Measuring Urban Dynamics Through Public and Private Sector Concentration Patterns: The Case of Thessaly, Greece

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Abstract

After the intense and unprecedented urbanisation of the last centuries, it is more than evident that a clear understanding of the ongoing trends of urban growth and clustering is needed if we are to aim for a better insight as to their possible future. The main aim of this paper is the definition of a methodological framework for the determination, analysis and cross-evaluation of urban clusters which are formulated within wider study areas, such as administrative regions. To this end, different methods and techniques are utilised, that stem from the fields of Statistics and Quantitative Spatial Analysis and which, during recent years, are all the more commonly applied to the different stages of Geographical Analysis. The definition of urban clusters is mainly based on different types of variables, such as the demographic characteristics of the cities, the number of public and private sector services located in them, as well as the total length of the different types of road network in the study area. Furthermore, a comparative indicator of spatial concentration is formulated that reflects the role and the relative weight of every urban area in the study region as well as its spatial influence. Such a measurement improves the definition and analysis of urban clusters and at the same time, constitutes an alternative assessment of their overall locational perspective. Both the proposed methodological framework and the formulated indicator are applied in the region of Thessaly, Greece.

Keywords: *Public and private sector services, quantitative spatial analysis, spatial concentration, Thessaly, urban clusters, urban growth.*

1. Introduction

The levels of urban growth and urban concentration observed over the last two centuries defined an unprecedented process in history. As a result, more than half of the world's population currently live in towns and cities.

In the most industrialised countries, where the spatial clustering and social diffusion processes of urbanisation seem to have come to an end, the question of future evolution is still under debate. In this respect, interpreting actual trends in urban growth in a correct way is a key for predicting further tendencies.

During recent years, the role of urban centres in their regions varies, depending mainly on their location and the relations with surrounding cities and settlements, since through their service levels they affect the dependence of settlements at a specific distance from them and thus their further development and the region's sustainability. Such varying levels of influence and service have led, during recent years, to the appearance of regional inequalities and many researchers have tried to interpret them through different scientific approaches. In most cases, they focused on the application of methods and techniques as well as the formulation of models, while seeking a theoretical framework. Firstly, it was Plato's ideas (4th century BC) concerning the role of urban centres, which stated that the ideal size of cities can be calculated with mathematic models (Pangle, 1979). In the mid 1960s, Doxiadis (1964), defined "*cities–states*" according to the distances travelled from centre to borders between sunshine and sundown, on foot. From approaches that focused on economic and social criteria, Christaller (1966) formulated his Central Place Theory, which was based on the supply and demand of goods and services. In a more recent work, Portnov and Erell (2001) used a location clustering indicator as a measure of relations between cities and with respect to applied regional policies.

The aim of this paper is the definition of a methodological framework for the study of relations that are developed between settlements, the degree of influence and their interdependence, and through this the definition and evaluation of urban clusters. The emphasis is on the analysis of public and private sector concentration patterns. Since this framework is mainly based on methods and techniques of spatial analysis performed in a GIS environment, it can constitute an important tool in the interpretation of urban systems and settlements formulations.

1. Urban Growth Theory and Methods

Operations and activities that are developed in the interior of settlements and at the extension of cities, play an important role in the development of the urban environment. At the same time, they influence the relationships

between people and create various problems, while they also offer important possibilities, strengthening the cities' growth level. The monitoring of urban changes constitutes an important subject of research for a lot of scientific sectors aiming at the interpretation of developments that transpire in the cities.

Sustainable urban growth as *"the potential of urban areas to attract new residents while maintaining the existing*" is undoubtedly a complex phenomenon. However, this statement if followed by a set of analyses with regard to the indicators and the criteria, which form the bases for the interpretation of the relation between the sustainable population growth of cities and the attributes of their locality (Portnov and Erell, 2001). Furthermore, indicators that promote growth in urban and regional planning must follow three rules (Wong, 1995):

i. Quantification of needs and opportunities that each geographic region or locality offers, for the distribution of resources.
ii. Placement of the terms with which improvement of an area through public political intervention can exist.
iii. Recognition of the most important opportunities and problems for each area as a basis for the determination of political objectives.

