"Urban clustering and residential concentration pattern assessment in a GIS environment. Application to the Region of Thessaly, Greece"

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INTRODUCTION

During the last 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 in 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 the last years to the appearance of regional inequalities and many researchers tried to interpret them through different scientific approaches. In most cases, they focused on the application of methods and techniques as well as in the formulation of models while seeking a theoretical framework. First, it was Plato's ideas (4th century BC) concerning the role of urban centres, who stated that the ideal size of cities can be calculated with mathematic models (Pangle, 1979). In the mid '60s Doxiadis (1964), defined "*cities–states"* according to 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 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 main 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 finally for the localisation or determination of urban clusters. Since this framework is mainly based on methods and techniques of spatial analysis can constitute an important tool in the interpretation of urban totals and settlements concentrations In this objective contributes selected use of existing,.

1. THEORETIC AND EMPIRICAL APPROACHES

Operations and activities that are developed in the interior of settlements and at extension of cities, play an important role in the development of urban environment. At the same time they influence the relations of people and create various problems, while they 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 becomes 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 place the bases for the interpretation of 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)

1.) Quantification of needs and opportunities that offers each geographic region or locality, for the distribution of resources.
2.) Placement of that terms with which can exist improvement of an area with public political intervention.
3.) Recognition of the most important opportunities and problems for each area as base 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. Last years sustainability 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 causes and consequences of cluster in these sectors differ enough with result the existence of various types of clusters, 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* describes mainly 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 effort for the interpretation of the above phenomenon began at 4 century b.C. when Platon 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 sizes of cities depend on movements realised between sunshine and sundown. Thus for the median city the distance from the borders should not exceed a 4-hour walking, for a small city 1-hour and 7-hour for major cities. Three more definitions of the size of 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 a significant economic growth. (see Table 1)

Table 1: *Empiric approaches for the determination of ideal city*

Writer	Year	Characteristics of ideal city
Platon	4 century b.C.	5040 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.

1.1 CENTRAL PLACE THEORY

The first consideration of the above parameters came with the introduction of central place theory by Christaller. According to this 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. To them belong 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)

1.2 THE CLUSTERS IN THE BARREN AREAS (GOLANY)

As stated by Golany (1982) the role of urban clusters becomes important by contributing to the reduction of 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.

1.3 STATISTICAL ANALYSIS OF URBAN CLUSTERS (KRAKOVER)

Another interesting formulation came from Krakover (1987) who analyzed the advantages and disadvantages of urban clusters by using statistical data for Northern Carolina and the Piedmont, Philadelphia in U.S.A. He managed to define two distinct stages of growth for the cities that are constitute urban clusters:

- At 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 in the suburbs. In the opposite case such an economic diffusion is less possible to appear in a cluster of smaller cities.

1.4 INDEX OF CLUSTERING (PORTNOV AND ERELL)

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 if 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,

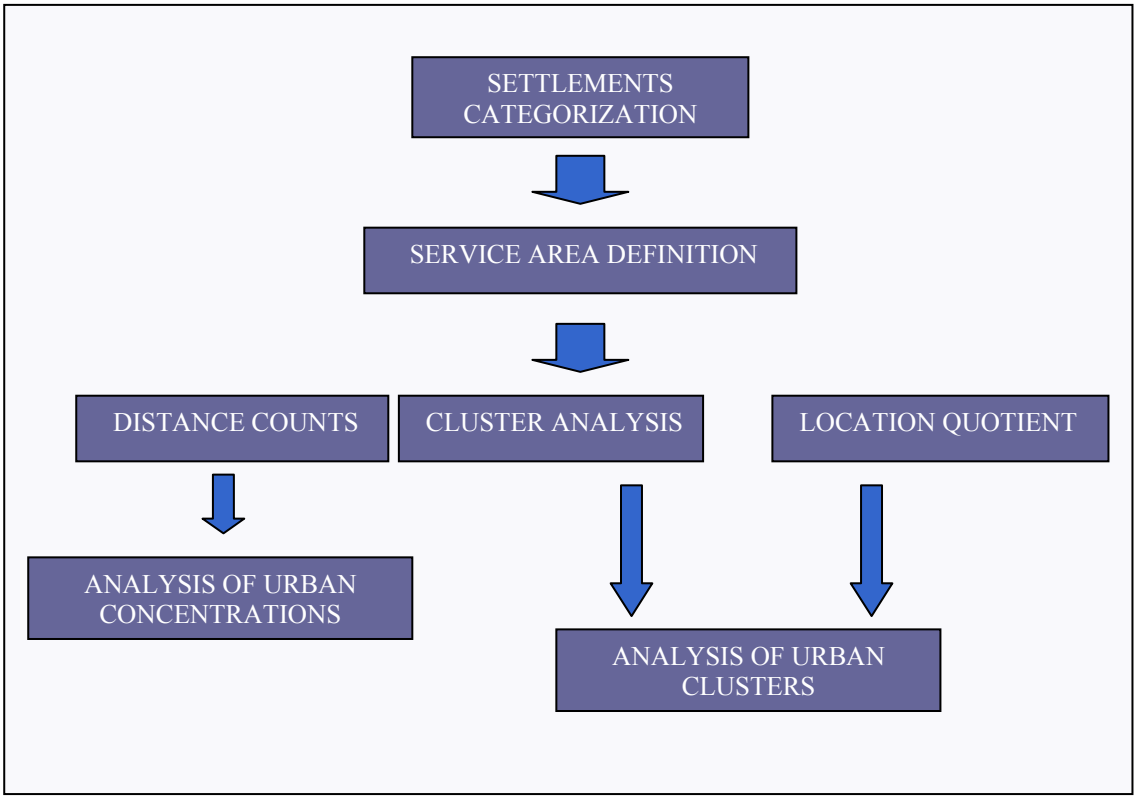
IR = the distance from the central city and

IS = the isolation.

