XXIX CONFERENZA ITALIANA DI SCIENZE REGIONALI

HIERARCHICAL ANALYSIS AND AGGREGATION OF TERRITORIAL UNITS: A COMPARATIVE STUDY CASE

Barbara Barboni

Dipartimento di Ingegneria Civile – Università di Roma Tor Vergata

ABSTRACT

This work presents a second step of a wide research in regionalisation that has been proposed in 2006. The aim of the research was the development and the implementation of a methodology to define regions at local level (Local Administrative Units – Level 1), according with the "Nomenclature of Statistical Territorial Units" at European Level.
To achieve this objective, a particular point of view has been adopted; it looks at territory as an urban system composed by many local territorial structures potentially LAU 1. The implementation on Italian case showed good results in terms of the effectiveness. However, the complexity structure of the Italian territory played a role in fitting the hierarchical approach adopted in the study. To verify the consistency of the procedure in itself, the same methodology has been applied in a very different territorial context: the Republic of Ireland. First, the evaluation of the consistency and the semantic of the model have been done. After that, technical problems have to be faced to implement the procedure due to the different territorial context. From a technical point of view, the results show that the procedure works well if the lowest level of the demographic size is around 10.000 inhabitants against the 40.000 inhabitants found in Italy. At the same time, the Irish context seems to be quite polarised around five great urban (Dublin, Cork, Galway, Limerick and Waterford); on the contrary, the internal areas – mainly rural areas – seem to be naturally clustered within a weak hierarchical structure.

Keywords: Hierarchical structure, polarisation, demographic size, local level

1 Background

This work presents a second step of a wide research in regionalisation that has been proposed in 2006 (Barboni and Schiavoni, 2006). The aim of the research was the development and the implementation of a methodology to define regions at local level (Local Administrative Units – Level 1), according with the "Nomenclature of Statistical Territorial Units" at European Level.

The discussion on a more detailed and homogeneous territorial subdivision is ongoing in the last few years, to improve and strengthen the statistics useful for European policies. In this context, it was required a regionalisation methodology easy to implement across Europe. Due to the wide range of topics covered by European policies, the nature of territorial units should have been general and not referring to a specific field of activity (EC, 2003). The complexity and heterogeneity of the European territory suggested to open a call for identify a methodology to define regions across Europe, in order to avoid disparities between different contexts. Furthermore, it has been stated that existing administrative partitions should have been respected by the new territorial units. For example, in Italy they have to be defined between NUTS 3 level (the Italian Provinces) and LAU 2 (the Italian municipalities). Furthermore, the maximum demographic size was fixed around 50.000 inhabitants.

1.1 The theoretical approach and the model

Within this framework, a particular point of view has been adopted; it looks at territory as an urban system composed by many local territorial structures; they could be seen as potential LAU 1. That is quite different from what is the main approach to regionalisation problem where a more or less complex objective function is assumed and objects are aggregated to minimise or maximise it. Of course, the last approach is the correct one when defining functional regions or when identify regions is a classification problem projected in the geographical space (Vallega, 1989).

Looking at territory as a structure requires the identification of principles underlying the structure in itself. Rather than looking at phenomena, we found useful to take into account human processes performed on territory so that it results from a combination natural characteristics and the output of human activities (living, working, moving, travelling, etc.).

The point is that the territory has a certain degree of inertia to modify itself and relevant changes are only visible in the long period. Some modifications could be temporary and not very deep depending on historical conditions; however, we think that under the skin the territory is organised in a hierarchical way reflecting the stratifications of long term processes

insisting on the geographical space. It means that two urban centres are connected in the territorial structure if there is a difference in their rank level and they are close each other more than with other urban centres.

Within this framework, we developed a double-step methodology: first, the construction of the hierarchical-geographical tree and, second, the segmentation of the tree under demographic size conditions. The sequence of processing steps (Fig. 1) consists of:

- the urban centres are ranked by population ;
- they are processed one by one within a defined spatial extent (e.g. provinces); each of them is linked with the closer centre higher in the hierarchy;
- the hierarchical-geographical tree is segmented to identify the LAU1.

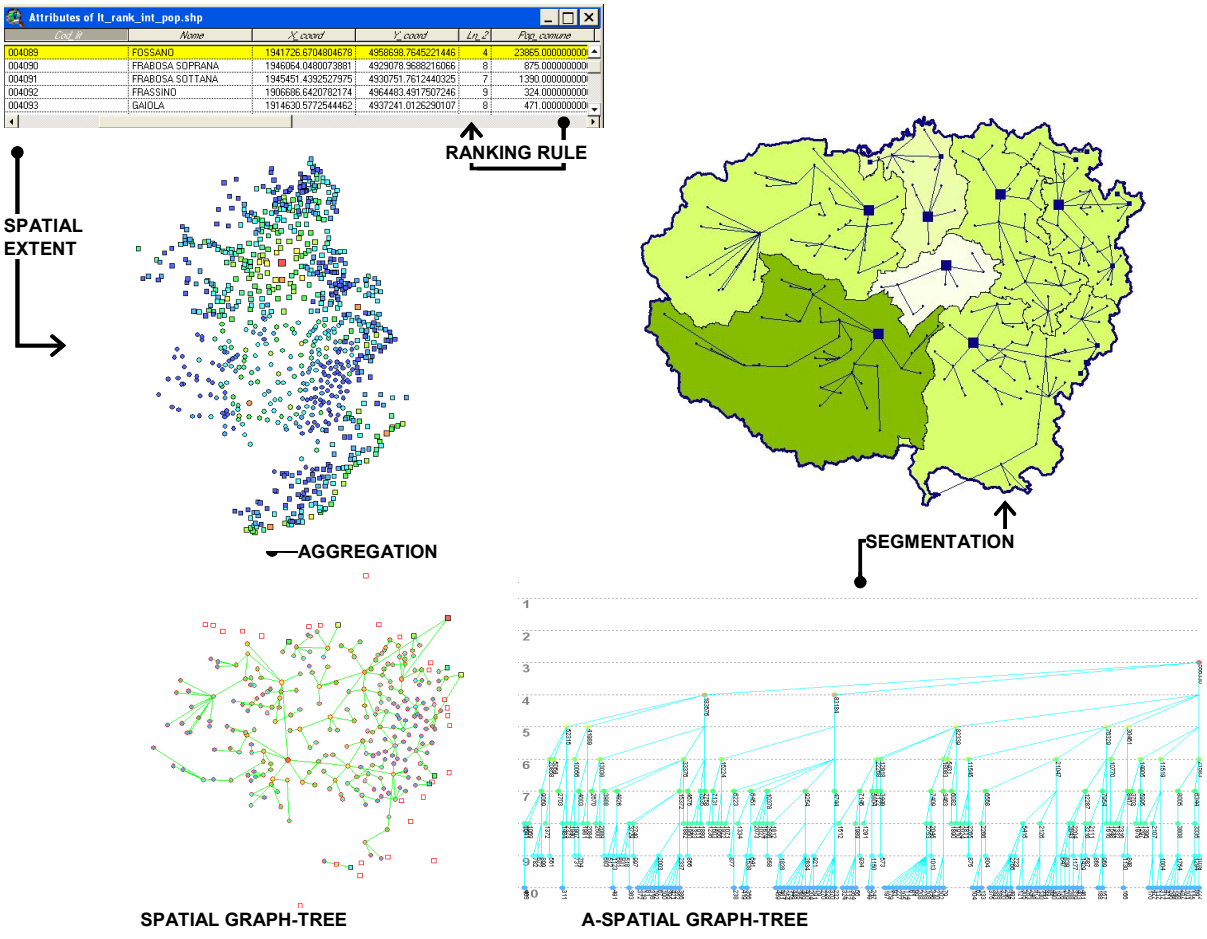


Figure 1. The processing flow

The model structure allowed us to implement different processing options; we implemented two kind of hierarchical rules (Rank-Size and Demographic Intervals), two spatial extent

(single province and contiguous provinces), two distance metric (geometric distance and road network distance), bottom-up and top-down approach to segmentation.

1.2 The Italian case: main findings

The implementation on Italian case has been useful to analyse and understand the complex mechanism of aggregation and segmentation by many aspects and gave us insights on the territorial structure. For example, the Italian provinces are organised by a hierarchy resulting from a single vertex of the hierarchical-geographical tree.

However, the main finding has been the good response of the methodology in terms of effectiveness. Depending on the processing schema, the share of segmented territory varies form 65% to 89% in terms of number of aggregated municipalities. It's a relevant result if considering that there are many centres with a population over the upper limit of the demographic range for LAU1. To define the 'best' choice of processing schema, 32 alternatives (resulting from all combination of options) have been measured by four dimension (% aggregated communes, % aggregated population, % aggregated area, % of not continuous LAU1), to separate the incidence of each processing option.