Accordingly, there are three basic categories of criteria that affect the sustainable growth of urban areas. Namely, the environment, the population and the economy, which constitute the bases for sustainability control. Sustainability over the last few years is related to a term which is used in many academic sectors, as the astronomy, the sociology, the economy, the statistics and the geography and the regional planning and is called "cluster". However, the interpretations of the causes and consequences of cluster in these sectors differ sufficiently for there to be various types of clusters, such as:

- *Clustering of galaxies,* Newton (1962).
- *Clustering of data.*
- *Clustering in social groups* (Moreno, 1953).
- *Clustering of opportunities* (Fotheringham, 1991).
- *Clustering of industries* (Weber, 1929).

In all these sectors, the term *cluster* mainly describes the same phenomenon: "*a set of neighbouring objects or entities which are connected with some concrete bond, either functional or attractive".* (Portnov and Erell, 2001). In the field of

geography and regional planning, the structure of clusters is reported and reflects in *urban clusters*. The attempt to interpret the above phenomenon began in the 4th century B.C., when Plato tried to determine the ideal city-state, considering that this should be constituted from 5,040 landowners and be checked from 37 law ephors and a council of 360 (Pangle, 1979).

Later, in contradistinction to the above opinion, Doxiadis (1964) concluded that the sizes of cities depended on movements realised between sunshine and sundown. Thus, for the median city the distance from the borders should not exceed that of a 4-hour walk; for a small city, 1-hour; and 7-hours for major cities. Three more definitions of the size of the ideal city came from Richardson (1977) and Clark (1982), Howard (1985) and Haughton and Hunter (1994). Clark and Richardson correlated the ideal size with minimal cost. According to Howard, the ideal size of cities are 32,000 residents in an area of 3,000 m^2. Finally, according to Haughton and Hunter, the ideal size of city is 100,000-250,000 residents, which implies significant economic growth. (*see* Table 1)

Table 1. Empiric Approaches for the Determination of Ideal City Size

Writer	Year	Characteristics of ideal city
Platon	4th century BC	5,040 landowners and a council of 360
Doxiadis	1964	Three kinds of cities– states, depending on the distance that can be covered between sunshine and sundown
Richardson, Clark	1977, 1982	The size depends on minimal cost
Howard	1985	Ideal size of 32,000 residents and 3,000 m^2
Haughton - Hunter	1994	Ideal size of 100,000-250,000 residents

However, while initially the only criteria for the determination and categorisation of urban clusters were population, area and distances travelled within their limits, later on economic, social, policies even psychological characteristics were also considered. The first consideration of the above parameters came with the introduction of central place theory by Christaller. According to this theory, cities attract a set of facilities from which their functions and activities stem and are distinguished in the following types:

- *General.* Executed by the city, in order to serve the neighbouring countryside.

- *Transport*. Usually executed in the nodes of transport networks.
- *Special.* Carried out in smaller or bigger areas. This type includes mining and industrial activities.

Although these categories can be considered as important factors of urbanisation, the main role of the city is to serve its hinterland. Consequently, they are two additional criteria for the definition of central place: *critical size*, which means the minimum population that is required in order to support an urban operation, and *scope*, which means the furthest distance to offer its goods or services. (Argyris, 1997)

As stated by Golany (1982), the role of urban clusters becomes important by contributing to the reduction of the spatial isolation of barren regions. In this respect, clusters of cities that are scattered in barren areas can have economic profits by decreasing infrastructure and transport costs. Another interesting formulation came from Krakover (1987), who analysed the advantages and disadvantages of urban clusters by using statistical data for Northern Carolina and the Piedmont, Philadelphia in USA. He managed to define two distinct stages of growth for the cities which constitute urban clusters:

- In the first stage, the cities are relatively small and the existing economic, technological and spatial conditions coincide with existing accumulated economies.
- In the second stage, when the cities exceed a certain population limit then a lot of businesses are moved into the suburbs. In the opposite case, such an economic diffusion is less likely to appear in a cluster of smaller cities.

An important contribution in the definition of urban clusters in the interior of regions was given by Portnov and Erell (2001), who formed an indicator which shows whether clusters exist in a greater region and how these can be described based on their distance from the central city (Equation 1):

$$IC = \frac{IS}{IR} \tag{1}$$

where:

IC = the index of clustering,

IR = the distance from the central city, and

IS = the isolation.

