Europe through the lens of the refined Degree of Urbanisation: First insights

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Abstract:

The degree of urbanization (DEGURBA) is a methodology proposed by the European Commission (adopted by Eurostat) which combines 1 km resolution grids of population and built-up to classify human settlements. A recently proposed refined methodology now combines several population and density thresholds to identify six classes of human settlements: Cities, Towns, Suburbs, Villages, Dispersed rural areas and Mostly uninhabited areas.

This paper describes the results of spatial analysis, conducted at the European Union (EU28) level, using the refined DEGURBA for a set of 11 territorial indicators computed by the LUISA Territorial Modelling Platform and the European Environmental Agency (EEA). These indicators took into consideration elements such as population, roads and accessibility, green infrastructure as well as landscape morphology. The analysis revealed that the refined DEGURBA provided, at country level, values significantly different for the majority of variables considered, confirming they indeed characterize different types of territorial developments. We then provided a detailed characterisation of European member states “through the lens” of the level 2 DEGURBA.

The refined DEGURBA indicates that 37% of the EU28 population lives in cities, 21% in Towns, 12% in Suburbs, 12% in Villages, 14% in Dispersed rural areas and 4% in Mostly unhabituated areas. Urban areas concentrate 72% of the population over only 3% of the EU territory but contain 17% of all roads (uniformly distributed between cities, Towns and Suburbs). In addition, the refined DEGURBA identified Slovakia and Slovenia as having the lowest proportion of population in cities (14%). Belgium presented the highest proportion of it population living in Suburbs (28%) while Slovenia had the highest proportion of population in Dispersed rural areas (33%) and Ireland had the highest proportion of population in Mostly uninhabited areas (19%). From this new classification we found that across Europe locations identified as Suburbs differed from Towns in that, they present lower population density, higher UGI per hectare (ha), lower percentage built-up areas, shorter distance to access sub-regional, regional but not to local services, more road and public transport stops per capita. Location classified as Villages differ from dispersed rural areas in that they presented a much higher density and percentage built-up area slightly better access to services, lower length of road per capita and more public transport stops per ha.

These first insights indicate that the refined DEGURBA provides a valuable new lens through which we can better understand urbanity in Europe and globally.

The current application of the LUISA Territorial Modelling Platform in Africa will also incorporate inputs from the global DEGURBA application methodology in the analysis of linkages between EU cooperation, development policies and urbanization processes over the whole Continent.

The level 2 degree of Urbanisation:

The degree of urbanization (DEGURBA) is a methodology proposed by the European Commission (adopted by Eurostat) which combines 1 km resolution grids of population and built-up to classify human settlements. It was developed to provide a harmonised city definition that does not rely on national (and often not comparable) definitions. The previously released "Level 1" degree of urbanisation (Dijkstra and Poelman, 2014) distinguished three classes: Cities (densely populated), Towns and Suburbs (intermediate) and Rural areas (thinly populated) and provided a harmonized comparable basis on which numerous statistics have since been developed. However a limitation from the level 1 DEGURBA was that it did not provide distinctions between towns and suburbs and did not account for small settlements within the "rural areas" class.

A recently proposed refined Level 2 DEGURBA methodology now combines several population and density thresholds to identify six classes of human settlements. The purpose of the present study is to identify how these new classes differ from each other and what new insights they provide at the EU28 scale.

The 1 km grid degree of urbanization used in this study was produced by the European Commission Joint Research Centre Global Human Settlement (GHSL) in cooperation with the Directorate General on Regional and Urban Policy (DG Regio). It was created by applying the new degree of urbanisation settlement model (see Florczyk et al. 2019) to the built-up areas of the European Settlement Map (Florczyk et al. 2016) and the 2011 Geostat population (https://www.eea.europa.eu/data-and-maps/data/external/geostat-2011-grid-dataset).

This new degree of urbanization (level 2, illustrated in Figure 1)) discriminate 6 classes compared to the 3 classes previously available in the level 1 (see Figure 2). The new classes (detailed in Table 1) now discriminates Towns from Suburbs and identify Villages and dispersed rural areas from the rural "background".