2. METHODOLOGY

According to the proposed methodology, the study of relations between settlements and central cities can be achieved with the application of the following framework (Figure 1).

Figure 1: Diagram of Methodological Framework



The first step of the approach is the categorisation of settlements aimed 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 corresponds to the term urban. Then service areas are calculated based on the each settlement's network accessibility cost (time or distance). In the GIS environment and with respect to road network arcs, data should be available about their length and the category they belong by means of average speed. Then time costs can be estimated.

After the determination of service areas methods and techniques of spatial analysis are applied in order to define urban clusters that exist in the study area. To this end, urban concentrations are assessed and then urban clusters evaluated.

The definition of urban concentrations is realised with the application of the *distance counts* method (Unwin, 1978), 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 urban clusters is realised via two methods. Firstly, a location quotient is used in order to compare each centre's serviceability with overall region's performance which then can be used as a indicator from which settlement clusters can be evaluated. The second method is the *cluster analysis*. The application of the 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 degree around each settlement in the study area. The variables utilised refer to critical service characteristics of each settlement–centre representing its importance in the study area.

3. METHODS AND TECHNIQUES OF ANALYSIS

Since clusters are critical to the field of Geography for the interpretation of phenomena at both the urban and the rural level, methods and techniques from the quantitative spatial analysis toolbox are needed. The validity of the methods and the effectiveness of the proposed methodological framework were evaluated during their application for the definition of urban clusters in the region of Thessaly, Greece. The specific region due to its morphology, inadequate and old road network as well as its sometimes extreme climate and weather conditions is an intriguing candidate.

3.1 SERVICE AREA

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 at a specific network radius. This task is performed in a GIS environment by the use of specific functions and routines.

3.2 DISTANCE COUNTS

The distance counts method is the set of settlements (points) that belong to each centre's service area attributing at the same time an altitude value for each centre. Consequently, its three-dimensional study and representation is feasible in a GIS environment, by graphically sketching out

the study area and getting a different perspective which can then utilised at the analysis and interpretation stages of the approach. (Photis, 2002)

3.3 LOCATION QUOTIENT

The results from each service area network can lead to further conclusions about the grouping of settlements, with the use of location quotient, which constitutes an indicator that measures the size at which certain parts of an area deviate from the average of the region they belong to (equation 2).

$$LQ = (x_i / x_j) / (\sum x_i / \sum x_j) \qquad (2)$$

where x_i = variable i in area x

$\sum x_i$ = sum of variable i in the region

x_j = value of variable j in area x

$\sum x_j$ = sum of variable j in the region

When LQ values are greater that 1, represent high concentrations, while smaller than 1 values represent low concentrations. In the case where LQ equals 1 the area and the region have the same ratio. (Photis, 2002)

3.4 CLUSTER ANALYSIS

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 thy begin from groups equal in number and progressively merge similar groups until a team which includes the total number of cases is formulated and bisectional, which begin from a set that contains the total of cases and progressively remove the most remote cases, creating a new set and redistributing every other case, until a predetermined number of groups is formulated optimally. (Maloutas, 1994)

4. APPLICATION: SPATIAL ANALYSIS OF URBAN CONCENTRATIONS IN THE REGION OF THESSALY

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

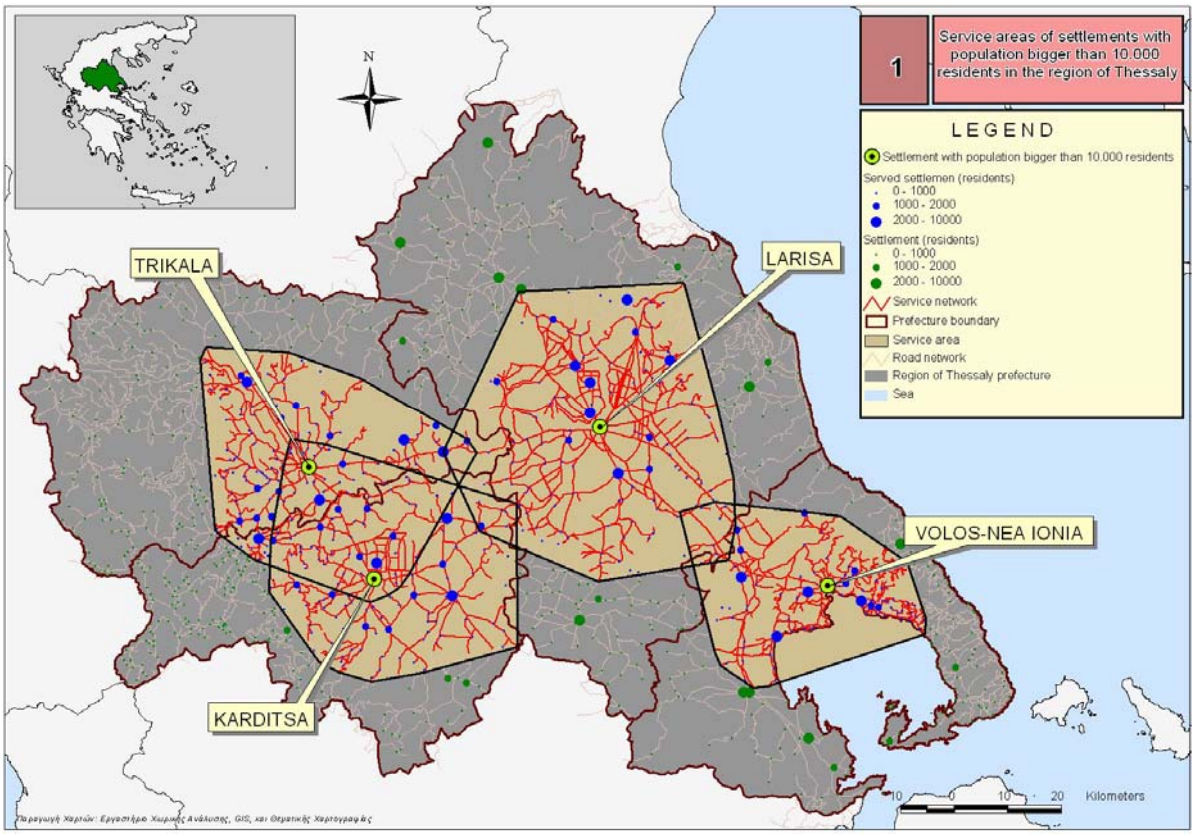
- Settlements with population less than 2.000 residents (922).
- Settlements with population more than 2.000 and less than 10.000 residents (27).
- Settlements with population more than 10.000 residents (6).

