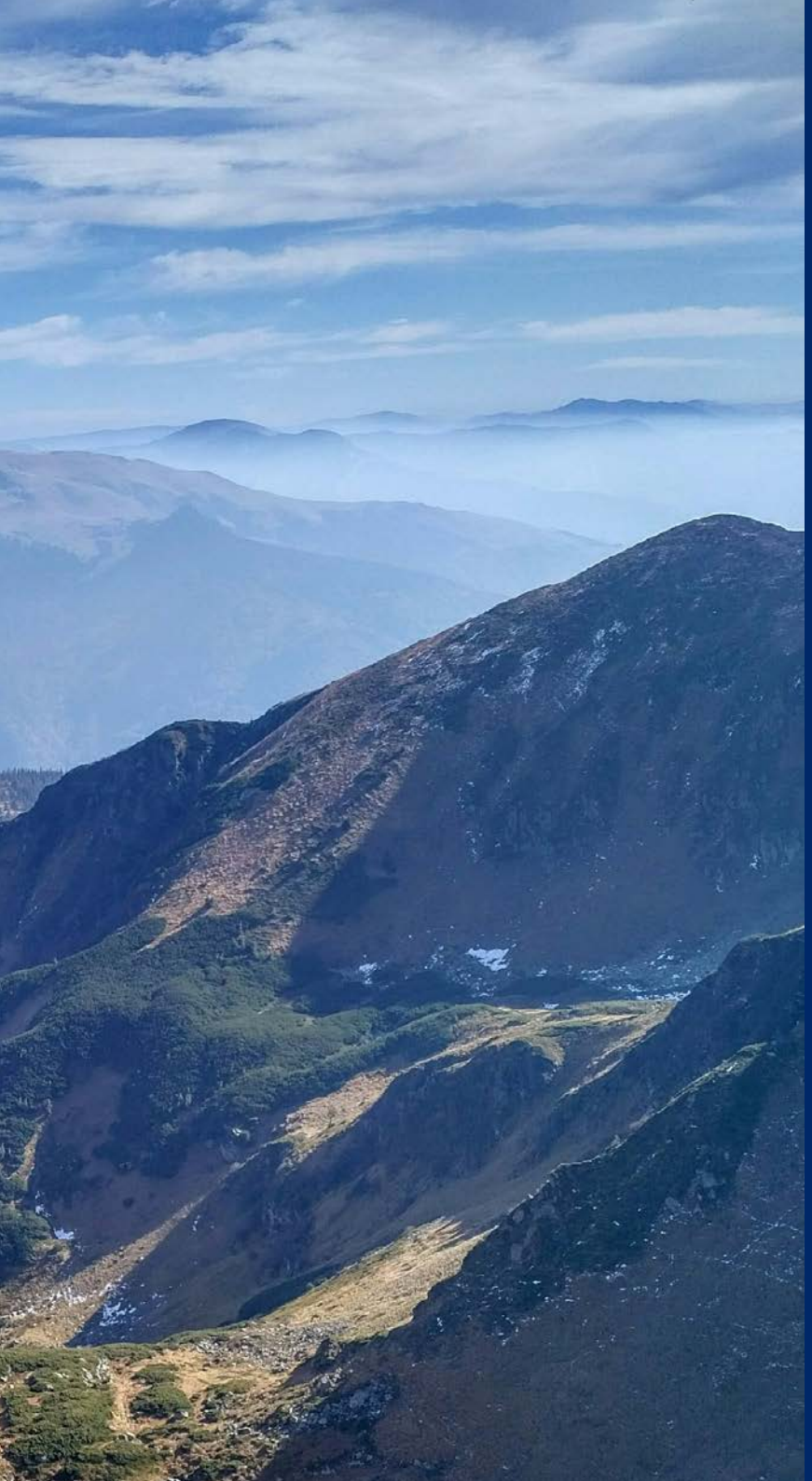

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Atlas of Carpathian Macroregion

Determinants and opportunities for the socio-economic and spatial development of the Carpathian region

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Carpathian Macroregion

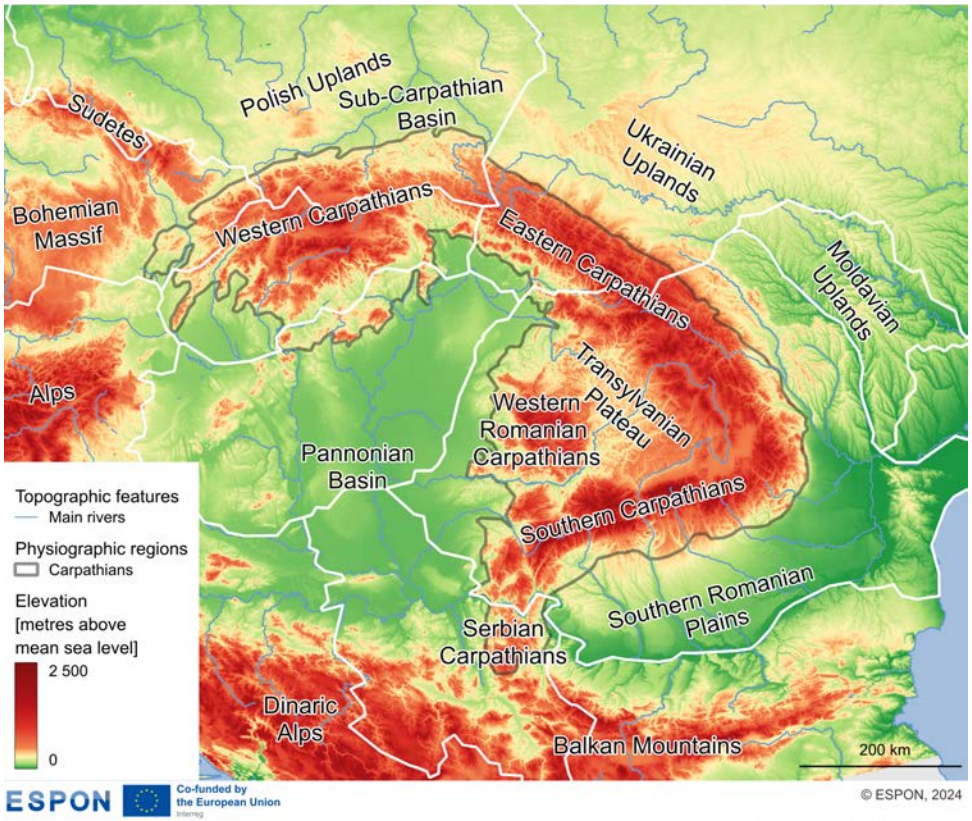
Carpathian macroregion – Study Area Delineation

The Carpathians are an extensive mountain system in Central and Eastern Europe, stretching approxi-mately 1,500 km across seven countries: the Czech Republic, Slovakia, Poland, Hungary, Ukraine, Romania, and Serbia. They are the second-longest mountain chain in Europe after the Alps, with their highest peak, Gerlach (2,655 m above sea level), located in the Slovak Tatras. The Carpathians are characterised by diverse landscapes, ranging from high mountains with alpine climates to forested ranges and valleys. This region holds significant natural and cultural importance, serving as a refuge for numerous protected species of flora and fauna, as well as being home to various ethnic groups who have preserved unique traditions and folklore.

- Western Carpathians, located in the Czech Republic, Poland, Slovakia, and Hungary, consisting of the Outer Western Carpathians, Central Western Carpathians, and Inner Western Carpathians, surrounded to the northwest by the Western Outer Subcarpathia and to the north by the Northern Outer Subcarpathia;
- Eastern Carpathians, located in Poland, Ukraine, and Romania, consisting of the Outer Eastern Carpathians and Inner Eastern Carpathians, surrounded to the northeast by the Eastern Outer Subcarpathia;
- Southern Carpathians, located in Romania and Serbia, including the Sub-Carpathians in Romania, as well as the Serbian Carpathians (Karpatsko-Balkanske planine);
- Western Romanian Carpathians and the Transylvanian Plateau in Romania.

The administrative structure of the Carpathian countries is diverse. At the regional level (NUTS2), administrative entities exist only in Poland (voivodeships) and Ukraine (oblasts). In other countries, this level is represented by either planning-statistical units, such as in Romania (macroregiunea) and Hungary (tervezési régió), or purely statistical units, as in the Czech Republic, Slovakia, and Serbia. Meanwhile, the Republic of Moldova can be treated as a single NUTS2 region, similar to the Baltic states. In most other Carpathian countries, the primary administrative regional structure is organized at the NUTS3 level. This includes Czech Republic (kraje), Slovakia (kraje), Hungary (megyék), Romania (județe), and Serbia (okruzi). In Poland, however, the NUTS3 level serves exclusively a statistical function, much like in the Republic of Moldova. In the latter case, administrative functions exist only in the autonomous region of Gagauzia, located in the southern part of the country. In Ukraine, following the administrative reform conducted in 2020, the rayon can be considered an equivalent to the NUTS3 level. However, due to the lack of available statistics at this level, especially for the

Map 1. Carpathian Mountain Range



Territorial level: NUTS0, 90 metre grid
Source: ESPON KARPAT, 2024
Origin of data: Copernicus GLO-90, Ecrins
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Map 2. Administrative/statistical divisions in Carpathian Countries and the Republic of Moldova – NUTS2 division

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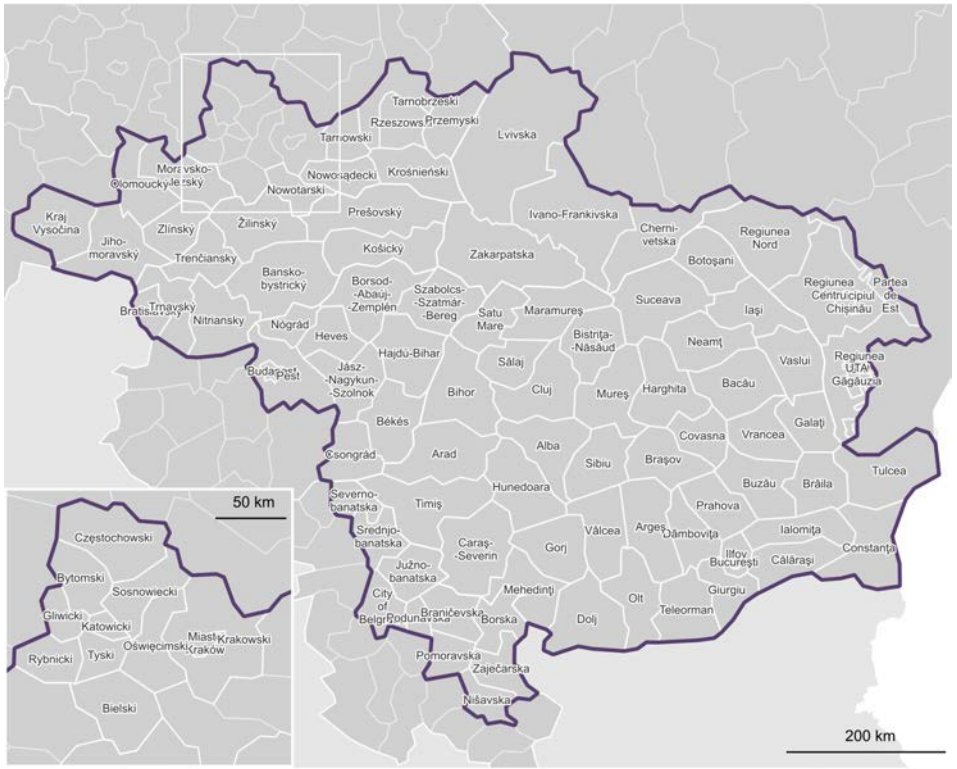
Territorial level: NUTS2
Source: ESPON KARPAT, 2024

Map 3. Administrative/statistical divisions in Carpathian Countries and the Republic of Moldova – NUTS3 division



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Territorial level: NUTS3
Source: ESPON KARPAT, 2024

period preceding the reform, Ukrainian oblasts are often treated interchangeably as NUTS2 or NUTS3 units in analyses, including this study, as is common in many other assessments.

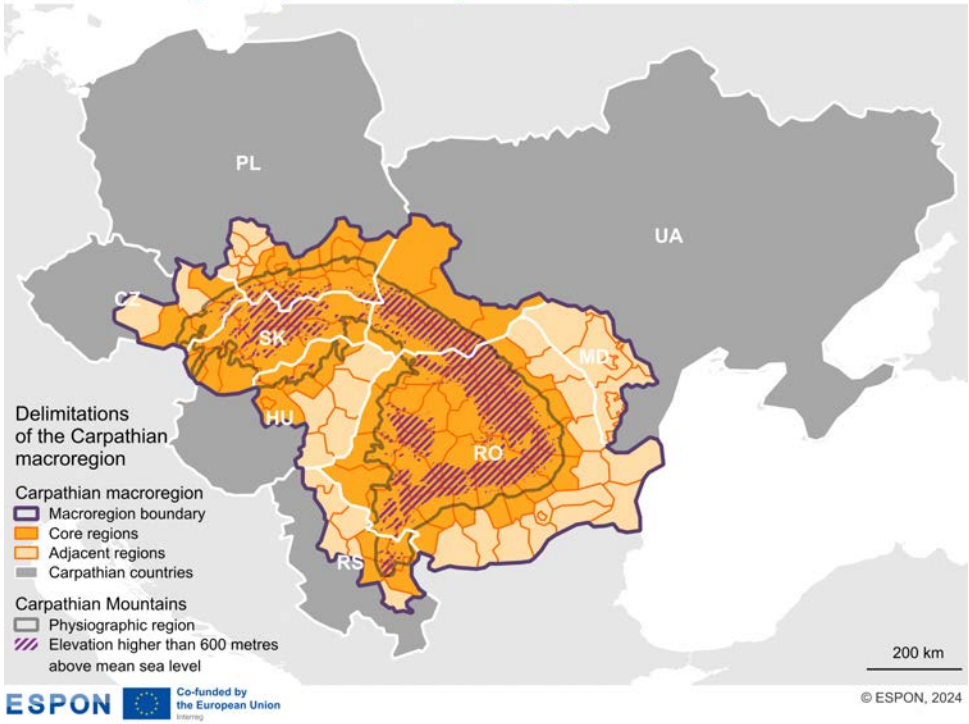
The delimitation of the Carpathian macroregion is not entirely unambiguous. This is due to different potential approaches to the region, which may be a 'cognition' region - defined by its characteristics and interactions, an 'action' region - as a place of implementation of actions and planning of public authorities, as well as a 'research' region - defined by aggregations of statistical units adjusted to the purpose of conducted analyses.

As a result of the use of physical-geographical and administrative-statistical criteria, we propose the following delimitation of the Carpathian macroregion (study area), based on the following two main princi-ples:

- Core regions: NUTS3 regions within boundaries of Carpathian Mountains (elevation above sea level of at least 600 metres and other parts of the Carpathian submountain areas) the in general follow Carpathian Convention area ,
- Adjacent regions: areas adjacent to the Carpathian Mountains: a) those which are part of NUTS2 regions (in the case of EU countries), that contain NUTS3 in the first category, b) other surrounding NUTS3 regions (or equivalent in non-EU countries) through which rivers originating in the Carpathian Mountains flow.

Thus delimited macroregion comprises 8 countries, including 7 signatories of the Carpathian Convention along with the Republic of Moldova. It consists of 102 NUTS3 level regions, which are part of 31 NUTS2 level regions. Among the former, 62 NUTS3 regions constitute the core area of the macroregion and another 40 are adjacent regions.

Map 4. Territorial coverage of Carpathian macroregion – study area



Territorial level: NUTS 0, NUTS 3
Source: ESPON KARPAT, 2024
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2

Determinants of Carpathian Macroregion Development

2.1. Natural and human geographies

Natural environment, protected areas

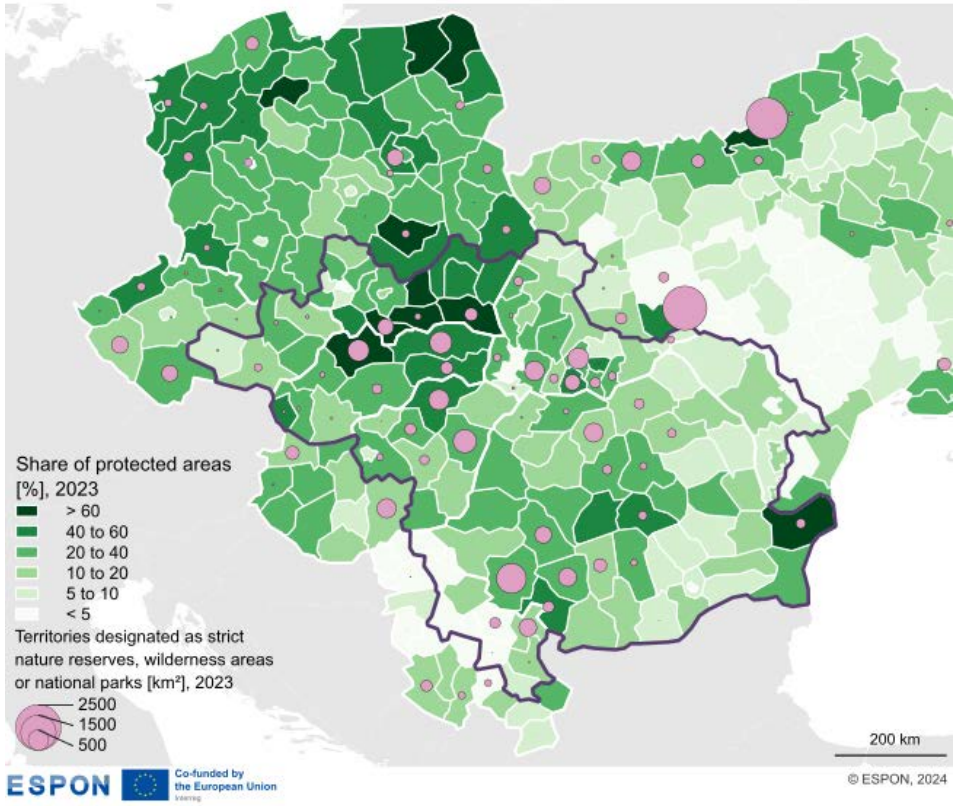
The Carpathian arc stretches over 1500 km across the central and eastern part of Europe, and covers an area of circa 190,000 square kilometres. With highest peaks exceeding 2,600 metres above the sea-level, the Carpathians encompasses a broad range of habitats ranging from lowland forests to alpine meadows and small patches of subnival zone. The Carpathian mountains are considered one of the key biodiversity hotspots on the continental scale. The region harbours the largest population of large carnivores (bear, wolf, lynx) in Europe, it also contains significant patches of natural (virgin) forests, i.e. forests that survived till modern times with only minimal human intervention.

The high biodiversity of Carpathian region necessitates an adequate level of protection. Each country has its unique system of protected areas, encompassing both country-specific forms of protection (eg. National or Landscape Parks), as well as elements of internationally recognized networks (eg. EU Natura 2000 sites or UNESCO World Heritage sites). Crucially, different forms of protected areas entail different protection regimes, and therefore vary in terms of effectiveness. Map shows both the total share of all protected areas in NUTS3 regions, and the size of strictly protected areas. The share of nationally-designed protected areas reaches up to 75% in regions of Tulcea (RO) (Danube Delta), Krośnieński and Nowotarski (PL) (Carpathian Mountains). However, protected areas that meet the IUCN strict protection criteria are much less common. In total, such areas cover only 9,000 square kilometers out of the whole Carpathian region, and are concentrated mostly in its Ukrainian and Slovakian part. This may raise concerns about the effectiveness of preserving the region's biodiversity.