Basically, the alternatives are clustered depending on the demographic range. The effectiveness values vary from 60% (range 50.000 – 150.000 inh.) to 80 % (40.000 – 160.000 inh.). In general, the Bottom – Up approach generates more regions than the Top-Down approach characterised by a smaller demographic size; the distance metric did not play a significant role and the geographical continuity of LAU1 has been achieved without imposition if a contiguity constraint. In fact, the aggregation and segmentation steps don't include any rule about contiguity between communes subject to aggregation or between leaves navigated by the segmentation algorithm. Despite, the share of not internally continuous LAU1 is around 15% in the worst case. This is particularly surprising while considering that the 9% of municipal boundaries are not continuous (due to old civic use of territory in many cases).

Taking into account both the European rules for LAU1 (they have to be included in provincial boundaries) both the territorial hypothesis (natural and human phenomena are not constrained by administrative boundaries); the best alternative is the pair of alternatives (inter-provincial and intra-provincial) with the lowest values. It is described by the following options: i) demographic intervals as ranking criterion; ii) not weighted geometric distance; iii) Bottom-Up segmentation.

Besides, this approach identifies structured units; each LAU1 is viewed as settlements' system organized in a hierarchical way. Consequently, the data gathering from the local level to the European level could be supported by the administrative organization already insisting on the territory. This is more important if we consider that every public or private strategy of

intervention on the territory is always dealing with the problem to understand the settlement's system. However, the "open" problems are: i) how to define the demographic range for the LAU1; ii) how identify sub-urban clusters (i.e. small settlements with a low rank level, immediately depending from a much bigger centre); iii) how subdivide the cities with a population of more then 150-200 thousands inhabitants.

2 The Irish context

Before discussing the results achieved by the implementation of the methodology in the Republic of Ireland, a brief introduction of Republic is presented. The description focuses on the last two decades, due to the extraordinary structural changes have been taken place in all relevant fields of human activities. By any standards, the Republic of Ireland (henceforth Ireland) is a country that has undergone enormous transformations since the start of the 1990s. Economically, socially, culturally, politically, environmentally, there have been profound changes to the Irish landscape and everyday life. The Celtic Tiger (that is the synthetic way to call the exceptional development and rate of growth of Ireland) is the envy for many nations. The booming economy has been studied by many analysts and planners to understand (and hopefully to emulate) how a radical transformation on a number of fronts is possible in a relatively short space of time. Six key trends and phenomena that underpin the occurred changes have been identified (Bartley and Kitchin, 2007):

- **social partnership and planning regime**; by making the social partners part of the political process, rather than being in opposition to it, negotiated settlement was achieved, thus providing long term and stable employer-employee relations. At the same time, the approach to planning started to be transformed to designate certain zones for regeneration using tax emption and public-private partnerships as a mechanism to encourage and drive development. Planning thus became more responsive to creating the environmentally and spatial conditions necessary to attracr inward investment.
- **foreign direct investment**; by providing favourable corporate tax rate, offering grant subsidies for the building of facilities, providing necessary resources and infrastructures. The Industrial Development Agency (IDA) focussed on high-skilled manufacturing encouraging them to locate their financial and business services, research and development, and marketing functions in Ireland.
- **the European Union**; by giving an opportunity to expand Irish markets and reducing the country's over-reliance on trade with Britain and by enabling Ireland to become a key gateway for US trade with EU. However the main impact has been in relation of receipt of financial transfer from EU funds. Ireland has developed an integrated approach in programming economic and spatial growth; the successive National

Development Plans (NDPs) have adapted to EU Cohesion Policy and incorporate the Community Support Framework (CSF) for EU Structural and Cohesion Funds. They move from an approach based on funding criteria (to maximise the potential funding) to a more systemic and strategic approach (long term) to investment based on a more suitable and enlightened view of resource planning and usage. Furthermore, many principles of the European Spatial Development Perspective have been incorporated into NDP and National Sptial Strategy (Egeraat et al., 2006).

- **the Peace process**; by creating political stability across the island and thus a favourable environment for investment. It also gave the impulse for a more coherent, all-island economy and enhanced cooperation between North and South.
- **secularisation and social change**, by changing patterns of wealth, consumption and lifestyle. The standard of living has increased dramatically over the past 15 years and has run ahead of population growth. Following this trend, Ireland has quickly become a consumer society due to the increasing wage levels and disposable income.
- **population change and increased mobility**; the overall growth in the economy and spatial unevenness of this growth has led to big population change and widening daily mobility patterns. Population change has been influenced by three key processes: general demographic variation, large-scale internal migration and net in-migration consisting of large-scale return migration and new migrants. There was a strong rural to urban flow of migrants, meaning that there was a decline in population in some rural areas, with strong growth in urban areas (Figure 2a). The demand is concentrated in the cities and their hinterlands. The Gateway cities (9 nodes identified by NSS) and their catchment areas included 73 per cent of population in 2002 and they are accounted for 83 per cent of population increase between 1996 and 2002. a large portion of this growth is located in the commuter areas as house price increases push housing development further away from city centres. This is particularly true for Dublin, Cork, Galway, Limerick and Waterford and it is reflected in the urban system of the Republic. The urban system is spatial unbalanced for historical reasons (industrialisation based-urbanisation in the North), the cross-border line has meant an uneven development between North and South where the last one has always played a secondary role in the island economy. Furthermore, there is a east-west differential broadly identifies ‘more-favoured south and east’ and ‘less-favoured north and west’ regions as defined in terms of land quality, historical settlement patterns, rural population density (Figure 2b)

The population density is around 48 inhabitants per km^2 (198 inh/ km^2 Italy) and the spatial extent of the Republic is 69.566,66 km^2 (301.870,80 km^2 Italy).

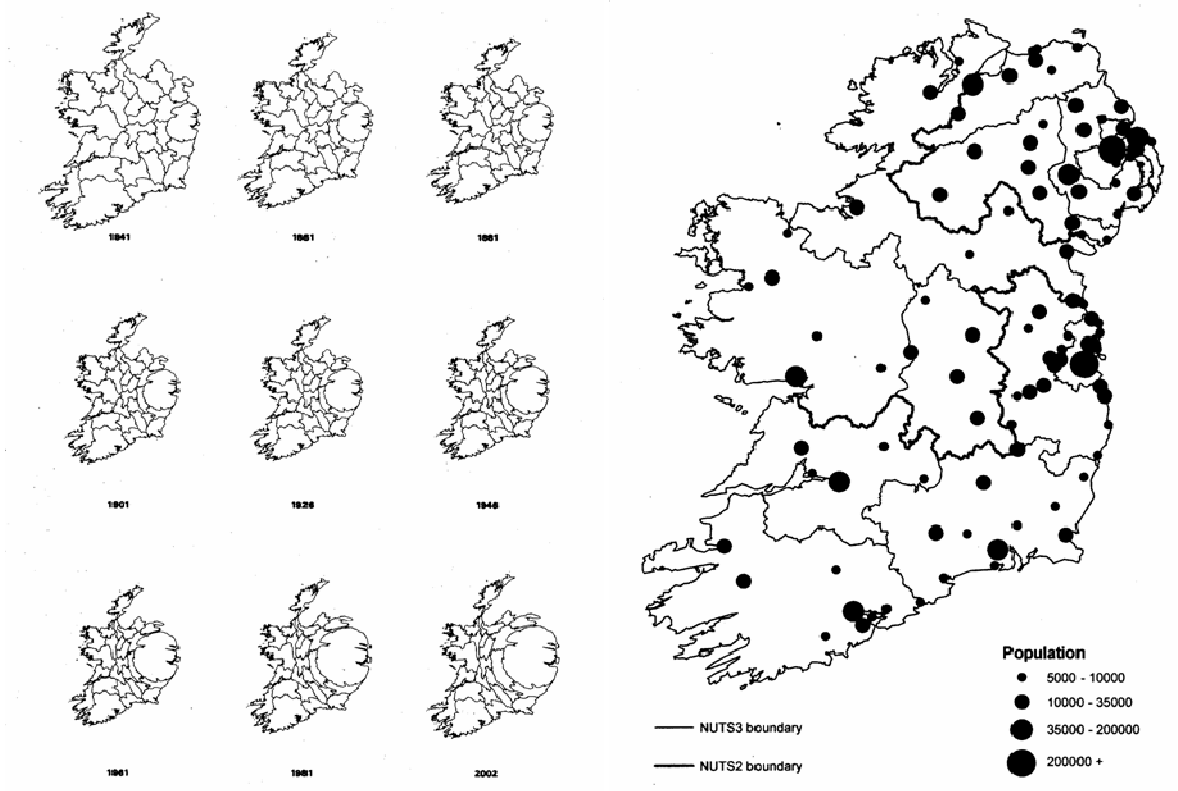


Figure 2. a) Cartograms of population change 1841 – 2002 (Source: Martin Charlton, NCG); b) Urban Centres over 5.000 population in Ireland and Northern Ireland (Source: CSO, OSi)

2.1 Verifying the consistency and the semantic of the model

Many problems have been faced to prepare the database because the system of territorial units is quite complex and not very completed (there are only two levels in the NUTS classification). The first problem is the choice of the territorial units to aggregate for the construction of the hierarchical-geographical tree. In Italian case, we used the administrative boundaries of municipalities (and related census data for population) and provinces as polygon entity and the centroid of the 'località principale' of municipalities (it means the geographic coordinate of the Town Hall approximately). In Italy, there is a complete, hierarchical system of territorial units ('Regioni, 'Province', Comuni', Sezioni di censimento') which is used both for administrative and analysis purposes. So, the municipalitiy is both a statistical partition and a significant representation of the settlement (Cori, 1991).