2. Methodological Framework

Since urban concentration assessment is critical for the interpretation of phenomena at both the urban and the rural level, methods and techniques from the quantitative spatial analysis toolbox are needed. According to the proposed approach, a thorough study and evaluation of the spatial relationships between settlements and central cities can be achieved with the application of the following methodological framework. The first step of the approach is the data collection and organisation, which eventually leads to spatial database formulation and management. Since both are essential for the definition of urban clusters, they must be corrected and updated in order to ensure the validity of the final results. The next step is the categorisation of settlements, intended to define groups in the study area. A typical way to deal with this issue is based on the population that each settlement has and the degree to which it corresponds to the term urban. In this respect, the critical problem variables which will be analysed in the framework of this study are defined. They refer to the strength of the area's urban centres in a demand, supply, and service concept. They will also contain data reflecting the number of public facilities and private sector enterprises, along with measures which reflect the overall accessibility of surrounding areas, utilising descriptive data on the existing road and railway network and the public transport system. In this stage, specific Geostatistical methods and techniques of spatial data analysis along with the technology of Geographic Information Systems (GIS) are adopted, in order to obtain a multivariate combinative exploitation of information.

The service areas calculation which follows is based on the each settlement's network accessibility cost (time or distance) and they can be defined by locating each settlement to the nearest urban centre, using the network distance or through the formulation a locational indicator. In the GIS environment and with respect to road network arcs, data should be available about their length and the category they belong to by virtue of average speed. Following the determination of service areas, spatial analysis methods and techniques are applied in order to define the urban formations and patterns that exist in the study area. To this end, point and services concentrations are assessed and thus, urban clusters evaluated. The definition of urban concentrations is realised, according to which the settlements density around each city is calculated, attributing at the same time the characteristics of urban clusters in the study region. The analysis of the resulting urban clusters is realised via *cluster analysis*. The application of this particular

method seeks urban clusters with similar characteristics, while simultaneously evaluating each cluster's importance taking into consideration every variable in the database.

Finally, a numerical indicator is formulated which reflects the clustering dynamics around each settlement in the study area. The variables utilised refer to critical infrastructural and developmental characteristics of each settlement-centre reflecting in this manner, its importance in the study area. The validity of the methods and the effectiveness of the proposed methodological framework are evaluated through their application for the definition of urban clusters in the region of Thesaly, Greece. The specific region, due to its morphology, inadequate and old road network as well as its sometimes extreme climate and weather conditions, constitutes an intriguing case study.

Each settlement, depending on its demographic size, assembles in his interior operations and services which respectively attract smaller populations from neighbouring settlements. In this respect, around each big and small urban centre, its service area is defined by a specific network radius. This task is performed in a GIS environment by the use of specific functions and routines.

Furthermore, cluster analysis refers to an extensive set of algorithms with which are grouped the lines (cases) or the columns (variables) of a data table. It is divided into two main methods. Hierarchical, which starts with groups equal in number and progressively merges similar groups until a team which includes the total number of cases is formulated, and bisectional, which starts with a set that contains the total number of cases and progressively removes the most remote cases, creating a new set and redistributing every other case, until a predetermined number of groups is formulated optimally (Maloutas, 1994).

3. Spatial Concentration Patterns in Thessaly

According to the proposed methodological framework, the settlements of Thessaly were categorised into the following groups, which in large part coincide with the groups that the National Statistical Service of Greece adopts:

a. settlements with a population of less than 2,000 residents (922),
b. settlements with a population of more than 2,000 and less than 10,000 residents (28), and
c. settlements with a population of more than 10,000 residents (4).

At this level of analysis and with respect to urban clustering dynamics, only settlements with 2,000 to 10,000 residents and settlements with more than 10,000 residents will be examined. For the calculation of service areas in the GIS environment, two digital coverages will be needed. A point coverage, with additional information about each settlement's population and altitude (2001 census data), and a line coverage of the road network, with length, maximum speed data. The three types of roads that were adopted are based on the international categorisations (Gutierrez and Urbano, 2002):

- 1st category, in which the E-75 highway belongs, with an average speed of 120 Km/h,
- 2nd category, in which the E-90 motorway belongs, with an average speed of 100 Km/h, and
- 3rd category, in which the rest of the national road network belongs, with an average speed of 70 Km/h.

3.1. Service Area Definition

Using the accessibility of each settlement to the nearest mean urban centre, the service areas of each urban centre with population bigger than 10,000 residents and those with population 2,000-10,000 residents were calculated. In the determination of service areas the following indicator of interaction was used:

$$L_i = \frac{W_j}{d_{ij}^2} \tag{2}$$

where:

L_i, is the strength with which the settlement i is influenced by each urban centre j,

W_j, is the weight of each urban centre j, and

d_{ij}, is the distance between the settlement i and the urban centre j.

