A multi-scalar analysis of ‘lonely places’ in the EU

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Abstract

It is essential to understand territorial disparities across different domains and geographical scales, as an in-depth comprehension of spatial inequalities, and the identification of marginalised places, is critical to produce policies that can actively contrast the current situation and improve the quality of life of citizens resident in these areas. This paper introduces a multi-perspective and multi-scalar analysis exploring a communal object of research, the ‘lonely’ places. This analysis goes beyond the dichotomy of rural-urban, involving multiple domains (agriculture, demography, migration, physical and digital infrastructure) and geographical scales, and presenting results at regional, municipal and grid levels.

In this paper, two specific case studies are presented: the uneven spatial access to the high-speed broadband network and the spatial distribution of urban amenities in EU cities concerning the access to service at the local and neighbourhood level. The data sets employed in this work include traditional sources and new sources of data, including spatiotemporal records collected through apps. The spatial analysis is performed at different geographical scales and employs a wide range of analysis techniques, including Machine Learning. Results reveal the patterns of territorial disparities across Europe and identify disconnected and marginalised places with the different domains. The localisation of spatial disparities of opportunities, as obtained with this analysis, is of high importance to understand the phenomena related to spatial inequality, as it provides geographical information for urban and territorial policy at high granularity to target the areas affected and the causes of disconnection.

Keywords **–** spatial disparities; broadband; urban amenities; unsupervised learning.

1 Introduction

The spatial inequalities existing within and across different EU regions represent, together with other socio-economic aspects, a challenge to the cohesion of European countries. They can be related to several spatial phenomena, including depopulation, limited access to urban services, low or no access to the broadband network. Some inequalities have been further exacerbated by the Covid-19 pandemic: the possibility of remote working or the spatial access to essential services at the local scale in cities during the lockdown.

Considering this, it is essential to understand territorial disparities across different domains and geographical scales. An in-depth comprehension of spatial inequalities, and the identification of disconnected and marginalised places, is critical to address the problem and produce policies that can actively contrast the current situation and improve the quality of life of citizens resident in these areas. Policies need to be supported by reliable quantitative evidence to target left-behind areas appropriately. Therefore, the availability of high-resolution spatial data is fundamental to produce the geographical evidence required across policy domains to successfully improve the well-being of people in cities, regions and rural areas. Moreover, the use of aggregated data may lead to the loss of significant spatial patterns in the averaged indicators: a lack of evidence may result in a lack of representation in the policy action.

This paper introduces a multi-perspective and multi-scalar analysis exploring a communal object of research, the disconnected ‘lonely’ places. When speaking about this topic, often rural areas come into mind. However, this analysis goes beyond the dichotomy of rural-urban, involving multiple domains (agriculture, demography, migration, physical and digital infrastructure) and geographical scales, and presenting results at regional, municipal and grid levels. The data sets employed in this work include traditional sources (i.e., Eurostat, Census), data and projections from in-house models (i.e., Luisa model for population data, gender and age segmentation), and new sources of data from web resources and open repositories, including spatiotemporal records collected through apps. The spatial analysis is performed at different geographical scales, depending on the granularity of the data available. It also employs a wide range of analysis techniques, including network analysis and Machine Learning.

In this paper, two specific case studies of the overall analysis are presented: the uneven spatial access to the high-speed broadband network and the spatial distribution of urban amenities in EU cities concerning the access to service at the local and neighbourhood level.

2 Spatial access to broadband

2.1 Data and method

This analysis employs extensive data containing spatial information about the quality of the broadband network in Europe for the last quarter of the year 2020. The data set is provided by Speedtest® by Ookla® (2020), with records of hundreds of millions of Speedtest®. Each record includes several attributes associated with each spatial unit (tiles of approximately 610.8 metres by 610.8 metres at the equator) for the fixed and mobile broadband networks. Attributes selected for this specific analysis are: the average download speed per tile (measured in kilobits per second); the average latency per tile (measured in milliseconds); the number of tests performed in each tile (as analysis unit). The network speed is classified into three categories: below 30 Mbps, between 30 and 100 Mbps and higher than 100 Mbps.

