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PROFECY – Processes, Features and Cycles of Inner Peripheries in Europe

(Inner Peripheries: National territories facing challenges of access to basic services of general interest)

Applied Research

Final Report

Annex 4. From Conceptualization to Delineation of Inner Peripherality in Europe

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PROFECY – Processes, Features and Cycles of Inner Peripheries in Europe

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Abbreviations

AoR	Areas-of-risk (to become inner peripheries in future)
GDP	Gross domestic product
GIS	Geoinformation system
IP	Inner periphery, inner peripheries
LAU	Local administrative units
min	Minutes
n.a.	Not applicable
NUTS	Nomenclature des unités territoriales statistiques
OSM	OpenStreetMap
POI	Point(s)-of-interest
SGI	Services-of-general-interest
TOR	Terms-of-reference
UK	United Kingdom

1 Introduction

The objective of this Annex is to provide additional information on the methods, parameters and thresholds implemented for the delineation of inner peripheries in Europe, helping to better understand the delineation results presented in Chapter 4 of the Final Report.

It will also provide additional maps and illustrations for interim steps, following the entire delineation process, and will discuss different options identified at certain steps, thereby complementing the results shown in the main report.

Some methodological remarks are applicable for all types of delineations, others are specific for individual delineations.

First, a brief background on the development of the delineations is presented in Chapter 2, then general remarks applicable to all delineations are described (Chapter 3), followed by detailed and specific information for each delineation (Chapter 4). Chapter 5 introduces options and methodologies for the identification of areas of risk to become inner peripheires in future. Finally, Chapter 6 gives an technical overview about the scripts developed and programming tools utilized to perform the GIS-based analysies, followed by recommendations as how to transfer the chosen approach to other cases (Chapter 7).

2 Conceptualizing Inner Peripheries

2.1 General rationale

An operationalization of the theoretical concepts of "inner periphery" developed in the conceptual framework (Annex 1), was carried out in first place (Chapter 2.2 of this document). This process has led to the conversion of the three theoretical concepts into four operational types that can be measured in terms of indicators and processes (Table 2.2). The four operational types have been the basis for the development of four delineations of inner peripherality in Europe.

The four delineations were developed in a way that they, regarding the methods and variables considered, differ as much as possible, in order to account for as many factors (variables) as possible, acknowledging that not all influencing factors can be integrated into one-fits-all delineation.

Delineation 1 (Section 4.1) goes back to the proposal in the terms-of-references by identifying areas of inner peripheries based on a lack of access to regional centres, i.e. **higher travel times to regional centres**. Areas of higher travel times, compared to surrounding areas, are considered as inner peripheries. This delineation was implemented at grid level, by calculating travel times from each grid cell to regional centres in Europe.

In Delineation 2 (Section 4.2) we are looking for interstitial areas in Europe which have **lower economic potentials** compared to surrounding regions, and can thus be considered as disadvantaged. The economic potential is measured by indicators of potential accessibility at NUTS-3 level.

The third delineation is based upon the assumption that inner peripheries are suffering from **poor access to services-of-general-interest** (SGIs) (Section 4.3). A set of important SGIs has been identified (Annex 3), and travel times from each grid cell to the nearest SGI facility has been calculated. Areas with poor access to these facilities, again in relation to neighbouring areas, have then been identified as inner peripheries.

The fourth delineation (Section 4.4) looks at inner peripheries as a process where the lack of connectedness to “organised proximity” (of whatever kind) results in lagging socio-economic development. At some point inner peripheries entered into a downward spiral of negative demographic and economic development. Here, the main idea is to identify ***depleting regions*** in order to map potential inner peripheries and to select some of these areas which are experiencing processes of peripheralization.

Following Table 2.1 illustrates the relationship of the four operationl types of IP delineations and the three theoretical concepts

Table 2.1: Relationship between theoretical IP concepts and operational delineations.

Theoretical concepts	**Operational types**			
	D1 Higher Travel time to regional centres	**D2 Lower economic potential interstitial areas**	**D3 Areas of poor access to SGIs**	**D4 Depleting areas**
Concept 1: Enclaves of low economic potential	✓	✓✓		
Concept 2: Poor access to SGIs	✓		✓✓	
Concept 3: Absence of "organized proximity"				✓✓

✓✓: indicates the main operacionalization of the concept.
✓: indicates the delineation can be used as a proxy.

While the general character of these four delineation approaches was developed as a result of the theoretical and conceptual considerations, the actual implementation took account of issues of data availability in Europe. Data availability was crucial in identifying the set of SGIs in Delineation 3 and in selecting the key variables in Delineation 4. The European-wide data situation also prevented us from some interesting analyses, like analysing the process of closing SGI facilities over time statistically, and relating the closures to demographic developments.

2.2 The Operational Types of Inner Peripheries

The conceptual framework of the research leads to think that the phenomenon of inner peripherality does not fit well the territorial dimensions of NUTS3, at least in a relevant part of European countries. The configuration of inner peripherality is dominated by functional processes and trends that contrast with the mostly administrative nature of NUTS3; In other cases, NUTS3 divisions are too extensive and heterogeneous to be identified with a single type of territory. Moreover, we believe that the correct way to identify and characterize inner peripheries, whatever the type, is to start with smaller territorial units (i.e. LAU2) acting as "building blocks" of the inner periphery that allow for the exclusion of areas that are not classifiable as IP but are "hidden" in the heterogeneity of larger units such as NUTS3.

However, since the LAU2 databases are clearly insufficient and the necessary information does not exist, even for a small percentage of European territory, the delimitation and characterization of the phenomenon at LAU2 level was beyond the scope of this project. This is a huge cross-sectional problem that affects the ability to deliver meaningful results in the territorial analysis. The construction of a statistical database homogenized at the LAU2 scale is more than necessary in the current context, if we want to achieve a more significant and relevant knowledge of the European territorial reality, and if we want to raise with greater assurance, recommendations and strategies for decision-making.

Inner peripheries are new territorial concepts in the scientific literature and in the main decision-making documents at European level as well as in the states and regions of Europe. According to the results of the theoretical framework of the project, IPs do not necessarily coincide with administrative units, but rather with functional realities, mainly on a subregional level. Consequently, the most appropriate scale for the identification and analysis of IPs is the territorial grid with data at municipal (local) level (grid + LAU2). This combination has been achieved for two of the four operational IP types identified, based on accessibility and gravitational models. On the other hand, the lack of statistical information of a socio-economic nature on a sufficiently discrete territorial scale considerably limits the possibilities of analysis.

For these reasons, NUTS3 as territorial reference framework have been used only when there is no viable alternative.

Each of the operational types may be applied at a range of scales, local, regional, national, macro-regional. Although the second and third tend to be rural/small town by definition, the other two could equally apply to urban neighbourhoods. At the same time, it is important to note the four types are not mutually exclusive. That is, most territories may share characteristics of different types of IP. For instance, regions where features of one of the definitions of IP dominate, but also show some characteristic features and processes of one or more of other types of IPs.

The 4 operational types have been the basis for the development of 4 Delineations of inner peripherality in Europe. The first three delineations are based on accessibility to regional centers (Delineation 1 ,section 4.1) and a set of Services of General Interest (SGI) (Delineation 3, section 4.3), as well as on the relative potential of access to population and GDP of each region (Delineation 2, section 4.2) In these three cases, the possibilities for the elaboration of maps are ample and this is shown both in the text of this document and in some annexes. On the contrary, Operational type 4 (section 4.4) focuses on processes of territorial connexity, relational proximity, social capital, power relations, etc., which represent more diffuse, multi-causal, path-dependent and contex-related situations. As a result, it is much more complex to capture the location of these areas on a European-scale map because, simply, adequate information is not available at an appropriate level of detail. This makes it necessary to be particularly cautious in interpreting the maps associated to the Delineation of Type 4.

None of the 4 IP types of IP identified is a priori incompatible with the rest of IP types. Therefore, no exclusions are made of territories with specific characteristics (for example, traditional or "remote" peripheries, mountain areas, etc.). The resulting delineations have been afterwards overlapped and combined (section 4.5).

Table 2.2: The four "Operational Types" of Inner Peripheries

#	Delineation Name	Description / Thematic focus of delineation	Factors / Variables considered
1	Higher Travel time to Regional Centres	Goes back to the proposal in the terms-of-references to consider regional centres as a proxy for administrative, economic and generally most important centres for SGI provision and for all social and economic activities. Areas experiencing a lack of access to such centres can thus be interpreted as 'inner peripheries'. This delineation accounts for the geographical distribution of regional centres, and for the existing transport networks connecting these centres with the surrounding territories.	- Geographical location (i.e. location of cities) - Population (via city size) - Accessibility (expressed as travel time to the closest regional centre) - Physical factors (via transport networks) - Quality of the transport systems
2	Lower economic potential interstitial areas	"interstitial" areas of increased peripherality, which are not on the physical edge of Europe, and are surrounded by areas of greater centrality. IPs here are areas of lower potential accessibility to population, relative to the average of the surrounding territories (see section 1.2 of Annex 1 with a review of previous works mapping economic potential).	- Geographical location (i.e. cities and metropolitan areas) - Potential accessibility (population and travel time) - Potential accessibility development (2001-2014) - Physical factors (via transport networks) - Quality of the transport systems
3	Areas of poor access to SGI	An adequate provision and access to the main Services of General Interest constitute an indicator of the degree of connectedness of territories. An easy and cheap connectedness to SGI ensures higher quality of life and contributes to fix population and jobs. This type of IP tries to capture areas that suffer from relative poorer access conditions than the average in the surrounding areas and/or in the region.	- Geographical location (i.e. location of the SGI facilities): - Accessibility (expressed as travel time to the closest SGI) - Physical factors (via transport networks) - Quality of the transport systems - Health: general doctors, emergency care (hospitals) and pharmacies. - Education: primary and secondary schools - Transport: main stations and all stations - Culture: cinemas - Retail sector (supermarkets and convenient stores) - Work: indicator of 'access' to UMZ as a proxy for jobs. - Business: banks.
4	Depleting areas	Areas which exhibit low levels of socio-economic performance which can be attributed to an absence of "organised proximity" (of whatever kind), which are in some way excluded from "the mainstream" of economic activity, or which can be said to be experiencing a process of "peripheralization"	- Population - Population change (2001-2015) - GDP per capita - GDP per capita change (2000-2015) - Unemployment rate - Unemployment rate change (2002-2016)

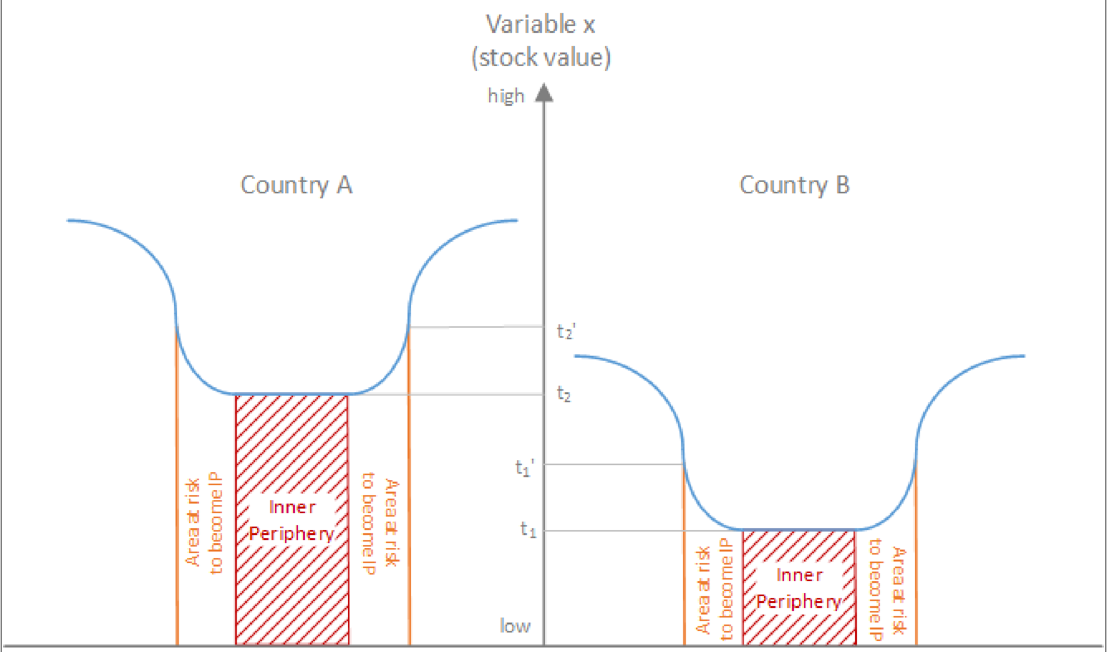
3 General remarks

This chapter elaborates some general remarks which were applied to all four delineation approaches, and which outline some general methodological ideas.

3.1 Identifying inner peripheries in relation to other regions

One of the key conclusions of the theoretical reflections and of the conceptualization on IPs (see Chapter 2) is that these areas cannot be delineated according to the absolute values of the chosen variables, but according to their performance relative to their surrounding areas (Figure 3.1:). The methodological concept developed, and in particular the definition of indicators, reflected this need. It is necessary to standardizing all variables before they enter the delineation workflow.

Figure 3.1: Identification of inner peripheries: basic principles.



Usually, the range of values for any variable differs from country to country, subject to various factors (e.g. country size, geographical conditions, economic power, demographic factors). If only one threshold would be applied to stock variables to all countries, it is likely that for some countries no areas were identified as inner periphery, or in contrary, most of the country were defined as IP. Thus, the variables should be first standardized, for instance, at the national averages, so that the value ranges are proportioned.
Second, the figure illustrates that IP must always be defined in relation to surrounding areas and not just by looking at any location alone.
Third, in order to identify areas at risk to become IP, a second threshold is needed.

Three options for the indicator standardization have been tested, which are (Figure 3.2)

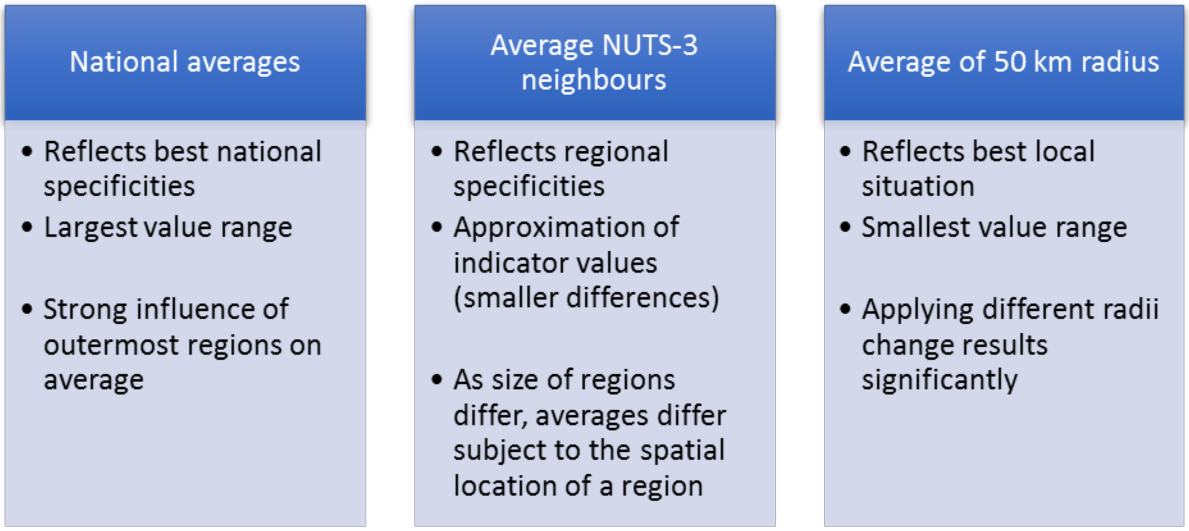
(i) Standardization at the national average

(ii) Standardization at the average of the neighbouring NUTS-3 regions (including the region itself)

(iii) Standardization at the average of the neighbouring grid cells, by applying a certain radius (here: 50 km)

Option (i) best reflects the national specificities as regards the destinations (for instance, spatial structures of the urban system, national regulation of the health care system when calculating access to hospitals or to doctors), and results in the largest value ranges (from minimum to maximum). National averages will result in nation-wide centre-periphery dichotomies. Outermost regions of a country and islands will have strong effects on the national averages (see below), with areas in the outermost regions and on island tend to show below-average indicator values, while mainland regions will show above-average indicator values.

Figure 3.2. Options evaluated for standardizing indicators.



