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Digital Accessibility in the EU

Territorial patterns and trends of broadband network access and performance, 2019-2024

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Contents

Abstract

Access to broadband networks is increasingly an essential enabler to drive the economic and social development of territories, improving access to essential services such as education and contributing to the number of workplaces. The improvement of digital connectivity and Internet network performance is a long-standing policy priority for the European Commission to strengthen regional development and resilience and overcome spatial disparities in access to opportunities across different European regions.

In this sense, mapping and understanding the spatial patterns of broadband network access and performance across regions in the EU27 is critical to adequately address the possible disparities and needs of different places and territories. Results presented in this report show that, over the last years, there has been a generalised improvement in broadband performance across all EU Member States, both for the fixed and mobile broadband networks. Whereas performance differences between cities and rural areas are still significant, contributing to a well-known 'digital divide', results also illustrate how, for several countries, the best performance improvements in network performance occurred in rural areas in recent years. These findings represent a promising signal for the current efforts to bridge the digital gap across territories in many European countries, envisioned by the Commission and sustained through dedicating policies.

Acknowledgements

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Executive summary

Territorial development and digitalisation are intertwined elements. Therefore, identifying which areas have access to broadband network with good performance and which not is of paramount importance to inform territorial policies that target marginalised areas and residents with the aim of improving the current conditions.

The objective of this report is to analyse and map spatial patterns of access to the broadband network across different areas in the EU27. In this analysis, spatial information on broadband network performance is employed to analyse patterns of digital accessibility and territorial disparities across regions in the EU27. This type of analysis is critical to understand better the needs of different places, also in terms of quality of the broadband connection (i.e., broadband speed). This study resorted to open big data from the Ookla® Speedtest® through the programme 'Ookla for Good', allowing to measure digital accessibility across Europe in detail.

Results show that, over the last years, there has been a generalised improvement in broadband performance across all EU Member States, particularly noticeable in France, Spain, Poland, and Romania. The analysis also reveals how, for the majority of the EU countries, more than half of the population can access to network performances higher than 100 Mbps. Whereas performance differences between cities and rural areas are still significant, results also show that in recent years the highest percent change in speed performance occurred in rural areas for several EU countries. This aspect is a promising signal of the current effort to bridge the digital gap across territories in many European countries, also envisioned by several Commission policy documents, including the 'Long-Term Vision for EU's Rural Areas' published in 2021.

The quantitative evidence presented in this report can inform policy of the current situation, highlighting which areas to target through place-based strategies and initiatives. Access and, more importantly, adoption of broadband might help to foster economic and social development, particularly in rural areas, where private investment in Internet network infrastructure is generally less appealing than in more populated areas like cities.

This report also showcases the usefulness and relevance of open big data sources to analyse emerging socioeconomic trends at high spatial and temporal granularity.

1 Introduction

Access to broadband network is increasingly an essential enabler to drive the economic and social development of territories, increasing access to essential services and contributing to the number of workplaces (Townsend et al., 2015; Stenfeldt and Andersson, 2016). However, broadband availability and performance can significantly differ across European regions, influencing the ability of people to seize opportunities in the knowledge economy (Sostero et al. 2020). According to literature and policy reports, digitalisation and economic development are intertwined elements (Gruber et al., 2014; European Commission, 2021), and access to a fast and reliable broadband network has also implications in terms of integrated policies (i.e., social cohesion, regional development, and market effects, see van Winden and Woets, 2004).

The improvement of Internet access and digital connectivity is a long-standing policy priority for the European Commission, to improve access to services and overcome spatial disparities in opportunities across different regions.

In 2010, the Commission (European Commission, 2010a, 2010b) established different target to be reached so that European citizens can have access to Internet connection: every European should have access to 'basic broadband' up to 30 Mbps by 2013, and over 30 Mbps by 2020, with at least 50% of citizens with an Internet connection over 100 Mbps. In 2016, new targets have been set up for 2025, aiming at all households, regardless of their degree of urbanisation, to have access to at least 100 Mbps (European Commission, 2016).

Despite all efforts and several funding dedicated to the scope, less than 50% of EU population living in rural areas would have access to a 30 Mbps broadband coverage in 2018 (ECA, 2018). A 2022 JRC report (Sulis and Perpina, 2022) dedicated to territorial disparities presented similar results, showing how targets for 2020 were not reached in many of the Member States, and that a significant digital divide existed between urban and rural areas across all regions in Europe. However, improvements in access to fast broadband connections can be observed in the recent years across several European regions.

The objective of this report is to analyse and map spatial patterns of access to the broadband network across different areas in the EU27. This type of analysis is critical to understand better the needs of different places, also in terms of quality of the broadband connection (i.e., broadband speed). The quantitative evidence presented in this report can inform policy of the current situation, highlighting which areas to target through place-based strategies and initiatives. Access and, more importantly, adoption of broadband might help to foster economic and social development, particularly in rural areas (Whitacre et al., 2014), where private investment in Internet network infrastructure is generally less appealing than in more populated areas like cities.

This report is structured as following: a brief description of data and methods, followed by the analysis of broadband performance at country level and per degree of urbanisation. Analysis also includes the identification of territorial disparities across different European regions in terms of performance change over time, deviation from country averages, and minimum performance threshold. The report ends with a discussion on results and the way forward.

2 Data description

The data provide geo-localised information about the performance of the fixed and mobile broadband networks. Spatially, the data are available for all the 27 EU Member States at grid level. Data are available from 2019 to 2024.

The data provide actual, real-world measurements of the network performances. The measurements are produced by users testing their own Internet connection (both fixed and mobile one) through the Speedtest® application. The way the data are produced lead to a high granularity of the spatial information that is not available with other data sources on the same topic. This method can also result in some bias in the data, in terms of coverage and representativeness, that will be discussed later.

The data are pre-processed by the provider, which aggregate and average the main technical components at grid level. Each tile (600x600 m) contains several attributes related to the network performance for both the fixed and the mobile network.

The fixed network is a non-cellular connection type (e.g., Wi-Fi and Ethernet).

The mobile network is a cellular connection type (e.g., 4G LTE and 5G NR).

The main attributes included in this analysis are:

— the average download and upload speeds, measured in Mbps, calculated for each tile.

— the latency, representing the responsiveness of the connection, measured in ms.

— the number of tests taken in each tile.

For this specific analysis, the temporal coverage spans from 2019 to 2024. Data have been aggregated to produce an annual median value at country level to compare and observe the performance improvements over years across all Member States. When calculated at municipal (LAU) level, indicators have been calculated as weighted averages using the number of tests taken in each tile as weights. This method makes it possible to minimise potential geographical discrepancies and limit the presence of measurement outliers (for example, only one unique test with very high or low speed per spatial unit).

As previously mentioned, the data are available for all 27 Member States at very fine granularity. However, the way in which measurements are produced can result in missing information for some areas, especially inner and rural areas in the countries of Spain, France, Greece. This fact may be related either to a lack of population in the areas, a lack of network connectivity reaching the areas, or a low level of digital literacy that influence the possibility of users testing their own Internet connection.

