the secondary focus. As above mentioned, planning practice has been primarily centred on the three-dimensionality of buildings and on land uses. In addition to a change in priorities (addressing firstly the town-plan), it is argued that these two issues (three-dimensionality and uses) must be reframed.

In relation to building fabric, the focus should be on the relationship between the height of buildings and the width of the street, introducing a concern with situations in which this relationship is excessively favourable to the second (street width, creating excessively 'open' sections – such as in the south of Vila do Conde parish, described in section 4) and exploring the possibility of a more favourable situation to the first (building height). Particular attention should also be given to the definition of the ground floor, due to its crucial importance for the definition of the street, as a central element of the physical form of cities. The density of doors along a street is a simple, but fundamental measure, to promote urban vitality. Also the presence of windows on the ground floor (possibly elevated, finding a balance between vitality and privacy) is another fundamental element to consider. The control of other elements related to the three-dimensionality of buildings, such as the design of the facade, the roof, the definition of materials or the structural organization of the interior (namely the position of staircases), should be done only in historical or urban areas of patrimonial interest – such as the historical kernel of Porto, described in section 4, or the 18th century's Rua do Almada, presented in section 3.

Finally, land and building utilization should also follow this logic of 'common sense', which is notably coincident with the results of scientific research. A phase of segregation of functions, developed throughout the 20th century, should be followed by a phase of functional mixture, that only safeguards the exceptionality of incompatible uses. This functional regulation should avoid the production of exclusively residential areas and exclusively non-residential areas, thus preventing the creation of areas without movement and, ultimately, without urban life.

Discussion of Results

It is not easy to address differences of scales, landscapes and periods of formation, and also the relations between physical form and urban life, and research and practice, in the scope of one single paper. Accordingly, the focus has been, and will continue to be, on the most essential aspects of these differences and relations.

The second section of this paper made evident the easiness of changing scales while maintain the focus on the town plan. Moving from the general to the particular, offering continuous detail of an overall perspective, the section started by briefly characterizing Porto metropolitan area, mainly based on the integration of the street system and on the density of buildings (Table 2, and Figures 2 and 3). This first metropolitan layer highlighted the central role of Porto. The zoom from metropolis to city revealed an increase of integration, and of the density of street-blocks and buildings. From the city, the paper then zoomed into a neighbourhood, Caxinas (one of the places with the highest building density in the metropolitan area). Maintaining the radius of analysis at 25,000, Caxinas has a lower average integration when compared with the average of the metropolitan area and the city of Porto. Yet, integration of Caxinas is very high when considering it at 500m and 3,000m radius. Caxinas has a higher density of street-blocks, and a much higher density of buildings and coincidence between building and plot frontages, when compared

to the metropolitan area and to Porto. More information was then added to the town-plan analysis of Caxinas, enabling a first characterization of its building fabric and land and building utilization.

One 'planned' landscape in the centre of Porto and one 'unplanned' landscape in the periphery of Gondomar have been addressed in the third section. Comparison of these two very different landscapes (Table 3 and Figure 7) made evident the strong differences between these two areas in terms of town-plan. The most expressive difference is the position of buildings on plots. Where in Almada all street-blocks have coincident building and plot frontages, in Gens is exactly the opposite. The difference in terms of integration in the street system is also expressive. Almada is one of the most integrated areas at any given scale, and Gens is always segregated, particularly at the intermediate scale of radius 3,000. Density of buildings and of street-blocks is higher in Almada than in Gens. Building height and mixture of uses is also higher in Almada than in Gens: the former is mainly made of three to four storeys' buildings of predominantly non-residential use; the latter is made of one to two storeys' residential buildings. It should be noted that while in this specific comparison, the 'planned' landscape holds higher values than the 'unplanned' landscape, that is not always the case. Just as an example, the southern part of Vila do Conde parish, presented in section 4, has a planned structure, and its values are lower than those of Almada.

Comparison between historical and new areas reveals more significant differences than comparison between 'planned' and 'unplanned' areas. Indeed, comparison between the historical kernel of Porto and the new area in the peninsula at south of Vila do Conde parish reveals significant differences in the four criteria under analysis: integration of the street system, density of street-blocks, of buildings and of coincident building and plot frontages, is much higher in the former than in the latter. Both areas are dominated by three to four storeys' buildings; while the former is predominantly non-residential, the latter is almost exclusively residential.

The application of the town-plan concept and of Morpho methodology in the detailed analysis of four small areas erected in different time periods enabled the identification of a coincidence (and not of a causal relationship) between higher values for town-plan characteristics and higher values for indicators of social and economic diversity and of environmental sustainability. This coincidence takes place at landscapes of medieval and of 19th century formation.

Finally, the sixth section explored, within the limited scope of a paper section, how to move from morphological description to planning prescription. It is argued that planning the physical form of cities must have a selective focus. One cannot, and should not, try to control everything. Attention should be paid to the most permanent elements of urban form – streets, street-blocks, plots (all these have been absent of mainstream planning practice) and the block-plans of buildings. In the regulation of these elements planning should be rigid. A secondary focus should be placed on the regulation of the building fabric and of the land and building utilization. In the former, planning should move from the control of architectural language to the control of more important elements such as the relation between the building height and the street width or the design of the ground floor. In the latter, planning should move its emphasis from segregation to integration.

Conclusions

The previous sections have made evident the ability of the town-plan concept and of Morpho methodology to offer a first morphological analysis of territories at different scales, with different landscape contents, and with different periods of formation. These sections also made evident the ability of the concept and methodology to start relating the physical form of cities with urban life, and scientific morphological research with professional planning practice. Future research should extend its scope into different geographical contexts and should continue to improve the technical and communicational aspects of the methodology.

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