Figures 1, 2 and 3, which follow, contain service areas with respect to serviced settlements for each urban centre of with more than 10,000 population (primary), with the indicator's weight formulated through the number of the public facilities or the number of the private enterprises, for each urban centre. Respectively, Figures 4, 5 and 6 exhibit the resulting spatial assignments for the urban centres with population sizes between 2,000-10,000 residents (secondary).

Figure 1. Population Weighted Service Areas of Settlements with Population of More than 10,000 Residents

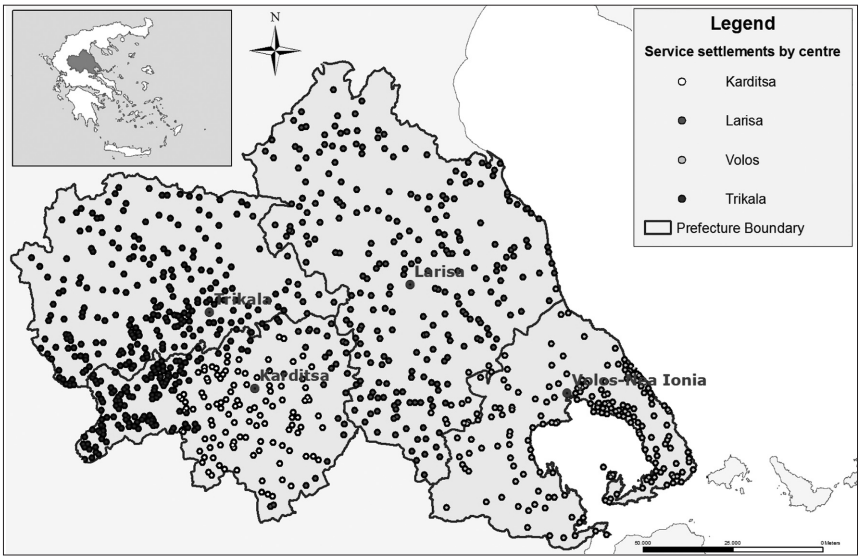


Figure 2. Public Sector Weighted Service Areas of Settlements with Population of More than 10,000 Residents

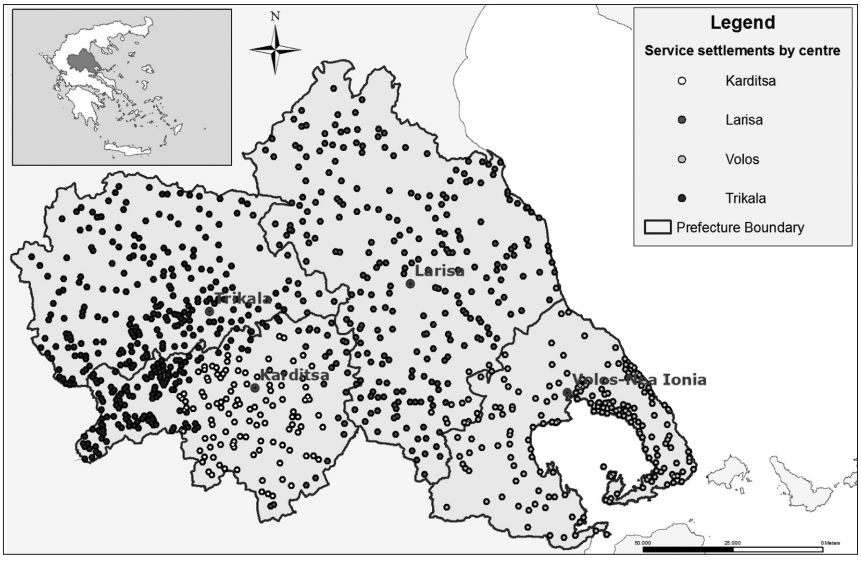


Figure 3. Private Sector Weighted Service Areas of Settlements with Population of More than 10,000 Residents