Regardless of this well-known limitation, the dataset provided by Ookla represents an invaluable data source for measuring digital accessibility across different European regions, and in fact has been previously successfully employed by several international bodies such as OECD (2021) and the World Bank, and it has also been used in the latest Cohesion Report (Sulis, 2024).

3 Data analysis: descriptive statistics and performance

This section presents the main results obtained from the statistical analysis of broadband performance at country and municipal level. The analysis has been performed for all 27 EU Member States to compare network performances across different territorial characterisations.

3.1 Broadband performance 2019-2024 at the national level

Table 1 presents the values for median download speed for fixed and mobile networks for the year 2024. The EU 27 median speed is 151 Mbps for the fixed network and 82 Mbps for the mobile network. Most EU countries shows a higher speed value for fixed network than for mobile network, with approximately half of the countries reaching a median speed higher than the EU median for fixed network. Cyprus and Greece present a median speed value for fixed network under 30 Mbps, the lowest value across all Member States. Regarding mobile network, most of the countries present median speed value higher than the EU median, and all countries reach a median speed value over 30 Mbps. Most of countries show a significant or very significant gap between median values for fixed and mobile networks, revealing different development status in the two infrastructural networks. For some countries, the gap is particularly important, as in Spain Hungary, or Romania, whereas other countries, such as Denmark, Austria, and Lithuania present a more balanced situation in terms of overall network performances.

One interesting aspect to consider is the improvement of network performances over time. The data allow to analyse the performance trends between the years 2019-2024, for both the fixed and the mobile network.

Figure 1 shows the median download speed for the fixed network in the 27 Member States and the entire EU. One can notice how there have been differences in network performance across different countries since the beginning of the records in 2019.

Overall, three main trend groups can be observed, based on the variation of performance across years. In the first group, countries start with quite a good performance already (median over 50 Mbps in 2019) and progress in the improvements over the years. The second group includes countries that started with quite low median values in 2019 but experienced a noticeable improvement in performances, catching up with the countries in the first group in 2024, with country median values above 151 Mbps (EU median value). Finally, the third group represents countries that started with values below the EU median in 2019 and are still below such median in 2024. Some of these countries do not reach a median value of 50 Mbps in 2024.

Figure 2 shows the median download speed for the mobile network in the 27 Member States and the entire EU. The situation appears quite different from the fixed network, with a more homogeneous pattern of improvement in performances across time, except for the outlier of Denmark.

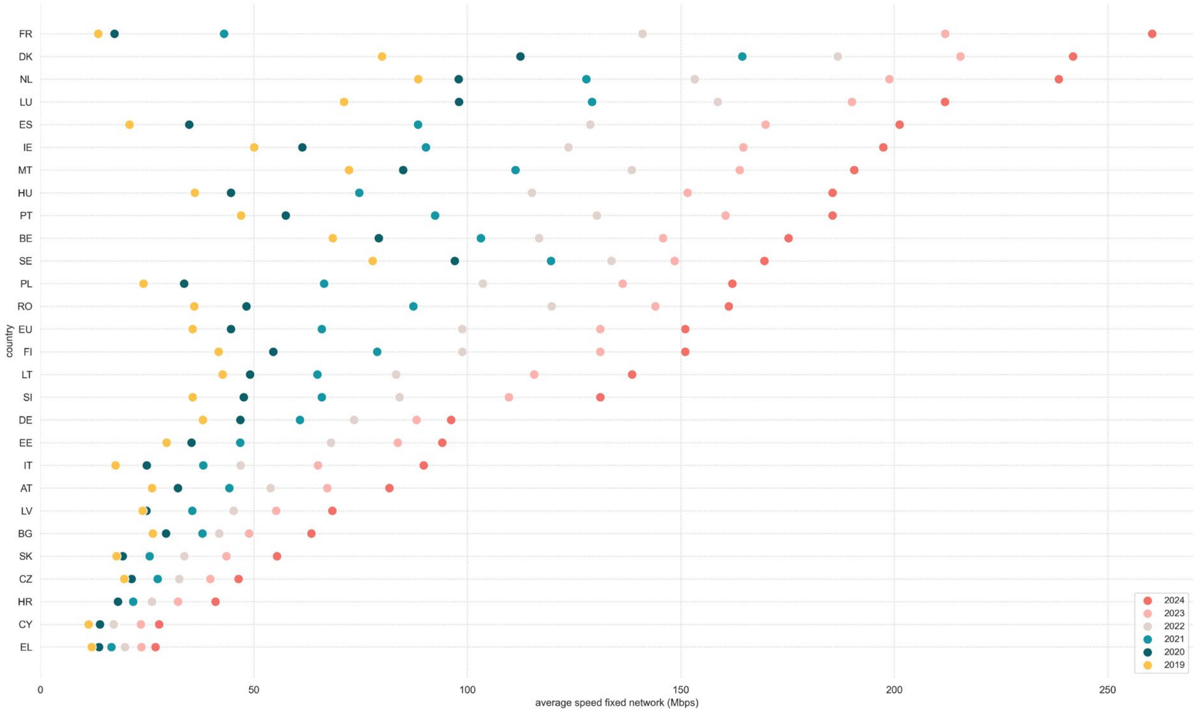
It is also interesting to notice how many countries that appeared to be below the EU median for fixed network here are above the median (see Greece, Latvia, Lithuania, etc.). One possible explanation is that they relied more on the mobile network infrastructure and antennas in areas that are sparsely populated or difficult to be reached with the fixed network (although high-speed must be supported by fibre backbones even for mobile network). This aspect has been observed even in other areas of the world.

Table 1. Median download speed for fixed and mobile networks at country level for 2024.

country	year	median fixed (Mbps)	median mobile (Mbps)
AT	2024	81.73	82.26
BE	2024	175.23	80.22
BG	2024	63.46	118.28
CY	2024	27.8	59.08
CZ	2024	46.4	53.12
DE	2024	96.19	56.06
DK	2024	241.86	213.15
EE	2024	94.12	133.85
EL	2024	26.94	83.12
ES	2024	201.24	45.51
FI	2024	151.03	113.2
FR	2024	260.4	72.36
HR	2024	41.0	88.68
HU	2024	185.54	42.28
IE	2024	197.42	67.8
IT	2024	89.77	79.24
LT	2024	138.58	138.26
LU	2024	211.86	109.3
LV	2024	68.37	94.6
MT	2024	190.61	85.3
NL	2024	238.54	129.31
PL	2024	162.06	61.55
PT	2024	185.53	55.13
RO	2024	161.23	33.54
SE	2024	169.57	104.43
SI	2024	131.14	85.52
SK	2024	55.41	39.09
EU	2024	151.03	82.26

