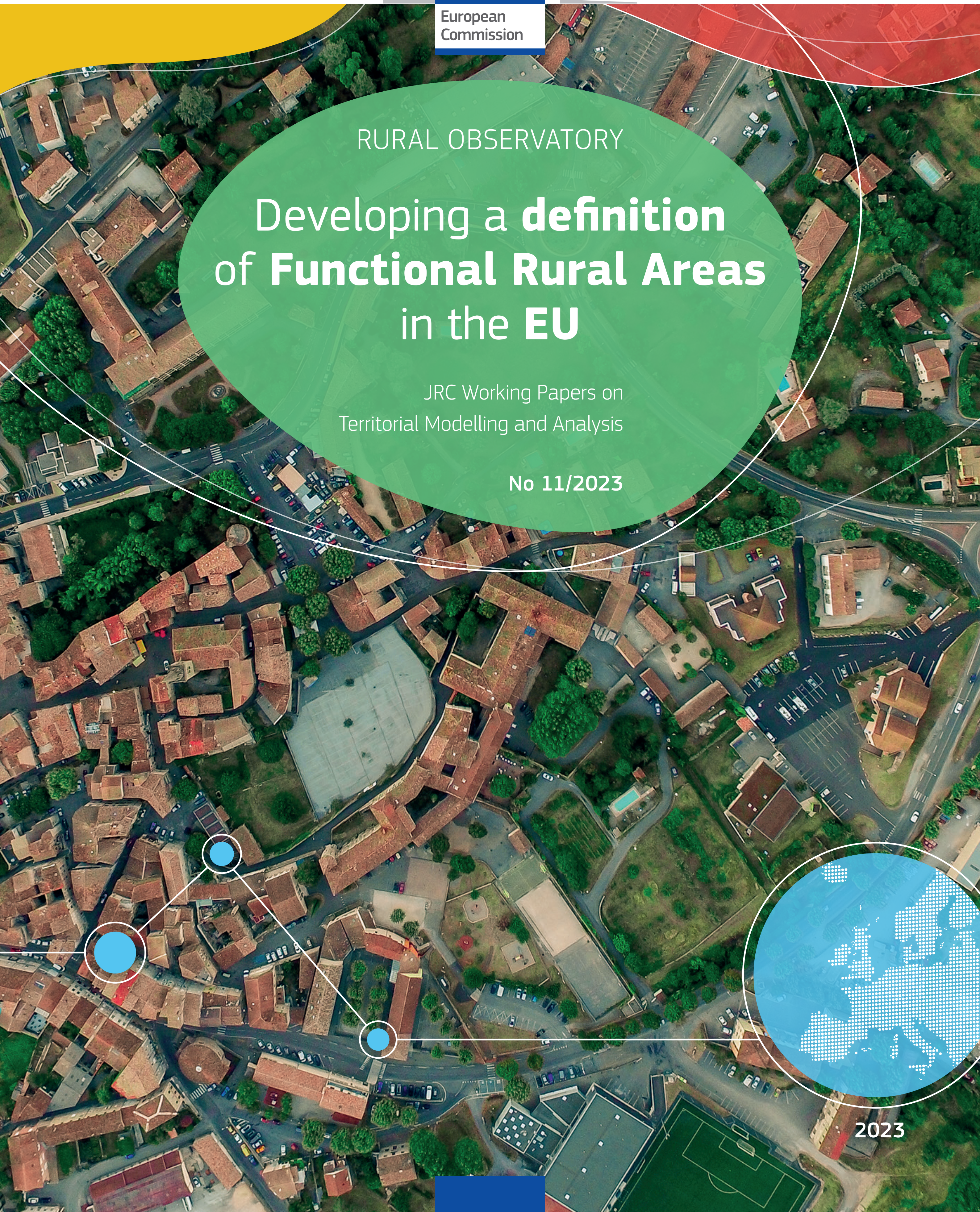
European Commission

RURAL OBSERVATORY

Developing a **definition** of **Functional Rural Areas** in the **EU**

JRC Working Papers on Territorial Modelling and Analysis

No 11/2023



2023

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JRC135599

Ispra: European Commission, 2023

Graphic design: Laura Spirito

How to cite this report: Dijkstra, L., Jacobs-Crisioni, C.(2023). Developing a definition of Functional Rural Areas in the EU. *JRC Working Papers on Territorial Modelling and Analysis No 11/2023*, European Commission, Ispra, JRC135599.

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Developing a **definition** of **Functional Rural Areas** in the **EU**

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Authors:
Lewis Dijkstra,
Chris Jacobs-Crisioni

Contents

Abstract

This paper develops a methodology to define functional rural areas in the EU. It seeks feedback on the method and the results. Functional rural areas cover all the territory outside functional urban areas. They are constructed in three steps. First, we define rural centres: they are the largest town or village within a 10-minute drive. Second, we create catchment areas by assigning every grid cell to the nearby rural centre that has the greatest gravitational pull. Third, we combine small and nearby catchment areas. We combine catchment area until each has at least 25 000 inhabitants or is more than an hour's drive away from the surrounding catchment areas. We also combine catchment areas that have centres that are less than a 30-minute drive apart, even if they have a population of at least 25 000 inhabitants. Next, we show that functional rural areas are more harmonised in terms of population and area size than LAUs and NUTS-3 regions. The analysis of population change and of the distance to the nearest school shows that the results by functional area are less volatile than the results per LAU and show more detail than the results per NUTS-3 regions. Functional rural areas can inform policies that promote access to services and that respond to demographic change. They can also be used to inform transport infrastructure investments and public transport provision.

Acknowledgements

From the European Commission, we would like to thank Alexia Rouby and Marina Royo De Blas from the Directorate-General for Agriculture and Rural Development, Jorge Duran-Laguna, Magda Grzegorzewska and Hugo Poelman from the Directorate-General for Regional and Urban Policy and Teodora Brandmueller from Eurostat for their useful comments on earlier versions of this paper. We would like to thank Claudia Baranzelli, Ana Moreno-Monroy and Alison Weingarden (OECD) and Bogdan Eugen Dolean and Marcel Ionescu-Heroiu (The World Bank) for their detailed comments.

We also want to thank the participants in the session on functional rural areas as part of the Rural Pact Conference in Brussels in June 2022 and the participants of the Eurostat meeting on Regional, Urban and Rural Development Statistics for their comments and feedback.

Finally, we would also like to thank Ioris Bussolari for creating the online interactive page with the functional rural areas.

AUTHORS

Lewis Dijkstra and Chris Jacobs-Crisioni

1 Introduction

In 2011, the European Commission and the OECD developed a definition of a functional urban area (FUA) (Dijkstra et al 2019). These FUAs combine a densely populated city with its surrounding commuting zone. Such a functional approach has the benefit that it captures a single labour and housing market. It avoids fragmenting such a daily urban system into multiple municipalities (local administrative units or LAUs). It also avoids combining multiple daily urban systems into a single spatial unit, which happens in some NUTS-3 regions.

Such a functional approach helps to overcome the wide variation in the area and population size of municipalities and NUTS-3 regions. This functional urban area definition has since been included in a Eurostat regulation and endorsed by the UN Statistical Commission[(1)] as part of the Degree of Urbanisation[(2)]. The Degree of Urbanisation level 2 also defines smaller settlements such as towns and villages.

Yet so far, no functional *rural* areas have been defined within the EU. This is a significant omission as FUAs cover only 21 % of the EU territory and 62 % of the EU population. This paper aims to address this omission.

The objective of a functional rural area is to define a daily rural system, i.e. an area which captures the vast majority of daily trips. These trips go beyond travel to work and include travel to services such as schools, hospitals, shops, sport and cultural facilities, as well as travel to friends and family. In a functional urban area, it is likely that most non-commuting trips also occur within the same FUA boundaries. In more rural areas, commuting between municipalities is probably less unidirectional and less focused on a single employment centre. As a result, commuting patterns may be less suitable to define a rural daily system.

In rural areas, services such as education, healthcare, shops, banks, and cultural and entertainment facilities are often clustered in a town or a village, which thus act as local centres. The functional rural areas developed in this paper are constructed around these local centres. Most services typically require a minimum critical population mass. To ensure that the residents can conduct most of their daily business within their FRA, we use a minimum population size threshold. This minimum population size threshold lies roughly between the minimum catchment sizes for a local and a subregional service[(3)]. However, FRAs should not cover too big of a geographic area to ensure that these services are sufficiently

1 *https://unstats.un.org/UNSDWebsite/statcom/session_51/documents/2020-37-FinalReport-E.pdf*

2 *https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Applying_the_degree_of_urbanisation_manual*

3 Kompil, M., Jacobs-Crisioni, C., Dijkstra, L. and Lavalle, C. (2019) Mapping accessibility to generic services in Europe: A market-potential based approach,Sustainable Cities and Society 47: 101372. *https://doi.org/10.1016/j.scs.2018.11.047*.

close-by for daily use, therefore this method uses a maximum travel time beyond which areas cannot be combined; which means that some FRAs will not reach the minimum population threshold. In such a context, services may be sustained through public intervention or for example through strategies such as integration of various service types.

Similar to the functional urban area, the functional rural area is constructed around a denser settlement. Instead of a city, functional rural areas are constructed around towns and villages as defined by the Degree of Urbanisation[4]. Instead of commuting flows, this method uses the driving time to the nearest town or village and the population size of the town or village to create a functional area. This has two benefits. First, it can be applied to all countries in the world, including those where (recent) commuting data is not available. This method is relatively straightforward to apply as it only requires a population grid and a road network as input data. Second, this method starts at a fine and uniform spatial resolution (grid cells of 1 sq km). Commuting is typically only available at the municipality level, which tends to cover large areas in some Member States especially in more rural areas. These large municipalities hide a lot of internal variation, which a commuting-based method cannot capture. Like the functional urban areas, functional rural areas can also be 'polycentric' meaning that they contain multiple settlements, i.e. towns and/or villages.