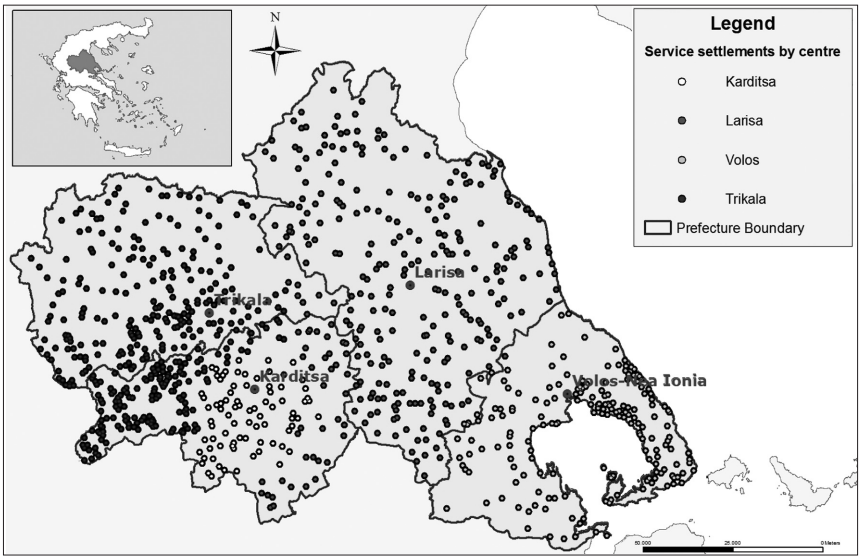


Figure 4. Population Weighted Service Areas of Settlements with Population of between 2,000–10,000 Residents

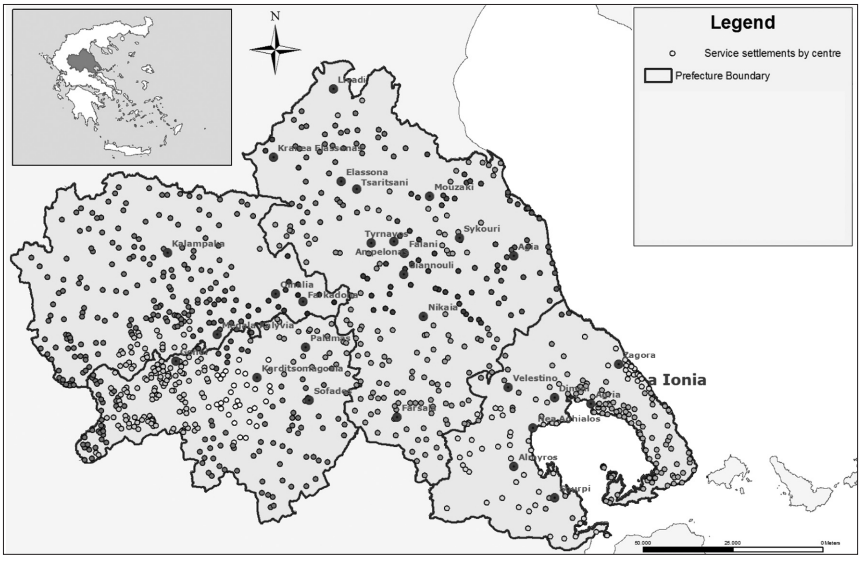


Figure 5. Public Sector Weighted Service Areas of Settlements with Population of between 2,000-10,000 Residents