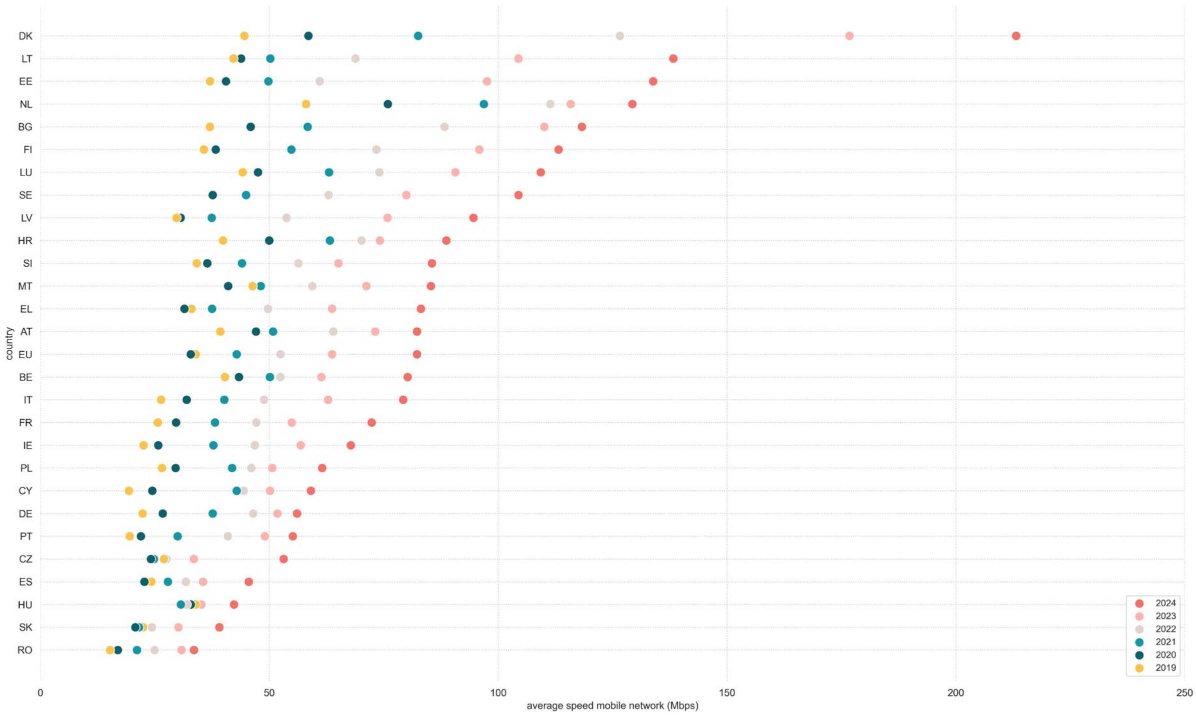
Source: Author's elaboration on Speedtest data 2024.

Figure 1. Median download speed for fixed network at country level for 2024



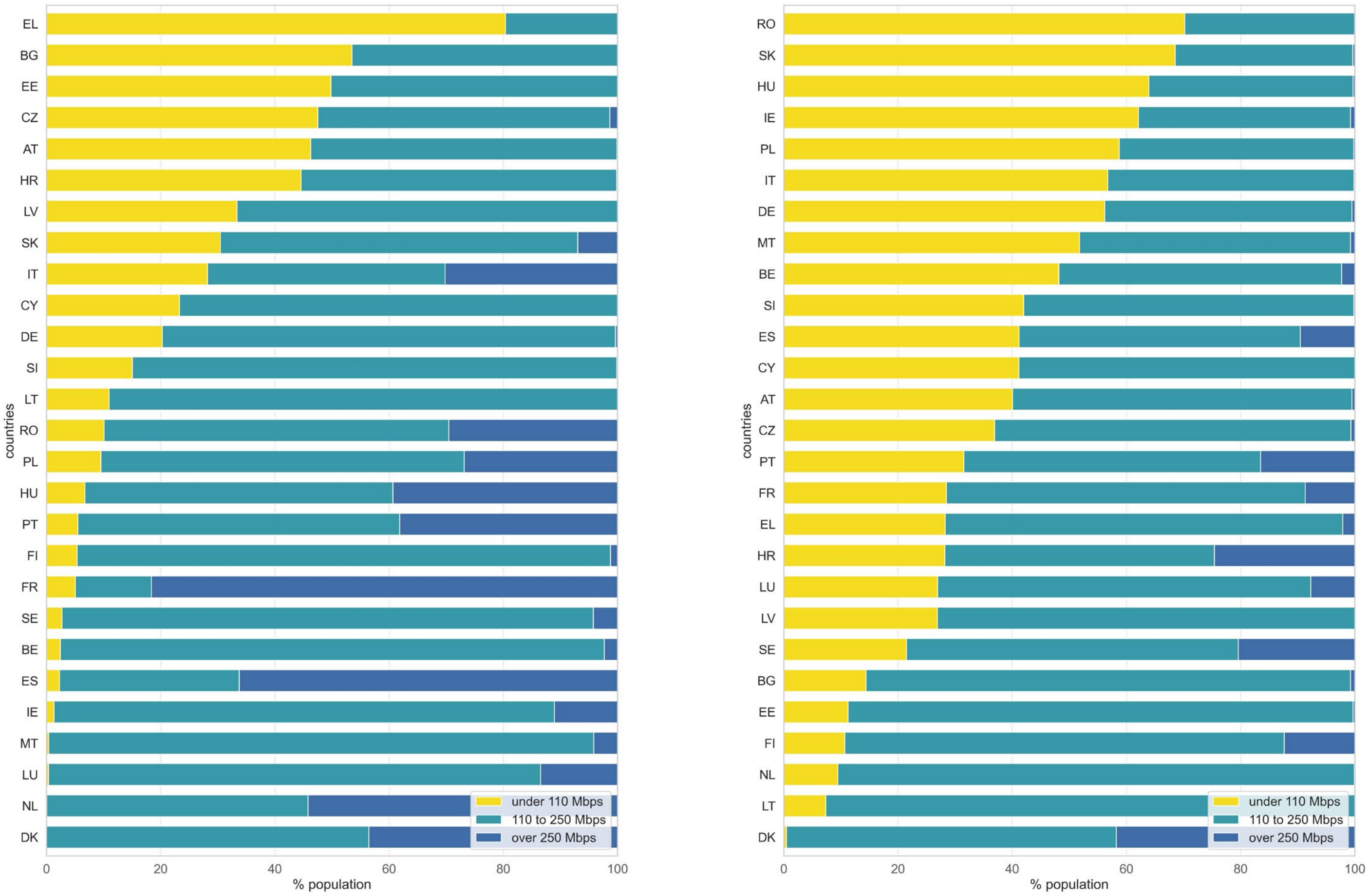
Source: Author's elaboration on Speedtest data 2024.

Figure 2. Median download speed for mobile network at country level for 2024



Source: Author's elaboration on Speedtest data 2024.