The relatively high proportion of protected areas in EU countries can partly be explained by the extensive Natura 2000 network. On average, Natura 2000 sites cover 20.0% of NUTS 3 regions in the Carpathian area in EU Members States – slightly above the EU-wide average of 18.6%. This figure has re-mained stable over time, increasing from 19.5% in 2011. The average extent of Natura 2000 sites in NUTS 3 regions is slightly higher in the Carpathian core regions, reaching 23.9%. However, some NUTS 3 regions (Sibiu, Košický, Krośnieński) have approximately 50% of their area under Natura 2000 protection, and Tulcea – over 70%.

Mapping the biodiversity level is a complex task, and often the data at hand is not comparable between countries, and of a highly limited spatial scope. We use the monitoring data collected for Natura 2000 protected sites, to calculate the spatially-explicit biodiversity index. For each Natura 2000 site, the index takes into account the presence of a permanent population of 5 high-importance species , and global assessment of the value of a given site for conservation of the species concerned. The resulting map of biodiversity hotspots, overlayed with data on the share of a given NUTS3 region covered by Natura2000 protected sites. The 15 major biodiversity hotspots – with value of the biodiversity index above 7 – are located mostly in Slovakia and Romania (six sites in each country), the remaining sites are in Poland (two), and in Hungary (one). All of them are established in the core of the Carpathian region, but they are not necessarily located on high altitudes. A high degree of biodiversity can also be expected to characterize the Carpathian Mountains in Ukraine not covered by this analysis.

Map 5. Protected areas in NUTS3 regions, 2023



Territorial level: NUTS3
Source: ESPON KARPAT, 2024
Origin of data: UNEP-WCMC and IUCN (2024) Protected Planet:
The World Database on Protected Areas (WDPA)
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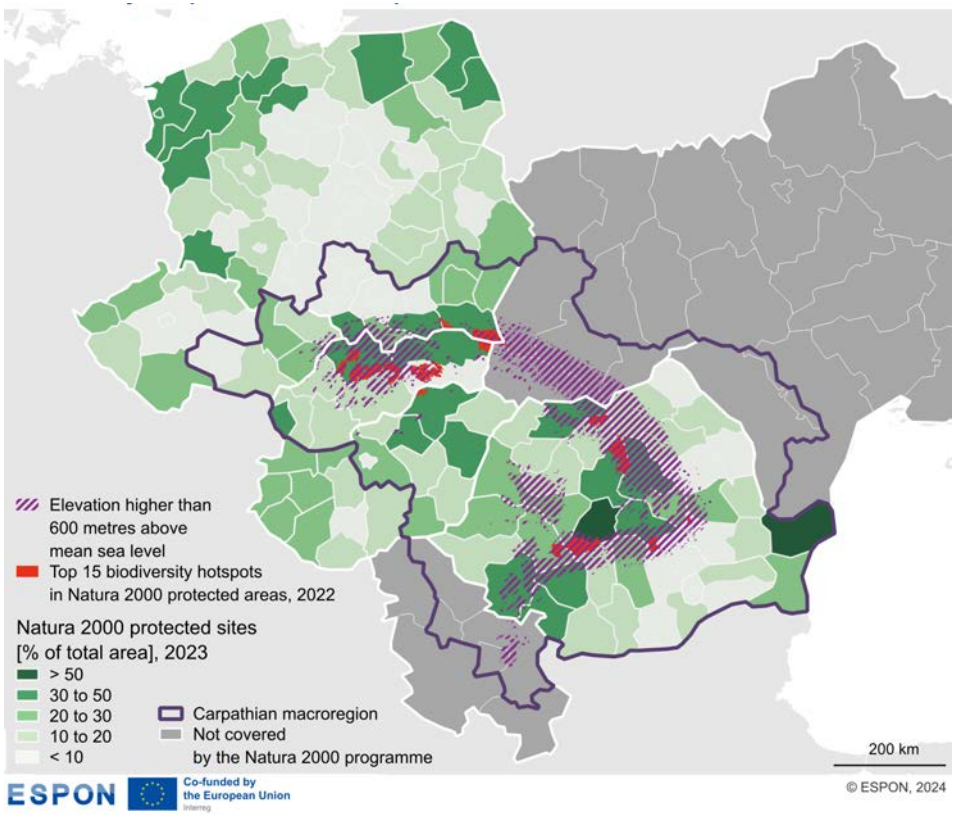
Map 6. Biodiversity hotspots in Natura 2000 protected sites, 2023



Territorial level: NUTS3
Source: ESPON KARPAT, 2024
Origin of data: European Environment Agency
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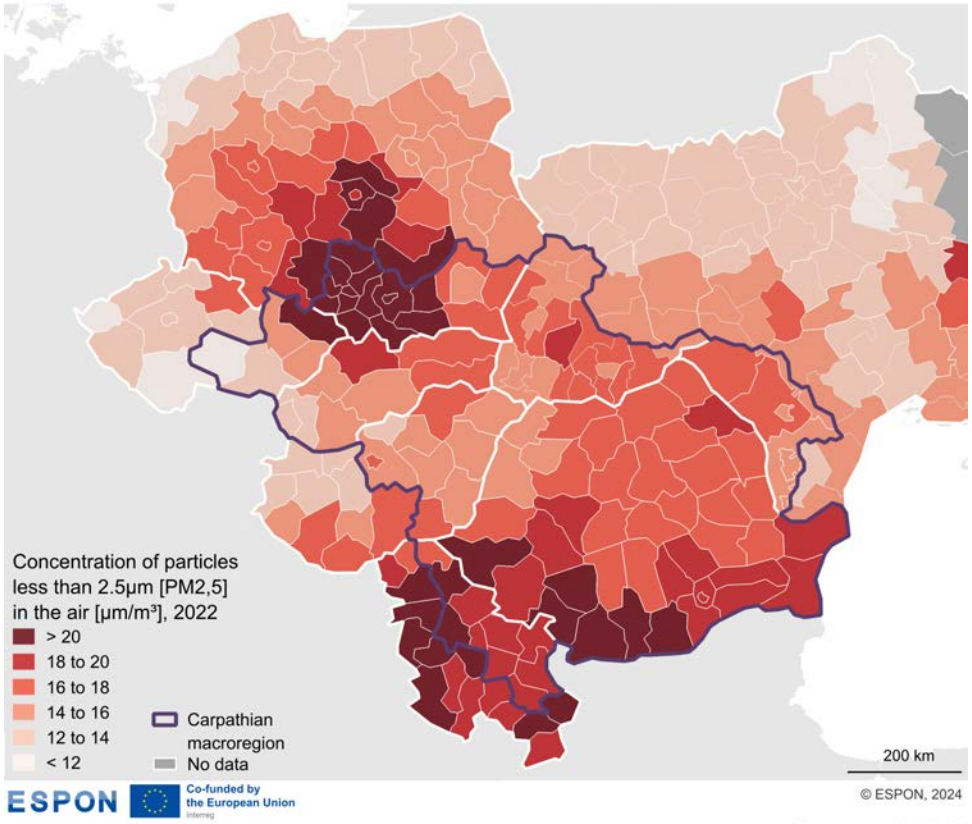
Air pollution

The quality of the environment is the function of both the state of natural endowment and pressure from anthropogenic pollution. With regard to the latter we focus on two indicators – air pollution and CO2 emissions from fossil fuels. Air pollution remains the leading environmental health risk in Europe, contributing especially to respiratory and cardiovascular diseases. Among various pollutants, the fine particulate matter PM2.5 has the widest negative impacts, with over 100 thousands premature deaths attributed to its excessive levels in Czechia, Hungary, Poland, Romania, Slovakia and Serbia combined. The revised WHO air quality guidelines recommended that the annual average PM2.5 concentration should not exceed 5 μg/m³ to ensure a safe and healthy environment. The actual PM2.5 levels in the Carpathian region range from 10 to 30 μg/m³, with the average for the region equalling 17.6 μg/m³. The reported values indicate that air pollution remains an unresolved issue in all Carpathian countries. The areas with the highest PM2.5 concentrations – southern Poland, northern Czechia, Serbia, southwestern Romania - often overlap with coalmining regions, where coal is commonly used for heating private homes.

Map 7. Air pollution, 2023



Territorial level: NUTS3
Source: ESPON KARPAT, 2024
Origin of data: Atmospheric Composition Analysis Group, Washington University in St. Louis
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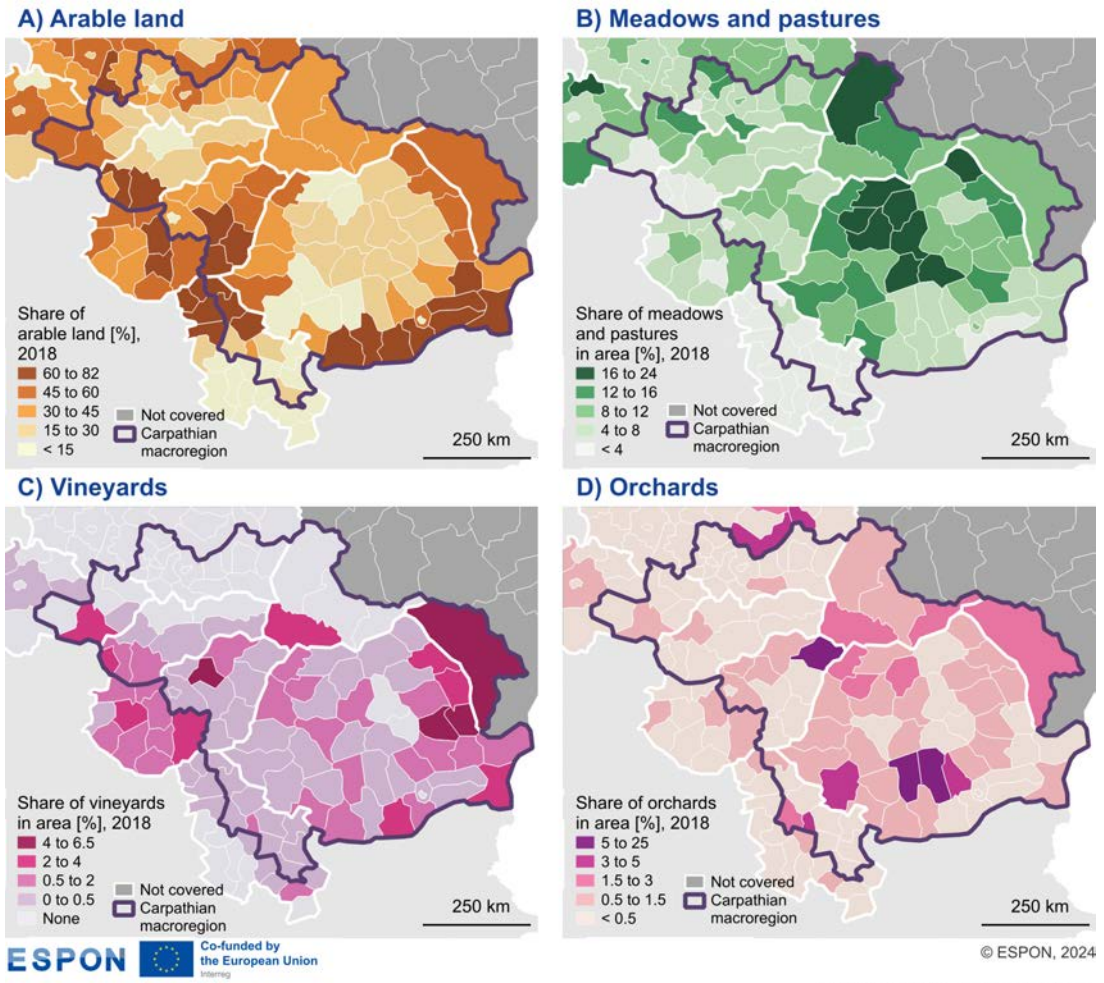
Primary sectors

Agriculture, forestry, and mining are classic examples of primary economic sectors, which played a particularly significant role in the early stages of economic development. Nevertheless, in certain areas of the Carpathian macroregion, these primary sectors remain an important part of the regional economic base and can still influence the specialisation of the regional economy.

Agriculture

Agricultural land use in the Carpathian macroregion reflects strong regional specialisation influenced by soil fertility and geographic conditions. Fertile areas such as Romania's Danubian Plain, Serbia's Vojvodina, the Pannonian Basin in Hungary and Slovakia, and the Republic's of Moldova Prut River valley are dominated by intensive crop farming. Eastern Hungary, Romania's Satu Mare region, and areas around Kraków in Poland also feature significant proportions of arable land. In contrast, mountainous regions like Slovakia's Žilina area, Romania's Apuseni Mountains, and northern areas such as Maramureș and Bistrița exhibit low percentages of arable land but are well-suited for livestock farming supported by extensive meadows and pastures. Grasslands are particularly notable in northern Romania's Transylvanian Plateau, the Prut River valley, and localised regions in Poland and the Czech Republic. Perennial crops further emphasise agricultural specialisation, with viticulture thriving in the Republic of Moldova, Romania's Danubian Plain, Hungary's Tokaj region, Slovakia, and Ukraine. The northern edge of vineyards aligns with the Carpathian range, and climate change may enable their expansion while enhancing wine tourism. Orchard farming is widespread on the southern slopes of the Carpathians, especially in Wallachia, northern Romania, Hungary, Ukraine, and Poland's Nowy Sącz region, which is particularly renowned for its orchard production.

Map 8. Agriculture land use, 2018



Territorial level: NUTS 3, NUTS 0 (MD)
Source: ESPON KARPAT, 2024
Origin of data: EEA based on Corine Land Cover
Estimations for MD and UA
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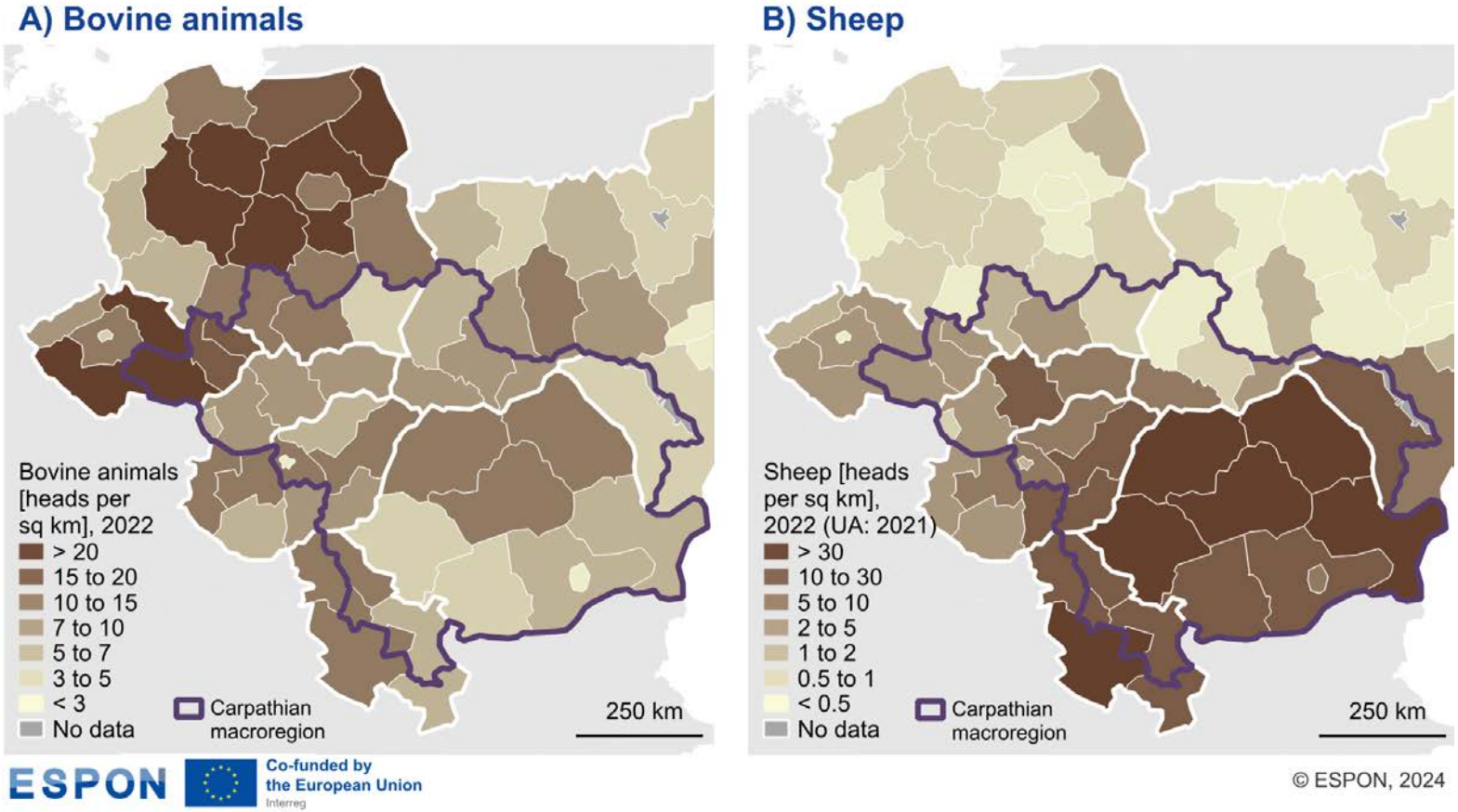
Animal husbandry can have a significant environmental impact, especially in areas with high livestock density. It can also lead to considerable greenhouse gas emissions, particularly methane, which is notably associated with cattle farming. In the Carpathian macroregion, areas with relatively high concentrations of cattle farming can be identified. These include primarily regions in the Czech Republic, followed by certain regions in Poland, Hungary, Romania, and Serbia. However, in many areas, crop production dominates, resulting in relatively low cattle density. This is particularly evident in Poland's Podkarpackie region, as well as in the Republic of Moldova and the southern regions of Romania.

Map 9. Livestock population, 2022



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT and UA, RS, MD statistical offices
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Mining and quarrying

Mining, particularly open-pit mining, imposes a significant burden on the natural environment. In the Carpathian macroregion, the greatest environmental threats related to mining affect specific regions, especially mountainous areas located in the Southern Carpathians of Serbia, as well as in the Southern and Eastern Carpathians of Romania. Northern Hungary and the regions of Silesia and Małopolska in Poland also experience a high percentage of such land use. This is largely due to the presence of valuable minerals, such as copper and gold in Serbia's Bor region, and energy resources like lignite coal mines in northern Hungary, as well as in southern Romania.

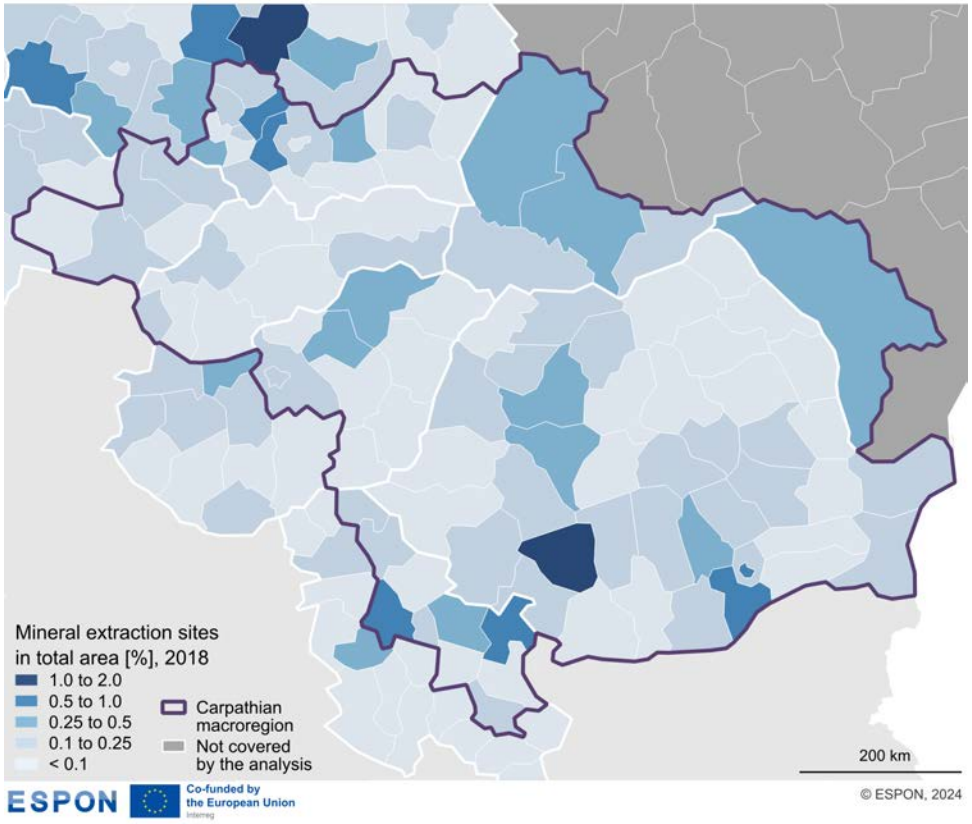
In Romania, metal ore extraction (including copper and iron) in the mountainous regions, along with lime-stone and salt mining, are significant. In Poland's Carpathian region, there are numerous open-pit mines for rock materials, and former sulphur extraction sites are currently undergoing reclamation. Meanwhile, in some agricultural regions of Hungary, Romania, and the Czech Republic, mining activities are marginal and have minimal impact on the natural environment.

