Urban/Rural Areas

Population density (from a 1 km^2 grid), land cover and remoteness as basic elements for an urban/rural typology at LAU2 level

(In progress…)

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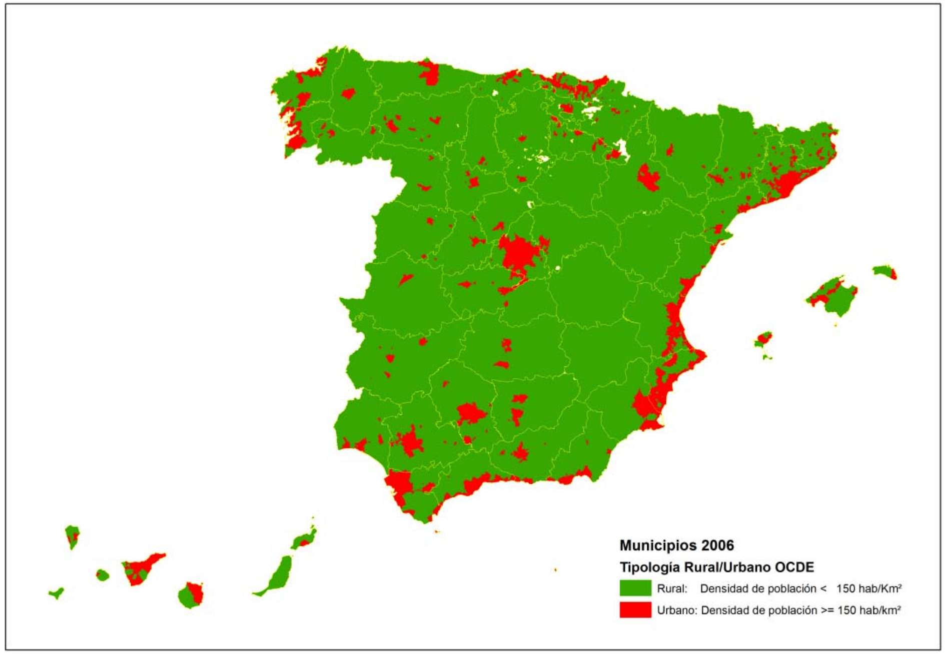
Approaches to define the urban/rural character of communes…

- There is no general agreement on how to classify urban/rural communes… so many classifications rules, typical employed by public bodies and statistical agencies, rely on thresholds in population density, settlement size or a combination of both.
- The old OECD classification rule identify rural communes as those with less than 150 inhab/km^2, or a typical rule used in Spain is to consider urban communes those as having at least 10.000 inhabitants.



OECD criteria: a commune is rural if its population density is lower than 150 inhab./km^2.

Rural LAU2: 87.1% (7,066)

Population: 24.9%

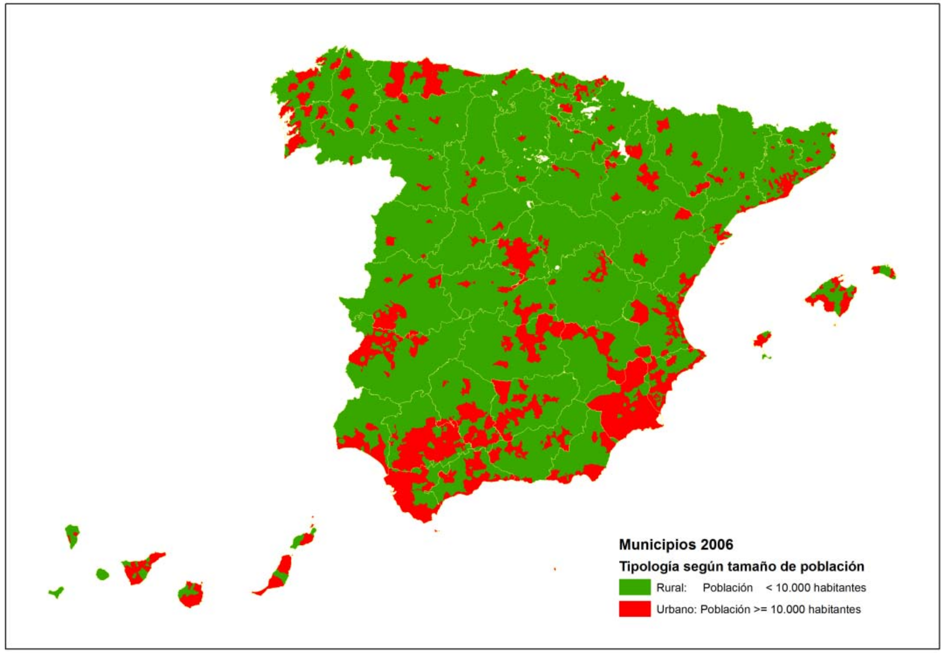
Territory: 91.1%

Minimum population size criteria: a commune is urban if its has at least 10.000 inhabitants, and rural otherwise.

Rural LAU2: 91.2% (7,399)

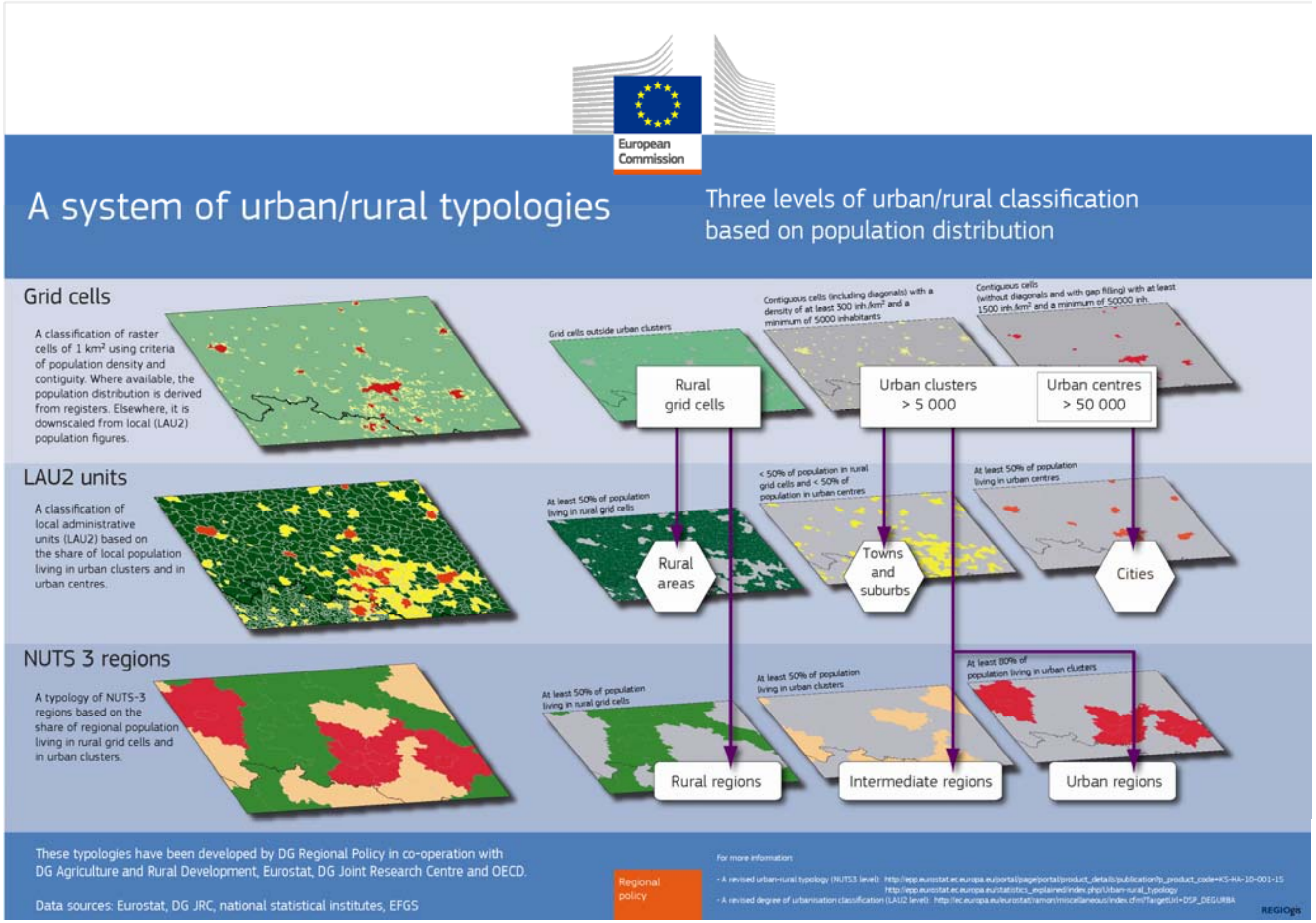
Population: 21.9%

Territory: 80.9%



Demography from a 1-km^2 population grid…

- Recently, a great effort has been done from *Eurostat*, *DG-Regio* and the OECD in order to define a consistent system of urban/rural typologies that starts from a 1 km^2 population grid.