The National Office for Statistics collect data at the lover level ('Sezioni'), and they are easily referable to other territorial units. That's not the same in Ireland where data are delivered at Electoral Divisions level and there are few territorial units systems each of them useful for administrative and planning activities. In some cases, the territorial unit system does not cover

all the national territory but it is defined as discrete system. Briefly, which data are useful for a description of the settlement system?

The major administrative unit in the Republic of Ireland is the County (29) with the major urban areas having County Borough status (5). These units form a complete spatial partition of Ireland. Urban Districts and Rural Districts (212) are the next level down in the hierarchy, with Electoral Divisions (3440) currently the smallest unit for which data area readily available. Within rural areas, there is another set of spatial units, Townlands, of which there are about 54,000 in the Republic. Townland boundaries are generally but not always conterminous with ED boundaries.

Within this framework, the EDs have been used as units subject to aggregation within the Counties boundaries (to simulate our provinces).

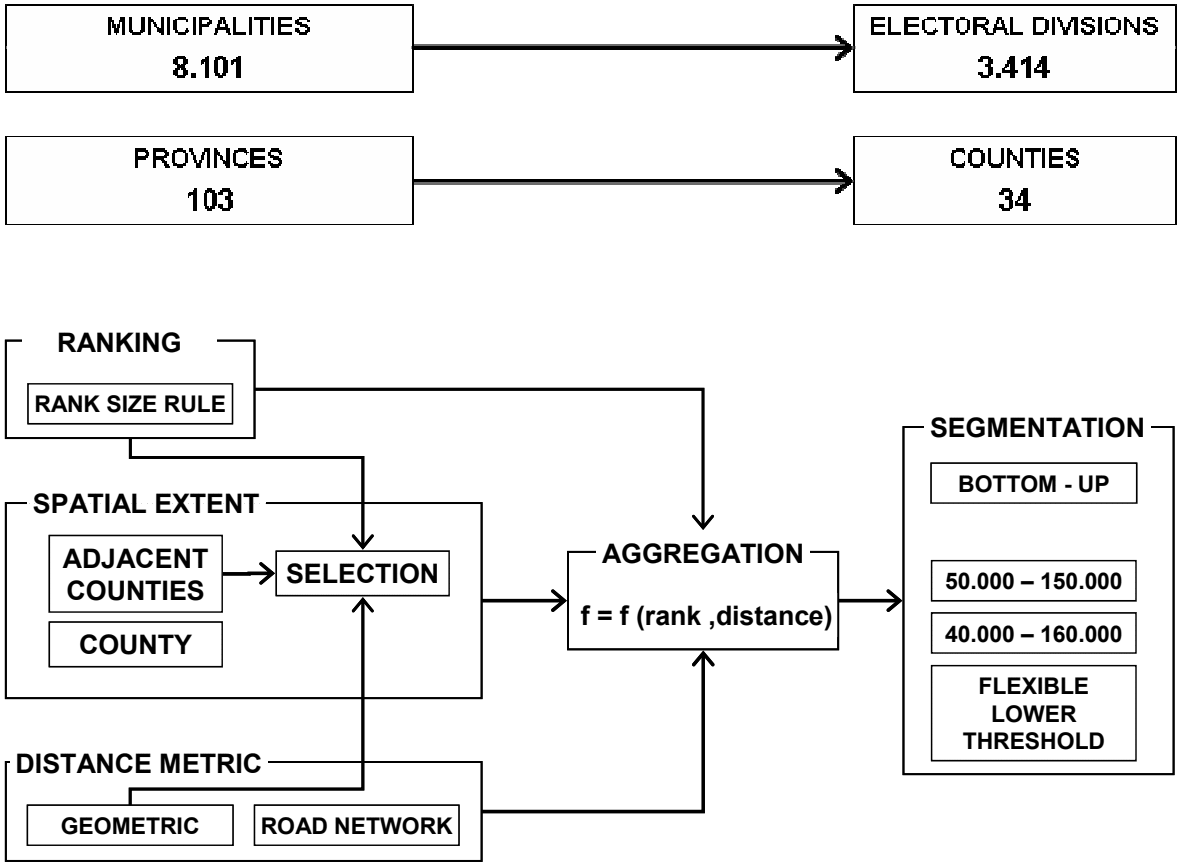


Figure 3. Flow chart of EDs aggregation

2.2 Pre-processing of data

The Electoral Divisions are historical units devised for a specific purpose and they need to be pre-processed to fit the semantic of the model. First, they have been built on a demographic base (99% of EDs has a population lower than 10.000 inhabitants) and they have been

adjusted with the increasing population. That is particularly evident within urban areas (e.g. the five main cities of Republic); they are very small (due to the high population density of the cities) and resulting not spatially homogeneous with EDs in rural areas (Figure 4a). Besides, the historical division between urban (the core of the settlement) and rural (the periphery) doesn't make sense if considering the continuous built-up area (Figure 4b). So, they have been pre-processed to ensure comparable results across the Republic of Ireland.

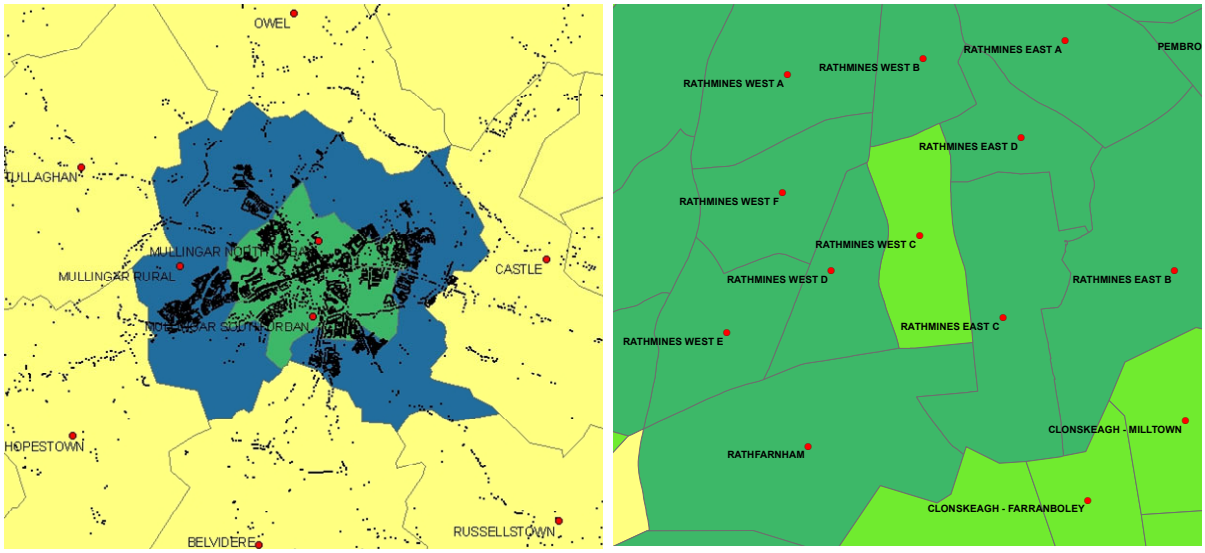


Figure 4. a) Urban – rural EDs; b) EDs in main cities

Looking at the dataset, it has been observed that some of them could be recognised by the nomenclature (Urban & Rural, A, B, C, D, etc.). Thus, they have been grouped by "name" to define "new" units representing the settlement' system at least, by an historical point of view (Figure 5).