Forests and Forestry

Biodiversity's key habitat, and at the same time an important economic asset, is the forest. The natural forest once covered almost the entire Carpathian region. Initially, it shrank due to pressure from agricul-ture, animal husbandry, expanding settlements, and the demand for fuelwood. Since the late 19th century, deforestation has either halted or slowed down as forests became managed under modern forestry prac-tices. Commercial exploitation brought about new practices, like clear-cutting, establishing forest planta-tions, and extending the network of access roads. Currently, forest cover in the region varies significantly, with the most forested areas having over 50% forest cover. The least forested regions are located mostly outside of the core Carpathian area, or in the vicinity of major urban centres (Kraków, Bratislava).

The net tree cover change illustrates the trend over the last two decades. Forest areas are ex-panding most rapidly in regions with low initial forest cover (the low base effect) outside the Carpathian core, mostly in Hungary and southeastern Romania. A slight increase is also observed in the Romanian and Polish parts of the Carpathian Mountains, with several regions enlarging their forest cover by 3-5% over the period of 20 years. Conversely, a decline in forest cover is affecting Slovakia and Czechia. The key driver for this loss is climate change-induced die-off of planted spruce forests.

Map 10. Mineral extraction sites, 2018



Territorial level: NUTS3, NUTS0 (MD)
Source: ESPON KARPAT, 2024
Origin of data: EEA based on Corine Land Cover
Estimations for MD and UA
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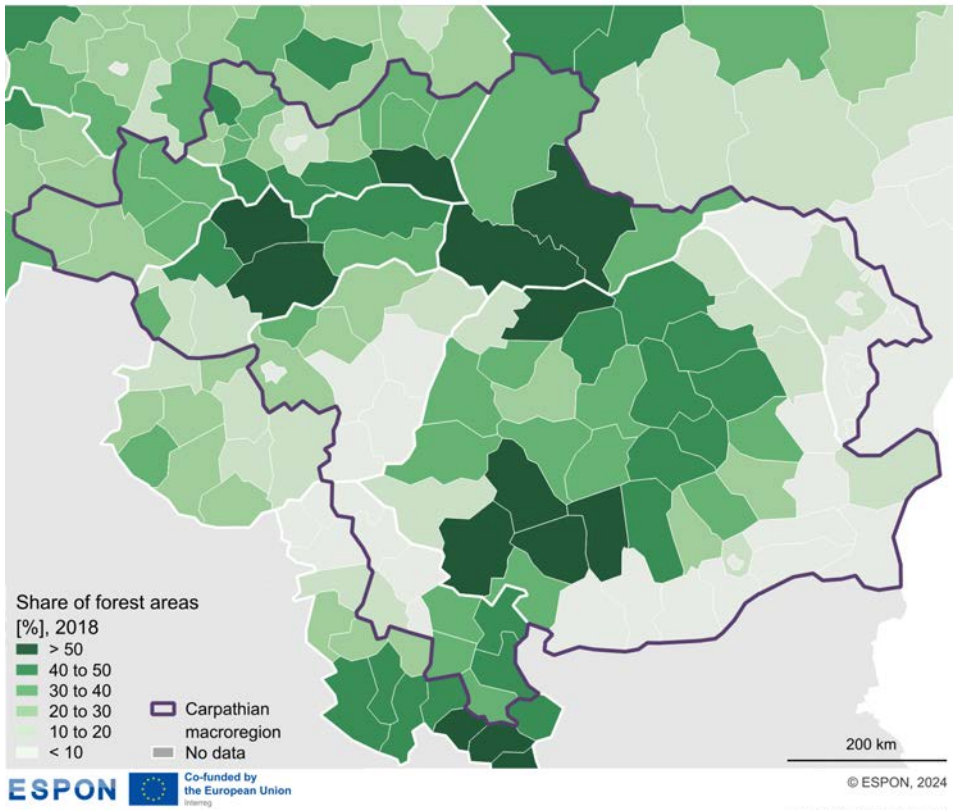
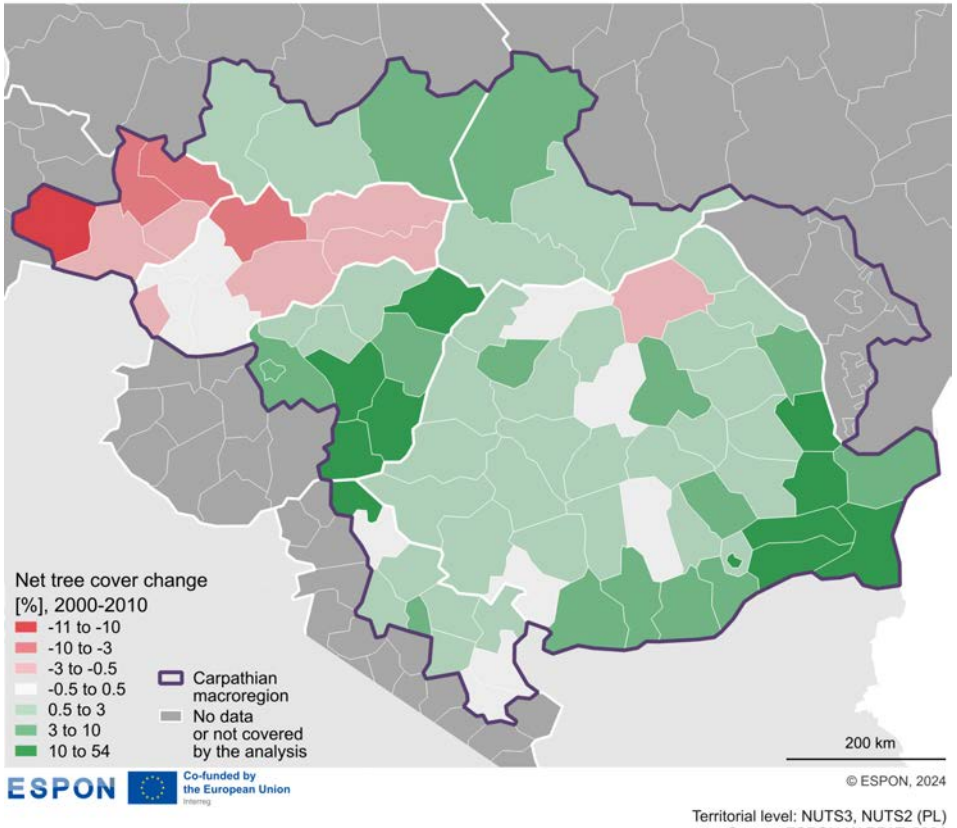
Map 11. Forest cover, 2023



Territorial level: NUTS3
Source: ESPON KARPAT, 2024
Origin of data: CORINE Land Cover 2018. UA: Національна інвентаризація лісів. MD: Global Forest Watch, World Resources Institute; © EuroGeographics for administrative boundaries

Map 12. Tree cover change, 2000-2020



Territorial level: NUTS3, NUTS2 (PL)
Source: ESPON KARPAT, 2024
Origin of data: Global Forest Watch, World Resources Institute; © EuroGeographics for administrative boundaries
No data for MD

Energy and climate

Energy

The key task for climate policies is to create a sustainable electricity production system. According to EU climate target, by 2030 the greenhouse gas emissions would have to be reduced by 55%, as compared to 1990 levels. To be in line with the UN Paris Climate Agreement European countries should quit coal-power by 2030 at the latest. Looking at the current electricity mix at the national level, coal remains a key source of energy for Poland, Serbia, and to a lesser extent Czechia. The current declarations regarding phasing out of coal-powered electricity generation are different across the region, with only Hungary and Slovakia pledging to leave coal before 2030. High share of coal translates to high carbon intensity of economy, which is the case of Poland, Serbia, but also natural gas-reliant Republic of Moldova. The transition to re-newable sources is the most advanced in Romania (42% of electricity production derived from renewables) and Serbia, i.e. the countries with large hydropower. Wind and solar, deployed mostly in recent years, have the combined share of up to 21% in Hungary and Poland, and 16% in Romania.

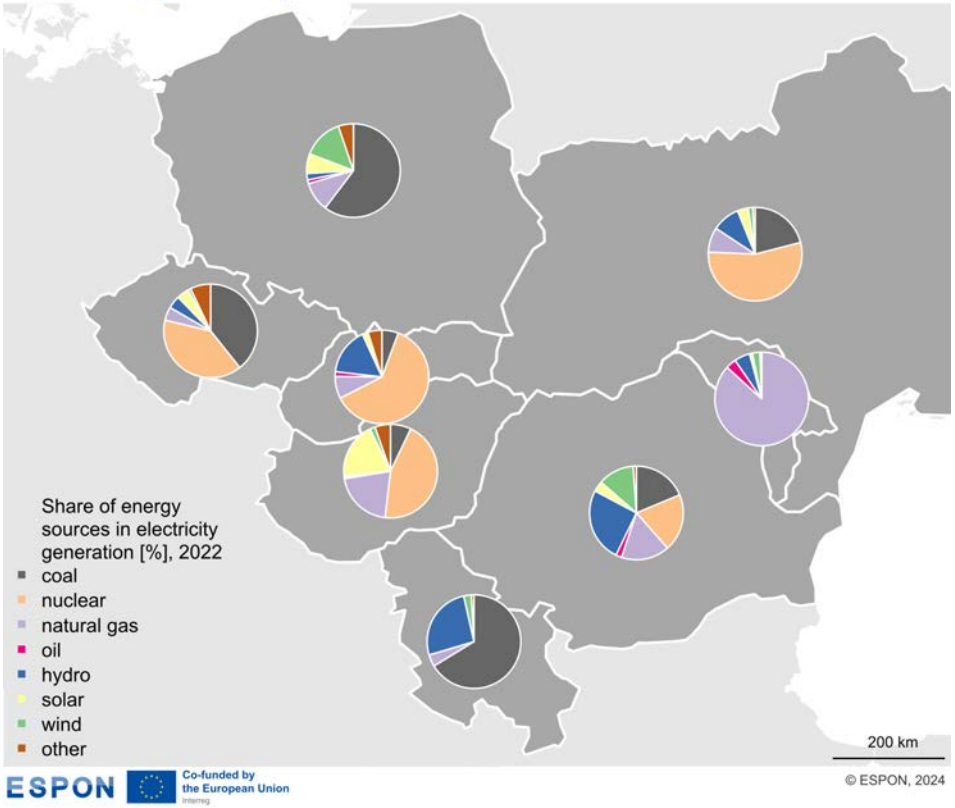
In terms of spatial distribution of electricity production, there is a notable lack of large power plants in the central Carpathian area, particularly in Eastern Slovakia, Ukraine and northern Romania. The largest power plants in the whole Carpathian region, in terms of capacity, are located in Silesia (coal), on the Czech-Slovak border (nuclear), and on the Serbian-Romanian border (hydroelectric). Wind power is con-centrated outside of the mountainous areas, especially along the coasts. The countries of the region did not follow the path of constructing large wind farms in mountainous areas, like e.g. Spain or Germany did. An analysis of the untapped potential for renewable energy highlights opportunities for the region, most notably in southeastern Romania. Additional electricity production could mainly come from rural solar PV installations. The onshore wind, rooftop solar PV, and hydropower has much les potential in the region.

Climate

The CO_2 emissions from fossil fuel combustion are the main driver of the global climate change, threat-ening the survival of human civilization. At the same time, it is an important indication for creation of necessary climate mitigation policies. The CO_2 emissions are presented on the per capita basis, with the mean value for all regions in the Carpathian area at 5.1 tons of CO_2 per capita, or approximately 2/3 of the EU-27 average. Among main types of fossil fuels, coal is characterized by the highest emissions per unit of energy. And indeed, out of 15 regions that report values of above 8 tons of CO_2 per capita, 14 harbour at least one large coal-fired power plant. Data on sectors with highest contributions to total greenhouse gas emissions shows that among EU NUTS2 regions within the Carpathian area the industry is a leading source for 13 regions, followed by transport (4 regions) and energy generation (3). It should be noted, though, that the emission data is production-based only and as such it does not account for the interregional flows of goods (eg. electricity transported to a neighbouring region).

The climate crisis – fuelled by greenhouse gas emissions - is becoming a global reality, bringing about harmful impacts to human populations. But the spatial patterns of these impacts are varied. A global temperature rise of 2°C by 2050 – the most plausible scenario given current global commitments to reduce GHG emissions – would result in a significant portion of the regional population being affected by the negative consequences of the climate crisis. In assessing the risks of windstorms, flooding, water shortages, and wildfires, the most vulnerable regions are found in Hungary and southern Romania, primarily due to water scarcity. However, recent floods have shown that even regions with a relatively low share of exposed populations can suffer dramatic consequences, both in terms of human and economic costs.

Map 13. Energy production by source, 2023



Territorial level: NUTS 0
Source: ESPON KARPAT, 2024
Origin of data: International Energy Agency
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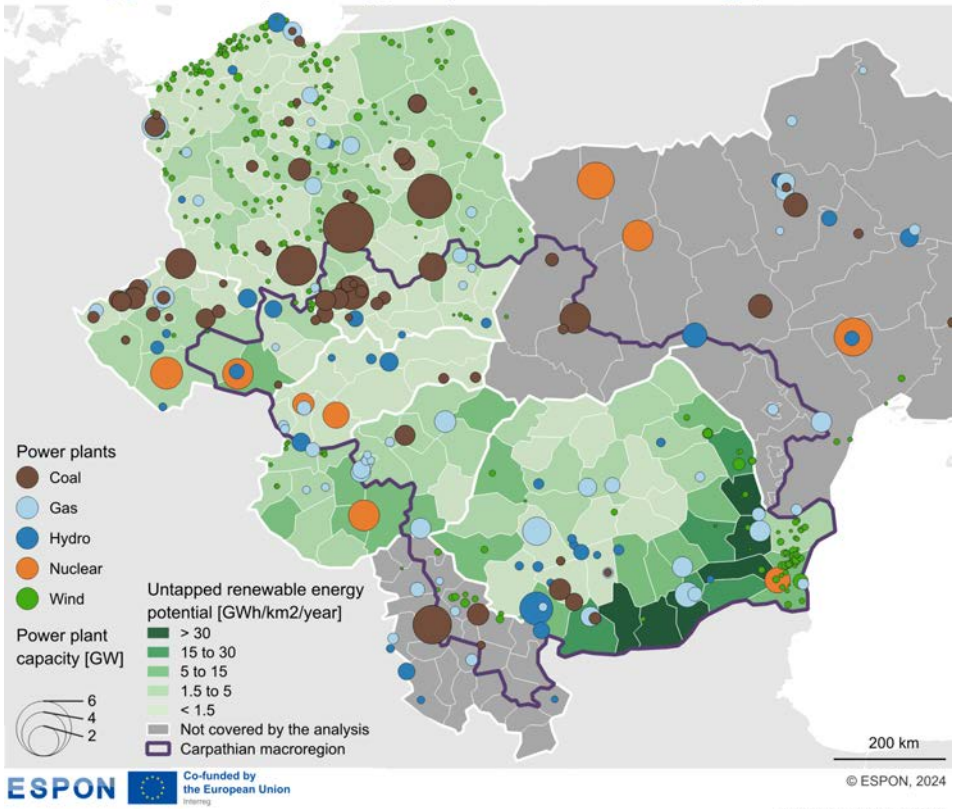
Map 14. Electric energy production: power plants and renewable energy potential, 2023



Territorial level: NUTS 0
Source: ESPON KARPAT, 2024
Origin of data: Global Energy Monitor for power plants; Perpiña Castillo et al. (2024) for the untapped potential
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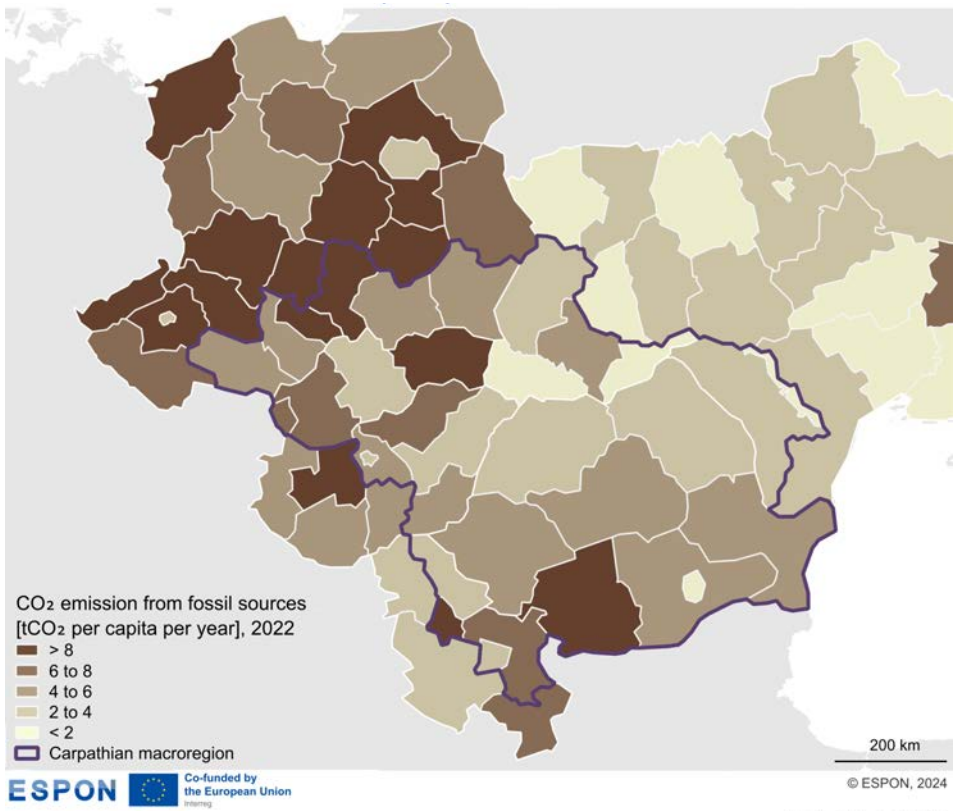
Map 15. CO_2 emission from fossil sources, 2023



