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MEASURING ACCESSIBILITY TO PASSENGER FLIGHTS IN EUROPE:

TOWARDS HARMONISED INDICATORS AT THE REGIONAL LEVEL

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Regional and Urban Policy

1. INTRODUCTION

Within the European statistical system, relatively rich data are available on flight traffic by airport. Amongst other series, these data include the number of flights and the number of departing passengers. To a certain extent, these data are also available by connection between airports (origin/destination data).

Using the point location data of the airports, the available statistics can easily be represented on a map. Nevertheless, if we want to analyse the situation of regions, territories, or cities, in relation with air traffic, these data or maps are quite hard to interpret without further analysis. For example, the Brussels region does not contain an airport, as Brussels Airport is located just outside the borders of the Brussels Capital region.

Therefore, it is useful to derive indicators at a regional, territorial, or city level. In particular, we can try to assess aspects of accessibility and connectivity, which can be related to the regions' competitiveness and attractiveness, or aspects relating to the potential for global integration. Other indicators could study the available potential for modal shifts in transport between regions.

In order to develop such indicators, we need to explore meaningful ways of combining airport point locations with regional or territorial borders, using additional geo-referenced datasets.

Accessibility of passenger flights in a particular region

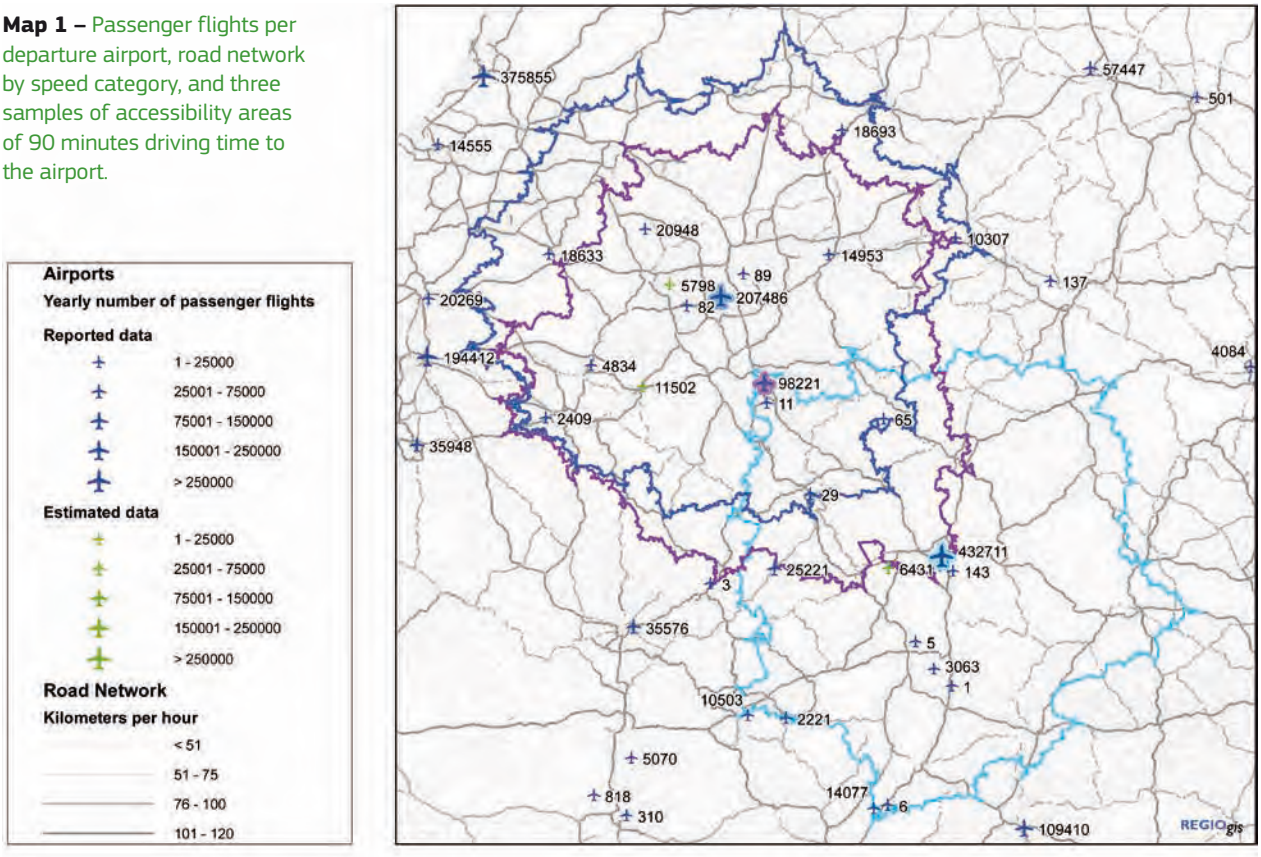
The relationship between airport locations and the (administrative) boundaries of a region can be quite arbitrary, and does not help to assess the actual availability of flights to the regions' population or territory.

To overcome this problem, we will define an area around each airport, in which there is reasonably good access to the airport. Although it would be preferable to model multimodal accessibility to airports, this option is hindered by substantial problems of data availability, especially on a European scale. As an alternative, we opt for an assessment of accessibility by road only.

Around each airport, a polygon-shaped area is identified, which can be accessed within 90 minutes driving time by car. The road network dataset used for this analysis needs to contain information on real road crossings and motorway access points, and needs to have an adequate density measure. In this analysis, we used a network dataset containing all primary and secondary roads [1]. Each segment of this network dataset has a speed attribute, which is used to calculate the driving time through the network. Not all countries were adequately covered by the dataset. The missing data [2] were complemented by EuroRegionalMap data (EuroGeographics Association). As this dataset does not contain any speed attributes, we estimated speed by road segment on the basis of legal speed limits per road category and country, adjusted by the presence of main urban areas and slopes [3].

Map 1 shows a sample of the input data: the location of the airports, combined with the reported data on the number of departing passenger flights, and with the road network, classified by speed category. The map also shows three examples of accessibility areas, created around three main airports.

Map 1 – Passenger flights per departure airport, road network by speed category, and three samples of accessibility areas of 90 minutes driving time to the airport.



1 Functional road classes (NET2CLASS) 0, 1, 2 and 3 of the TeleAtlas Multinet (2009) network.

2 Most of the main roads in Cyprus, Romania and Iceland.

3 The estimated speed per segment is lower when the road crosses an Urban Morphological Zone (UMZ, defined by the European Environment Agency EEA) or an area with an average slope of more than 6 %.