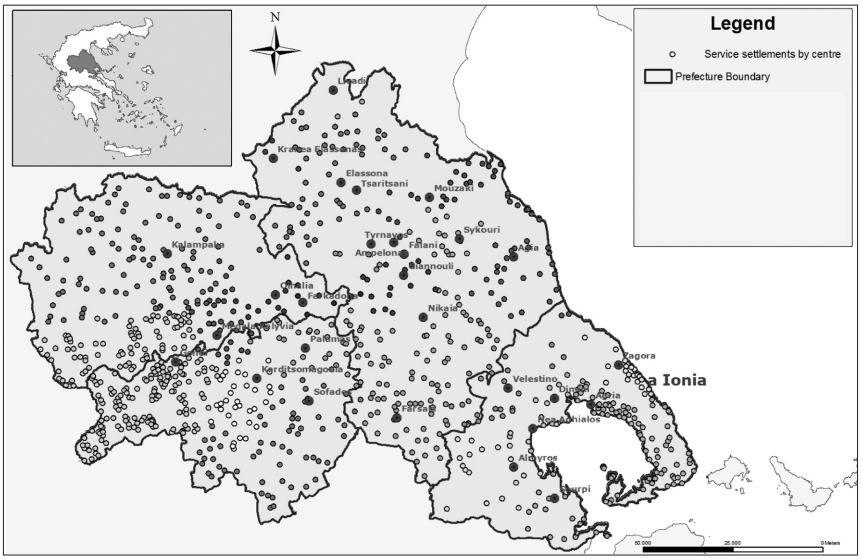
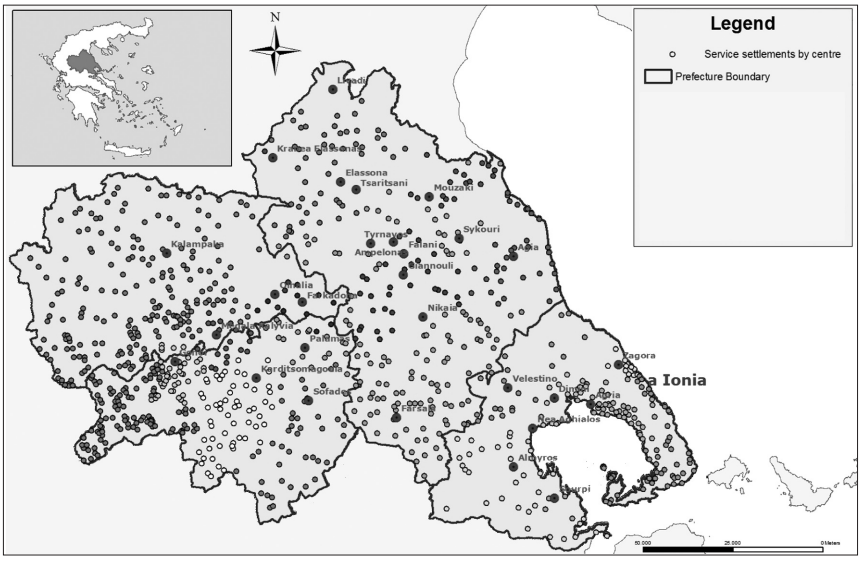


Figure 6. Private Sector Weighted Service Areas of Settlements with Population of between 2,000-10,000 Residents



With the determination of service areas for each settlement–centre, additional data are created and added to the database regarding the number of settlements covered, the total population served, the percentages of road network per category and the size of the coverage area. It is evident that for the settlements with populations of more than 10,000 residents, in the prefectures of Trikala and Larisa the number of served settlements is more than 200, while in the counties of Karditsa and Magnisia this number is smaller and reaches to the 100 settlements. In Figure 6, the picture largely changes for centres with population 2,000-10,000 residents.

Higher concentrations, exceeding 30 served settlements on average, are observed in the western parts of the Karditsa and Trikala prefectures, as well as in the southern part of the prefecture of Larissa, while in the prefecture of Magnesia the higher concentration is observed in its centre. On the other hand, lower concentrations, with less than 20 served settlements, are observed in the northern part of the prefecture of Larissa.

3.2. Analysis of Settlements Concentrations

Of increased interest in our case, are urban centres of 2,000-10,000 residents, since in most instances they represent and define both the spatial distribution and concentrations of settlements inside the study region's boundaries. According to the proposed methodological framework, and in order to assign settlements to this category of centres, K-means analysis was adopted. The method of K-means cluster analysis was applied through the utilisation of SPSS 13.0. Settlements were grouped into three categories with respect to a set of variables. Tables 2 and 3, show the groups which were formulated when the variables referring to the number of public services were processed. Respectively, Tables 4 and 5, show the groups which were formulated when the variables reflecting the number of private enterprises were processed.

On examining the following two tables (*see* Tables 2 and 3), it is apparent that Groups 1 and 3 contain settlements that constitute the Major Service centres of Thessaly. Respectively, they share common characteristics, while Group 2 exhibits different, and in most cases lower, service levels. In this respect the resulting settlement-centre hierarchy is Group 3 – Group 1 – Group 2.

Table 2. K-means Public Sector Clusters of Settlements with 2,000-10,000 Residents

Group 1		Group2		Group 3
Ampelonas	Agia	Karditsomagoula	Oihalia	Almyros
Elassona	Agria	Kranea Elassonas	Sourpi	Kalampaka
Palamas	Velestino	Livadi	Sykouri	Sofades
	Giannouli	Megala Kalyvia	Tsaritsani	Tyrnavos
	Gonoi	Mouzaki	Falani	Farsala
	Dimini	Nea Aghialos	Farkadona	
	Zagora	Nikaia		

Table 3. Public Sector Cluster Characteristics for Settlements with 2,000-10,000 Residents

	Group 1	Group 2	Group 3
% of Population	0.079900	0.038400	0.106000
% of Education	0.049155	0.024424	0.072811
% of Emergency	0.037736	0.033019	0.045283
% of Culture	0.043860	0.032237	0.044737
% of Sports	0.090909	0.026515	0.039394

In the same manner, if we examine the following two tables (*see* Tables 4 and 5) it appears that Groups 1 and 3 also contain settlements that constitute the Major Service centres of Thessaly. Respectively, they share common characteristics, while Group 2 exhibits different and in most cases lower service levels. Only this time, the resulting settlement-centre hierarchy is Group 1 – Group 3 – Group 2. A first conclusion derived from the application of K-means analysis is that the resulting groups successfully reflect the notion of urban clusters, in terms of their centre's degree of diachronic development.