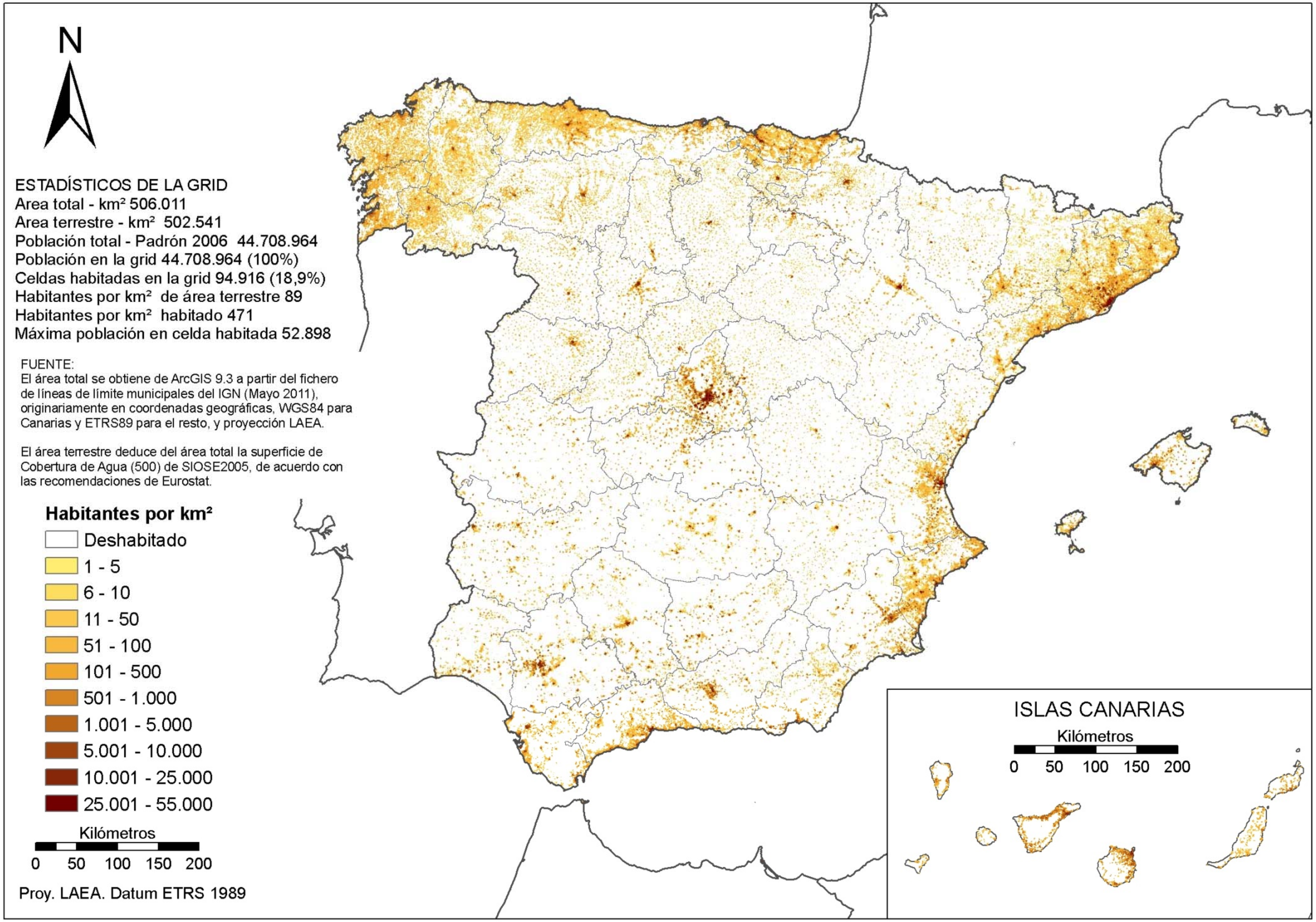
The key element is to distinguish between urban and rural cells.

Urban and rural cells…

- The three key concepts are:

1. **Rural cells**: Grid cells outside urban clusters. Rural grid cells can be inhabited or not.
2. **Urban clusters**: Clusters of contiguous, including diagonals, grid cells of 1 km^2 with a density of at least 300 inhabitants per km^2 and a minimum population of 5,000 inhabitants.
3. **Urban centers or High density clusters (city center)**: Clusters of contiguous, excluding diagonals but filling gaps, grid cells of 1 km^2 with a density of at least 1,500 inhabitants per km^2 and a minimum population of 50,000 inhabitants.

The grid…


N
ESTADÍSTICOS DE LA GRID
Area total - km² 506.011
Area terrestre - km² 502.541
Población total - Padrón 2006 44.708.964
Población en la grid 44.708.964 (100%)
Celdas habitadas en la grid 94.916 (18,9%)
Habitantes por km² de área terrestre 89
Habitantes por km² habitado 471
Máxima población en celda habitada 52.898
FUENTE:
El área total se obtiene de ArcGIS 9.3 a partir del fichero de líneas de límite municipales del IGN (Mayo 2011), originariamente en coordenadas geográficas, WGS84 para Canarias y ETRS89 para el resto, y proyección LAEA.
El área terrestre deduce del área total la superficie de Cobertura de Agua (500) de SIOSE2005, de acuerdo con las recomendaciones de Eurostat.
Habitantes por km²
Deshabitado
1 - 5
6 - 10
11 - 50
51 - 100
101 - 500
501 - 1.000
1.001 - 5.000
5.001 - 10.000
10.001 - 25.000
25.001 - 55.000
Kilómetros
0 50 100 150 200
Proy. LAEA. Datum ETRS 1989
ISLAS CANARIAS
Kilómetros
0 50 100 150 200

…the rural/urban cells…

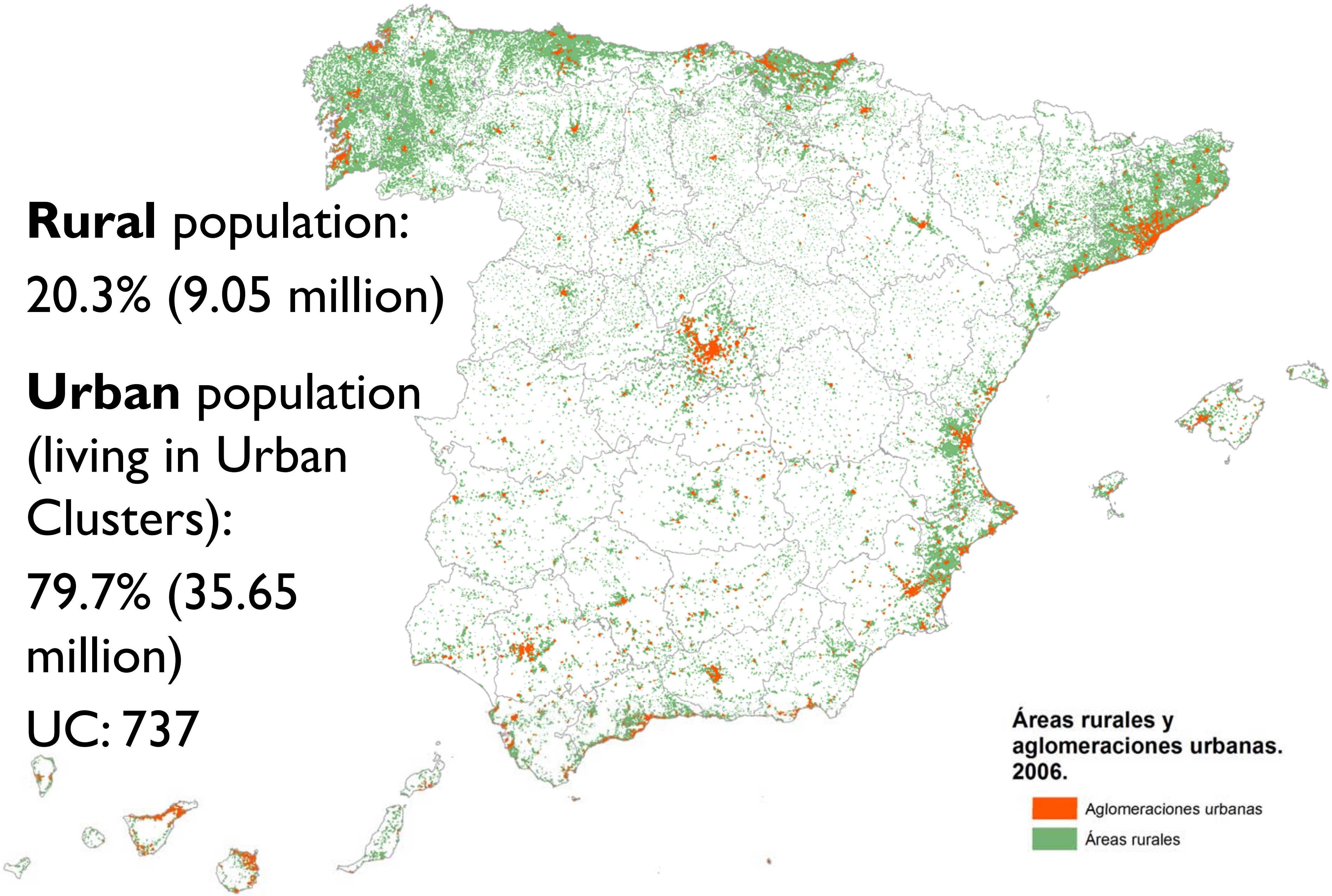
Rural population:

20.3% (9.05 million)

Urban population (living in Urban Clusters):

79.7% (35.65 million)