The following section briefly describes the method to define functional rural areas in layman's terms. The next section compares the population and area size of functional rural areas with smaller units (municipalities) and large units (NUTS-3 regions). The two following sections show that using functional areas provides a more robust picture of population change and distance to schools than municipalities do, while providing more detail than NUTS-3 regions do. The last section concludes and discusses the next steps. A more detailed methodology is included in the annex.

This paper was developed within the framework of the Rural Observatory[5] and supports the EU vision for rural areas.

4 The Degree of Urbanisation level 2 defines two types of towns. Dense towns at the grid level consist of a cluster of dense urban cluster cells (>1 500 inhabitants per sq km) with a population between 5 000 and 50 000. Semi-dense towns consist of a cluster of semi-dense urban cluster cells (> 300 inhabitants per sq km) that are not contiguous with other urban cluster or urban centre cells. A village at the grid level consists of a cluster of rural grid cells with a density of at least 300 residents per sq km with a population between 500 and 5 000.

5 The Rural Observatory (*https://observatory.rural-vision.europa.eu*) supports knowledge production and improved data collection and dissemination related to EU rural areas

2 A short description

2.1 MARKET TOWNS INSPIRE THIS APPROACH

This definition of a functional rural area (FRA) is inspired by a market town. A market town is where farmers from the surrounding area used to come to sell their produce and animals. Many market towns still have a weekly market today. It is often also where people come to meet in a café or a restaurant. The town typically has a post office, a grocery store, a bank, a school and a doctor, which all serve the wider community. In some cases, this town is the provincial capital hosting a variety of government services. As a result, these market towns play an important role as local and regional centres for the wider community.

The services in such a town mean that some people work in the town. We assume that most of these workers likely live nearby and only a few commute from further away. Most people in the wider area, however, have a job located outside this town. Some work on a farm or in a factory or in construction. Others work in an office outside the town, in a business park or in a distant city. As a result, the community role of this town and the services it provides are more important and have a wider geographical reach than its role as an employment centre.

Although we do not have data for all these daily trips, the method aims to capture these trips by creating a functional area around a town or a village. To create FRA, we start by setting up catchment areas around towns and villages. Subsequently, we combine catchment areas that are nearby and catchment areas that have a very small population. When we combine catchment areas, we select the closest ones because they are more likely to be functionally linked.

Functional rural areas are defined per Member State. This has the benefit that all the FRAs fall within national borders, as the functional urban areas do, so that FRA-based statistics can be computed and aggregated per Member State. This does have the drawback that in areas where many people cross the border to go shopping or to go to work, these flows will not be captured and two separate functional areas will be created on each side of the border. FRAs do not need to follow regional borders, so that we assume that services that are often managed regionally (for instance health care) are sufficiently integrated within Member States to allow for service uptake across regional boundaries.

FRAs can be defined using a population grid, the Degree of Urbanisation and a road network. The steps to define functional rural areas are outlined in **Section 2.2** and explained in detail in **Annex I.**

Functional rural areas comply with five simple rules:

1. Every FRA contains at least one village or town.
2. Every FRA contains at least 25 000 inhabitants except if there is no other town or village within one hour's drive (see below).
3. Maximum travel time: FRAs that are more than 60 minutes apart cannot be combined (travel time is measured between the main settlements of each FRA).
4. Minimum travel time: FRAs that are less than 30 minutes apart are combined.
5. Functional rural areas cover all the territory outside a functional urban area (FUA). In other words, the combination of FRAs and FUAs completely covers the territory without any gaps or overlaps.

We selected these rules for the following reasons:

— The FRAs are constructed around a town or a village to ensure that it includes at least one (likely) location for services to concentrate.

— The minimum population size ensures that within the FRA there is enough demand for a range of basic services. We propose using 25 000 inhabitants as research on different types of services (Kompil et al, 2019) suggests that such a population size is big enough to support a wide range of local services, and may also be enough to sustain key subregional services, especially in isolated contexts. Highly specialised regional services such as universities and academic hospitals need a much larger population, and are therefore are not expected to be present in each FRA.

— The maximum travel time avoids combining areas together that are too far apart to function as a daily system. Thus in some cases, a FRA will not meet the minimum population threshold. Nevertheless, these small FRAs may still have most public and private services. This could be because costs may be lower, prices may be higher and/or additional public funding may be provided.

— The minimum travel time of 30 minutes was introduced because, in relatively densely populated regions, nearby settlements may have services spread across them. For example, a school may be located in one town while the supermarket is located in another nearby town. In this way, these services are kept together in a single FRA. As most people in the EU have a commute of less than 30 minutes[6], this minimum travel time makes it more likely that many of the commuting trips will start and end within the same FRA.

— Functional rural areas and functional urban areas are defined as mutually exclusive entities. Nevertheless, regular trips are likely to occur between adjacent FRAs and FUAs. The benefit of a seamless match between functional urban and functional rural areas is that the entire territory can be analysed using functional areas without double counting or missing parts of the territory. In addition, it avoids having to modify the FUA definition.

6 According to Eurostat, more than half (61.3 %) of all employed people in the EU travelled less than 30 minutes from home to work (*https://ec.europa.eu/eurostat/web/products-eurostat-news/-/ddn-20201021-2*).

2.2 APPLYING THE DEFINITION IN A STEPWISE APPROACH

The definition is applied in four steps:

STEP 1: SELECT ALL RURAL CENTRES

We select the towns and villages that are the biggest settlement in a 10-minute drive. We consider those as rural service centres. A recent publication[7] shows that, across Europe, settlements that are the biggest in a 10-minute drive are much more likely to have a primary school, a bank or a shop than other settlements of the same size. We only consider settlements that are outside of a FUA.

STEP 2: CREATE A CATCHMENT AREA AROUND EACH RURAL CENTRE

We then establish a catchment area around each of these rural centres by assigning every grid cell to a rural centre. We only consider cells that are not part of a FUA. Grid cells are assigned to the centre that exerts the largest market attraction on that grid cell among the five nearest centres. This market attraction is defined like a gravity pull that is stronger from more populated centres but diminishes rapidly with longer travel times. These catchment areas are then cleaned, for example by removing unpopulated exclaves and by joining small enclaves to their surrounding territory. These catchments may include locations that are much farther than 10 minutes away from their assigned local centre. For example, in a mountainous area, it may take 20 or 30 minutes to reach the nearest village or town.

STEP 3: COMBINE SMALL AND NEARBY CATCHMENT AREAS

To create FRAs from these catchment areas, we go through an iterative process combining catchments that are too small or located very close to each other. In each iteration, a catchment area can only be combined with a single other catchment area. Catchment areas can be combined for two reasons:

1. Population is below the minimum size threshold: In each iteration, a catchment area with a population below 25 000 inhabitants is combined with its closest contiguous catchment area if the town or village of that contiguous catchment area is located less than one hour's drive away.
2. Another catchment area is nearby: A catchment area is combined with a contiguous catchment area if it is less than a 30-minute drive away. If a catchment area has multiple adjacent areas within a 30-minute drive, it is combined with the closest one.

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7 Jacobs-Crisioni, C., Kompil, M., & Dijkstra, L. (2023). Big in the neighbourhood: Identifying local and regional centres through their network position. *Papers in Regional Science,* 102(2), 421– 457. https://doi.org/10.1111/pirs.12727

Iterations are repeated until no more catchment areas can be combined. In other words, all remaining catchment areas are at least a 30-minute drive time apart and all either have at least 25 000 inhabitants or lack a contiguous catchment area within an hour's drive.

The distance between different catchment areas is calculated as the driving time between the population-weighted centroid of the rural centres. If a catchment area contains multiple rural centres, the population-weighted average of the distances from these centres is used.

The combination of two catchment areas is wholly based on travel time minimisation. The assumption behind this approach is that lower travel times likely lead to more functional interdependence between adjacent catchment areas. The advantage of using only travel times is that the method can be applied virtually anywhere as road travel time information is available globally.

This final set of catchment areas are the functional rural areas at the grid level (FRAGs). To help identification, we search which settlement is the most populated in that FRAG and consider that settlement the unit's main settlement. The FRAG is named after that settlement (if a name is available) and, similar to the approach that the World Bank takes in designating functional areas in Romania, we flag the degree of urbanisation of the largest settlement, so that we discern whether FRAGs have a city[8], town or village as main settlement.

These three steps are also presented in **Figure 1.**

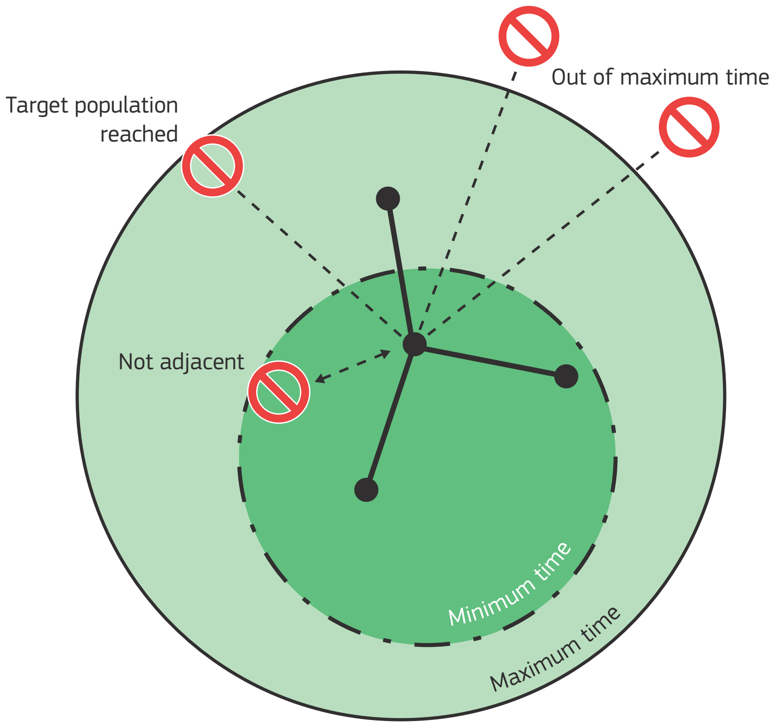


Figure 1. Conceptual model of FRAs and the effect that assumptions and thresholds have on their generation.