Territorial level: NUTS2
Source: ESPON KARPAT, 2024
Origin of data: JRC EDGAR Community GHG database
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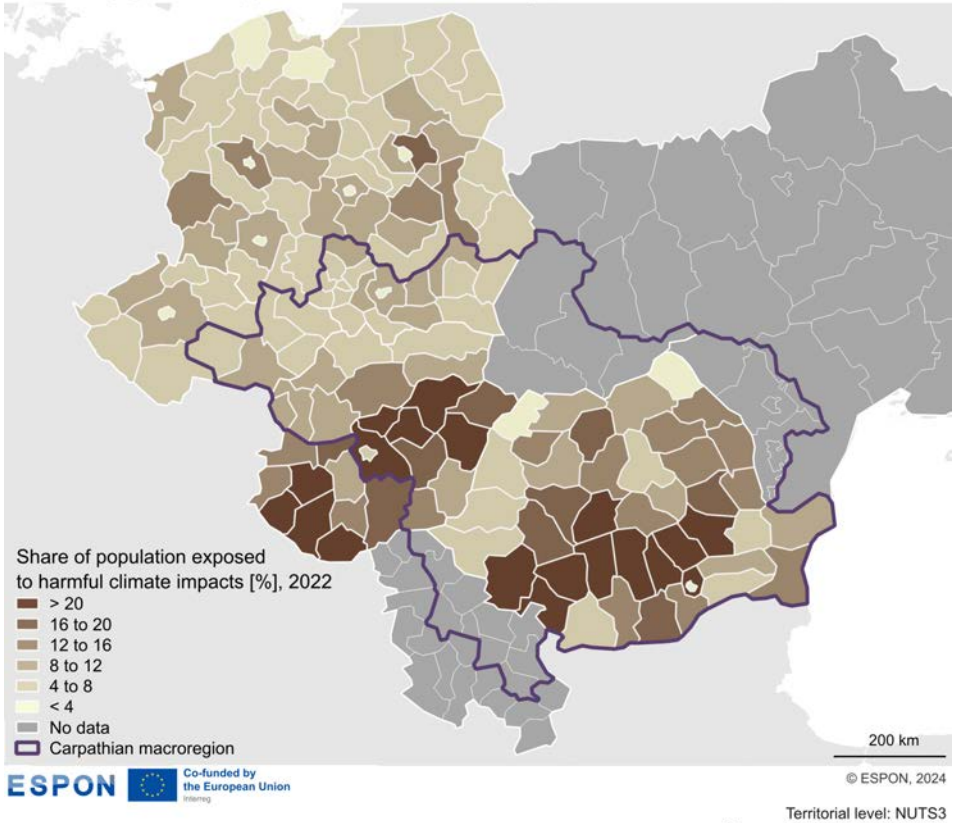
Map 16. Share of population exposed to harmful climate impacts, 2023



Territorial level: NUTS3
Source: ESPON KARPAT, 2024
Origin of data: 9th Report on economic, social and territorial cohesion;
No data on MD, UA, RS
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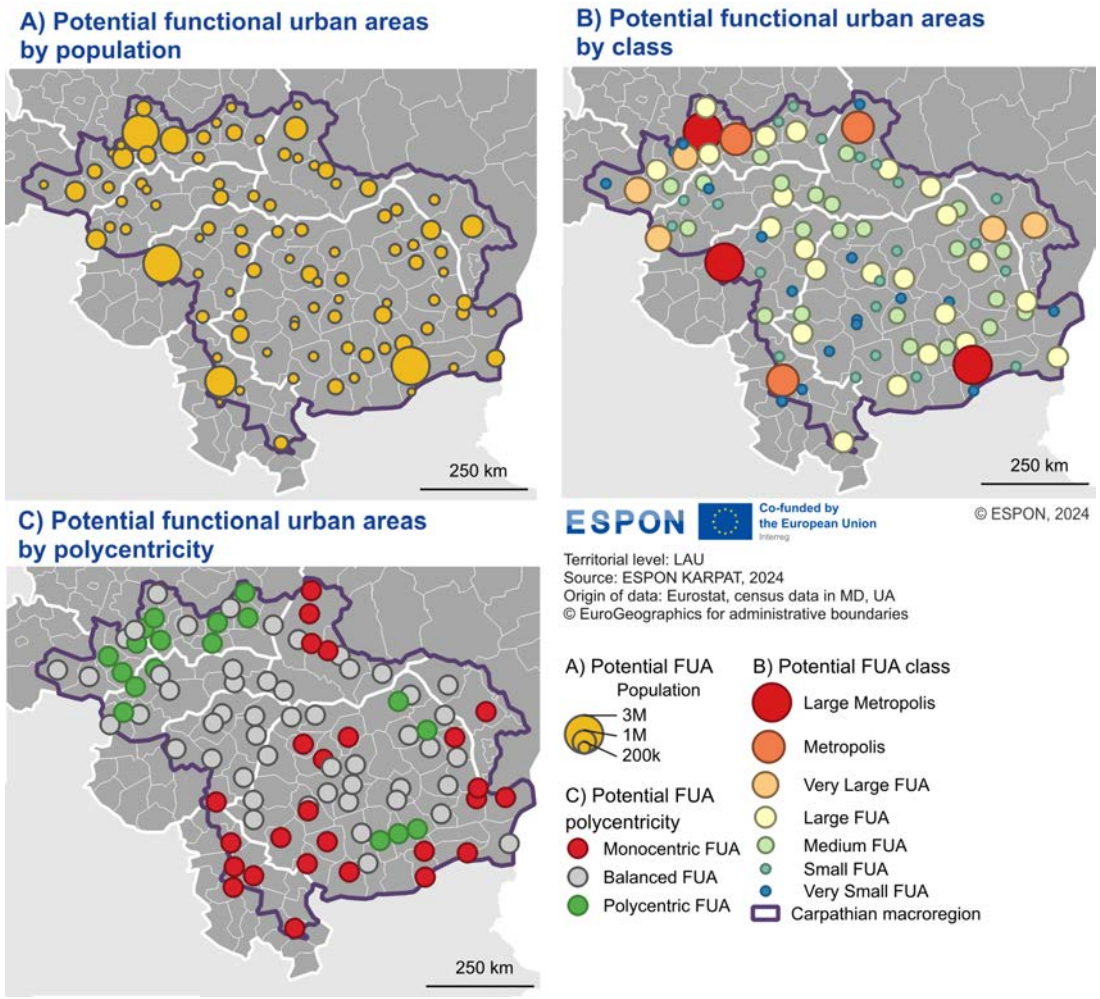
Settlement structure

The settlement system of the Carpathian macroregion is marked by a polycentric structure, characterized by numerous functional urban areas exceeding 250,000 inhabitants. These areas are unevenly distributed, with most major cities located on the peripheries of the macroregion. In the northwest, a dense urban network forms a pentagon connecting the Upper Silesia Urban Area (centered on Katowice), Kraków, Budapest, Bratislava, and Brno. Additionally, a linear pattern of urban centers follows the outer arc of the Carpathians, linking Kraków, Lviv, Iași, and Bucharest. In contrast, the inner arc of the Carpathians features fewer large cities, with Cluj-Napoca, Brașov, Debrecen, and Košice standing out as key urban hubs. Metropolitanization processes are pronounced, with 23 cities hosting populations over 250,000, including six with over 1 million residents. These cities serve as focal points for regional development, driven by their roles in higher-order functions, modern services, and administrative activities.

Beyond the largest cities, subregional urban areas with populations over 100,000 play a significant role, particularly in providing higher-order public services to surrounding areas. Smaller cities with populations between 50,000 and 100,000 face challenges in maintaining their functional roles, as larger metropolises increasingly absorb economic and administrative activities. Nevertheless, these smaller cities remain vital to their hinterlands, offering employment opportunities and market services. The spatial organization of settlements reflects regional disparities: in northern parts of the macroregion, such as Poland, the Czech Republic, and Slovakia, suburban settlement networks are well-developed, often featuring clusters of smaller urban centers around major cities. In contrast, southern and eastern areas, such as Romania and Serbia, display sharper urban-rural divides, with urban municipalities often including expansive rural areas. This creates a more centralized population distribution in the southern macroregion, where cities concentrate over 75% of their region's population.

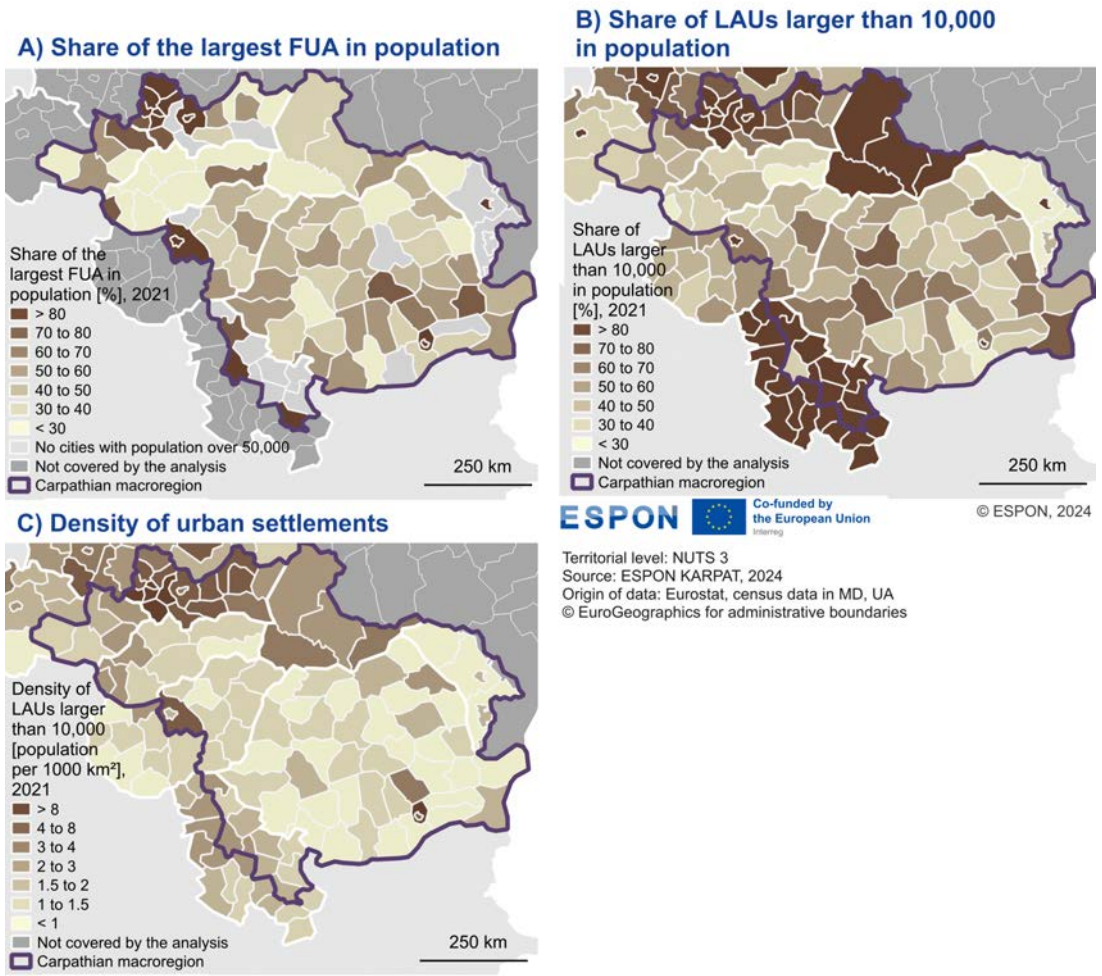
Map 17. Potential Functional Urban Areas, 2022



The role of major cities is also evident in the structure of NUTS3 administrative regions. Regions centered on cities such as Budapest, Belgrade, Bucharest, Kraków, and Bratislava benefit from significant positive agglomeration effects, translating into higher regional productivity and development. Some regions, such as Rzeszów, Brno, Szeged, and Debrecen, see over 50% of their population concentrated in the largest city or its surrounding area. However, other parts of the macroregion, particularly in Slovakia, Poland, and Romania, feature fewer or smaller urban centers, resulting in limited agglomeration effects. While this does not eliminate urbanization benefits, it does suggest a more fragmented settlement structure and weaker urban influence in those regions.

Settlement density further highlights disparities within the macroregion. In Poland and parts of Ukraine, Serbia, and Slovakia, dense settlement networks are evident, with high numbers of municipalities exceeding 10,000 residents per 1,000 km². By contrast, rural areas in Romania, Hungary, and Slovakia have fewer urban centers, leading to challenges in public service delivery and economic development. This uneven density reflects the interplay of geography, administrative systems, and the influence of major urban centers. The macroregion's settlement patterns are shaped by historical, geographic, and demographic factors, emphasizing the centrality of urban areas in regional development while highlighting disparities that impact smaller cities and rural regions.

Map 18. Role of cities and functional urban areas in settlement system, 2021



Transport infrastructure and accessibility

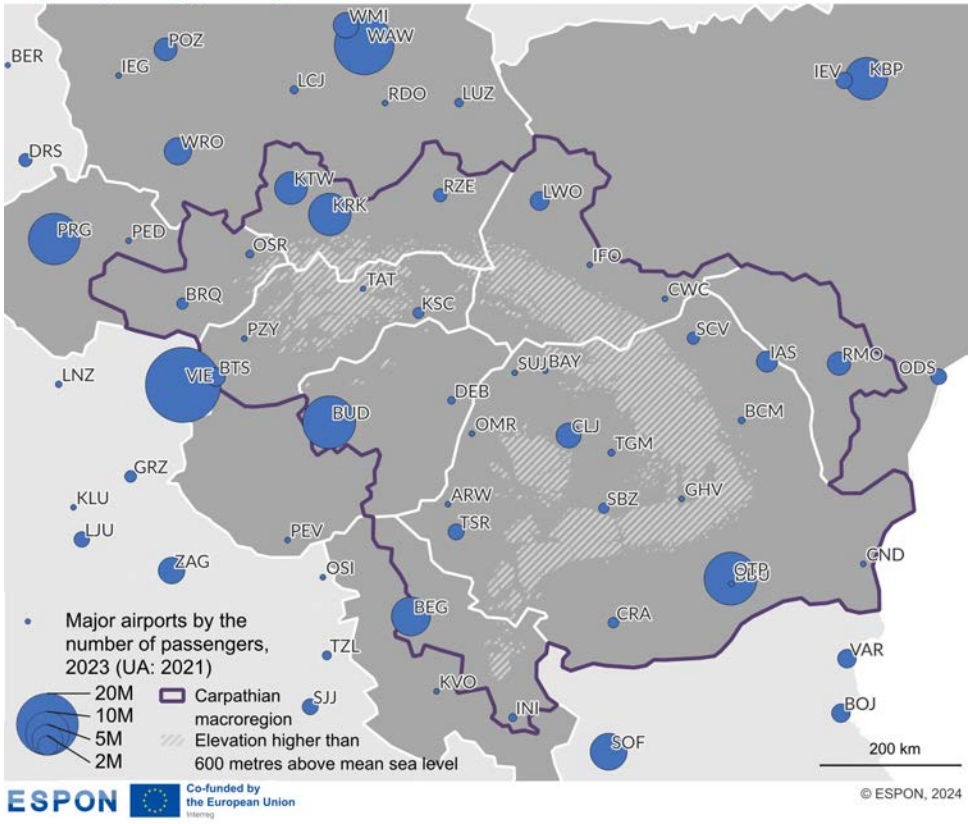
Transport plays a key role in the economy by enabling the efficient movement of goods, people, and services, which directly influences regional development. Transport networks, such as roads, railways, ports, and airports, stimulate economic activity by connecting local markets with national and international trade hubs. With well-developed transport infrastructure, it becomes possible to quickly deliver raw mate-rials to industries and finished products to consumers, which lowers production and distribution costs. Investments in transport infrastructure also foster job creation, attract investors, and increase the attractiveness of a region.

From a societal perspective, transport is crucial for people's mobility and access to essential services such as education, healthcare, and culture. In regions with well-developed transport infrastructure, people have greater opportunities to find employment and improve their quality of life, which helps combat social marginalization. At the same time, sustainable transport development that minimizes negative environmental impacts is an important factor in enhancing the quality of life in regions.

Airports

The Carpathian macroregion is served by central national airports, such as Bucharest-Otopeni (OTP), Belgrade (BEG), and Budapest (BUD), as well as regional ones. The role of regional airports is particularly pronounced in Poland, where Katowice-Pyrzowice (KTW) and Kraków-Balice (KRK) airports attract high numbers of passengers and serve the north-western part of the macroregion, including parts of Slovakia and Czech Republic. Parts of these countries are also within the catchment area of Vienna Airport (VIE) and Prague Airport (PRG). Therefore, nearby regional airports in Bratislava (BTS) and Brno (BRQ) attract a relatively smaller number of passengers. Hungarian, Serbian, and the Republic's of Moldova air traffic is largely dominated by central airports in Budapest (BUD), Belgrade (BEG), and Chișinău (RMO). Romanian and Ukrainian regional airports serving the region, such as Lviv (LWO), Cluj-Napoca (CLJ), Timișoara (TSR), and Iași (IAS) have increased their importance since the early 2000s. Passenger traffic in Ukrainian airports has been halted since 2022 due to Russian aggression on the country.

Map 19. Location of airports and passenger traffic, 2023



Territorial level: Points
Source: ESPON KARPAT, 2024
Origin of data: Eurostat (avia_paoa), Wikipedia
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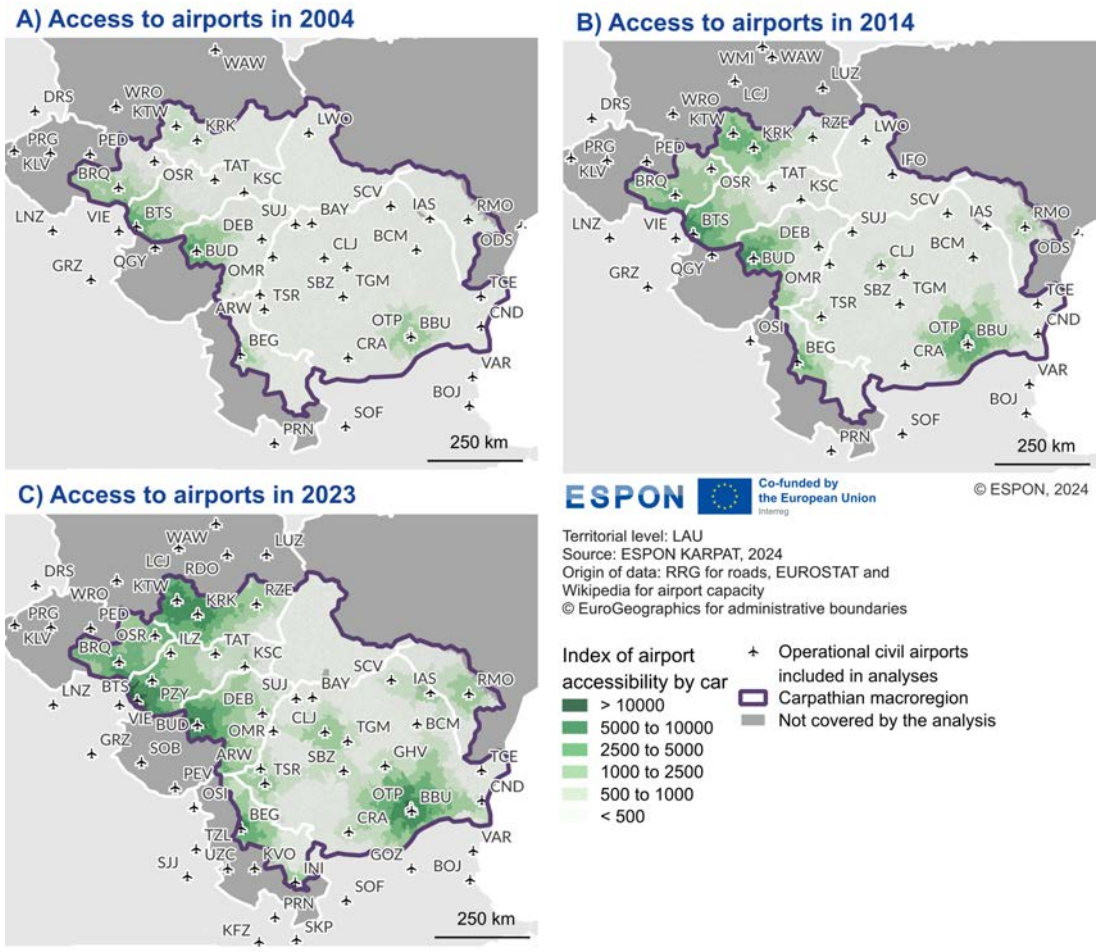
Air traffic in the region has grown rapidly since the early 2000s. Particularly important for stimulating this growth was liberalisation of the aviation market in the mid-2000s. It opened the market to foreign traditional and low-cost carriers (LCCs) and stimulated the formation of LCCs based in the region. It reduced the role of national carriers (such as LOT, TAROM) and increased the role of those LCCs that were able to stay in the market, such as Hungarian-based WizzAir. Market opening and public investments developed regional airports, which, together with the development of highways, improved spatio-temporal accessibility of air travel to the region's inhabitants and businesses measured with AAI index (Rosik et al. 2017).