The spatial analysis is performed applying descriptive statistics and geospatial computational tools to analyse spatial patterns of the broadband network across the EU. It shows the geographical distribution of broadband accessibility and quality aggregated at the Local Administrative Units (LAU2), classified at the municipal level as city, town and suburb, rural area. In addition, remote municipalities, defined as areas where the majority of the population live more than a 45-minute drive by car from the nearest city, are used to explore the urban-rural digital divide.

Finally, to understand the territorial similarities of European municipalities across countries in terms of vulnerable areas, an unsupervised learning technique is applied to all units of analysis at the LAU2 level, regardless of their Degree of Urbanisation. For this exploratory phase, a k-means clustering algorithm was employed, including the following attributes:

- the average speed and latency, critical to establishing the presence of a reliable connection, especially in terms of remote working and access to e-service;

- the population density as a proxy for density of urbanisation;

- the remoteness classification as a proxy of distance from major urban centres.

2.2 Results

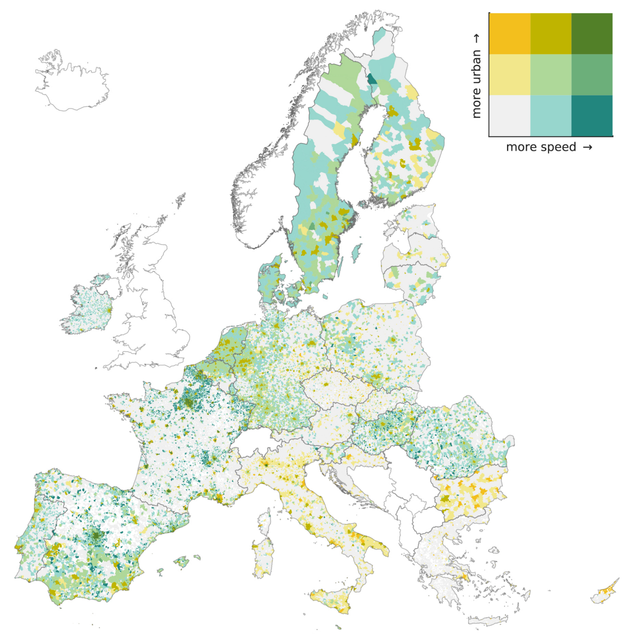

Figure 1. Average speed and degree of urbanisation.

Results strengthen the empirical understanding of the geographical disparities in digital access across municipalities. A neat digital divide is noticeable between the two spatial categories comparing broadband access between urban and rural municipalities. In most cities of EU27, the urban population has access to broadband speed higher than 30 Mbps, and a good percentage also to 100

Mbps. However, in rural areas, the situation is quite different: the majority of residents has access to an average speed below 30 Mbps, and very few countries show access to over 100 Mbps broadband for the rural population (Denmark, Sweden, the Netherlands, Luxembourg).

The divide is even more evident when overlapping the spatial patterns of average speed (for fixed broadband) and the classification of municipalities according to Degree of Urbanisation (city, town and suburb, rural). Figure 1 shows that cities present the highest speed in broadband connection in all countries, revealing how the areas already most connected in terms of physical networks (i.e., with roads and railways) are also the most connected from the digital point of view. This aspect is especially evident for rural areas, which show the lowest speed connection in most countries (in greyish colour). Most rural municipalities are characterised by low to very low-speed broadband connection, although northern countries show an exception to this trend and rather good access to the broadband network. Data are not available for some of the inner parts of France and Spain: this is possibly due to the lack of a critical mass of population that do not justify the deployment of the broadband infrastructure.