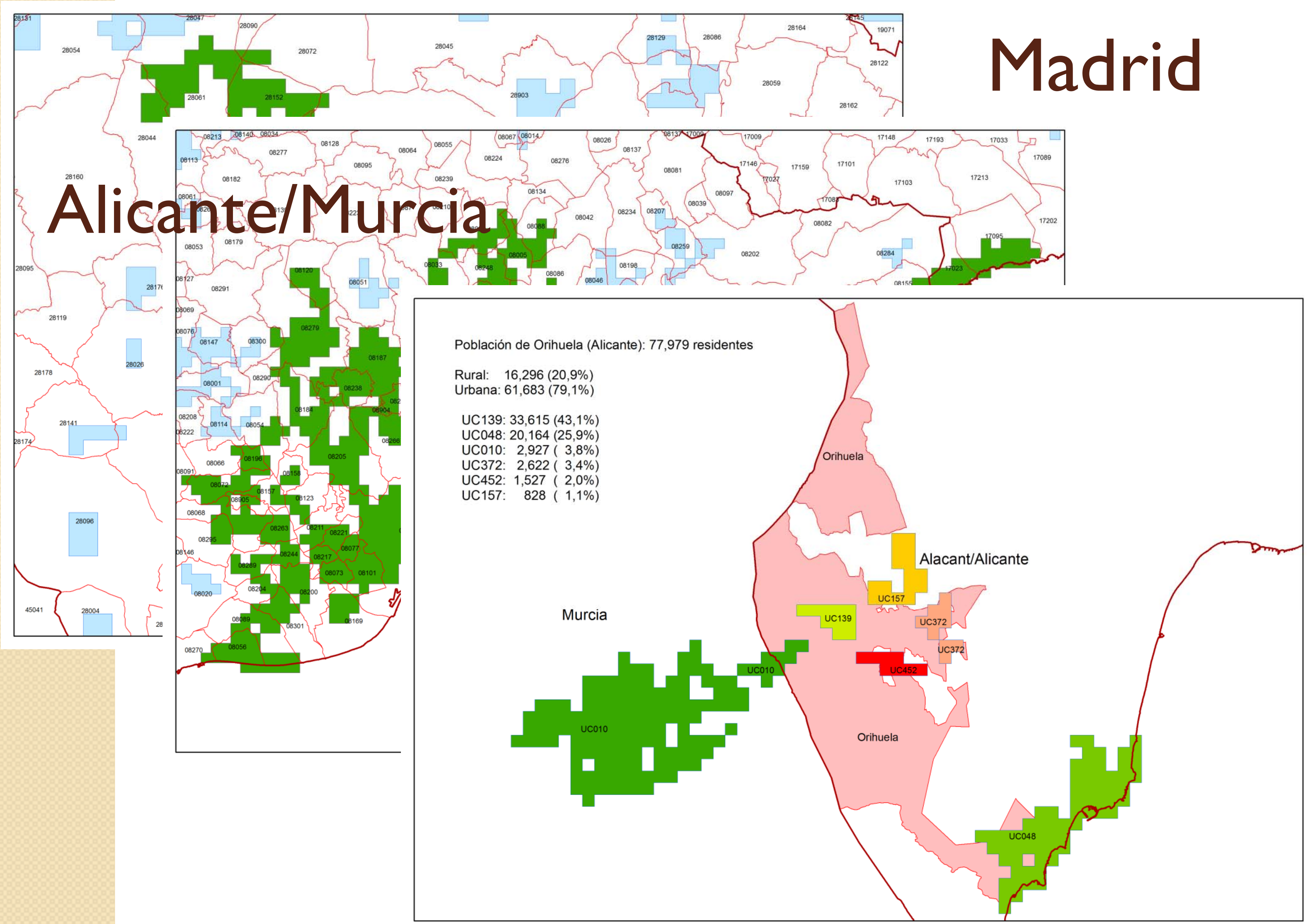
UC: 737



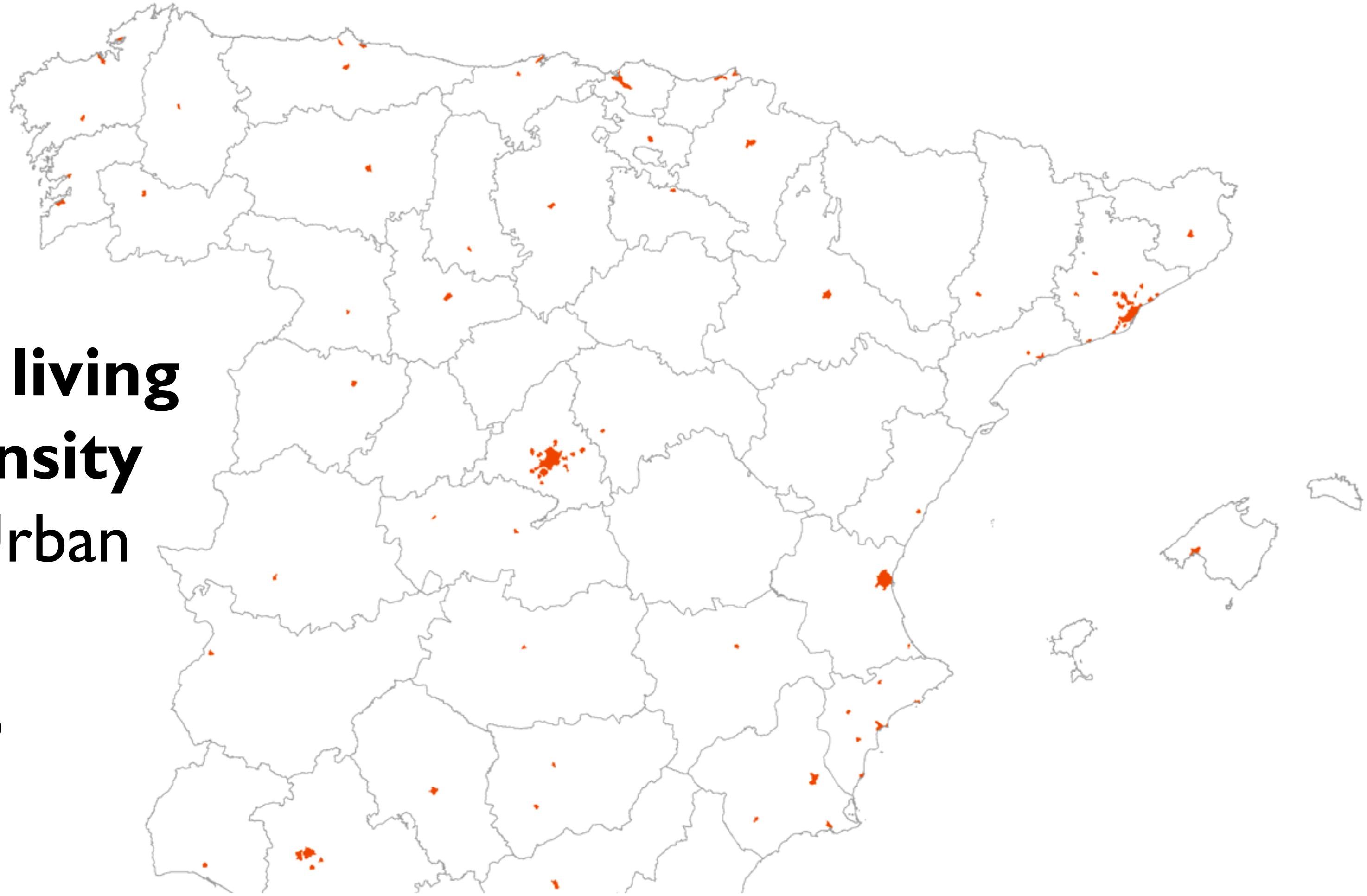
Some Urban Clusters…

Madrid

Alicante/Murcia



…and the high density clusters.



Population living in High Density Clusters (Urban Centers):

50.0% (22.35 million)

HDC: 105

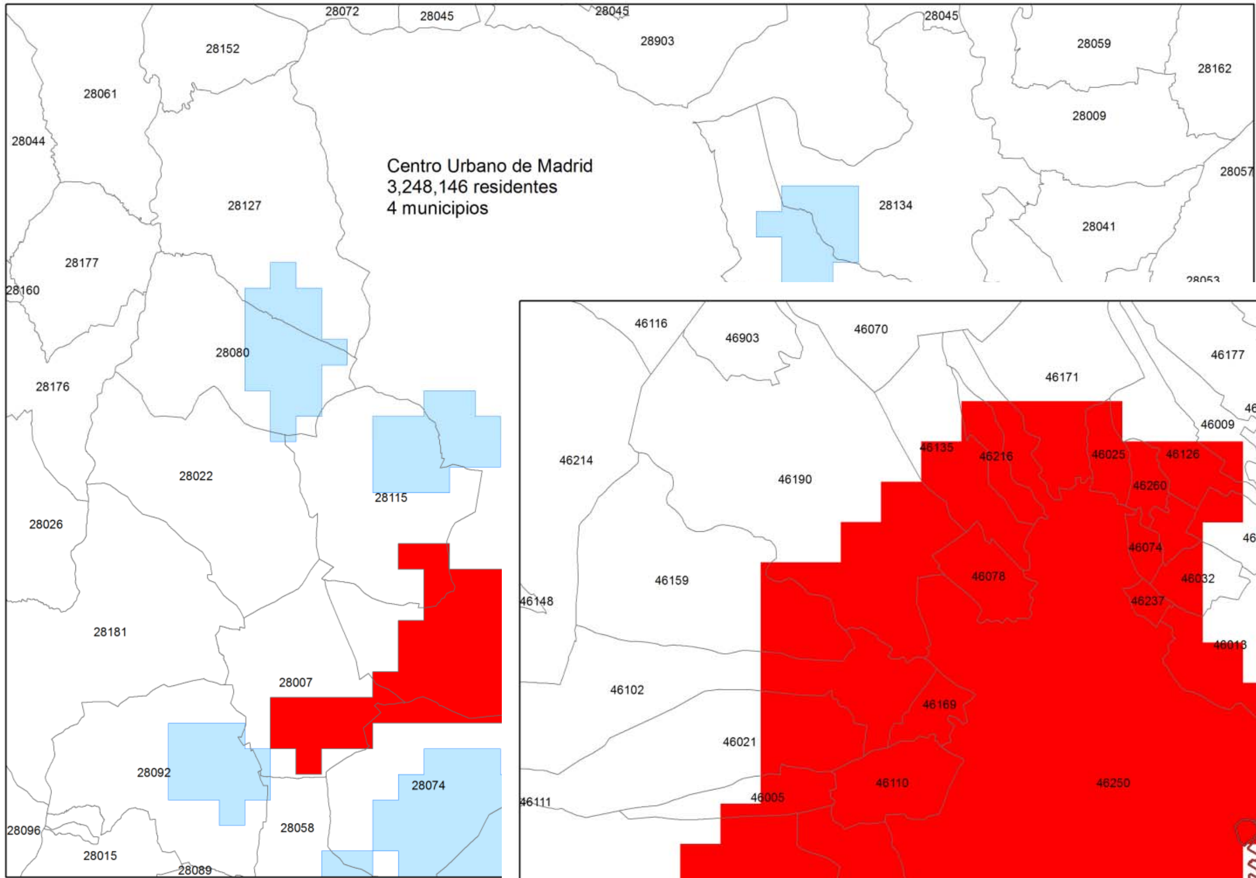
Table 1. Population distribution acording to the types of cells amd number of clusters.