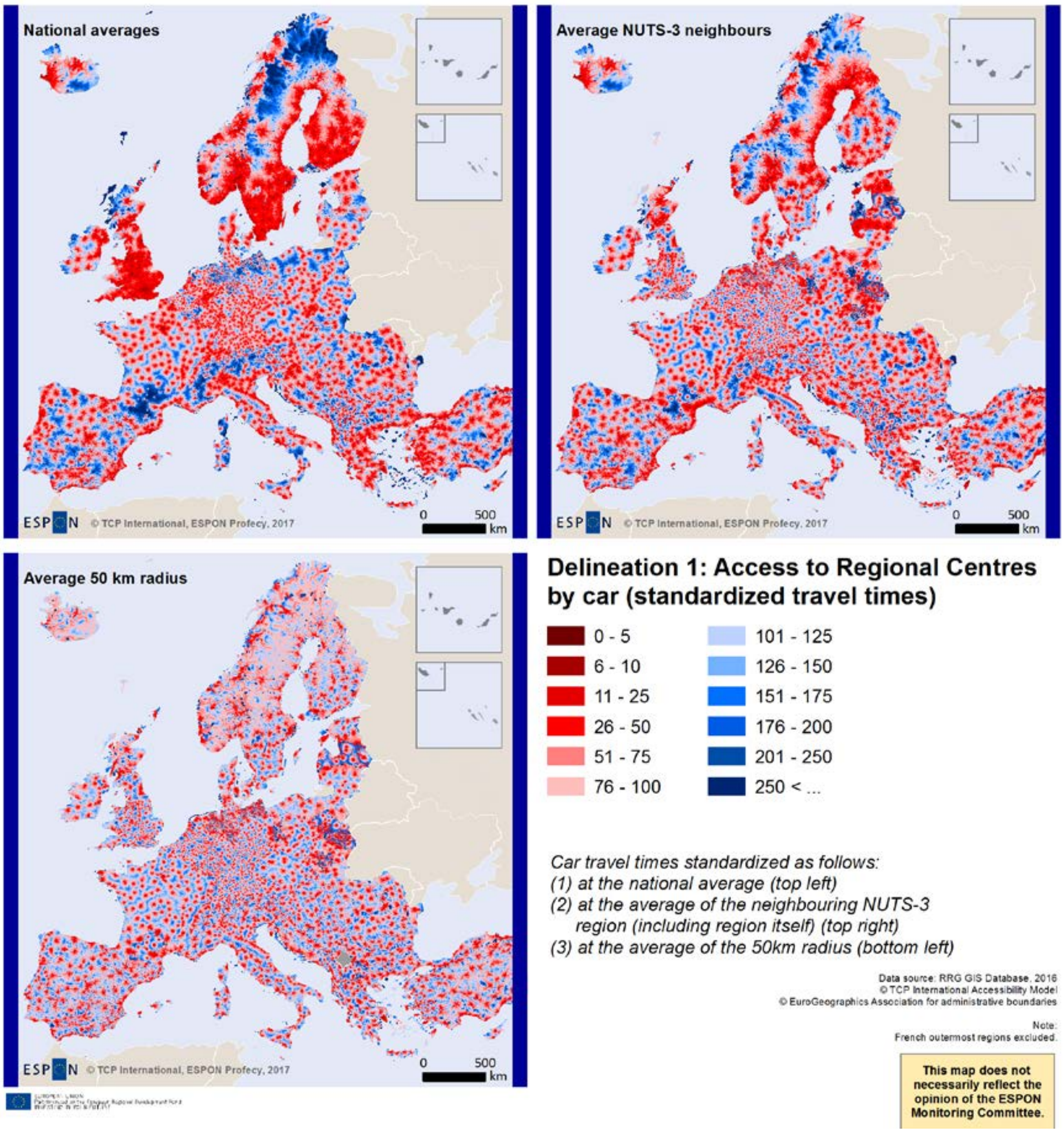
Option (ii) best reflects regional specificities such as urban-rural relationships, urban morphological zones, or regional city networks. Differences in the value range (minimum / maximum) are smaller compared to option (i); however, as the size of NUTS-3 regions differ between the countries and sometimes even within them, the effective territory used for the standardization might be quite different, so that the resulting averages may differ due to the geographical location of a grid cell (in countries like Spain or Sweden very large areas will be used to calculate the averages, while in countries like Belgium, Netherlands or Germany only rather small areas will be taken into account)

Option (iii) best reflects the local situation. Compared to the other two options, only small value ranges (minimum/maximum) are to be expected (the larger the selected radius is, the smaller the value range will be). The standardization results, however, are highly dependent on the chosen radius. A change of the radius will cause the results to change significantly, i.e. the indicator values are not 'robust'.

Options (ii) and (iii) result in some form of ‘floating’ averages, where different averages are applied depending on the location of the grid cell.

Map 3.1 exemplifies the three options by standardizing the car travel times to regional centres (Delineation 1) at the national average (top left), and the average of the NUTS-3 region neighbours (top right), and at the average within 50 km (bottom left).

Map 3.1: Options to standardize indicator values: national averages (top left), neighbouring NUTS-3 regions (top right), 50 km radius (bottom left).



At a glance, the three maps look quite similar, but with very specific differences:

(1) the value range is largest for the national averages, resulting in largest areas in deep red and deep blue, while the value range for the 50 km radius option is smallest.

(2) The national averages highlight best disparities between the most peripheral and most central areas in a country. This results in seamless central territories such as

Southern England, Southern Sweden or Southern Finland, compared to their northern counter-parts. Looking at the average of the neighbouring NUTS-3 regions, there are much more spatial details to observe, so that, for instance, inner peripheries will also emerge in Southern England, Southern Sweden and Southern Finland.

Conclusions:
As a result of these tests, the project team decided to implement option (ii), i.e. to standardize the variables at the average of the neighbouring NUTS-3 regions.
This way of standardization will then be applied whenever necessary to all variables in all four delineations.

3.2 Spatial levels

The basic idea of PROFECY is to delineate and identify inner peripheries at the lowest spatial level possible. Due to data availability and data processing, a distinction must be made between those delineation approaches relying on the analysis of travel times to certain destinations (i.e. Delineations 1 and 3), and those approaches based upon statistical indicators (i.e. Delineations 2 and 4).

While the PROFECY team will generate travel time surfaces itself, by using GIS techniques, there is freedom of choice to select the most appropriate spatial level for Delineations 1 and 3. The project team decided to base these approaches on a European-wide reference grid. Therefore, the entire territory of the 32 ESPON countries were divided into regular raster cells (grid). Unlike the actual ESPON Reference Grid[a], which covers both land masses and water bodies, the PROFECY grid will only cover the land masses (European continent, plus islands).

The choice of the grid resolution determines the results to a large degree. Generally one can say that the finer the resolution, i.e. the smaller the area of each grid cell, is, the higher the accuracy of results will be. But in contrary, the finer the resolution is, also the higher the total number of grid cells is and thus the longer the computational processing time is. Therefore, a good compromise between resolution and computation times needs to be found.

The three ESPON reference grids (Table 3.1:) own resolutions of 10x10 km, 50x50 km and 100x100 kilometres, all of which, with the view of delineating inner peripheries in Europem seem to be too coarse. Another example is the population grid developed by the European Environmental Agency, which owns an extremely high resolution of 100x100 meters, which would be too ambitous for PROFECY. The previous ESPON TRACC project already found a

[a] Available in the actual ESPON Grid MapKit

good compromise between both by applying a raster system of 2.5x2.5 km for entire Europe (including western parts of Russia). After these tests, it was decided to use the same reference grid of 2.5x2.5 km as ESPON TRACC for the entire ESPON space, resulting in almost 920,000 grid cells (excluding Russia).

Table 3.1: Comparison of reference grids.

Source	**Resolution**	**Number of grid cells**	**Spatial coverage**
ESPON Reference Grids	100 x 100 km	5,628	Entire Europe, Caucasus, Northern Africa, incl. oceans (Atlantic Ocean, Arctic Sea, Mediterranean sea, Black Sea, Caspian Sea)
	50 x 50 km	22,512	
	10 x 10 km	562,800	
ESPON TRACC	2.5 x 2.5 km	1,168,748	Entire Europe, including western parts of Russia and Turkey, no water bodies
EEA Population grid	100 x 100 m	3,621,725	EU Member States, no water bodies
ESPON PROFECY	**2.5 x 2.5 km**	**919,421**	**ESPON space, no water bodies**

In contrast, the other two delineations rely on the analysis of existing indicators which means that due to a lack of data small-scale spatial levels such as LAU-2 units or grid cells cannot be used for European-wide analyses. The project team thus decided to apply NUTS-3 level (according to the 2013 NUTS classification) for Delineations 2 and 4.

Comparisons of approaches (Table 3.2):

The big advantage of the two grid approaches Delinations 1 and 3 is their high spatial resolution enabling to identify very small patches and areas of inner peripheries. Their drawback however is that information about the historic development of the destinations, i.e. the regional centres and the different services-of-general-interest, is not available, so that only one actual point in time can be considered.

In contrast, the two NUTS-3 based approached do not own such a high spatial resolution, but instead the actual state and the development over time can both be analysed.

Table 3.2. Classification of delineation approaches.

Spatial basis	**Time**	
	Actual situation	**State & Trend**
Grid level	Delineation 1 Delineation 3	
NUTS-3 level		Delineation 2 Delineation 4

Grid results for Delineations and 3 will, in any case, be later aggregated to LAU-2 and to NUTS-3 levels (see Chapter 3.7) allowing to compare them with results of Delineations 2 and 4, and to further analyse them statistically.

3.3 Thresholds

After standardization of the variables, suitable thresholds need to be applied to differentiate areas of poor access (i.e. areas considered as inner peripheries) from areas with good or fai access (i.e. non-IP areas).

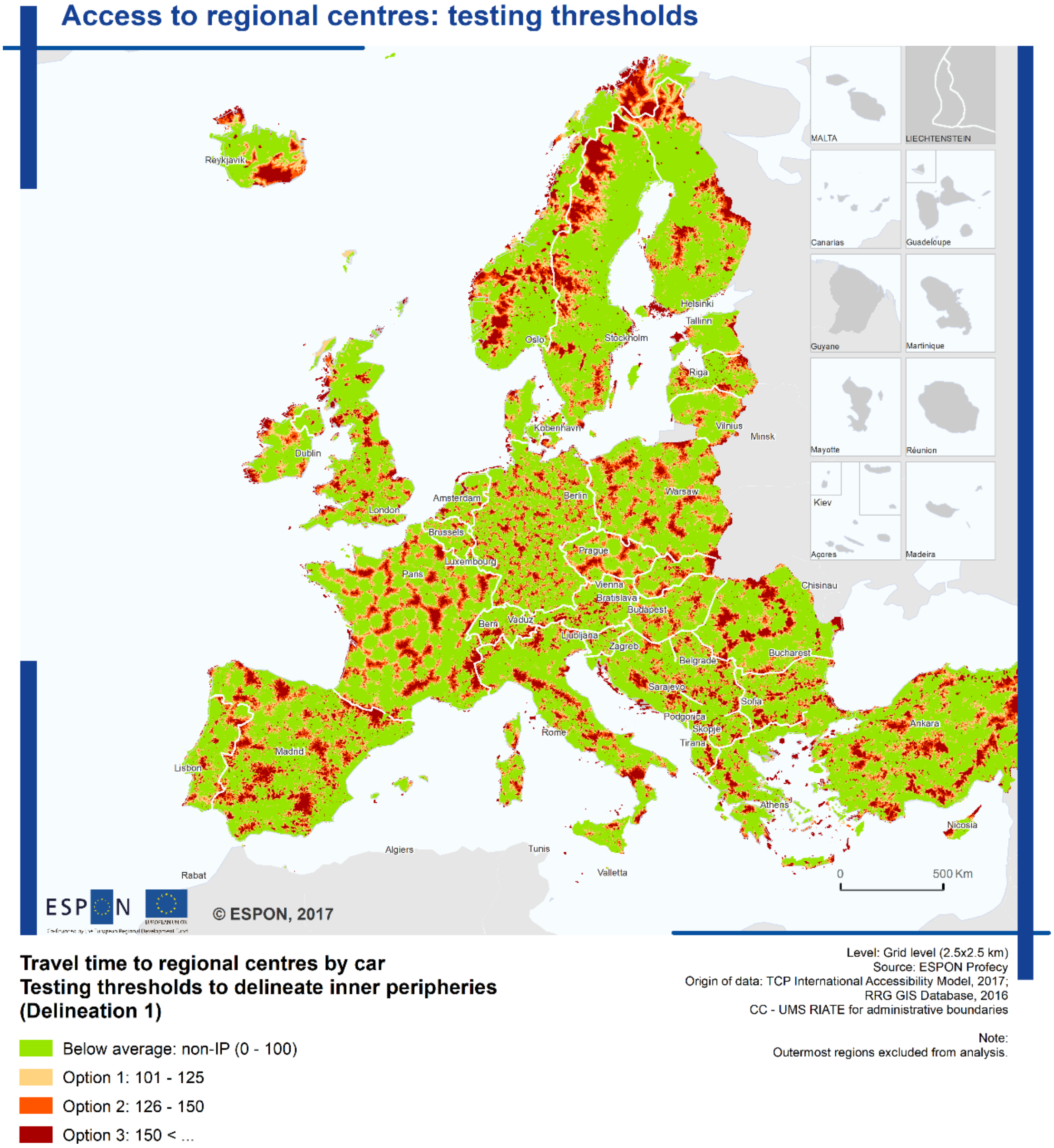
In case of travel time variables (like access to regional centres, or access to SGIs, to be applied in Delineations 1, 2 and 3), standardized indicator values greater than 100 indicate areas of poor accessibility, in relation to the neighbouring areas, while indices below 100 indicate areas of higher accessibility (again in relation to their neighbours).

In contrast, for statistical variables (to be applied in Delineation 4), standardized indicator values of less than 100 indicate 'poor performers' (i.e. potential inner peripheries), while values greater than 100 indicate 'high performers'.

The project team tested different options (Map 3.1) with the following main criteria:

(i) The thresholds should be clear and easy-to-communicate.
(ii) The project team wishes to identify core areas of inner peripheries, i.e. narrow areas that can clearly be considered areas of poor access.
(iii) There should be room for a second threshold to identify areas-of-risk to become IP in future

Map 3.2: Testing different thresholds for distinguishing 'poor' performing areas from 'good' performers.



Conclusions:

The tests revealed to use the following thresholds:

Accessibility variables: Areas with indices of greater or equal 150 will be considered as areas of poor accessibility. This corresponds to areas with a 1.5-times higher travel time compared to the average.

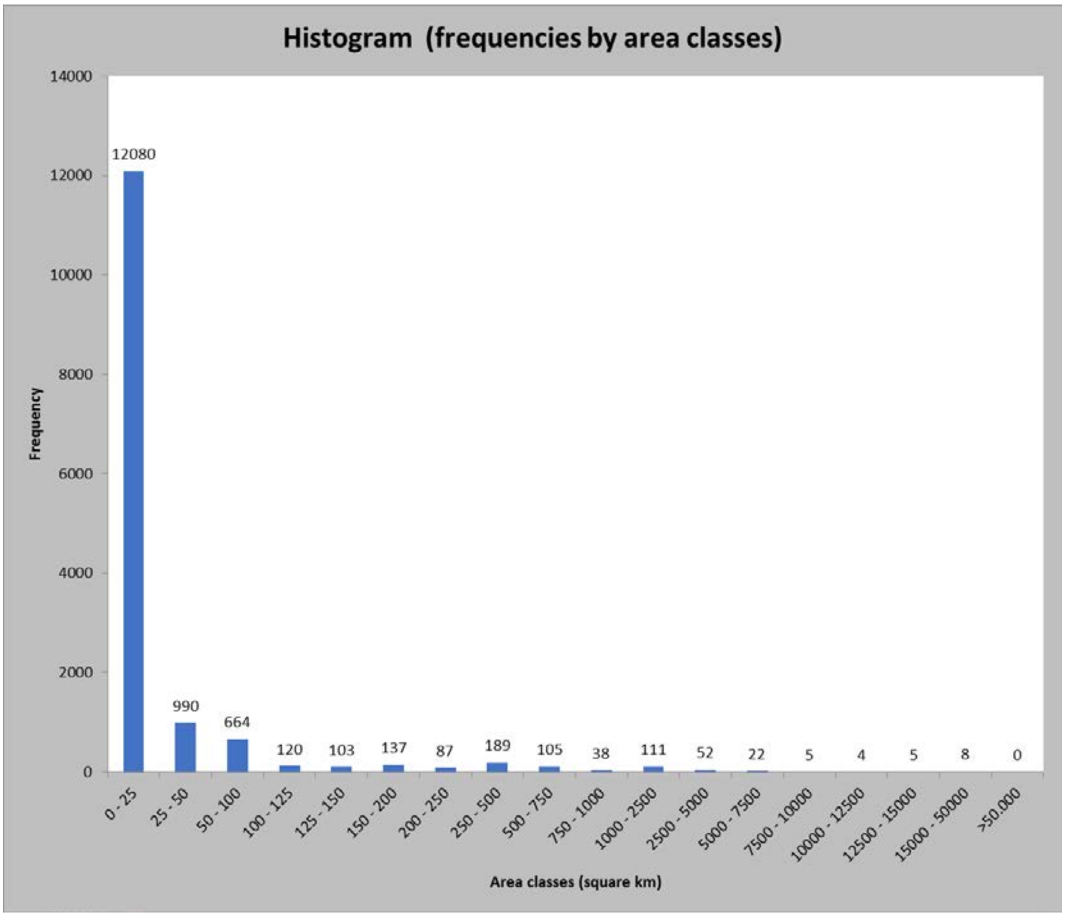
Statistical variables: all regions below 100% or below 75% of the average will be considered as “poor performers”.

3.4 Minimum patch sizes at grid level

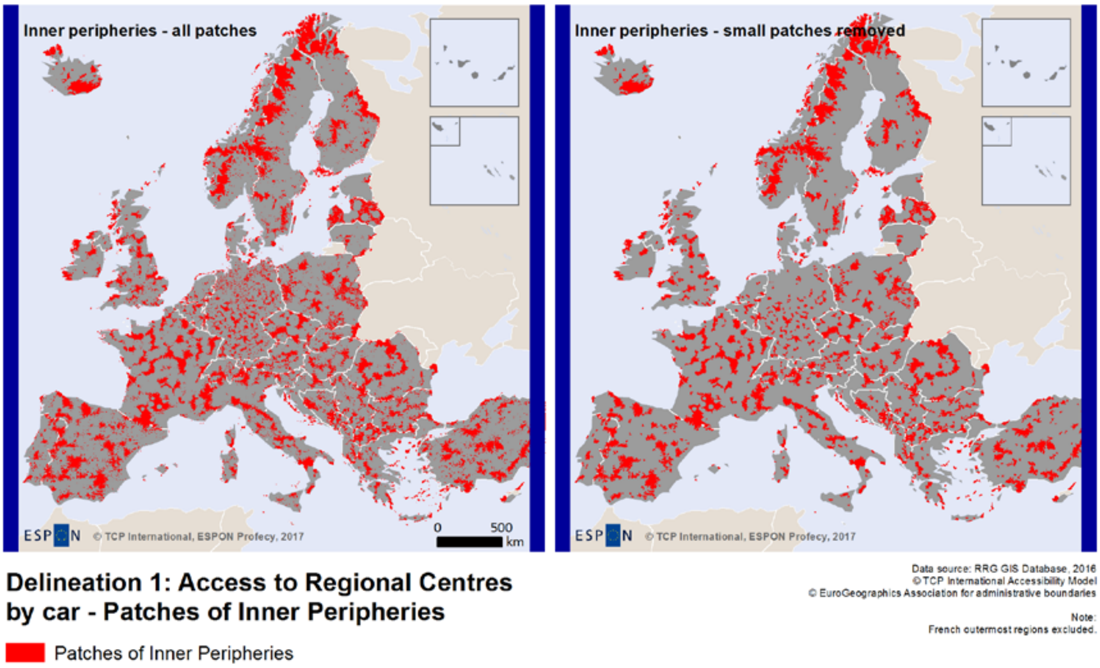
The delineations based on travel time analyses in Delineation 1 and 3 are based upon small-scale grid approaches. As a result of these travel times calculations and indicator standardizations, small sliver polygons of areas of poor access may occur. They may either represent very small local areas of poor access, or they may represent small artefacts of the grid-based approach. However, PROFECY is mainly interested in identifying inner peripheries of Euroepan importance, i.e. the areas identified as inner peripheries should have a certain size (or area).