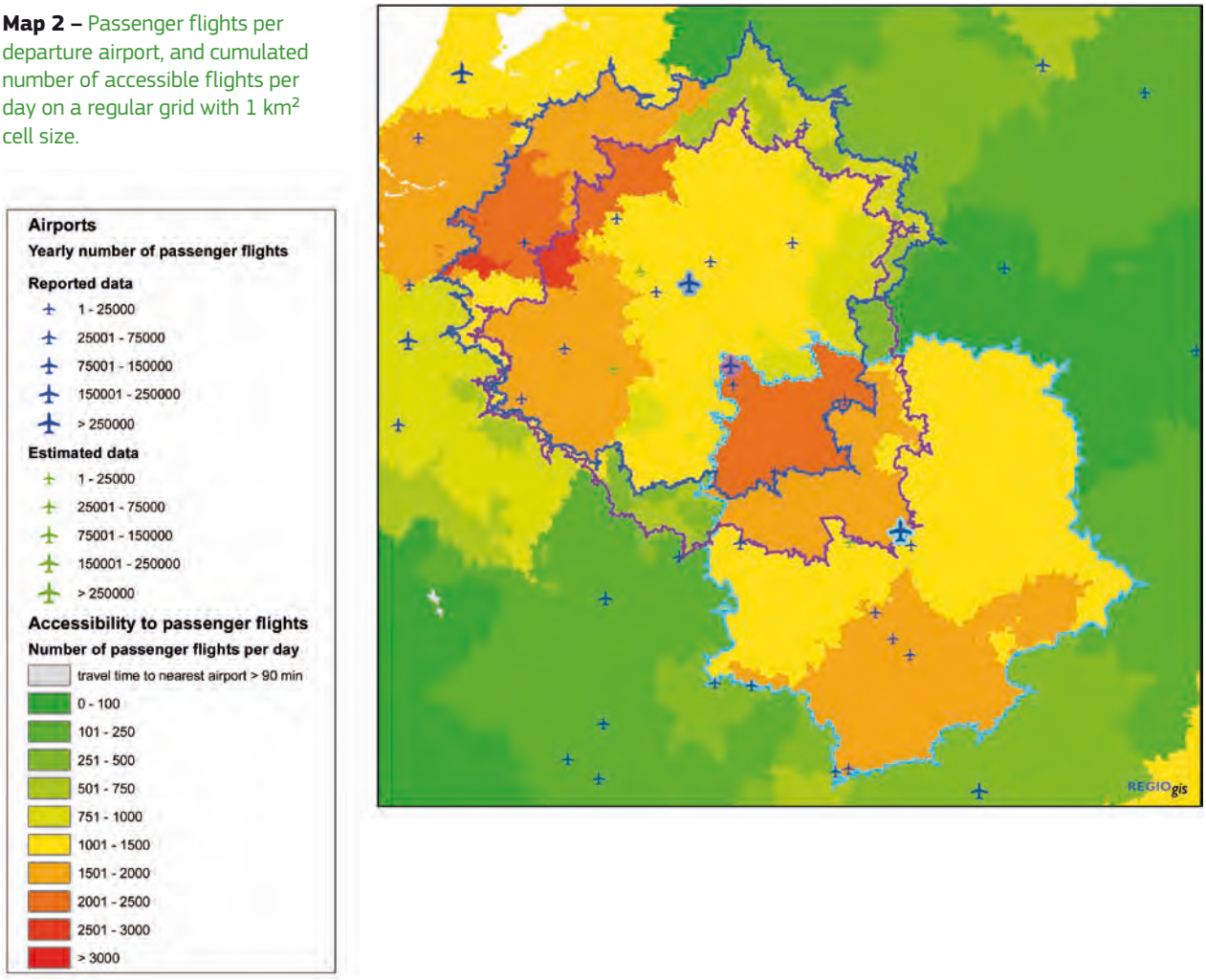
Each of the created areas can be identified by the airport around which it is established, so we can attribute the number of passenger flights departing from the airport to the area created around it. Eurostat publishes flight data per airport in two series. For the comprehensive series of airports (about 700 airports) the data do not provide the distinction between passenger flights and freight flights, whereas the series of main airports (about 500 airports) offers specific data on passenger flights. For the accessibility analysis, we used data on all airports. Where specific data on passenger flights were not available (i.e. for around 200 airports), their number was estimated to be equal to 95 % of the total number of flights. Indeed, from the available data we observe that on average 95 % of the total number of flights are passenger flights.

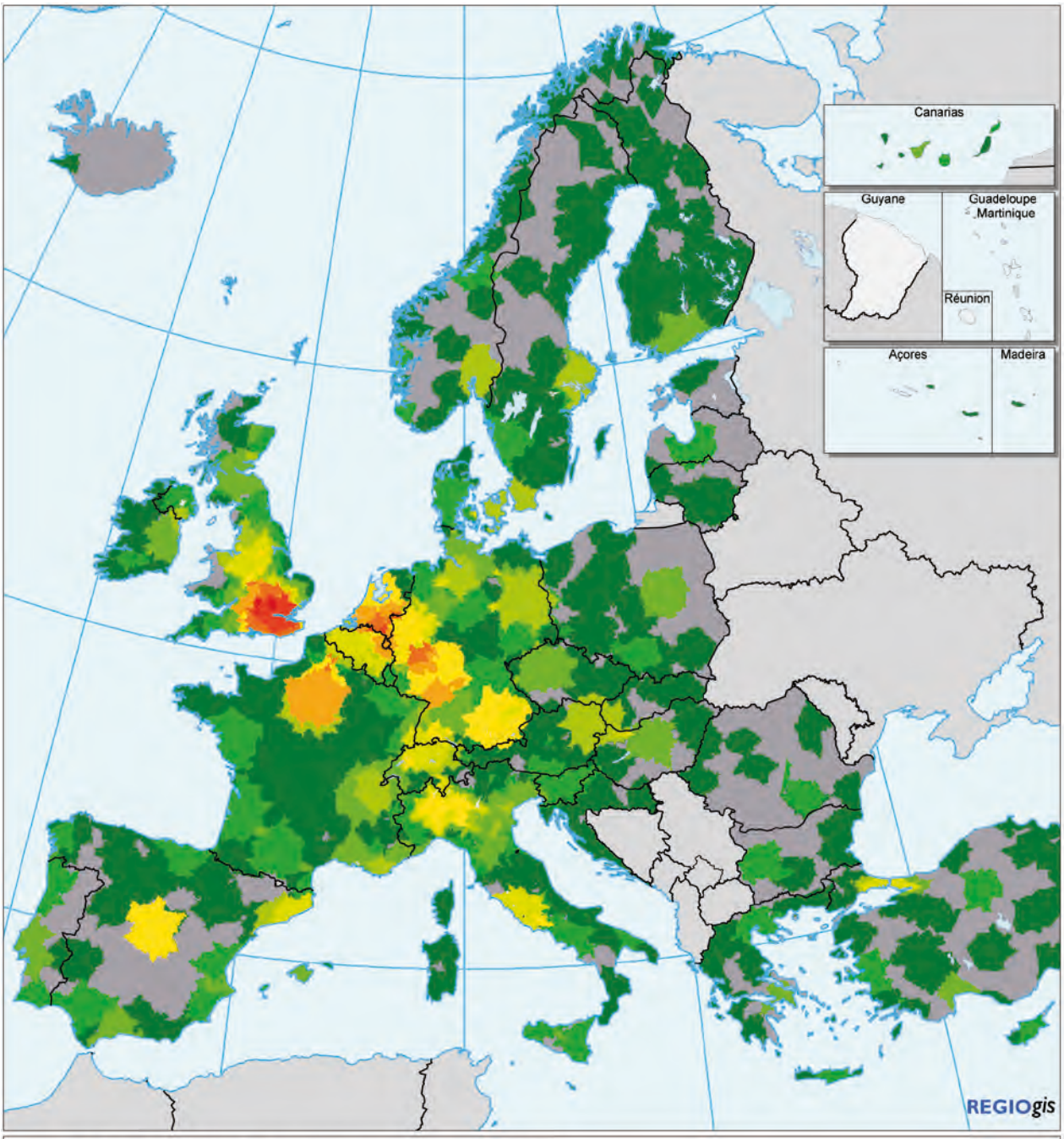
In a lot of territories, the accessibility areas created around the airports show partial overlaps. Our main interest is to evaluate the accessibility of all airports, rather than to a specific airport. Hence, we can quantify, for every location on the European territory, the total number of passenger flights available within 90 minutes driving time. This is done by aggregating the flights of each overlapping accessible area.

