The Athens Form: Exploring the Spatial Signatures of Functional and Configurational Typologies of Athens Urban Area

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Abstract: The relation between spatial configuration and land-use intensity has always been at the forefront of space syntax research. There are numerous studies that investigate this link but far less focus on large geographical regions. In this paper, we explore the spatial signature of functional and configurational typologies of Athens Urban Area (Attica), an extensive and densely built-up area, spanning over 412 km2.
This paper has a three-fold focus. Firstly, to provide a reproducible methodology for identifying functional and configurational centralities, secondly to explore the geospatial signature of Attica form as defined by its functional (activity) and configurational (syntactical) centres, and thirdly to investigate the role of spatial configuration, as quantified by space syntax analysis, in shaping the existing land-use pattern. The proposed centre-identification methodology is based on Kernel Density Estimation method, and geospatial and geostatistics analyses are employed for exploring the signature of these typologies. The outcome of this paper is a comprehensive analysis of the functional and configurational form of Attica derived by fine-scale land-use and road network data, provided by official sources (Hellenic Statistical Authority). A study, in a region with such extent and characteristics, could shed light on how historic Mediterranean cities are assembled.

1. Introduction

The last several decades, contemporary cities have been transformed into large metropolitan regions, with low population density and car-depended suburbs (Buliung, 2011). Therefore, the past structure of the historic core of the city defining its form and function has been deemed to be somewhat obsolete and has been evolved into a network of urban centres and sub-centres that have absorbed some of the functions previously reserved for traditional central business districts. Understanding these new forms of centrality is crucial for constructing an up-to-date planning approach towards sustainable form, spatial justice and meaningfully successful urban centres (Anas *et al.*, 1998; Zhong *et al.*, 2015; Shen & Karimi, 2017).

There are numerous approaches for examining urban centres but in this paper, we focus on the relevant geographical and configurational approaches. Geographical research puts forward functional pattern, meaning land-use distribution and density, when it comes to identifying

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and analysing urban centres (e.g. Batty *et al.*, 1997) while configurational studies focus mostly on the structural properties of spatial configurations creating urban centres (e.g. Hillier, 1999). The exploration of the different centrality structures identified by these complementary approaches can offer valuable insight into the diverse phenomenon of centrality.

In this context, spatial configuration and specifically network centrality is a crucial theoretical and methodological tool for understanding this process, since numerous researchers have suggested that network centrality is at the epicentre of the mechanism that supports 'spontaneous' and 'organic' urban evolution (Jacobs, 1961, 1993; Hillier, 2003; Porta *et al.*, 2009). This mechanism is termed by Hillier (2003) as "*city creating process*" which is based on the principles of "*natural movement*" (Hillier *et al.*, 1993, p. 32) and "*movement economy*" (Hillier, 1996/2007, pp. 125-127), and suggests that cities can be approached as self-organising spatial systems that evolve from collections of buildings to vibrant cities through the interaction of spatial configuration, human movement and land-use distribution. Space Syntax is a theoretical and methodological approach, introduced by Hillier and his colleagues (Hillier & Hanson, 1984; Hillier *et al.*, 1987), that quantifies geometry and topology of the urban grid, in order to conceptualize 'city creating process' and predict human activity in urban space. Rooted in graph theory, space syntax is an elemental tool for analysing centrality and its importance has been highlighted by various studies that prove the strong correlation among street centrality, human movement and economic activities (e.g. Hillier, 1999; Porta *et al.*, 2009, 2012; Scoppa & Peponis, 2015; Serra & Hillier, 2019).

This paper has a three-fold focus. Firstly, to provide a compact reproducible methodology framework for identifying functional and configurational centralities, secondly to explore the geospatial signature of 'Athens Urban Area' as defined by the functional (activity) and configurational (syntactical) centres of Attica, and thirdly to investigate the role of spatial configuration, as quantified by space syntax analyses of angular choice and integration, in shaping the existing land-use pattern and the methodology framework, its results and the corresponding conclusions are described in the following sections.

2. Methodology

2.1. *Study Area – Data Sources*

The study area is the Athens Urban Area (AUA), generally known as Athens or Attica[1], as comprised by Greater Athens and Greater Piraeus, a large geographical region with heavy historical significance and great social, morphological and functional diversity. Attica is a continuous densely built-up area spanning over 412 km^2 with a population of 3,090,508 people as of 2011. Attica consists of 40 municipalities, 35 of which make up what is referred to as the Greater Athens municipalities, located within 4 regional units; and a further 5, which make up the Greater Piraeus municipalities, located within the regional unit of Piraeus. The Athens Urban Area is considered to shape the city of Athens as a whole, despite its administrative divisions, and is the largest urban area in Greece and one of the most populated urban areas in Europe.