Note: Thick black lines indicate catchments from which a FRA is composed, dotted lines indicate catchments that are excluded from the FRA because they do not meet an eligibility criterion.

8 In principle, each city is part of a FUA and therefore a FRA cannot contain a city. For these draft FRAs, a few FUAs are missing which is why some FRAs contain a city. The final FRAs will only contain towns and villages as they will be combined with the FUAs defined using the census 2021 data.

STEP 4: ASSIGN MUNICIPALITIES TO A FUNCTIONAL RURAL AREA – FROM FRAGS TO FRAUS

Although a growing amount of data is available at the grid level, it is still useful to match these grid level (FRAGs) with municipal or local administrative unit (LAU) boundaries. A significant amount of data is only available at the municipal level, including a large amount of census data. Furthermore, municipalities are an important political and policy-making level.

We follow a similar approach as used in the Degree of Urbanisation: every municipality is assigned to the Functional rural administrative unit (FRAU) that contains the highest share of its population. Each FRAU should consist of only contiguous municipalities. In a few cases, where this procedure produces FRAUs that are not entirely contiguous, one or more municipalities are reassigned to ensure that all FRAUs comply with this requirement.

As LAUs are quite small and most of them contain at least one village or town, it was quite straightforward to match them with FRAGs. In most Member States, each FRAG could be matched with a FRAU (**Table 1**). In a limited number of complex cases, LAU2 borders cannot be matched automatically with a FRAG. This occurs for example in Belgium, where the partially enclave municipality of Baarle Hertog is described by two separate FRAGs, and only one of those FRAGs is matched with the FRAU. This explains why some manual adjustments of FRAGs will be necessary before final publication.

The resulting FRAUs still guarantee full territorial coverage, but there are 28 less FRAUs than FRAGs (1 963 instead of 1 991). Sweden and Finland have relatively large municipalities, as a result they both have some that cover multiple FRAGs. The number of FRAUs in these countries is respectively 9 and 8 smaller than their number of FRAGs (see **Table 1**).

Table 1. Number of FRAGs and FRAUs per Member State.

Member State	Number of FRAGs	Number of FRAUs	Difference
FR	264	264	0
IT	233	230	3
DE	212	212	0
PL	196	195	1
ES	187	187	0
RO	173	171	2
EL	96	95	1
SE	79	70	9
HU	66	66	0
CZ	53	53	0
BG	49	49	0

Member State	Number of FRAGs	Number of FRAUs	Difference
FI	47	39	8
PT	45	45	0
HR	39	38	1
AT	38	38	0
SK	35	35	0
DK	34	32	2
IE	28	28	0
LT	27	27	0
NL	23	23	0
BE	22	21	1
LV	14	14	0
SL	13	13	0
EE	12	12	0
CY	5	5	0
MT	1	1	0
EU-27	**1991**	**1963**	**28**

3

Population and **area size** of LAUs, FRAs and NUTS-3 regions

The draft FRAs in this paper are based on the 2018 JRC-GEOSTAT population grid (Batista e Silva et al. 2021) and the FUAs provided by EUROSTAT. A definitive set will be produced based on 2021 census grids once the degrees of urbanisation and FUA boundaries based on those grids are published. For now, the boundaries of the towns and villages are based on the 2011 GEOSTAT grid. The FRAs can also be explored online at *https://observatory.rural-vision.europa.eu/thematic-analyses/functional-rural-areas*. This page also shows two variants: one with a higher minimum population threshold (50 000) and one a lower maximum travel time (45 min). **Table 2** and **Figure 2** show the results for the FRAs based on the thresholds described above. The goal of presenting these FRAs is to seek feedback both on the method and the results.

This method produces 1 991 separate FRAGs and 1 963 FRAUs. These units are less than half the population and area size of an average NUTS3 region and roughly 40 times larger than the average municipality (LAU). One attractive feature of the FRAGs and FRAUs is that they are more comparable in size. The variation in population and area is much smaller than among municipalities (see the coefficients of variation in **Table 2**). And despite having more than twice the number of units as compared to rural NUTS-3 regions, the variation is lower for area and only slightly higher for population. In short, the FRAs circumscribe more comparable geographies than LAUs or NUTS-3 regions.

Only in the very sparsely populated parts of northern Sweden, Finland and Spain, do we find significant variation as these FRAs typically cover a large area and some do not reach the minimum population threshold.

Table 2. Statistics on geographical sizes of various statistical units in the 27 EU.

Note: For comparability with FRAs, in this report we consider rural LAUs to be all LAUs outside a FUA. Note that these do not match the rural areas as defined by the Degree of Urbanisation.

Type of spatial unit	Number of units	Average unit size (km²)	Coefficient of variation	Average population of a rural unit	Coefficient of variation
Rural LAU	98 945	46	5.3	2 413	2.7
FRAG	1 991	1 621	1.54	84 108	0.87
FRAU	1 963	1 656	1.79	85 840	0.84
Non-metro NUTS[3]	729	4 269	1.8	249 799	0.7

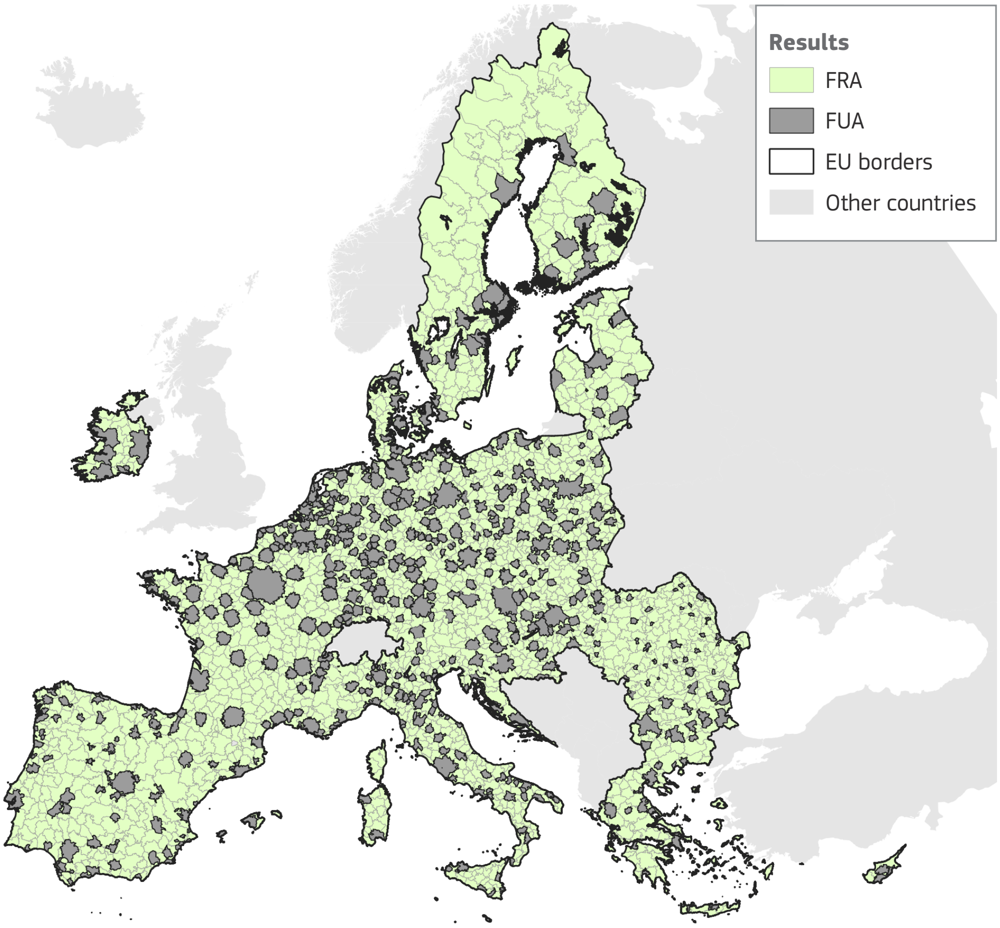


Figure 2. FRAs created using the currently preferred definition.

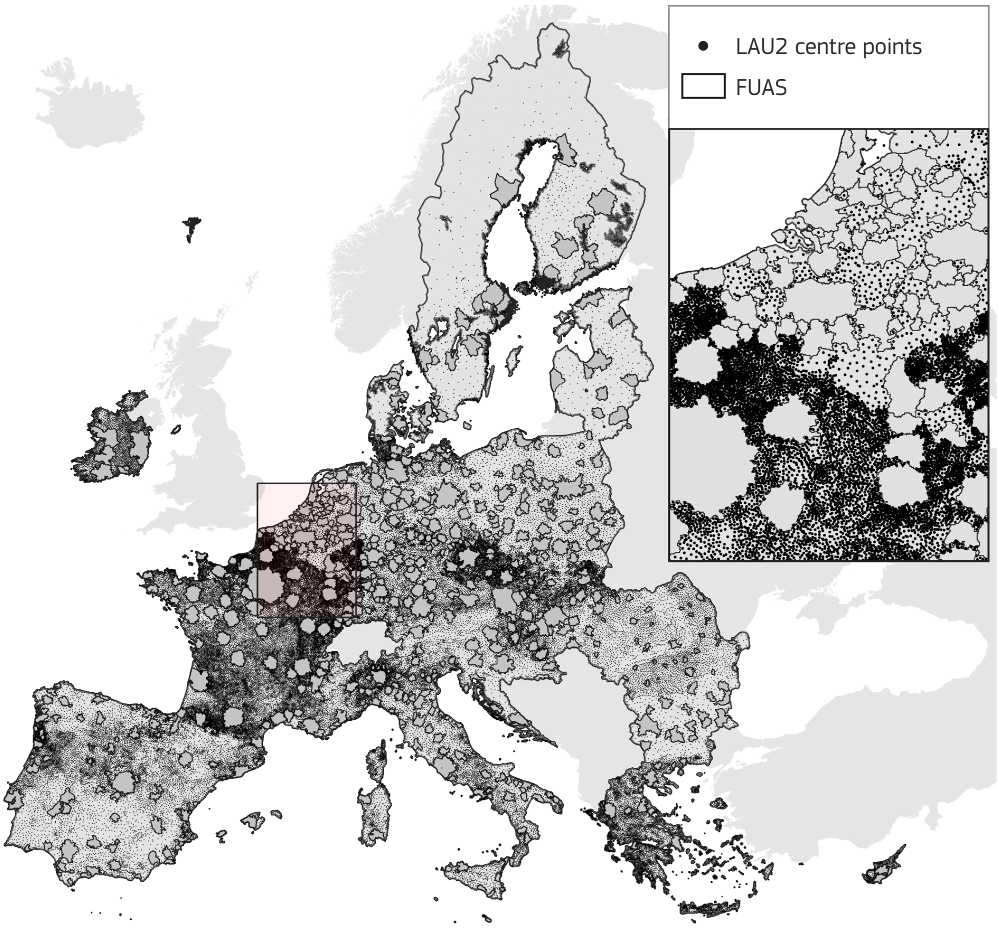


Figure 3. The uneven distribution of LAUs outside FUAs across Europe, visualised using the centre points.