	Cells		Population		Clusters	LAU2
	Number	%	People	%		Support
Rural Areas	84,449	89.0%	9,054,928	20.3%		
Urban clusters (UC)	10,467	11.0%	35,654,036	79.7%	737	1,493
Total	**94,916**	**100.0%**	**44,708,964**	**100.0%**		
Urban Centers (HDC)	2,463	2.6%	22,348,890	50.0%	105	287

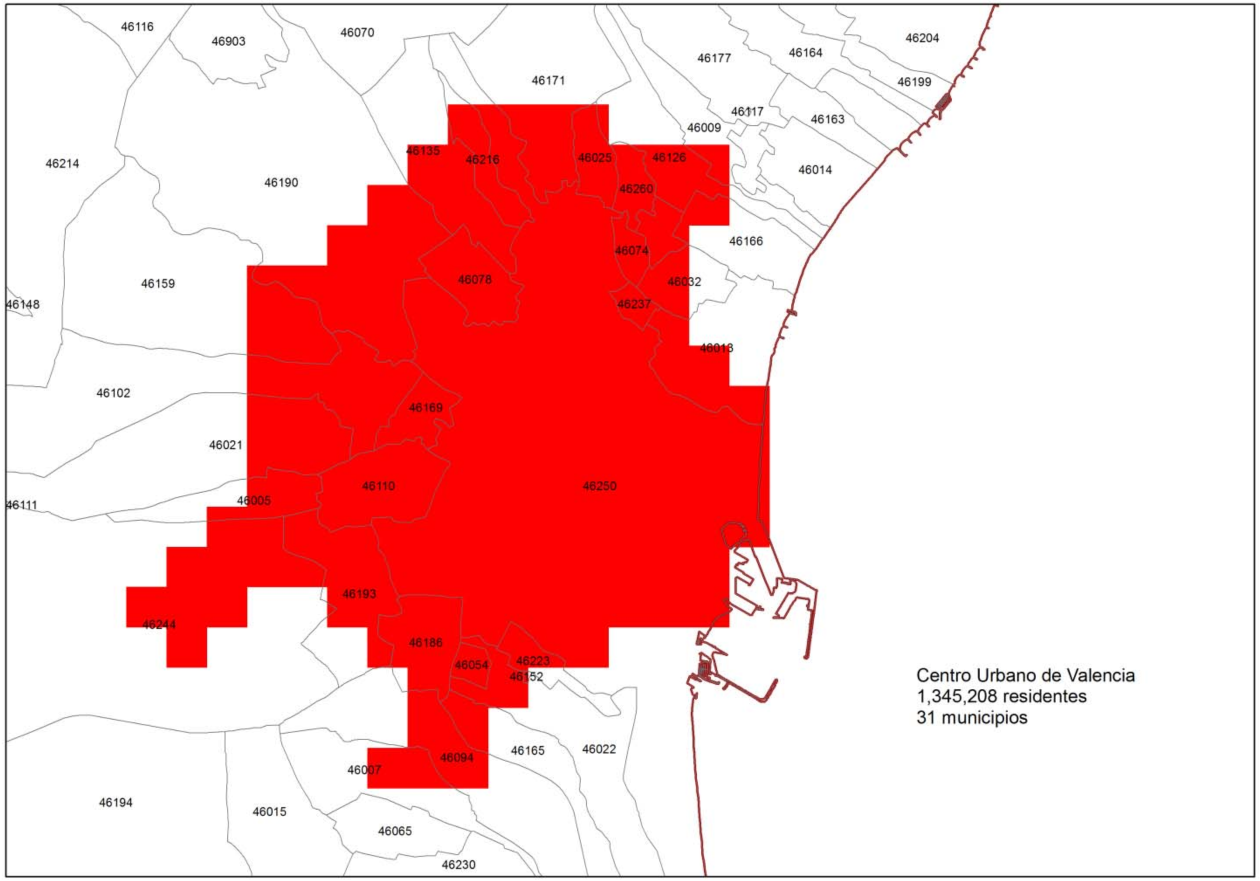
Source: Own elaboration.

Some High Density Clusters…

Madrid



Valencia



From urban/rural cells to urban/rural communes…

- The rules are based on the share of population living in rural cells and the different type of clusters

1. **Rural commune (area) or thinly populated area**, if at least 50% of the population lives in rural grid cells.
2. **Small urban commune (area), towns and suburbs or intermediate density area**, if less than 50% of the population lives in rural grid cells and less than 50% of the population lives in high density clusters.
3. **Large urban commune (area), cities or densely populated area**, if at least 50% of the population lives in high density clusters.

Commune Urban/Rural typology

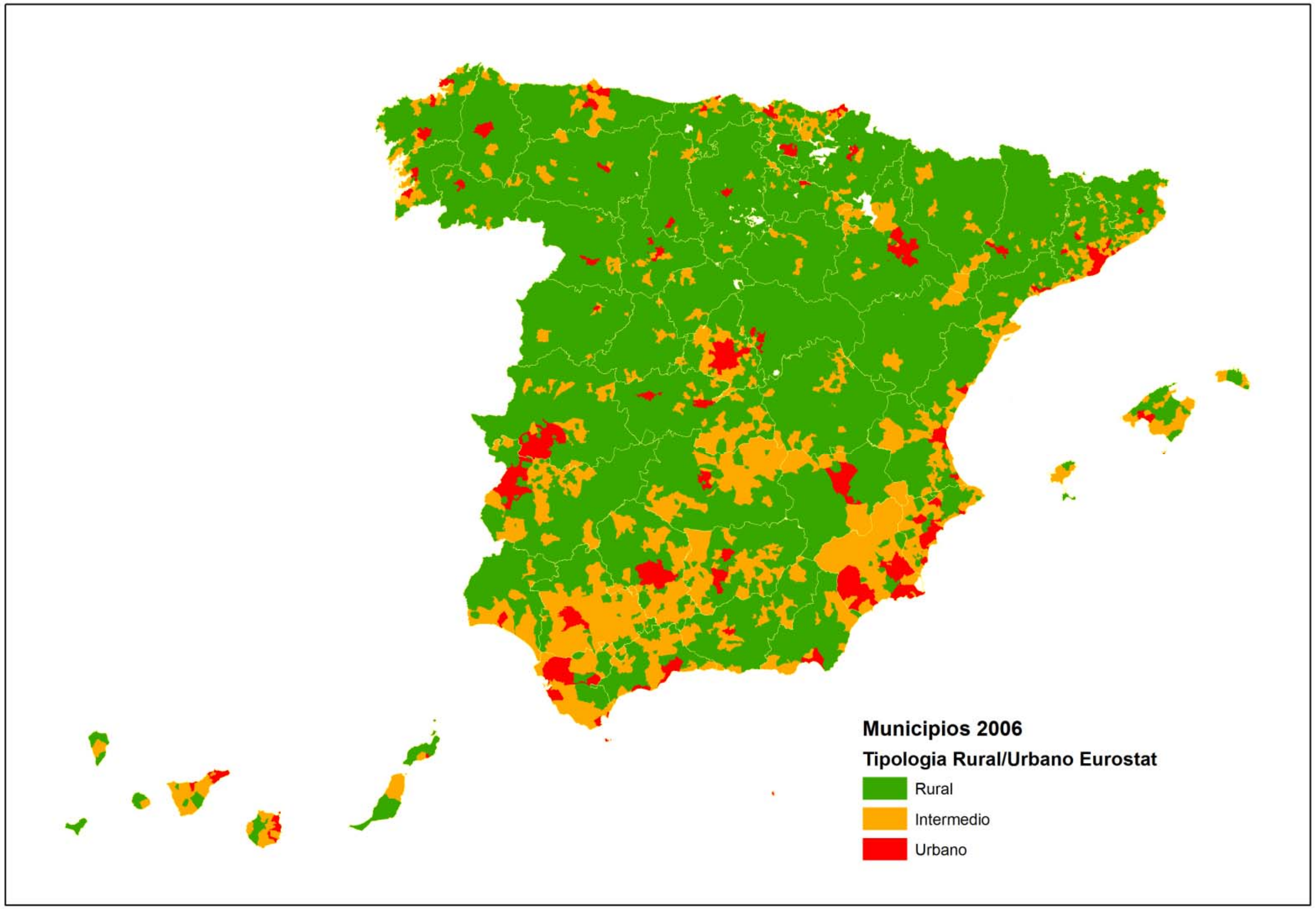


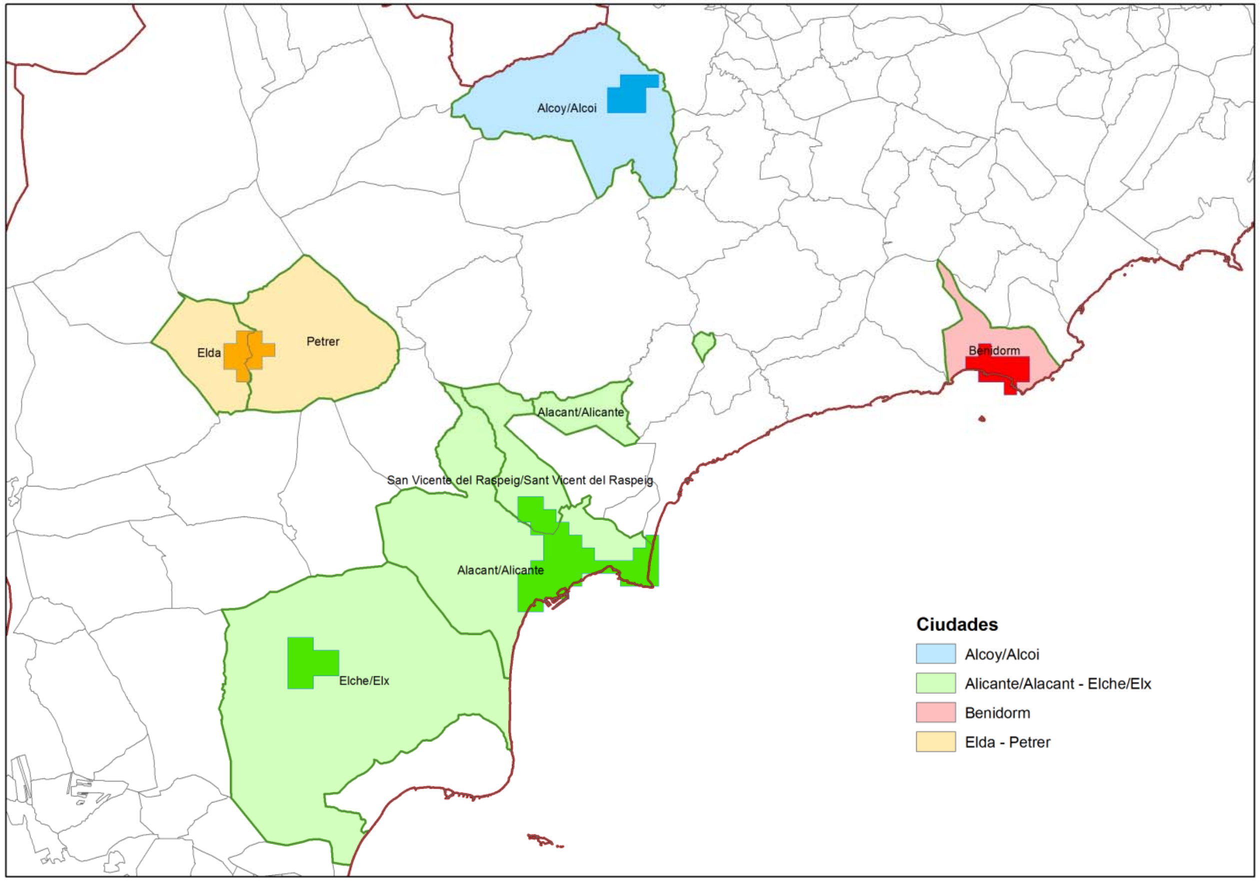
Table 2. LAU2 Typology from the Urban/Rural grid cells: Communes, population distribution within the commune and surface.