For further evaluation, this information is stored in a grid composed of square cells of 1 km², covering the whole territory for which data are available.

Map 2 shows a sample of cumulated numbers of accessible passenger flights, at the level of the grid cells. To facilitate the interpretation of the resulting numbers, the yearly numbers of flights are divided by 365 to obtain daily averages. The three accessibility areas of map 1 are also shown in map 2, to highlight the effect of the high availability of flights in the areas where the accessibility zones overlap.

Map 2 – Passenger flights per departure airport, and cumulated number of accessible flights per day on a regular grid with 1 km² cell size.





Map 3: Accessibility to passenger flights, 2010

Number of passenger flights per day

- Travel time to nearest airport > 90 min
- < 100
- 100 - 250
- 250 - 500
- 500 - 750
- 750 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500
- 2500 - 3000
- > 3000
- No Data

Sources: Eurostat, EuroGeographics, TeleAtlas, REGIO-GIS

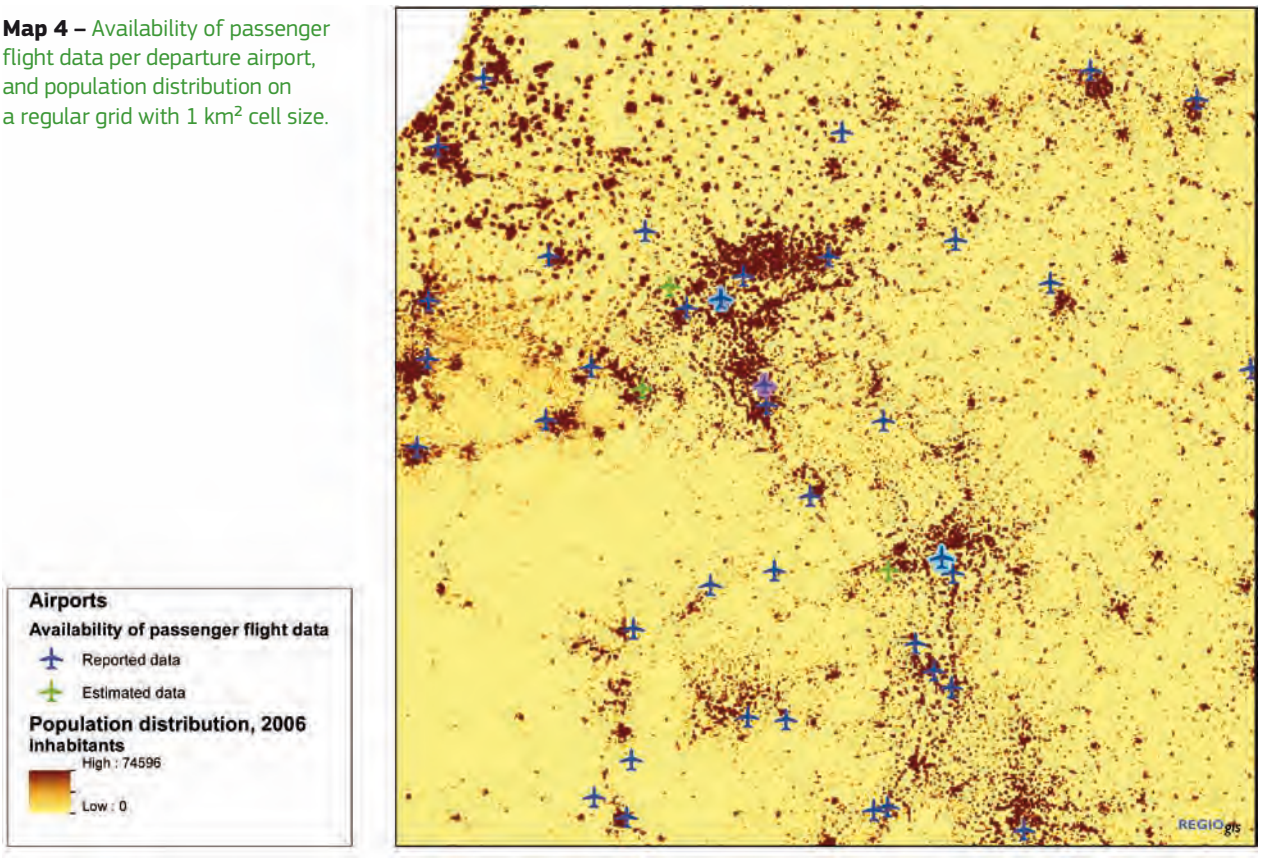
0 500 Km

The grid-based results for the whole of Europe are shown on map 3. The overwhelming number of flights at the major hubs contrasts with many areas, especially in Eastern Europe, Spain, and Northern Europe, located further than 90 minutes by road from any airport. The availability and efficiency of the road network is reflected in the size of the accessibility areas around each airport. The average size of these areas around the bigger airports (airports with more than 100 flights per day) varies from approximately 13 000 to 14 000 km² in Greece and Spain to more than 35 000 km² in Austria, Germany or Belgium. These differences might be reduced if traffic conditions, such as congestion problems on the network, could be taken into account in the model.

Although the grid map reveals the availability of flights and their accessibility throughout the territory, it still lacks the relevance of this accessibility for the population of the regions.

To create a meaningful indicator at regional level, we will aggregate the regular grid coverage by NUTS[4] region, while taking into account the population distribution inside the region. This population distribution is available at the level of 1 km² grid cells, overlapping with the grid cells on passenger flights. The population distribution grid refers to data of 2006 (see map 4). For several countries, it is based on 'bottom-up' population counts: geo-coded addresses are matched with population registers and allow the production of observed population counts at grid cell level. Other countries use hybrid methods for the creation of grid-based population counts, combining bottom-up information with disaggregation methods. For the remaining countries, we used downscaled population estimates, based on population figures at local administrative level[5].