All the necessary data derive by the Hellenic Statistical Authority and refer to the latest census available (2011). Specifically, to analyze the configurational form of Attica, the corresponding road-centre-line dataset is used and the functional form of Athens is analyzed via the

1. The study area of this paper is 'Athens Urban Area', generally referred to as Athens or Attica and in this paper will be referred to as 'Attica' or 'Athens Urban Area'.

built-environment dataset which is available at block-level. Furthermore, is worth mentioning that the format of the built-environment dataset, although provided only on block-level, offers a detailed depiction of the land-use distribution of Attica. The software used for space syntax analysis was QGis 2.16.3 and PST (Place Syntax Tool, a plugin for Qgis) and for geospatial and geostatistics analysis was ArcGIS 10.7 and MS Excel 2016.

2.2. *Methodological Framework*

The objective of this paper is to explore the spatial signature of functional and configuration centralities to this end a detailed 3-step methodological framework is presented: (1) Data Cleaning, (2) Spatial Analysis & Identification of Centralities and (3) Geospatial Signature of Centralities

The first step refers to the validation and preparation of our data, a lengthy but necessary process in every project involving large datasets. In this stage the urban blocks feature class (**.shp*) is joined with the attributes table consisting the information about built- environment (**.xlsx*) to create a spatial dataset with all the information about built-environment. Subsequently, the validation of our data is performed and any duplicate records are deleted. Next, the original Road-Centre-line dataset[2] is processed in order to remove errors, to optimize representation and decrease calculation time by reducing the number of line-segments. Specifically, invalid, duplicate and overlapping geometries are removed and snapping (*threshold: 2 meters*) and generalizing (*threshold: 10 meters*) of the dataset is performed. Moreover, before the final segmentation of the Road-Centre-lines to line-segments, "disconnected islands"[3] are removed from the road network dataset.

The second stage forms the main part of the methodological framework and contains the spatial analysis of functional and configurational typologies and the subsequent identification of the corresponding centralities. In order to analyze the functional typologies, the *Adjusted Functional Centrality Ratio (AFCR)* per block is introduced, a measure depicting the relative and overall functional density, suitable for the format of the given built-environment dataset[4].

For the analysis of configurational typologies, space syntax analysis is utilized and specifically angular choice (betweenness) and angular integration (closeness) constrained by metric radii that correspond well with local and global movement, in order to unearth the municipal, inter-municipal and metropolitan configurational structures. The radii that are selected for this paper and are deemed suitable for Attica, are 900 meters for local movement and 15 km for global movement. The identification of centralities is the next part of the second stage of our methodological framework and a distinct methodological approach based on the Kernel Density Estimation (KDE) method[5] is introduced to this end. A crucial element for the identification of centralities via KDE method, especially in extensive urban areas, is the careful selection of

2. The original street network come from the official statistical and mapping authority, (Hellenic Statistical Authority), and is a Road-Centre-line map that refers to the motorized network of Athens Urban Area.

3. 'Disconnected islands' are the disconnected sub-graphs that can be found in a (street) network dataset, which are not connected to the main (street) network.

4. The format of the available built-environment dataset is the following: For every block the degree of non-residential built-use is given in 3 categories: The first category refers to the exclusively non-residential buildings per block, the second category refers to the mixed-use buildings with non-residential being the dominant use and the third category refers to the mixed-use buildings with non-residential being the secondary use. Thus, for calculating the total number of non-residential buildings per block the following assumption is made, that every mixed-use "*dominantly*" non-residential building occupies 60% of it, and every mixed-use "*secondarily*" non-residential building occupies 40% of it.

5. The KDE estimates the density within a range (bandwidth) of each observation to represent the value at the center of the window. Within the bandwidth, the KDE weighs nearby objects more than far ones based on a kernel function. The KDE generates a density of the events (discrete points) as a continuous field (raster).