Typology	Communes		Total Population		Superface	
	Number	%	Total	Total (%)	Km²	Km² (%)
Urban	220	2.7%	24,002,578	53.7%	22,975	4.6%
Intermediate	1,025	12.6%	13,635,414	30.5%	100,068	19.8%
Rural	6,865	84.6%	7,070,972	15.8%	381,544	75.6%
Total	**8,110**	**100.0%**	**44,708,964**	**100.0%**	**504,587**	**100.0%**

Source: Own elaboration.

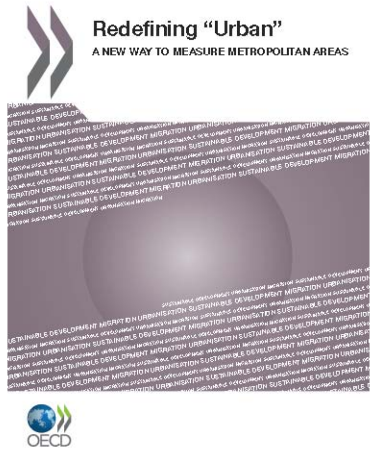
Administrative cities…

- Because LAU2 administrative boundaries are too restrictive to identify directly urban communes with the wider concept of a city, we also define **administrative cities** as **contiguous urban communes.**



Administrative cities…

- As a result: **105 high density clusters** (50.0% of population) determine **220 urban or high density populated communes** (53.7% of population), which in turn are mapped into **70 administrative cities**.
- This is similar (but not identical!), to the current definition used by the *DG-Regio* and the OECD.



- We don’t have data (yet!) on commuting, so this is not taken into account.
- Cities will be important when introducing accessibility.

Some Administrative Cities…

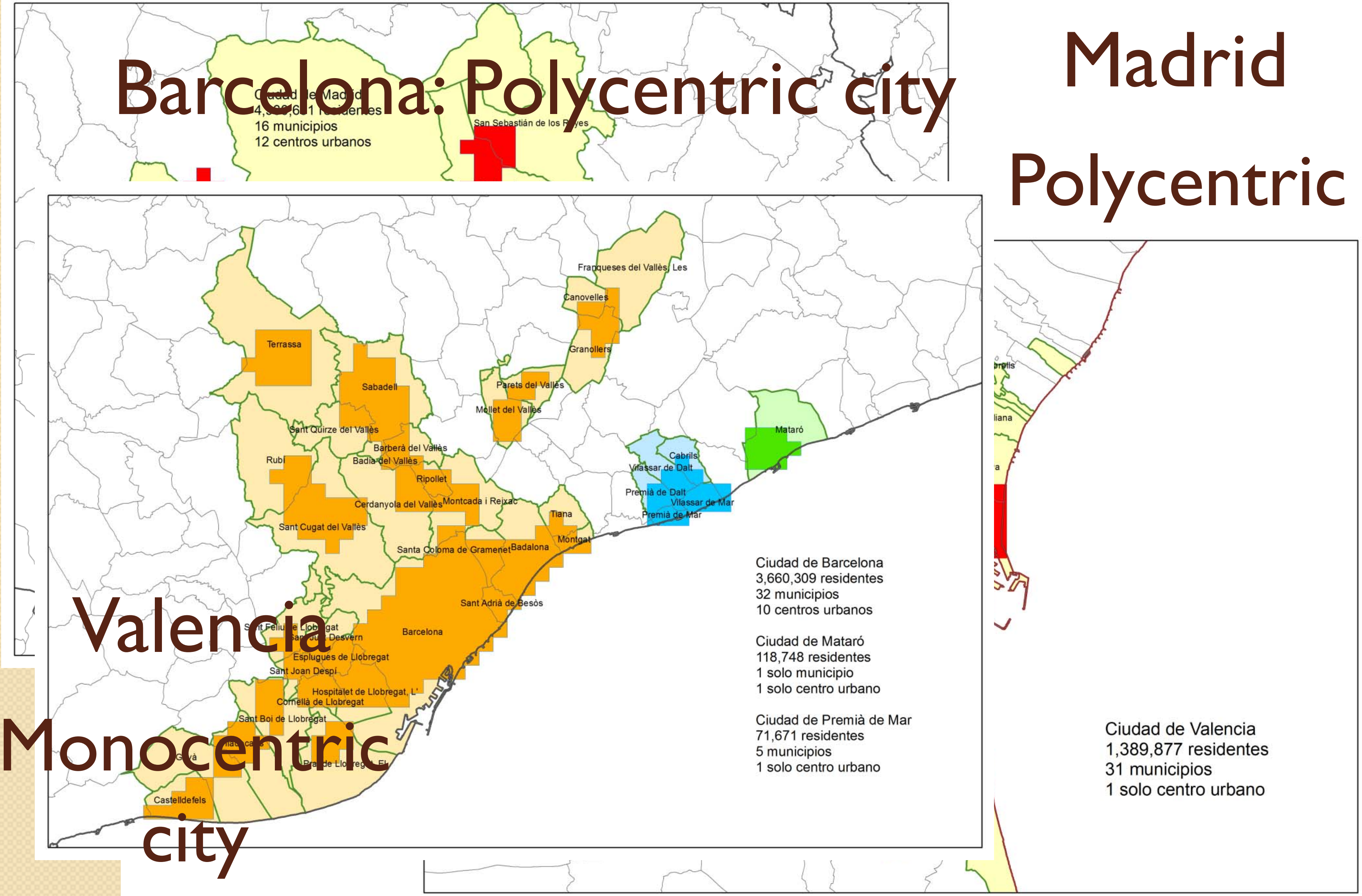
Madrid

Polycentric

Barcelona: Polycentric city

Valencia

Monocentric city



Urban/Rural Typology from a 1-km^2 population grid.

- This urban/rural typology from a 1-km^2 is currently in used by Eurostat/DG-Regio, and it is being implemented in EU-SILC and LFS.
- In fact it has already been implemented in Spain by INE in the Household Budget Survey, so we can look at some socio-economic indicators:

Table 3. Economic indicators by Rural/Urban Typology based on population clusters

	Spain	Typology		
		Urban	Intermediate	Rural
Income Per capita	8,821 €	9,594 €	8,526 €	7,562 €
Gini Index (Inequality)	33.2%	33.1%	32.5%	32.4%
Poverty Index (Head count)	20.0%	17.1%	20.1%	25.7%

Source: Own elaboration from Spanish HBS 2011

- **Main drawback**: This typology takes into account only the demographic factor, population density, but it is free from commune size administrative boundaries.

Extending the Urban/Rural Typology taking into account other factors…

- Population pressure is only one aspect of the urban/rural landscape: It is a proxy for rural/urban influence.
- However, urban/rural typologies should take into account the **degree of human intervention of the landscape**, that can be proxied by the share of artificial surfaces/build-up areas in land cover.
- And this can be measured using land cover information without any reference to population.
- **Define**: "**open space**" as *agricultural*, *forest*, *natural areas*, *wetlands* and *inland water*, and "**close space**" as built-up areas: *artificial surfaces*, including reservoirs.

Open/Closed space LAU2´s…

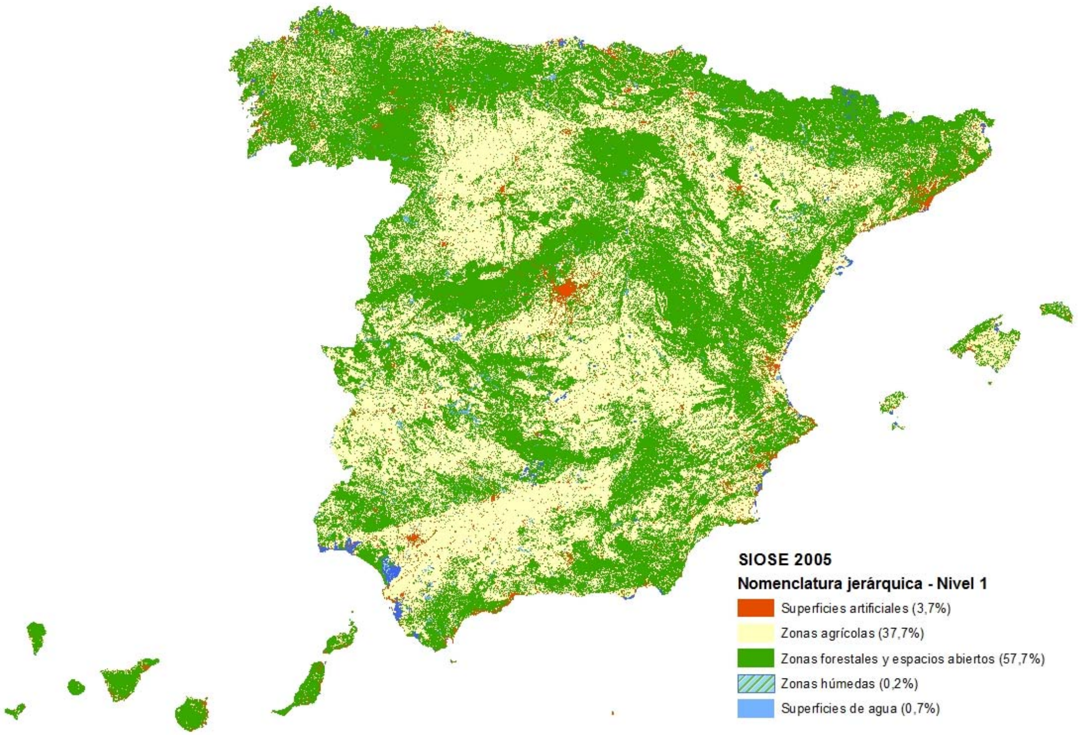
- The communes are classified according to their share of artificial surfaces using the following rules:

1. **Open space commune** if at least 90% of its surface is "open space". At the most its artificial surface account for 10% of its total surface.
2. **Intermediate commune** if its surface of "open space" is at least 75%, but lower than 90%. Its artificial surface is more than 10%, but at the most is 25%.
3. **Close space commune** if more than 25% of its surface is "closed space", this is artificial surface. Less than 75% of its surface is "open space".

SIOSE: The land cover data set.

- We use a national high resolution land cover data set: **SIOSE**: Minimum Mapping Unit for artificial areas of 1 ha.
- The process is very simple:

1. Overlay the land cover data set with LAU2 boundaries.



2. Reclassify the land cover classes into “open” and “closed” spaces.
3. Recalculate surfaces, and determine the corresponding shares.

Open/Closed space LAU2´s…

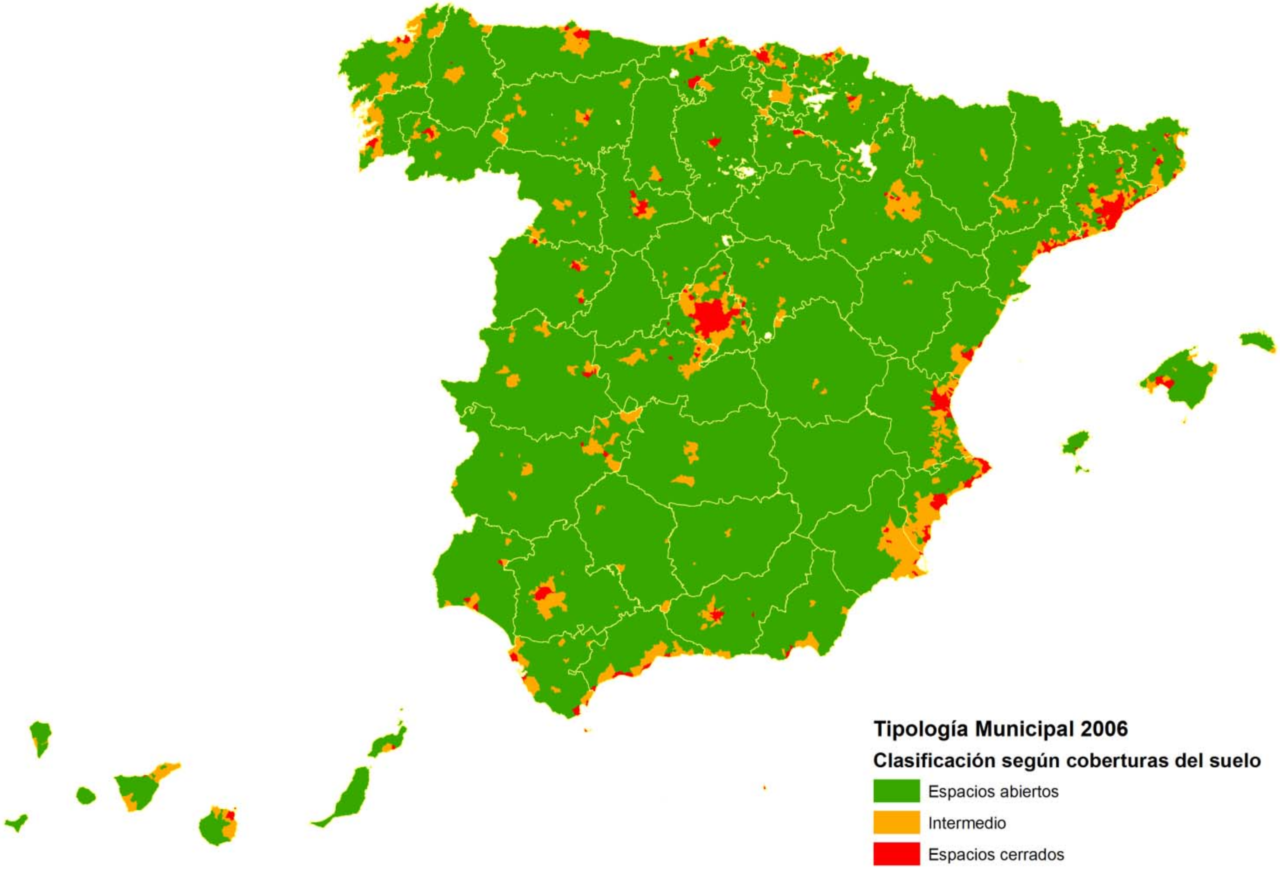


Table 4 Commune typology using land cover information.

	Communes		Population		Surface	
Typology	Number	%	Inhabitants	%	Km²	%
Closed space	351	4.3%	19,857,972	44.4%	8,425	1.7%
Intermediate space	779	9.6%	11,069,746	24.8%	34,243	6.8%
Open space	6,980	86.1%	13,781,246	30.8%	461,920	91.5%
Total general	**8,110**	**100.0%**	**44,708,964**	**100.0%**	**504,587**	**100.0%**

Source: Own elaboration.

Crossing the typologies…

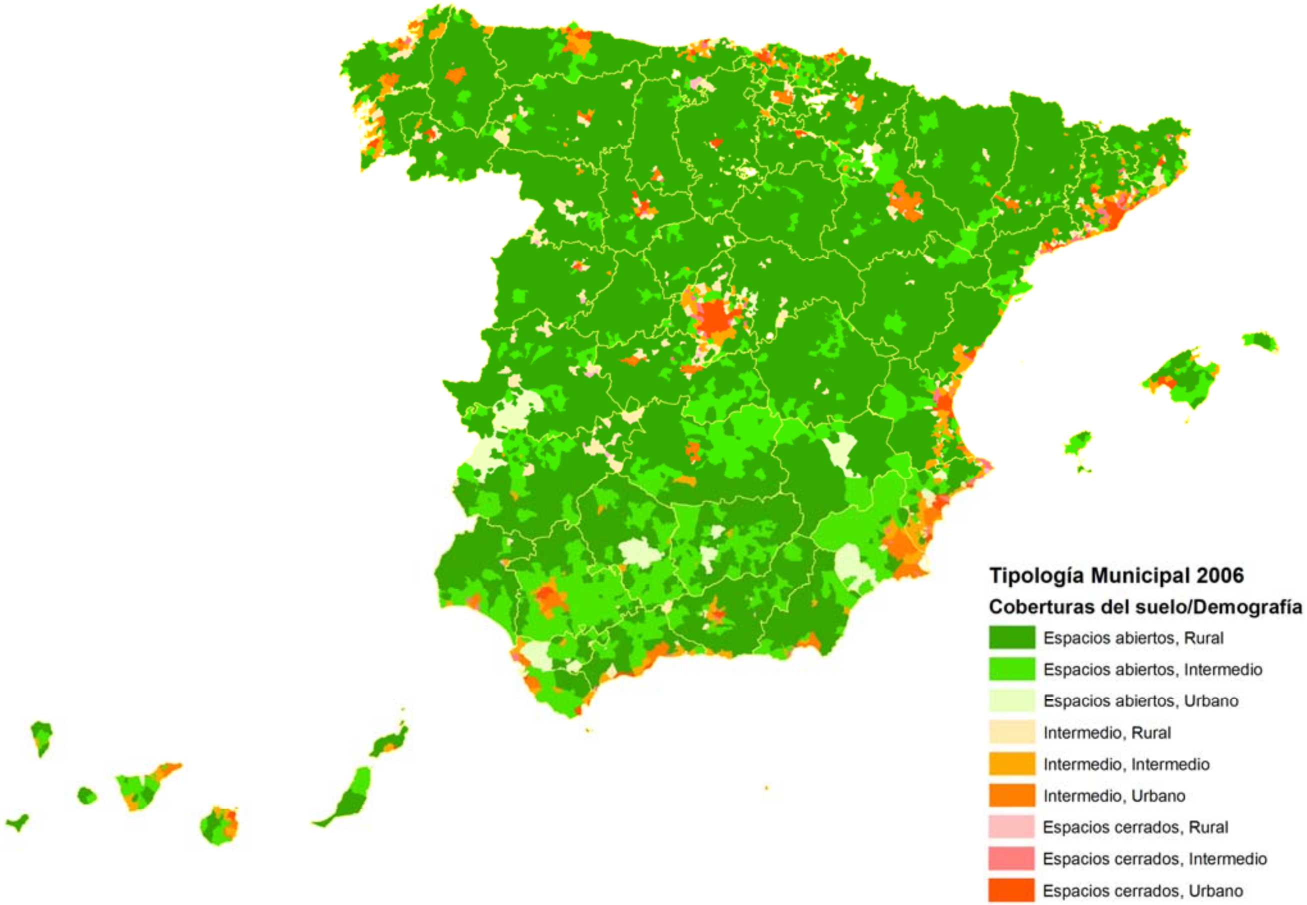


Table 5 Commune typology from Urban Clusters and Land Cover

Urban Clusters (Demography)	Land Cover: Closed space Number	%	Intermediate space Number	%	Open space Number	%	Total Number	%
Urban	148	1.8%	55	0.7%	17	0.2%	220	2.7%
Intermediate	171	2.1%	376	4.6%	478	5.9%	1,025	12.6%
Rural	32	0.4%	348	4.3%	6,485	80.0%	6,865	84.6%
Total	**351**	**4.3%**	**779**	**9.6%**	**6,980**	**86.1%**	**8,110**	**100.0%**

Crossing the typologies…

- We find that 80% of communes are Rural/Open, against less than 2% Urban/Closed, but in terms of population the importance is reversed: 39% of population live in Urban/Closed against 14% in Rural/Open communes.