Figure 3. Share of population with access to different download speed class for fixed (left) and mobile (right) networks at country level for 2024



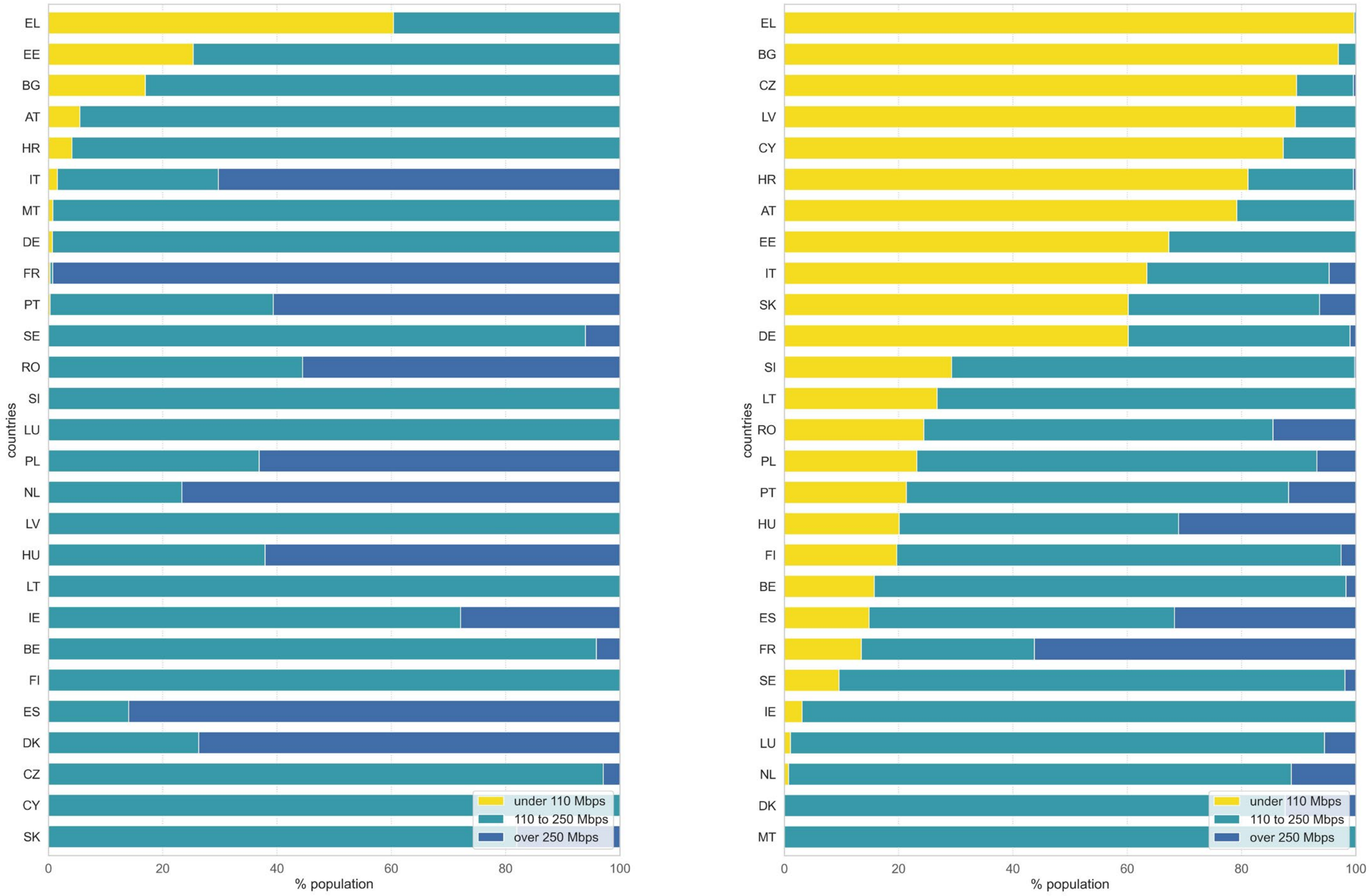
Source: Author's elaboration on Speedtest data 2024.

One critical aspect to evaluate is the percentage of people that have potential access to the best-performing broadband network. To do so, the analysis calculated the share of population living in areas characterised by different speeds. The analysis considered the resident population for the year 2021 and calculated the percentage of population of each country that can potentially have access to different network performances.

Results in **Figure 3** show that, for most of the EU countries, more than half of the population can access to network performances higher than 100 Mbps (with the noticeable exception of Greece). The 2024 situation appears in line with the analysis performed for previous years (Sulis et al. 2022), with almost the entire population of Denmark, the Netherlands, Luxembourg, and Malta having potential access to very high-speed connection (reaching 250 Mbps and over). It is relevant to observe the case of France and Spain: even at this highly aggregated level, results show most of the population covered by network performance over 250 Mbps. Overall, the situation at the country level greatly improved for all countries, compared to what was observed in a similar analysis with data from the year 2021.

When considering different territorial characterisation (urban, towns, and rural areas), results tell quite a different story, highlighting the well-known urban-rural divide from a digital perspective. **Figure 4** presents the share of population accessing different network performances on areas classified as cities (left) or as rural (right). The difference in network performance between the two territorial categories is striking. Few people (10% or less) living in areas classified as cities have access to a service that performs below the threshold of 110 Mbps, except for Greece. Denmark, France, Italy, Spain, and the Netherlands show the highest share of population in cities with access to a very fast broadband connection (250 Mbps and over). The situation for rural areas (**Figure 4** on the right) is rather different, with most of the resident population having access only to the lowest speed class in many countries. Even considering how some countries (such as the Netherlands or Denmark) have fewer areas classified ‘rural’ than others, still it is evident how this digital divide greatly affect rural areas and contribute to aggravating the condition of territorial disparities already identified in previous analyses (Sulis et al., 2021) and that persists across European regions.

Figure 4. Share of population with access to different download speed class for fixed network at country level for areas classified as cities (left) and rural (right) for 2024.