LAUs outside FUAs vary substantially in area and population size across and between countries. On the map (**Figure 3**), the difference in centroid density between France and Belgium is clearly visible. Within Spain, a wide diversity can also be seen. The size distribution of LAUs depend on the evolution of political and administrative units within a country over time. They were not designed to produce comparable spatial statistical units. Some government reforms have also led to a dramatic increase or decrease in the number of LAUs. Combining LAUs based on their relationship with the FRAGs increases their comparability, but some will still experience changes over time due to changes in the LAU boundaries.

Figure 4. Distribution of the geographic sizes of non-metro NUTS3, FRA and rural LAU units.

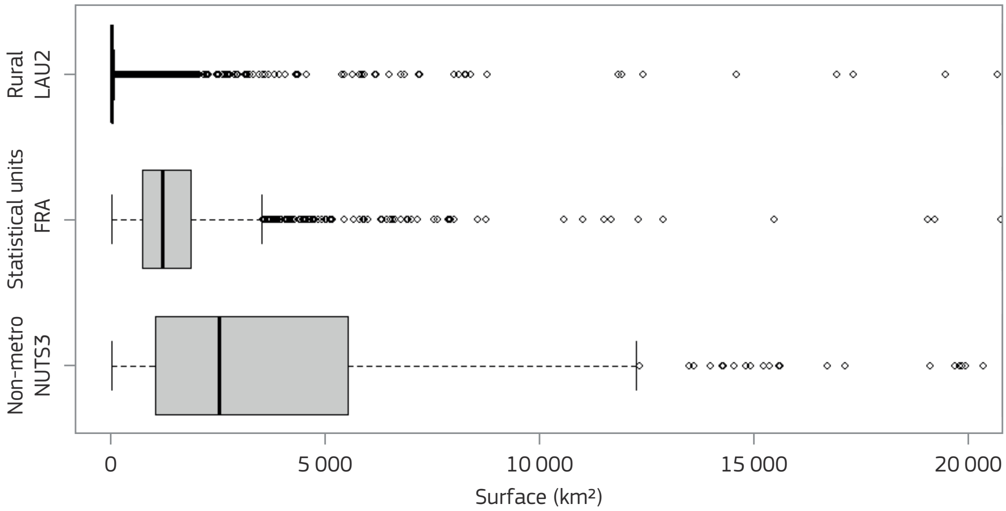


Figure 5. Distribution of the 2018 population sizes of non-metro NUTS3, FRA and rural LAU units.

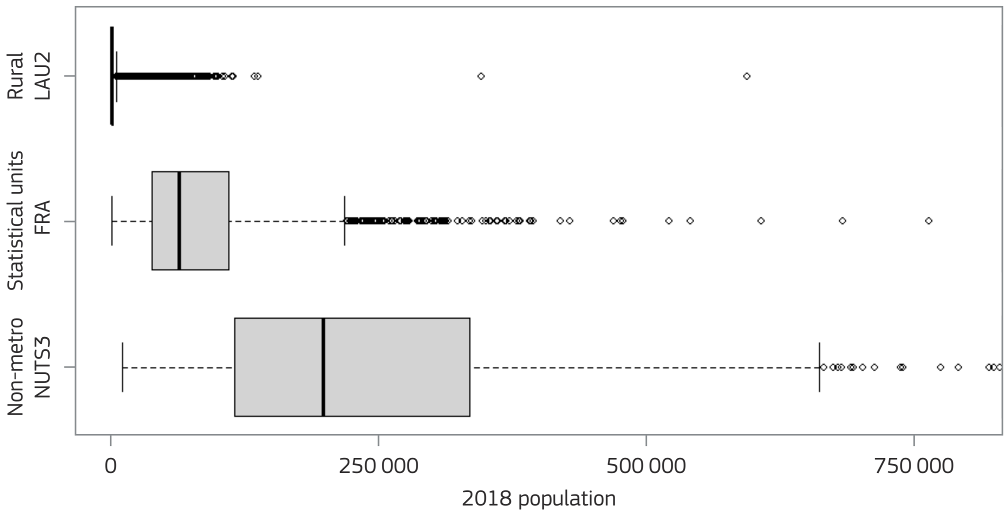


Figure 4 and **Figure 5** show a boxplot of the population and area size distribution of the rural LAUs, the FRAs and non-metro regions. These foremost show how small most rural LAUs are, as a large share of EU municipalities is in France, so that municipalities in all other Member States are typically represented as outliers. However, those municipalities have few inhabitants. If the population of a LAU is very small, a small change in the total population can lead to very large growth rates. If in a LAU of 50 people, a household of five people moves in, that LAU will have a population growth rate of 10 %. These extreme values make the interpretation of the results more difficult.

FRAs do show some variation in geographic and population sizes, which is partially due to exclaves, and partially due to the size differences in very sparsely populated regions in Sweden, Finland and Spain. However, non-metro NUTS-3 regions vary more in population and area size than FRAs with a much wider range between the 25th and 75th percentile (the vertical line at the left and the right hand of the box in **Figure 4** and **Figure 5**). NUTS-3 regions are regulated[9] and have to comply with minimum and maximum population thresholds (150 000 and 800 000 respectively), but not area size. If NUTS regions are administrative regions, only the average population of all NUTS regions in a country has to comply within the minimum and maximum threshold, which allows for more variation. For example, the NUTS-3 region of El Hierro in Spain has only 11 000 inhabitants, while the NUTS-3 region of Madrid has 6.5 million inhabitants[10]. Also non-metro NUTS-3 regions vary substantially in size, for example, Pas-de-Calais has a population of 1.5 million.

To give an idea of how sensitive the FRAs are to the thresholds used, we published two alternative versions of the FRAs with different thresholds. These are:

— A version of the FRAs with the same population thresholds (25 000) and minimum travel time (30 minutes) but smaller maximum travel time (45 minutes instead of 60 minutes); and

— A version of the FRAs with a higher population threshold (50 000) and the same minimum and maximum travel times.

Lowering the maximum travel time threshold increases the number of FRAGs and FRAUs somewhat, with an increase of about 80 additional FRAUs across the EU. On the other hand, doubling the population threshold decreases the number of FRAGs and FRAUs with about 400 to 500 units.

9 *https://ec.europa.eu/eurostat/web/nuts/legislation*

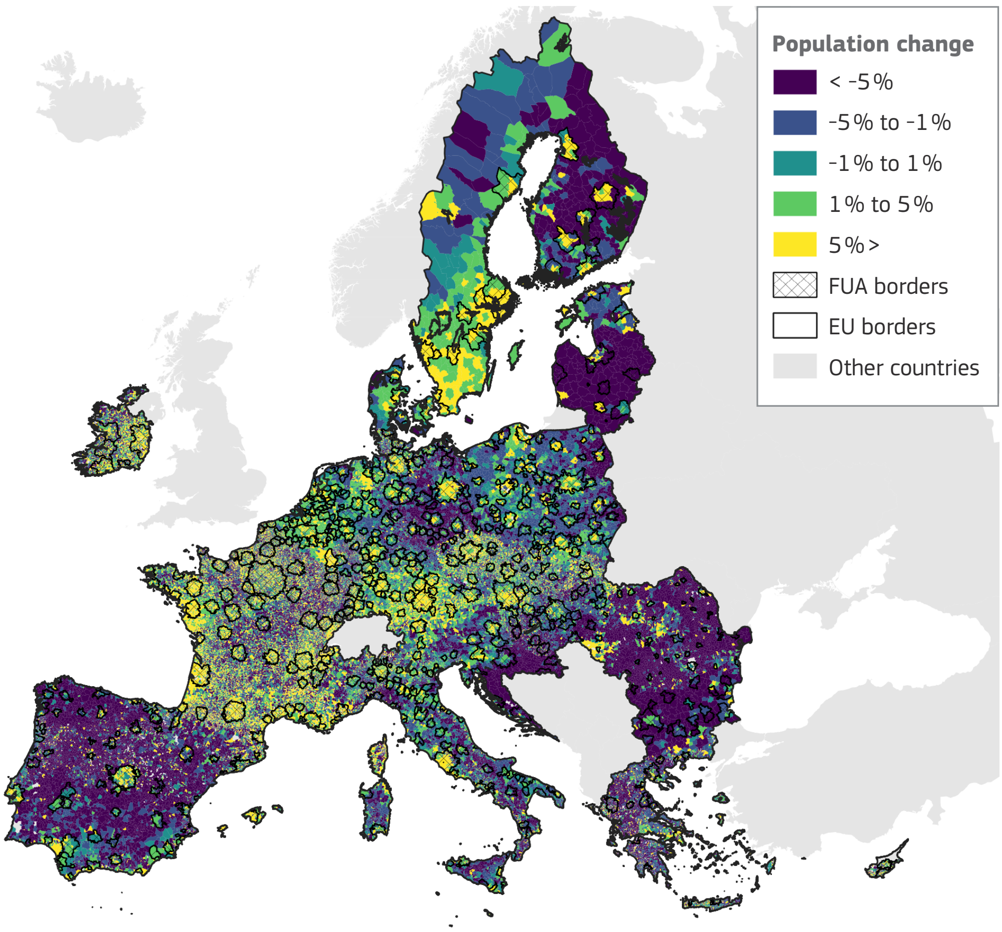
10 *https://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/ks-gq-22-010*

4 Demographic change in LAUs, functional areas and NUTS-3 regions

To show the differences between the LAUs, functional areas and NUTS3 regions, population change between 2011 and 2018 has been visualised at all three levels in **Figure 6, Figure 7** and **Figure 8**. From the first, municipality-based map shows the problem with municipalities. The sheer number of small municipalities especially in countries like France and Spain produces a noisy image of population change there, as small population change can lead to high change rates, which gives the false impression that local population changes in countries with much larger municipalities are much less volatile.