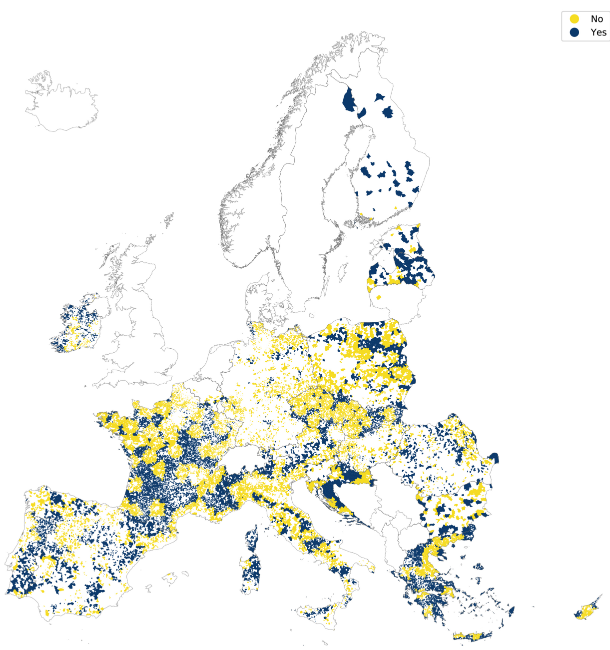

Figure 2. Municipalities with speed under 30 Mbps.

When considering only municipalities with access to (fixed) broadband under 30 Mbps speed (the minimum standard), it is possible to include the dimension of physical connection into the analysis, distinguishing areas between remote and non-remote. Results illustrated in Figure 2 show that the digital divide is not merely a matter of urban-rural, but mostly an urban versus non-urban matter, with municipalities classified as cities not appearing on the map.

Finally, a cluster analysis is performed on all municipalities to show patterns of similarity across countries in terms of spatial access to high-speed broadband infrastructure. Observing the results illustrated in Figure 3, one can notice that not all remote and scarcely populated places are also necessarily disconnected from a digital point of view. Municipalities belonging to label 3, although classified as remote ones, show quite a good average speed. At the same time, places that would not be considered disconnected from the physical perspective (non-remote and with high population density) can be effectively disconnected from the broadband perspective (see label 1, with low speed and high latency).

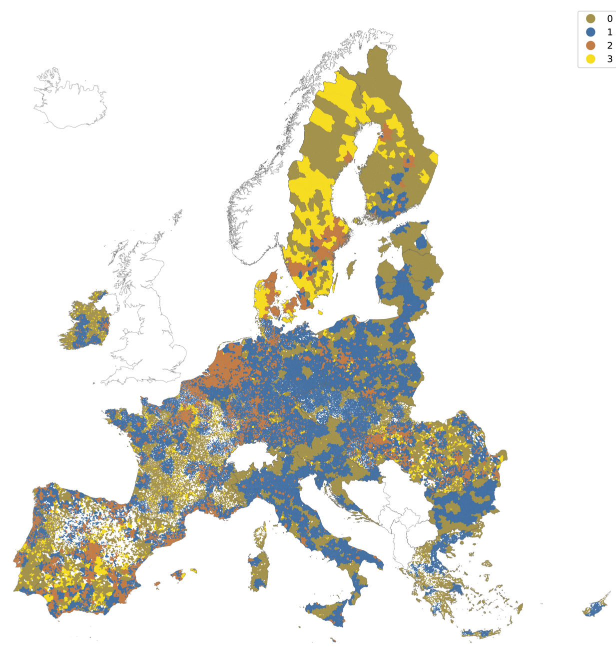

Figure 3. Patterns of similarity to broadband network.

Municipalities belonging to label 2 are the most connected areas from all points of view and are indeed highly populated areas often corresponding to big cities and capital cities. Finally, areas belonging to label 0 represent the most disconnected, left-behind places (remote, low population density, very poor quality of broadband).

3 Spatial patterns of amenities

3.1 Data and methods

This analysis employs an extensive data set collected through the Google Maps API in 2018. The data set contains approximately three million records about urban amenities for the capital cities of the 27 EU Member States. Each record is a Point of Interest (POI) representing an individual amenity, and it contains several attributes associated with it. For this specific analysis, the ones employed are the amenity typology (restaurant, school, hospital) according to the data classification of the provider, and the amenity location, expressed in geographical coordinates (latitude, longitude).

Data have been collected within the boundaries of 'Cities' and 'Greater Cities' for the EU27 capital cities. The 'Cities' boundary corresponds to the local administrative unit (LAU), where most of the population lives in an urban centre of at least 50.000 inhabitants. The 'Greater Cities' boundary represents an approximation of the urban centre when it stretches far beyond the administrative city boundary. After the collection, data have been aggregated at the grid level to compare the analysis results across cities beyond the specific administrative boundary.