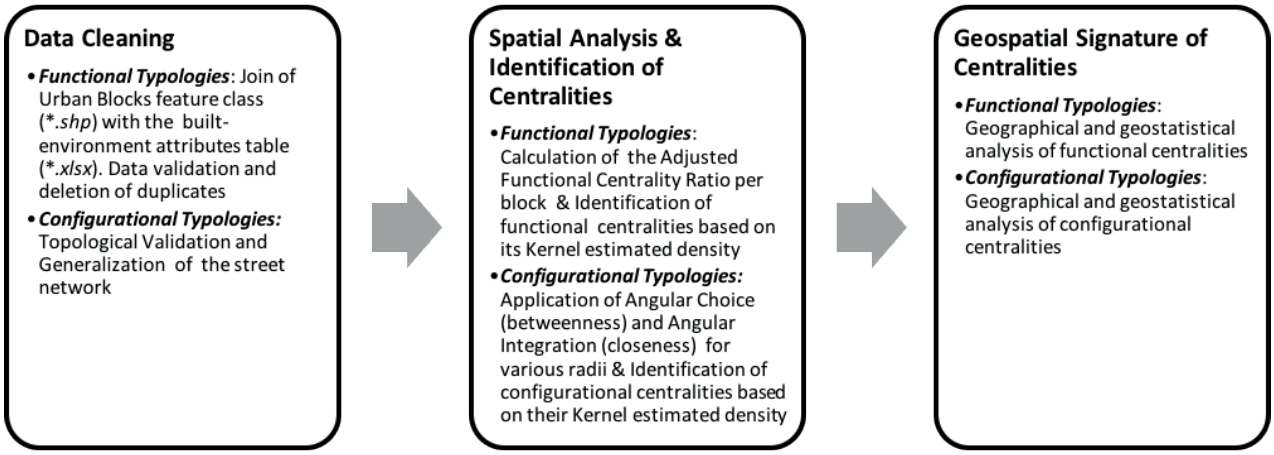


Figure 1. *Methodological steps.*

KDE's cell-size and bandwidth, since they should correspond with the (minimum) size and the magnitude of a typical centre respectively, according to the centre-identification literature and particularities of the study area[6]. Functional centralities are identified via the Kernel Estimated Density of the *Adjusted Functional Centrality Ratio (AFCR)* per block, after a suitable cut-off threshold is implemented. Moreover, in order to explore the magnitude and significance of each functional centrality in the urban system of Attica, the AFCR density of the identified centralities is classified (based on Jenks Natural Breaks classification[7]) in 3 categories so as to recognize the (1) Metropolitan Functional Centralities; (2) Inter-municipal Functional Centralities and (3) Municipal Functional Centralities.

In order to identify configurational centralities and specifically "Choice Configurational Centralities" and "Integration Configurational Centralities" KDE is applied for angular choice and angular integration respectively, and for the selected local and global radii. Similarly to the functional centrality identification method, a cut-off threshold is implemented (, in order to single out the "Choice Configurational Centralities" and "Integration Configurational Centralities". However, as mentioned throughout the article, an elemental objective of this paper is to unveil the different city structures that emerge in different scales. To this end and influenced by the extensive relevant research of Berghauser Pont and her colleagues (Berghauser Pont *et al.*, 2017, 2019), we propose a multi-scalar approach for classifying configurational centralities of an Urban Area.

For Attica three (3) classes are selected that correspond with "Municipal", "Inter- municipal" and "Metropolitan" scale, which are defined as follows (its conceptual explanation is also depicted in Table 1. Explanation of the multi-scalar approach for classifying Configuration Centralities.): As "Municipal Configurational Centralities" are characterized areas with local configuration centrality (900 m) but without global configuration centrality (15 km), as "Inter-municipal Configurational Centralities" are characterized areas which simultaneously have Local Configurational Centrality (900 m) and Global Configurational Centrality (15 km), and

6. We select a 300-meters bandwidth, which approximates the typical size of neighborhoods in urban design literature (e.g. Perry, 1929), and a 200-meters cell-size, which equals a 40,000 m2 area that corresponds with 6.5 typical blocks of Attica, for identifying the non-residential centralities of Athens Urban Area.

7. The Jenks Natural Breaks Classification is a data classification method designed to optimize the arrangement of a set of values into "natural" classes, meaning the most optimal class range found "naturally" in a data set. This classification method seeks to reduce the variance within classes and maximize the variance between classes.

as "Metropolitan Configurational Centralities" are characterized areas with Global Configurational Centrality (15 km) but without Local Configurational Centrality (900 m).

Finally, the third stage of the proposed methodology framework refers to the geographical and geostatistical signature of functional and configurational centralities and has a two-fold focus: The first is to analyse the socio-economic setting in which the various centralities emerge and thus the geography of the identified centralities is examined. The second, is to explore the role of configurational centralities in shaping the land-use distribution, namely the identified functional centralities and cross-tabulation is utilised to this end.