The number of passengers served by an airport was used as a proxy of airport's capacity. The highest rates of accessibility improvement between 2004 and 2023 were observed in areas adjacent to the region's main airports that lie at the periphery of the macroregion. Access to air connections has also notably improved in the central part of the region thanks to the Cluj-Napoca airport development. Higher spatiotemporal and financial accessibility in the region has generally facilitated inbound and outbound international tourism, international business connections, and economic migrations out of the region.

Map 20. Airport accessibility by car, 2004-2023



Railway network

The railway network in the Carpathian macroregion and its surroundings was shaped historically and was linked to the need to improve transport, which was very under-developed in terms of infrastructure in the 19th century. In Austria-Hungary, the construction of a railway network began in the mid-19th century with the aim of integrating the various regions of the state. In the Carpathian Mountains, one of the most important projects was the construction of the so-called Galician Iron Railway, which was to connect Vienna to Lviv and further to Krakow, as well as to Przemysl, which was of enormous strategic and econom-ic importance.

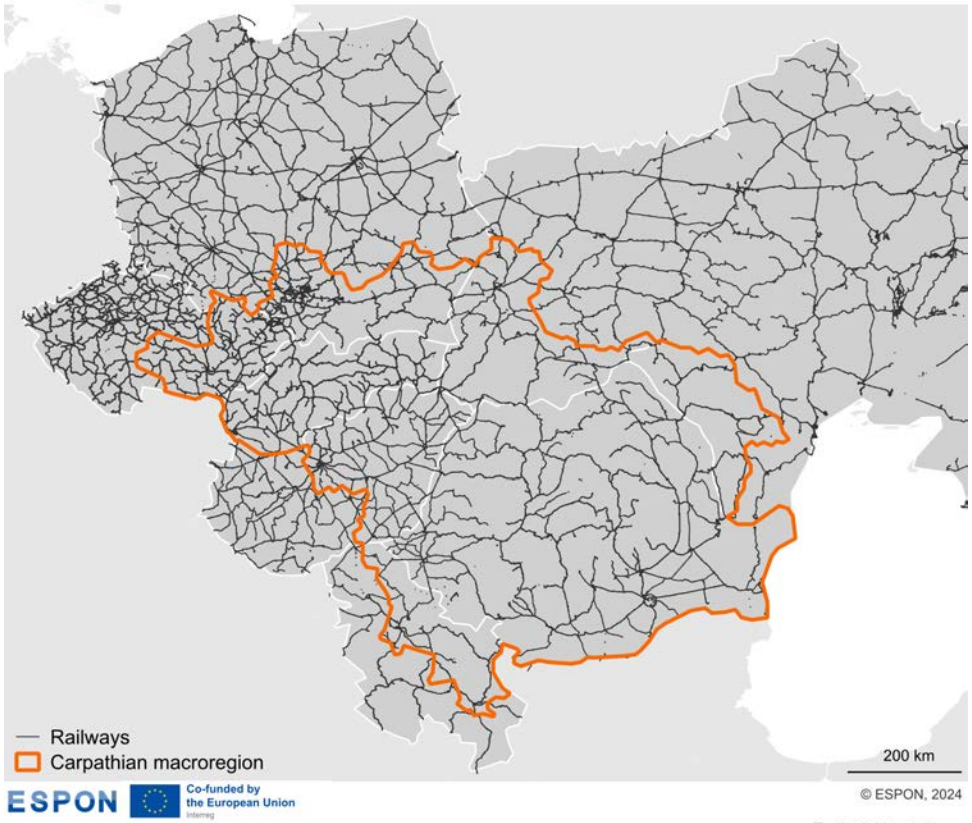
The Carpathian Mountains, as a mountain range, represented a major barrier both geographically and technically. Delineating railway lines in mountainous terrain required a great deal of effort and an accu-mulation of engineering structures, such as tunnels bridges, viaducts and sections with steep gradients.

Rail transport in the Carpathians is unsatisfactory despite many lines, with traffic primarily on trunk and first-class lines in flat or foothill areas and few year-round north-south crossings. The main west-east lines include the Karol Ludwig Galician Railway, connecting Krakow to Lviv with modernized infrastructure; the Galician Transversal Railway, a mountain route with outdated sections; and the Košice-Bogumin Railway, which offers good speeds and connects Slovakia to Poland. Other lines, such as Brzeclaw-Budapest-Arad-Bucharest, perform well but face challenges in mountain areas, where journey times increase.

Key north-south routes include Katowice-Ostrava-Vienna, offering high speeds, and Katowice-Zwardoń-Slovakia, where trains slow significantly in mountainous areas. The Tarnów-Košice line is under modernization but remains underutilized, while tourist trains on some routes are limited to summer weekends. The Zagórz-Medzilaborce line, crossing Poland and Slovakia, suffers from low speeds and limited use, particularly on the Polish side.

In Ukraine, the Lviv-Uzhhorod line handles passenger and freight traffic but needs upgrading, while the Lviv-Chop line connects to southern Europe via Slovakia and Hungary. Connections between Ukraine and Romania are nearly nonexistent. Serbia's rail links are minimal, with reconstruction ongoing on some routes. Overall, few lines support non-stop, year-round traffic, emphasizing the need for infrastructure improvements and better international connectivity.

Map 21. Railway network, 2024



Territorial level: Lines
Source: ESPON KARPAT, 2024
Origin of data: OpenStreetMap
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Railway density

The density of the railway network in the Carpathian Mountains is generally low and the railway infrastructure facilities are not able to meet the needs of businesses, residents and tourists, especially in the more remote, mountainous parts of the region. Exceptions are selected areas, the main ones located on both sides of the mountain chain and in the western part of the study area, where rail is one of the main means of transport.

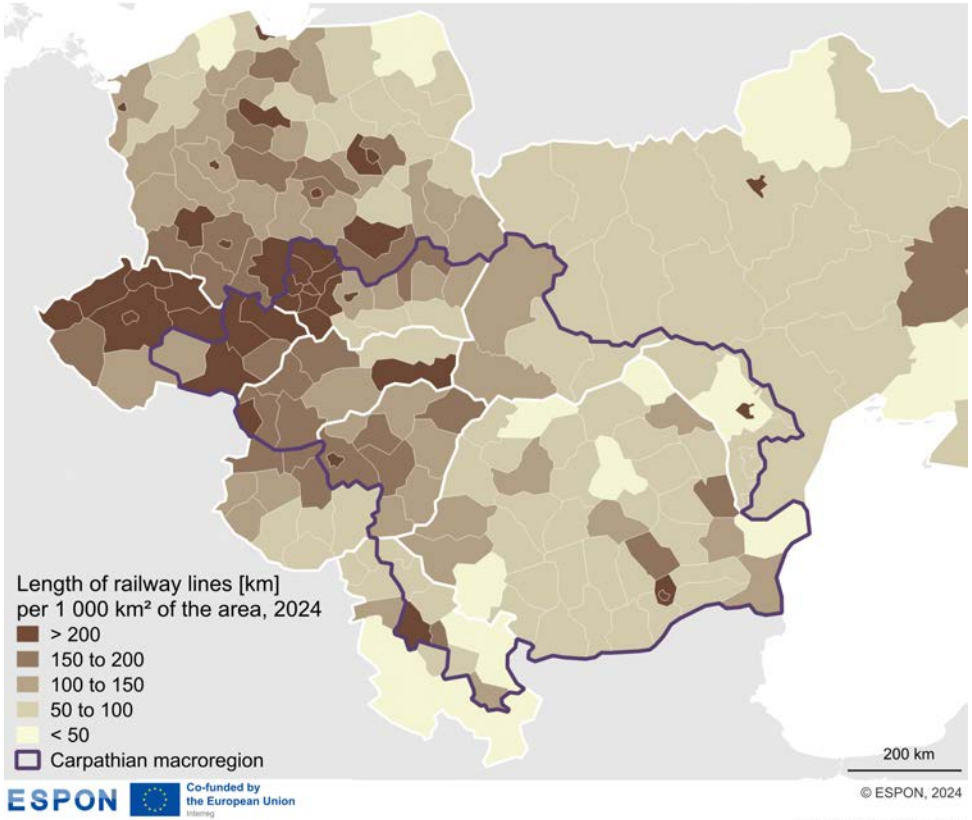
In Poland, in the Carpathian Mountains, especially in Eastern Małopolska and Podkarpacie or, the density of the railway network is not lower than in the rest of these regions. Most of the railway lines through the Carpathians are of regional or tourist nature, connecting smaller ones and complementing the main network. Some of the lines also terminate blindly in mountain towns.

Slovakia, like Poland, has a dense railway network in the Carpathians, especially in the Tatra Mountains, where rail is one of the main means of transport among tourists. Railways there are also used to transport goods, including natural resources mined in the region. The Slovak Carpathians, with their narrow valleys and high altitude differences, pose challenges for railway construction, and the railway network itself is relatively sparse compared to other regions of the country.

The railway infrastructure in the Ukrainian Carpathians is also relatively underdeveloped, although some lines have been modernised in recent years. There are several important routes connecting the mountain regions to major cities, but their density is low. The rail network in Ukraine is struggling with infrastructure problems, including a small number of tracks and difficulties in maintaining old rolling stock.

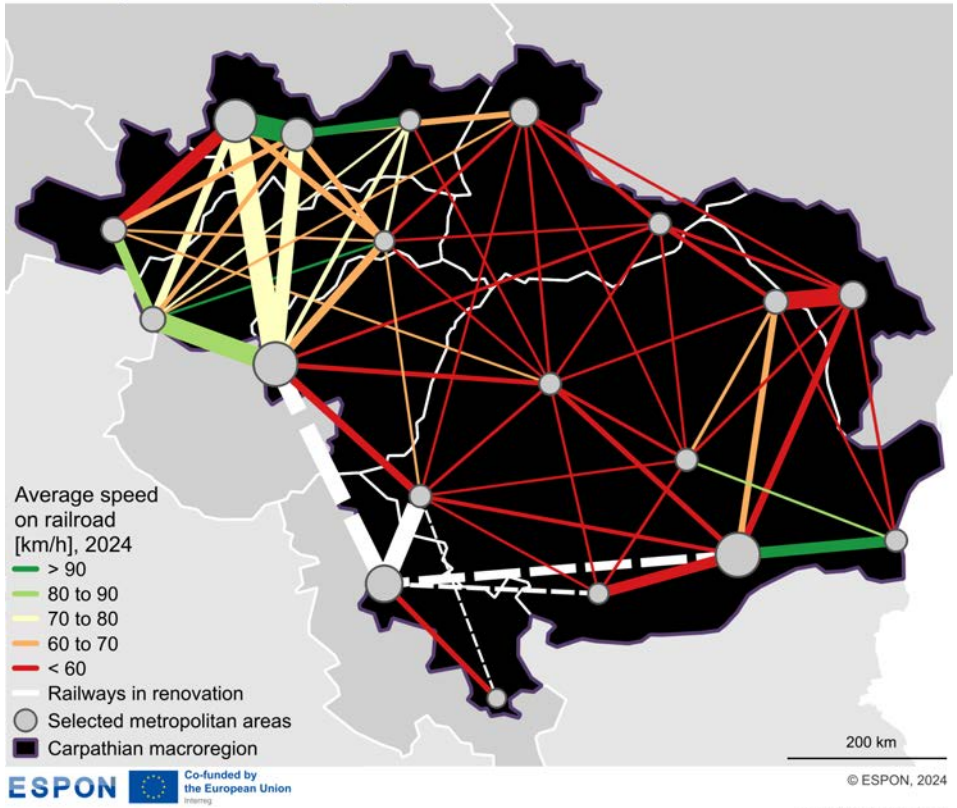
In Romania, the Carpathian Mountains are challenging for rail transport, but some lines, especially in Transylvania, connect larger cities to smaller centres. The density of the rail network in this region is also quite limited.

Map 22. Density of railway network, 2024



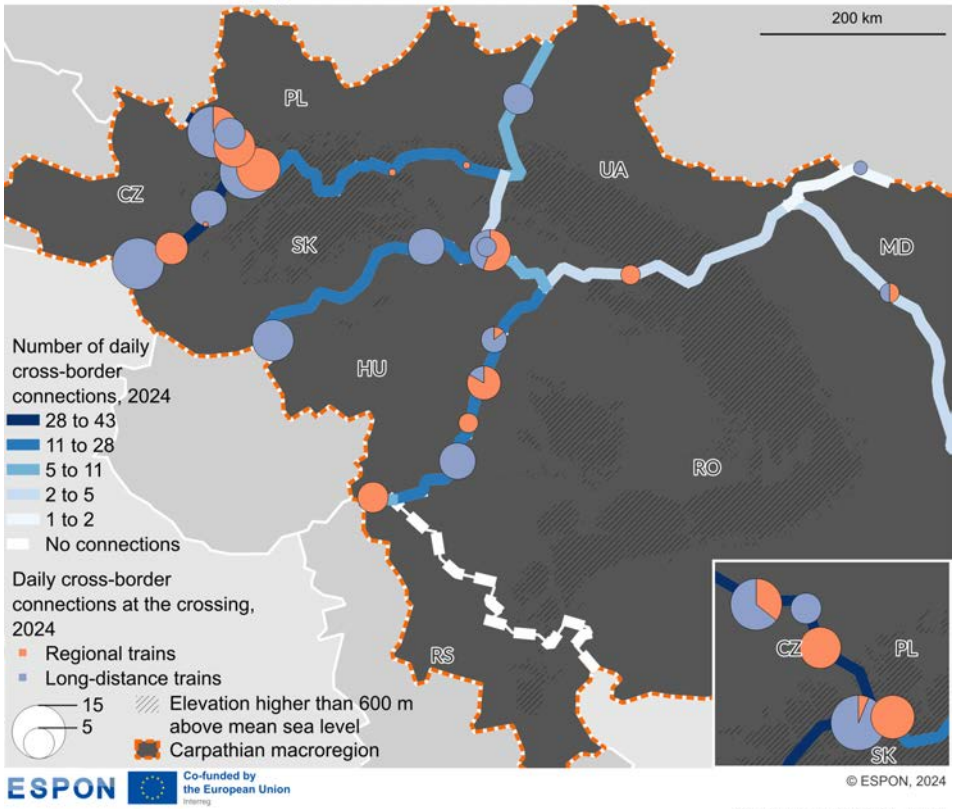
Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: OpenStreetMap
© EuroGeographics for administrative boundaries

Map 23. Intermetropolitan connectivity by train, 2024



Territorial level: Lines
Source: ESPON KARPAT, 2024
Origin of data: timetables
© EuroGeographics for administrative boundaries

Map 24. Interborder connectivity by train, 2024



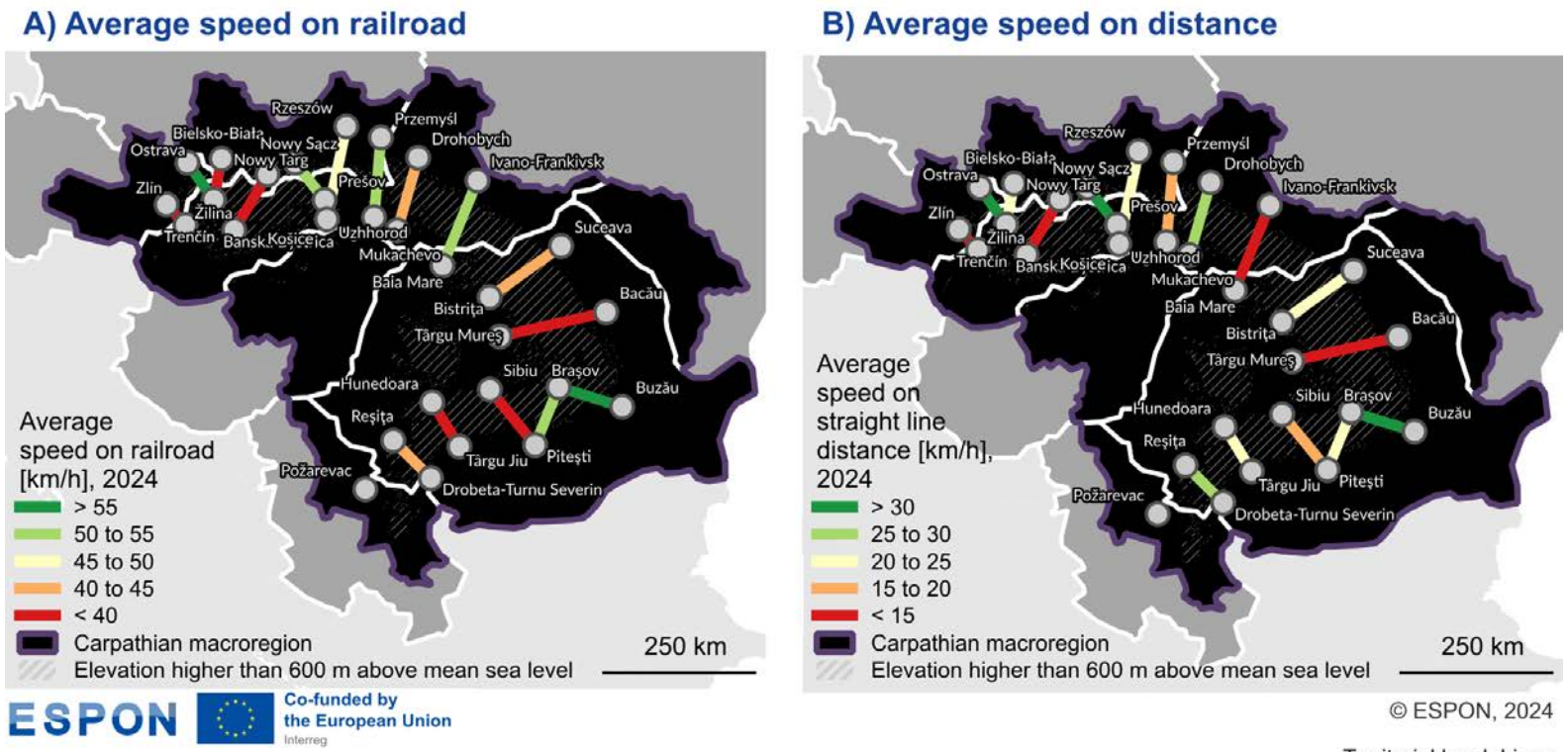
Territorial level: NUTS0, points
Source: ESPON KARPAT, 2024
Origin of data: Timetables
© EuroGeographics for administrative boundaries

Rail accessibility and connectivity

The railway network is better developed in the western part of the macroregion, especially within the polygon formed by the Upper Silesian and Zagłębie Metropolis (Katowice), Ostrava, Bratislava and Buda-pest. However, in terms of travel time relative to physical distance, access to trunk lines generally cir-cum-navigates the mountains.

The mountain barrier is particularly pronounced in travel times between urban centres located on oppo-site sides of the Carpathian range. This barrier affects virtually all the links analysed, but is particularly pronounced in the Eastern Carpathians, followed by the Southern Carpathians, while it is relatively less significant in the Western Carpathians. Nevertheless, in all cases this transport barrier is expected to have a limiting effect on socio-economic inter-actions between neighbouring towns.