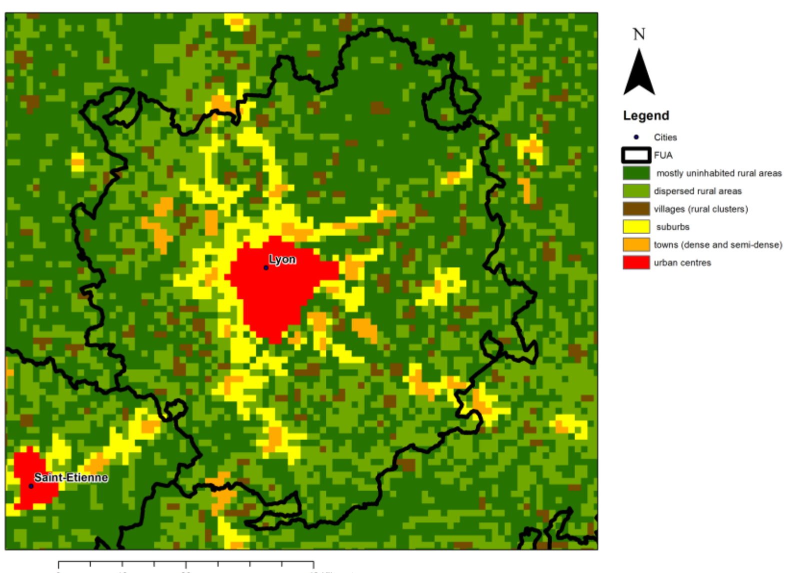

Figure 1 : Level 2 degree of urbanisation around Lyon, France

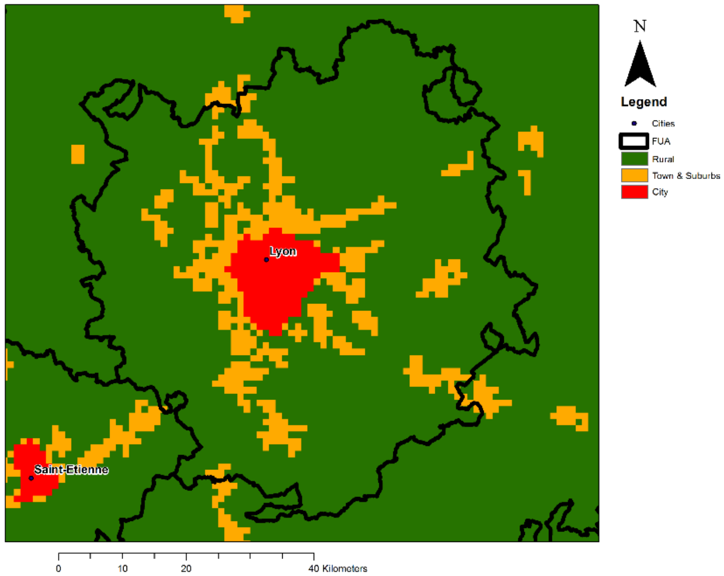

Figure 2 : Level 1 degree of urbanisation around Lyon France

Level 1 degree of urbanization	Level 2 degree of urbanization	DEGURBA code
Cities	Cities	30
Towns and Suburbs	Towns	22
	Suburbs	21
Rural areas	Villages	13
	Dispersed rural areas	12
	Mostly uninhabited areas	11

Table 1: Degree of urbanization reference table

How are the new DEGURBA classes different from each other?

In order to determine whether the distinctions identified by the Level 2 degree of urbanization characterized different features of the urban environment across EU28 countries, we performed a Students's t- test, testing means difference across various variables comparing the following DEGURBA values:

- 22 vs 21: Towns vs Suburbs;
- 22 vs 13: Towns vs Villages ,
- 21 vs 13: Suburbs vs Villages
- 13 vs 12: Villages vs Dispersed rural areas

T-tests were performed looking at the variables described in Table 2. These variables were selected based on data availability and on the capacity of the data to be summarized at pixel level.

Variable	Source
Day / night population ratio	JRC ENACT project
Number of hotel rooms per ha	Extracted from Booking.com and Hotels.com
Distance to local, sub-regional and regional services	LUISA platform (Kompil et al. 2019)
Percentage Built-up Area (PBA)	EEA
Urban Green Infrastructure (UGI)/ha	LUISA platform
Population density / ha	GEOSTAT

Number of public transport stop per ha	DG Regio (based on GTFS data)
Average road distance per ha	Tele Atlas

Table 2 : Variable used to calculate T-test

In order to obtain a sufficiently large number of “samples” on which to conduct the t-test, we vectorized the DEGURBA raster into individual clusters (multipart) and associated to each cluster its DEGURBA value, NUTS 0 and FUA (Functional Urban area) codes. This step led to the creation of roughly 300,000 clusters across the EU28, 120,000 of which were located within Functional Urban Areas (FUA).

This analysis applied at the level of the EU28 resulted in a rejection of the null hypothesis (DEGURBA are not different from each other) for all variables and all considered DEUGBA classes except for Hotel rooms/ ha between Towns vs Suburbs (22/21). When considering only clusters located within FUA, the null hypothesis was also rejected for all considered variables except the number of hotel rooms / ha between Towns and Suburbs (22/21) and Villages and Dispersed rural areas (13/12) (see Figure 3).

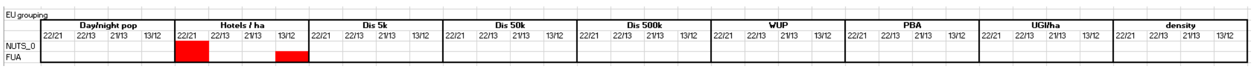

Figure 3 : result from t-test analysis using all clusters at EU28 scale and clusters contained within FUA. Cells coloured in red indicate cases where the null hypothesis (p value > 0.05) could not be rejected.

The same systematic analysis was also repeated by aggregating data at country level for both the whole EU28 clusters (Figure 4) and those located within FUA (Figure 5).

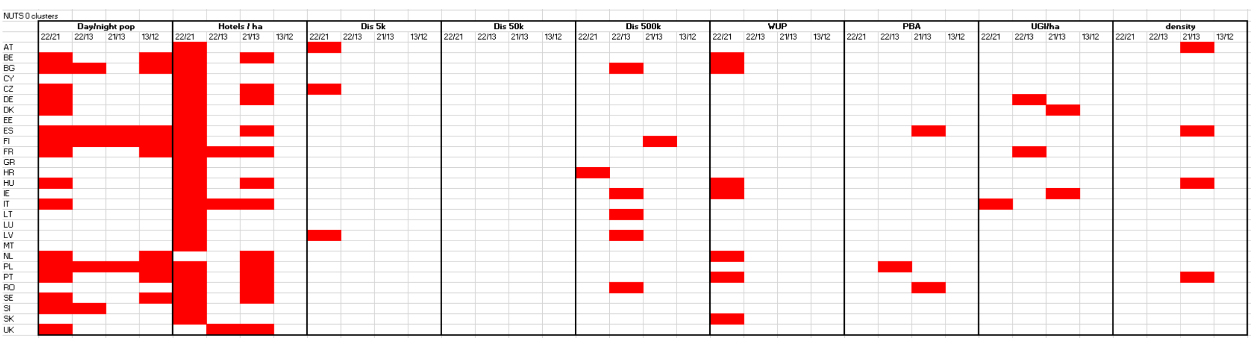

Figure 4 : result from t-test analysis using all clusters at EU28 scale, aggregated by country. Cells colored in red indicate cases where the null hypothesis (p value > 0.05) could not be rejected