3. Analysis/Results

3.1. *Exploratory analysis: The formal form of Attica (master plan)*

Attica, as a historic Mediterranean city has been transformed extensively throughout the centuries. The ancient settlements in the region were replaced by self-organised and self-built refugee settlements after the Asia Minor disaster (1922), which were turned into suburbs after the end of World War II and the following Greek Civil War (1949) due to the need for affordable housing and living wage that impelled the working class to move to the industrial Athenian suburbs. However, the most critical process that definitively altered the contemporary form of Attica was the middle-class suburbanization that occurred during the '80s and '90s and continues until nowadays. A substantial volume of the newly established middle- and high-class population *exited* the compact urban core of Athens and moved to distant, low-density suburban areas, shaping a car-dependent (sub-)urban form (Leontidou, 1990/2006). It is apparent that the urban form of Attica is the result of political, historical and cultural processes that despite their top-down and institutionalized character, were imprinted organically and without a formal plan on Attica's form, which in itself, constitutes a "formal plan" of some sort.

Nevertheless, the last decades have been established extensive urban planning legislation and zoning plans that designate areas with permitted land-uses at Municipality level, outline the desires and plans of formal planning for the Athens Urban Area and that de facto shape the "formal form" of Attica. At the epicentre of this paper is the analysis of the ever-evolving phenomenon that is centrality and its various typologies, and thus the analysis of the *formal*

Table 1. *Explanation of the multi-scalar approach for classifying Configuration Centralities.*

	Local Configurational Centrality (900 m)	Global Configurational Centrality (15 km)
Municipal Configurational Centralities	✓	X
Inter-municipal Configurational Centralities	✓	✓
Metropolitan Configurational Centralities	X	✓

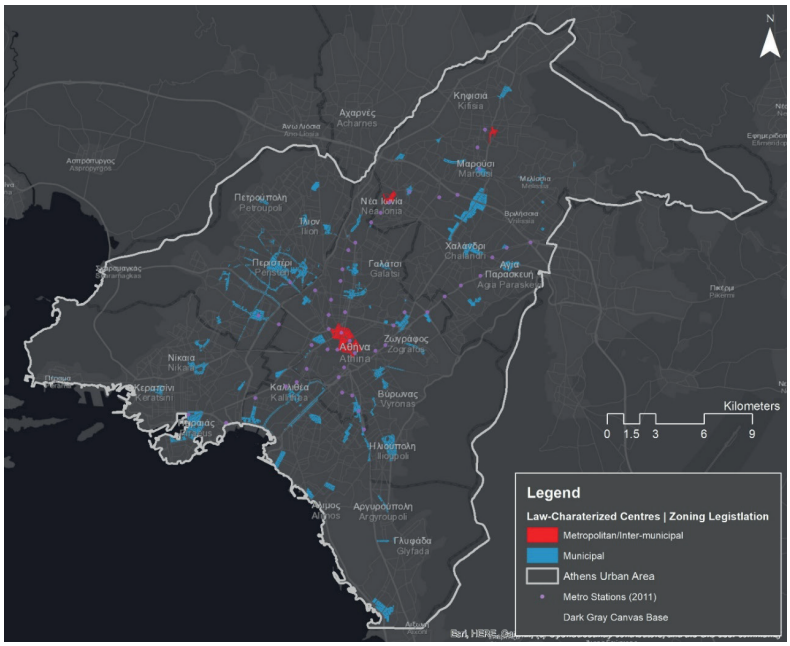
form that arises from the Greek zoning plans is essential to understand the constitutional background from which these typologies have emerged. This is the reason why we deem necessary to first analyse the geography of formal centres, as defined by the Greek urban planning laws, and specifically as mapped in the relevant municipal regulatory plans.

Map 1 depicts the areas characterized as centres by the Greek Urban Planning Legislation. As shown in Map 1, as "Metropolitan/Inter-Municipal Centres" are characterized areas in the historic centre of Athens and in the northern suburbanities of Nea Ionia and Kifisia. It is striking, and at the same time typical of the Greek spatial planning system, that in Piraeus; the second most populous city of Attica, a port with pan-European significance and self-evidently the second most prominent city in Attica, there is no area characterized as "Metropolitan/Inter-Municipal Centre". It is also fascinating how limited is the number of areas characterized as "Metropolitan/Inter-Municipal Centre", which highlights the non-sustainable Attica form, even in paper, since there is no way to facilitate the needs of the various municipalities by only proposing three metropolitan centres, without depending heavily in individual vehicular transportation.