According to the approach the 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):

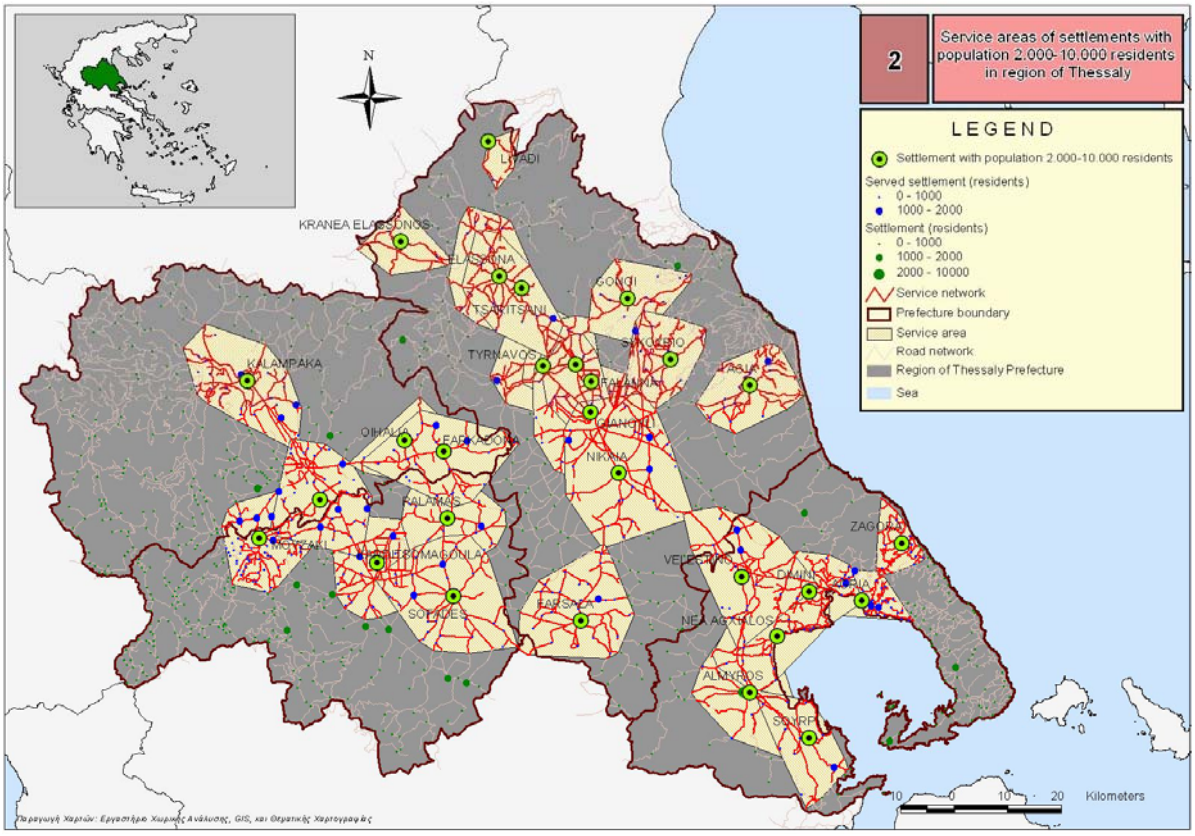
- 1st category, in which the E-75 highway belongs with average speed 120 Km/h
- 2nd category, in which the E-90 motorway belongs with average speed 100 Km/h
- 3rd category, in which the rest national road network belongs with average speed 70 Km/h

- Using Network Analyst Extension, of the ArcView 3.2 Geographic Information System, service areas were calculated for the two major categories of settlements which are shown in maps 1 and 2. Time-cost (service radius) was set to 20 minutes from each settlement-centre with population more than 10.000 residents, and 10 minutes from each settlement-centre with population between 2.000 and 10.000 residents. Assigning in this respect, the different capacity and influence possibility of settlements which directly affect spatial concentrations in the region. It should be added that settlements with population more than 10.000 residents incorporate facilities and services that sometimes are unique in each of the four prefectures (i.e. hospitals).