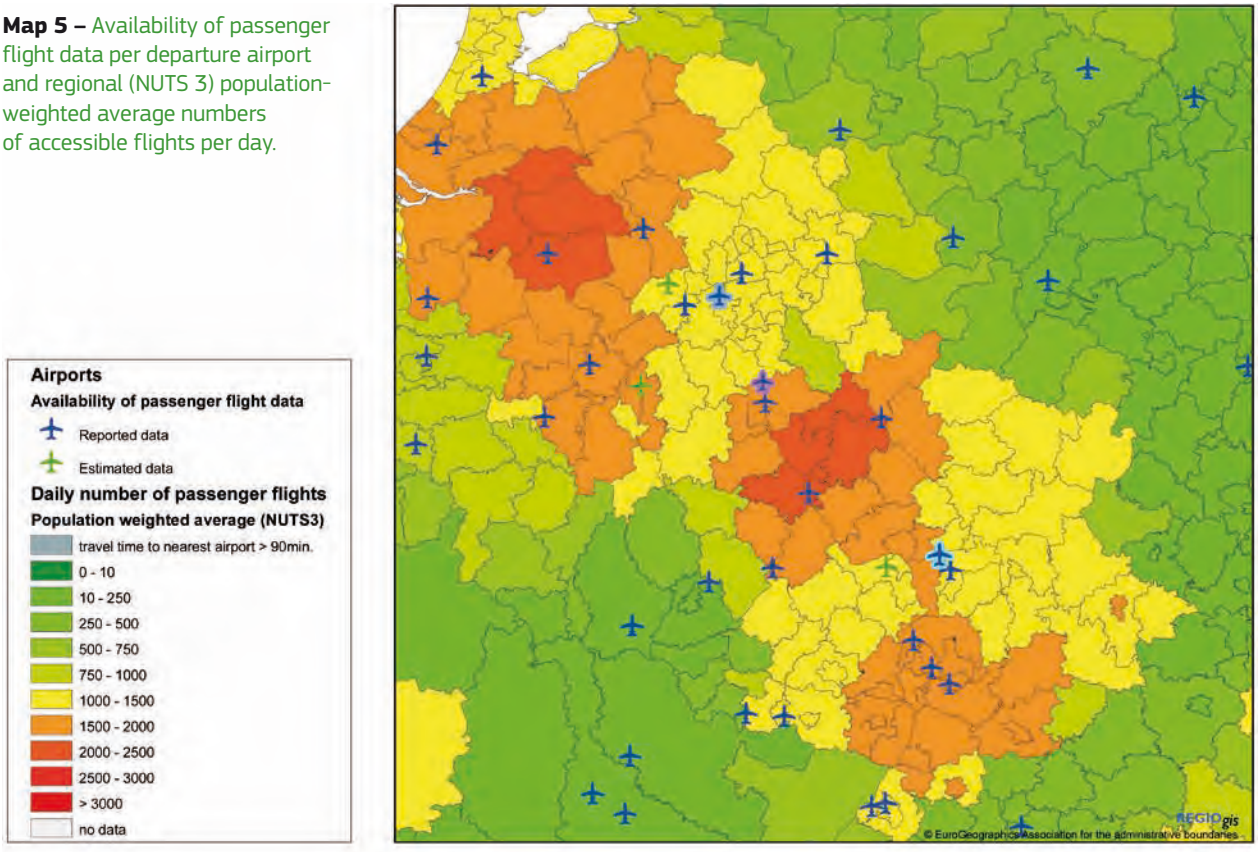
Map 4 – Availability of passenger flight data per departure airport, and population distribution on a regular grid with 1 km² cell size.



4 Nomenclature of Territorial Units for Statistics.

5 Population grid data published by Eurostat as the GEOSTAT 2006 grid:
http://epp.eurostat.ec.europa.eu/portal/page/portal/gisco_Geographical_information_maps/popups/references/population_distribution_demography
This dataset was complemented by disaggregated population estimates for Cyprus and Croatia, produced by DG Regional and Urban Policy and DG JRC, based on national statistics institutes population data, and by ORNL LandScan population data for Turkey.

Map 5 – Availability of passenger flight data per departure airport and regional (NUTS 3) population-weighted average numbers of accessible flights per day.



Combining the population grid with the grid on accessible passenger flights allows us to calculate a population weighted average number of accessible flights for each region (map 5).

The regional average number of accessible passenger flights, F, is:

$$F = \sum_{1}^{N} (p * f) \Big/ \sum_{1}^{N} p$$

With: p = population of a grid cell
f = number of accessible passenger flights in a grid cell
N = the number of grid cells in a region

Europe-wide maps 6 and 7 show the population-weighted daily average number of accessible passenger flights at NUTS 3 and NUTS 2 level.

The average accessibility at NUTS 3 level shows substantial disparities across Europe. A small number of NUTS 3 regions, mostly in Romania and Eastern Poland, are located entirely outside of 90 minutes travel time from any airport, while other regions in Eastern and Southern Europe have only a limited average number of flights available within a reasonable distance. Very high values can be observed not only in regions close to a major hub, but also in regions located in between important airports that have good accessibility to two or more of them (e.g. some regions in the south of the Netherlands).

The same phenomenon is visible at NUTS 2 level (map 7), although disparities at NUTS 2 level are significantly smaller than at NUTS 3 level. No NUTS 2 region is entirely located outside of a 90 minute accessibility area.

The same method of aggregation can be used for major cities and agglomerations or for territories of specific kinds (e.g. mountain massifs), provided the size of the territories is big enough in comparison to the grid cell size.

Map 8 shows the results at the level of cities and greater cities in relation to the city size, measured by total population (represented by the size of the circles). Accessibility to flights varies substantially between cities, even when considering only major agglomerations.

Access to long-distance flights

In addition to the total numbers of departing flights per airport, Eurostat provides origin-destination information for all major airports. These data allow further analysis of accessibility to long-distance flights. In particular, we want to assess the number of accessible long-distance flights (i.e. flights with a length of more than 5 000 km) within 90 minutes of driving time to the airport.

The geo-referenced data on airports need some further preparation in order to enable this analysis. First, all airports mentioned in the origin/destination tables need to be geo-referenced, especially the ones outside Europe. Secondly, the distances of all connections between these airports are estimated by means of a GIS calculation, as no actual flight routes or lengths are available. Some of the origin/destination data only contain information about the destination country, not the precise destination airport. For these cases, we calculate the minimum distance between the airport of origin and the destination country. Once all distances are estimated, they are coupled with the origin/destination flight data. From the origin/destination data, we select the flights of those connections having an estimated length of more than 5 000 km. Finally, these data are summarised per (European) departure airport, and attached to the accessibility areas created around the airports.

The accessible long-distance flights per airport are aggregated in the same way as the total number of accessible flights. Nevertheless, we introduce a distinction between areas further than 90 minutes from any major airport, and areas that are closer to airports but from which no long-distance flights are leaving.