3.2. *The Functional Form of Attica*

In Map 2 the functional form of Attica is outlined by the functional centralities of the study area, as defined by our methodology.

As expected, the historic centres of Athens and Piraeus have been identified as "Metropolitan Functional Centralities", but there is no other area identified as "Metropolitan". On the other hand, there is a significant number of "Inter-Municipal Centralities", especially around the Athens "Metropolitan Centre". What is more, the great number of – limited in extent – "Inter-Municipal Centralities" dispersed mostly in the eastern and northern part of Attica, and in most cases located near metro stations. Prominent examples are the northern suburbs of Nea Ionia and Marousi, the eastern suburbs of Peristeri and Sepolia, and the central suburbs of Ag. Ioannis and Dafni, along with a number of districts throughout central Athens (e.g. Ampelokipoi, Panormou, Neos Kosmos, Koukaki). Apart from the metro-influenced "Inter-Munic-



Map 1. *Law-Designated Centres, Greek Urban Planning Legislation.*

ipal Centralities", "*independent*" "Inter-Municipal Centralities" are found in Nikaia, in Syggrou Avenue and in the northern suburbs of Chalandri and Kifisia. Finally, "Municipal Centres" are found throughout Attica and function as municipality centres for the inner and bedroom Athenian suburbs. Nevertheless, it is tellingly that there are municipalities without "Municipal Centrality", or any centrality for that matter, especially in the western part of Attica.

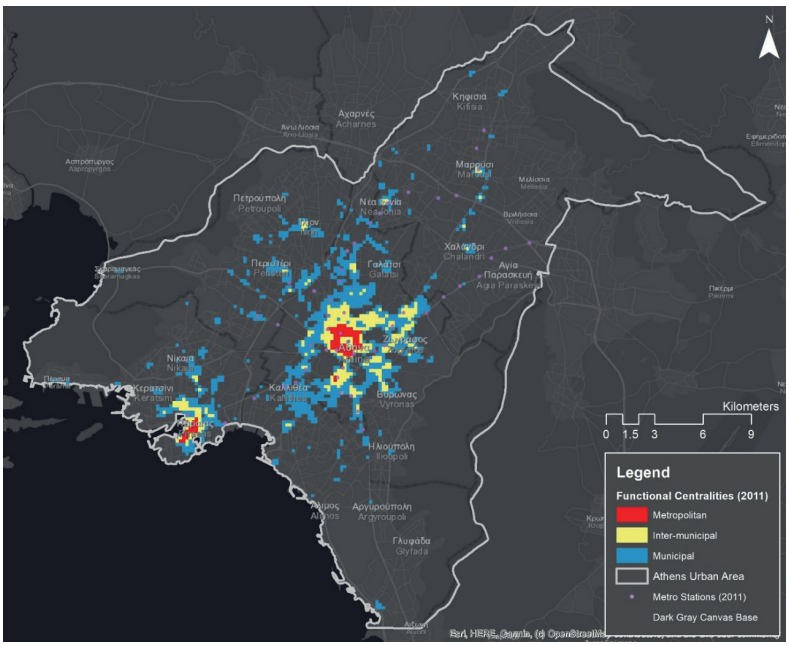
Regarding its form, Attica cannot be characterized as an organized polycentric metropolis, since seems to function as a dual-core city (Athens and Piraeus) with some satellite centralities around these metropolitan centres and beyond that, some local centralities that facilitate the everyday retail and communal needs of residents. The non-sustainable form of Attica is highlighted by the absence of "Inter-Municipal Centres" and the limited presence of "Municipal Centres" in the western suburbs of Attica.

3.3. *The Configurational Form of Attica*

In Maps 3 the configurational form of Attica is outlined by angular choice (*betweenness*) and integration (*closeness*) centralities of the study area, as defined by our methodology.

These two measures of spatial configuration, are by definition highlighting different aspects of network-driven centrality and this is clear in our analysis, as well. Choice has singled out as "Metropolitan Centralities", linear areas that act as the routes for regional movement in Attica. The linearity of the identified areas is such that simulate the corresponding roads because such important avenues have a substantial area. Notably, the various motorways that are located in the study area have been identified as "Metropolitan Choice Centralities" (e.g. Kifissou Avenue, Attiki Odos) as well as other significant Athenian avenues (e.g. Mesogeion, Panepistimiou). A similar pattern is observed in "Inter-Municipal Choice Centralities" where the roads that facilitate the inter-municipal movement are revealed (e.g. Filolaou, Char. Trikoupi). "Municipal Choice Centralities" create a more centre-like pattern and are located primarily in the eastern distant Attica suburbs and secondarily in western suburbs close to Athens.