Map 25. Transcarpathian rail accessibility, 2024



ESPON Co-funded by the European Union Interreg

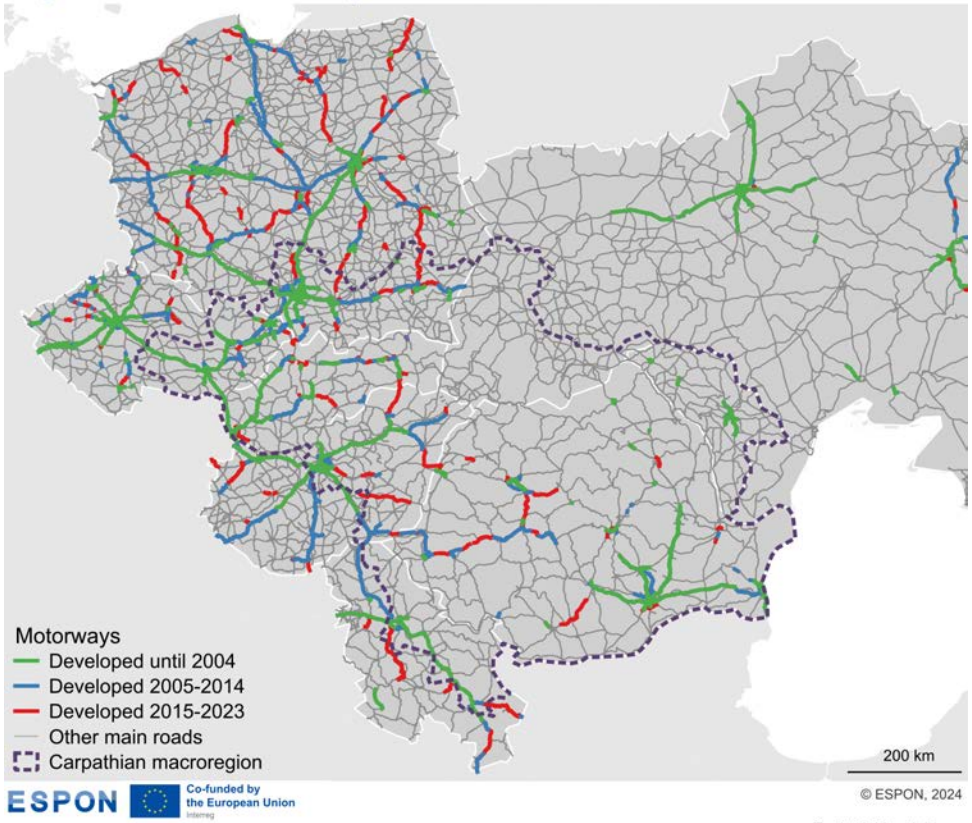
Territorial level: Lines
Source: ESPON KARPAT, 2024
Origin of data: Timetables

Road network

The road network in the Carpathian macroregion and its surroundings indicates a greater potential for developing economic connections in areas bordering the main Carpathian range. This applies to regions located to the north (the A4 motorway corridor from Silesia to the Ukrainian border) and the west (the motorway routes from Silesia to Brno, Brno to Bratislava, Bratislava to Budapest, Budapest to Belgrade, and further to Niš and the Bulgarian border). It also partially includes the south (the Craiova-Bucharest-Constanța transport corridor) and the east (the under-construction A7 motorway from Bucharest to Suceava), extending outward from the Carpathian range. These developments are linked to the existing and expanding network of motorways and expressways. Breaking away from this "around Carpathian" scheme are motorways in eastern Hungary and Romania's Transylvania region, which form dis-tinct infrastructural patterns.

In the mountainous Carpathian areas, the most significant transport projects to date—still incomplete—are the A1 motorway in Slovakia (Bratislava–Košice) and the A1 motorway in Romania (Timișoara–Alba Iulia–Bucharest). It is worth noting that neither of these has a direct cross-border function. However, the Slovak A1, through its connections with Poland, Ukraine, and Hungary, holds cross-border potential, while the Romanian A1 links Bucharest with the Hungarian border. The remaining projects are at varying stages of progress, including the connections between Bielsko-Biała and Žilina, and Rzeszów and Prešov, or are still in the planning phase, including those related to the development of trans-European transport corridors discussed below.

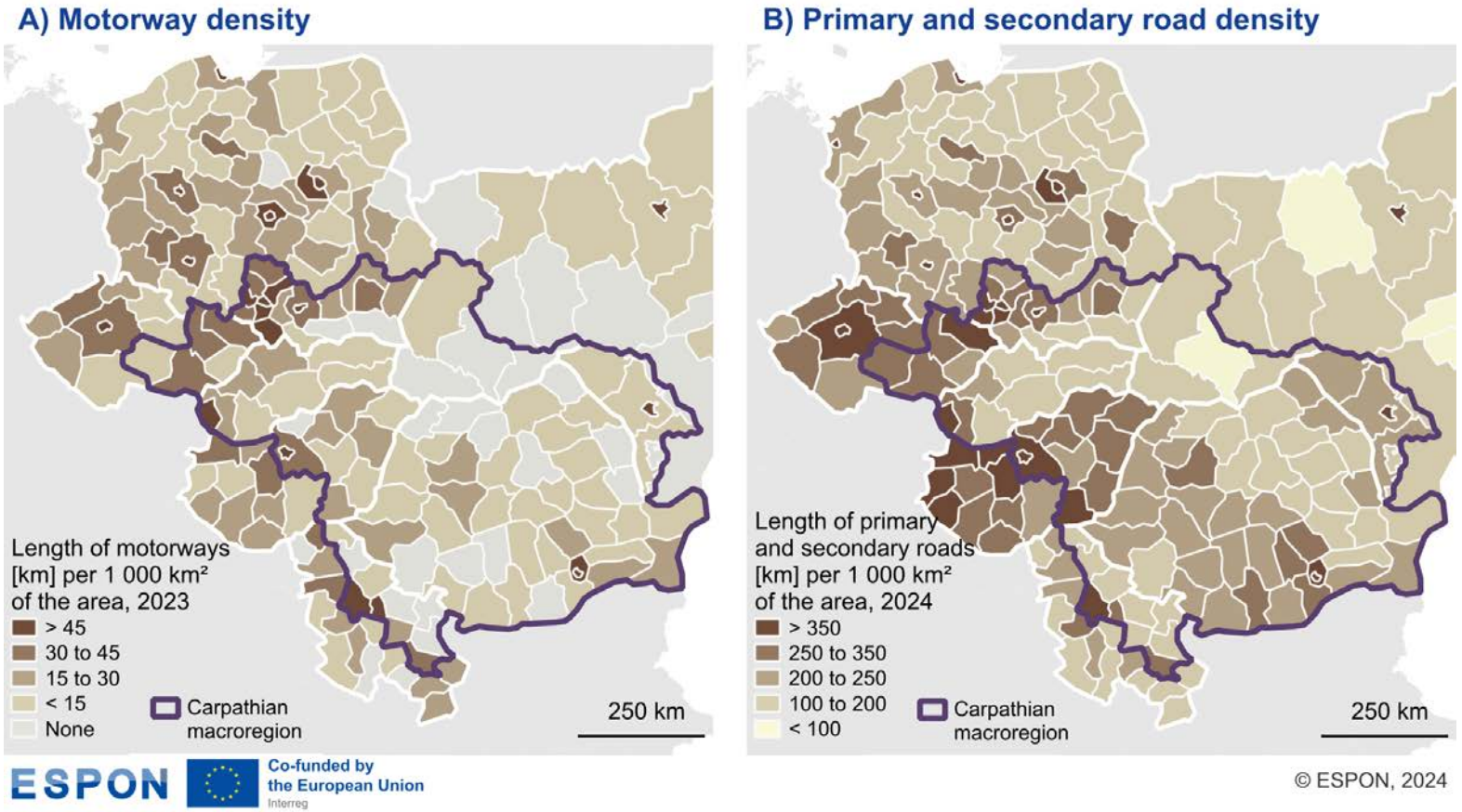
Map 26. Road infrastructure,2004-2023



The layout of the main existing transport corridors described above is reflected in the density of motor-ways and express-ways per 1,000 km² across NUTS3 regions. This density is particularly high in the northern and western peripheries of the Carpathian macroregion, while many NUTS3 regions in the eastern and, to some extent, southern areas remain unconnected to the motorway network. This results in lower transport accessibility, potentially impacting their developmental opportunities.

The road network is generally more developed in the western parts of individual countries, a trend particularly evident in Romania. Hungary and the Czech Republic also feature dense road networks at this level. However, differences between countries partly stem from variations in the classification of regional roads, as seen, for example, in comparisons between the Republic of Moldova and eastern Romania.

Map 27. Density of road network, 2023



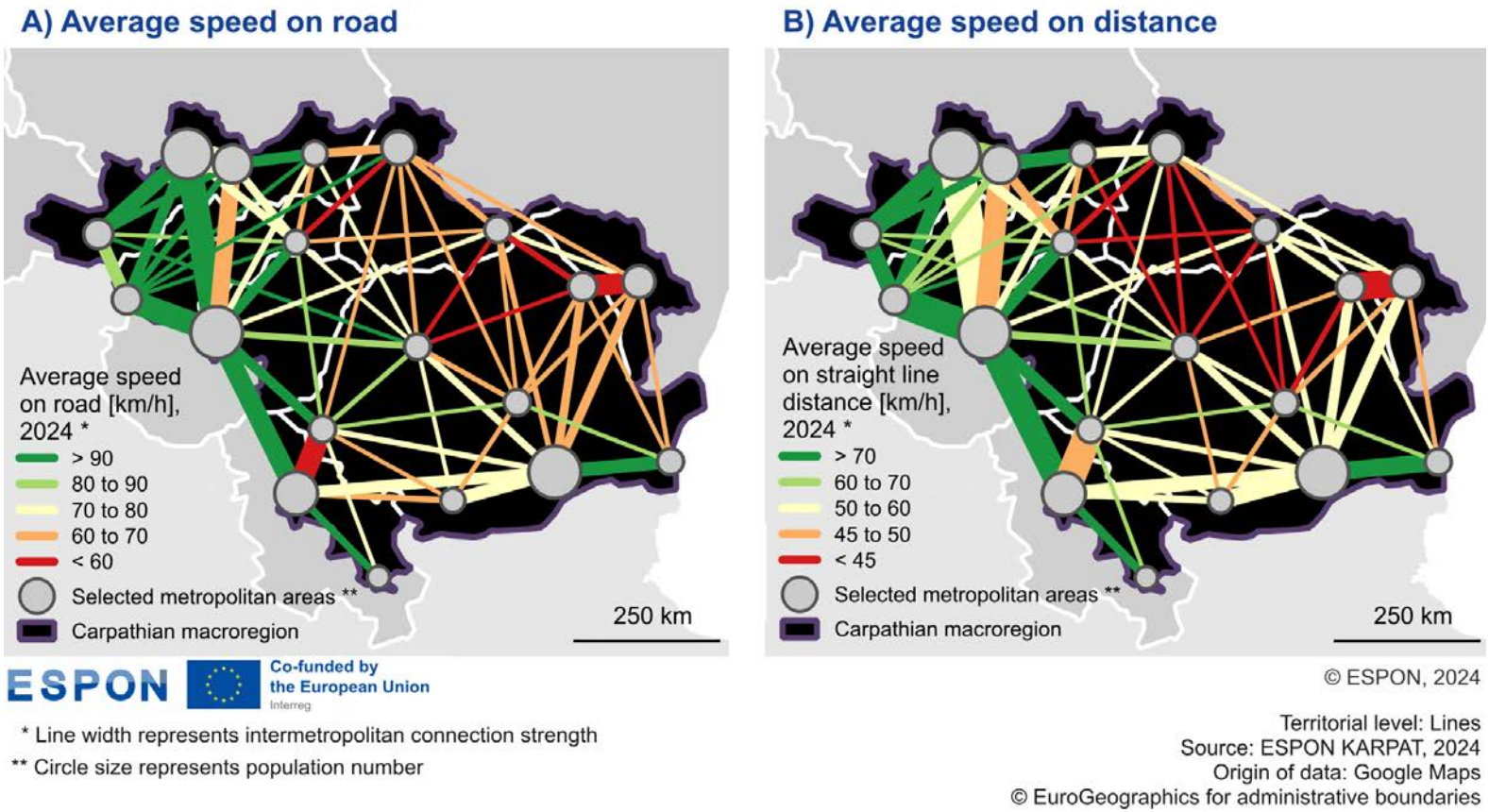
Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: A - RRG, 2023, B - OpenStreetMap, 2024

The road network is more developed in the western macroregion, particularly within the polygon formed by Katowice, Brno, Bratislava, and Budapest. However, accessing high-speed roads often requires detours, notably between the Upper Silesian Conurbation and Budapest.

In the eastern macroregion, travel times between major cities are longer due to infrastructure gaps and the Carpathians. This is most pronounced in Ukraine, the Republic of Moldova, and eastern Romania, and also affects connections between Serbian and Romanian cities in the south, and Polish and Slovak cities in the north.

While lowland areas like the Republic of Moldova and nearby Romanian regions benefit from shorter routes, mountainous areas still face significant travel time issues due to physical and infrastructural challenges.

Map 28. Intermetropolitan connectivity by car, 2024



ESPON Co-funded by the European Union Interreg

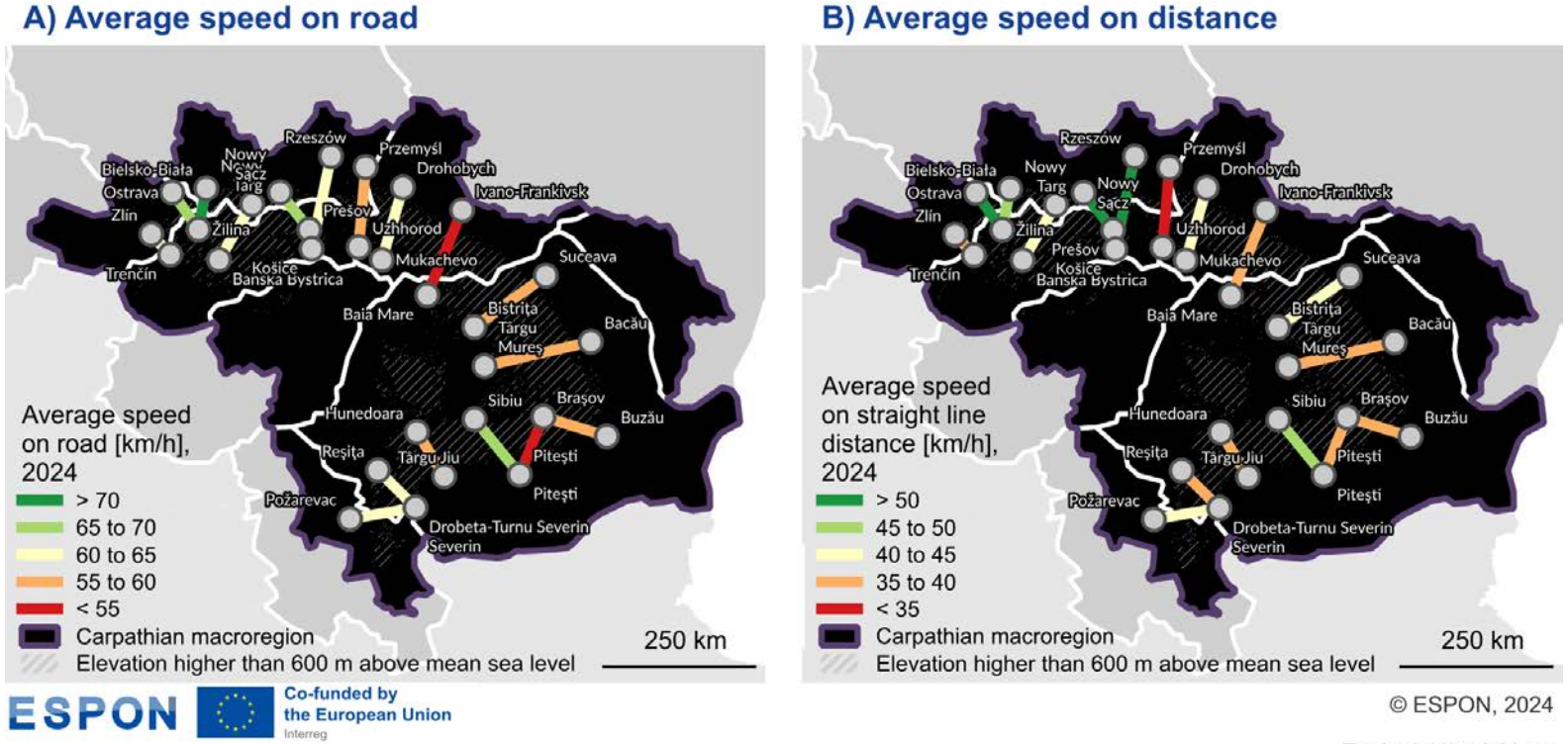
* Line width represents intermetropolitan connection strength

** Circle size represents population number

Territorial level: Lines
Source: ESPON KARPAT, 2024
Origin of data: Google Maps

The mountain barrier is particularly evident in travel times between urban centres located on opposite sides of the Carpathian range. This barrier affects virtually all analysed connections, but it is especially pronounced in the Eastern Carpathians, followed by the Southern Carpathians, while it is relatively less significant in the Western Carpathians. Nevertheless, in all cases, this transport barrier is expected to have a reducing effect on the socio-economic interactions between neighbouring cities.

Map 29. Transcarpathian road accessibility, 2024



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Territorial level: Lines
Source: ESPON KARPAT, 2024
Origin of data: Google Maps

TEN-T network

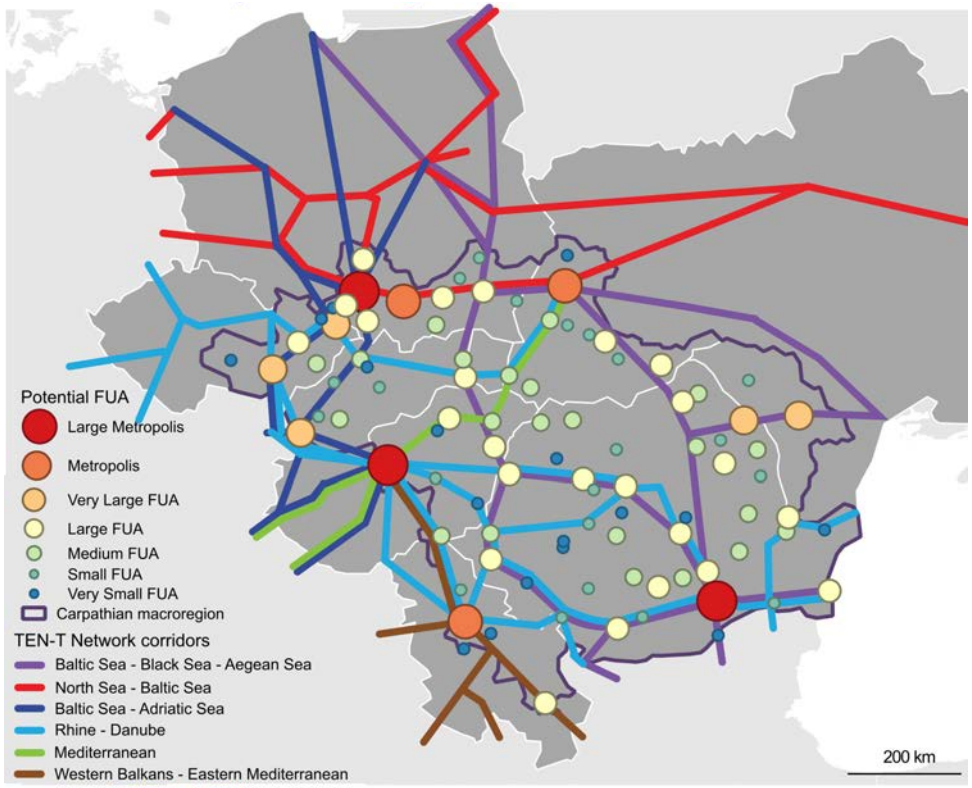
There two types of TEN-T corridors in the macroregion: those crossing the Carpathian range longitudi-nally, such as the Scandinavian–Mediterranean (Via Adriatica) and Baltic Sea–Black Sea–Aegean Sea (Via Carpathia), and those with a latitudinal trajectory, such as the Mediterranean corridor (with a branch through Budapest to Lviv) and the Rhine–Danube corridor. Additionally, two other corridors skirt the Carpathian range: the North Sea–Baltic Sea (including a branch to Ukraine – Lviv, Kyiv, Mariupol) and the Western Balkans–Eastern Mediterranean corridor.