About the amenity classification, several POIs in the original data set were associated with a generic typology ('point of interest'). POIs have been re-classified by an automatic process and associated with a specific typology (primary school, food shop, others) and then aggregated into sub-groups to analyse in detail (i.e., shopping, essential service). Each group represents a specific aspect to analyse about the local access to amenities and quality of life.

The focus of the analysis is to identify similarities in the spatial patterns of amenities within cities. It employs a Machine Learning technique to exploit best the richness of the data set available. The spatial distribution and variety of amenities are analysed within each city using an unsupervised learning technique similar to previous work (Sulis and Manley, 2019; Sulis and Lavalle, 2020). This technique measures the similarity of each spatial unit according to the predominance of typologies in each cell area. The similarity is calculated using the Jensen-Shannon distance metric on the discrete distributions of amenities located in each grid cell. Later, a clustering technique is used to label each grid cell. Cells with a similar distribution of amenity typologies are labelled under the same class. The clustering technique used is the density-based hdbscan method (McInnes et al, 2017).

3.2 Results

Results of the cluster analysis uncover the similarities in the spatial patterns of amenities within cities. Each area in the city is assigned a different label according to the variety of amenity typologies located in the grid cell (see Figure 4). When clustering urban functions together (leisure, education, shopping), one can observe how results corroborate the empirical understanding of urban features:

- the inner parts of the city, many areas show a balanced variety of amenity typologies all located in the proximity; some places also present a prevalence of specific amenity typologies related to leisure, such as tourist and historical attraction, eating out, culture and entertainment;

- in the outer parts of the city, the analysis reveals how areas tend to present more specialised profiles, with less mix amongst different urban functions and one or two amenity typologies distinctively characterising the places. For example, areas can be characterised by the prevalence of parks, sports facilities, goods shops, etcetera.

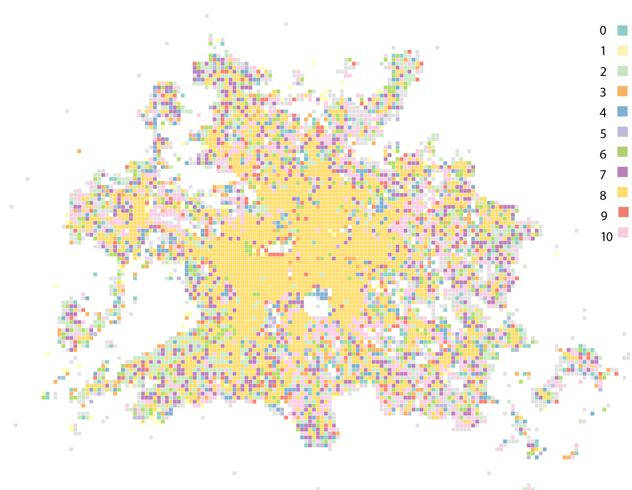

Figure 4. Berlin, spatial patterns of amenities.

Following these results, the analysis further explored the spatial patterns of individual urban functions across all cities included in the data set to understand how the presence or lack of some services in places might have an impact on the residents' quality of life. The areas with a balanced variety of amenities mean that the residents have a wide offer of services at the local level, with no need to travel too far away in the city for daily needs. This aspect is valid for all amenity typologies and especially relevant for shopping and essential service, whereas, about urban leisure, an aggregation of amenities around the inner area of cities is expected. However, leisure amenities have a different attractiveness (Schläpfer et al, 2021) in comparison to other functions such as grocery shopping or primary schools and a different temporal scale (Alessandretti et al, 2020) in respect to the daily needs for a good quality of life. Therefore, this aspect was considered when evaluating the analysis results.

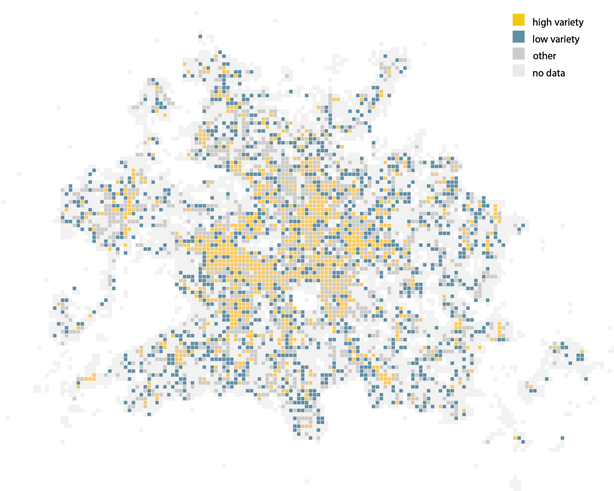

Figure 5. Berlin, shopping amenities, high and low variety.