Again in both cases, the null hypothesis was rejected for most variables and considered DEGUBA classes. However the null hypothesis could not be rejected for Day/Night population ratio between Towns and Suburbs (22/21), for both clusters located in NUTS 0 and FUA. It was also rejected for clusters in NUTS 0 for most countries for number of hotel rooms/ha between Towns and Suburbs (22/21) and between Villages and Dispersed rural areas (13/12) for clusters in FUA.

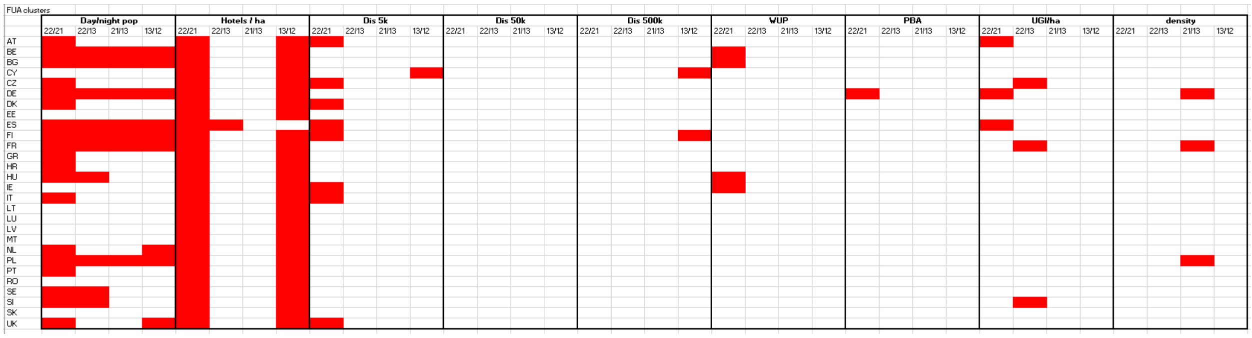

Figure 5 : result from t-test analysis using all clusters located within FUA, aggregated by country. Cells coloured in red indicate cases where the null hypothesis (p value > 0.05) could not be rejected.

The same t-test applied to the number of public transport stops (bus/tram and train), only available for a selected number of countries also led to a rejection of the null hypothesis for most countries and DEGURBA classes.

Following this very simple systematic analysis, we concluded that the additional distinctions provided by the level 2 degree of urbanization relative to the previously available level one were indeed characterizing distinct features of the urban European landscape.

The second part of this paper provides an analysis, "through the lenses" of the level 2 degree of urbanization of the EU28 landscape.

Europe through the lens of the Level 2 degree of urbanization

The statistics presented below correspond to NUTS 0 level aggregations and while aggregations considering data included only in FUA provided slightly different numbers, general observed trends were similar.

Landscape perspective:

At the EU28 scale, cities, Towns, Suburbs and Villages cover less than 6% of the territory (Table 3). However this proportion strongly varies between countries to reach more than 50% for Malta to less than 1 % for Finland. We also observe that on average in the EU28, Villages cover twice the surfaces occupied by Towns. Again large national variations exists with villages covering less than half the surface of Towns in Malta while they represent they cover almost 5 times more surfaces in Romania.

The area covered by Suburbs is almost 1.5 times that covered by Towns in the EU28 but it covers 3.5 the size of Towns in Belgium and 2/3rd in Bulgaria (Figure 6).

Level 2 degree of urbanization	**Percentage of land surfaces**	**Percentage built-up area**	**Road length per ha**	**Road length per capita**
Cities	0.9	68.8	156.6	3.5
Towns	1.0	50.4	115.7	5.5
Suburbs	1.6	33.6	82.8	10.2
Villages	2.0	28.0	76.5	11.0
Dispersed rural areas	11.8	9.8	44.0	32.3
Mostly uninhabited areas	82.6	3.3	18.0	374.3

Table 3: Characterization of the EU territory across the level 2 DEGURBA classes

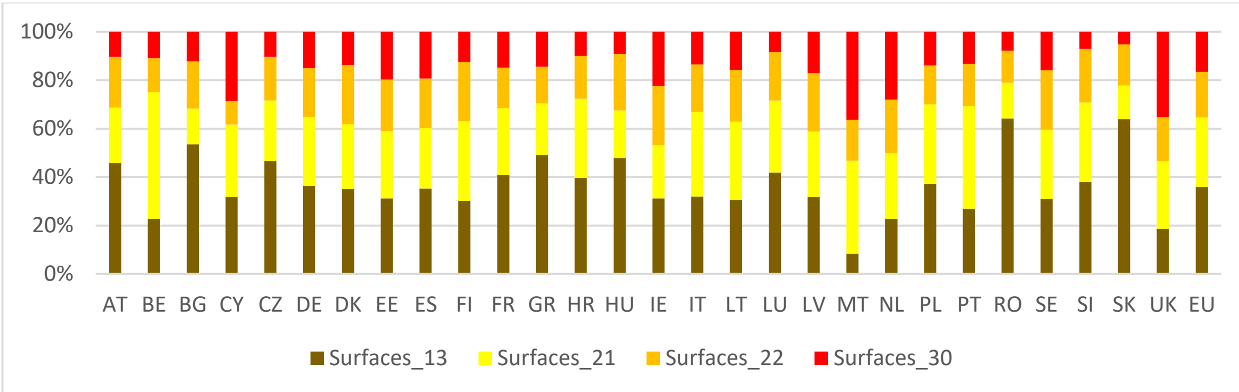

Figure 6: Percentage of surfaces of cities Suburbs Towns and Villages.