Road freight transport

Transport barriers may affect the scale of economic connections measured by road freight transport. In recent years, freight transport by road has been growing rapidly, driven by the development of warehouse logistics and changes in trade and transport service models. The volume of freight transport, measured in terms of cargo per capita, varies significantly across the NUTS3 regions within the Carpathian macroregion. Generally, the western regions of most countries, with the exception of Ukraine, tend to experience higher volumes of road freight shipments compared to the typically more peripheral eastern regions. This is largely due to established trade connections and the main destinations for foreign direct investment. This trend is particularly noticeable in the northwestern regions of Romania and west-ern Slovakia. Similar disparities between the western and eastern parts of the country are also evident in the Czech Republic and Hungary. In Poland, the situation is more mixed, but the Carpathian mountain regions remain among the most peripheral in terms of road freight transport. Meanwhile, the western regions of Ukraine play a much smaller role in freight shipments compared to the central and eastern parts of the country.

Between 2018 and 2022, for which data on this category of transport was available, there was a marked increase in freight shipments, particularly in the Polish and Romanian regions. However, this growth did not occur uniformly across all regions. Some mountainous regions of Lesser Poland, for in-stance, experienced noticeable declines or stagnation in freight volumes. Similar decreases were observed in the Czech regions, as well as in most eastern regions of Hungary, excluding the Miskolc region. In Slo-vakia, declines were also recorded, with the exception of the Banská Bystrica region. The situation in Ukraine was more varied, with freight volumes increasing in the Zakarpattia and Ivano-Frankivsk oblasts, while declines were noted in the Lviv and Chernivtsi regions.

Map 30. TEN-T network in Europe, 2024



Territorial level: Lines
Source: ESPON KARPAT, 2024
Origin of data: European Commission
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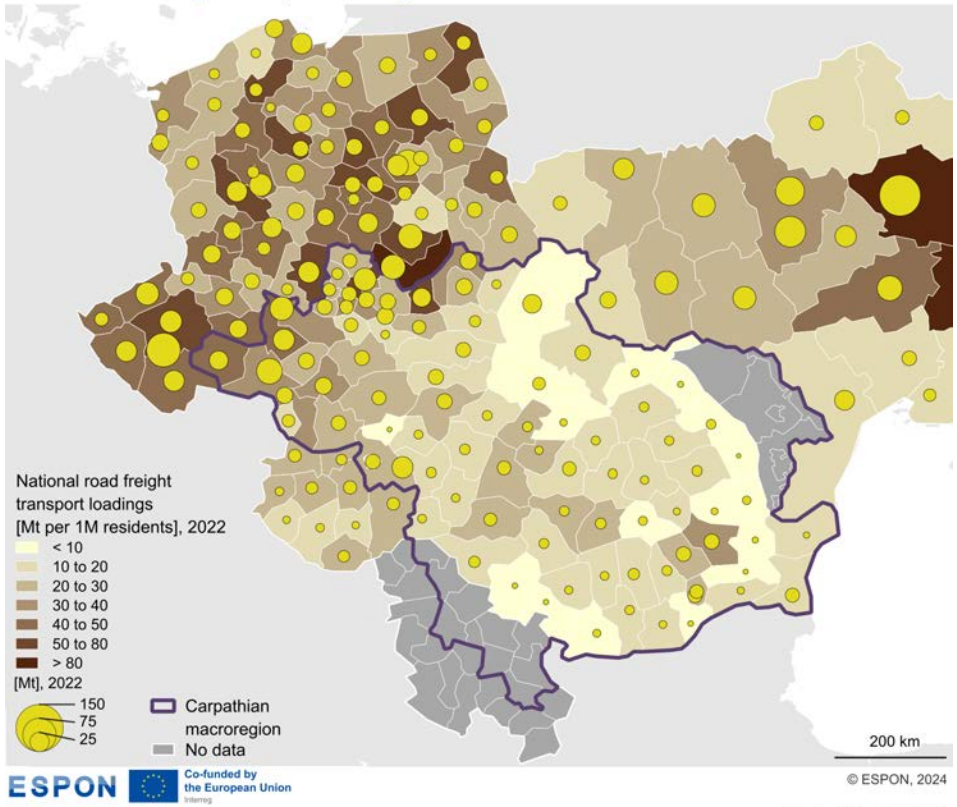
Map 31. National road freight transport loadings, 2022



Territorial level: NUTS3
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT and UA statistical office
No data ofr RS and MD
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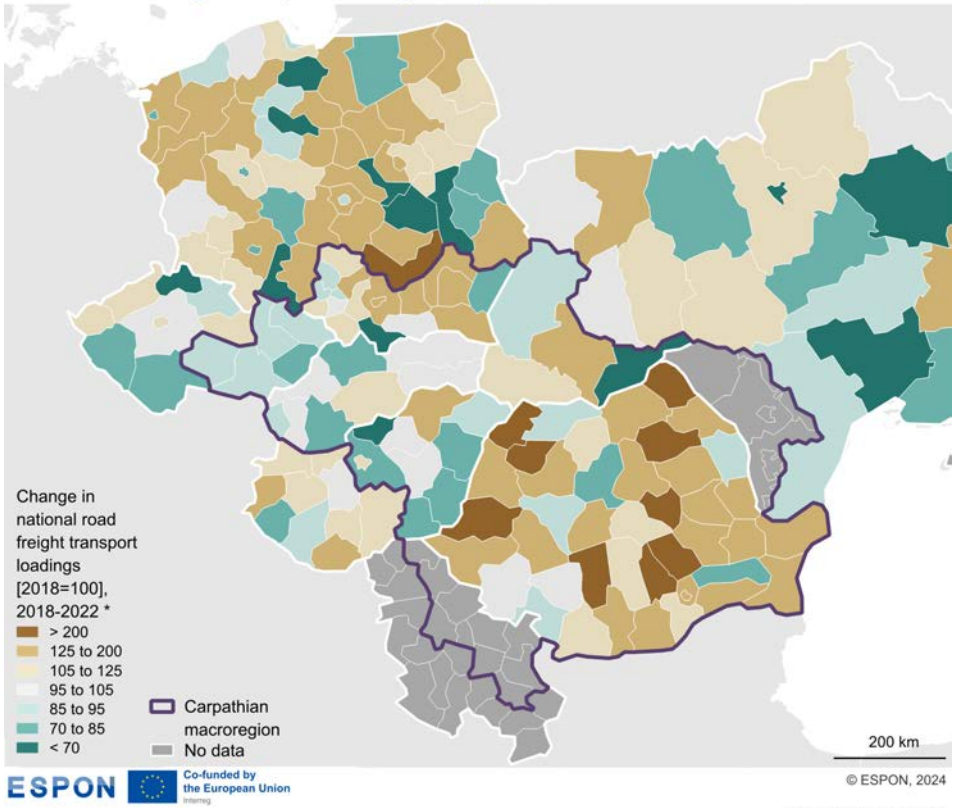
Map 32. National road freight transport loadings - change, 2018-2022



Territorial level: NUTS3
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT and UA, MD statistical offices
* For Ukraine change 2018-2021; No data ofr RS and MD
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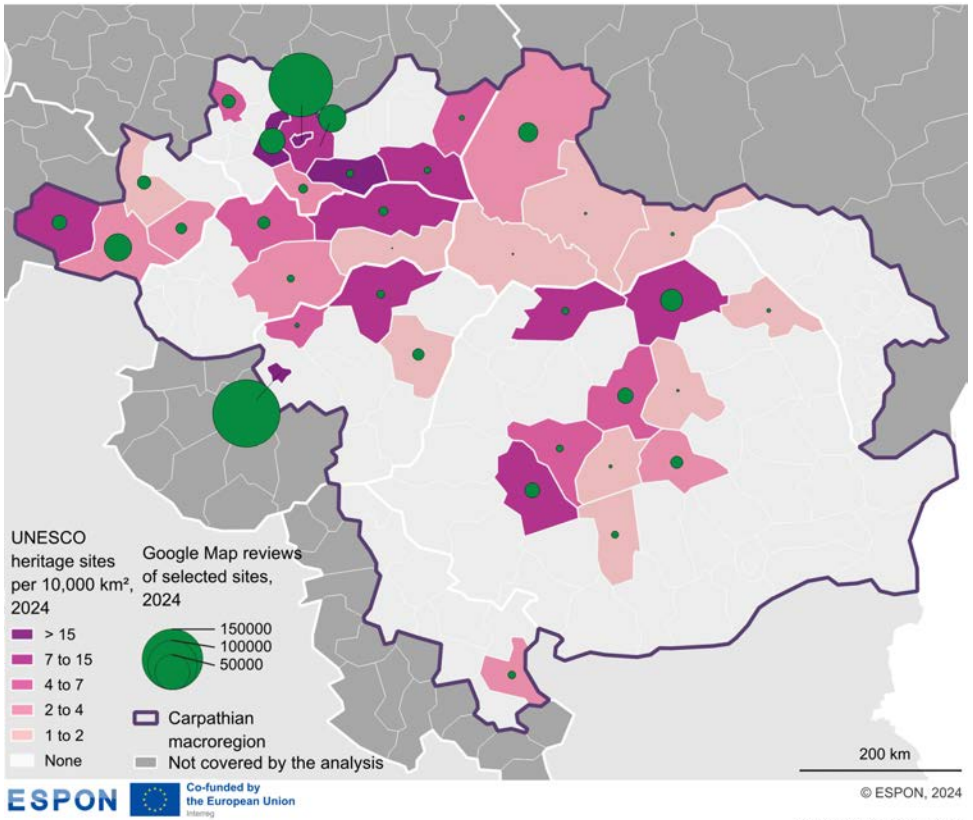
Cultural heritage and tourism

Cultural heritage and tourism, including nature-based tourism, play a vital role in developmental processes by fostering economic growth, preserving traditions, protecting natural landscapes, and enhancing social cohesion. Cultural heritage, encompassing historical landmarks, traditional practices, and local arts, serves as a foundation for identity and pride within communities, attracting both domestic and interna-tional tourists. Similarly, nature-based tourism leverages the appeal of unique ecosystems, biodiversity, and scenic landscapes, contributing to sustainable economic growth while emphasizing environmental preservation. Tourism linked to cultural and natural heritage not only generates significant economic benefits through job creation and infrastructure development but also promotes sustainable development by valuing and protecting local traditions, natural resources, and ecosystems. Furthermore, cultural and nature-based tourism fosters intercultural understanding and collaboration, contributing to more inclu-sive and resilient societies. By integrating cultural and natural heritage into tourism strategies, regions can develop holistic approaches that balance economic progress with the preservation of both cultural identity and natural assets.

Cultural heritage

The Carpathian macroregion hosts 42 UNESCO World Heritage sites, including three area-based sites of cultural and natural significance: Hortobágy National Park, the Tokaj Wine Region Historic Cultural Landscape, and the Ancient and Primeval Beech Forests. Wooden sacred architecture, such as the Wooden Churches of Małopolska, Maramureș, and the Carpathian region, forms a unique network spanning 38 locations, highlighting the potential for a trans-Carpathian UNESCO heritage trail. Regions like Maramureș, Suceava, Nowosądecki, and Prešovský kraj serve as key hubs, while prominent clusters in Kraków, Budapest, and other urban areas benefit from tourism infrastructure and accessibility. However, eastern and southeastern Carpathian regions face challenges of lower site density, visibility, and infrastructure, requiring targeted strategies to promote equitable heritage tourism across the macroregion.

Map 33. UNESCO heritage objects and their recognisability, 2024



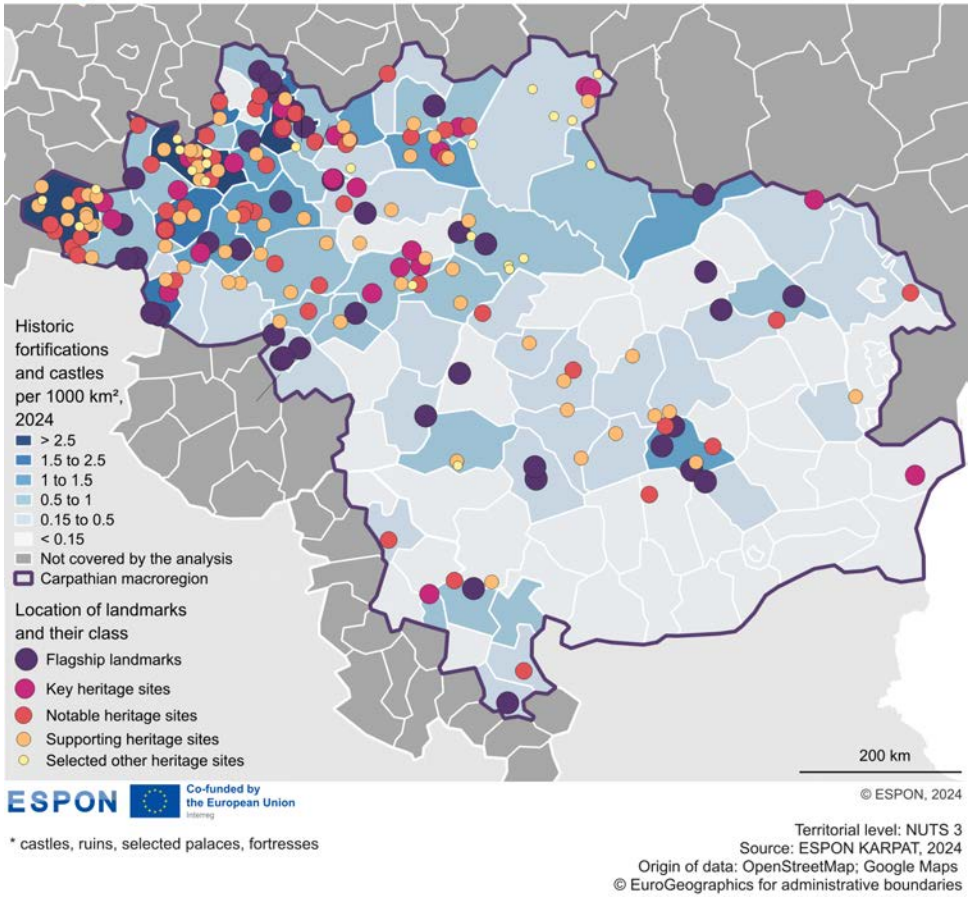
Other main cultural heritage sites

A lot of other important historical sites i.e. castles, selected palaces (often transformed from older structures or following the style of original castles) and other prominent fortifications, scattered across the Carpathians, reflect the political, military, and cultural changes that have shaped these part of Central and Eastern Europe over centuries.

The distribution of historic fortifications and castles shows clear clustering in the northern and western parts of the Carpathian macroregion. The highest density of historic castles and fortifications per 1,000 km² (over 2.5) occurs in the Czech regions (especially Vysočina and Moravskoslezsko) as well mountain regions of Slovakia, Poland and Hungary as well as in some regions of Romania (especially region of Brașov). Lower densities are observed in some eastern and southern parts of Carpathian mountain range. There is a prominent lack of recognisable historic fortifications and castles in the southern and eastern parts of the macroregion. Spatial patterns of concentration of historical landmarks reflect historical patterns of wealth, trade routes, strategic defence locations, and administrative centres.

The Carpathian region contains almost 200 identified fortifications and castles with Google reviews of which 145 exceed 1,000 reviews, 41 exceed 10,000 reviews of which 12 surpass 20,000 reviews. The most recognisable sites include Wawel Royal Castle in Kraków, three Romanian castles/palaces – Bran, Peleș as well Corvin Castle in Hunedoara, Buda Castle in Budapest and Bratislava Castle. Accessibility and metropolitan location significantly influence recognisability of fortifications and castles. Majority of "flagship landmarks" are situated in highly urbanized areas, whereas sites in mountainous regions are markedly less recognisable, mostly classified as "supporting heritage sites." Despite their number, sites in Ukrainian regions tend to have relatively lower recognisability. Conversely, sites in Romania, particularly in Brașov, exhibit relatively higher recognizability.

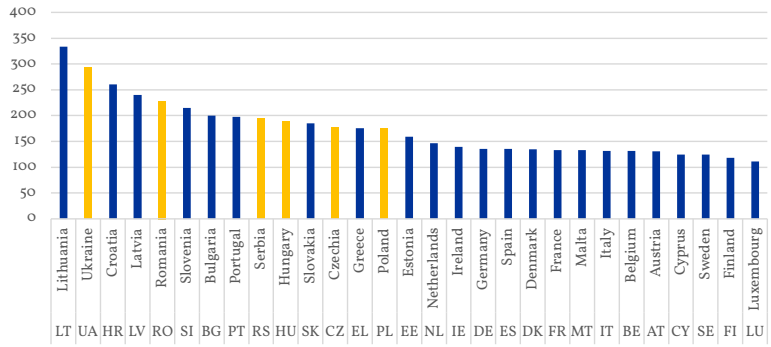
Map 34. Selected heritage sites related to defensive architecture and their recognisability, 2024



Tourism

Tourism in the Carpathian macroregion varied widely but generally matched or exceeded national averages. High tourist activity, measured by overnight stays per 1,000 residents, was seen in urban and metropolitan areas like Bratislava, Budapest, Kraków, and Brno, averaging two tourists per resident annually. This was driven by year-round "city breaks" and business tourism.