Map 1: Service areas of settlements with population bigger than 10.000 residents in the Region of Thessaly



Map 2: Service areas of settlements with population 2.000-10.000 residents in the Region of Thessaly

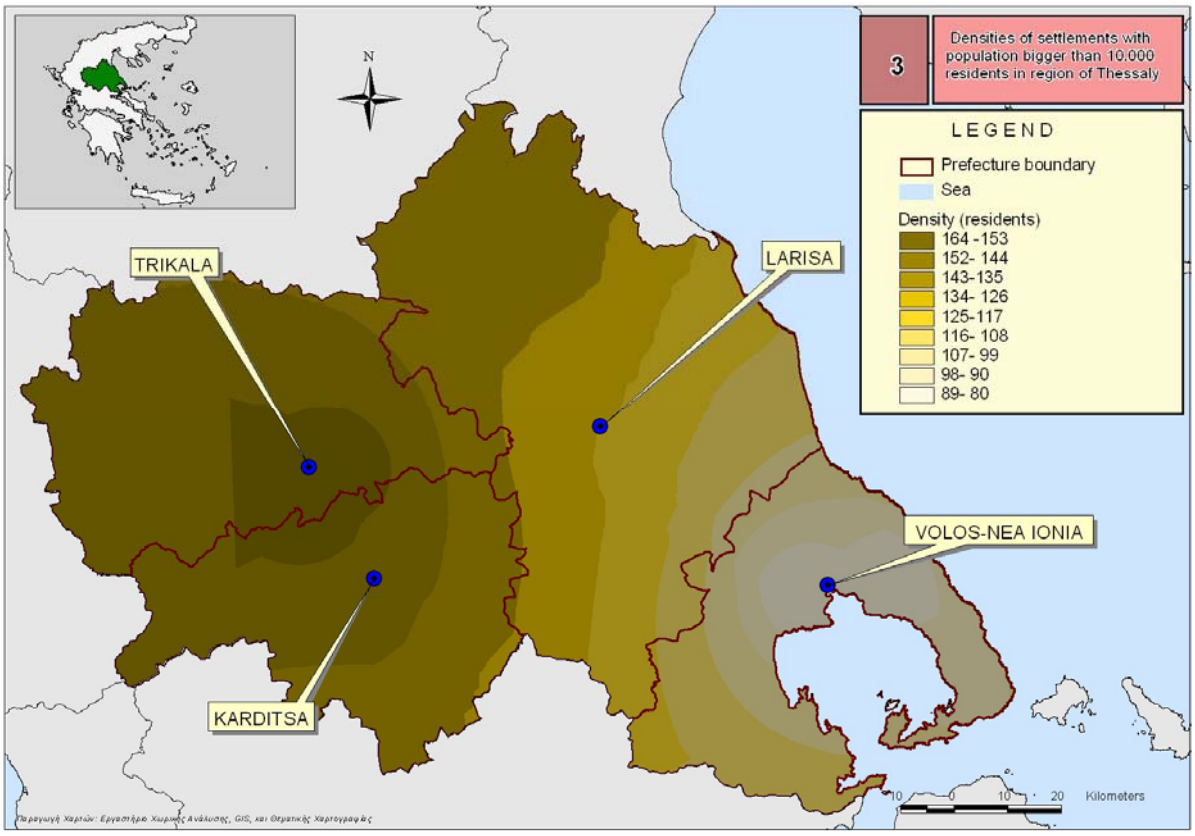


4. 1 SPATIAL ANALYSIS OF SETTLEMENTS CONCENTRATIONS

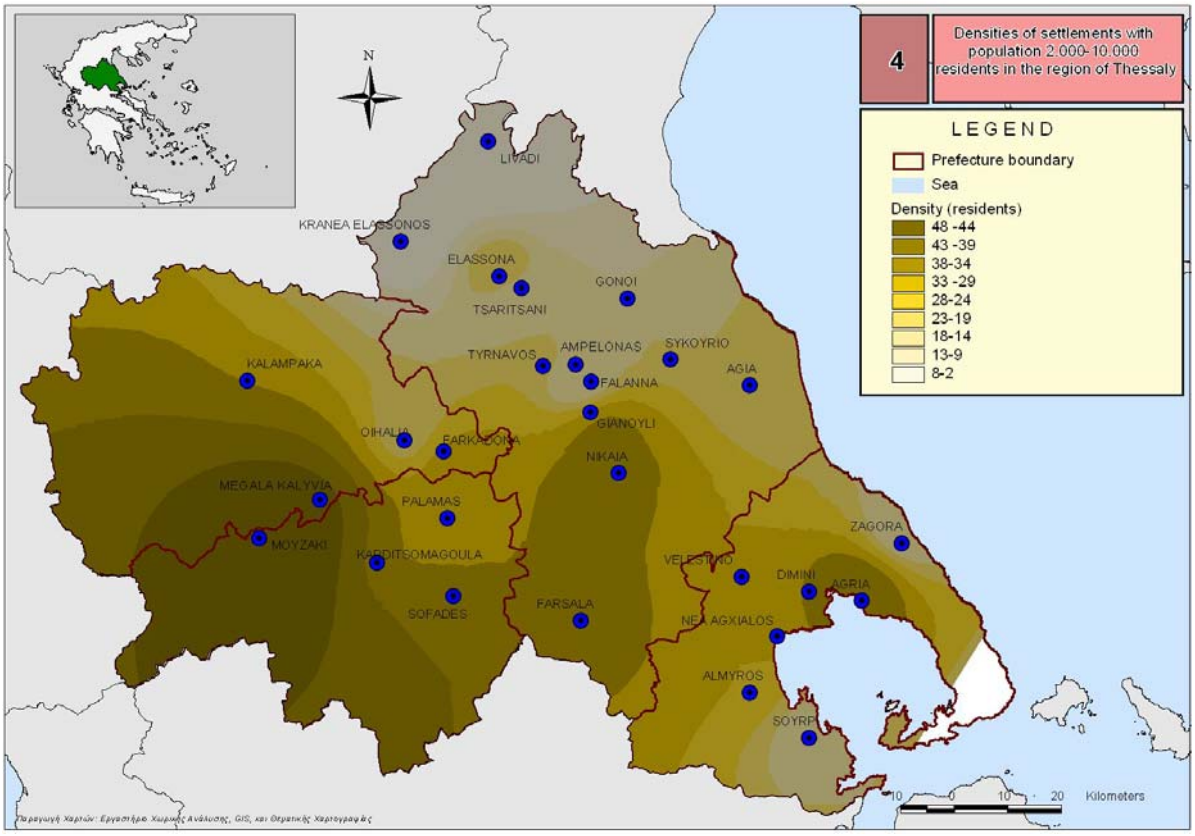
With the determination of service areas for each settlement–centre additional data are created and added to the database about the number of settlements covered, the total population served, the percentages of road network per category and the size of the coverage area. After the application of the distance-counts method with the use of the ArcGis Geostatistical Analyst, maps 3 and 4 were created which showing the density of settlements differentiations in the region.