Regarding The percentage of built-up area (PBA) we observe a very consistent trend across Europe (Figure 7), showing Cities as the most built-up followed by Towns and then Suburbs. These figures are in line with what we would normally expect for each described DEGURBA class.

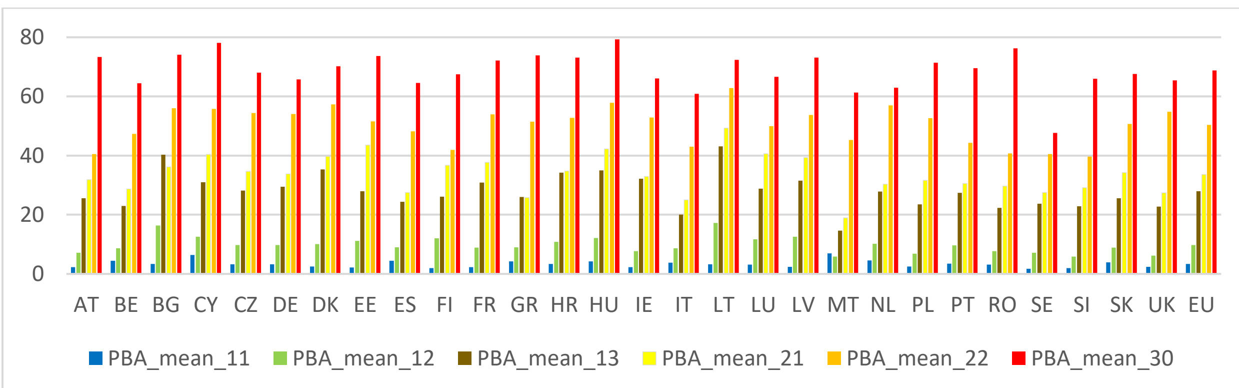

Figure 7: Mean percentage of built-up area per DEGURBA categories

When considering the prevalence of roads across the different DEGURBA classes (Figure 8), we observe a very similar EU28 trend to that observed for PBA with the average ha or City hosting longer distances of roads than Towns, Suburbs and Villages.

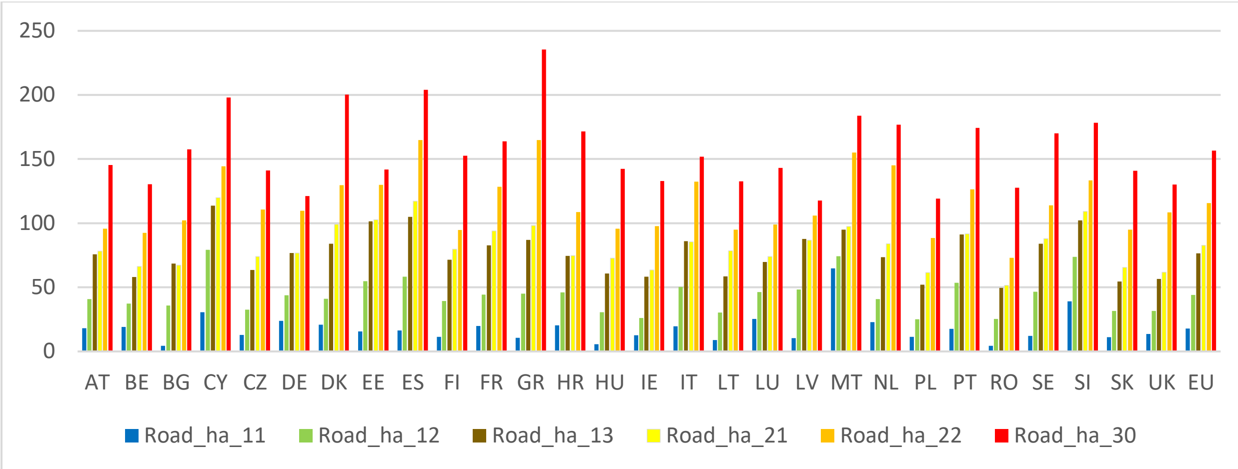

Figure 8: Average length of road per pixel of DEGURBA class

When considering the length of road per capita per DEGURBA class (Figure 9), we see the reverse of the previous indicators (Cities having the lowers distance of road per capita, followed by Towns and Suburbs), but we can also see that differences that existed in road/ha get offset when looking at the per capita basis. For example while Slovakian Cities host 40% more roads than Towns, their ratio per capita is almost equal.