On the other hand, "Integration Configurational Centralities" has a more diffused pattern in which "Inter-Municipal Integration Centralities' dominate. The identified "Metropolitan



Map 2. *Functional Centralities of Attica (2011).*

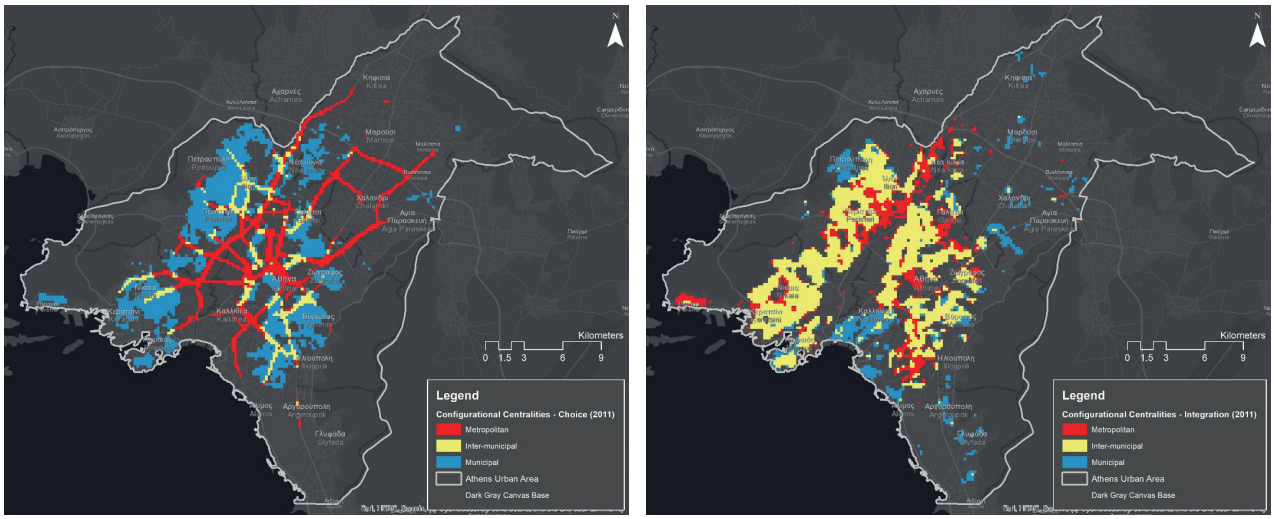
Integration Centralities" are located mainly in the historic centre of Athens, in the northern neighbourhoods of Athens Municipality (e.g. Polygono, Patisia), in the eastern middle-class inner suburbs (e.g. Peristeri, Nea Filadelfeia) and in their southwestern counterparts (e.g. Agios Dimitrios, Nea Smirni). Regarding "Inter-Municipal Integration Centralities", is striking that they have been found mostly in areas that "Inter-Municipal Choice Centralities" has been identified, as well. Specifically, in the eastern suburbs of Attica and the western inner suburbs close to Athens. "Municipal Integration Centralities" has been detected in various suburban neighbourhoods (e.g. Kalithea, Moschato).

3.4. *Relation between the various typologies of Attica Form*

An elemental part of this paper is the investigation of the role of spatial configuration, as quantified by space syntax analyses of angular choice (betweenness) and integration (closeness), in shaping the existing land-use pattern. However, as analysed in the previous section the restrictions put by municipalities' top-down zoning plans, attempt to contain (or "*organize*") the movement-generated form of functional centrality This is the reason why firstly we examine the role of zoning plans in the emergence of functional centralities. In tables 2 and 3 the relationship between "Law-Characterized and Functional Centralities" is depicted.

As shown in maps 1 and 2 but is also apparent from tables 2 and 3 the zoning restrictions cannot definitively contain functional centrality since only a fraction of Functional Centres abide by the zoning laws. There is a significant difference between the typologies of formal and functional centralities. It is striking that the extent of law-characterized centres (18,394,452 square meters) is only one-third of the functional centralities' extent (63,396,870 square meters). Furthermore, the cross-tabulation analysis of functional and law-characterized typologies illustrates that zoning laws failed spectacularly to dictate the materialization of certain types of functional centralities.