More specifically, in map 3 it is realised that for the settlements with population more than 10.000 residents, in the prefectures of Trikala and Karditsa the number of served settlements is more than 130, while in the counties of Larisa and Magnesia this number is smaller and reaches up to the 80 settlements. In map 4 the picture largely changes for centres with population 2.000-10.000 residents. Higher concentrations, exceeding 25 served settlements on average, are observed in the western parts of 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 side lower concentrations, with less than 20 served settlements, are observed in the northern part of the prefecture of Larissa.

Map 3: Densities of settlements with population 10.000 and more in the Region of Thessaly.



Map 4: Densities of settlements with population 2.000-10.000 residents in the Region of Thessaly.



4.2 ANALYSIS OF URBAN CONCENTRATIONS

According to chapter 3 of this paper, the determination of service areas and the database update constitute the first step for the examination of Thessaly's urban clusters. For the purposes of the specific study different techniques will be applied to the two categories of settlements since in principle, represent cities with significantly varying in number, population and service characteristics. Thus, for settlements with population more than 10.000 the location quotient will be calculated, comparing in fact, settlements–centres with the whole region. For the other category, K-means cluster analysis will be applied.

4.2.1 SETTLEMENTS WITH MORE THAN 10.000 RESIDENTS

With respect to service areas for settlements–centres of 10.000 residents and more the following table is constructed.

Table 2 : Service Data for settlements with more than 10.000 residents[1]

Settlement - centre of service	Karditsa	Larissa	Volos - Nea Ionia	Trikala	Region
Population 2001	32.031	124.394	113.243	48.686	737.423
Population 1961	23.708	55.391	67.424	27.876	670.545
Population 1971	25.685	72.336	71.245	34.794	640.489
Population 1981	27.291	102.048	97.251	40.857	681.098
Population 1991	30.067	112.777	107.996	44.232	719.401
Population change 61-71	7,7	23,4	4	19,9	-5,3
Population change 71-81	5,9	29,1	28,1	14,8	5,1
Population change 81-91	9,2	9,5	7,5	7,6	5,3
Population change 91-2001	6,1	9,3	6,4	9,1	2,53
Medium Population change	7,2	17,8	11,5	12,8	1,9
Total of population that is served	89.529	82.697	45.377	98.480	646.617
Total of settlements that is served	143	124	78	162	951
Settlements with 0-1000 residents	124	108	67	138	875
Settlements with 1000-2000 residents	15	8	7	18	48
Settlements with 2000-10000 residents	4	8	4	6	28
Settlements that intercovered	76	14	6	72	0
Population that intercovered	47.160	8.495	2.244	48.679	0
Area of covered surface (in km^2)	1.724	2.475	1.176	1.782	13.773
Total length of road network (in m.)	942.906	1.326.953	636.889	1.002.687	8.119.801

Using the data of the above table various indicators were calculated according to the location quotient structure, in order to comparatively evaluate the region with its four larger urban areas as well as each centre with the others. The results are presented in the following table.

[1] Data refer to Thessaly's continental area.

The indicators that were calculated aim to evaluate the particular characteristics of the four larger urban centres, taking into consideration the number of served settlements and also to reflect their diachronic evolvement and development. The results of calculation of indicators are presented in the table 3.

Table 3: Location quotients for settlements with more than 10.000 residents

Location quotient	Larissa	Volos - Nea Ionia	Karditsa	Trikala
1. Settlements of service/Population of service	1,020	1,169	1,086	1,118
2. Settlements of service of/road network	0,798	1,046	1,295	1,379
3. Settlements of service of/surface of service	0,726	0,960	1,201	1,316
4. Road network/surface of service	0,909	0,918	0,927	0,954
5. Settlements of service (0-1000 residents.) / Total of Settlements of service	0,947	0,934	0,942	0,926
6. Settlements of service (1000-2000 residents) / Total of Settlements of service	1,278	1,778	2,078	2,201
7. Settlements of service (2000-10000 residents) / Total of Settlements of service	2,191	1,742	0,950	1,258
8.% change (' 91-2001)/population 2001	21,791	16,473	55,508	54,480
9. % change ('91-2001)/Population of service	0,035	0,028	0,057	0,042
10. Settlements of service/Population 2001	0,773	0,534	3,462	2,580
11. Population 1961/population 2001	1,902	2,315	0,814	0,957
12. Population 1971/population 2001	2,600	2,561	0,923	1,251
13. Population 1981/population 2001	3,449	3,287	0,922	1,381
14. Population 1991/population 2001	3,609	3,456	0,962	1,416

According to location quotient data for the first four indicators values are near 1, with those for Trikala and Karditsa more deviated than those of Larissa and Volos-Nea Ionia. For the rest indicators values significantly differ from 1 whilst Trikala and Karditsa represent the most extreme cases. From the above, it can be stated that location quotient can give an initial estimate for the existence as well as the importance of urban clusters in the region of Thessaly. At the same time it can constitute an important evaluator for their diachronic development mainly based on their population which could be optimised if successive road network data could be found.