Table 4. K-means Private Sector Clusters of Settlements with 2,000-10,000 Residents

Group 1		Group2		Group 3
Kalampaka	Agia	Karditsomagoula	Nikaia	Almyros
	Agria	Kranea Elassonas	Oihalia	Velestino
	Ampelonas	Farkadona	Sourpi	Elassona
	Sofades	Livadi	Sykouri	Tyrnavos
	Gonoi	Megala Kalyvia	Tsaritsani	Farsala
	Dimini	Mouzaki	Falani	Giannouli
	Zagora	Nea Aghialos	Palamas	

Table 5. Private Sector Cluster Characteristics for Settlements with 2,000-10,000 Residents

	Group 1	Group 2	Group 3
% of Population	0.0935	0.0417	0.0947
% of Industry businesses	0.1984	0.0299	0.1733
% of Commercial businesses	0.1684	0.0356	0.1456
% of Private Services businesses	0.4043	0.0324	0.0532

3.3. Urban Concentration Indicator (UCI)

The applied methodological approach can form the basis for the creation of an indicator which will compare settlements in terms of clustering status and potential, taking into consideration their critical service characteristics and determining at the same time their dominance and importance in the region. The mathematical formulation of the Urban Concentration Indicator (UCI) is:

$$D_j = \frac{\left(\frac{\sum_{i=1}^{N} a_{ji} + 1}{N+1}\right) * \left(\frac{P_j + \sum_{i=1}^{N} P_i a_{ji}}{P_j + \sum_{i=1}^{N} P_i}\right)}{\left(\frac{m'_j * m_j}{m'_j}\right)} * \left(\frac{S_j}{\sum_{j=1}^{M} (S_j)}\right) * 1000 \quad (3)$$

where:

$j = 1,\ldots,$ M service centres

$i = 1,\ldots,$ N settlements served (inside region I)

$P =$ population of each settlement or centre of service

$S =$ number of services

$m_j =$ average distance travelled, $m_j = \frac{\sum d_{ij}}{N}$

where:

d_{ij} the distance between i and j

$$\begin{cases} 1 \text{ if } d_{ij} < m_i \\ \text{and} \quad a_{ij} = \\ 0 \text{ if } d_{ij} > m_i \end{cases}$$

m'_i is the medium distance of settlements with $d_{ij} > m$

The indicator that is presented above constitutes a combination of variables and it aims to analyse and evaluate the dynamics of settlements-centres and the urban concentrations around them, based on two main parameters, the cluster of serviced settlements and the settlement-centre. Consequently the general form of the above indicator is the following:

$$D = CLUSTER * SERVICE\ CENTRE * 1000$$

The first term of the equation examines the serviced settlements cluster based on the number of settlements, the population served and their average distance, and reflects its clustering status and perspective. The second term examines the capacity of the settlement-centre in association with the number of public services, as cultural, educational and emergency, or the private businesses services as industry, commercial and private services, that it offers. Based on the UCI, the settlements with populations of 2,000 -10,000 residents were ranked and the results appear in Tables 6 and 7.

Table 6. Public Sector Urban Concentration Indicator for Settlements with Population of 2,000-10,000 Residents

	Settlement - centre of service	Indicator of urban concetration		Settlement - centre of service	Indicator of urban concentration
1	Tyrnavos	369.7837	14	Agria	159.1259
2	Farsala	366.2827	15	Agia	156.2878
3	Almyros	311.0211	16	Moyzaki	153.4448
4	Nea Aghialos	301.2717	17	Farkadona	141.2366
5	Elassona	295.2091	18	Sykourio	132.565
6	Kalampaka	253.3141	19	Nikaia	128.6869
7	Palamas	251.3871	20	Oihalia	128.3622
8	Sofades	226.9316	21	Sourpi	114.9073
9	Giannouli	184.1596	22	Livadi	110.3783
10	Ampelonas	168.7334	23	Megala Kalyvia	97.91365
11	Kranea Elassonas	164.1392	24	Karditsomagoula	96.80786
12	Zagora	163.0302	25	Gonoi	92.21739
13	Velestino	159.1302	26	Dimini	88.56842