Figure 3.3 exemplifies that from a total of 14,700 IP patches, 13,734 patches are smaller than 100 km^2, corresponding to 93% of all patches. Map 3.3 illustrates the effects of removing all patches with a size of less than 100 km^2. Having removed such small sliver polygons, the overall spatial patterns of IP areas in Europe become much clearer (Map 3.3, right hand map compared to map on the left).

Figure 3.3. Delineation 1 (cars): Histogram of areas size of IP patches.



Map 3.3: Impact of patch sizes when identifying inner peripheries.



The left map shows a total of approx. 14,700 patches of Inner Peripheries of all sizes. In the right map, all patches of less than 100 square km were removed, resulting in a total of approx. 1,000 patches. Many islands and also traditional peripheries are, though, still included in the right map.

Conclusions:

The terms-of-reference state that the delineation of inner peripheries should "… if possible, be made by using local building blocks (LAU-2 or grid) but result in areas that have a sufficiently large size in the European context (i.e. a size comparable with the size of NUTS3 regions)." (ToR, pages 6 and 7). Although the size of NUTS-3 regions vary significantly across Europe (comparing, for instance, NUTS3 regions in Germany with Swedish or Spanish ones), wherefore a clear minimum size cannot be derived from the ToR, it is clear that patches of less than 100 km^2 do not represent average NUTS3 region size.

Thus, in order to identify areas of inner peripheries from a European perspective, removing sliver polygons is in line with the overall project objectives.

Using a threshold of 100 km^2 seems plausible from the empirical evidence (see Figure 3.3). However, these small IP patches will only be removed after neighbouring IP grid cells have been merged and their boundaries smoothed (see Chapters 3.4 and 3.5).

3.5 Merging of IP patches and smoothing of boundaries

As a result of the grid-based travel time calculations and standardizations in Delineations 1 and 3, areas of poor access to regional centres and to SGIs at grid level were identified, i.e. individual grid cells were identified that represent potential inner peripheries.

In order to identify larger IP areas, neighbouring grid cells were merged to form continuous areas of poor accessibility. Grid cells were merged, if

- they represent 'real' neighbours (i.e. are located next to each other), or if
- the gap between two or more clls is smaller than 5 km (i.e. depending on the spatial situation, if there are 2-3 grid cells in between the two).

After that, boundaries of the merged patches were then 'smoothed' (Figure 3.4), and eventually small sliver polygons with an area of less than 100 km^2 were removed (see Chapter 3.4).

Figure 3.4. Merging and smoothing grid cells before further processing.

3.6 Combination of different variables in Delineation 3

As the PROFECY team developed four different methods for the delineation of inner peripheries, of which three are composed of two or more independent variables, the question arose how to combine the delineation results, respectively the results of the individual variables. What happens if an area is considered IP for one variable (delineation), but not for another variable (delineation)? In the Inception Delivery we already identified three options (1, 2 and 3), meanwhile two further options have been added (Table 3.3):

Table 3.3. Options for combining the results for different variables/indicators.

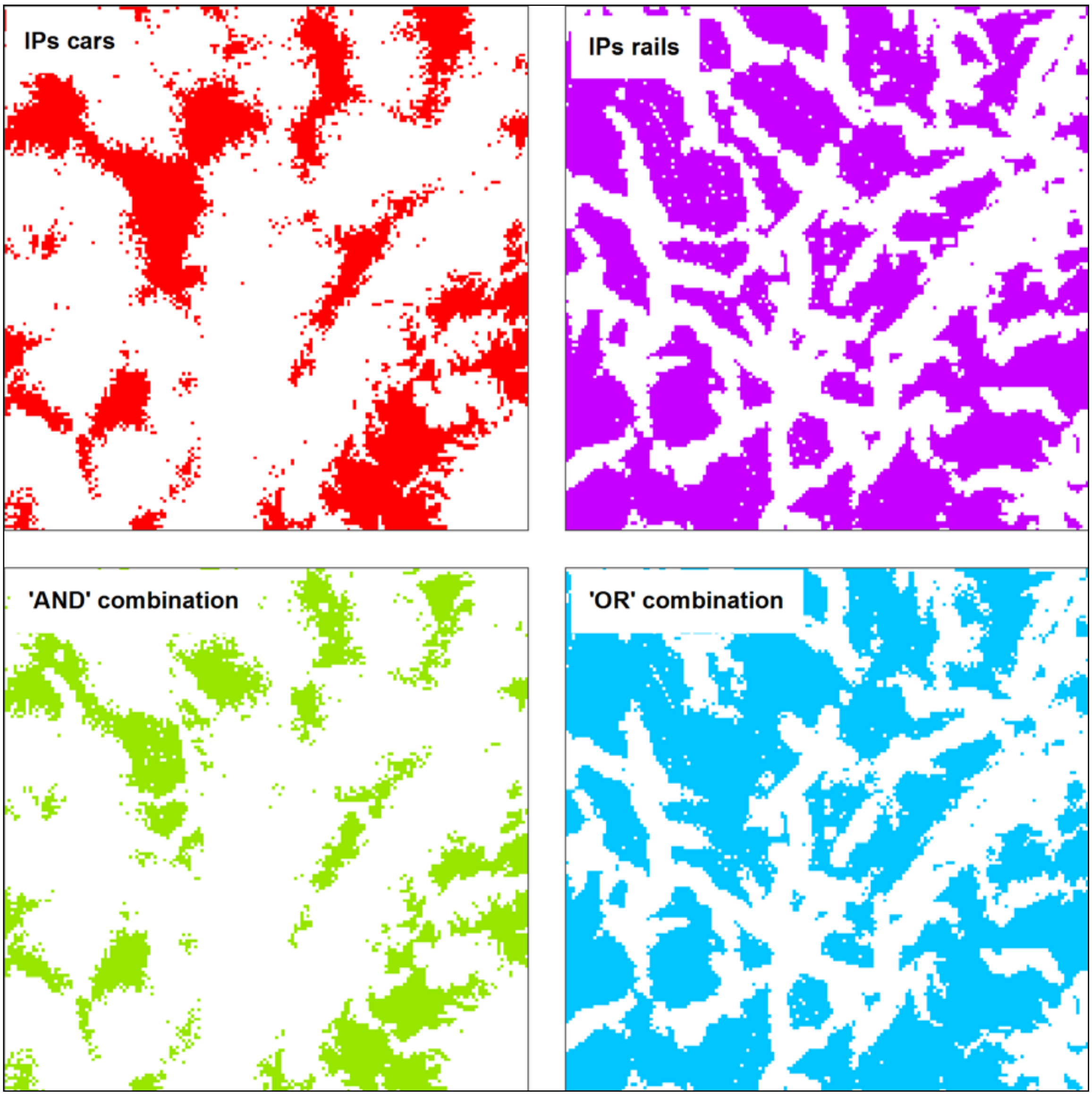
Option	**Rule**	**Description**	**Comment**
1	AND	Any area will be identified as IP if it fails to pass the defined threshold for indicator 1 AND for indicator 2 AND for indicator 3 ... $Ind1 \cap Ind2 \cap Ind3 \ldots$	Areas will only be IP if they fail in all indicators. This may lead to a limited but very focussed set of IPs. Underperformance in one indicator may be compensated by overperformance in another indicator.
2	OR	Any area will be identified as IP if it fails to pass the defined threshold for indicator 1 OR for indicator 2 OR for indicator 3 ... $Ind1 \cup Ind2 \cup Ind3 \ldots$	Areas will be IP if they fail in any of the selected indicators. No compensation foreseen between the indicators. This will lead to a larger set of IPs (both in terms of number of IPs and in their size) compared to option 1.
3	WEIGHTS	Basically like option 1, but the indicators will be weighted, assuming that not all indicators are of similar importance in relation to IP. $\frac{Ind1}{w_1} \cap \frac{Ind2}{w_2} \cap \frac{Ind3}{w_3} \ldots$	Option 3 represents a combination of 1 and 2; however, the definition of the weights is another challenge (in addition to the definition of thresholds), which would require some testing.
4	COUNTING	It will be counted, for how many indicators an area experienced a poor performance. All areas with a count above a certain threshold will be considered as an IP.	The idea is that an area does not constitute an IP if it fails in one or two indicators; problems increase, and thus the problem of inner peripherality aggravates, the higher the number of indicators with poor performances.
5	COUNT & WEIGHT	This option represents an combination of the counting and the OR option. Basically like option 4, but upon the condition that the areas perform badly for certain selected key indicators.	This option tries to combine the advantages of the counting option with the OR option.

Figure 3.5 illustrates the effect of the ‘AND’ and ‘OR’ combinations. Given the delineation of IPs for cars (top left) and for rail (top right), the ‘AND’ combination (bottom left) identifies areas of inner peripheries failing for both road and rail modes. Underperformance in one mode may be compensated by an overperformance in the other. The ‘OR’ combination (bottom right) instead add the rail IPs to the road IPs resulting in much larger combined IP territories.

Conclusions:

There is no definite solution, after testing all options. The different variables used in Delineation 3 will be combined with option 5 (count & weight).

Figure 3.5. Options for combining different variables/indicators.



3.7 Overlay of grid results with NUTS-3 regions and LAU-2 units

According to the ToR, the IP areas delineated at grid level in Delineations 1 and 3 should be overlaid with the boundaries of the NUTS-3 regions in order to identify inner peripheral NUTS-3 regions. This step poses the question about the rules to apply for this overlay. Different options are possible:

(i) **Completely covered**: A NUTS-3 region will be identified as an inner periphery when its entire territory is covered by an inner periphery at grid level (100% coverage).

(ii) **Majority of territory covered**: A NUTS-3 region will be identified as an inner periphery, when the majority of its territory is covered by an inner periphery at grid level (>50% coverage).

(iii) **Partial overlay:** A NUTS-3 region will be identified as an inner periphery, when any part of its territory is covered by an inner periphery at grid level (>1% coverage).

(iv) **Touched by IP areas**: NUTS-3 regions will be identified as an inner periphery, if the NUTS-3 territory is touched by IP grid patches.

(v) **Percentage**: a NUTS-3 region will not be assigned a ‘yes’ or ‘no’ (‘in’ or ‘out’) in relation to its overlay with inner peripheries, but just the percentage of its overlay with IPs (share) will be indicated . The higher the percentage is, the higher is the influence of IPs.

Option (i) will produce the lowest number of IPs at NUTS-3 level, and favors countries with smaller NUTS-3 units (such as Germany, Benelux countries, or Italy). Countries with larger NUTS-3 units are likely to get only very few or even no IP at NUTS-3 level at all.

In contrast, options (iii) and (iv) will produce the largest (maximum) number of IPs at NUTS-3 level, as many NUTS-3 regions are touched by the boundaries of IPs.

While eventually options (i), (ii), (iii) and (iv) will make a binary decision (yes/no, in/out) whether a NUTS-3 region is considered as an inner periphery, option (v) acknowledges that such a binary characterization does not comply with reality; instead, the percentage of overlay will be used as the relevant information.

Table 3.4 gives a qualitative assessment of the five options after evaluating the results for Delineation 1 and 3.

From the empirical results, only option 3 seems feasible (see below). Option 5 will in any case be implemented, since the share of overlap is an important information for the analysis and characterization if inner peripheries.

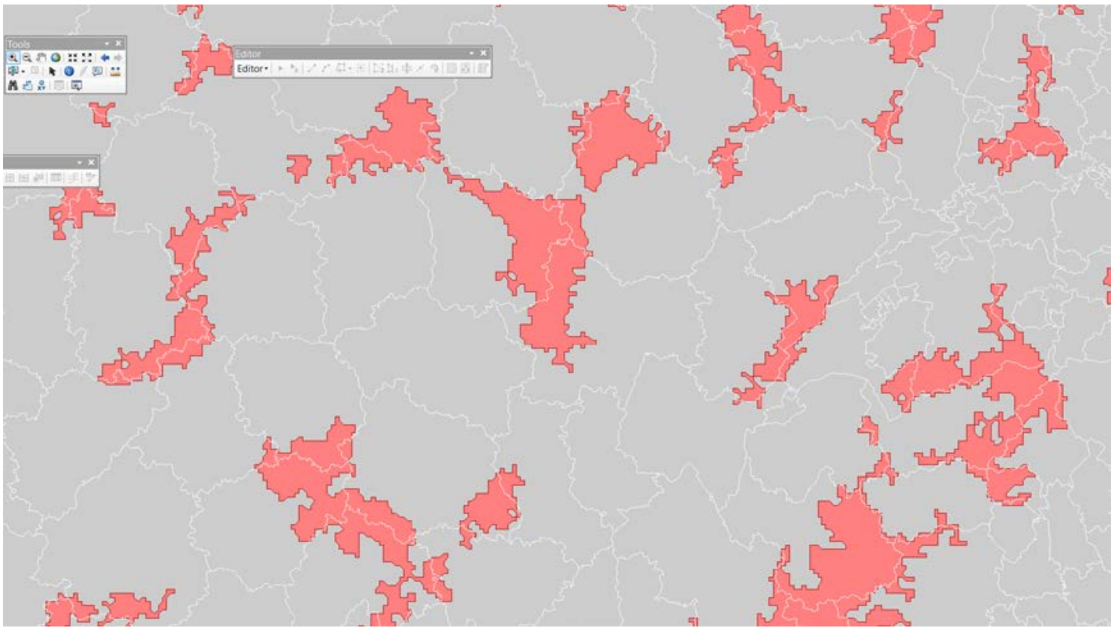
Having seen the empirical results, and regardless of the existing political interest to get to know which NUTS-3 regions can be regarded as inner peripheries, and the options to compare NUTS-3 level IP regions with other typologies (such as urban-rural, core-periphery) and with other spatial phenomena, from a methodological point of view the usefulness of the NUTS3 level seems doubtful on the basis of the available results.

Table 3.4. Assessment of overlay options.

Option	Assessment
1 Completely covered	Almost no NUTS-3 region is complete covered by grid IP patches, neither for Delineation 1 nor for the various variables of Delineation 3. So, this option is not practicable.
2 Majority of territory covered	For both Delineations 1 and 3, only few NUTS-3 regions are covered by grid IP patches by more than 50% of their territory. This option would be possible, however, only very few scattered NUTS-3 regions would be identified as IP.
3 Partial overlap	The majority of percentage share of overlap of NUTS-3 region territories by grid IP patches is between 20% and 40% for both delineation approaches. This is the case occurring most often.
4 Touched by IP areas	Many areas are just touched by boundaries of grid IP patches, in particular for many variables in Delineation 3. If this option would be selected, a large majority of NUTS-3 regions in Europe would be identified as inner peripheries. This would be counter-intuitive.
5 Percentage	This option will in any case be implemented, in order to calculate the share of overlaps for options 2 and 3, but also as a variable for the analysis and characterization of inner peripheries.

The available results of the delineation of inner peripheries at the raster level are very detailed. Many of these areas geographically extend along NUTS-3 boundaries and along national borders (Figure 3.6), extending over two or more NUTS-3 units. As a result, when aggregating the grid level results to the NUTS-3 level, the percentage of the NUTS-3 regions overlaid by grid patches of inner peripheries is relatively low. This is especially true for those countries with large NUTS-3 regions, such as the Scandinavian countries, Spain, or France.

Figure 3.6. Grid level inner peripheries (red) overlaid by NUTS-3 region boundaries (while lines).



This has several consequences:

(1) Relatively low percentages (> 30%) had to be used for the identification of inner peripheries, since only very few regions showed shares of more than 50%. This may lead to NUTS-3 regions being attributed as ‘inner periphery’ whose territory is only overlaid by 1/3 by grid IP patches (see Map 3.4 for examples).

(2) Large IP areas at grid level cannot be depicted at NUTS-3 level, since the percentages are often too small. This causes them to fall out at NUTS-3 level. The resulting NUTS-3 delineation does not properly reproduce the shape and extend of the initial IP areas at grid level.

(3) In case of relatively large NUTS-3 regions, such NUTS-3 regions may also be considered to be internal peripheries, which normally would not be regarded as disadvantaged "inner" areas. The mapped results are thus in a way “counter-intuitive” to many people, if, for instance, these larger NUTS3 regions include cities or towns.

(4) Many areas identified as inner peripheries at grid level “disappear” at NUTS-3 level.

For these reasons, the spatial “jump” from the raster level to the NUTS-3 level by leapfrogging LAU levels appears to be too great from a methodological point of view.

Map 3.5 illustrates the different results of overlaying grid level IP areas with NUTS-3 regions (top) contrasted by overlying them with LAU-2 units (bottom) for southern Italy.

For instance, at NUTS-3 level inner peripheries in Sicily so as the areas between Maratea and Policoro and south of Rossano virtually disappear, while at LAU-2 level the grid level results in these areas are maintained in a very distinct way.

In order to overcome this problem, the more adequate alternative would be using administrative units at a lower scale than NUTS-3. From a methodological point of view, we thus consider overlay with LAU-2 units as preferable over NUTS-3 region overlays[b].