Figure 6. Population change 2011-2018, LAU level.

Source: Ardeco (2022) and authors' elaborations.



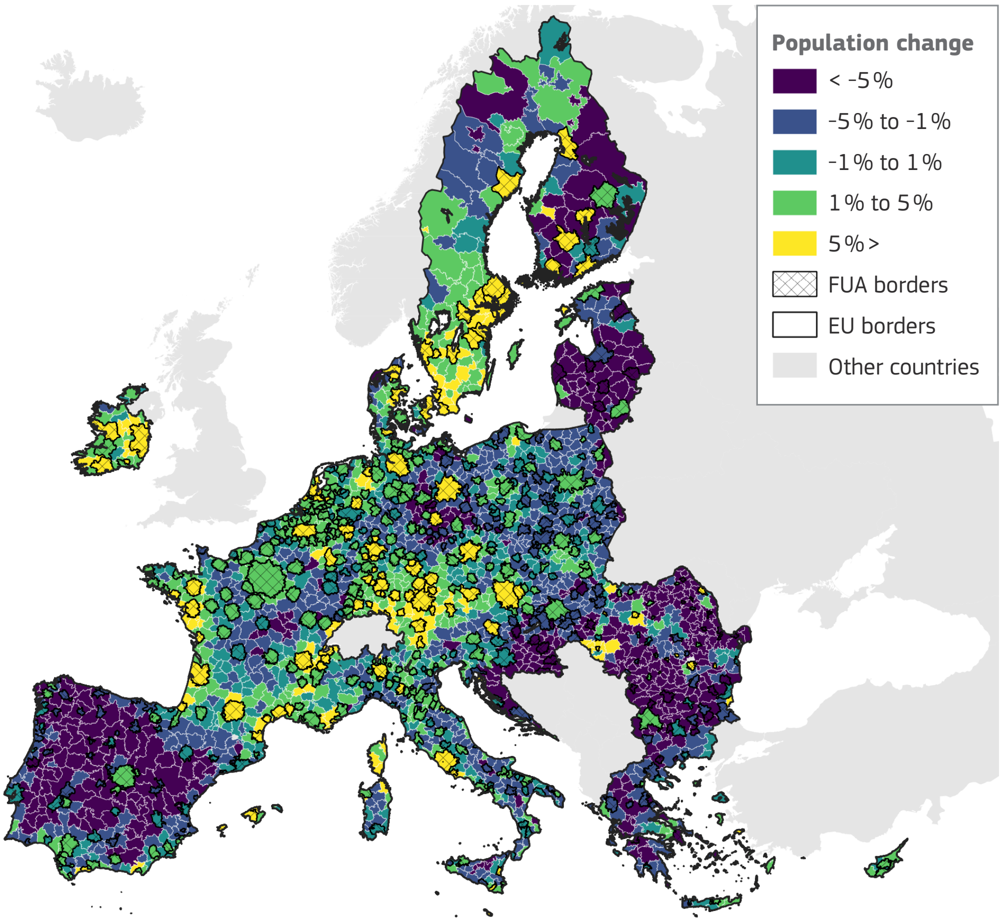


Figure 7. Population change 2011-2018, Functional area grid level.

Source: Ardeco (2022) and authors' elaborations.

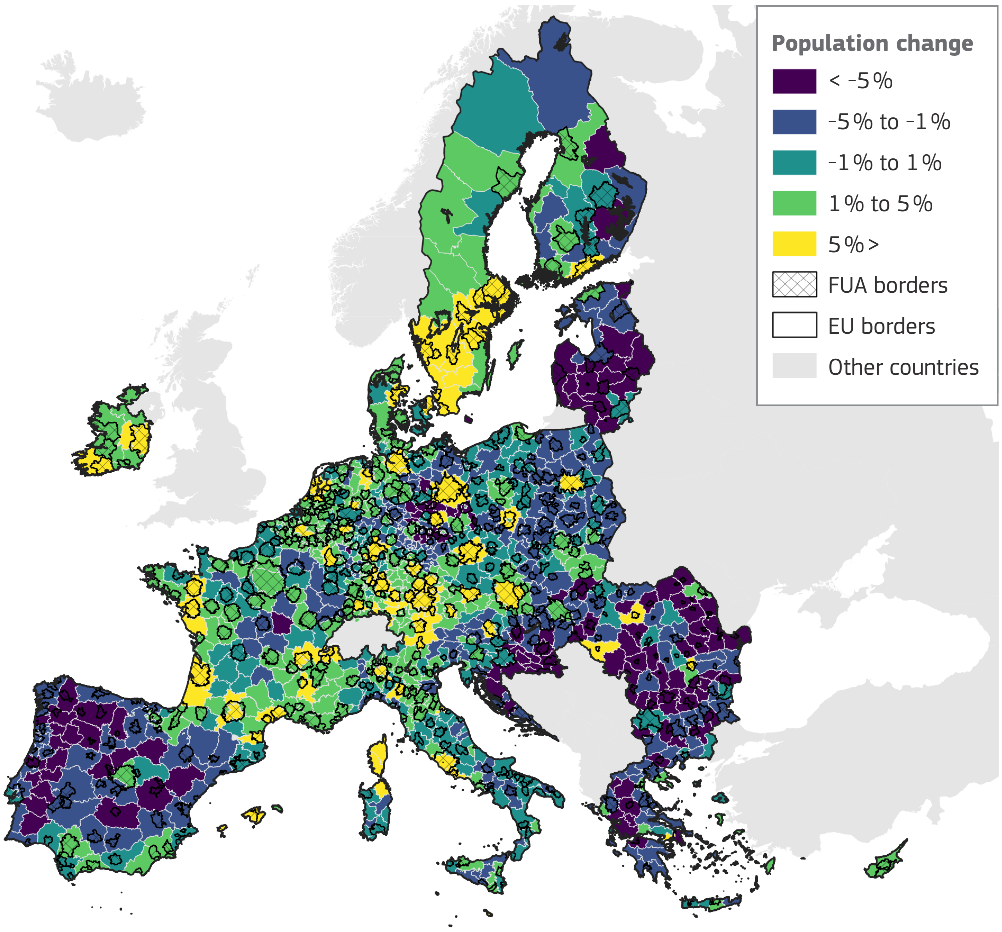
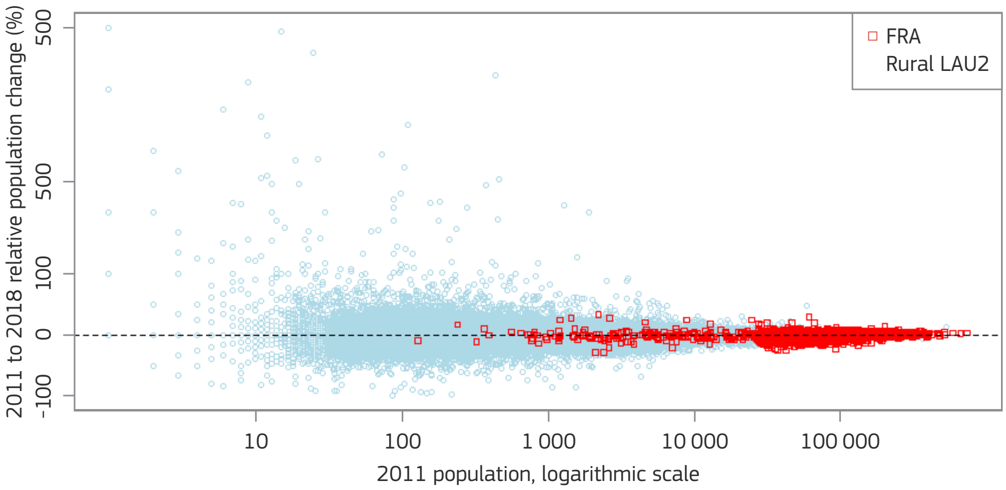


Figure 8. Population change 2011-2018, Metro regions and other NUTS-3 regions.

Source: Ardeco (2022) and authors' elaborations.

By comparison, the functional areas yield a much clearer picture of how population changes have played out across the EU territory. Comparing results at the functional area level with results at the NUTS3 level, the heterogeneity of the later units becomes apparent. The municipality and functional area-level maps show that depopulation in Spain is primarily a rural phenomenon. Because many NUTS-3 regions contain a combination of functional urban and rural areas, the NUTS3 regions hide these discrepancies.

Figure 9. Relative population change in FRAGs and rural municipalities, compared with 2011 population size.



Relative population change in FRAs falls within a much narrower range that those of individual LAUs (**Figure 9**), including when comparing FRAs and LAUs with a similar population range. Although a few FRAs have a population below 25 000, very few have less than 1 000 inhabitants and none less than 100 inhabitants. In contrasts, thousands of LAUs have such small populations. **Figure 9** also shows that the smaller the initial population of a LAU, the more extreme their relative population change can be. This large variation of sizes between LAUs is problematic as it may bias impressions of population change across the EU territory.