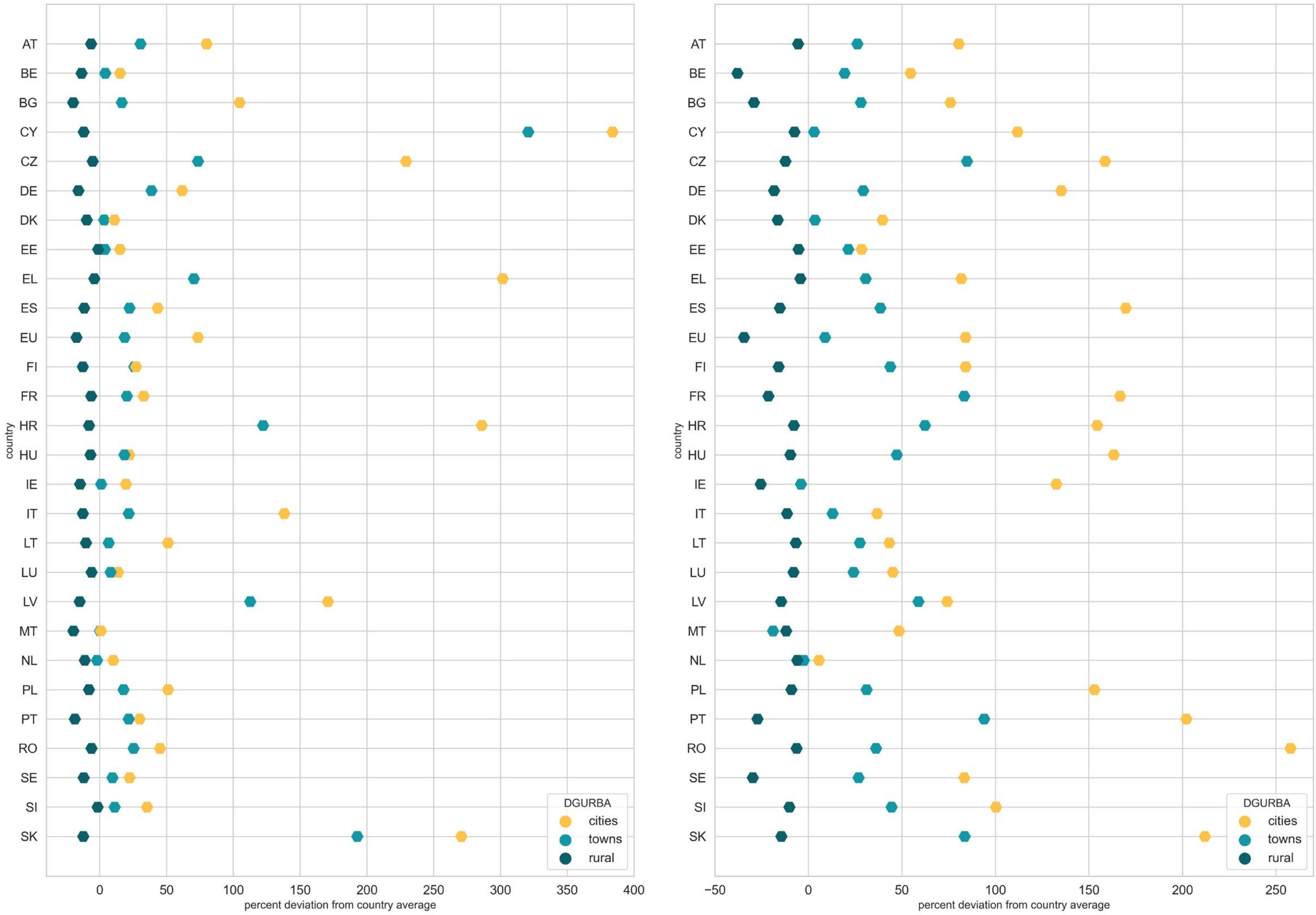


Source: Author’s elaboration on Speedtest data 2024.

3.2 Broadband performance 2019-2024 per degree of urbanisation

The digital divide highlighted in the previous section is also confirmed when analysing the difference between the country median and the median for each Degree of Urbanisation (DGURBA) territorial classes, illustrated in **Figure 5** and **Figure 6**. The analysis performed on fixed network data shows how, in rural areas (in dark blue in **Figure 5**), speed performances are lower than the median speed calculated for the entire country. Towns (in green) show a better performance (generally up to 50% higher than country median), together with cities (in yellow), which present the highest gap in speed performance (see Cyprus and Greece). The smaller the gap, the less disparities in network performances across different areas.

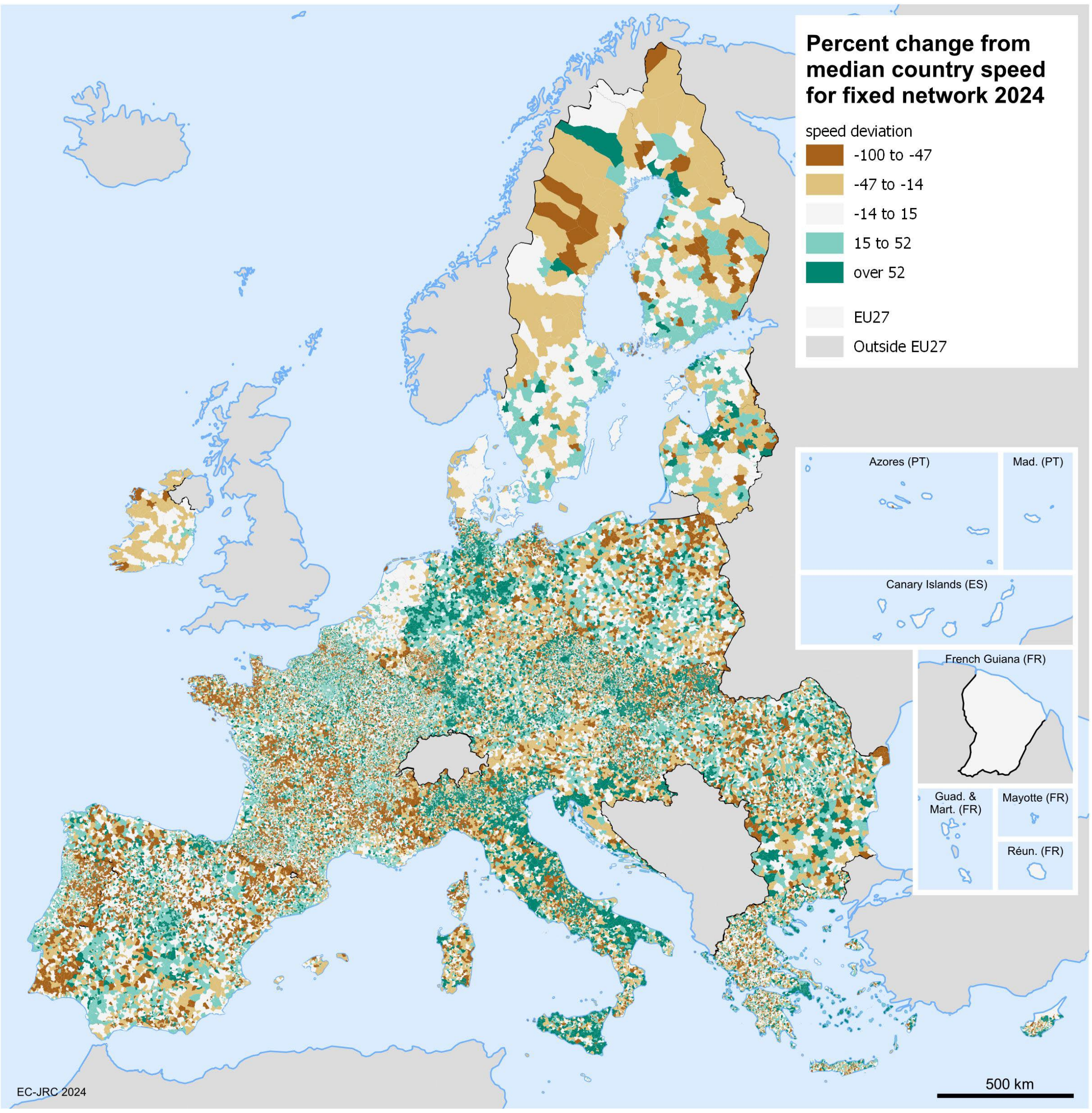
Figure 5. Percent deviation from median country speed for fixed (left) and mobile (right) networks at country level for 2024.