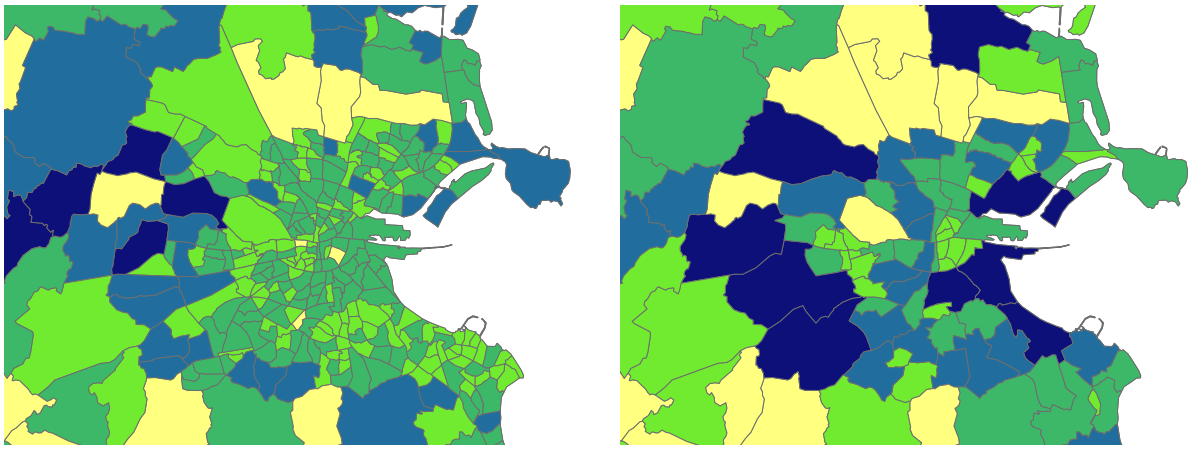


Figure 5. EDs of Dublin City after pre-processing

This operation reduced the number of EDs from 3.414 to 3.043, and the demographic distribution resulted less homogeneous. The last is also important in making hierarchy given

that the model is built on settlement ranked by demographic size.

2.3 From geometric centroid to buildings centroid

Unfortunately, the pre-processing operations did not solve all the problems about dataset. As described above, the model works with geographic coordinates of points to evaluate distance between pairs of nodes. Thus, the geographical location is important in the aggregation algorithm given that the distance is one f the two criteria on which it works.
By a semantic point of view, the entity point should represent the core of the settlement; that is the reason because we did not use the geometric centroid of municipalities as nodes in Italian implementation. However, there is no correspondence with any punctual entity in the Irish system. Thus, first the geometric centroid of EDs has been evaluated.
The visual and geographical analysis of the resulting coverage put in evidence two different (but correlated) problems: i) the geometric centroids do not represent the core of the settlement (roughly identified by the built-up area); ii) due the convexity/concavity of polygon features, in few cases the geometric centroids are outside the perimeter of polygons (red circle in Figure 6).
To find a feasible solution, the built-up area within the Electoral Division had to be taken into account. Hopefully, the Geo-directory - a collaborative project between the Ordnance Survey Ireland and An Post (2004), the experts in postal and geographic addressing in Ireland - contains the geographical coordinates of all buildings of the Republic. Each of them is stored as record in the database (1.769.802 records) with a X and Y coordinates.
Leaving out discussions about accuracy, consistency and completeness of the database, it can be assumed as proxy for evaluating the core of the built-up area within EDs. Therefore, the centroid of a point distribution has been evaluated (blue triangle in Figure 6).

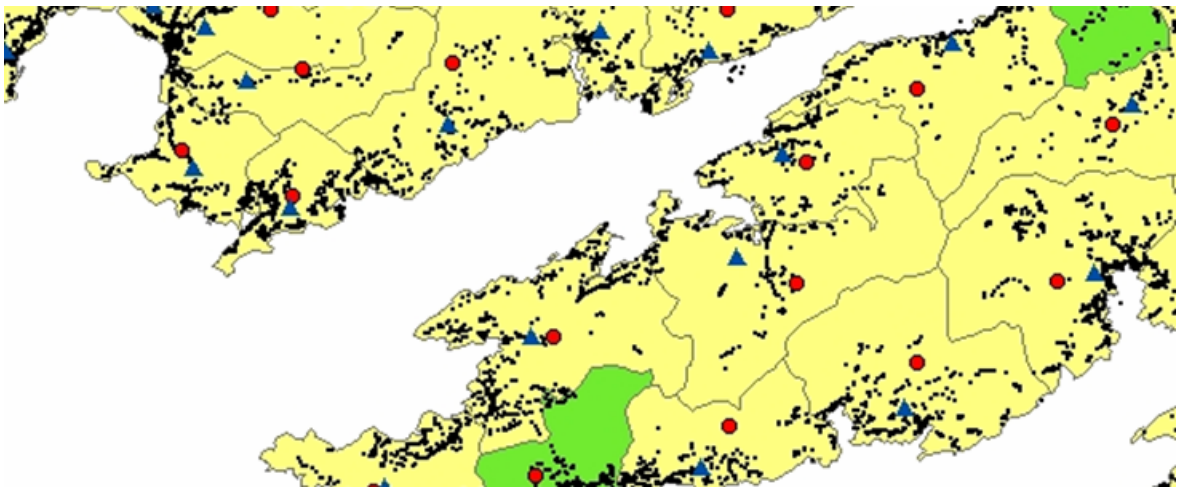
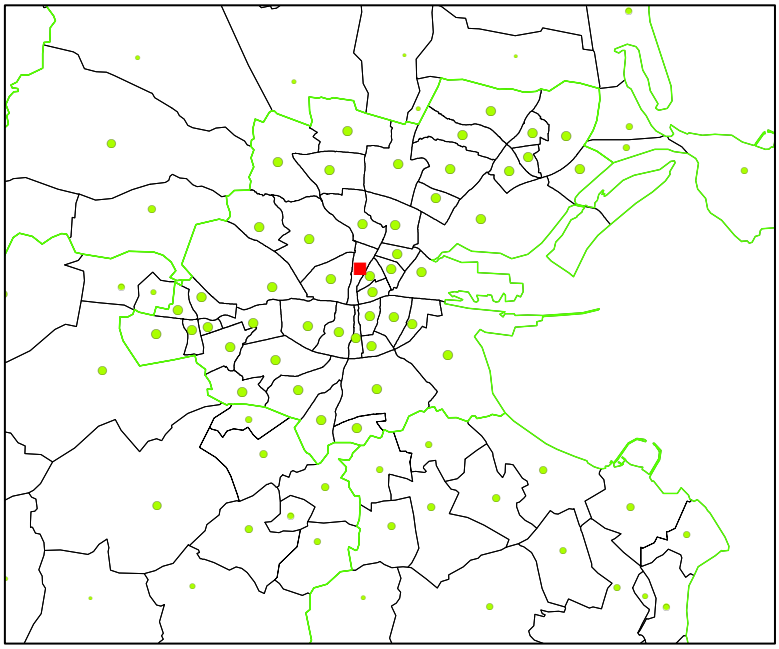


Figure 6. Polygon and buildings centroid for EDs

The coordinates of centroids have been mathematically calculated and stored in a database and a tool has been developed to generate the punctual coverage.

3 Building the hierarchy

Building the hierarchy is a complex step of the model because the rank level does have a great incidence in the construction of the hierarchical-geographical tree and, consequently, on the segmentation of the territory. The nature and characterisation of the Irish territorial units (EDs) make the process even more complicated. As described above, the EDs are only a proxy of the settlement' system and they show an almost flat population distribution. In the model, the population of a centre represents the 'mass' of the centre (Christaller, 1966) and, therefore, its degree of attraction for a dependent (lower in the hierarchy) urban centre. In other word, each centre asks for goods and services depending on its own rank level. it means that the lower centres in the hierarchy cannot satisfy all civil services by themselves and they gravitate on centre higher in the hierarchy for satisfying all their demands. Again, the territorial unit system does not match the model requirements; in fact, in the model all the EDs of Dublin City work together being the 'mass' of the Greater Dublin Area. A second step of grouping could have be done, however, the lesson from Italian implementation have been learnt; it is not possible to segment a territory containing an urban centre having a dimension bigger than the upper limit of threshold (see par. 1.1). Taking advantage of detailed subdivision within city counties, fictitious nodes has been defined (centroid of centroids) for each city county (Figure 7) and the higher rank level (r=1) has been assigned to them.



Figur 7. Centroids and fictitious node of Dublin City

This results in a shift in the hierarchy of the EDs (it starts from rank = 2) but, it allows the construction of the hierarchical-geographical tree between neighbourhood EDs and portion of greater urban area and, at the same time, the definition of the tree within the city county in itself. The last does have a very simple shape because of the rank of EDs is the second level of the hierarchy and they do depend directly from the fictitious node. The obvious graph-tree does have a certain utility when running the procedure with the option of adjacent counties.
Cleared up the last critical point about the consistency of the dataset, the hierarchy of EDs by population has been evaluated. To avoid problem concerning the definition of size categories, the Rank-Size rule has been using the most populated EDs (Tallaght – Avonbeg with 62.931 inhabitants) as 'primate city'. It resulted in ten rank level (the higher rank is 1 and the lower is 10). The distribution of number of EDs by rank level shows the existence of many centres having very low level (rank 7, 8 and 9), few centres of rank (e.g. the EDs of the main cities) and the absence of centres of medium size.