Table 7. Private Sector Urban Concentration Indicator for Settlements with Population of 2,000-10,000 Residents

	Settlement - centre of service	Indicator of urban concetration		Settlement - centre of service	Indicator of urban concetration
1	Farsala	512.3282	14	Megala Kalyvia	96.10815
2	Kalampaka	508.5882	15	Ampelonas	95.55118
3	Tyrnavos	479.1138	16	Farkadona	95.30963
4	Elassona	458.7954	17	Moyzaki	94.13456
5	Almyros	447.0259	18	Agria	92.04151
6	Velestino	419.7764	19	Sykourio	88.71854
7	Giannouli	338.9321	20	Nikaia	59.20964
8	Nea Aghialos	221.7873	21	Oihalia	47.24823
9	Agia	201.3452	22	Sourpi	42.29568
10	Karditsomagoula	166.2898	23	Gonoi	33.94385
11	Sofades	158.2677	24	Zagora	32.73217
12	Dimini	130.4029	25	Kranea Elassonas	24.16688
13	Palamas	115.6648	26	Livadi	18.05716

In order to compare the resulting ordering for both the public and private sector indicators, Table 8 was formulated, which presents the fluctuation of each settlement-centre of service positioning, for the value of public and private sector indicators respectively. According to this, the first seven cities (green cells) are centres that achieved higher values for the private than the public sector indicator, while the reverse holds for the last six cities (yellow cells), which obtained higher values for the public sector indicator. The other settlements constitute the group with similar levels of development in terms of both indicators.

Comparing the results of the two approaches, and with regard to settlements ranking and grouping, a more detailed conclusion is that Almyros, Kalampaka, Tyrnavos and Farsala constitute the four major service centres of the area, with Velestino, Sofades and Elassona steadily defining the second-best group.

Table 8. Hierarchy Placement Comparison

Settlement - centre of service	Difference in hierarchy public vs private	Settlement - centre of service	Difference in hierarchy public vs private
Kranea Elassonas	-14	Oihalia	-1
Zagora	-12	Sourpi	-1
Palamas	-6	Farsala	1
Ampelonas	-5	Elassona	1
Nea Aghialos	-4	Farkadona	1
Agria	-4	Giannouli	2
Livadi	-4	Gonoi	2
Sofades	-3	Kalampaka	4
Tyrnavos	-2	Agia	6
Almyros	-2	Velestino	7
Moyzaki	-1	Megala Kalyvia	9
Sykourio	-1	Karditsomagoula	14
Nikaia	-1	Dimini	14

4. Conclusions

The role of urban centres is crucial in the configuration of any urban system, such as in the case of Greek. This comes as a result of relationships created between centres, cities and the neighbouring settlements that they serve, formulating urban clusters which strengthen the overall developmental process. In order to better define and manage urban concentrations, new methods, techniques, models and indicators of spatial analysis are needed in a robust decision to support a methodological framework, which could be applied to different scales of urban and regional planning. Furthermore, there is no doubt that the geographical location of urban centres and their relations with neighbouring settlements constitute two of the most important parameters influencing their diachronic development. Such direct or indirect relations acquire greater importance with respect to the size of both the urban centre and the neighbouring settlements which they serve. In this paper, a methodological framework for the analysis and comparative evaluation of service areas of urban centres was determined, mainly based on their topological and institutional characteristics and applied to the region of Thessaly, Greece. Moreover, the proposed methodological approach is strengthened by the formation of a comparative indicator of

urban concentration (UCI) which, while assisting the analysis of urban clusters, constitutes an alternative estimator of their role.

The overall effectiveness of the approach is dependent on the type and the volume of initial information and the quality of the variables taken into consideration. Furthermore, by examining the phenomenon of urban clusters, it can be stated that their diachronic development and degree of growth are influenced, and in most cases are determined, by the number of facilities and services located in any settlement. In this manner, a major city with significant population size, number of services and an efficient road network attracts settlements with ain critical distance, while in the opposite case isolation can be observed. The resolution of such problems although not in the objectives of this study, can stem from the reformation of performed regional policies and the redefinition of various political and developmental objectives from the corresponding agencies and institutions.

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