Source: Author's elaboration on Speedtest data 2019-2024.

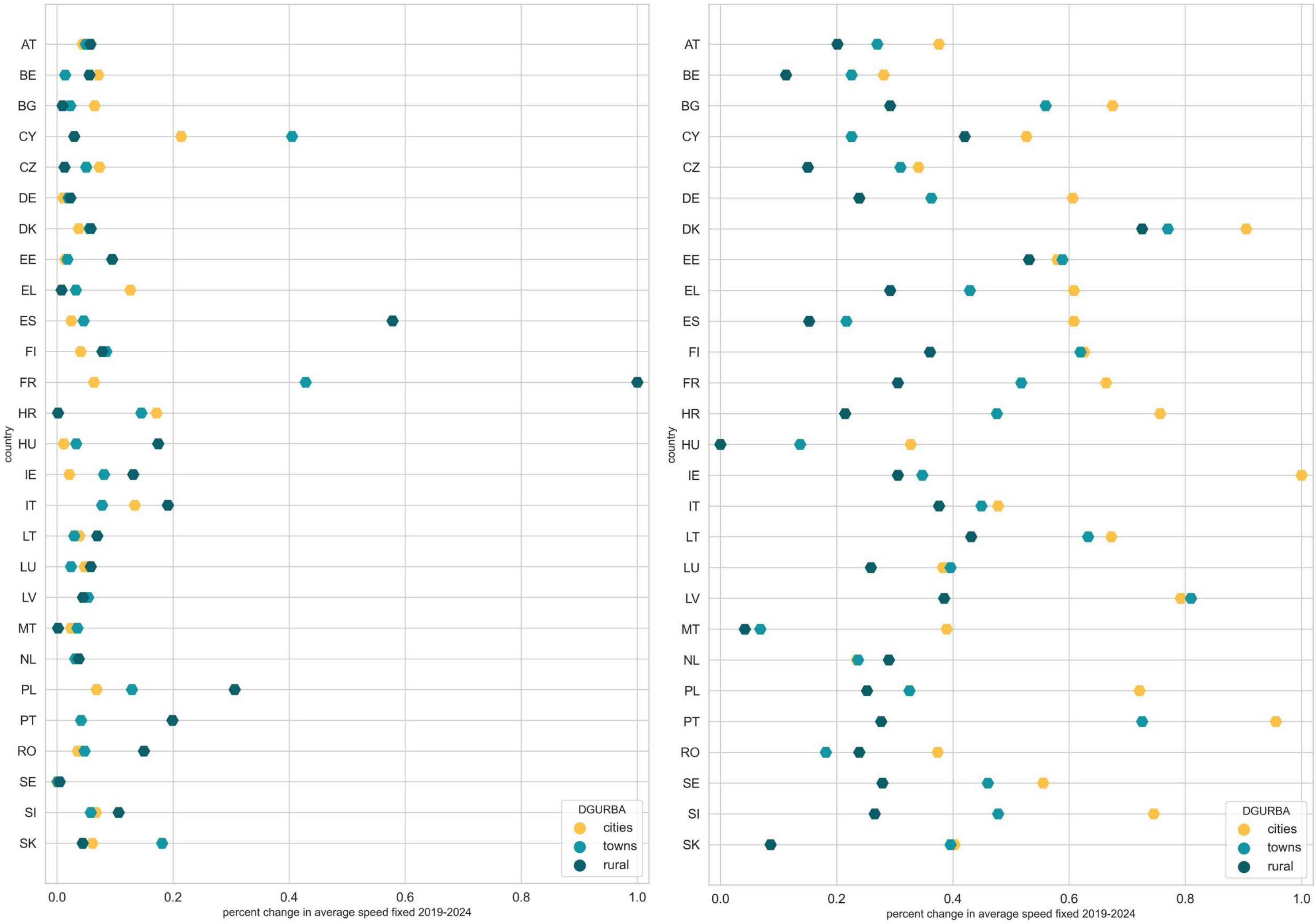
A similar pattern can be observed also for the mobile network (**Figure 5** on the right), with rural areas underperforming when compared to the country median in all EU member states. Once again, cities outperform other territorial classes in terms of speed performance if compared to the country median, with many countries showing significant gaps in speed performances between cities, towns, and rural areas. The localisation of spatial differences in speed performances at municipality level are illustrated in **Figure 6**.

Figure 6. Spatial patterns of percent deviation from median country speed for fixed networks at municipal (LAU) level for 2024.



Source: Author's elaboration on Speedtest data 2024.

Figure 7. Percent change of median speed for fixed (left) and mobile (right) networks at country level for 2019-2024.