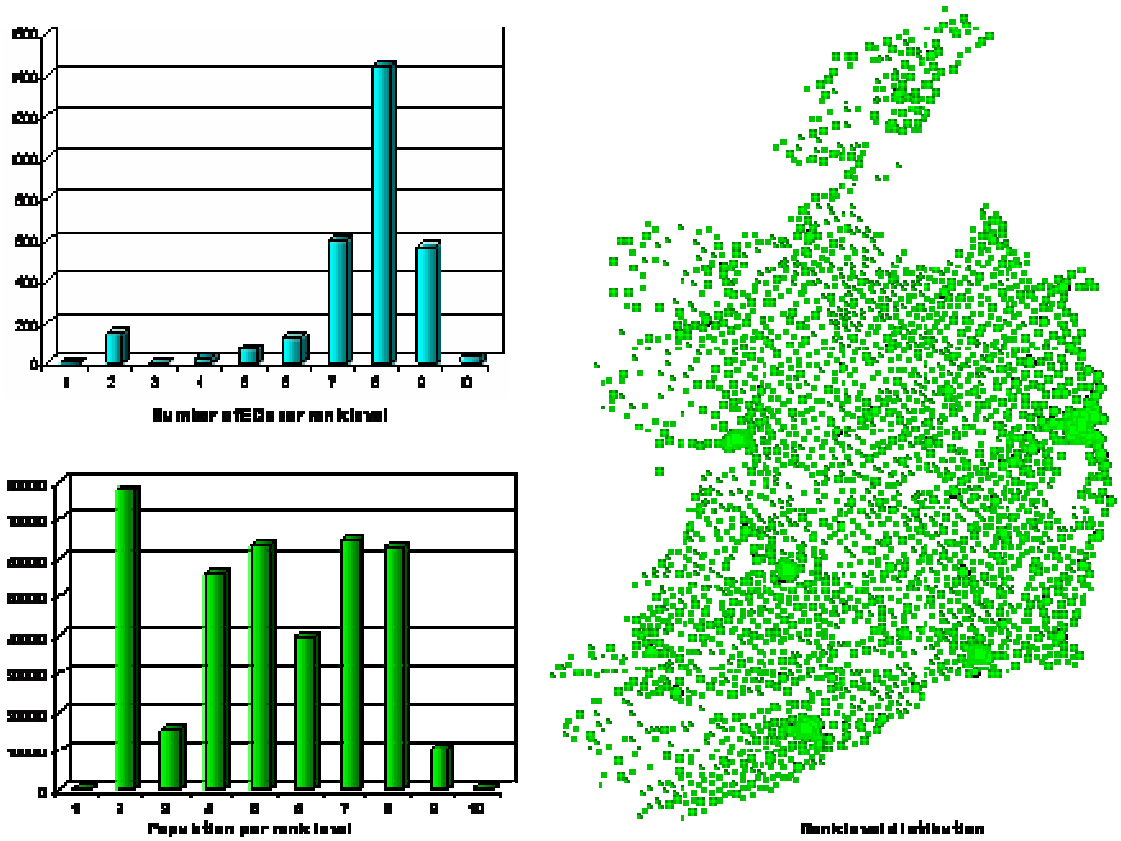


Figure 8. Distribution of number of EDs and population by rank level

The higher ranks are not spatially distributed but they are located in and around Dublin, Limerick, Cork, Galway and Waterford. In the Grater Dublin area is also evident a east-west line connecting Dublin with Naas and Newbridge as well as two cost line both on the North and South. Looking at population distribution by rank level, it results less unbalanced due to

the fact that a few big centres give the same result of a great number of small centres in terms of total population.

4 Comparative observations on hierarchical-geographical trees

Before discussing results at national level, a qualitative analysis on the shape of graph-trees is presented. Defining the 'standard graph-tree' as a tree having only one vertex at the top level and each rank level occupied by one or more nodes, a visual analysis has been performed on these characteristics. It can be composed by a variable number of branches with a more or less complex structure.

The standard case described above is the common shape of the hierarchical-geographical trees in the Italian implementation. Looking at building criteria, this means that in each province there is a mix of rank levels spatially distributed; the complexity of the graph-tree is a function of the number of municipalities within the provinces and of relationship in the geographical dimension (by the mean of the distance).

By running the model in a different context, it has been find out three kind of hierarchical-geographical tree:

- standard case as described above;
- 'star tree'; the graph-tree does have a single vertex at the top level and all nodes are connected to it directly;
- naturally clustered graph-tree; a graph-tree having more than a single vertex at the top level;

These three types of graph-trees are briefly discussed in the following using some examples. They are looked as resulting after the elaboration both within the county (simple spatial extent) and within adjacent counties (complex spatial extent) and how they look after the segmentation step.

The first case (Figure 9) shows the Cavan County (in the North East of the Republic, it s cross border territory). The 'standard' shape of the graph-tree results from both spatial extents and the graph-trees are completely clustered by the segmentation algorithm. They only differ in the number of aggregated EDs (88 versus 117) and in aggregated population (56.546 versus 66.466). In both case, it has been defined only one LAU1 and all the territory has been segmented (100%).

The second case (Figure 10) shows the Dublin City County. The graph-tree on the upper corner on the left (and related a-spatial graph) is the result both for single county and adjacent counties. The star tree cannot be subdivided due to the fact that none of the branch reach the lower limit of the demographic size.