4.2.2 SETTLEMENTS WITH 2.000-10.000 RESIDENTS

In the second category of settlements with population 2.000-10.000 residents the method of K-means cluster analysis was applied through the utilisation of SPSS 11.0. Settlements were grouped into four categories with respect to a set of variables, that describe their service status and potential (tables 4 and 5).

Table 4: K-means clusters of settlements with 2.000-10.000 residents

1	2	3	4
Tyrnavos	Velestino	Agia	Agria
Farsala	Gonoi	Zagora	Almyros
	Dimini	Kranea Elassonos	Ampelonas
	Karditsomagoyla	Moyzaki	Giannoyli
	Livadi	Sykoyrio	Elassona
	Megala Kalyvia	Falanna	Kalampaka
	Ojhalia		Nea Aghialos
	Soyrpi		Palamas
	Tsaritsani		Sofades
	Farkadona		
	Nikaia		

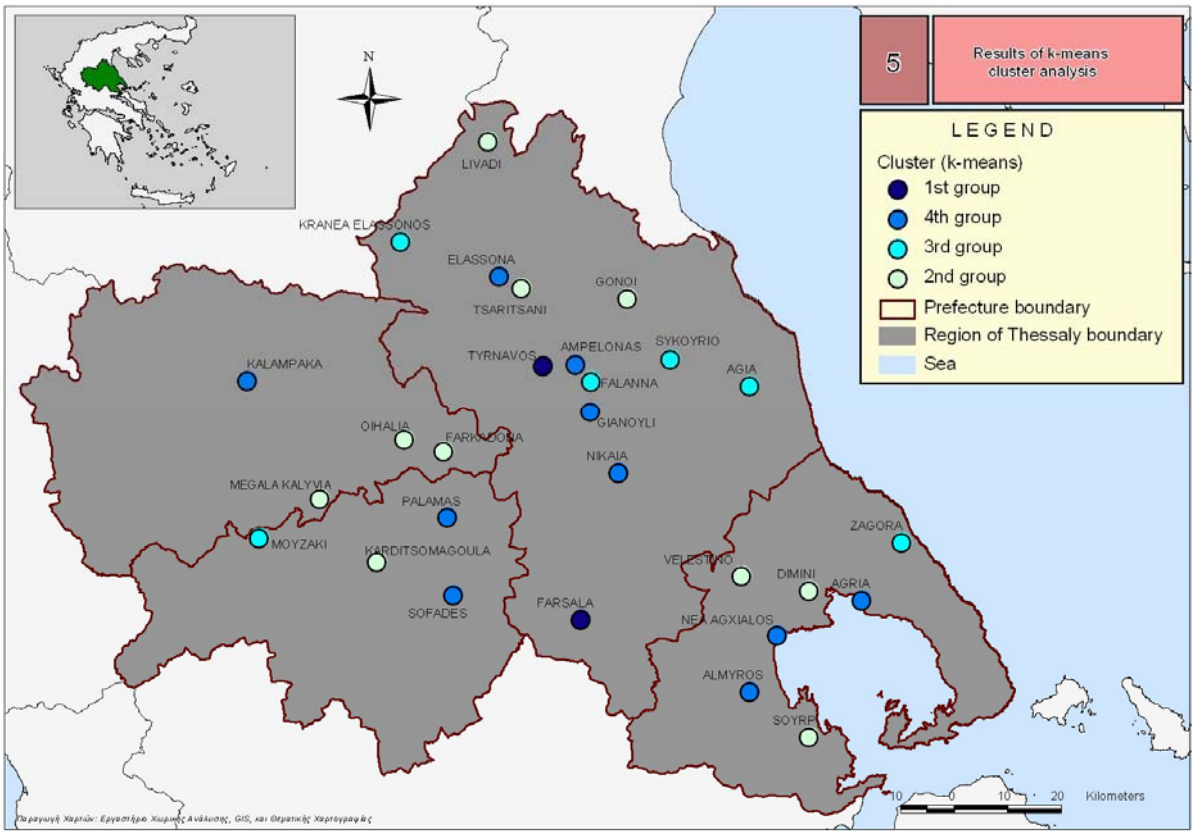
Table 5: Cluster characteristics for settlements with 2.000-10.000 residents

	1	2	3	4
Population	10.458,5	2.516,4	2.722,2	6.293,6
Settlements of service/population of service	0,00243	0,00196	0,00246	0,00244
Medium Population change	5,3	0,0	-0,8	9,9
Medium distance from the settlement	9.727,6	9.840,5	7.402,1	9.557,8
Length of road network /surface	0,00055	0,00056	0,00073	0,00062
Education	16,5	4,5	6,0	10,9
Emergency	2,0	1,7	1,8	2,1
Culture	2,5	2,1	2,8	3,4
Sports	3,0	1,6	2,2	3,2

Examining the above two tables it appears that groups 1 and 4 include settlements that constitute the major centres of service. The first group which has an average population of 10.500 residents and shows significant services usage and population change values. The fourth group has similar characteristics with those of the first while in certain cases, as in cultural services and population change is at higher level. Counterwise, the other two groups exhibit different and in most cases lower service levels than groups one and four formulating in this respect, the following settlement-centre hierarchy: Group 1 – Group 4 – Group 3 – Group 2. (Map 5)

The general conclusion from the use of K-means cluster analysis is that the resulting groups can be characterized as urban clusters, showing at the same time and the degree of their diachronic development. It should be pointed however that with respect to the group they belong to Velestino, Farkadona and Giannoyli constitute special cases since the first two settlements are well established centres while Velestino is one of the most important industrial areas in the study region.