Map 9 shows the results at the level of 1 km^2 grid cells. Major hubs for long-distance flights are extremely visible on these maps, while the disparities in the accessibility over the territory are much bigger than in the case of all flights. Many areas of Eastern and Northern Europe, as well as parts of Spain and Portugal, have no main airport available within 90 minutes driving time. Maps 10 and 11 show the results aggregated by NUTS 3 and NUTS 2 region. For these maps, we assume that no long-distance flights are available at smaller airports (those not included in the data collection by main airport). Consequently, only a few entire NUTS 3 regions (map 10) are shown as located far away from any airport. In substantial parts of the territory, at least one main airport can be reached within 90 minutes, but no or very few long-distance flights are available there. The concentration of available long-distance flights is particularly visible in countries like Spain or France, while countries like Germany and Italy show a more nuanced pattern. The diversity amongst NUTS 3 regions inside the NUTS 2 regions is often quite big. Hence, the pattern on the NUTS 2-based map 11 only highlights the more extreme values.

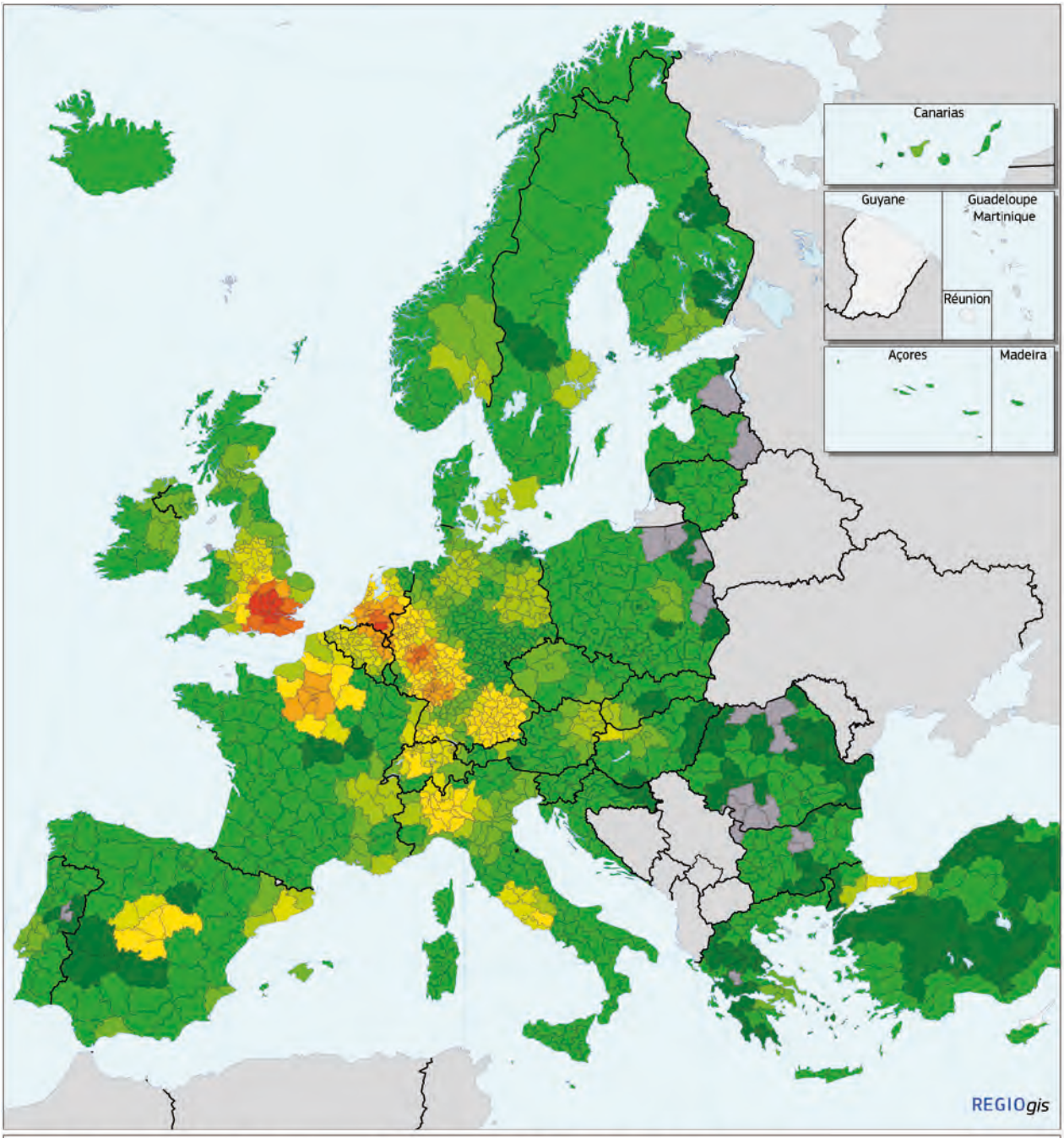
Suggestions for further analysis, and data issues

The current analysis assesses accessibility only in terms of the road network. This analysis could be enhanced if coherent data on railway accessibility could be used, which would require reliable and complete timetable information, usable at European level.

The density of the road network used in the analysis is considered adequate for an EU-wide analysis. Nevertheless, although this network reflects the recent situation on the ground, these data have no precise reference year. Hence, if we create a (short) time series concerning accessible flights, we are actually measuring the differences in flight availability at the airports, because the driving time analysis remains constant over time.

The regional aggregates of the indicators would benefit from an enhanced population distribution grid. Grid data on the registered population are clearly preferable in comparison to modelled top-down downscaling methods. As for the road network, regular updates of the population distribution grid are also important.

Differences over time in airport coding and the presence of partly missing data regarding flights and passengers can lead to distorted results, especially when considering changes over time. Although these coding differences and missing data are relatively rare, special care needs to be taken when interpreting results in areas with a relatively low offer of flights.