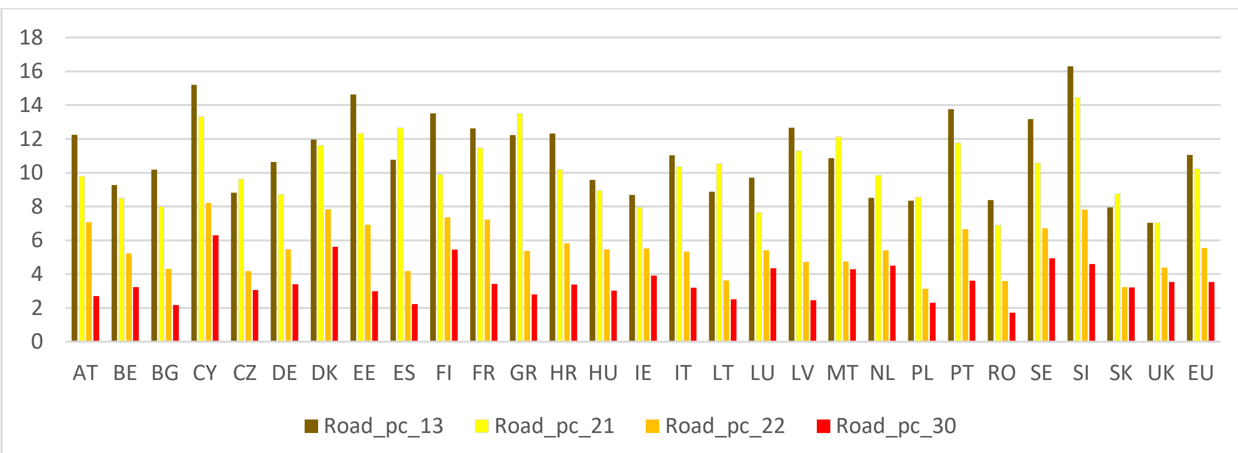

Figure 9: Average length of road per capita per category of DEGURBA

Population perspective

From a population perspective (Table 4) we found that 37% of the EU population lives in Cities, 21% in Towns, 12% in Suburbs and in Villages, 14% in dispersed rural areas and 4% in mostly unhabituated areas.

The country where City population were the highest (>40%) were Malta, the UK, Spain, Cyprus and the Netherlands. While the population of Towns largely exceeded that of Suburbs (almost double) across most countries (particularly in Slovakia, the Netherlands, Bulgaria and Spain), Suburbs populations were higher in Cyprus and in Belgium. The population living in Villages were highest in Slovakia (27%) and in Romania (21%) (Figure 10).

Level 2 degree of urbanization	Percentage of total Population	Population density (person per km^2)	Day / night population ratio
Cities	37.3	4780	1.06
Towns	21.0	2200	0.93
Suburbs	11.6	810	1.08
Villages	12.3	697	0.85
Dispersed rural areas	14.3	138	0.97
Mostly uninhabited areas	3.6	6	2.54

Table 4: Population characteristics per DEGURBA level

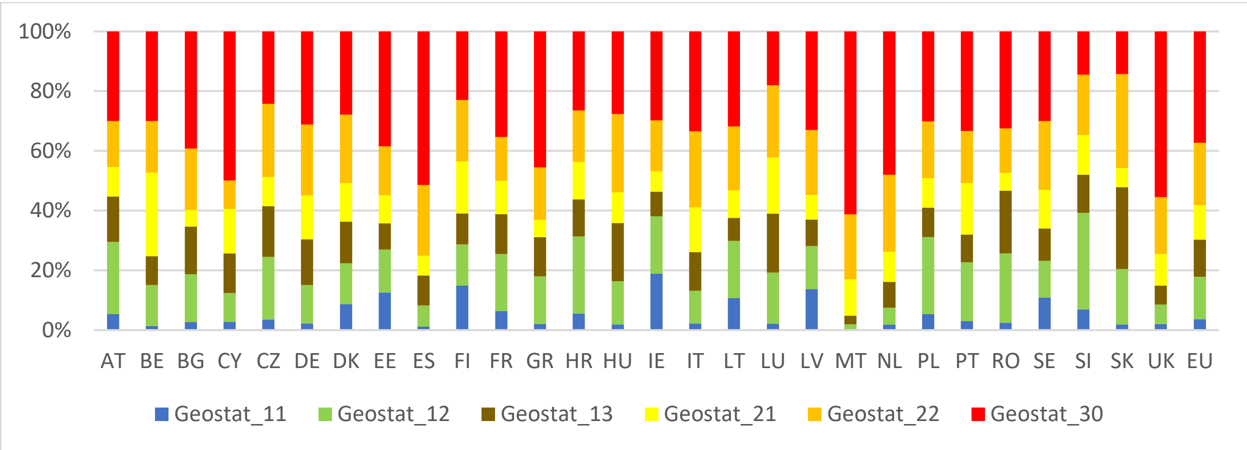

Figure 10: Total population per DEGURBA level

Looking at population density (Figure 11) we observe a very clear pattern repeated consistently across all EU28 countries where the density of Suburbs (810 person / ha) and Villages (700) are very similar across Europe while densities in Towns and cities reach much higher levels (2200 and 4800) with the highest density being reached in Spain for both Cities and Towns. Indeed the average density in Spanish towns exceed the average density reached in Cities in Cyprus, Germany, Denmark, Finland, Ireland Luxembourg, Sweden and the UK.