Map 5: K–means clusters of settlements



4.3 URBAN CONCENTRATION INDICATOR (UCI)

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

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

where
j = 1,…, M service centres

i = 1,…, N settlements served (inside region I)

P = population of each settlement or centre of service

C = number of cultural services

E = number of educational services

Em = number of emergency services (hospital, fire brigade, police department etc)

m_j = average distance travelled, $m_j = \frac{\sum d_{ij}}{N}$ where d_{ij} the distance between i and j

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

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 cultural, educational and emergency. services that it offers. Based on the UCI the settlements with population 2.000-10.000 residents were ranked and the results appear in Table 6 and Map 6.

Table 6: Urban concentration indicator for settlements with population 2.000-10.000 residents

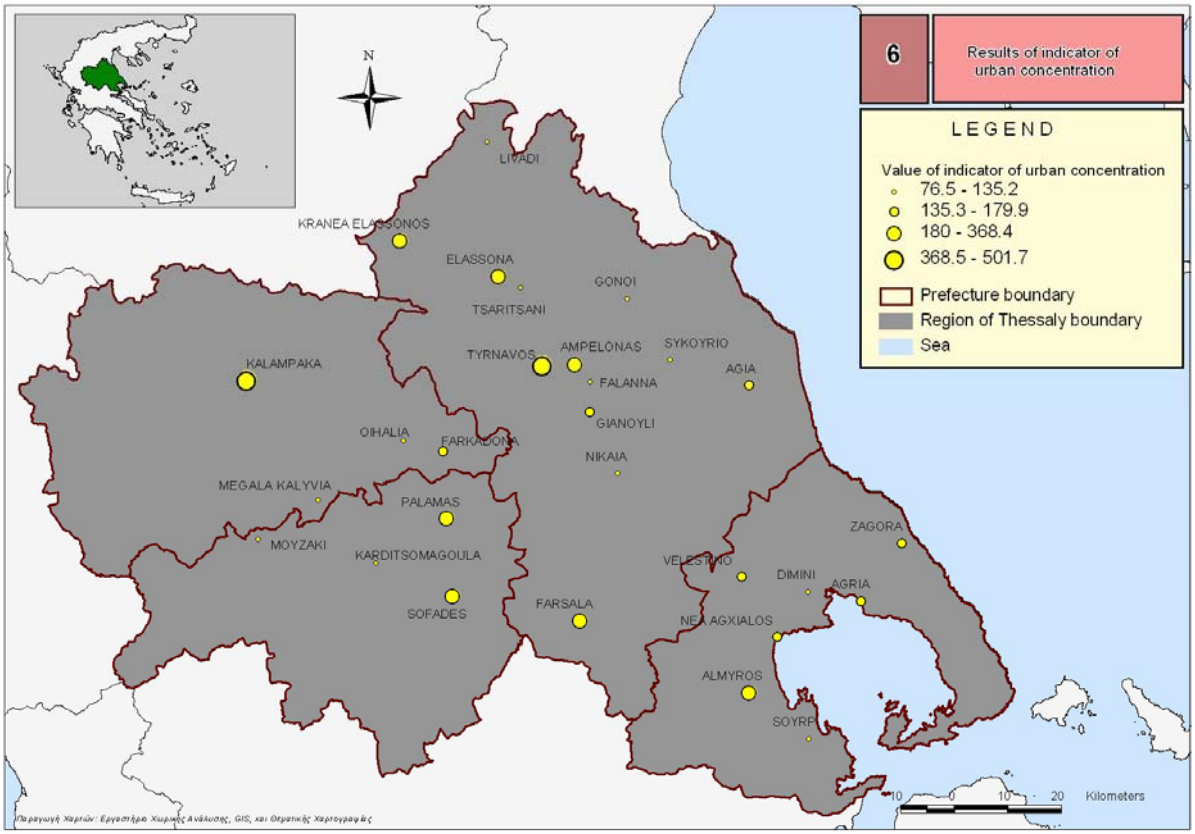
Settlement - centre of service	Indicator of urban concetration	Settlement - centre of service	Indicator of urban concetration
Tyrnavos	501,68	**Agia**	154,96
Kalampaka	368,60	**Zagora**	148,45
Farsala	329,17	**Nikaia**	135,17
Elassona	319,04	**Oihalia**	129,59
Almyros	316,15	**Karditsomagoyla**	127,13
Ampelonas	289,96	**Falanna**	126,10
Sofades	263,20	**Sykoyrio**	124,32
Palamas	260,73	**Moyzaki**	121,77
Kranea Elassonos	257,97	**Soyrpi**	118,04
Agria	179,87	**livadi**	116,13
Nea Aghialos	171,04	**Megala Kalyvia**	106,34
Giannoyli	165,54	**Tsaritsani**	100,42
Velestino	162,90	**Dimini**	86,12
Farkadona	162,09	**Gonoi**	76,50