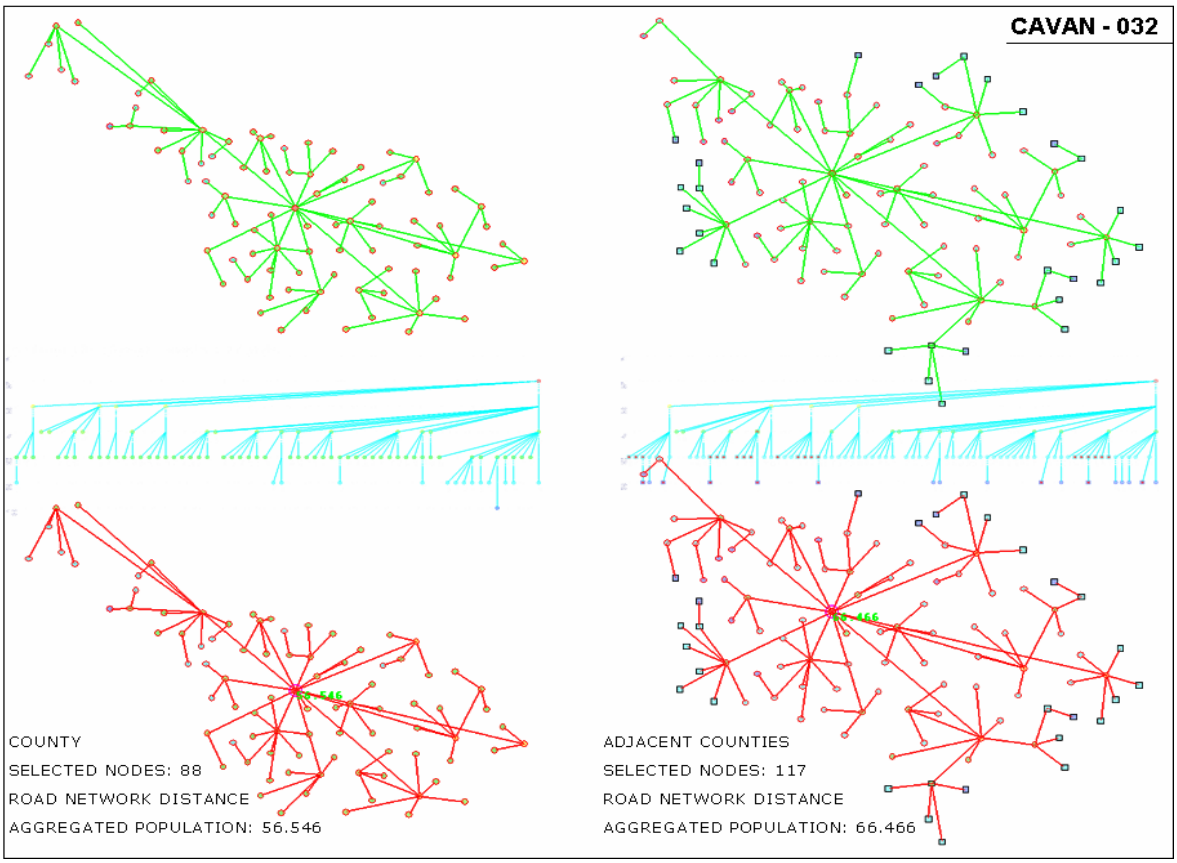


Figure 9. 'standard' graph-tree: Cavan County

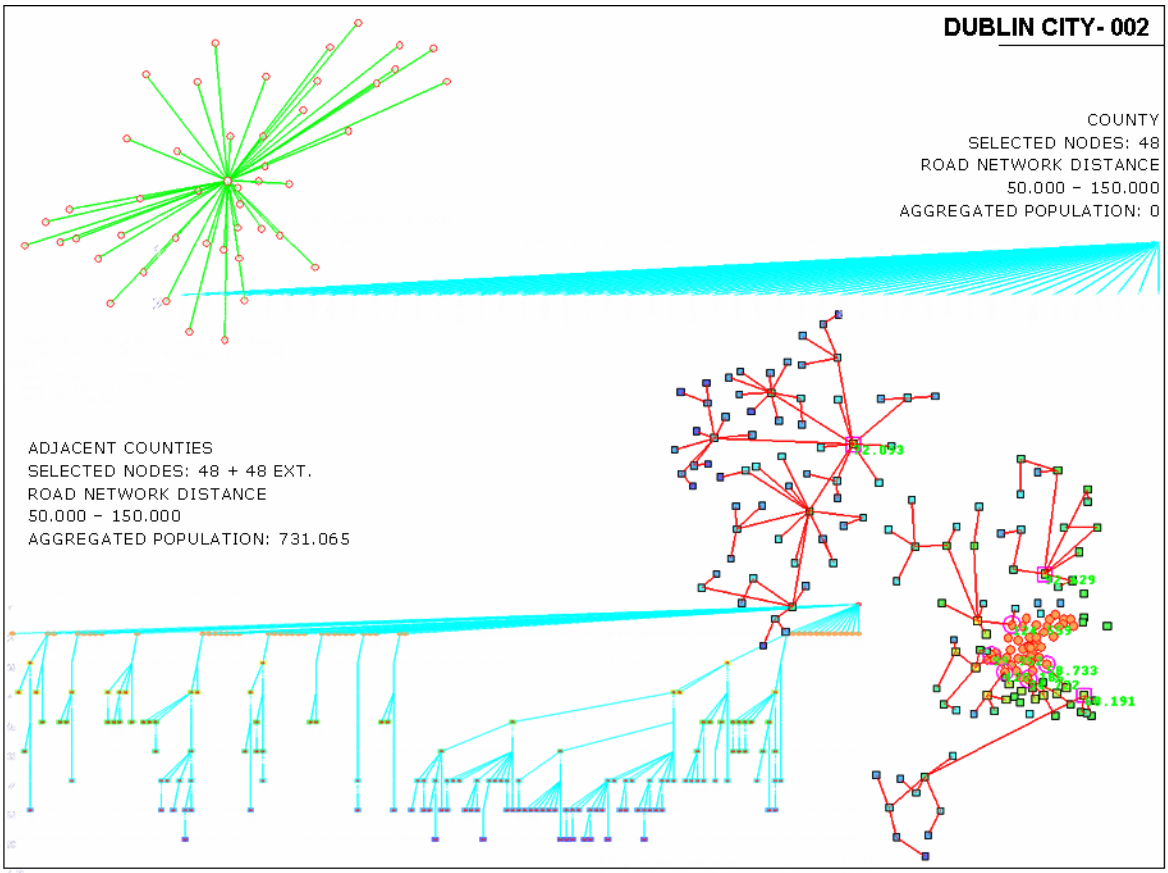


Figure 10. 'Star tree': Dublin City County

Instead, in the last case, the model envisages a further constructive step to re-connect the single running into a unique graph-tree at national level (the re-building step is an operative step and it is not required in the case of single county). Thus, the Dublin City County is given by a more complex graph-tree (on which the dependencies of neighbourhoods are shown) and it has been segmented in many regions.

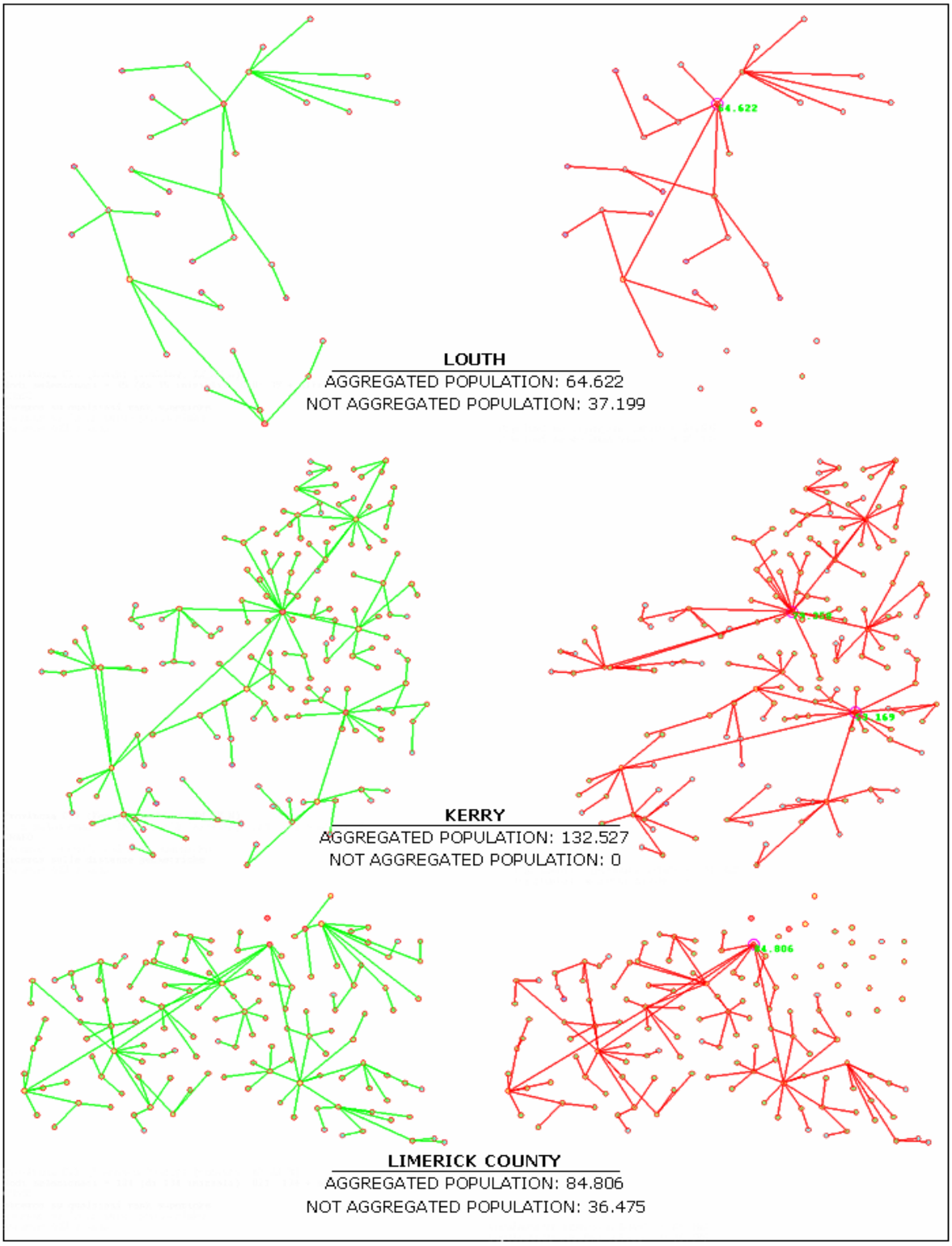


Figure 11. Naturally clustered graph-tree: Dublin City County

The third case (Figure 11) shows naturally clustered graph-tree. They are composed by two clusters (Louth and Kerry) and by three clusters. Looking at Louth, it can be argued that it cannot be completely segmented because one of the two natural clusters does not reach the minimum size (e.g. 50.000 inhabitants in the example). That is the same for Limerick County where only one clustered have been found and two branches remained un-segmented.
On the contrary, the double clustered graph-tree representing Kerry has been totally segmented because both branches do have a demographic size between 50.000 and 150.000 inhabitants.

The preliminary analysis suggested implementing a new option in the procedure due to the low population density of the Irish territory and the absolute low value of national population if comparing with Italian context. The original segmentation algorithm works with a defined demographic range (e.g. 50.000-150.000); graph-trees are navigated by the algorithm verifying the demographic size of branches; if a 'right' branch were found, a link is removed and the branch isolated as LAU1. The mechanism has not been changed, but after the first navigation if no LAU1 were found the lower limit is decrement and the procedure is iterated.
The procedure is stopped when the lower limit 10.000 inhabitants because under these threshold doesn't not make sense defining a region in our approach.
These option achieves two objective; first it improve the knowledge on our nodel and it helps in defining the lower threshold (that is not defined in the European rules; in the Italian case, it has been defined by a Commission of the National Statistics Office working on the same topic) and, secondly, improving the effectiveness of the procedure.