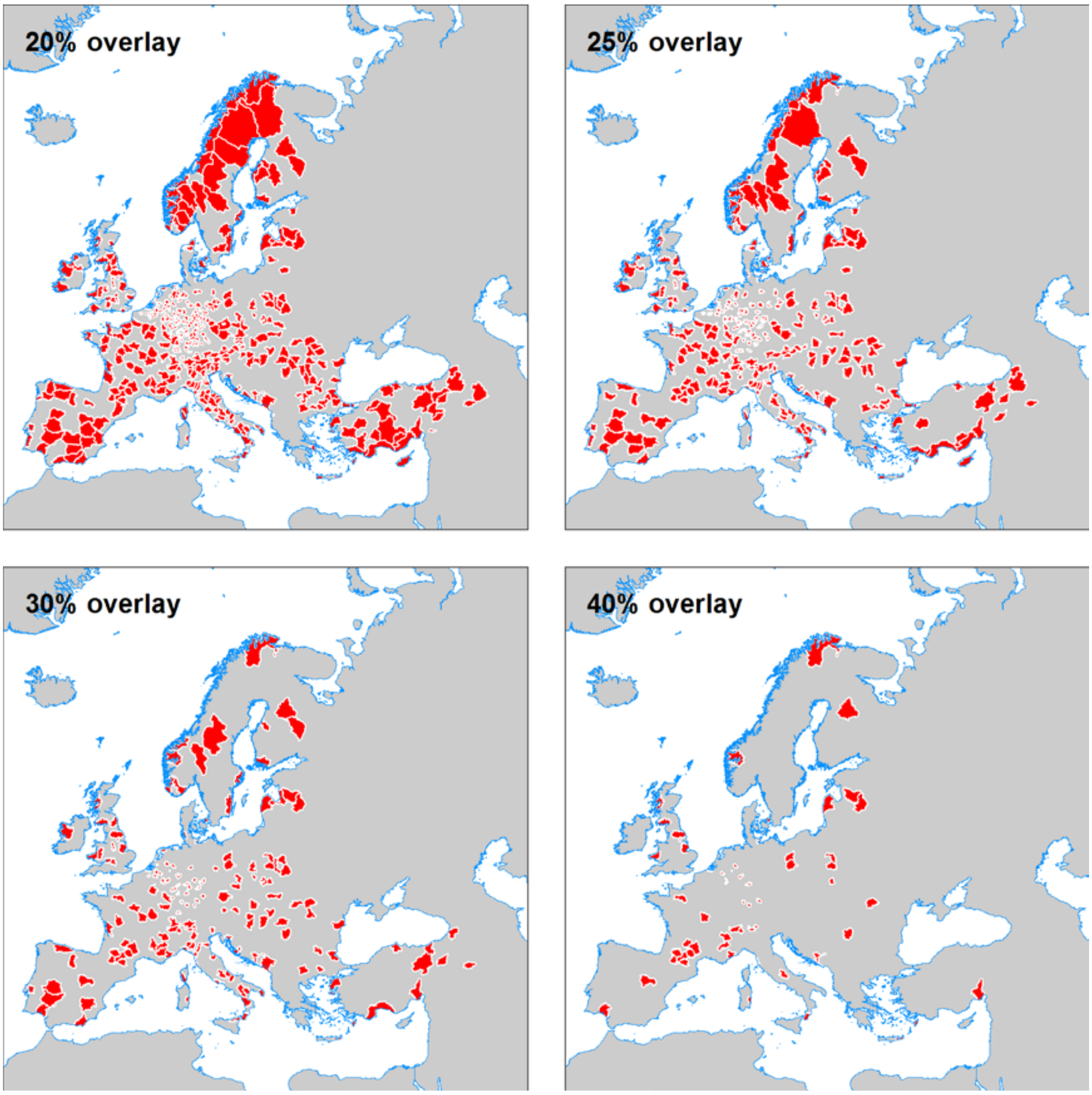
[b] It is worth to note that the basic problem will not disappear just by using LAU-2 units. In case of Scandinavia, for instance, with its large LAU-2 units, the same problem still persists, although at a somewhat ‘smaller’ scale.

Conclusions:

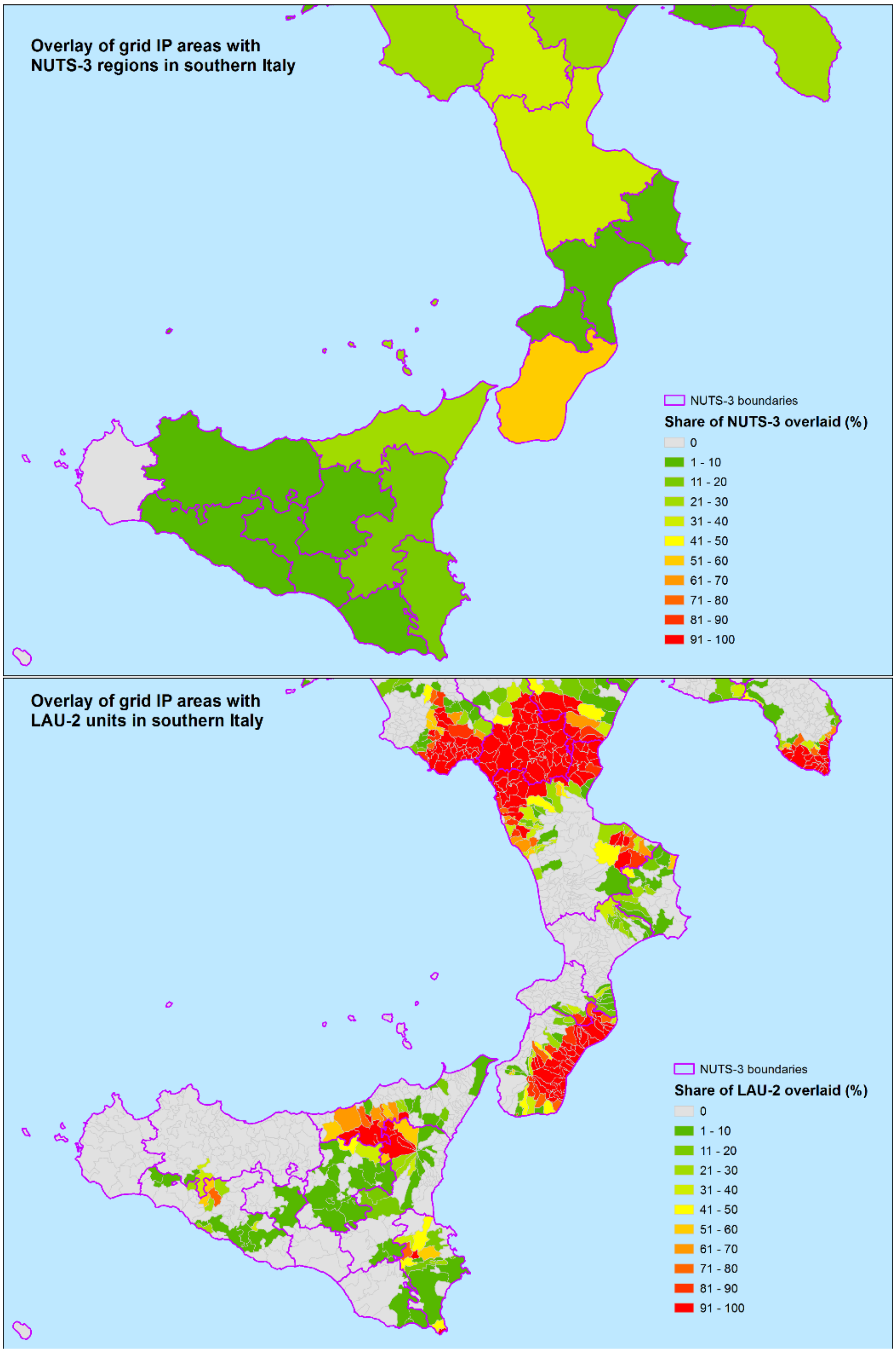
Regardless of existing political interest to get to know which NUTS-3 regions can be regarded as inner peripheries, and regardless the options the NUTS-3 level provides to compare NUTS-3 level IP regions with other typologies and with other spatial phenomena, from a methodological point of view, the usefulness of aggregating grid level results to the NUTS-3 level seems doubtful on basis of the available results. The spatial “jump” from the grid level to NUTS-3 level by leapfrogging LAU levels appears to be too large for many countries.

An overlay of grid level results with LAU-2 units seem preferable over NUTS-3 units.

Map 3.4: Selection of NUTS-3 regions according to different overlay criteria. Example: results of Delineation 1 - access to regional centres by car: NUTS-3 regions with 20% of their territory overlaid by grid IP patches (top left), 25% (top right), 30% (bottom left), 40% (bottom right).



Map 3.5: Overlay with NUTS-3 regions (top) vs. overlay with LAU-2 units (bottom).



3.8 Normative exclusion of certain areas

As PROFECY is the first European-wide project ever trying to develop a methodology for the delineation of inner peripheries, the question needs to be addressed whether there are any specific types of areas which should be excluded from the delineation before the analysis in a normative way, as they cannot conceptually be labelled as ‘inner peripheries’?

Concretely, from a conceptual point of view, this question is targeting towards

- Outermost regions

- Northernmost regions of Scandinavia
- Islands

This does not presuppose that the above-mentioned types of regions do not suffer from any (economic/demographic) problems, but the question rather being whether these problems were caused by different processes, and not because these areas represent ‘inner peripheries’.

Outermost regions

Outermost regions were excluded in this analysis because – due to their geographical location - they cannot be considered inner peripheries. Outermost regions[c] in policy terms have a social and economic structure characterized by “remoteness, insularity, small size, difficult topography, climate and economic dependence on a few products”, according to the Treaty on the Functioning of the European Union, (TFEU, article 349).

Even though Spanish African territories are not outermost regions in the formal sense, they should also be excluded as they are autonomous cities, with an area lower than 20 km^2, separated from the African continent by large fences, thereby isolated, and do not fit in the regional scale of the analysis.

Svalbard (Norway) will also be excluded representing an outermost (and northernmost) region.

Northernmost regions of Scandinavia

The northernmost regions of Finland, Norway and Sweden are characterized by, and suffer from, harsh climatic conditions, extremely low population densities, absence of larger agglomerations and settlements, and their very peripheral geographical location leading to extreme distances within the regions and towards other regions.

The absence of regional centres, however, poses the question whether conceptually inner peripheries may emerge at all in these areas. Therefore, the northernmost territories of the three countries were excluded as well.

Islands

Attending to the contiguity criteria we may want to exclude islands, as (at least small) islands may not have a system of cities and towns that does allow to build some form of inner

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[c] Guadeloupe, French Guiana, Martinique, Réunion, Saint-Barthélemy, Saint-Martin, the Azores, Madeira and the Canary Islands (TEFU, article 349).

peripheries, especially if the size of the island is small. Larger islands[d], in contrast, may well develop very accentuated patterns of inner peripheries.

Small islands, thus, may not develop inner peripheries due to their small size and due to their absence of centres; therefore, they were excluded normatively from the analysis.

In addition, as empirical results and testing has demonstrated, islands will cause some methodological problems when standardizing the travel times in Delineations 1 and 3. Usually, islands have rather poor access to centres and to SGIs, compared to their mainland counterparts. If islands are included in the averaging process, they tend to decrease the overall average, that way implicitly increasing the performance of the neighbouring mainland regions. By way of consequence, the mainland areas will never be considered as inner peripheries, if too many and too large islands are nearby. Table 3.5 illustrates these effects for selected countries, while Map 3.6 shows the impacts in map form: entire mainland areas of Norway, Portugal, Greece and even Denmark are considered highly accessible, when including island in the standardization procedure.

Table 3.5. Impacts of islands and outermost regions on the averages (example: Delineation 1, car travel times).

Country	**Average car travel time to next regional centre**		**Change (%)**
	Including outermost regions and islands	**Excluding outermost regions and islands**	
Denmark	134.75	41.26	-69.4
Greece	71.18	55.67	-21.8
Norway	1,683.73	174.30	-89.6
Portugal	76.09	34.76	-54.3
Spain	42.16	40.75	-3.3

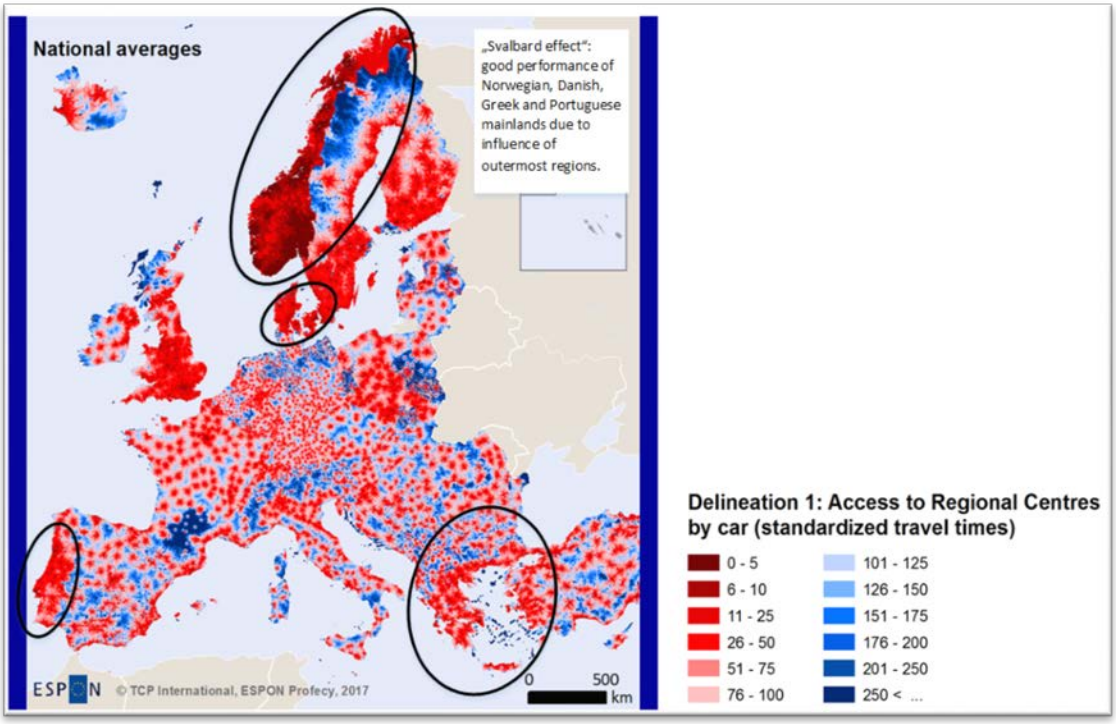
Findings:

Islands, in combination with outmost regions, have significant effects on the calculation of the averages and thus on the standardization results. Including them in the averaging will reduce the average and will cause all mainland areas to become ‘highly accessible areas’ after standardization – which they are from the perspectives of islands, but which they don´t are in the specific national or regional contexts.

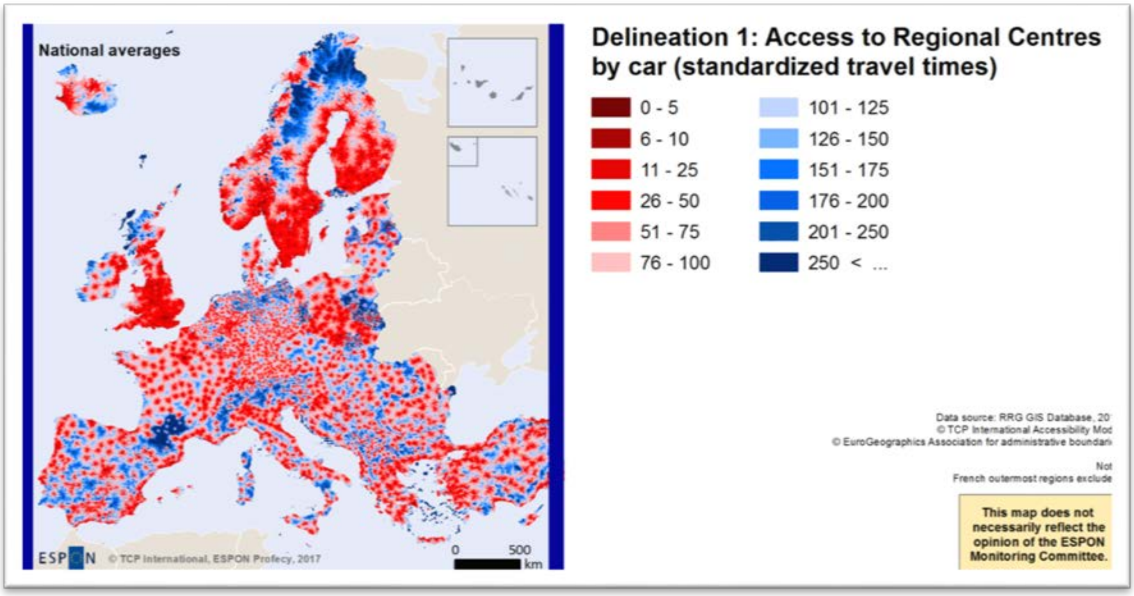
After excluding the outermost regions, a re-standardization of the national averages for Denmark, Greece, Norway, Portugal and Spain reveals the picture as shown in Map 3.7.

[d] like Sicily, Crete, Sardinia, Iceland, and of course Ireland and the UK.

Map 3.6: Effects of including outermost regions and islands in the standardization.



Map 3.7: Recalculated standardized travel time exluding islands and outermost regions.



Conclusions:

The discussion of the 'island case' lead us to the following results:

1. From a normative point of view, we remove very small islands such small Greek islands, Finnish and Swedish islands ('skerries'). Here we are applying a pragmatic approach to identify small islands.
2. Islands consisting of more than one NUTS-3 unit (such as Crete, Sardinia, Sicily, Corsica, Ireland, UK etc.) will be kept.
3. Islands constituting a country (Cyprus, Malta, Iceland etc.) will also be kept.

3.9 Public transport mode

As explained in the PROFECY Interim Report, it was not possible to compile a complete geodatabase on public transport networks for the entire ESPON space including railways, metros, trams, and bus systems. In particular data on bus networks appeared to be only rarely available.

Thus, in an attempt to model public transport, we used a complete railway network for the entire ESPON space.

The results of this attempt, however, were not really convincing (Map 3.8). Due to the low density of the rail networks in many European countries, for some countries almost the entire territory is considered as Inner Periphery after standardization (see, for instance, Spain, the Nordic countries, Ireland, Turkey, Greece, countries of former Yugoslavia). Only small corridors along the rail links appear to be non-IP areas. Assigning entire countries as IP for public transport seems, however, not reasonable and not realistic, and contradictional to the general idea of inner peripheries.