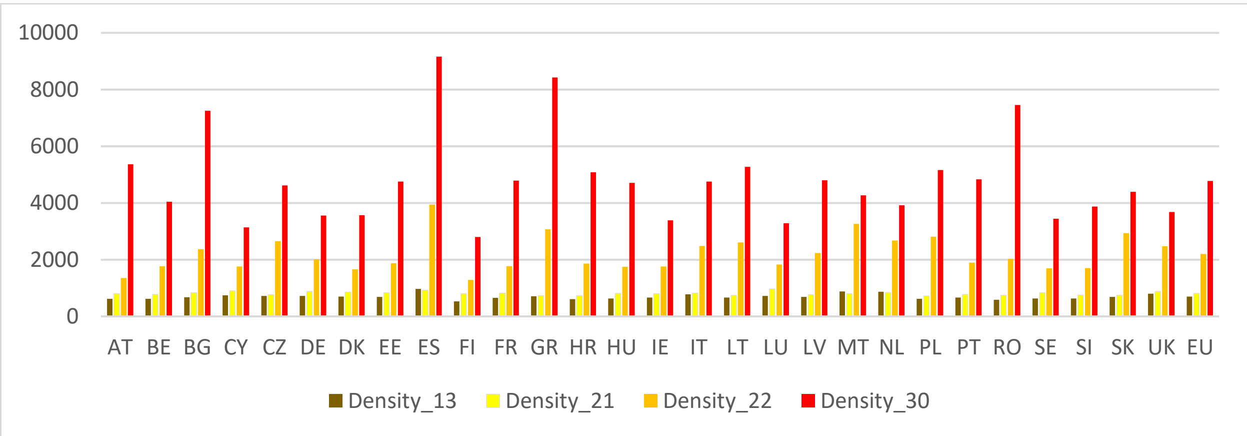

Figure 11: Population density per DEGURBA level

Considering the ratio between day and night populations through the DEGURBA lens (Table 4), we observed that at EU level cities had a positive ratio, indicating slightly more people worked in cities than lived in them (except in Cyprus, Estonia, Spain, Greece and Sweden). Towns and Villages in particular showed ratio < 1 indicating more people live than work there. However, contrary to our expectations, we observe that, for most EU28 countries, Suburbs also showed a positive ratio (Figure 12). This higher proportion of day to night population in suburbs was particularly high in Bulgaria and Greece.

This observation, seem to indicate that the Suburb class identified by the DEGURBA may contain elements that are different from what is typically perceived as suburb (from which people would commute to work and come back to sleep). The Day/night ratio for Mostly uninhabited (Table 4) areas also show the same counter intuitive trend but much more pronounced (with on average 2.5 time more people during the day than at night), particularly in Bulgaria (4 times), Spain (6 times), Greece (5 times) and Malta (7 times).

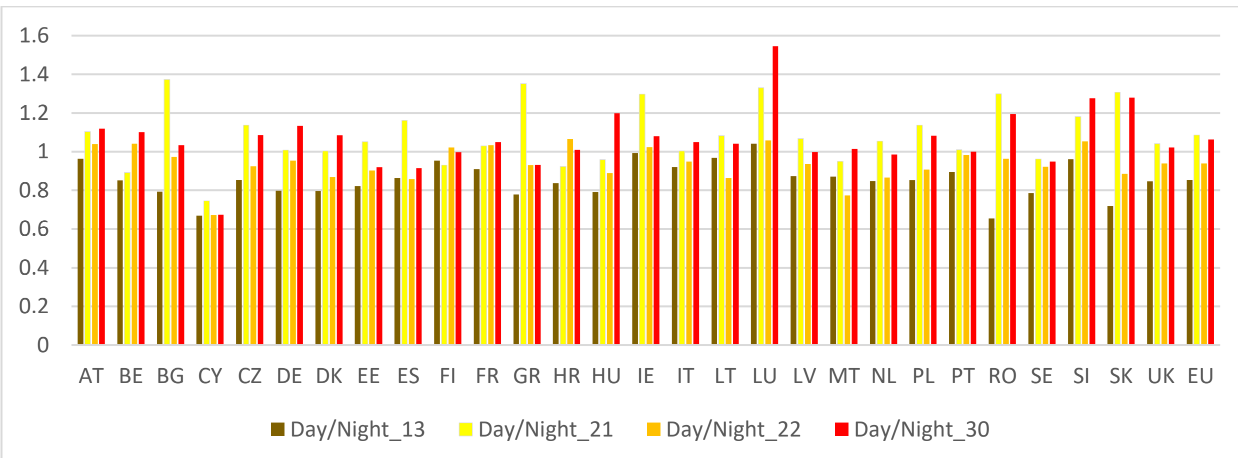

Figure 12: Day / night population ratio per DEGURBA level

These counter intuitive results can be explained by the fact that DEGURBA classes were attributed only to populated pixels (from the GEOSTAT 1 km grid) and classified other types of land-uses as mostly uninhabited. Consequently a large amount of commercial and industrial land-use classes (see Figure 13) which are associated with high day populations and low night populations were also labeled as uninhabited. We believe this issue, which may also be responsible to the trend observed in Suburbs, could be easily resolved by slight adjustment of the methodology.

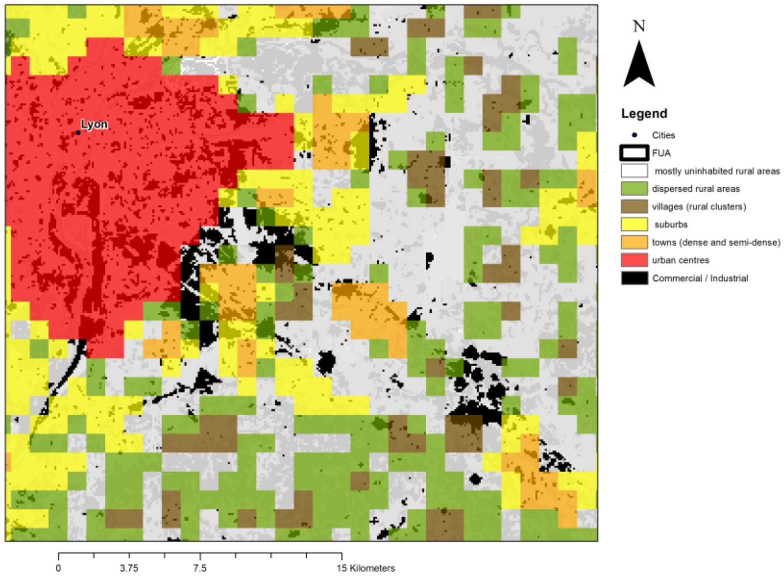

Figure 13: Correspondence between DEGURBA classes and land-use map.