In the following Tables 4 and 5, the relation between the different functional and configurational (choice) typologies is detailed. It is worth mentioning that the results are appeared illegible to some extent, because, as expected, there is a vast percentage of the study area is not in either way *central* and does not belong in either centrality pattern (89.99% for "Functional Centralities" and 78.55% for "Choice Configurational Centralities").



Map 3. *Configurational Centralities of Attica (2011), Choice (Above) & Integration (Below).*

Table 2. *Relation between typologies of Law-Characterized Centres and Functional Centralities.*

	Law-Characterized Metropolitan/Inter-municipal	Law-Charaterized Municipal	Law-Charaterized Non_Centre	Grand Total
Functional Metropolitan/Inter-municipal	0.24%	0.32%	2.12%	2.68%
Functional Municipal	0.03%	0.86%	6.36%	7.25%
Functional Non_Centre	0.03%	1.40%	88.64%	90.06%
Grand Total	0.30%	2.58%	97.12%	100.00%

Table 3. *Relation between Law-Characterized Centres and Functional Centralitiesz.*

	Law-Characterized Centre	Law-Charaterized Non_Centre	Grand Total
Functional Centre	1.5%	8.5%	9.9%
Functional Non_Centre	1.4%	88.6%	90.1%
Grand Total	2.9 %	97.1%	100.00%

As shown in Tables 6 and 7 there is a substantial link between "Choice Configurational Centralities" and "Functional Centralities". Specifically, the relative majority of "Metropolitan Functional Centralities" (approx. 40%) have been established in relation to their "Choice Configurational" counterparts. Likewise, a significant relative percentage of "Municipal Functional Centralities" (approx. 30%) have emerged in "Municipal Configurational Centralities'. The weaker connection, but not in any way weak per se, is detected between "Inter-municipal Functional Centralities" and "Inter-municipal Choice Centralities" since "Inter-municipal Functional Centralities" are identified in various choice scales (25% in Metropolitan, 19% in Inter-Municipal and 24% in Municipal). Another interesting finding is that the vast majority of functionally non-central areas is also configurationally (choice) non-central (approx. 83%). However, the results are making a lot more sense when we examine the dipole central and non-central (Table 5) as regards to "Functional Centralities" and "Choice Configurational Centralities" where an undeniable and direct link is detected, since 62% of functional centralities has been established in areas that are configurationally (choice) central.

The same connection but only stronger occurs regarding "Functional Centralities" and "Integration Configurational Centralities", where the 71% of functional centralities has emerged in configurationally (integration) central areas (Table 7). A more detailed image regarding the relations between the various typologies of "Functional Centralities" and "Integration Configurational Centralities" is depicted in the following Table 6.

In contrast with "Inter-municipal Choice Centralities", "Inter-municipal Integration Centralities" influences crucially the emergence of "Inter-municipal Functional Centralities", since

Table 4. *Relation between typologies of 'Configurational Choice Centralities' and 'Functional Centralities'.*

	Choice Configurational Metropolitan	Choice Configurational Inter-Municipal	Choice Configurational Municipal	Choice Configurational Non_centre	Grand Total
Functional Metropolitan	0.21%	0.05%	0.13%	0.14%	0.53
Functional Inter-Municipal	0.55%	0.41%	0.52%	0.70%	2.18%
Functional Municipal	1.28%	0.88%	2.22%	2.93%	7.31%
Functional Non _centre	4.07%	1.41%	9.72%	74.79%	89.99%
Grand Total	6.10%	2.75%	12.59%	78.55%	100.00%

Table 5. *Relation between Configurational (Choice) Centralities and Functional Centralities.*

	Choice Configurational Centre	Choice Configurational Non_centre	Grand Total
Functional Centre	6.2%	3.8%	10.0%
Functional Non _centre	15.2%	74.8%	90.00%
Grand Total	21.4%	78.6%	100.00%

almost 60% of "Inter-Municipal Functional Centralities" are located in their integration counterparts. As for the rest, the correlations between the different typologies of functional centralities and the various scales of integration centralities simulates the corresponding correlations between the typologies of functional and choice centralities.

4. Discussion/Conclusion

This paper constitutes the first attempt to understand the urban form of Attica by visualising its functional and configurational centralities, the two most fundamental aspects of form, analysing their geography and examining the role of spatial configuration in shaping the functional form of Athens as a whole. To this end, we constructed a compact, reproducible methodological framework for identifying functional and configurational centralities, suitable for extensive urban areas. Furthermore, the "planned form" of Attica was examined so as to explore its influence in shaping the functional and configurational, form of Attica.