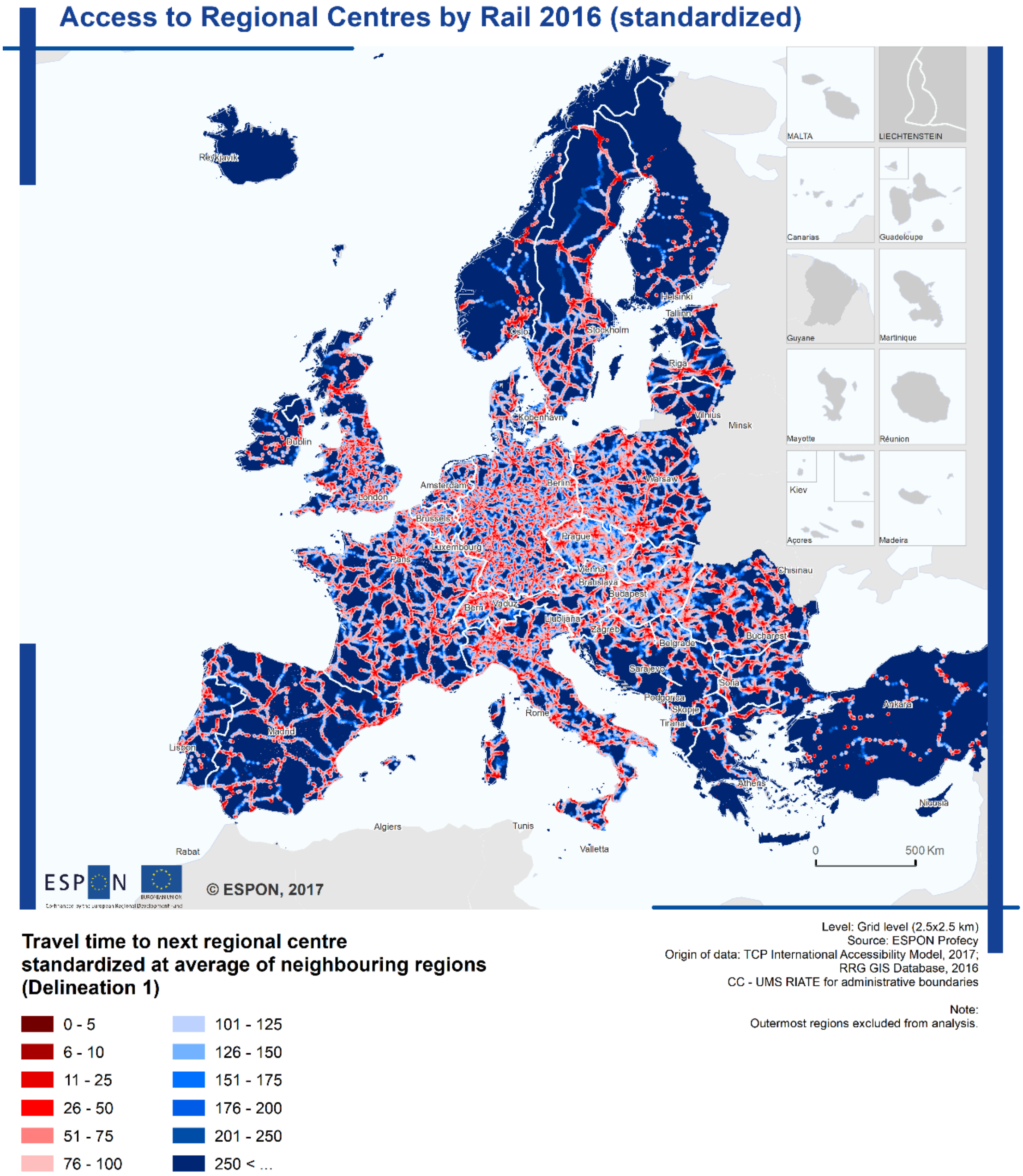
So far, the results reflect the combined impacts of the the (scarce) density of the railway network and the lack of bus networks, rather than any IP patterns. Therefore, no further results have been produced as regards access to regional centres by public transport in Delineation 1, nor as regards access to SGIs by public transport in Delineation 3.

Conclusion:

As long as there is no complete bus network available for the entire ESPON space, modelling access to regional centres or to SGIs by public transport in a grid-based approach does not provide convincing results.

In many regions in Europe, who are disconnected from train services, bus services will provide public transport and of course thereby provide public access to centres and to SGIs. A modelling approach without considering busses seems therefore inappropriate.

Map 3.8:Delineation 1: Standardized rail travel times to regional centres.



4 The four delineation approaches

Following the general remarks given in the previous chapter, Chapter 4 will provide further explanations on specificities of the implementations of the four developed delineation approaches, including a stepwise description of the applied methos. The input data used for the different delineations are presented in Annex 2, while maps illustrating the interim steps of the delineations are collected in Annex 6 and Annex 7. The final delineation results are then presented in the Final Report itself.

4.1 Delineation 1 – Access to regional centres

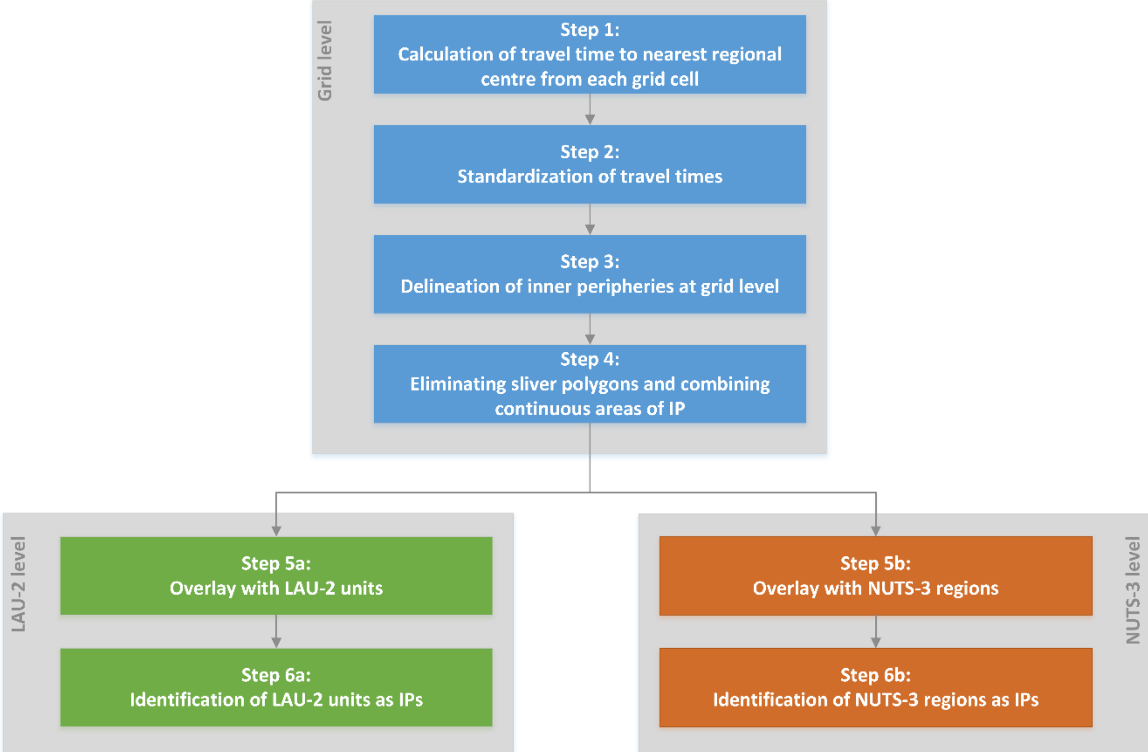
The main characteristics of this delineation can be summarized as follows:

Origins	Grid cells
Destinations	Regional centres
Transport modes	Car
Variables considered *(explicitly or implicitly)*	- Geographical location (i.e. location of regional centres) - Population (via size of regional centre) - Accessibility (expressed in travel time from each grid cell to closest regional centre) - Phyiscal factors (density and connectivity of the road networks) - Quality of the transport systems (road types, speed limits, …)

The method for the delineation and identification of areas of low access to regional centres in Europe in Delineation 1 involves a series of six consecutive, partly also parallel steps, as illustrated in Figure 4.1.

The starting point of the delineation process was the identification of regional centres in Europe.

Figure 4.1. Sequence of steps to delineate inner peripheries for Delineation 1.



After generation of the necessary database (see Annex 2 of the Final Report), **Step 1** calculates the travel time from each grid cell to the nearest regional centre. As the access patterns per se reflect the national urban systems (in terms of number, density, and spatial distribution of cities), with short travel times in areas close to a centre, we need to standardize them in a way that they

a. reflect the regional contexts with areas of comparatively high and comparatively low travel times, and

b. in a way that allows to identify interstitial areas of low access (i.e. rather long travel times compared to surrounding areas).

Step 2 thus standardized the travel times at grid level at the average of the neighboring NUTS-3 regions, including the NUTS-3 region itself where the grid cell is located[e].

After standardization, areas of low access to regional centres (i.e. areas with high standardized index values above a certain threshold) were considered areas of inner peripheries at grid level. A threshold of 150 of the average was applied, i.e. all grid cells above this threshold were considered as inner peripheries (**Step 3**).

In **Step 4**, neighbouring grid cells of inner peripheries were merged, their boundaries smoothed and a threshold of 100 km^2 for a minimum patch area for IPs was applied[f]. Finally,

[e] see Chapter 3.1 of this Annex for more details.

IP grids representing small islands (such as small Greek islands) and outermost areas were removed, as they per definition do not represent inner peripheries (see Chapter 3.8). As an outcome of this step, we obtained a ***delineation of inner peripheries at grid level*** for Delineation 1 (see Map 4.1 in Chapter 4 of the main report).

Once these adjustments at grid level were implemented, the procedures splits into a parallel processing for LAU-2 units and NUTS-3 regions[g]. in **Step 5** the resulting grid patches were overlaid with NUTS-3 region and LAU-2 boundaries, respectively. One important finding of this overlay was that geographically areas of inner peripheries are most often located along the borders of NUTS-3 regions or LAU-2 units and along the country borders, resulting in rather low shares of NUTS-3 and LAU-2 territories overlaid by inner peripheries. Therefore, it appeared not to be suitable enough to solely rely on a certain share of overlay to identify NUTS-3 regions and LAU-2 units as being inner peripheries, because many large IP areas at grid level (result of Step 4) would not appear[h]. Instead, a combined approach was chosen in **Step 6** to identify such LAU-2 units and NUTS-3 regions, on the one hand by applying an overlay thresholds (minimum of 30% (50%) of the NUTS-3 (LAU-2) territory needs to be overlaid by grid cells of inner peripheries), combined on the other hand with a condition that the 75 largest IP patches at grid level needs to be represented by NUTS-3 regions and LAU-2 units. As a positive side effect, this procedure ensured that IP areas were identified in most ESPON countries.

As explained in the above methodology, the definition of the regional centres is a crucial aspect of this delineation. The following criteria for the selection of regional centres in the ESPON space have been applied:

Criteria for the selection of regional centres:
Crtierion 1: all cities with more than 50,000 inhabitants
Criterion 2: NUTS-3 region centroids (whatever their population size)
Criterion 3: cities participating in urban audit programme
Criterion 4: ten largest cities in a country, if not yet included in criteria 1 to 3
Criterion 5: five largest cities > 15,000 inhabitants in large NUTS-3 regions (>10,000 km^2), if not already included in criteria 1 to 4

Table 4.1 summarizes the number of reginal centres selected by country and by criterion, and indicates their average population numbers and the number of top cities (in terms of population) covered.

[f] see Chapter 3.4 of this Annex for more details.

[g] according to Eurostat´s NUTS 2013 classification.

[h] obviously, the spatial step from the grid level to NUTS-3 level is too large for many countries, leapfrogging LAU1/2 levels.

Table 4.1. *Number of selected regional centres by country and criterion.*

Country	Number of cities in selection set						Average population size	Top XX cities covered[i]
	Total	Criteria						
		1	2	3	4	5		
AD - -Andorra	1	0	1	0	0	0	22,546	1
AL - Albania	15	10	4	0	1	0	11,279	10
AT - Austria	36	9	27	0	0	0	90,715	11
BA - Bosnia and Herzegovina	10	6	2	0	2	0	96,287	10
BE - Belgium	52	30	22	0	0	0	95,870	31
BG - Bulgaria	30	19	11	0	0	0	127,567	19
CH - Switzerland	29	10	19	0	0	0	61,998	10
CY - Cyprus	5	4	0	0	1	0	114,115	5
CZ – Czech Republic	22	22	0	0	0	0	154,363	21
DK - Denmark	19	15	4	0	0	0	106,659	15
DE - Germany	474	205	269	0	0	0	86,664	100
EE - Estonia	11	3	3	0	5	0	69,552	10
EL – Greece	75	42	33	0	0	0	66,237	20
ES - Spain	231	172	7	0	0	52	119,952	145
FI – Finland	53	18	7	0	0	28	64,856	15
FL - Liechtenstein	1		1	0	0	0	5,429	1
FR – France	183	151	31	1	0	0	103,007	107
HR - Croatia	20	7	13	0	0	0	95,339	14
HU – Hungary	23	20	3	0	0	0	160,415	20
IE – Ireland	16	6	4	0	3	3	75,026	10
IS - Iceland	10	1	1	0	8	0	23,930	10
IT - Italy	173	155	18	0	0	0	125,893	125
KS - Kosovo	14	12	0	0	2	0	73,047	14
LT – Lithuania	12	6	4	0	2	0	120,100	10
LU – Luxembourg	4	1	0	0	3	0	48,494	4
LV – Latvia	11	5	1	0	4	1	100,172	10
ME - Montenegro	9	2	0	0	7	0	43,774	9
MK -Macedonia	10	5	4	0	1	0	88,036	10
MT - Malta	3	0	2	0	1	0	11,478	1
NL - Netherlands	76	71	5	0	0	0	107,287	67
NO – Norway	38	15	9	0	0	14	63,113	14
PL -Poland	109	96	9	0	0	4	140,793	86
PT - Portugal	46	30	16	0	0	0	95,928	19

[i] *According to national population ranks of cities*

RO – Romania	45	41	4	0	0	0	161,742	41
RS – Republic of Serbia	25	18	7	0	0	0	117,843	18
SE - Sweden	65	28	8	0	0	29	77,485	20
SI – Slovenia	16	4	9	0	3	0	50,599	10
SK – Slovakia	11	11	0	0	0	0	115,006	11
SM – San Marino	1	0	1	0	0	0	10,724	1
TR – Turkey	179	174	5	0	0	7	293,178	168
UK – United Kingdom	322	293	29	0	0	0	144,613	136
Sum	*2,492*	*1,717*	*593*	*1*	*43*	*138*		

Of course, it would have been interesting to look into dynamics of this delineation. For example, what happened in case of shrinking regional centres, i.e. cities that appear to be a regional centre today, but which may not fulfil its functions in future anymore ? Or conversely, what happened if certain centres improve and extend their functions (on the expense of others, neighbouring centres)? Unfortunately, relaibale information on future dynamics of the urban system and thus for the regional centres for entire ESPON space is not available; any assumptions as to these development would therefore be highly speculative, and results thus very sensitive. For this reason the project team decided not to model any forecasts in this delineation.

4.2 Delineation 2 – Economic potential interstitial areas

Unlike the previous delineation, which used grid-based accessibility indicators to regional centres as the starting point, Delineation 2 utilizes an approach based on NUTS-3 regions. Here, the economic potential of a region is expressed as the potential accessibility of a region. The most recent European-wide calculation of potential accessibility indicators was done in the ESPON Matrices project in 2014, updated in 2017 to NUTS 2013 classification. In ESPON Matrices, the following accessibility indicators at NUTS-3 level for entire ESPON space were calculated:

- Potential accessibility by road for 2001, 2006, 2011 and 2014
- Potential accessibility by rail for 2001, 2006, 2011 and 2014
- Potential accessibility by air for 2001, 2006, 2011 and 2014
- Potential accessibility multimodal for 2001, 2006, 2011 and 2014 (as a combination of road, rail, and air)

In the ESPON Matrices project, the accessibility values were standardized at the ESPON average resulting in the well-known large scale European core-periphery divide. For PROFECY, however, we are looking into regional accessibility patterns. Therefore, after obtaining the unstandardized potential accessibility raw values from ESPON Matrices, we restandardized the numbers at the average of the neighbouring regions, similar to the approach in the other delineations. The results of this re-standardization are presented on the following pages.

Since air transport is irrelevant from the point of view of regional transport and regional access to centres and SGIs, the potential accessibility by air indicator and, by way of consequence, the multimodal potential accessibility indicator has not been used in PROFECY, and focus was given on road and rail modes.

All NUTS-3 regions that fulfil the following criteria have been identified as inner peripheries:

Criterion 1	all NUTS-3 regions whose standardized potential accessibility for road in 2014 is below average of neighbouring regions (i.e. < 100)
Criterion 2	all NUTS-3 regions whose standardized potential accessibility for rail in 2014 is below average of neighbouring regions (i.e. < 100)
Criterion 3	all NUTS-3 regions whose development of the standardized potential accessibility for road in period 2001-2014 was negative (i.e. change rate < 0)
Criterion 4	all NUTS-3 regions whose development of the standardized potential accessibility for rail in period 2001-2014 was negative (i.e. change rate < 0)

All four criteria have been combined with the ‘AND’ operator. A map visualization of these criteria can be found in Annex 6.

Rationale for this approach:

All NUTS-3 regions currently having an economic potential below the regional average for road and rail and which have experienced a poorer development of the accessibilities for road and rail in the period 2001 to 2014 compared to their neighbouring regions are regarded as disadvantaged, and thus are regarded as inner peripheries according to this delineation

The main characteristics of this delineation can then be summarized as follows:

Origins	NUTS-3 regions (2010 NUTS classification)
Destinations	NUTS-3 regions (2010 NUTS classification)
Transport modes	Road, rail
Variables considered *(explicitly or implicitly)*	Potential accessibility 2014 Potential accessibility, development 2001-2014 Physical factors (connectivity of transport networks) Quality of the transport system (road types, speed limits, train speeds and schedules)

4.3 Delineation 3 – High travel times to SGIs

The main characteristics of this delineation can be summarized as follows:

Origins	Grid cells
Destinations	Different types of SGIs: - Banks - Cinemas - Doctors - Hospitals - Pharmacies - Retail sector (both supermarkets and convenient stores) - Schools (primary and secondary schools) - Train stations (main stations and all stations) - UMZ (proxy for jobs)
Transport modes	Car
Variables considered	- Geographical location (i.e. location of the SGI facilities) - Accessibility (expressed in travel time from each grid cell to the closest SGI) - Physical factors (connectivity and density of the road network) - Quality of the transport systems (type of roads, speed limits)

The methodology applied for this delineation approach follows one by one the 6-steps method developed for Delineation 1 (Figure 4.1), i.e. it starts with the calculation of travel times to the nearest SGI facility (**Step 1**), followed by standardization of the travel times (**Step 2**), delineation of inner peripheries at grid level (**Step 3**), elimination of sliver polygons and merging of IP areas with a smoothing of boundaries (**Step 4**), overlay with NUTS-3 regions and with LAU-2 units respectively (**Step 5**), and finally the identification of IPs at NUTS-3 and LAU-2 levels (**Step 6**).