- As expected, we have more diversity in intermediate communes from both perspectives.

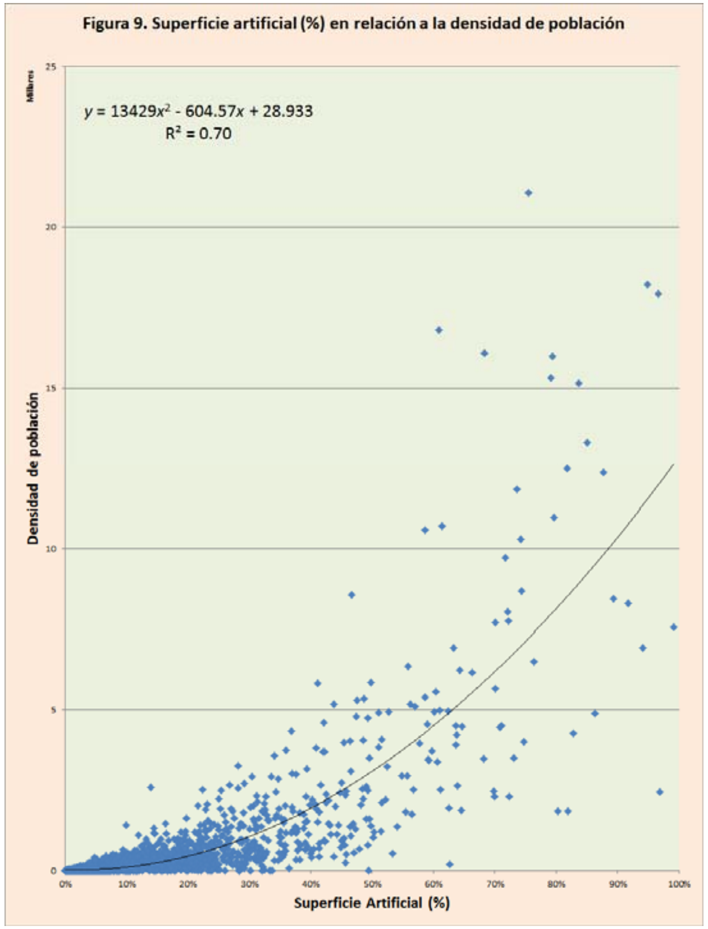
Table 6 Population in commune typology from Urban Clusters and Land Cover

Urban Clusters (Demography)	Land Cover							
	Closed space		Intermediate space		Open space		Total	
	Inhabitants	%	Inhabitants	%	Inhabitants	%	Inhabitants	%
Urban	17,507,765	39.2%	5,007,128	11.2%	1,487,685	3.3%	24,002,578	53.7%
Intermediate	2,285,234	5.1%	5,252,111	11.7%	6,098,069	13.6%	13,635,414	30.5%
Rural	64,973	0.1%	810,507	1.8%	6,195,492	13.9%	7,070,972	15.8%
Total	**19,857,972**	**44.4%**	**11,069,746**	**24.8%**	**13,781,246**	**30.8%**	**44,708,964**	**100.0%**

Source: Own elaboration.

Population density *versus* built-up areas…

- We can see that 94% of Rural communes are classified as "Open space", which indicates a high relationship between demographic density and built-up areas (correlation coefficient 0.73).
- This relationship is far from linear. Non-linearity is clear for Intermediate and Urban communes.
- The natural conclusion is that "population pressure" and "human intervention" play a different role in urban/rural relationships, which is specially true in "non-Rural"/"non-Open space" communes.



Accessibility as a differential factor among Rural Areas.

- As a discriminating factor among rural areas we study its accessibility to cities.
- From the set of accessibility indicators we choose (for the time being) "travel time", but are in the process of extending the indicators, the transport modes and the type of analysis.
- **Main drawback**: GIS network data is scarce and of very bad quality, specially the data sets coming directly from the *National Geographical Institute* (IGN).
- We were forced to restrict the calculations to the road network, and a lot of time was devoted to create the "Network Dataset" (ND) at the required level of detail.

The “Network Dataset”…

- We experimented with 3 different data sets:

1. **Official topographic maps** (IGN, *vector format*): BCN200, scale 1:200.000.
   Advantages: Official data. **Disadvantages**: scale, broken network at many point and incomplete data.

2. **Open Street Maps** (OSM, vector format):
   Advantages: ArcGIS editor. ArcGIS Editor for OpenStreetMap
   Continuous updating, information increasing rapidly.
   Disadvantages: not official data, reference date unknown, quality uneven.

OpenStreetMap
The Free Wiki World Map

3. **Google´s API´s** (not GIS data):
   Advantages: Numeric data, continuous updating.
   Disadvantages: not official data, reference date unknown, quality uneven, queries limited by Google.

Google Developers

Google Maps API

- Introduction
- Directions API
- Distance Matrix API
- Elevation API
- Geocoding API
- Time Zone API

The "Network Dataset"…

- Eventually we used OSM, even if we were reluctant to used non-official data.
- **Conclusion**: Open source free geographical data poses a lot of pressure to official mapping agencies.
- Travel speed limits are defined for:

1. **Motorway**: 120 Km/h.
2. **Trunk road**: 110 Km/h.
3. **Primary road**: 90 Km/h.
4. **Secondary road**: 70 Km/h.
5. **Slip road**: 70 Km/h.
6. **Local, tertiary, residential & living streets**: 50 Km/h.

- These speed limits are adjusted by slope and congestion in cities.

The "Network Dataset"…

- Travel time (in minutes) is calculated as:

$$Travel\_Time = \frac{Shape\_length * Slope\_index * Congestion\_index}{Speed\_limit * \frac{1000}{60}}$$

  Shape_length in meters and *Speed_limit* in Km/h.

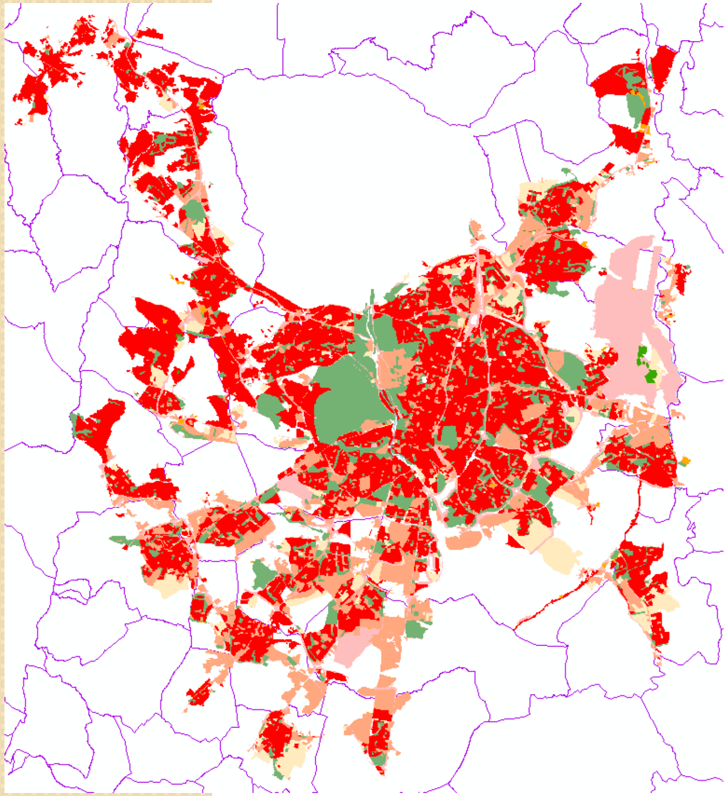
- Travel time is affected by relief: the **slope** gradient on each road segment was derived from a Digital Elevation Model (DEM): NASA Shuttle Radar Topographic Mission (**SRTM**).
- Also, because our dataset is quite detailed, **tunnel segments** were also taken into account, to avoid outliers in the slope index. In these cases, the *Slope_index* was substituted by a *Tunnel_index* in the previous formula.

The "Network Dataset"…

- Travel time (in minutes) is calculated as:

$$Travel\_Time = \frac{Shape\_length * Slope\_index * Congestion\_index}{Speed\_limit * \frac{1000}{60}}$$

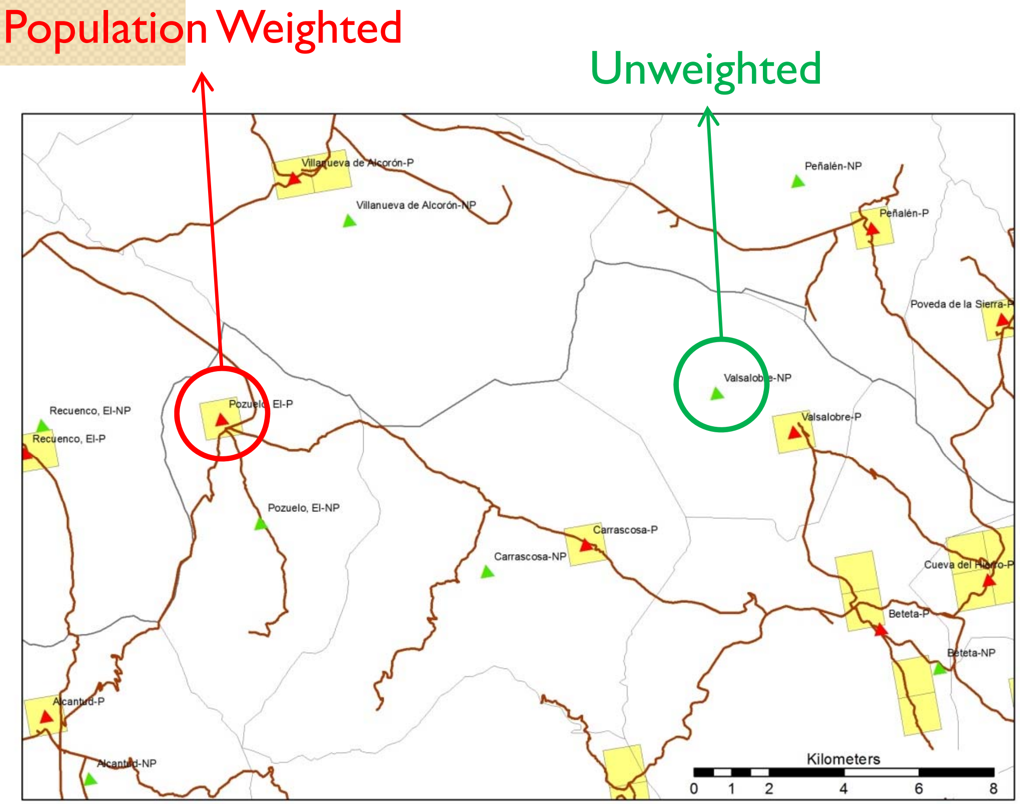
Shape_length in meters and *Speed_limit* in Km/h.