The **distance** to **schools** in LAUs, FRAs and NUTS-3 regions

5

Another useful example is distance to schools, which is shown at the LAU and functional area level in **Figure 10** and **Figure 11** respectively. School locations were collected by Eurostat, and distances to schools computed by GISCO and shared as a grid map. Salient gaps in access to school coverage were filled by JRC data on access to schools, with school locations provided by the ESPON profecy project[11]. For visualisation in this report, these distance to schools were subsequently averaged to represent the average distance that an inhabitant of a LAU or a functional area would be separated from the closest school. Broadly speaking the results reflect European population densities, with particularly short distances to school in the northwest of Europe, north of Italy, and the triangle between Vienna, Bratislava and Budapest. Distances to school are particularly long in Sweden and Finland as well as in some of the Baltic states.

The considerable size variation among LAUs reduces comparability. In countries with small LAUs, more LAUs with few inhabitants will not have a school in the immediate vicinity. Consequently their population will have a long average distance to school. In countries with large LAUs the long school distances for small communities will be smoothed out somewhat, even if those countries had exactly the same distribution of population and schools. Thus LAU map distributions are biased towards countries with small units. This diversity in the size of LAUs and the big differences between neighbouring LAUs makes the LAU map hard to interpret. For instance, in central Spain and western Romania, it is difficult to see whether overall access to schools is poor or not. The map with distance per functional areas sketches a more balanced and easier to interpret picture. This map still shows significant variation between functional rural areas, sometimes even in the same Member State. For example, Spanish functional rural areas in the centre and south have fairly good access to schools, while access to schools is lower in north-western Spain.

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11 Kompil, M., Jacobs-Crisioni, C., Perpiña Castillo, C. and Lavalle, C., (2022) Accessibility to services in Europe's Member States – an evaluation by degree of urbanisation and remoteness, European Commission, JRC124457.

Figure 10. Average inhabitant's distance to closest school, LAU level.

Source: GISCO, JRC.

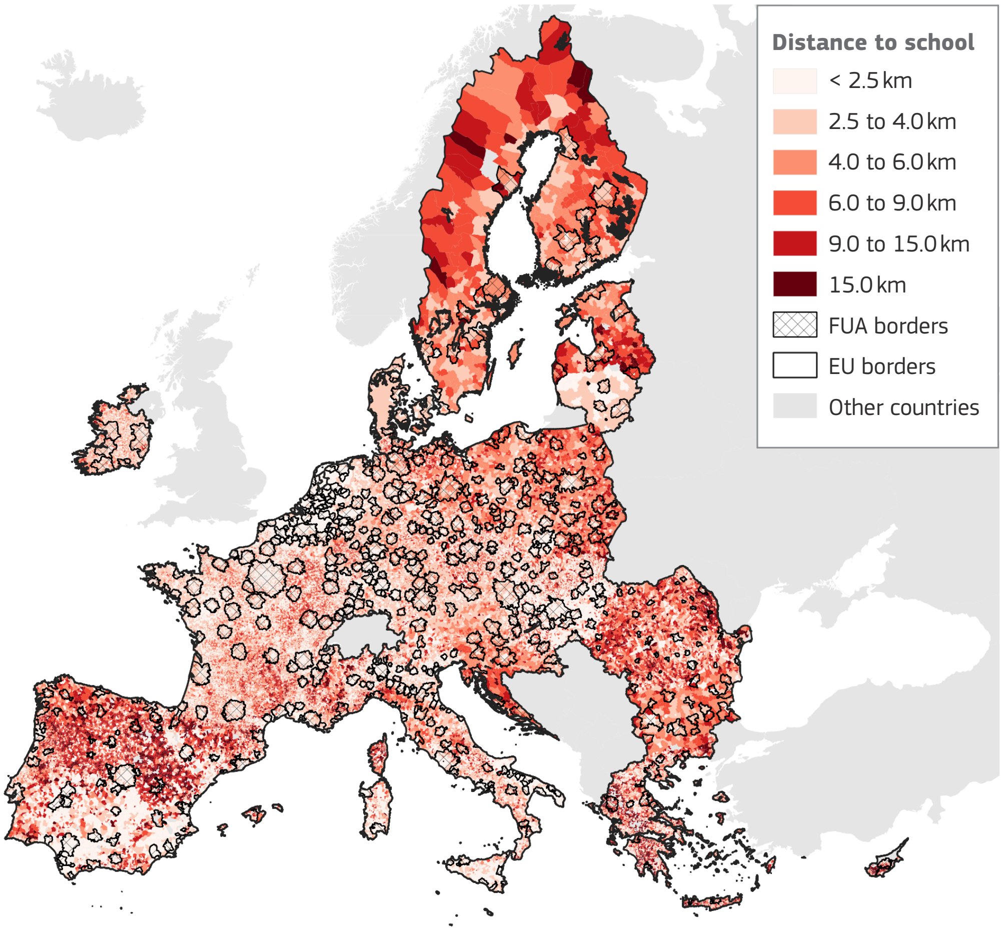
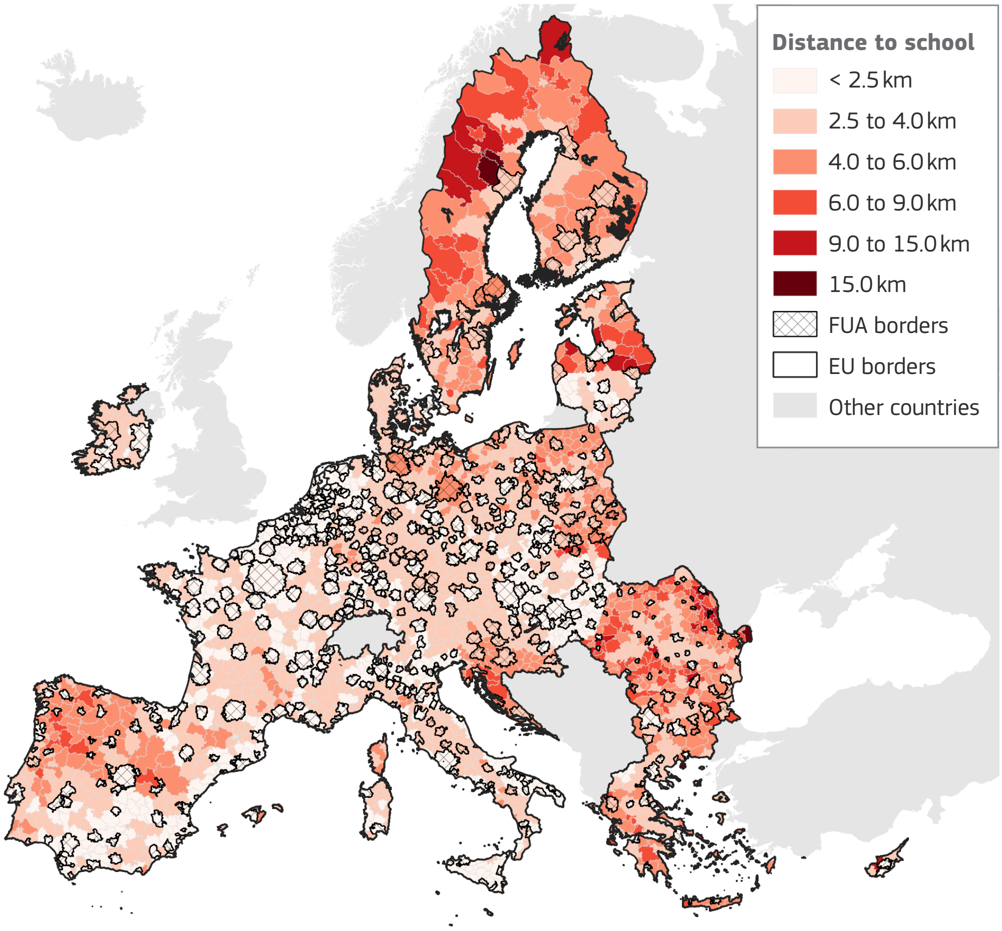


Figure 11. Average inhabitant's distance to closest school, Functional area grid level.

Source: GISCO and authors' elaborations



The pattern of LAUs with small population leading to more extreme values is very clear in **Figure 12**. The results for the FRAs fall within a much narrower range as compared to the rural LAUs. The smaller the population of the LAU, the more likely that it will have an extreme value.

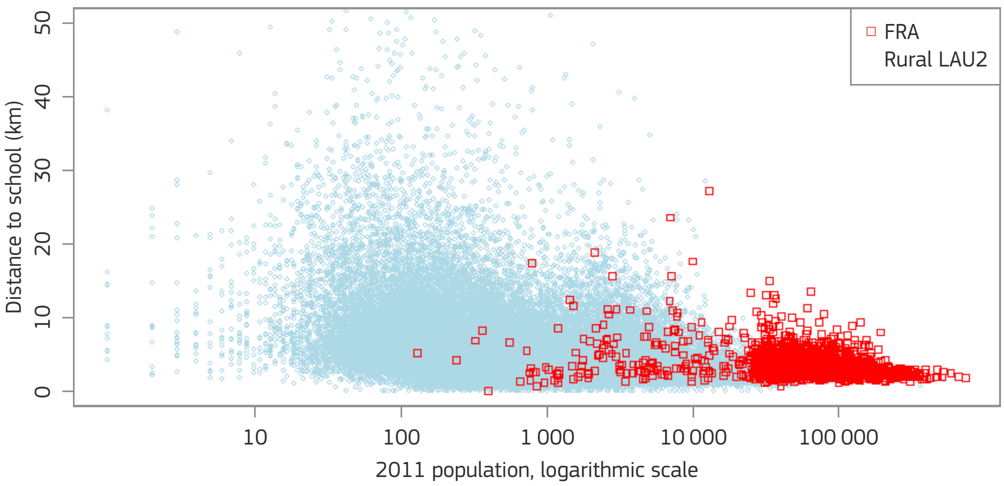


Figure 12. Average distance to schools in FRAGs and rural municipalities, compared with 2011 population size.