This sequence of steps has been implemented for each service-of-general-interest individually, by developing a set of Python scripts (see Chapter 6). Altogether, delineations for the following variables (SGIs) have been generated as part of Delineation 3:

- Banks
- Cinemas
- Health care I: Doctors
- Health care II: Hospitals
- Health care III: Pharmacies
- Schools I: primary schools
- Schools II: secondary schools

- Retail (supermarkets and convenient stores)
- Urban morphological zones (proxy for jobs)
- Train stations (all passenger train stations)

Except for the health care sector and for schools, for all other SGI types we allow the accessibility model to visit destinations abroad, which means that we acknowledge that people cross borders to go shopping, working, to take trains, go to cinemas or to banks. For the health and education sector, which are very much regulated by national directives, it is in contrast rather unlikely that people go abroad for general treatments or for basic education. Therefore, in these cases the accessibility model only considered domestic destinations.

Due to problems of data coverage for the doctors and pharmacies data sets, certain countries have been excluded from processing for these two SGIs. For pharmacies, Turkey was excluded; for doctors, the following countries have been excluded: Albania, Bosnia e Hercegovina, Greece, Finland, Kosovo, Latvia, Lithuania, Macedonia, Malta, Montenegro, Norway, Romania, Republic of Serbia, and Turkey.

The complete set of maps produced during the delineation process for Delineation 3 is documented in the Annex 7.

After individual IP delineations for the ten SGIs had been finalized, the individual results had to be combined in order to obtain one overall delineation of inner peripheries for Delineation 3. Table 3.3 of Chapter 3.6 already introduced options of how to combine the results. Having tested all options, eventually the Count&Weight option was selected as the most suitable one for PROFECY.

4.4 Delineation 4 – Depleting areas

In this delineation, the phenomenon of inner peripheries is considered as a process. At some point in time, regions may enter into a negative downward spiral, often triggered by external shocks like closure of important industries or loss of importance of raw material deposits. Such shocks may then lead to increasing unemployment, decreasing wealth (GDP per capita), with further impacts on out-migration. A population loss may then weaken the basis (demand) for further economic activities which may results in closure of services and so to a further increased risk of out-migrations.

Such processes may occur even if the area in question has good access to regional centres or to SGIs. Therefore, the basic idea of this delineation is to go beyond accessibility variables by looking into key demographic and economic indicators. Depleting areas are thus areas exhibiting low levels of socio-economic and socio-demographic performance which can be attributed to an absence of “organized proximity” (of whatever kind), which are in some way excluded from the “mainstream” of economic activity, or which can be said to be experiencing a process of “peripheralisation”.

The main characteristics of this delineation can then be summarized as follows:

Origins	NUTS-3 regions (2013 NUTS classification)
Destinations	n.a.
Transport modes	n.a.
Variables considered	Population 2015 Population change (2001-2015) GDP per capita 2015 GDP per capita change (2000-2015) Unemployment rate 2016 Unemployment rate change (2002-2016)

The delineation uses three main variables, which are demography (population), wealth/output (GDP), and labour market (unemployment). For each variable, the situation in the most recent year as well as the development over the last decade was analysed

A NUTS-3 region is considered as an inner periphery, if the region has, in comparison to its neighbours, a comparatively poor performance in the most actual year, and if it experienced a negative trend over the last year.

In detail, as regards the demographic situation, the following two criteria have been applied:

All NUTS-3 regions are identified as inner peripheries,

1. Demographic development: Standardized *population density <50%* of neighbouring re-gions **AND** negative mean annual change rates in time period 2000-2015 **OR**

2. Economic performance: Standardized *GDP per capita* in 2015 is <85% of the average of neighbouring regions **AND** who experienced GDP development in time period 2000-2015 below the average of ESPON space **OR**

3. Social inclusion: Standardized *unemployment rate* in 2016 is > 125% of the average of neighbouring regions **AND** who experienced increasing unemployment rates in time peri-od 2002-2016.

As shown, the state and trend of one variable are combined with the **AND** operator, while the three variables are combined with the **OR** operator[j].

4.5 Combining the four delineations

Since the four approaches are based on completely different theoretical concepts, a combination into one single delineation is not possible without comparing "apples with pears". Instead, the four delineations are overlaid spatially, to see to what extent they overlap and

[j] Note that there is no NUTS-3 region in the ESPON space that has poor demographic development **AND** poor economic performance **AND** poor social inclusion at the same time, so combining the three variables with the **AND** operator would result in an empty selection.

where they do, and the resulting combinations are qualitatively described at the level of the raster cells.

As we have four delineations, each of which differentiating non-IP from IP regions, we altogether observe 16 different combinations (Table 4.2). As half of the delineations were gird-based, the other half NUTS-3 level based, it was decided to combine the delineations at grid level; results of Delineation 2 and 4 (i.e. those based upon NUTS-3 regions) were then disaggregated to grid level; thereafter, all results at grid level were combined[k].

As Table 4.2 shows, almost 45% of the entire ESPON territory can be attributed as inner periphery, at least according to the outcome of one delineation, of which 16% of the territory is identified as IP under two or more delineations, and almost 30% are IP under only one delineation.

Map 4.1 illustrates the patchwork of all possible 16 combinations, which is somehow difficult to interpret. Therefore, Map 4.2 and Map 4.3 try to aggregate these overlay results.

First, Map 4.2 counts the number of IP assignments across the four delineations. Areas which are identified as IP in just one delineation can be found basically everywhere in Europe, those in two delineations are concentrating in mountain ranges (Alps and Apennines, Pyrenees, Scotland, southern Norway), in Turkey and parts of East European countries, and in large parts of Spain and Portugal. Areas identified as IP in three delineations are found in Scandinavia, Iceland, Turkey, Spain, Italy, Poland and Romania, and as small patches in France, Germany, and the UK. IP areas in all four delineations finally are situated in Turkey, Romania, Poland, western Spain, and the UK.

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[k] The project team is aware that this approach will cause some distortions to the combination results, as the spatial accuracy and detail of Delineation 1 and 3 are much higher than for the other two; still, the project team considers the outcome as valid, at least as an explanatory excurses to draw conclusions.

Table 4.2. Possible combinations of the four delineations.

#	Delineation [1]				%	Comment	Main driver
	1	2	3	4			
1	0	0	0	0	54.6	Non-IP area, high accessibility	./.
2	0	0	0	1	9.0	high accessibility and economic potential, but still depleting	(iii)
3	0	0	1	0	6.4	Poor access to services, but high economic potential and good/stable demography	(ii)
4	0	0	1	1	1.3	Poor access to SGIs and (thus) depleting	(ii)+(iii)
5	0	1	0	0	10.3	Good accessibility and good (stable) demography, but low future potentials	(i)
6	0	1	0	1	1.4	Low economic potential and depleting, but good accessibility	(i)+(iii)
7	0	1	1	0	1.2	Poor economic potentials and poor access to SGI, but stable demography	(i)+(ii)
8	0	1	1	1	0.3	Although good access to centre, poor economic potential, overall poor access to SGIs and thus depleting	(i)+(ii) +(iii)
9	1	0	0	0	4.0	Poor access to a centre, but still good economic potential, good access to SGIs and thus good /stable demography	(ii)
10	1	0	0	1	0.6	Poor access to a centre and depleting, but still economic potentials and good access to SGIs	(ii)+(iii)
11	1	0	1	0	7.1	Low access to centres and services, but still good economic potentials and not yet depleting	(ii)
12	1	0	1	1	1.5	Low access to centres and services, depleting, but still good/stable economic potential	(ii)+(iii)
13	1	1	0	0	0.9	Low access to centres and low potentials, but still good/stable access to SGIs and thus not yet depleting	(i)+(ii)
14	1	1	0	1	0.1	Low access to centres and services, low potentials, but not yet depleting	(i)+(ii)
15	1	1	1	0	1.5	Remote (poor accessibility), and low potentials, but still not depleting	(i)+(ii)
16	1	1	1	1	0.3	absolute remote and depleting	(i)+(ii) + (iii)

[1] 0 = non-IP; 1 = IP area

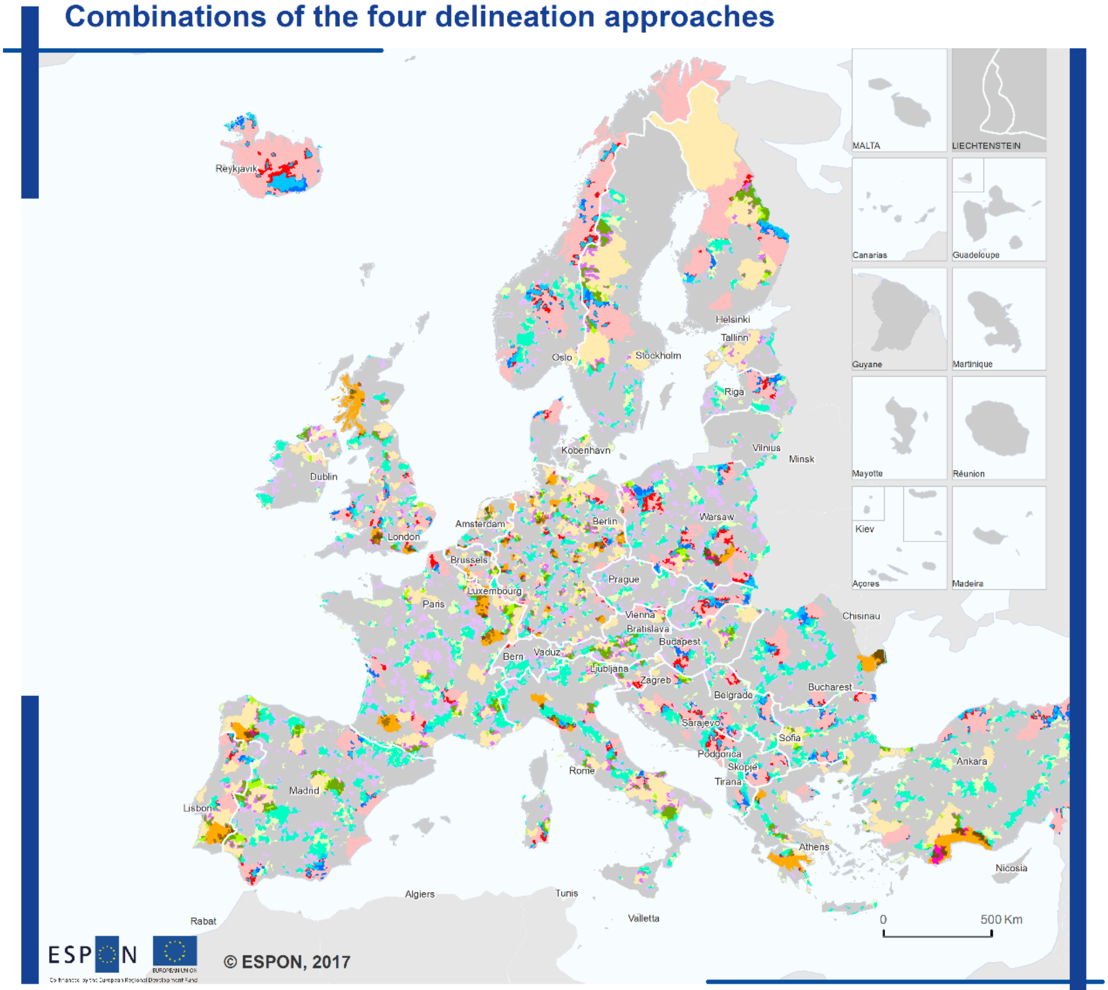
Then, Map 4.3 tries to identify the main drivers of inner peripherality, by aggregating the 16 combinations into three classes.

Main drivers of inner peripherality are

(i) low economic potentials (Delineation 2) or
(ii) poor access to regional centres in Delineation 1 or to SGIS in Delineation 3,
(iii) a poor socio-economic situation (absence of organized proxity, Delineation 4),
(iv) or a certain combination (aggravation) of them.

In other words, these main drivers correspond to the developed theoretical concepts of IP. The final column of Table 4.2 relates the 16 combinations to these main drivers.

Map 4.1:Possible combinations of the four delineations.



Overlay of results of the four individual delineations (possible combinations at grid level)

Level: grid cells (2.5x2.5 km)
Source: ESPON Profecy
Origin of data: TCP International Accessibility Model, 2017
CC - UMS RIATE for administrative boundaries

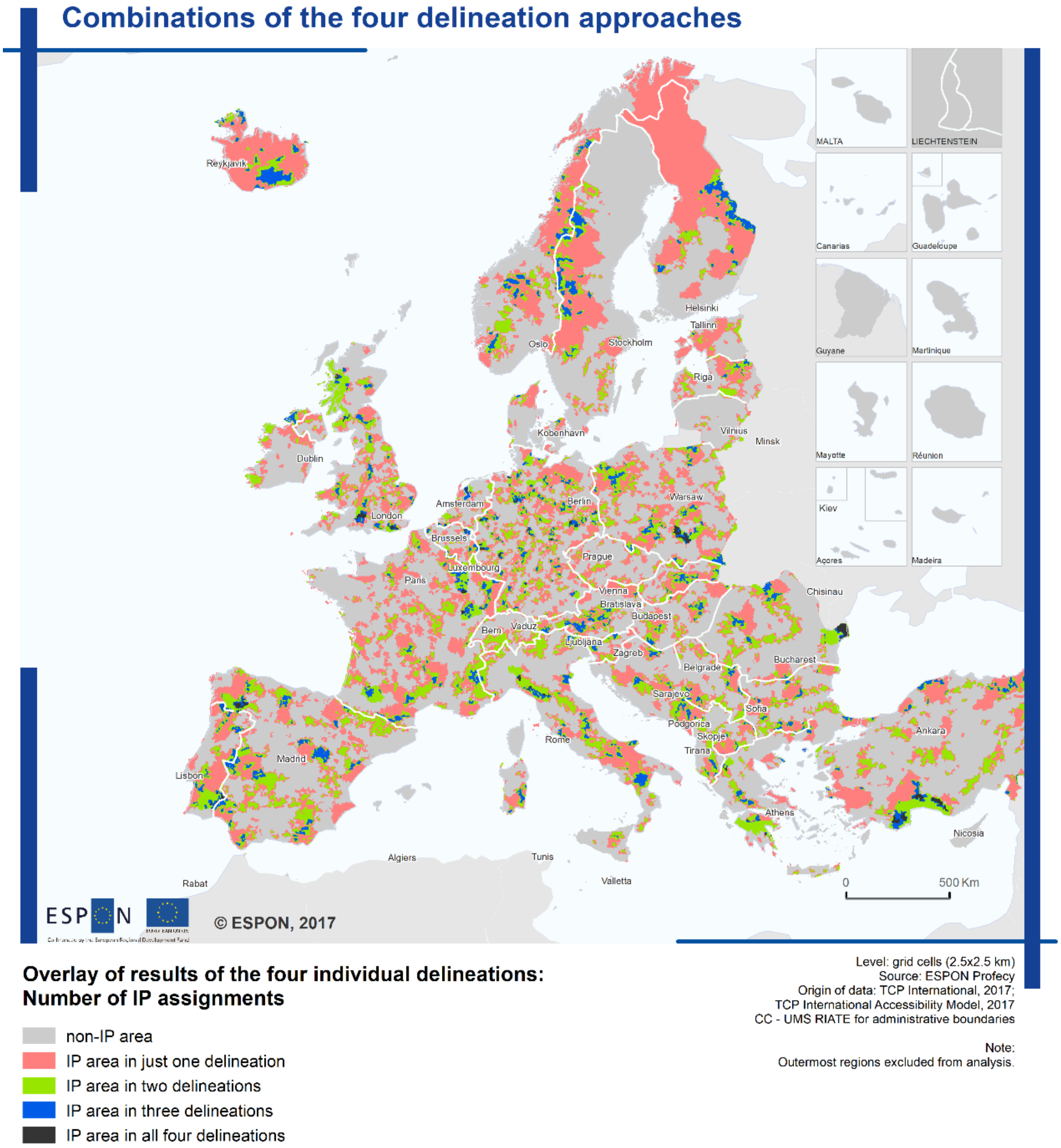
Note:
Outermost regions excluded from analysis.

- 0-0-0-0 non-IP area
- 0-0-0-1 Good accessibility and economic potential, but depleting
- 0-0-1-0 Poor access to services, but good economic potential and socio-demographic situation
- 0-0-1-1 Poor access to services, and depleting
- 0-1-0-0 Good accessibility and demographic situation, but low future potentials
- 0-1-0-1 Low economic potential and depleting, but good accessibilty
- 0-1-1-0 Low ecoomic potential and poor access to services, but good demographic situation
- 0-1-1-1 Good access to centres, but bad access to services, poor economic potential and depleting
- 1-0-0-0 Poor access to centre, but good economic potentials, good access to services and good socio-economic situation
- 1-0-0-1 Poor access to centre and depleting, good economic potentials and good access to services
- 1-0-1-0 Poor access to centre and services, but good economic potentials and good socio-economic situation
- 1-0-1-1 Poor access to centre and services and depleting, good economic potentials
- 1-1-0-0 Poor access to centre and low economic potentials, but good overall access to services and good demographic situation
- 1-1-0-1 Poor access to centre and low economic potentials and depleting, but good overal access to services
- 1-1-1-0 Poor access to centres and services, low economic potentials, but still not depleting
- 1-1-1-1 Poor access to centres and servics, low economic potentials and depleting

Delineations:
1 - 2 - 3 -4

0 = non-IP area, and 1 = IP area

Map 4.2:Combining the four delineations: Number of IP assignments.



According to Map 4.3, interestingly, the main driver in most Scandinavian IP areas and IP areas in Iceland is not a lack of access (as one may presume according to their general peripheral situation), but their poor economic and demographic basis, i.e. a lack of demand. Similar cases can be found in East Germany, in the Baltic States, Turkey, southern Italy, in Portugal and parts of Spain, and in Scotland and parts of Eastern Europe. Altogether, 46% of all IP areas are predominantly suffering from its poor economic potential and poor demographic situation (corresponding to 21% of entire ESPON space). IP areas with a lack of access (to centres and/or services) as key driver account for some 45% of all IP areas (or 20% of entire ESPON space), and are located in the Alps, Apennines, as well as in France, Spain, Poland, Romania, and West Germany, but also in southern Scandinavia. IP areas which are both triggered by poor access and by a poor economic and demographic situation are scattered around Europe in small patches, accounting for approx. 9.4% of all IP areas;

however, some concentrations of these areas can be observed in Poland, Slovakia, in countries of former Yugoslavia, and in the border region between Portugal and Spain.