Services perspective:

Looking at the availability of Green infrastructure at EU28 level (Table 5), we observe that cities typically show similar UGI/ha values than Towns and that Suburbs have similar values than Villages.

Level 2 degree of urbanization	UGI /ha	Distance to access local, sub regional and regional services (km)	Number of public transport stops* per ha / stops per person	Hotel rooms per ha / room per person
Cities	0.17	1.5 / 3.4 / 16.3	0.08 / 1 per 462	0.50 / 1 per 89
Towns	0.16	1.9 / 10.0 / 48.8	0.04 / 1 per 430	0.23 / 1 per 99
Suburbs	0.23	2.9 / 8.6 / 40.5	0.03 / 1 per 304	0.08 / 1 per 102
Villages	0.22	7.9 / 18.9 / 53.3	0.02 / 1 per 316	0.07 / 1 per 101
Dispersed rural areas	0.34	10.2 / 20.0 / 57.1	0.01 / 1 per 134	0.02 / 1 per 57
Mostly uninhabited areas	0.59	13.7 / 24.2 / 61.6	0.001 / 1 per 57	0.005 / 1 per 13

*Table 5: Characterization of the EU services at the level 2 DEGURBA classes (*Only computed based on numbers from UK, BE, NL, DK, EE, SE, FI)*

We observe however some variations between member states with The Czech Republic, Ireland, Lithuania and the UK showing higher values in Cities compared to Towns, Suburbs or Villages (Figure 14).

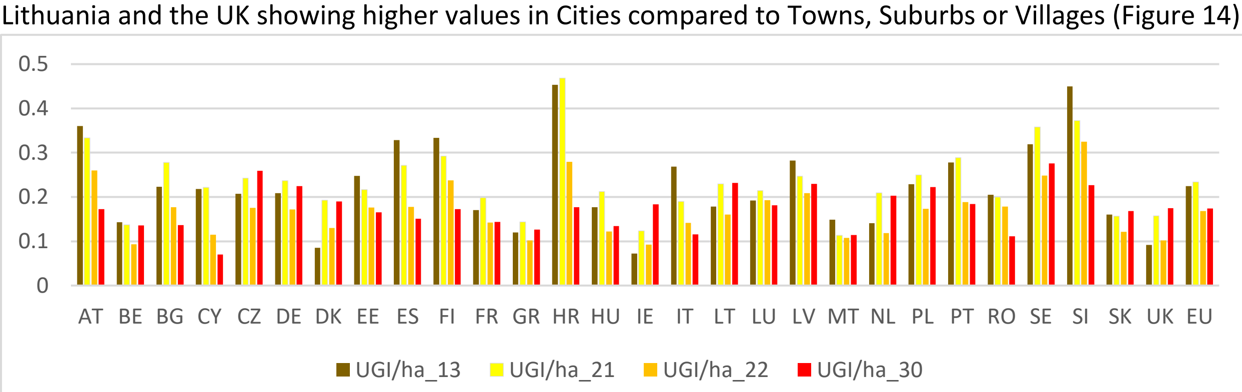

Figure 14: Green infrastructure per ha as a function of DEGURBA levels

The average modelled distance to access sub-regional services (Figure 15) such as regional hospitals or secondary high schools serving 50000 inhabitants or more, indicate that across most of Europe residents of cities have better access (lower values) followed by people living in Suburbs then in Towns and Villages. We also observe large variation across member states with for example people living in Towns in Estonia and Finland having to travel twice the distance of people living in Suburbs to access sub-regional services.

The same trend also occurs for the distance to access regional services (such as specialized health and education services) with a more pronounced advantage for Suburbs over towns (Table 5). However, when considering distance to access to local services (schools, childcare facilities), Towns show lower values than Suburbs in all EU28 countries.

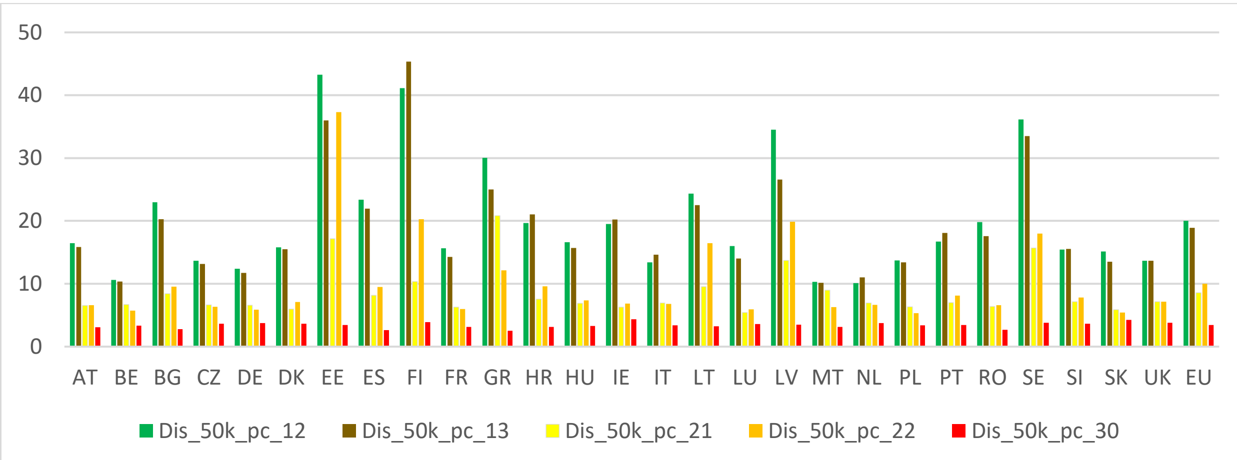

Figure 15: Modelled access distance to sub-regional services as a function of DEGURBA levels (not calculated for Cyprus)