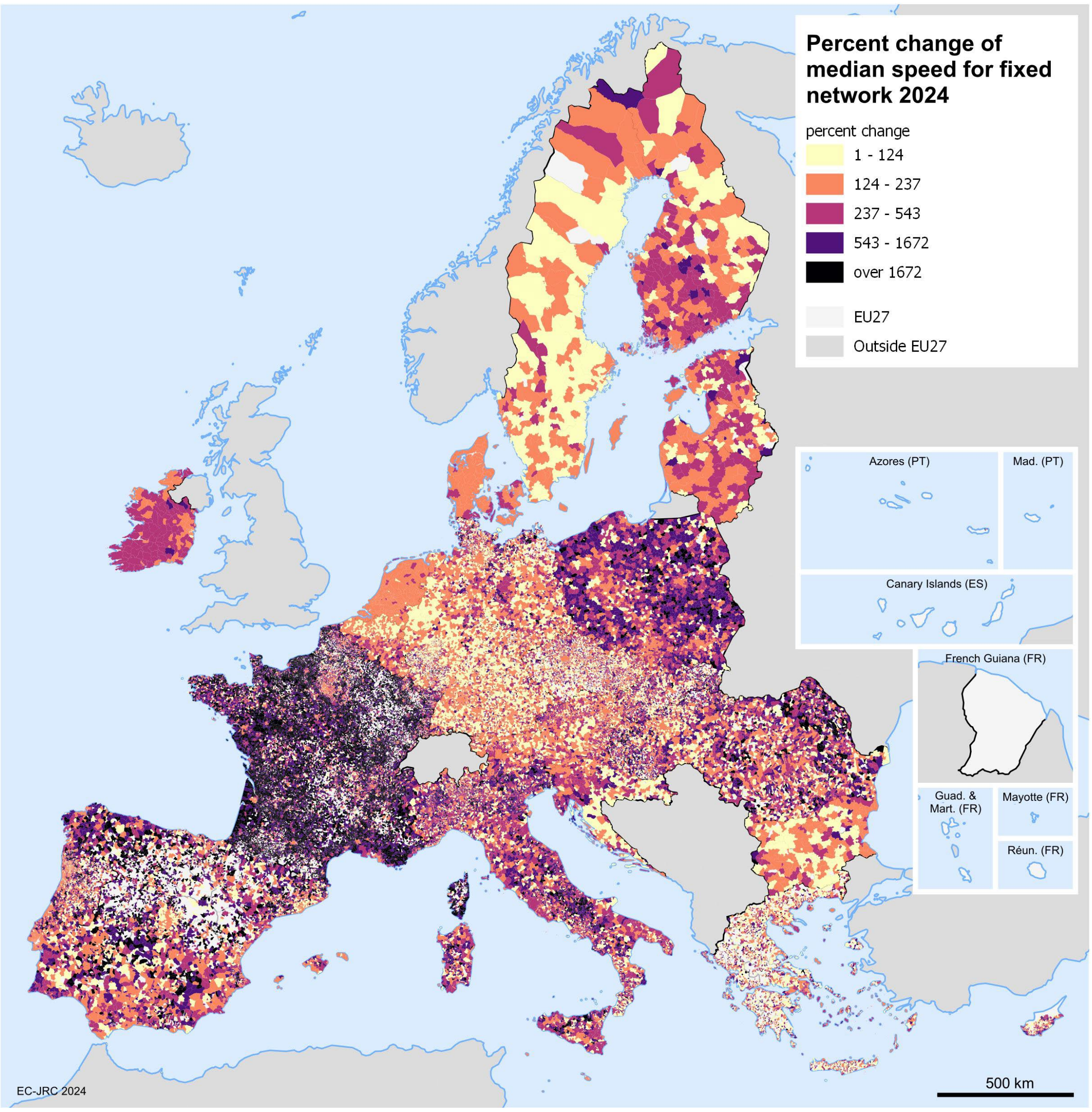


Source: Author's elaboration on Speedtest data 2019-2024.

A closer look at the performance trends for the fixed network from 2019 to 2024, presented in **Figure 7** (left), show that in recent years rural areas (in dark blue) outperformed both towns and cities in terms of increase in speed performances in several countries. In some of them, such as France and Spain, the increase has been particularly significant, also driving the country median speed up. Noticeable increases in the fixed network performance can also be observed in Poland, Portugal, Romania, and Hungary. Despite the evident improvement in performance, this was still not enough to catching up and closing the gap with urban areas, levelling up the rural areas to the rest of the country. Improvement in performance for the mobile network (**Figure 7** on the right) shows a different pattern, with cities ahead in many countries in terms of speed increase. Towns and rural areas show significant improvements in performances too, generally higher than the fixed network.

The localisation of change in speed performances between 2019 and 2024 at municipality level are illustrated in **Figure 8**.

Figure 8. Spatial patterns of percent change of median speed for fixed networks at municipal (LAU) level for 2019-2024.



Source: Author's elaboration on Speedtest data 2024.

3.3 Broadband performance for different users and digital divide

To identify underserved areas in relation to digital accessibility, actual measurements of broadband performance in Europe have been used to determine the availability and the quality of the service across different areas. Performance thresholds are needed to evaluate well-served and under-served places across different regions in Europe.

Previous work on digital accessibility (Sulis et al. 2022; Spadafora 2022; Feijóo et al. 2018) suggest standard threshold for average download speed as follows:

- from 0 to 30 Mbps (web surfing, e-mail, social networking, and moderate video for one or two devices).
- from 30 to 100 Mbps (multiple devices and online multiplayer gaming and 4 K streaming).
- over 100 Mbps (more devices and sharing large files and live streaming video).

Differently from previous approaches, for this report a composite indicator has been developed in order to assess the overall performance of the broadband network as a service. To do so, a threshold was needed to define the minimum requirement for satisfactory network performance.

Different uses of the Internet connection would require different performance characteristics: the most common tasks such as web surfing or standard video streaming are not particularly demanding in terms of bandwidth. For example, a download speed of 5 Mbps or higher and a latency of 100 ms per person is sufficient for an optimal experience in browsing the web or watching a 360p SD (standard definition) video online. To experience higher resolution video streaming (4K) services, such as those commonly offered nowadays by several streaming platforms, a download speed of 20 Mbps or more and a latency of 50 ms or less per person would be needed. Other activities, such as telework, videoconferencing, or online gaming, would also require a quite robust upload speed to guarantee a smooth experience for multiple users in the same household.[1]

This analysis applies a comprehensive approach to the performance of the broadband network and considers different technical parametres, including the responsiveness of the connection in activities such as video calling and other remote working-related tasks[2]. For example, for teleworking, the performance of parametres such as upload speed and latency might have a greater impact on the overall connection experience than download speed, which was regarded as the primary focus of recent analyses and policy targets. Another aspect to consider when evaluating broadband performance for the average (non-business) user is how the bandwidth allocated to download speed is generally higher than that to upload speed, with ratios depending on technology that can reach up to 10:1.

[1] The minimum download speed recommended for telework is generally between 5-25 Mbps per person. Therefore, technical requirements for telework would be satisfied within the capabilities of a basic broadband service of up to 30 Mbps (although this would also depend on the number of users per household). This level of service was already widely available in 2020 in cities, towns and suburbs across the EU, though not in many rural areas (see Sulis, 2022).

[2] Microsoft Teams recommends 4Mbps in both download and upload for best performance in video meetings, which would require high-speed broadband, especially considering multiple users per household.

Considering all these elements, and the improvements on network performance in European countries in the latest years, the thresholds selected for the analysis represents a varied and quite intensive use of the broadband connection, in order to cover different online activities, including video meetings, beyond the most basic ones.

The composite indicator is defined by following minimum requirement thresholds for satisfying an acceptable network performance per person in each household:

— 25 Mbps or higher for the download speed.

— 3 Mbps or higher for the upload speed.

— 100 ms or lower for latency.

These thresholds represent the minimum requirement per person for a smooth experience for video streaming (4K) and remote working (e.g., video calls, and document sharing).