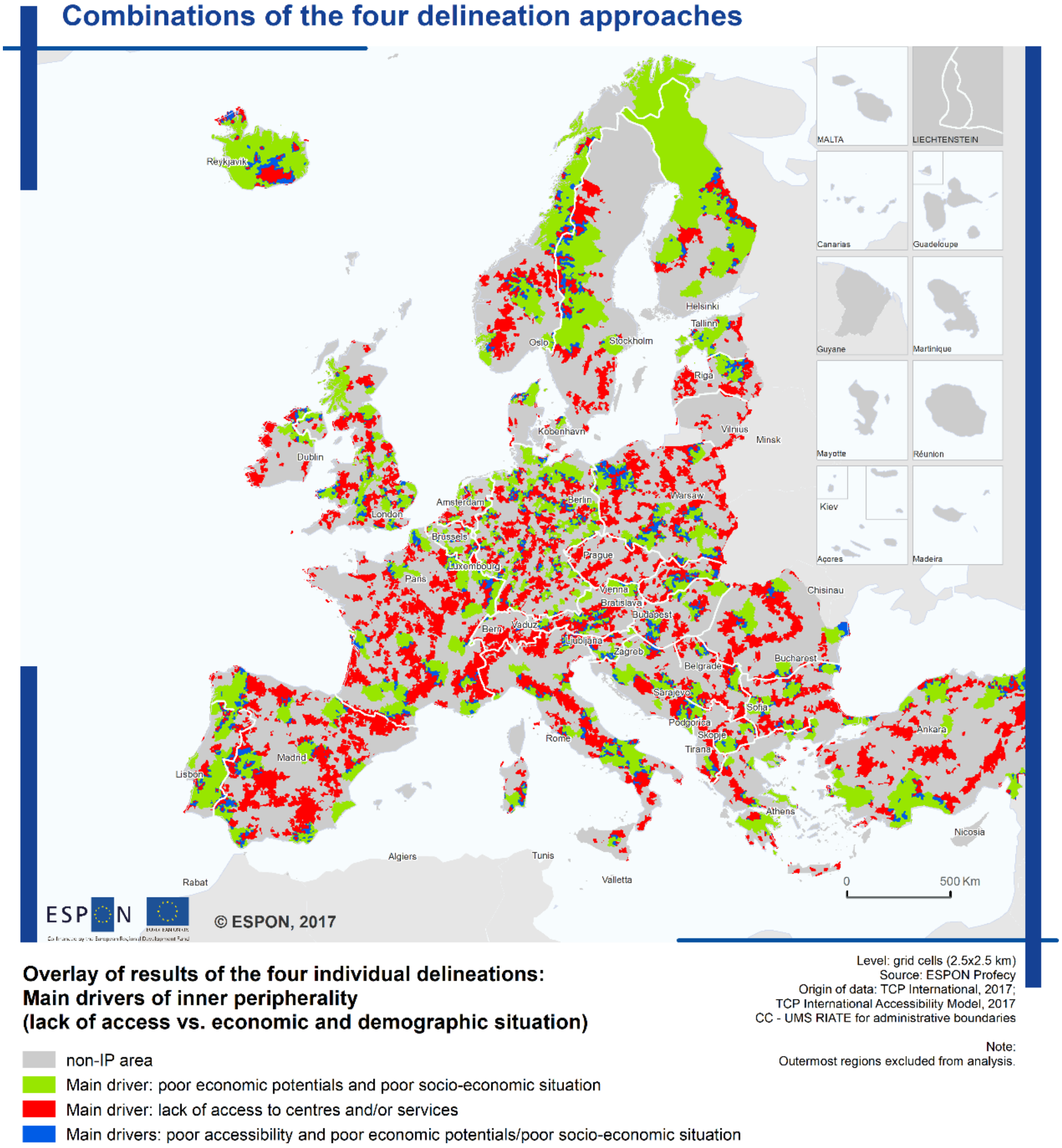
Table 4.3 summarizes the proportions of IP areas in relation to the ESPON territory, as well as the shares of different kind of IP areas[l].

Table 4.3. Combining the four delineations: summary statistics.

Area	**Share on entire ESPON territory**	**Share on all IP areas**
Non-IP areas	54.6 %	
IP areas	45.4 %	100.0 %
Of which		
IP for one delineation	29.2 %	35.3 %
IP for two or more delineations	16.2 %	64.7 %
Of which (see* Map 4.3*)		
IP, main driver poor economic/demographic situation (green areas in Map 4.3)	21.1 %	46.0 %
IP, main driver lack of access (red areas in Map 4.3)	20.0 %	44.6 %
IP, with both lack of access and poor economic / demographic situation as main driver (blue areas in Map 4.3)	4.3 %	9.4 %

[l] All percentages calculated at grid level. Similar calculation at LAU-2 or NUTS-3 levels would result in different proportions.

Map 4.3:Combining the four delineations: main drivers of inner peripherality (3 categories).



Definition of main drivers in three classes (Map 4.3):

Delineations 1 and 3 are identifying areas with poor access to regional centres and services, respectively. Thus, in these two delineations the main driver of inner peripherality is poor accessibility / lack of access (red areas in Map 4.3). Delineations 2 and 4, in contrast, identifying areas with low economic potentials and poor socio-economic situations, therefore, the main driver of inner peripherality in these cases is (poor/low) economic potentials and poor socio-economic situation (green areas in Map 4.3). A third category identifies a combination of both drivers (blue areas in Map 4.3).

The three classes then identify those drivers that predominantly led to inner peripherality (acknowledging that the other factors may, in individual cases, also further contribute to a disadvantaged state of inner peripherality). The three classes then identify those drivers that predominantly led to inner peripherality (acknowledging that the other factors may, in individual cases, also further contribute to a disadvantaged state of inner peripherality).

Interpreting Map 4.3 – the case of IP regions in Sweden and southern Norway (some guidelines):

Case of Sweden

The main driver of inner peripherality for most of the IP areas in Northern Sweden along its border to Norway is its poor economic potentials and poor demographic situation (green class in Map 4.3). This may somehow appear to be counterintuitive for many people because traditionally these areas are considered as remote, peripheral areas. Why is the main driver now not a lack of access, as one would assume, but poor economic and demographic situation? The reason for this classification is that the neighbouring regions in Sweden towards the Baltic Sea, and also the neighbouring regions in Norway, have a similar bad situation in terms of accessibility, but do perform much better in economic terms and also have a much larger demographic basis (in Sweden, for instance, all larger cities and centres are located towards the Baltic Sea, away from the Swedish-Norwegian border area).

Case of Southern Norway

In contrast, many IP areas in Southern Norway, which at the same time representing mountain areas, appear to suffer predominantly from a poor lack of accessibility. Here, we have a rather good demographic basis (at least compared to regions further North and to the neighbouring Swedish regions), and good economic potentials, but in relation to the neighbouring Norwegian regions of Oslo and Bergen a comparatively low access to regional centres and services, which is mainly due to its difficult geographic location within mountain ranges.

It is however still worth mentioning that although Map 4.3 tries to identify the main driver for inner peripherality, one IP area may, even though a lack of access may be its main problem, also suffer from poor economic potentials. In this case Map 4.1 should be consulted providing the full range of all 16 combinations.

5 Areas of risk to become inner peripheries in future

Apart from identifying and delineating inner peripheries, it is also interesting to identify areas of risk to become inner peripheries in future. According to the four delineation approaches of inner peripheries, it is understandable that, by way of consequence, there is not only one method to identify areas of risk. Based upon the theoretical considerations, and the ways the four delineation approaches were implemented (Chapter 4), different options for identifying areas of risk have been tested, reflecting different rationales:

(i) ***Standardized access times***: Here, areas of risk are defined at grid level for each variable by selecting those grid cells that have a standardized access time between 100 and 150% of the average. Areas of risk thus represent, geographically, some kind of transition areas or buffer areas between non-IP and IP areas. Their access to services being below the average, but not as poor as for the IPs.

It is however difficult to justify why these areas are in risk to become IP in future, as it is unlikely that the travel time to the next facility will increase in future. Eventually, they only were selected because of their geographical location between IP and non-IP areas. For this reason, this option was not followed up.

(ii) ***Comparison of results of all four delineations***: Here, areas of risk are those NUTS-3 regions that are considered inner periphery only due to one out of the four delineations.

All these areas have, essentially, been identified as inner periphery in one delineation. So, when comparing all four delineations, why should they be considered as area of risk, and not as IP? For this reason, this option was not followed up.

(iii) ***Comparison of results of Delineation 3***: An adaptation of Option (ii) was applied to the results of Delineation 3 by looking at the poor access to the ten individual SGIs. The idea being that all areas, which have not been identified as IP for Delineation 3, but which experience poor access to three or four types of services, are considered as areas of risk[m].

The results of this attempt are illustrated in Map 5.1. In effect, areas in all European countries have been identified as areas-of-risk. Most of these areas are comparatively small, scattered across the countries. Even though that the importance of each individual area may be rather low, due to their small size, altogether they account for a significant proportion of the national territories, and, if they would enter into a peripheralization process, would increase the number and size of national IP territories significantly.

(iv) ***Process of peripheralization***: Here, areas of risk are those NUTS-3 regions that experienced negative development trends in key indicators over the last decade, but

[m] In contrast to areas with poor access to five or more SGIs, which were considered as inner peripheries in Delineation 3.

which have not been identified as inner peripheries, because their current socio-economic situation is still good/fair.

The drawback of this option is that it can only be implemented at NUTS-3 level, since data on socio-economic situation are not available for entire ESPON space below that level. Due to the pitfalls of using NUTS-3 regions in this exercise (see Chapter 3.7), this option was not implemented.

(v) ***Dependency upon one facility***: This option is based on the idea that areas which today have good or fair access to services may lose this good accessibility, if the closest facility, which serves the area, is closed[n], and if no other facility of the same type is within reach in reasonable travel time. Thus, areas who have access to just one facility of a certain service type are at higher risk to become inner peripheries in future compared to areas who have access to several of these facilities[o].

In addition to Option (iii) (Map 5.1), Option (v) was selected and applied to two main variables, which is access to primary schools (=basic education) and access to hospitals (=health care).

Areas of risk are then those areas that satisfy the following conditions:

- Areas, which have access to just one primary school within 15 min and to just one hospital within 60 min, and which
- have not been identified as inner periphery in Delineation 3, and whose
- continuous territory is larger than 100 square kilometres[p].

The following series of three maps illustrate areas-of-risk individually for primary schools (Map 5.2) and for hospitals (Map 5.3), and as a combination of these two (Map 5.4).

For primary schools, large areas in south-east Europe, in the Baltic States, Iceland, Turkey, and the Iberian Peninsula, so as parts of East Germany, Southern France, Italy, Scotland and Wales and Ireland represent areas-of-risk, as they grant access to only one primary school within reasonable time. However, as the school systems in many countries is very much regulated at national levels by normative rules, partly including a determination of fixed school areas, Map 5.2 to some extent also reflects that these areas are serviced by just one school.

Still, when a primary school is closed in these areas, there is risk that they area in question enters into a process of peripheralization, as there is no alternative within reach.

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[n] Whatever the reason for such a closure may be, such as decisions to privatise or concentrate services, changing service delivery technologies (such as replacement of offices by internet solutions), or austerity policies, or just a lack of demand.

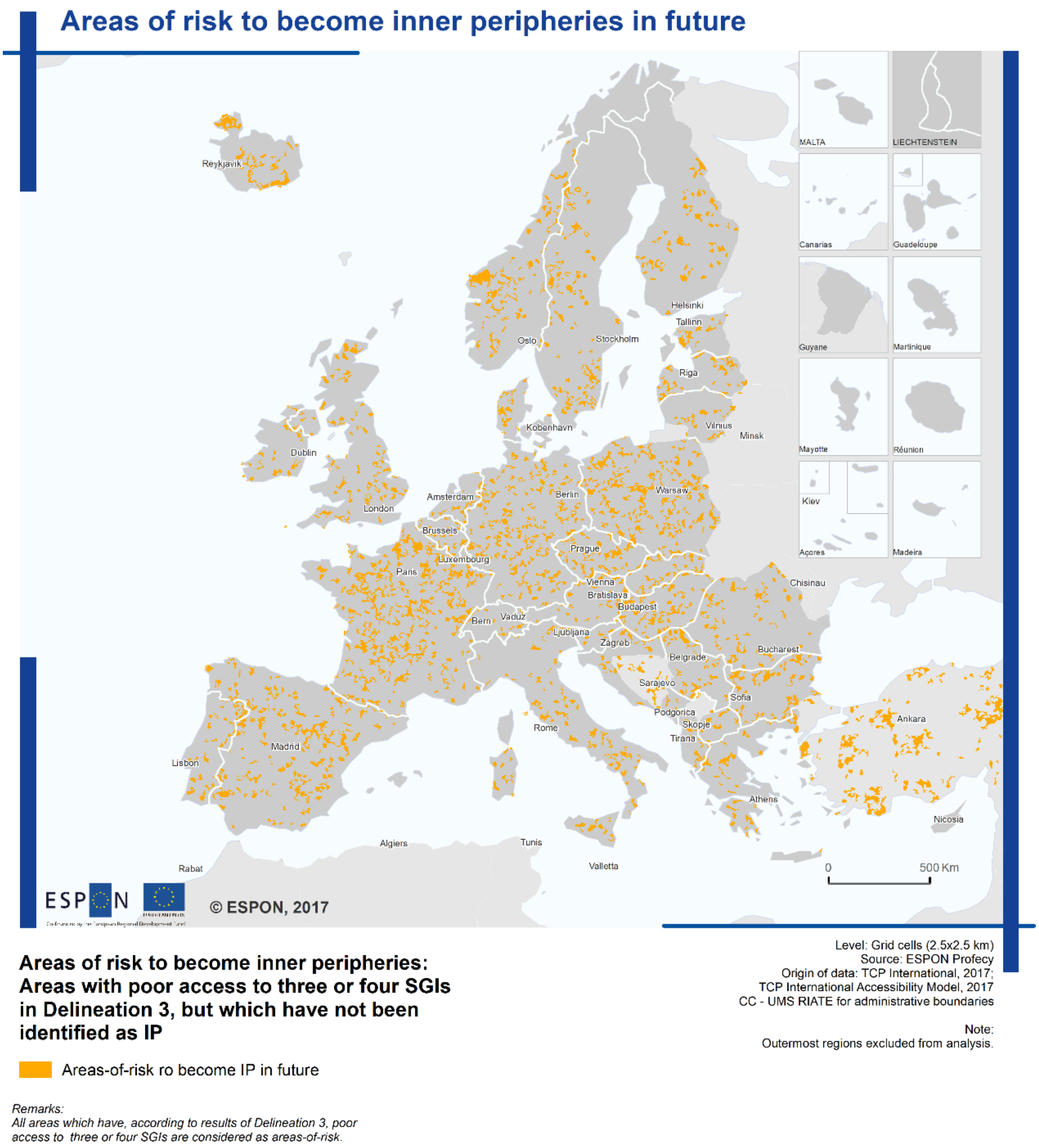
[o] A series of maps illustrating the number of facilities within certain travel times for each type of service are presented in Annex 7 – Delineation 3 Map Series.

[p] Similar to the procedure as implemented for identifying inner peripheries at grid level (see Chapter 3.4 for further information)

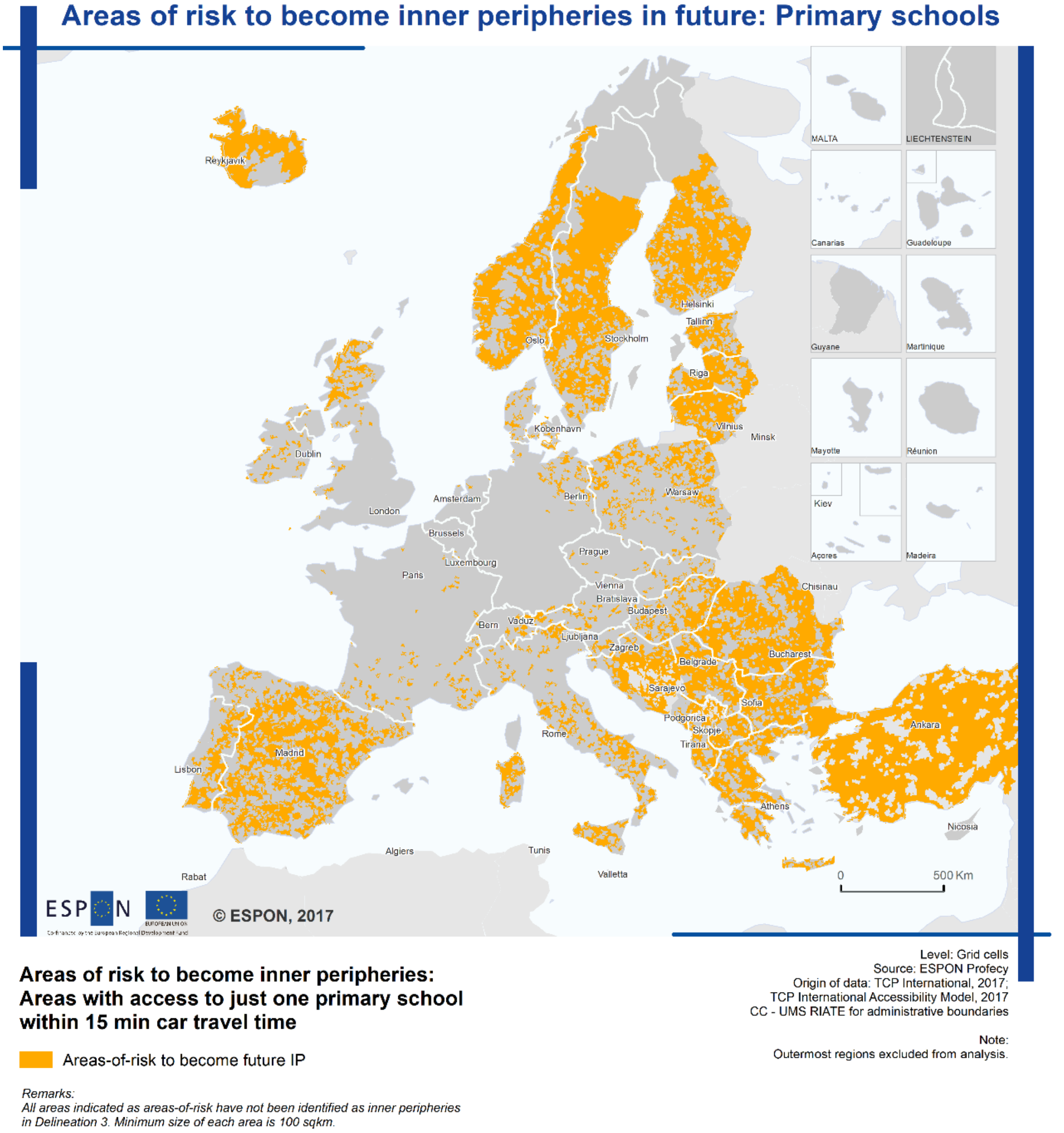
The same map for hospitals (Map 5.3) again highlight that many areas in Scandinavia, Iceland, Scotland, Turkey, of the Balkans and in Spain and Portugal are at risk to become inner peripheries into future. The extend and number of these areas is much smaller compared to the case of primary school, as a larger travel time threshold has been applied, but still the provision of health care services in these areas is at risk, if the only reachable facility closes.