- Congestion also affects travel time. The *Congestion_index* is defined when roads overlay with Urban Morphological Zones (**UMZ**), defined as "*A set of urban areas laying less than 200 m apart*".
- Those **UMZ** were obtained by us in a previous study from **SIOSE** land cover data set.

The "OD travel time matrix"…

- Given the ND data set, the next step is to construct the Origin-Destination (**OD**) matrix by defining origins and destinations.
- **Origin**: LAU2 (8,110). **Population weighted** (with the 1 km^2 grid) **centroids** of local units.



Population weighting matters a lot in rural areas in order to locate people of local units at a single point.

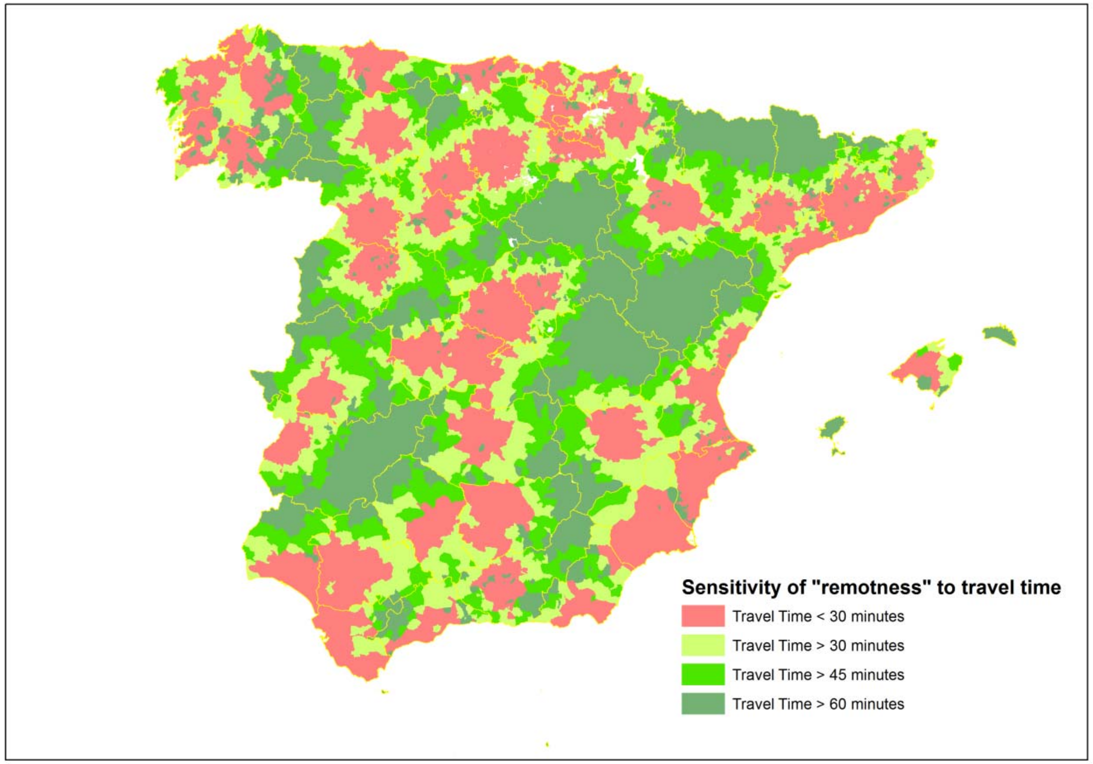
Roads are frequently quite far from geometric centroids, but they always cross populated cells.

The "OD travel time matrix"…

- **Destinations**: Urban Centers (HDC, 105). They are the core in the determination of densely populated communes (220), which in turn aggregate to cities (70). **Population weighted** (with the 1 km^2 grid) **centroids** of HDC, even weighting is not now very important.
- Hence, we eventually have a 8,110×105 OD travel time matrix with the **minimum travel time to reach** the nearest Urban Center, or if you prefer **the nearest city**.

Remote/Close to a city classification.

- Using as threshold 60 minutes, we classify a commune as remote if the travel time to reach an Urban Centre, a City, is of at least 60 minutes.
- Results are however quite sensitive to the threshold value, so further experimentation is probably necessary.



Sensitivity

60 minutes threshold	Communes Number	%
Close	6,185	76.3%
Remote	1,925	23.7%
Total	**8,110**	**100.0%**

45 minutes threshold	Communes Number	%
Close	4,753	58.6%
Remote	3,357	41.4%
Total	**8,110**	**100.0%**

30 minutes threshold	Communes Number	%
Close	2,943	36.3%
Remote	5,167	63.7%
Total general	**8,110**	**100.0%**

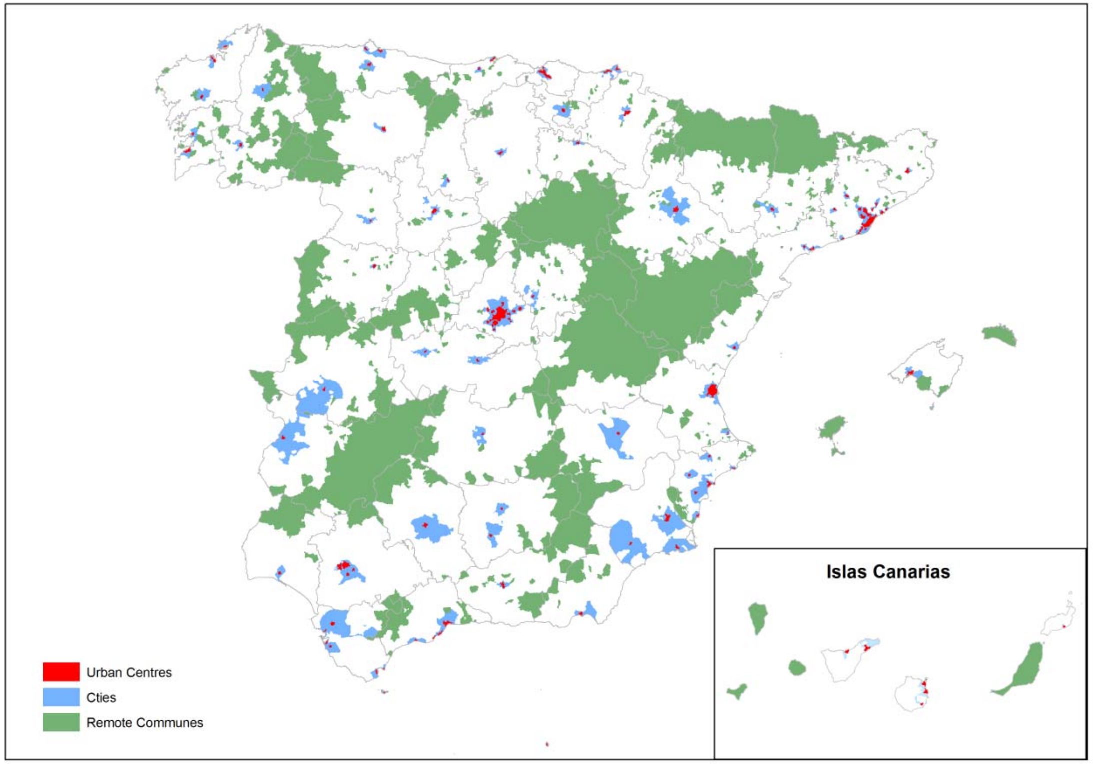
Source: Own elaboration.

Remote *versus* Close Rural Communes

Table 9 Close *versus* Remote Rural Communes

Urban Clusters (Demography)	Land Cover							
	Closed space		Intermediate space		Open space		Total	
	Number	%	Number	%	Number	%	Number	%
Urban	148	1.8%	55	0.7%	17	0.2%	**220**	**2.7%**
Intermediate	171	2.1%	376	4.6%	478	5.9%	**1,025**	**12.6%**
Rural	32	0.4%	348	4.3%	6,485	80.0%	**6,865**	**84.6%**
Close	*28*	*0.3%*	*307*	*3.8%*	*4,698*	*57.9%*	***5,033***	***62.1%***
Remote	*4*	*0.0%*	*41*	*0.5%*	*1,787*	*22.0%*	***1,832***	***22.6%***
Total	**351**	**4.3%**	**779**	**9.6%**	**6,980**	**86.1%**	**8,110**	**100.0%**

Source: Own elaboration.



- Using this threshold, 27% of rural communes are classified as remote.
- This accounts for 24% of rural population, 3% of the total population.
- Average size of rural/remote communes is just 700 inhabitants,

Next step…

- Next step is measuring economic performance by commune typology, since for the moment we only have demographic information at this level of geographical detail.
- For example, mean age for Spain is 42 years, mean age for rural communes is 49 years, and for rural/remote communes reaches 52 years.
- After Census 2011 data is released we expect to apply Small Area Estimation (SAE) techniques to disaggregate economic variables and measuring economic performance for different typologies.

Many thanks for your attention.