From the resulting hierarchy groups of settlements can be formulated determining corresponding urban clusters. Furthermore, by comparing the indicator values with the results of initial analysis and mainly the cluster analysis of table 4, it is evident that to the greater extent the two approaches reach the same grouping of settlements. (Table 7 and Map 7)

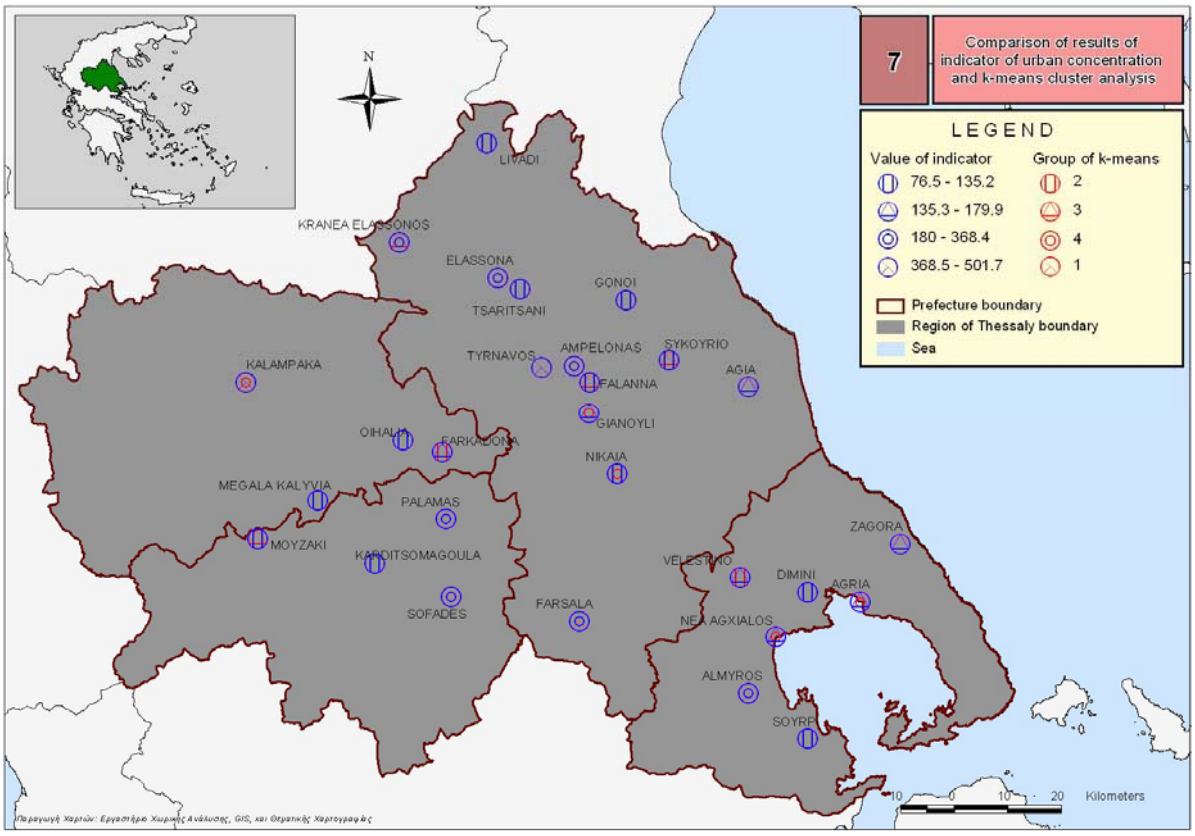
Table 7: Comparison of indicator of urban concentration and K - means cluster analysis

Settlement - centre of service	K-means cluster analysis	Indicator of urban concentration	Settlement - centre of service	K-means cluster analysis	Indicator of urban concentration
Tyrnavos	1	501,68	**Agia**	3	154,96
Kalampaka	4	368,60	**Zagora**	3	148,45
Farsala	1	329,17	**Nikaia**	2	135,17
Elassona	4	319,04	**Oihalia**	2	129,59
Almyros	4	316,15	**Karditsomagoyla**	2	127,13
Ampelonas	4	289,96	**Falanna**	3	126,10
Sofades	4	263,20	**Sykoyrio**	3	124,32
Palamas	4	260,73	**Moyzaki**	3	121,77
Kranea Elassonos	3	257,97	**Soyrpi**	2	118,04
Agria	4	179,87	**livadi**	2	116,13
Nea Aghialos	4	171,04	**Megala Kalyvia**	2	106,34
Giannoyli	4	165,54	**Tsaritsani**	2	100,42
Velestino	2	162,90	**Dimini**	2	86,12
Farkadona	2	162,09	**Gonoi**	2	76,50

Map 6: Results of Indicator of Urban Concentration



Map 7: Comparison of results of Indicator of Urban Concentration and k - means cluster analysis



Comparing the results of the two approaches and with regard to settlements ranking and grouping a first conclusion is that Velestino, Giannoyli and Farkadona are assigned to clusters closer to their pragmatic status in the region with Velestino and Farkadona constituting more important centres than Giannoyli. Moreover, the initial interpretation of clusters and the resulting ranking of settlements-centres led to similar results which coincide with their role and potential in the region of Thessaly.

5. CONCLUSIONS

The role of urban centres is crucial in the configuration of any urban system so as in the case of Greek. This comes as result of relations created between centres, cities and neighbouring settlements that they serve, formulating urban clusters, 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 an robust decision support 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 to the type and the volume of initial information and the quality of 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 service located in any settlement. In this manner, a major city with significant population size, number of services and efficient road network attracts settlements in 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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