6 Conclusion and next steps

This paper proposes a draft methodology to define functional rural areas. This method has been applied to a 2018 population grid and the results can be consulted in a series of interactive maps online. The comparison with LAUs and NUTS-3 regions shows that functional areas are more harmonised in terms of population and area size than LAUs and NUTS-3 regions. Furthermore, the interpretation of indicators, such as relative population change and distance to the nearest school, are easier to interpret as the values fall within a more restricted range and generally concern at least 25 000 inhabitants.

We propose three next steps: consulting, updating and analysing functional rural areas.

- This initial methodology has already been presented at the Rural Pact conference on 15-16 June in Brussels. It will be presented at other conferences. This paper has been circulated widely among a variety of rural stakeholders, requesting them to provide feedback. The received feedbacks have led to several changes in the method, including adapting a lower population threshold, and adopting catchment areas based on market attraction rather than shortest driving time.
- These functional rural areas will be updated using the 2021 population grid, the updated functional urban areas and applied to the census 2021 LAU boundaries. The update should be available in 2024.
- The same methodology can also be applied to other countries as long as a population grid, a road network and FUA boundaries are available. The OECD is developing FRAs for some of its Member States and has received the necessary computer code and technical assistance to generate their own versions.
- This paper proposes several hypotheses that we cannot test empirically for all EU Member States, but we may be able to find the right data to test these in some Member states. We will therefore test our hypotheses against real-world data where possible. The tested hypotheses include:
  - → Most daily trips start and end within a FRA.
  - → Most FRAs provide a wide range of daily services: i.e, do most FRAs have at least one of each type of 'important local service' like health care facility, secondary school, etc? Do they tend to have multiple options for some or all services?
  - → Rural centres function as community centres with a wide range of public and private services.

  - → Employment is less concentrated in a rural centre as compared to a city, so that commuting in a rural centre is less unidirectionally, i.e. less focused on one destination agglomeration.
  - → Commuting within a FRA is less intense than within a FUA, so that a comparatively small share of FRA citizens commute long distances. There is some evidence that working rural district inhabitants in the UK are more likely to work from home, with the remainder seemingly either commuting shorter distances, or much longer distances[12].

— Finally, it would be useful to assess whether labour market areas produce a similar geography or whether it shows consistent differences.

12 Champion, T. (2009) Urban–Rural Differences in Commuting in England: A Challenge to the Rural Sustainability Agenda? Planning Practice & Research 24:2, 161-183, doi:10.1080/02697450902827329

References

Batista e Silva F, Poelman H, Dijkstra L (2021), The JRC-GEOSTAT 2018: A novel small-area population estimation for Europe. In: European Forum for Geography and Statistics, 7-8 september 2021

Dijkstra, L., H. Poelman and P. Veneri (2019), 'The EU-OECD definition of a functional urban area', OECD Regional Development Working Papers, No. 2019/11, OECD Publishing, Paris, *https://doi.org/10.1787/d58cb34d-en*

European Commission, Eurostat, Applying the degree of urbanisation: a methodological manual to define cities, towns and rural areas for international comparisons: 2021 edition, Publications Office of the European Union, 2021, *https://data.europa.eu/doi/10.2785/706535*

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Annex 1 **Detailed methodology** and **caveats**

CREATION OF INITIAL CATCHMENT AREAS

The FRAs combine multiple catchment areas of rural local centres. These centres need to be identified first. The process to do so is described in this section and shown graphically in **Figure 13.** This is done by establishing travel times between all settlements within each Member States; and counting the population in these settlements. Travel times are obtained from travel time matrices that were created using TomTom road networks. Population counts are obtained from JRC-GEOSTAT 2018 population grids. A settlement is presumed to be a local centre if it is the largest (in terms of population) within a specified travel time. In the preferred approach, settlements are considered to be local centres if they are the largest settlements in a 10-minute drive.

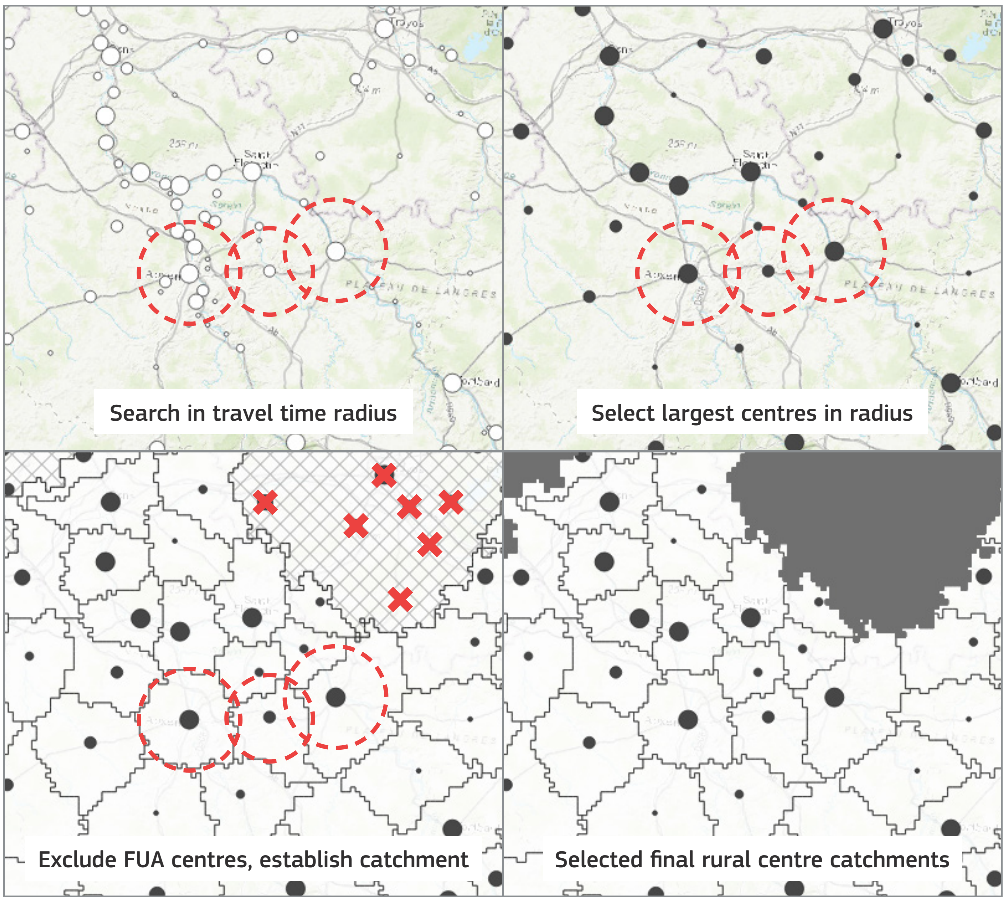


Figure 13. Process to create rural local centre catchment areas.

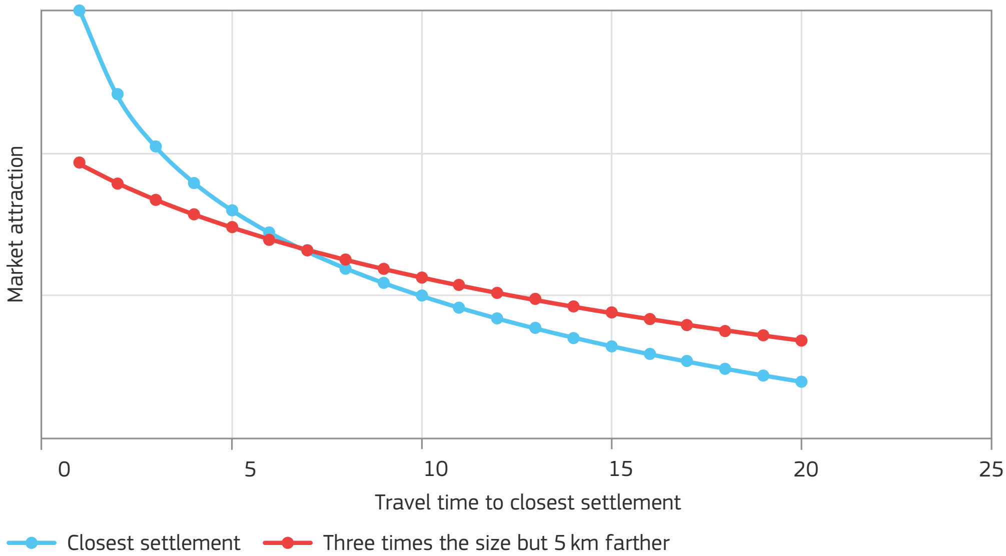
The largest settlements within the specified travel time are considered relevant destinations to create a catchment area around. All other settlements are discarded. There are roughly 19 000 of these rural centres in the EU and UK, of which about 15 000 have less than 10 000 inhabitants and about 4 000 even less than 1 000 inhabitants. All largest settlements that are within FUA boundaries are also discarded, so that only rural local centres are included. These rural local centres can only be towns or villages, as every city is part of a FUA.

Subsequently, using travel time matrices obtained from TomTom data, the market attractions are estimated that nearby rural local centres exert on the EU territory. To do so, the shortest travel times to the five closest centres are sought for every 1 km grid across the territory in all EU member states. All 1 km grid cells that are within FUA boundaries are discarded, as they do not need to be taken into account in the analysis. The result is a table with travel times to the five closest local centres from the 1 km grids. Next market attraction is estimated by multiplying the population of local centres with the inverse squared travel time to those centres. Then every grid cell is allocated to the catchment centre of whichever local centre that exerts the highest market attraction on that grid cell (see **Figure 14**). The implication is that, all other things held equal, settlements with comparatively more population will have bigger catchments, which is what you would expect in practice.

The final outcome is a set of boundaries of catchment areas that covers the entire EU territory outside of FUAs and indicates the most attractive rural local centre within country borders. Some light curation is subsequently performed, in which empty isolated cells are discarded, single enclave cells are added to the dominant neighbouring catchment area and isolated cells with limited population are flagged as exclaves. The curated grid is then transformed into single areal units that indicate likely catchment areas for Europe's rural local centres.