A combination of these two maps (Map 5.4) more or less replicates the findings for hospitals, with areas of risk being located in Scandinavia, Iceland, Scotland, parts of Turkey, Spain and Portugal, and the Balkans.

Map 5.1:Areas of risk to become IP in future: Areas with poor access to three or four SGIs.



Map 5.2: Areas-of-risk to become IP in future: Primary schools.

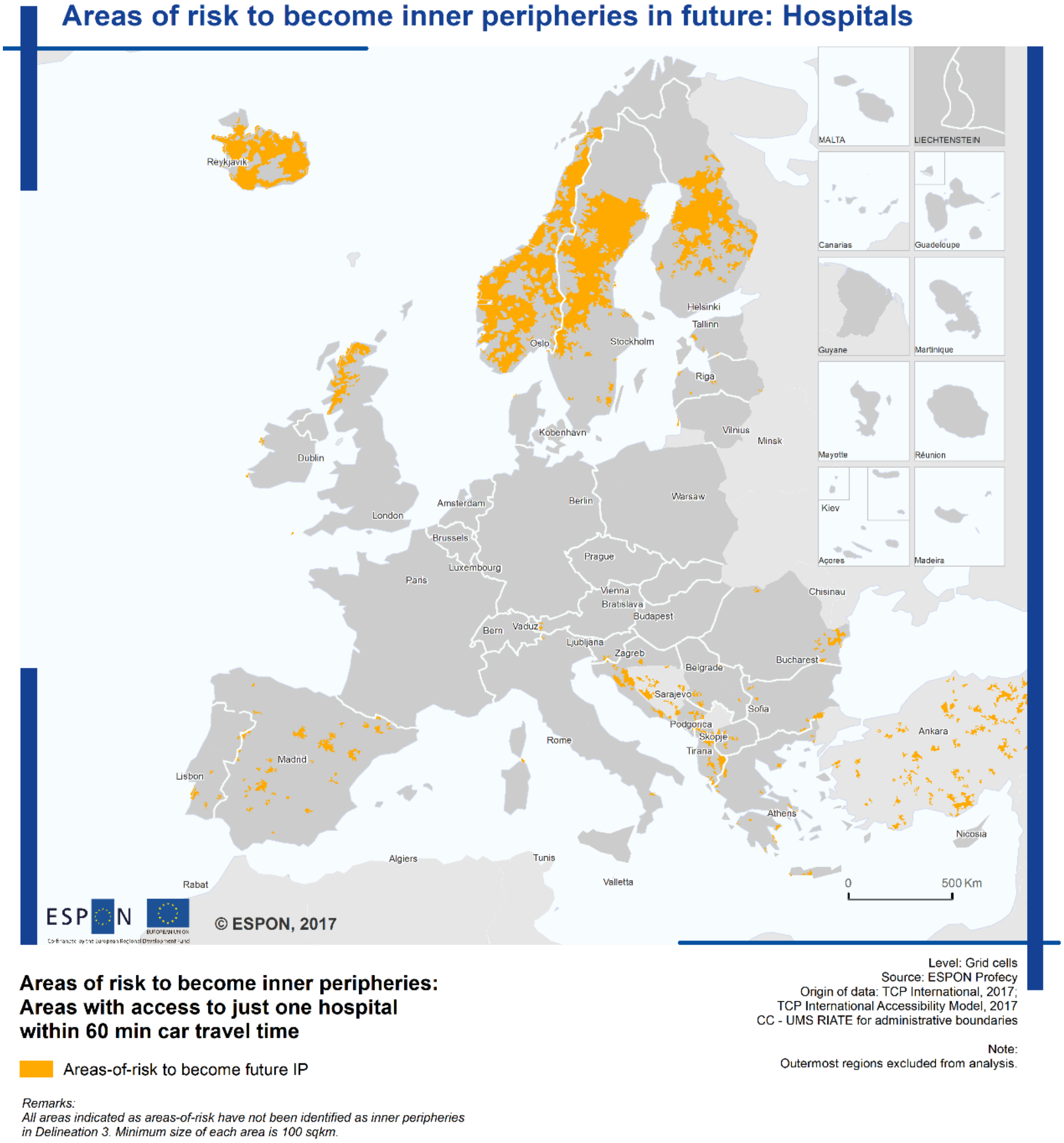


Areas-of-risk to become IP in future (Option (v))

It is worth mentioning that the identified areas-of-risk currently do have access to primary schools and to hospitals, and that this access will only change if the facility within reach is being closed and no substitute is offered. The assessment of these areas to be at risk is purely based upon the travel time analyses. It cannot be concluded from this analysis that any of these facilities will indeed be closed in the near term. However, if this were to happen - for whatever reason - the areas would be at risk to develop into an IP situation.
In order to avoid such situations in reality, different policy measures may be thought of:

- Open additional facilities
- Strengthening of the population basis, i.e. stabilize or increase the demand for such services
- Improve transport infrastructures, so that more distant facilities become reachable
- Introduce new technologies, such as internet services (distant learning, distant health care systems etc.)

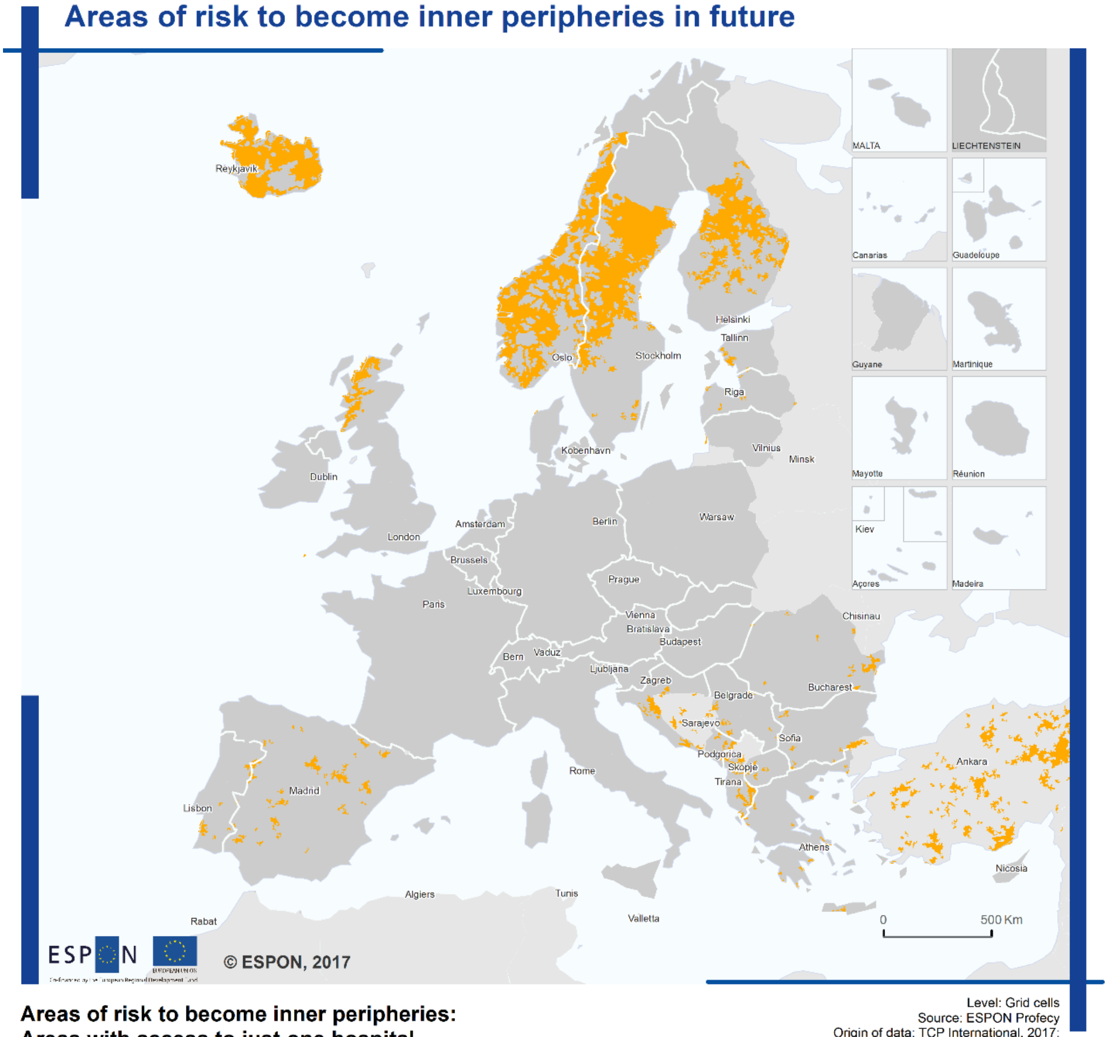
Map 5.3: Areas-of-risk to become IP in future: Hospitals.



Conclusions: Methods to identify areas-of-risk

While Option (v), as demonstrated in Maps 5.2 to 5.4, is a good and the preferred option to identify areas of risk for just one single type of service, the approach very quickly becomes complicated when looking at a bunch of services. Therefore, Option (iii) applied on the grid-level results of Delineation 3 is preferable as it produces robust and more realistic results.

Map 5.4:Areas-of-risk to become IP in future: Primary schools and hospitals.



Areas of risk to become inner peripheries:
Areas with access to just one hospital within 60 min and to just one primary school within 15 min car travel time

Areas-of-risk to become future IP

Level: Grid cells
Source: ESPON Profecy
Origin of data: TCP International, 2017;
TCP International Accessibility Model, 2017
CC - UMS RIATE for administrative boundaries

Note:
Outermost regions excluded from analysis.

Remarks:
All areas indicated as areas-of-risk have not been identified as inner peripheries in Delineation 3. Minimum size of each area is 100 sqkm.

6 Usage of scripts and programming tools

The development of the required input database, as well as the (grid-based) delineation of inner peripheries required the processing of large scale datasets. In order to allow for an efficient, accurate and timely processing, a series of scripts has been developed to automate these processes.

All scripts were developed based on Python scripting language, and utilizes ArcPy libraries[q]. Scripts were developed to

- download and process OpenStreetMap data (POIs and road networks)
- delineate areas of inner peripheries for Delineations 1 and 3,
- amalyse the availability of facilities, and
- identify areas-of-risk

In detail, the following scripts were developed (Table 6.1):

Table 6.1. Overview of the developed Python scripts.

Script name	**Purpose**
Download and process OSM data	
OSM_ExtracingBanks.py	Downloaded, extracting and processing bank POIs
OSM_ExtracingCinemas.py	Downloaded, extracting and processing cinema POIs
OSM_ExtracingDoctors.py	Downloaded, extracting and processing doctor POIs
DoctorsDenmark.py	Processing additional datasets on doctors for Denmark
DoctorsSweden.py	Processing additional datasets on doctors for Sweden
OSM_ExtracingHospitals.py	Downloaded, extracting and processing hospital POIs
OSM_ExtracingPharmacies.py	Downloaded, extracting and processing pharmacy POIs
OSM_ExtracingSchools.py	Downloaded, extracting and processing school POIs
SplittingSchools.py	Processing additional school datasets
OSM_ExtracingRetail.py	Downloaded, extracting and processing retail POIs
OSM_ExtracingRoads.py	Downloaded, extracting and processing road networks
Delineation 1	
AccessRegionalCentresCar.py	Calculating travel times to regional centres by car
AccessRegionalCentresRail.py	Calculating travel times to regional centres by rail
D1_Car_Average.py	Standardizing travel times to regional centres at average of neighbouring NUTS-3 regions for car
D1_Rail_Average.py	Standardizing travel times to regional centres at average of neighbouring NUTS-3 regions for rail
Delineation 3	
AccessBanks.py	Calculating travel times to banks by car
AccessCinemas.py	Calculating travel times to cinemas by car
AccessDoctors.py	Calculating travel times to doctors by car

[q] Python version 3.5.2 was used. ArcPy represents a large library of geoprocessing tools as part of the ArcGIS scripting environment. In order to run these scripts, ArcGIS license (at least version 10.4.1), a license of the ArcGIS Network Analyst and Python 3.5.2 is required.

AccessHighways.py	Calculating travel times to highway ramps by car
AccessHospitals.py	Calculating travel times to hospitals by car
AccessRetail.py	Calculating travel times to retail shops by car
AccessSchools.py	Calculating travel times to schools by car
AccessStations.py	Calculating travel times to stations by car
D3_Banks_Average	Standardizing travel times to banks at average of neighbouring NUTS-3 regions
D3_Cinemas_Average	Standardizing travel times to cinemas at average of neighbouring NUTS-3 regions
D3_Doctors_Average	Standardizing travel times to doctors at average of neighbouring NUTS-3 regions
D3_Hospitals_Average	Standardizing travel times to hospitals at average of neighbouring NUTS-3 regions
D3_Pharmacies_Average	Standardizing travel times to pharmacies at average of neighbouring NUTS-3 regions
D3_Retail_Average	Standardizing travel times to retail shops at average of neighbouring NUTS-3 regions
D3_Schools_Average	Standardizing travel times to schools at average of neighbouring NUTS-3 regions
D3_Stations_Average	Standardizing travel times to stations at average of neighbouring NUTS-3 regions
D3_UMZ_Average	Standardizing travel times to UMZ at average of neighbouring NUTS-3 regions
Delineation 4	
D4_Population_Average	Standardizing population figures at average of neighbouring NUTS-3 regions
Availability of facilities / Areas of risk	
NumberBanks30min	Availability of banks within 30 min car travel times
NumberCinemas45min	Availability of cinemas within 45 min car travel times
NumberDoctors30min	Availability of doctors within 30 min car travel times
NumberHospitals60min	Availability of hospitals within 60 min car travel times
NumberPharmacies15min	Availability of pharmacies within 15 min car travel times
NumberRetail15min	Availability of retail shops within 15 min car travel times
NumberStations20min	Availability of stations within 20 min car travel times

7 Transfer of approaches to other cases

The approaches developed and implemented for Delineations 1 and 3 may be transferred to other cases, for instance to national or regional case studies. Although technically these approaches could be implemented one-by-one as described in this Annex Report, one may wish to implement some adaptations to better reflect national or reginal circumstances or to better account for individual regional or local issues.

The methodology leaves however room for several adaptations, without changing the general character of the approach:

Grid system

In PROFECY, a grid resolution of 2.5x2.5 km was chosen which reflects the European scale quite well. For national or regional studies, one may wish to use even higher disaggregated grid systems, such as 1.0x1.0 km (national studies) or even 0.5x0.5 km for regional studies. Generally, any grid resolution can be applied.

The higher the resolution, and the greater the spatial extent of the study area, the longer the general processing time.

Aggregates

In PROFECY, grid level results have been aggregate to European-wide LAU-2 and NUTS-3 level results. For national or regional studies, other aggregates seem also possible such as suburban districts (below LAU-2), ZIP code areas or any other statistical or administrative units.

Standardization

In PROFECY it was decided, after some tests, to standardize the travel times to the average of the neighbouring NUTS-3 regions (including the region itself). For studies with a smaller extent of study area, one may prefer to standardize the travel times at the average of LAU-2 units or other units such as suburban districts, ZIP codes areas or others.

It is recommended that the unit used for standardization should correspond to the units used for aggregations.

One crucial aspect that shoud be maintained, however, is the standardization of the neighbouring spatial units (whatever the units are).

Destinations / SGIs

In PROFECY, regional centres (Delineation 1) and ten SGIs (Delineation 3) were used as destinations. Other studies may be interested to use other destinations such as city halls, police stations, theaters, restaurants, airports, concert halls, universities, parks, or others.

Basically, any type of public or private service or any kind of facility or destination can be incorporated into the delineation approach.

Modes

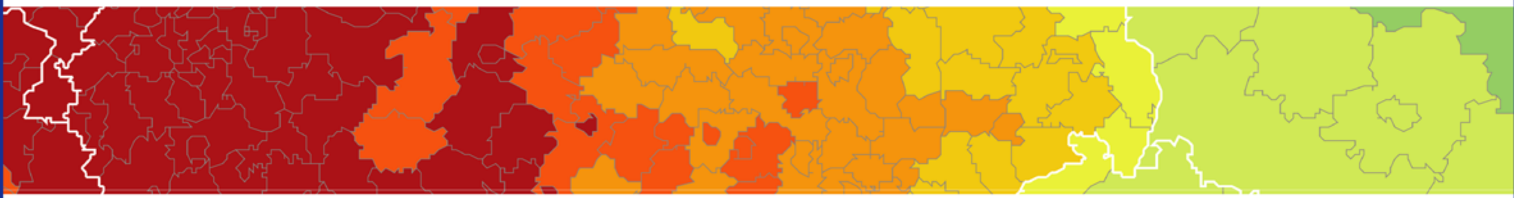
For the said reasons (see Chapter 3.9), in PROFECY only access by car was considered. If in other studies a complete public transport network, including busses, trams, metros, and railways, is available, it may well be used in addition to road networks.

Considering public transport, however, makes only sense if a complete bus network is available.

Areas of risk

If only one SGI (destination) is used in a study, Option (v) (Chapter 5) could be preferred to identify areas of risk; of several SGIs are considered, Option (iii) should be applied instead.

This analysis could even be extended if, on a local or regional scale, information about the future provision of services is available, in particular information on facilities that will close. In this situation, areas of risk might be identified even more precisely, if the modelling results are contrasted with the future provision.



ESPON 2020 – More information

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