Looking at the number of hotels per ha of DEGURBA, we observe that for most countries across Europe, cities have the highest hotel rooms concentration (except Malta and Cyprus). Towns then appear as having the second highest concentration at levels that greatly exceed those found in Suburbs or Villages, except in Cyprus where Suburbs show the highest concentration of hotel rooms. Considering the number of hotel rooms per capita, the difference between Cities, Towns and Suburbs becomes much smaller at EU level.

Taking into consideration the number of public transport stops per ha (Figure 16), we observe that cities had the highest density of stops, followed by Towns and Suburbs. Looking on a per capita basis (Figure 17) we observe that Cities tend to have a lower ratio (often compensated by a higher frequency of transport) than Towns and Suburbs, except in Finland, Ireland and the Netherlands where the lowest number of public transport stop per capita is reached in Towns.

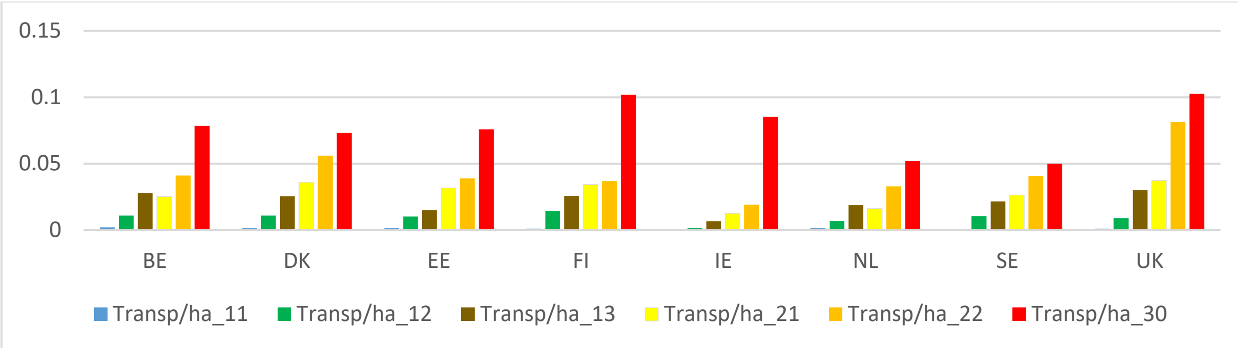

Figure 16 : number of public transport stops (bus, tram and train) per ha of DEGURBA class (calculated only for countries for which nationwide data was available).

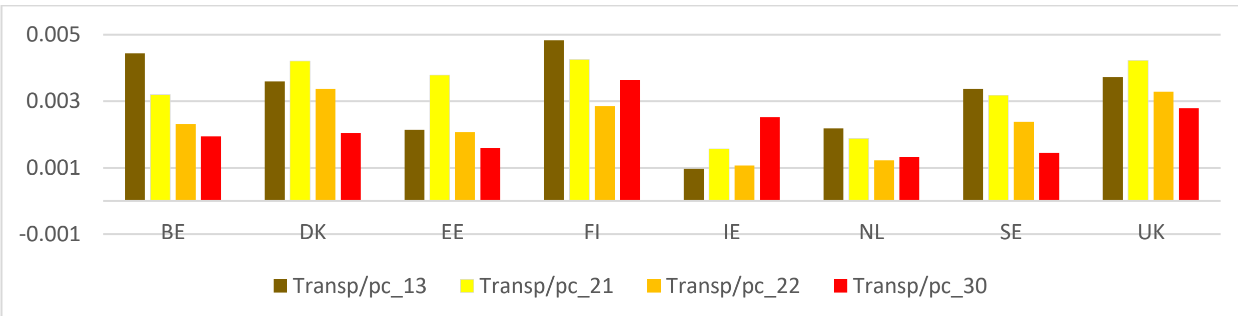

Figure 17: number of public transport stops per capita per class of DEGURBA (calculated only for countries for which nationwide data was available).

Conclusion

Overall, our observations indicate that across the indicators considered the new level 2 degree of urbanization identify different characteristics for each class indicating that indeed they capture distinct elements of human settlements at the EU and member state level. Although several of the indicators used to assess the DEGURBA were based on modelled data, we believe the information presented in this study provides a credible picture of the DEGURBA variation across the EU28.

These categories, interpreted across various indicators, provide results are in line with what would be "intuitively" expected from the different categories. In particular the new classes seem to successfully distinguish Suburbs, with lower density higher UGI and good access to regional services, from Towns. The identification of villages from the "rural background", presenting a much higher density and percentage built-up area slightly better access to services, also provides a new dimension through which to investigate more rural populations.

However, we would like to highlight that within DEGURBA classes we found large variations across member states for several indicators highlighting the need of further studies at more localised level to investigate the implications of regional specificities.

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