This article sheds light into the form of the emblematic Mediterranean city of Athens, a historic region that has developed organically during different time periods and scales. Therefore, our analysis contributes significantly in better understanding the configurational form of Attica and its prominent role in shaping the functional pattern of the city, since in more than 6 cases out of 10 (62% for choice and 71% for integration), functional centralities has been

Table 6. *Relation between typologies of Configurational (Integration) Centralities and Functional Centralities.*

	Integration Configurational Metropolitan	Integration Configurational Inter-Municipal	Integration Configurational Municipal	Integration Configurational Non_centre	Grand Total
Functional Metropolitan	0.16%	0.25%	0.05%	0.08%	0.53
Functional Inter-Municipal	0.23%	1.30%	0.11%	0.53%	2.18%
Functional Municipal	0.75%	3.71%	0.52%	2.32%	7.31%
Functional Non _centre	3.54%	8.77%	3.60%	74.07%	89.99%
Grand Total	4.68%	14.03%	4.28%	77.01%	100.00%

Table 7. *Relation between Configurational (Integration) Centralities and Functional Centralities.*

	Integration Configurational Centre	Integration Configurational Non_centre	Grand Total
Functional Centre	7.1%	2.9%	10.0%
Functional Non _centre	15.9%	74.1%	90.00%
Grand Total	23.0%	77.0%	100.00%

developed in configurationally central areas. It is also worth mentioning that, as expected, functional centralities, compared to their configurational counterparts, have been developed to a lesser extent since the inherent property of the grid to attract dense human movement has yet to evolve into functional centrality in every case, which however can be interpreted as outliers of a future centrality pattern. Furthermore, another interesting, yet expected, finding of our research, is the organic character of Attica's functional centrality, that cannot be contained by zoning laws since only 15% of functional centralities are characterised as 'centre' by zoning laws.

The presented research and associated findings can be used as references to better understanding the dynamic phenomenon of centrality, functional and configurational, and how it shapes the form of a historic Mediterranean city as Attica. Moreover, the methodology presented in this paper regarding the identification and analysis of functional and configurational centralities could be integrated into a decision support system in order to inform transportation planning, urban planning and urban design procedures towards sustainable urban form, sustainable mobility, and vibrant and viable urban centres. Specifically, it offers two valuable applications to this end. Firstly, it can be utilised to evaluate the compactness of (Attica) form by analysing the sustainable mobility service area that is facilitated by *today's* (2011 to be exact, the year of the latest Hellenic Statistical Authority census, which is the source of our data) centrality pattern. Secondly, it could be employed in an integrated urban planning and transportation planning approach for designing pedestrian-friendly centres and streets by re-organising central areas and street network hierarchy.

While the research detailed in this article has illustrated meaningful insights into the study of urban form, several of its aspects could be further developed. First and foremost, a crucial step moving forward, would be the spatiotemporal analysis of the evolution of Attica form by applying this methodology for previous censuses (e.g. for 2001, 1991, 1981, etc.). Also, the application of the presented methodological framework in other European Urban Areas could offer much-needed information regarding the centralities of European space, and how centrality emerges in cities with different urban characteristics. Moreover, the addition of urban morphology (e.g. urban density, buildings' age, patterns of plots) as a separate element, would make our research approach "*perfect*", since all aspects of urban form (functional, configurational, morphological) would be represented and analyzed. Furthermore, the implementation of advanced spatial analysis methods for the identification and analysis of centralities (e.g. grouping analysis, clustering analysis, Principal Component Analysis – PCA, correlation analysis, geographically weighted regression – GWR), could contribute significantly in our research. Especially in the identification of configurational centralities, which in our method are considered ax-based while in reality human activity and movement is mainly sidewalk-based and therefore block-based. Moreover, the utilization of multiple radii and especially middle radii between local (900 m) and global (15 km), would draw a more complete picture of configurational centrality.

Finally, the presented research was fairly constrained by the data-cleaning and data-processing requirements of an extensive study area. Firstly, the research area (Athens Urban Area) was selected in a somewhat empirical way, yet influenced by the administrative boundaries of municipalities. A different definition of the study area, probably based on the Urban Morphological Zones used by European Environmental Agency, ßwould have even better results but it would overly complicate an already lengthy and demanding data cleaning procedure. Also, future research could extend the "configurational analysis area", meaning the area where space syntax analysis is implemented, in order to avoid the possible "boundary effect" to the space syntax results.

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