Figure 14. Graphical display of market attraction of two settlements.

Note: This graph is based on a hypothetical case, given the travel time to the closest settlement, and a second settlement that is three times larger but consistently 5 minutes farther. Any grid cell that is at least 7 minutes away from the closest settlement would be allocated to the much larger settlement, as it exerts much more market attraction at longer distances.



Two caveats of this method are important to flag. First, for computational reasons, the catchment area generation method is implemented per member state. The settlement networks from which the largest settlements are chosen therefore only consider settlements within the same country. As a consequence, there might be too many settlements chosen close to boundaries, where in reality one cross-border settlement is dominant. This is also true for the resulting catchment areas. In addition, in odd cases, territory in a Member State can only be reached by passing through another Member State. This is for example the case for the Jungholz enclave, which is Austrian territory that can only be reached by passing through Germany. The network limitations would cause the algorithms to describe this enclave as an isolated, self-contained unit while it is not in practice.

Second, some parts of the EU territory are relatively inaccessible, as they do not have a road connection nearby. When creating the travel time matrices needed for this method, connectivity has been simulated for otherwise inaccessible grid cells by presuming that the cells are connected with a relatively slow transport link. These are straight links with a 30 km/h speed that have been assumed between origin grid cells and the closest driveable road network links (see **Figure 15**). Detailed analysis indicates that the presumed connections probably overestimate the accessibility of locations with a simulated connection. For the creation of catchment areas this is relatively harmless, as such inaccessible locations are mostly uninhabited, and in any case all human activity in these locations still depends on services in the allocated local centre, regardless of the time needed to reach that centre.

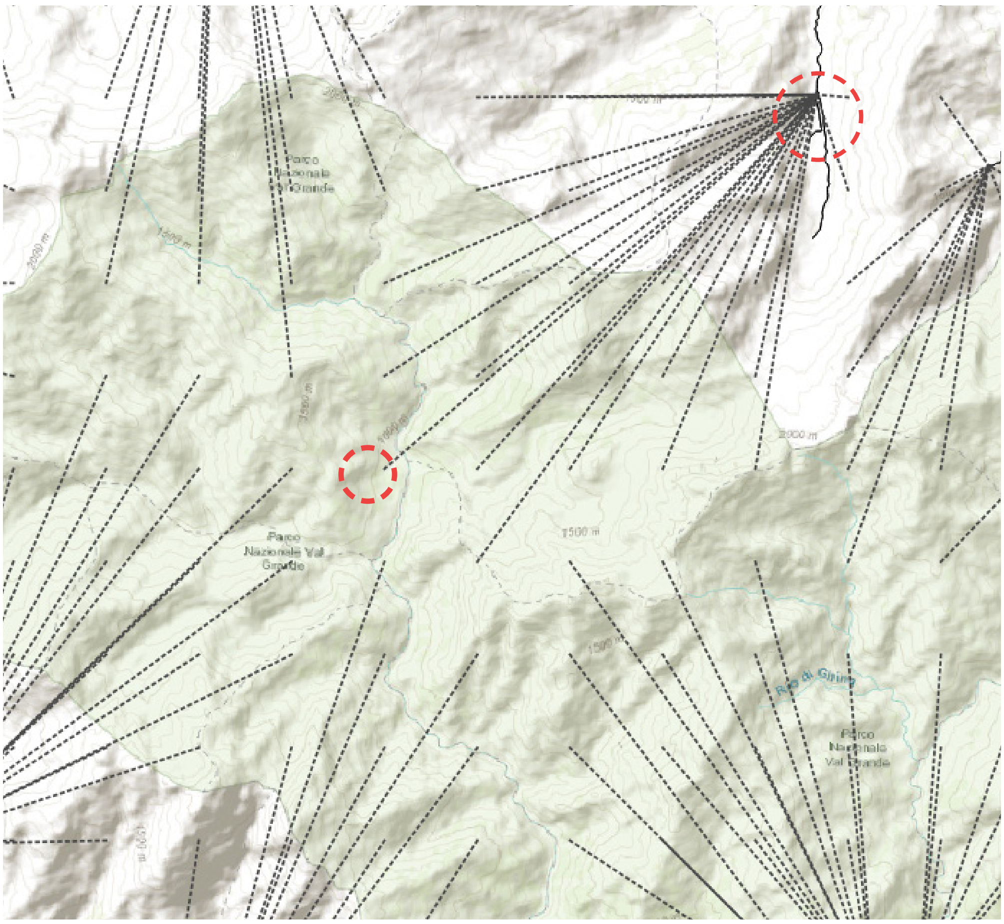


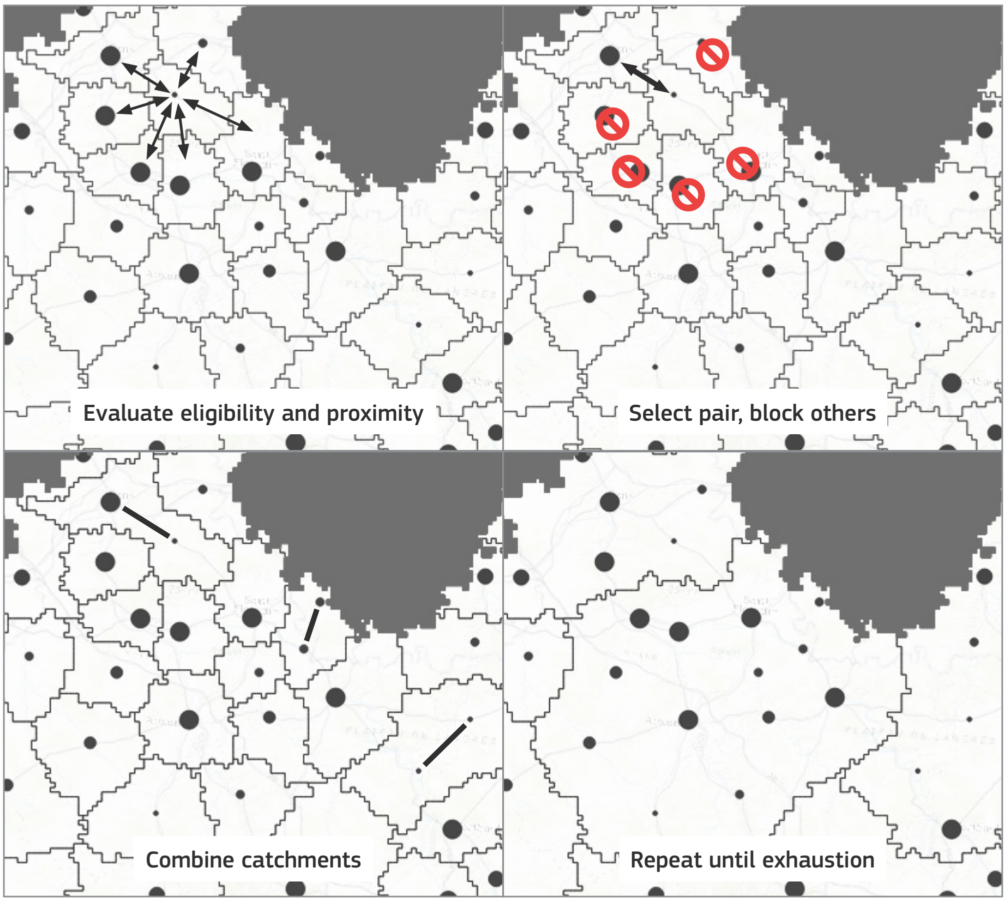
Figure 15. Example of simulated access to a location without proximate road connectivity.

Note: The 'In la Piana' location in the middle of the Val Grande wilderness area in the northwest of Italy (middle circle) is connected by a straight line from the closest parking space in Val Loana (circle in top right). The simulated travel time is 12 minutes, indicated hiking time is 4.5 hours.

COMBINATION INTO FRAS

After the creation of small catchment areas, a procedure is run that repeatedly combines pairs of rural catchment areas that are the closest together, until all eligible catchment pairs are exhausted. This procedure is explained in this section and shown graphically in **Figure 16.** It starts by establishing, for every catchment area, the travel time from the catchment's central settlement to all other catchment centres that are within the specified maximum travel time in the country. Additionally, the procedure flags whether catchment area pairs share a boundary and counts the population in each catchment area. Subsequently, catchment pairs are sought and combined repeatedly.

Figure 16. Process combining catchment areas into FRAs.



COMBINATION PROCEDURE

The rules that are used in the combination process have been described above. In short, the centre of a catchment area should be at least a 30-minute drive away from the centres of contiguous catchment areas. A catchment should have at least 25 000 inhabitants if it has contiguous catchment areas within the same country that are less than an hour's drive away.

The combinations of catchment pairs is done in an iterative fashion until no more pairs can be combined, in other words when all catchment areas comply with the above mentioned criteria. Contiguity and travel times are symmetrical measures, implying that they have the same value regardless of which of the two catchment areas in the pair is the origin or destination. With regard to population size, the population from the least populated catchment area is taken into account. Thus a catchment that already satisfies all criteria, including the minimum population size criterion, can still be combined with an additional area, if the other area in the pair does not meet the minimum population size criterion.

Subsequently a mechanism is put in place that verifies, for every eligible pair of catchment areas, which eligible pair is the closest together. This is done to ensure that a catchment area is not selected for a combination with multiple other catchment areas simultaneously. In every repetition, only the closest eligible pair is selected; so that slightly more distant eligible pairs are neglected if one of the catchments in these pairs are already part of the selected pair.

The highest scoring pairs are flagged, and subsequently their catchment areas are combined to form new pairs. The contiguity criterion is re-evaluated for all remaining zones. Populations are summed. Travel times between the centres of catchments are re-evaluated. For new combinations, the travel times with outside catchments are computed using a population-weighted average value from the two previous catchments.

The combination procedure is repeated until there are no more eligible combination pairs available in the country. When all eligible pairs are exhausted, the areas that were composed through the described combination process are being stored and are considered FRAs for the country at hand.

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