Areas are classified according to broadband performance for the fixed network into three classes:

— Areas below the threshold with insufficient network performance (class 3)

— Areas above the threshold with satisfactory network performance (class 2)

— Areas above the 75th percentile of all areas above the threshold with best network performance (200 download speed, 20 upload speed, 25 latency) (class 1)

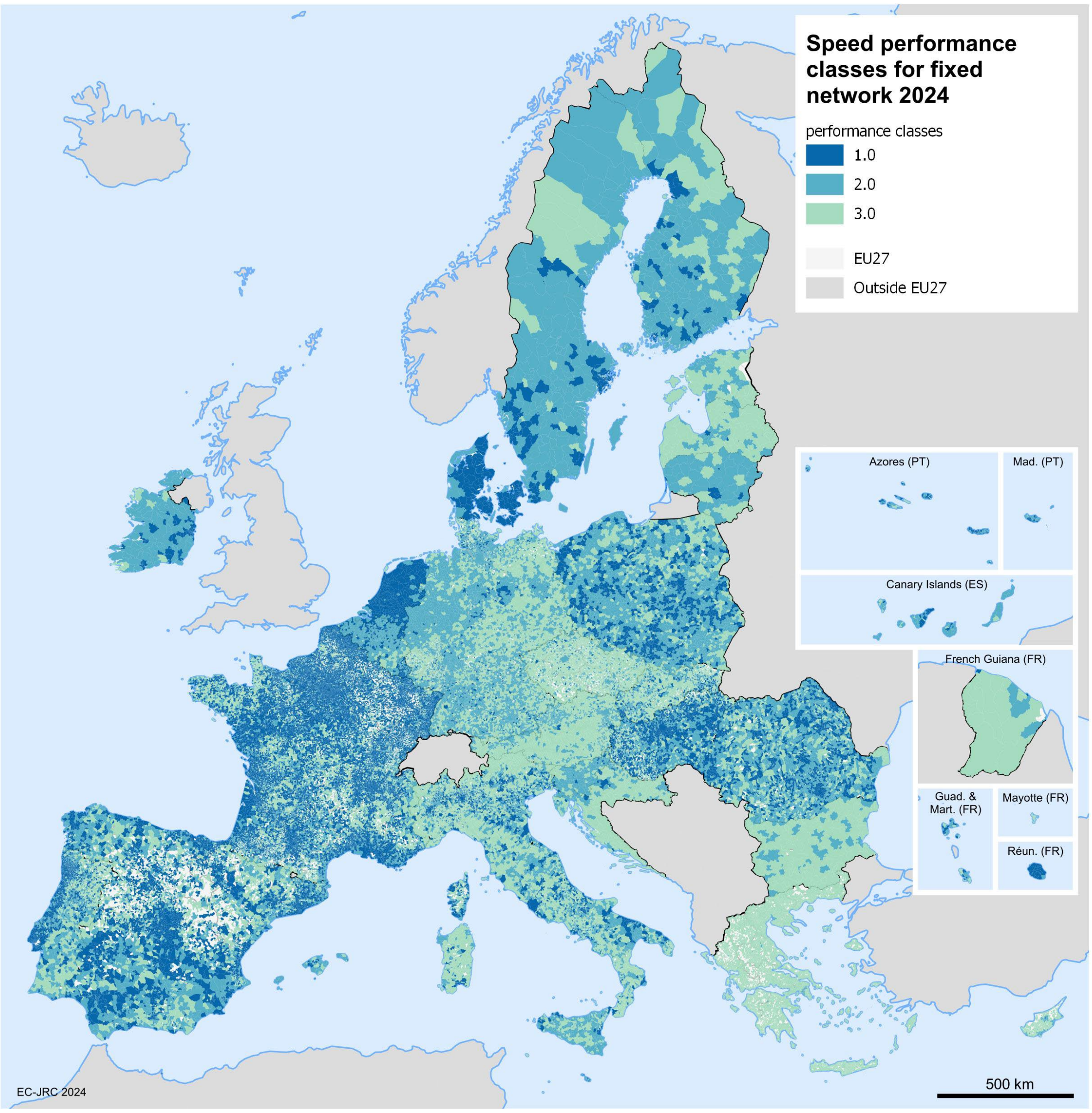
Table 2. Thresholds for performance classification.

classes	**download speed**	**upload speed**	**latency**
class 1	>= 200 Mbps	>= 20 Mbps	<= 25 ms
class 2	>= 25 Mbps	>= 3 Mbps	<= 100 ms
class 3	< 25 Mbps	< 3 Mbps	> 100 ms

Source: Author's elaboration on Speedtest data 2024.

Figure 9 illustrates the spatial patterns of performance classification at municipal level for the year 2024. The map shows a heterogeneous situation across and within EU countries. The overall situation appears satisfactory, with many municipalities across all countries belonging to class 2 (therefore over the minimum performance threshold), and some countries such as The Netherlands and Denmark almost entirely classified in the highest performance class (represented in deep blue in the map in Figure 9). On the other hand, several municipalities in Greece, Bulgaria, Croatia, Austria, and Eastern Germany appear lagging behind and not meeting the minimum threshold for a satisfactory broadband connection. Other countries, such as Romania, Poland, Hungary, and Italy, present a patchy situation, while the noticeable improvements in network performances are evident for France and Spain.

Figure 9. Spatial patterns of performance classes for fixed networks at municipal (LAU) level for 2024.



Source: Author's elaboration on Speedtest data 2024.

4 Conclusions

Territorial development and digitalisation are intertwined elements. Therefore, identifying which areas have access to broadband network with good performance and which not is of paramount importance to inform territorial policies that target marginalised areas and residents with the aim of improving the current conditions.

In this analysis, spatial information on broadband network performance is employed to analyse patterns of digital accessibility and territorial disparities across regions in the EU27. Results show that over the last years there has been a generalised improvement in broadband performance across all EU Member States, particularly noticeable in France, Spain, Poland, and Romania. The analysis also revealed how, for most of the EU countries, more than half of the population can access to network performances higher than 100 Mbps. Whereas performance differences between cities and rural areas are still significant, results also show that in recent years the highest percent change in speed performance occurred in rural areas for several EU countries. This is a promising signal of the current effort to bridge the digital gap across territories in many European countries, also envisioned by several Commission policy documents, including the 'Long-Term Vision for EU's Rural Areas' published in 2021 (see also Perpina et al, 2021).

Improvements in network performances, possibly boosted up by the Covid-19 emergency in 2020, progressed further in the following years, leading to significant jumps in network performance for several rural areas, particularly in France and Spain, that were not meeting the minimum threshold of 30 Mbps previously set up by the Commission (2010). This aspect leads to some interesting territorial patterns to be observed, especially in the analysis performed at municipality level. It can be noticed how towns and rural areas in some countries show higher performance than cities, especially in the fixed network. This aspect can be related to the fact that improvements are not gradual but sudden due to the advancement in broadband technology (i.e., copper lines replaced by fibre altogether or even by satellite technology in very remote areas).

It is important to mention an aspect related to the representativeness of the data source employed. Measurements on broadband performance are produced through voluntary testing by users via the Speedtest® app. Due to this, spatial information is missing for some municipalities. For example, fewer records are available for scarcely populated areas classified as 'remote' in some countries (mostly for inner areas in Spain and France). Nevertheless, previous analyses performed with the same data source, both by the JRC and by other international research bodies (OECD, World Bank), showed how the spatial coverage and the representativeness of this data source for European countries are highly reliable. Results also showcase the usefulness and relevance of open big data sources to analyse emerging socioeconomic trends at high spatial and temporal granularity.

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