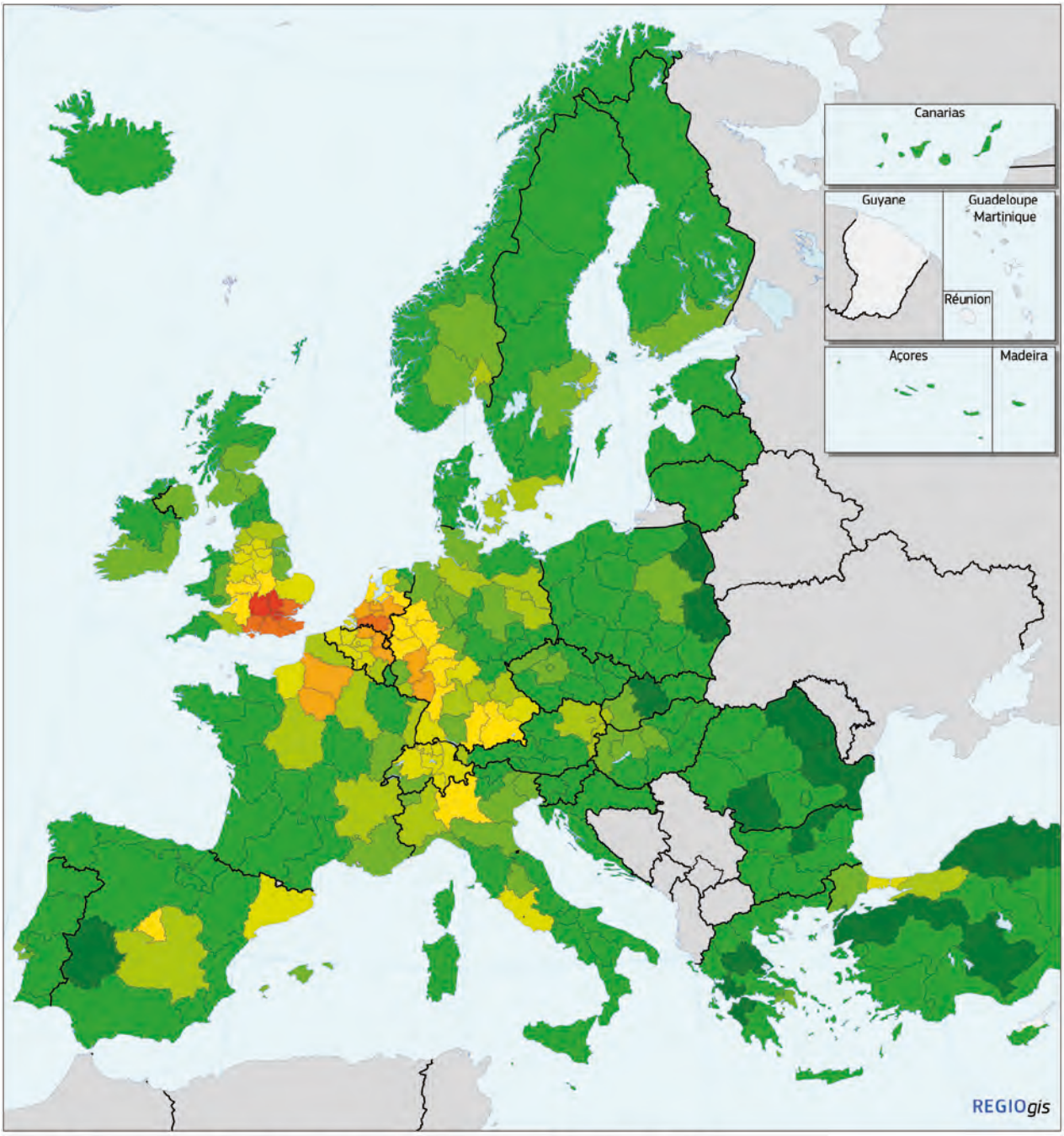
Map 6: Accessibility to passenger flights by NUTS3 region, 2010

Number of passenger flights per day

- travel time to nearest airport > 90min.
- < 10
- 10 - 250
- 250 - 500
- 500 - 750
- 750 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500
- 2500 - 3000
- > 3000
- no data

Population weighted average at NUTS 3 level
Sources: Eurostat, Eurographics, TeleAtlas, JRC, EFGS, LandScan, REGIO-GIS

0 500 Km



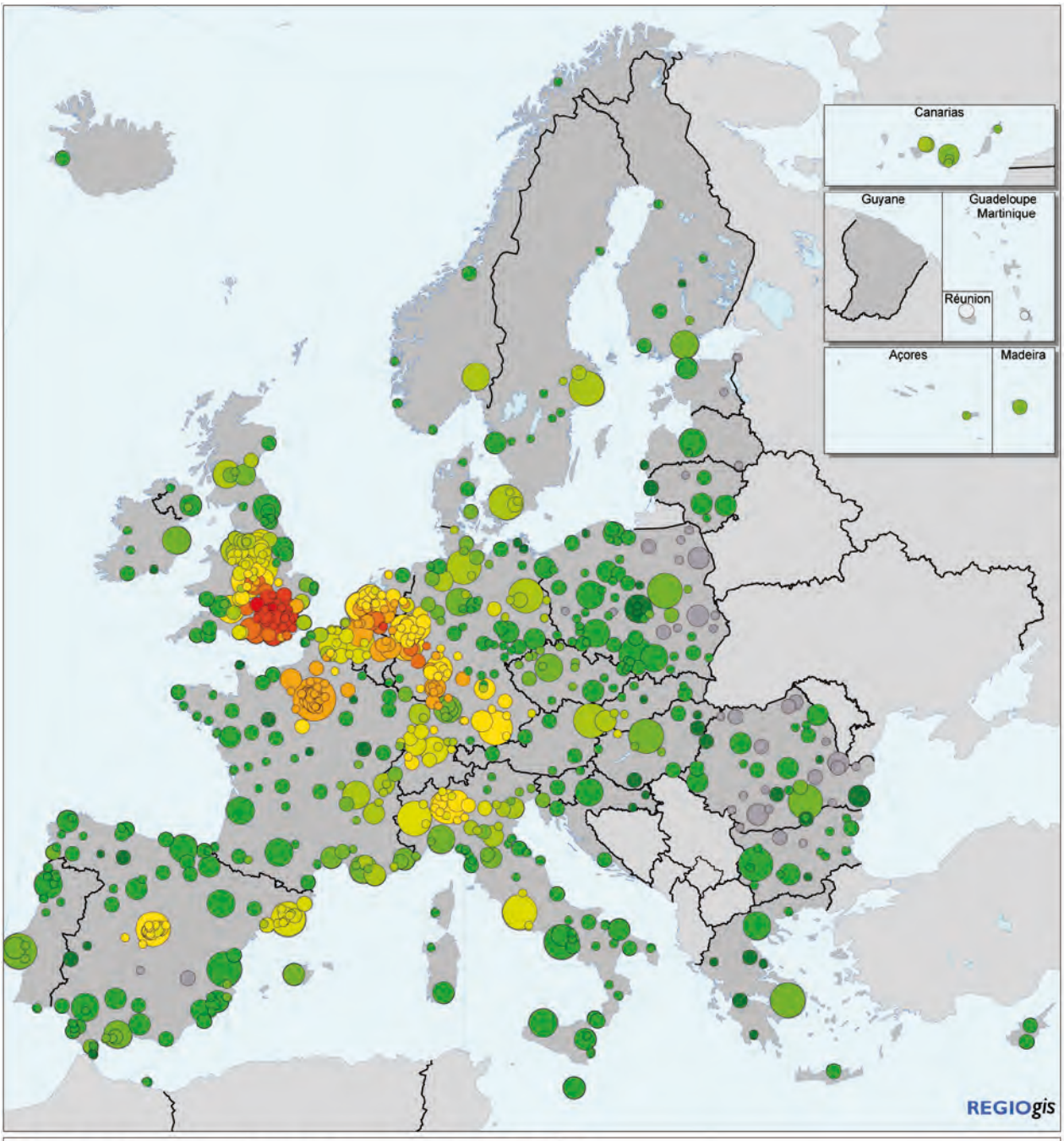
Map 7: Accessibility to passenger flights by NUTS2 region, 2010