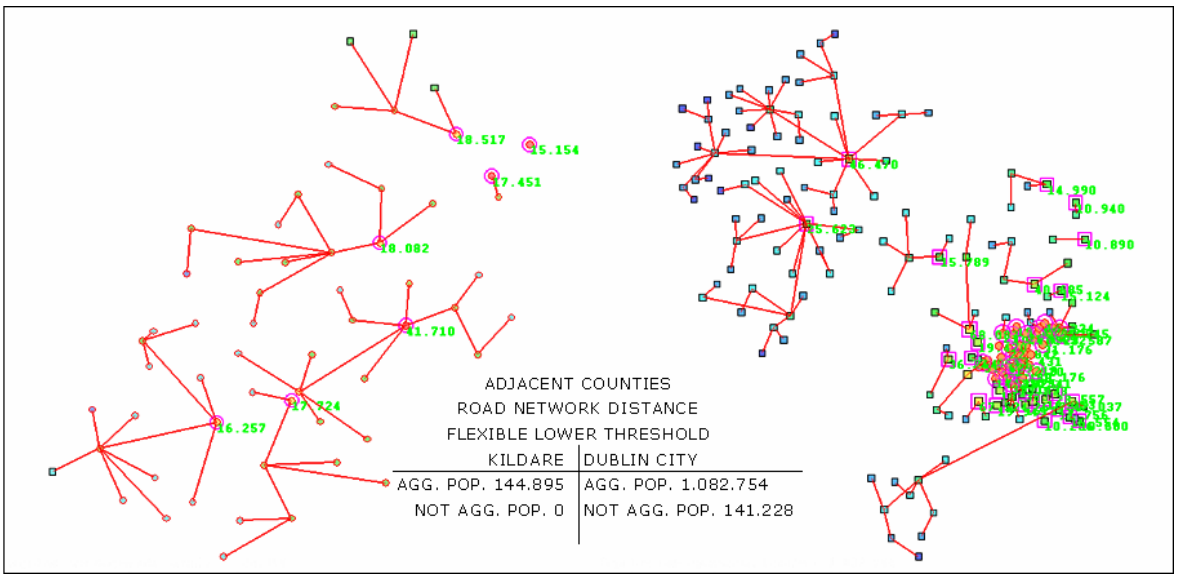


Figure 12. Flexible lower threshold: Dublin City County

With these option (Figure 12), it is possible to subdivide more and more and counties resulting not segmented) at all (naturally clustered as described above, for example, Kildare in

the following picture in the previous running can be easily subdivided.

5 Results and main findings

Finally, the results covering the whole territory of the Republic of Ireland are presented in the following pictures. They illustrate three different processing schemas by varying the spatial extent (county in Figure 13 and adjacent counties Figure 14) and implementing the flexible lower threshold (Figure 15). All other parameters (ranking criteria, road network distance) have not been changed.

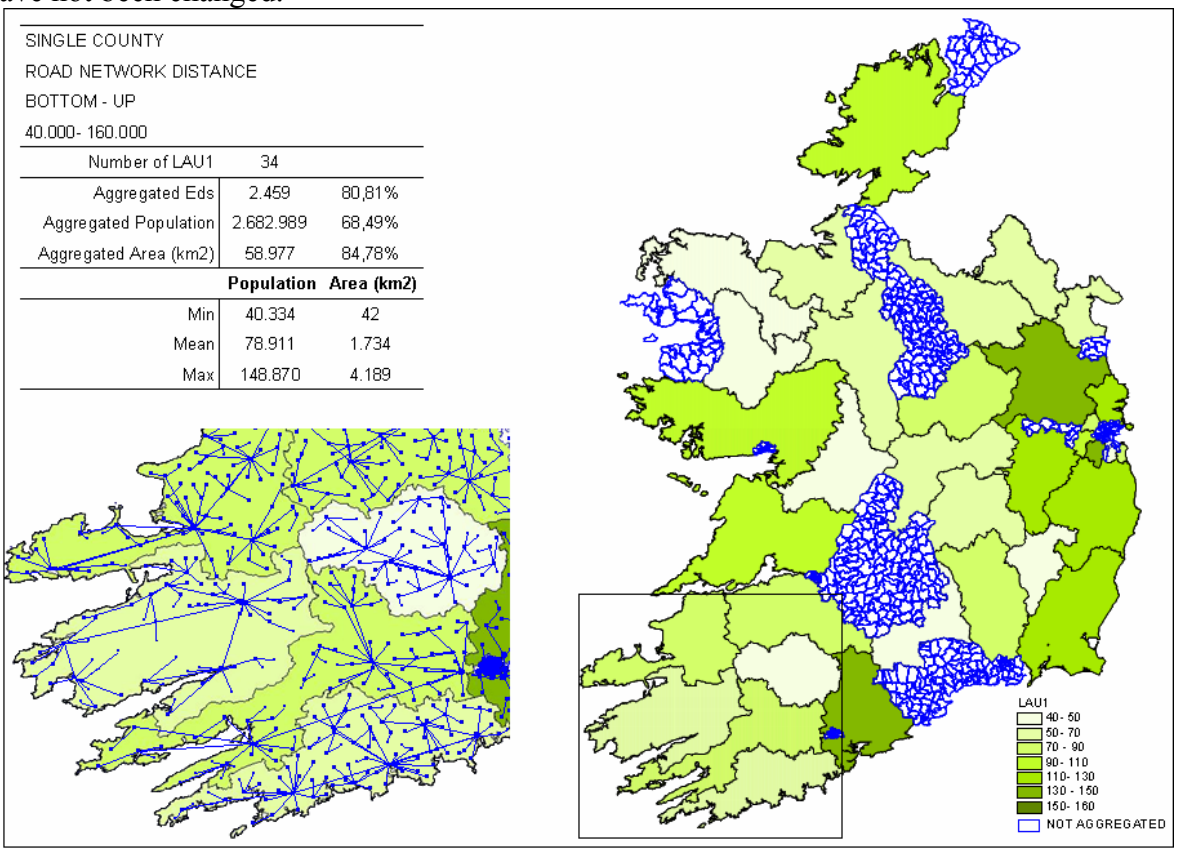


Figure 13. Single County processing schema

Basically, the effectiveness of the procedure improve from single county (80,81% in terms of aggregated EDs) to adjacent counties (81,27%). In terms of population, the improvement is a bit better because the effectiveness improves from 68,49% to 71,76%. That is congruent with result form Italian implementation.

Not imposing the administrative boundaries on the aggregation means a less constrained problem to solve. However, the improvement reached by the not imposition of the administrative boundaries does not have a great relevance.

In both cases, the central part of Ireland (mainly rural) could not been segmented; that means there is a correlation between population density and the procedure.