Figure 5 shows the case of Berlin for the shopping category. The analysis makes it possible to identify places characterised by a mix of different shopping typologies (in yellow), mainly located in the centre. In these areas, residents have easy access to a higher variety of services in proximity, whereas, in the outer part of the city, places show lower variety in the shopping typologies and they are often characterised by the prevalence of one specific typology, as shown in Figure 6 (in blue).

4 Conclusion

Results of the analysis reveal the patterns of territorial disparities across Europe and identify disconnected and marginalised places with the different domains (ageing and depopulation, service accessibility, digital connectivity and more). Rural areas appear to be more exposed than others to the risk of spatial inequality and disparities in opportunities. However, also some urban areas present aspects of marginalisation, especially concerning specific demographics such as the elderly or the migrants.

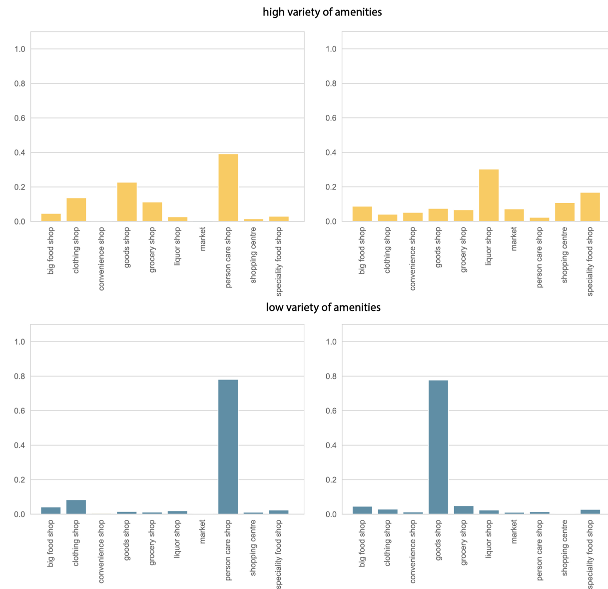

Figure 6. Berlin, amenity distribution.

Without policy support, the lack or the poor access to high-speed broadband might leave some areas. Unveiling spatial patterns of access to the broadband network is significant as it can inform policy with quantitative evidence of the current situation. Furthermore, it is also critical to highlight how to overcome current disadvantages and barriers to development to seek new opportunities. In this sense, there are several possibilities to improve the conditions of rural and remote areas exploiting the potential that connectivity and digitalisation represent for education and training, cooperation and networking, access to service and markets, to make rural areas more attractive to people and businesses. Access to broadband and the building of digital skills are elements that might help to foster new business and economic activities in rural and remote areas.

The characteristics of places where people live can prevent them from reaching satisfactory well-being. The availability and spatial access to urban services have an impact on the quality of life of citizens. Therefore, a quantitative understanding of this aspect is of paramount importance to produce urban policies that can target the current situation and prioritise interventions to improve the conditions of residents, especially the most vulnerable, as is the case for elderly residents in cities.

The localisation of 'lonely' places and the spatial disparities of opportunities, as obtained with this analysis, is of high importance to understand the phenomena related to spatial inequality, as it provides geographical information for urban and territorial policy at high granularity to target the areas affected and the causes of disconnection. The results and spatial knowledge produced by the multi-scalar analysis contribute with quantitative and granular evidence to the understanding of marginalised places and inform policies aiming at improving the current status. A place disconnected from a geographical perspective might also result in a social and political disconnection of residents: the lack of representation in the data may result in a lack of representation in the policy.

Policy recommendations include practical indications for local authorities about areas that might be considered lonely and might require local interventions, possibly leveraging on a combination between local and regional, national or European funding and eventually the involvement of private and non-profit partners. These interventions can improve cities and human settlements and make them more inclusive, safe, resilient, and sustainable.

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