Number of passenger flights per day

- travel time to nearest airport > 90min.
- < 10
- 10 - 250
- 250 - 500
- 500 - 750
- 750 - 1000
- 1000 - 1500
- 1500 - 2000
- 2000 - 2500
- 2500 - 3000
- > 3000
- no data

Population weighted average at NUTS 2 level
Sources: Eurostat, EuroGeographics, TeleAtlas, JRC, EFGS, LandScan, REGIO-GIS

0 500 Km



Map 8: Cities: accessibility to passenger flights, 2010

Number of passenger flights per day

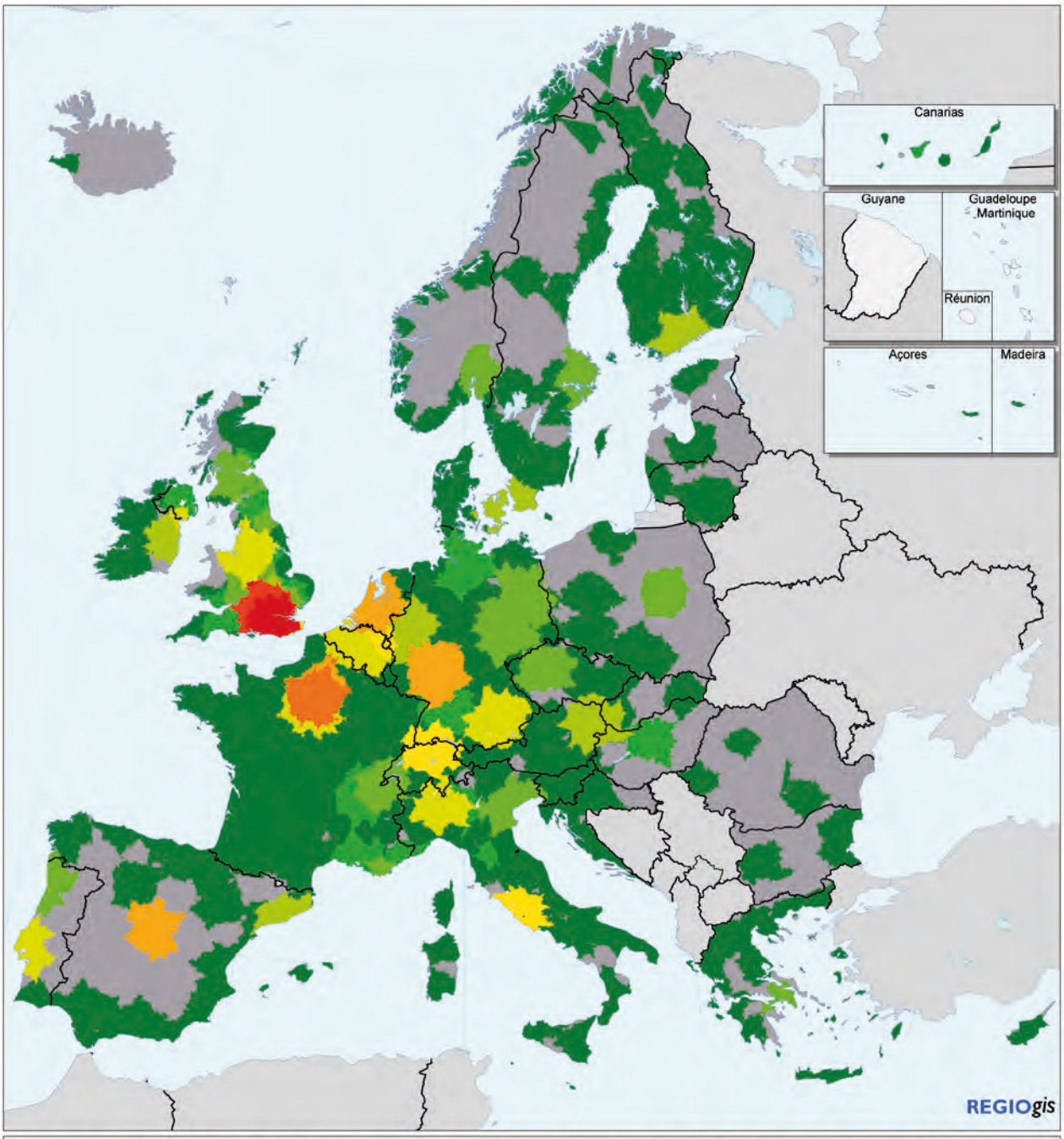
- Travel time > 90'
- 1 - 10
- 11 - 250
- 251 - 500
- 501 - 750
- 751 - 1000
- 1001 - 1500
- 1501 - 2000
- 2001 - 2500
- 2501 - 3000
- > 3000
- No Data

City population

- < 100000
- 100001 - 250000
- 250001 - 500000
- 500001 - 1000000
- 1000001 - 5000000
- > 5000000

Population weighted average number of passenger flights per day, accessible within 90 minutes of travel by road, at the level of cities and greater cities.
Sources: Eurostat, EuroGeographics, TeleAtlas, JRC, EFGS, REGIO-GIS

0 500 Km



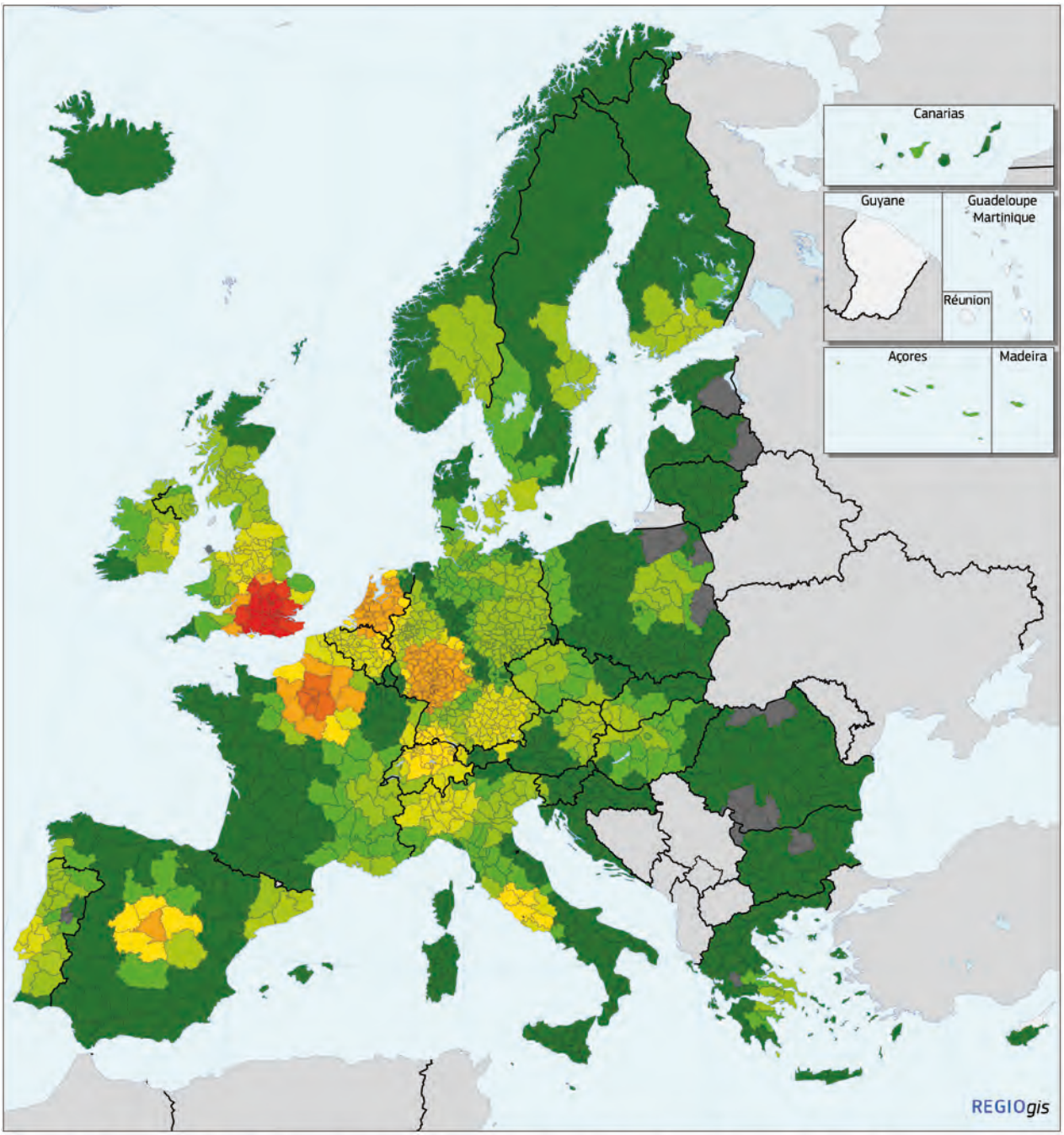
Map 9: Accessibility to long distance passenger flights at main airports, 2010