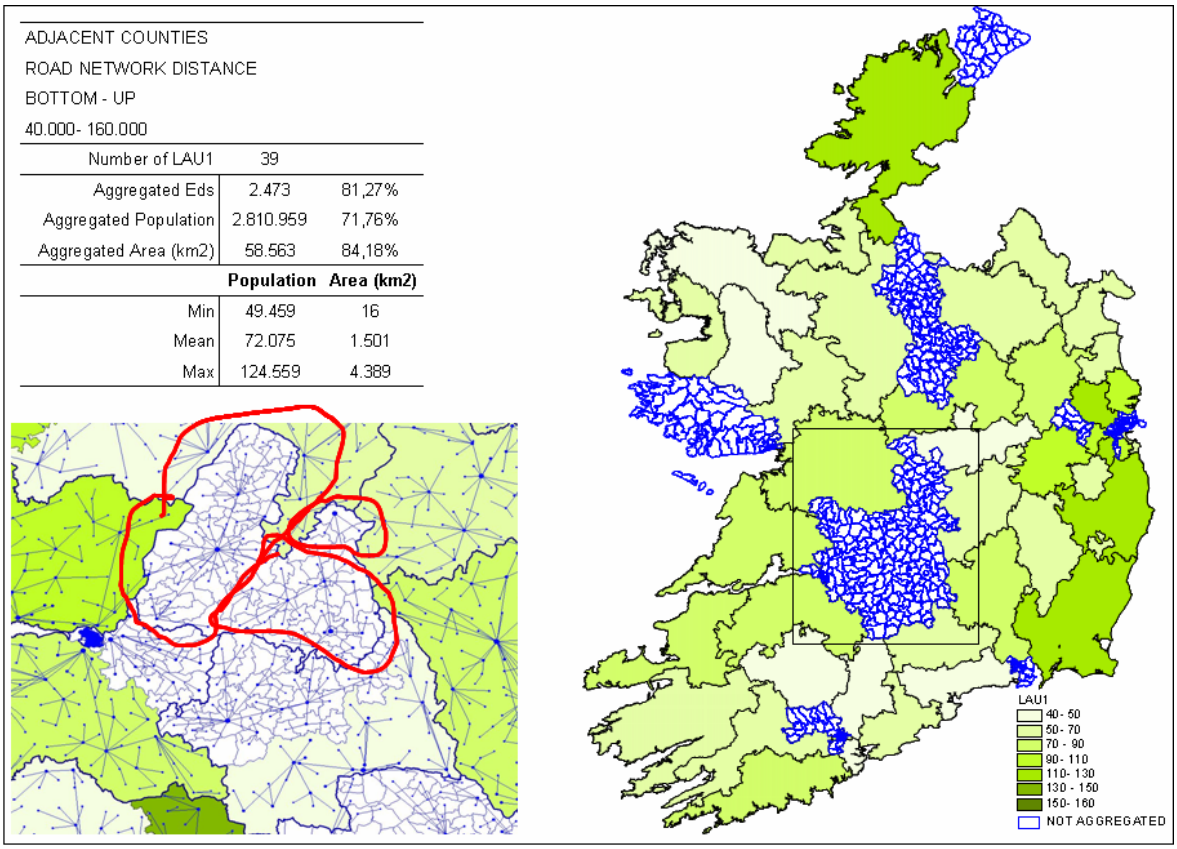


Figure 14. Adjacent Counties processing schema

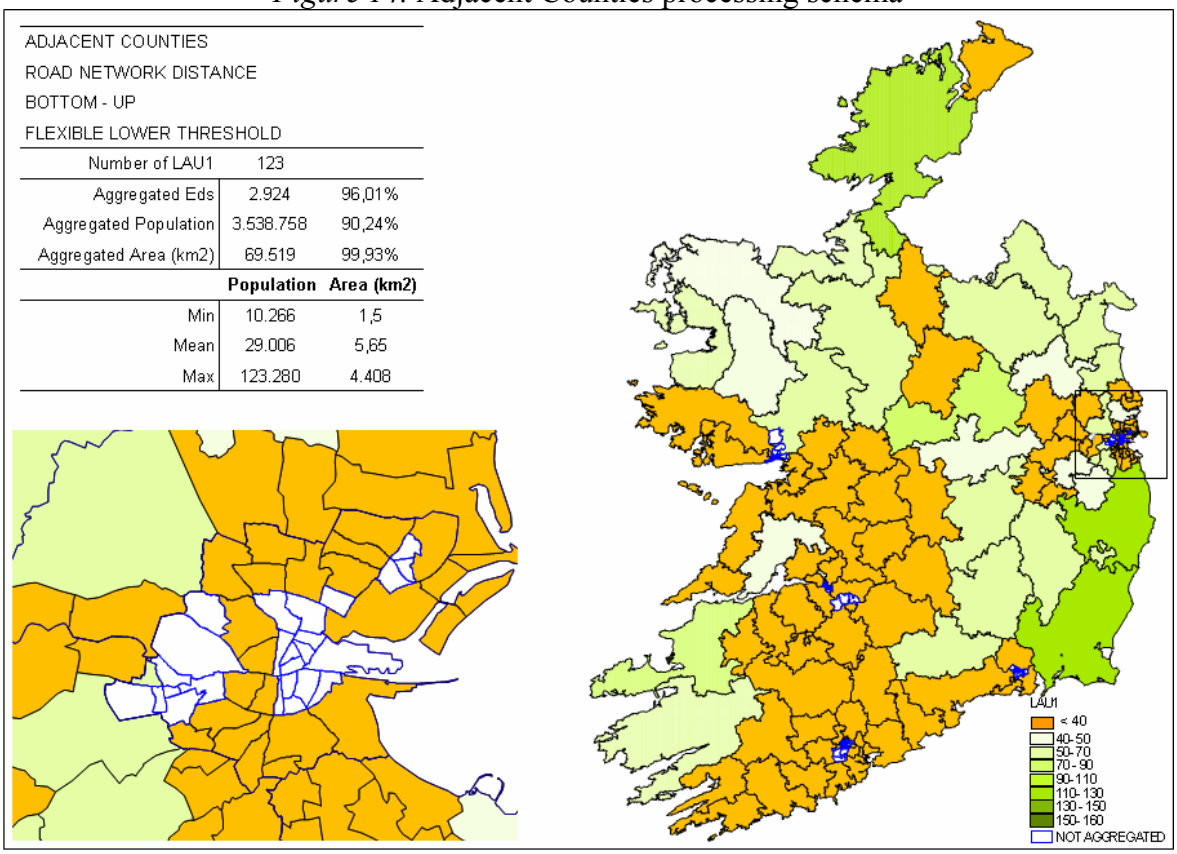


Figure 15. Flexible lower threshold processing schema

On the contrary, the flexible lower threshold (it can be viewed as a not imposition of a dimensional constraint) improves significantly the effectiveness of the procedure.
With this option, the 96,01% of EDs have been aggregated corresponding to the 90,24% of population. The result is even better if looking at aggregated area; the 99,93% of area have been aggregated. The not segmented area are the core of the city counties, as shown in the map; and this explains the big difference between area and population because those area do have high population density.
An important remark has to be done about the flexible lower threshold. Because its implementation seems to confirm that some open questions (see par. 1.2) are still open. The definition of the demographic size does have a great incidence in defining regions and it cannot be dealt as an operational problem; it requires a more accurate analysis and, more important, a political decision. Furthermore, great urban areas need special attention and a more accurate definition of the role they should play in the Local Administrative Units 1 system.

Acknowledgements
The author would like to thank Prof. Stewart A. Fotheringham and Martin Charlton of National Centre for Geocomputation at the National University of Ireland Maynooth for hosting her in 2007 and providing data, maps and any kind of support for developing this work.

6 References

Barboni B., Schiavoni U., (2006), Analisi gerarchica e aggregazione di unita' territoriali per le "Local Administrative Units 1", in proceedings of *XXVII Conferenza Italiana di Scienze Regionali*, Pisa, October 12-14 2006.

Bartley B., Kitchin R., (eds), (2007), Understanding Contemporary Ireland, Pluto Press, London.

Central Statistics Office (2004), Population and Migration Estimates, Dublin: CSO.

Cori B., (1991), "L'Italia come sistema di citta'", in Bertuglia C.S., La Bella A., (eds), "I sistemi urbani", Vol. 1, Le teorie, il sistema e le reti, Franco Angeli, Milano

Christaller W., (1996), Central Places in Southern Germany, Prentice Hall, New Jork.

EC (2003), Regulation No 1059/2003, in *Official Journal of the EU of 21/06/2003* – L. 154/1, Luxembourg.

Egeraat C. van , Sokol M., Stafford P., (2006), Greater Dublin in the Celtic Tiger economy: towards a polycentric mega-city region? in Hall P. and Pain L. (eds), *The Polycentric Metropolis: learning from Mega-City regions in Europe*, James & James, London

Ordnance Survey Ireland and An Post, (2004), GeoDirectory Technical Guide, working paper Osi, Dublin.

Vallega A., (1989) Geografia umana, Mursia, Milano

ABSTRACT

This work presents a second step of a wide research in regionalisation that has been proposed in 2006. The aim of the research was the development and the implementation of a methodology to define regions at local level (Local Administrative Units – Level 1), according with the "Nomenclature of Statistical Territorial Units" at European Level. They should have been defined between NUTS 3 level (the Italian Provinces) and LAU 2 (the Italian municipalities).

To achieve this objective, a particular point of view has been adopted; it looks at territory as an urban system composed by many local territorial structures potentially LAU 1. This approach led us to development a double-step procedure: first, the re-construction of the hierarchical-geographical tree and, second, the segmentation of the tree under demographic size conditions.

The implementation on Italian case showed good results in terms of the effectiveness and quality of the defined territorial units. However, it was quite clear that the complexity and strong structure of the Italian territory played a role in fitting the hierarchical approach adopted in the study. To verify the consistency of the procedure in itself, the same methodology has been applied in a very different territorial context: the Republic of Ireland. It's just the case to remember that the total amount of Irish population reached four millions in 2004 and more than 12% lives in the Great Dublin Area. Many problems have been faced to prepare the database because the system of territorial units is quite complex and not very completed (there are only two levels in the NUTS classification). The first problem was the choice of the territorial units to aggregate for the construction of the hierarchical-geographical tree. The major administrative unit in the Republic of Ireland is the County (29) with the major urban areas having County Borough status (5). These units form a complete spatial partition of Ireland. Urban Districts and Rural Districts (212) are the next level down in the hierarchy, with Electoral Divisions (3440) currently the smallest unit for which data area readily available. The EDs have been used as units subject to aggregation within the Counties boundaries (to simulate our provinces). However, the EDs boundaries within urban areas (e.g. the five main cities of Republic) are not homogeneous with EDs in rural areas. So, they have been pre-processed to ensure comparable results across the Republic of Ireland. Second, the demographic size of the potential LAU 1 had to be defined according with the total amount of Irish population. From a technical point of view, the results show that the procedure works well if the lowest level of the demographic size is around 10.000 inhabitants against the 40.000 inhabitants found in Italy. However, few doubts about the correctness of the hierarchical approach to this territory rose during this work. In fact, the Irish context seems to be quite polarised around Great Dublin Area and, less, around the other four main cities (Cork, Galway, Limerick and Waterford); on the contrary, the internal areas – mainly rural areas – seem to be naturally clustered within a weak hierarchical structure.