Cumulated daily number of passenger flights available within 90 minutes of travel by road to main airports

- Travel time to nearest main airport > 90min
- 0
- 1
- 2 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- No Data

Long distance flights: > 5000km
Sources: Eurostat, EuroGeographics, TeleAtlas, REGIO-GIS

0 500 Km



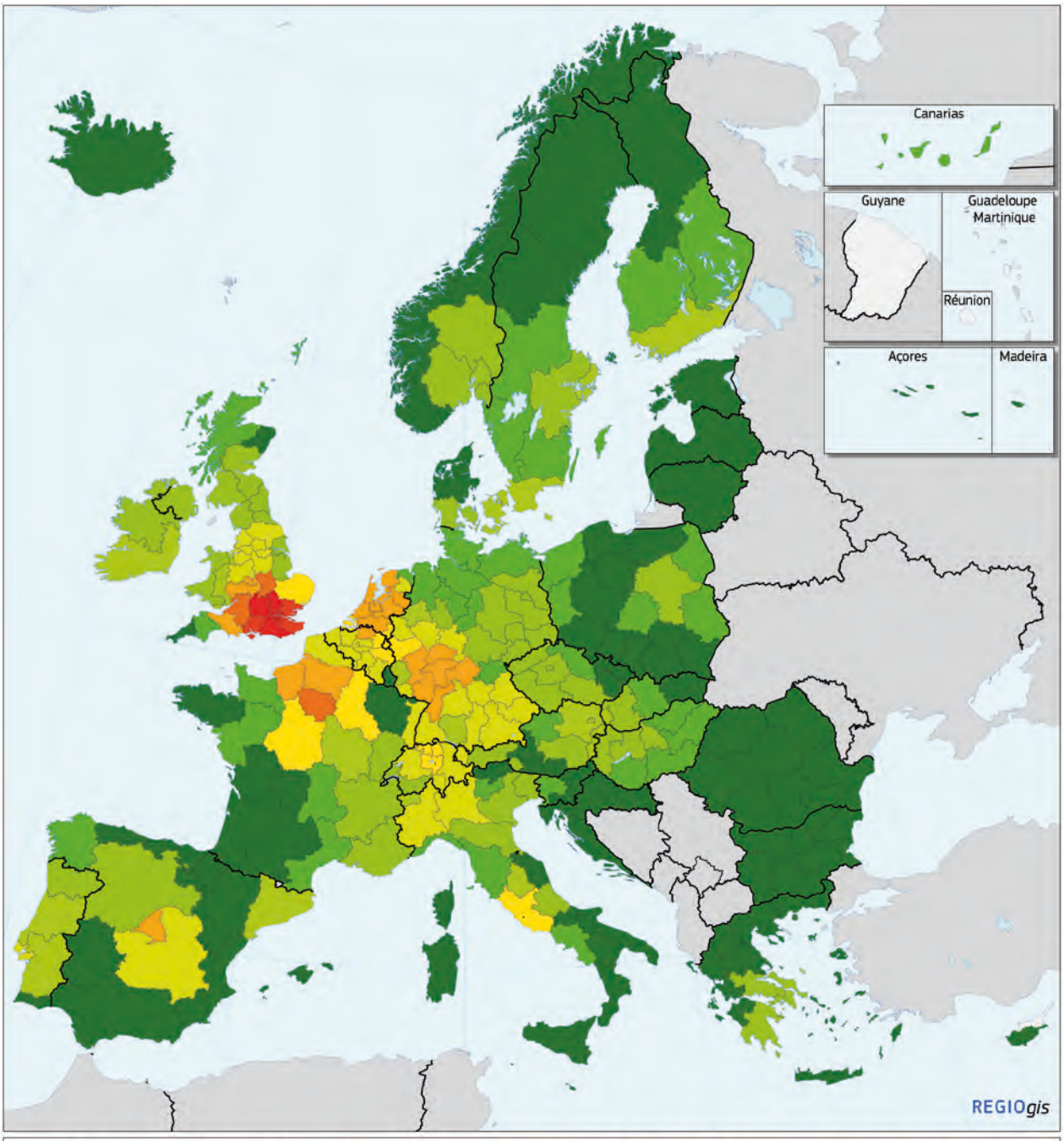
Map 10: Accessibility to long distance passenger flights at main airports (NUTS3 regions), 2010

Number of long-distance passenger flights per day

- travel time to nearest airport > 90 min
- 0
- 1
- 2 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- no data

Population weighted average at NUTS 3 level
Long distance flights: > 5000km
Sources: Eurostat, EuroGeographics, TeleAtlas, JRC, EFGS, REGIO-GIS

0 500 Km



Map 11: Accessibility to long distance passenger flights at main airports (NUTS2 regions), 2010

Number of long-distance passenger flights per day

- travel time to nearest airport > 90 min
- 0
- 1
- 2 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- no data

Population weighted average at NUTS 2 level
Long distance flights: > 5000km
Sources: Eurostat, EuroGeographics, TeleAtlas, JRC, EFGS, REGIO-GIS

0 500 Km

Any questions, comments or contributions should be sent to the following address:
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