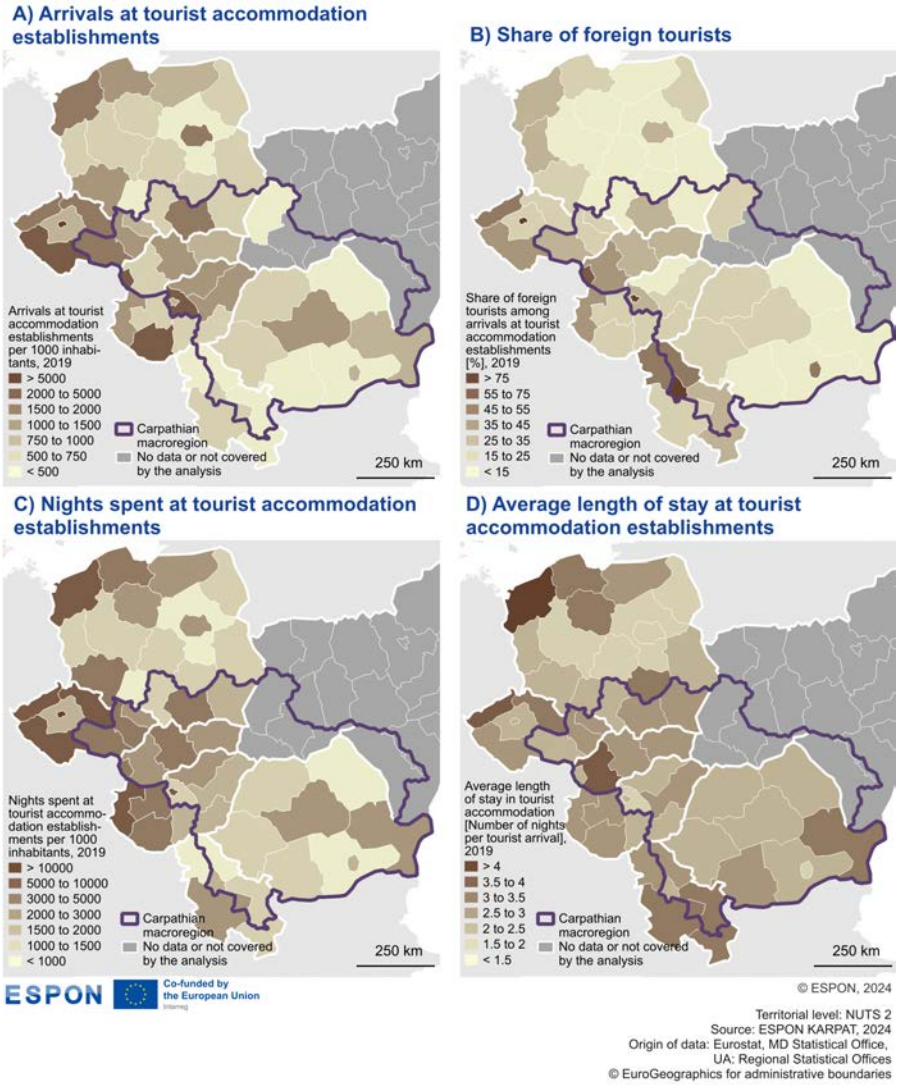
Fig 1. Change in the number of tourists, 2010-2019 (2010=100)



Regions like central Slovakia, northeastern Hungary, and Romanian Transylvania also attracted significant tourism due to their natural and cultural resources, including spa, skiing, and hiking opportunities. In contrast, lowland areas of Romania and the Republic of Moldova were less attractive. Border formalities further hindered cross-border tourism in non-EU countries.

Foreign tourists accounted for over 50% of visits in areas such as Budapest, Bratislava, and Bucharest, as well as in western Slovakia and Serbia's Vojvodina, where this was often driven by transit tourism. In Slovakia and Poland's Małopolskie region, foreign tourists made up one-third of visitors, supported by cross-border tourism and low-cost flights. Tourism intensity, measured by nights stayed, was lower in the Carpathian regions than in western parts of the Czech Republic, Hungary, and Poland's coast, highlighting regional disparities.

Map 35. Tourist arrivals, 2019

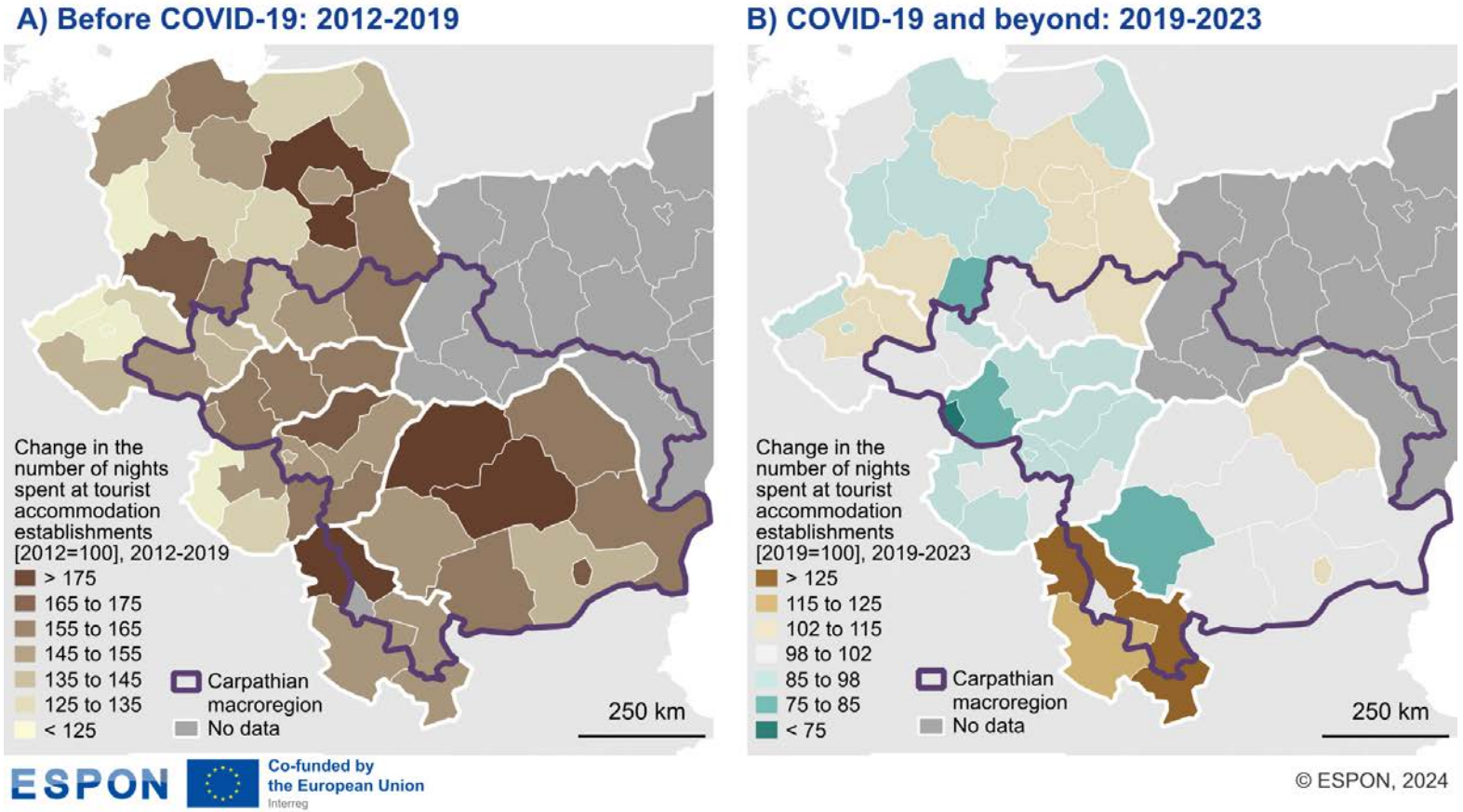


Changes in tourist stays

Tourism in the Carpathian macroregion grew rapidly from 2012 to 2019, with overnight stays increasing by around 50%. Central and northwestern Romania, northern Serbia, and northern Hungary saw the highest growth (over 65%), while smaller increases (above 25%) were noted in Poland's Silesian region, the Czech Republic, central Moravia, and Bucharest.

The COVID-19 pandemic temporarily halted this growth, but tourism largely rebounded to 2019 levels by 2023. Serbian regions even surpassed pre-pandemic activity, while Slovak regions, especially Bratislava, saw slower recovery, likely due to shifts in business tourism. Northeastern Hungary and Romania's Timișoara region also reported lower tourism intensity.

Map 36. Change in number of nights spent at tourist accommodation establishments, 2012-2023



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT
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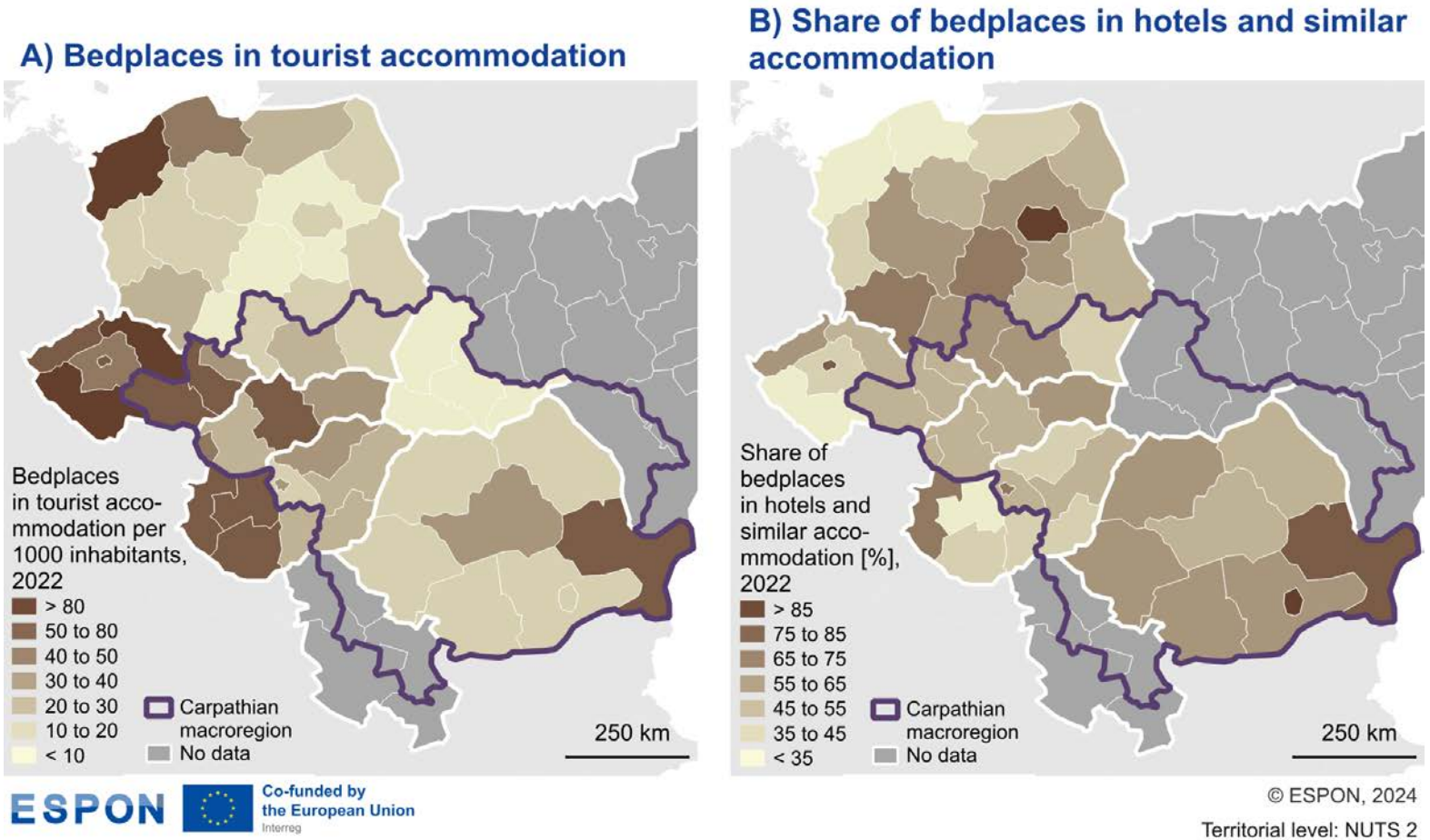
Accomodation capacity

Accommodation facilities in the Carpathian macroregion are unevenly distributed, with some regions, like Moravia, central Slovakia, and Romania's Constanța, exceeding 50 beds per 1,000 residents, while others, particularly in Ukraine and parts of Romania, offer fewer than 10.

Hotels dominate official accommodation statistics, comprising over 50% in areas with lower facility density, such as Romania, Poland, and eastern Slovakia. However, alternative accommodations, including mountain lodges, agritourism, and rental apartments facilitated by platforms like Airbnb and Booking.com, significantly complement the region's tourism infrastructure but are often excluded from official data.

Map 37. Tourist accommodation capacity, 2022



ESPON Co-funded by the European Union Interreg

Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, UA: Regional Statistical Offices

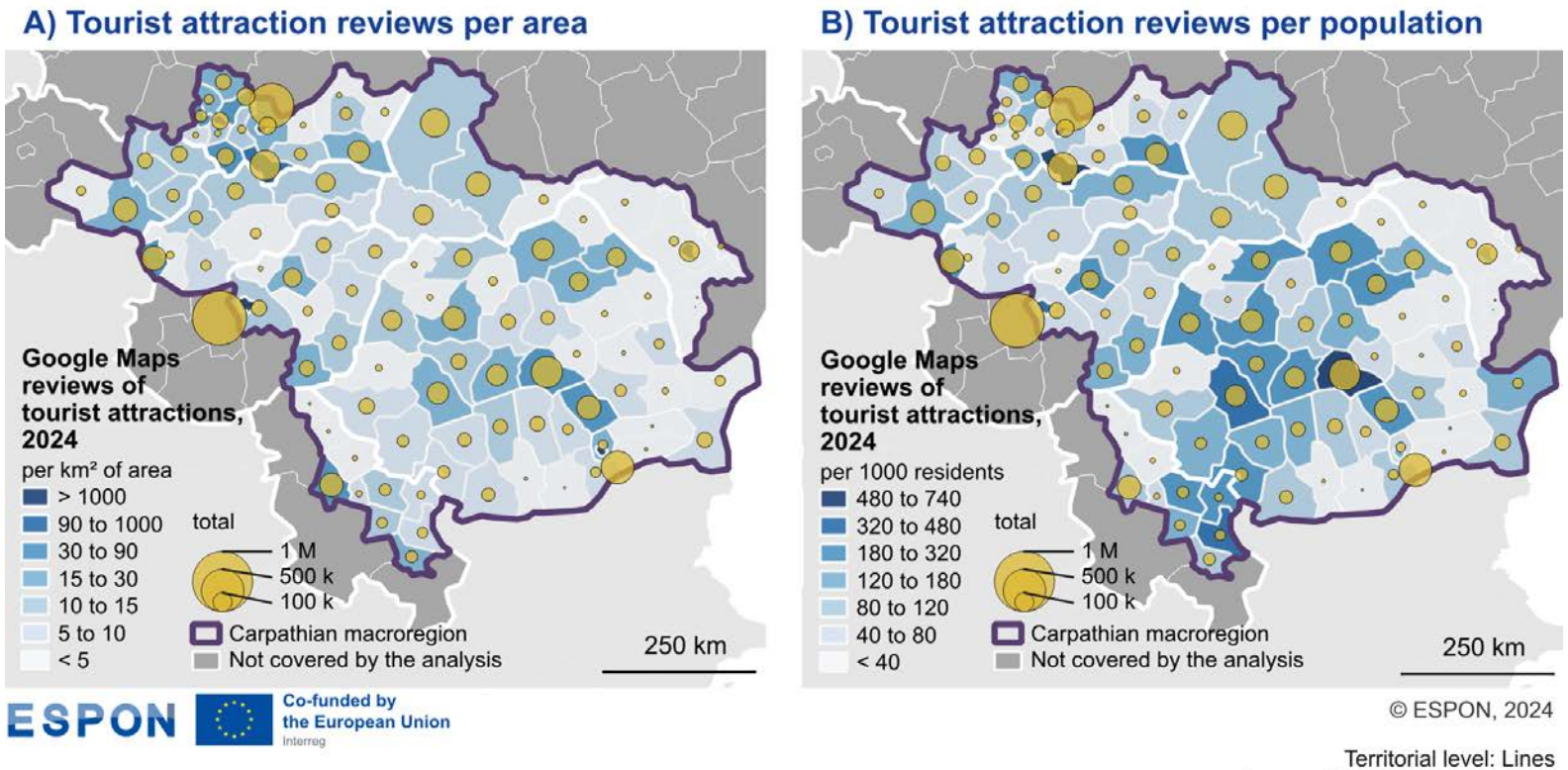
Recognisability of tourist attractions

Tourist attraction reviews in the Carpathian macroregion highlight major hubs like Budapest, Kraków, and Bucharest, which lead in both total reviews and density per 100 km², underscoring their popularity and visitor engagement.

Mountain regions such as Nowotarski, Brasov, and Sibiu also show high review density, linked to key heritage sites. Regions like Nowotarski (734 reviews per 1,000 inhabitants) and Kraków (680) exhibit significant tourist engagement relative to their population, reflecting concentrated tourism activity.

Southern Romania and Transylvania also stand out for their high review scores and strong visitor interest.

Map 38. Tourist attractions - and their recognisability, 2024



ESPON Co-funded by the European Union Interreg

Territorial level: Lines
Source: ESPON KARPAT, 2024
Origin of data: Google Maps

Hiking trails

The highest number of hiking trails is in Slovakia's Banskobystrický (5160 km), Žilinský (4915 km), and Prešovský (4824 km) regions, and the Czech regions of Jihomoravský (4185 km) and Moravskoslezský (4125 km). Trail density peaks near Budapest and Nógrád in Hungary and Bielsko in Poland. A consistent network spans the northwestern Carpathians, from Poland's Nowosądecki to Slovakia's Žilinský and Trenčiansky regions, extending to Bratislava. In contrast, Ukraine's Zakarpatska and Romania's Maramureș and Suceava regions have less-developed, fragmented trail systems, with isolated clusters in southern Romania, including Harghita and the Bucegi Mountains near Brașov.

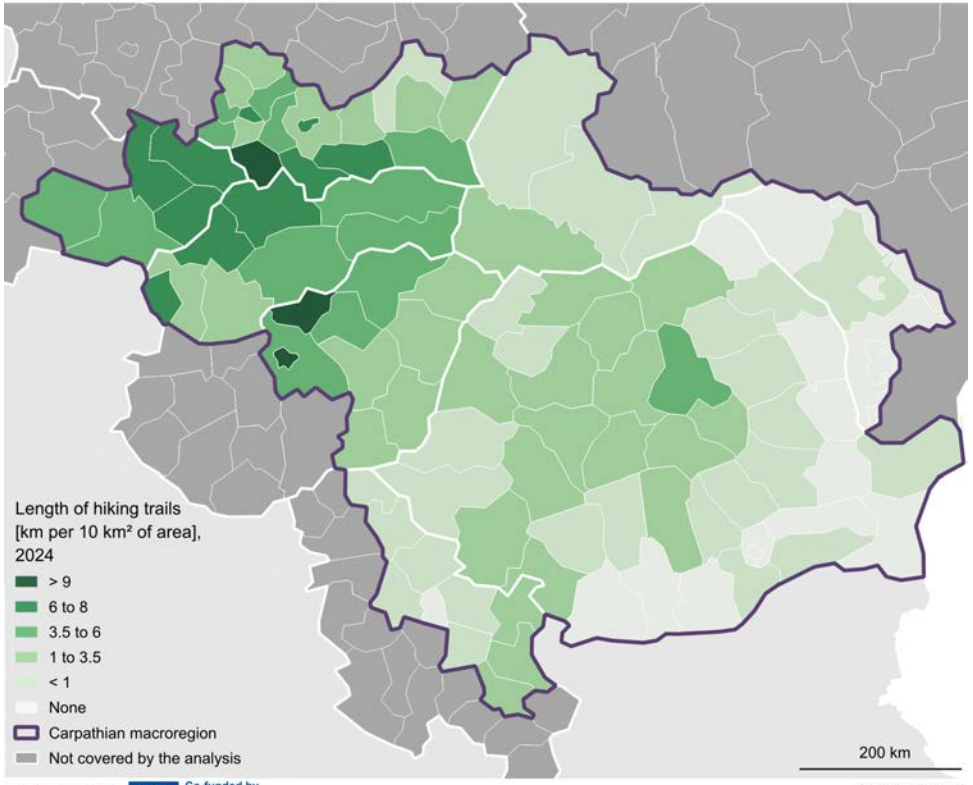
Ski infrastructure

Ski tourism in the Carpathian macroregion thrives in Slovakia, Poland, and Czechia, with key hubs along the Poland-Slovakia border, such as Nowotarski, Bielski, and Žilinský, offering a combined 267 km of ski infrastructure. Slovakia's resorts, including Jasná Nízke Tatry and Tatranská Lomnica, and Poland's Szczyrk and Białka Tatrzańska, cater to diverse skill levels, while Zakopane struggles with fragmentation. The interconnected network extending from Prešov to the Sudety ski areas enhances accessibility, but improvements like shared passes and better transport could reduce congestion. Elsewhere, isolated mega-resorts like Bukovel in Ukraine and Romanian resorts like Straja lack integration, limiting their competitiveness.

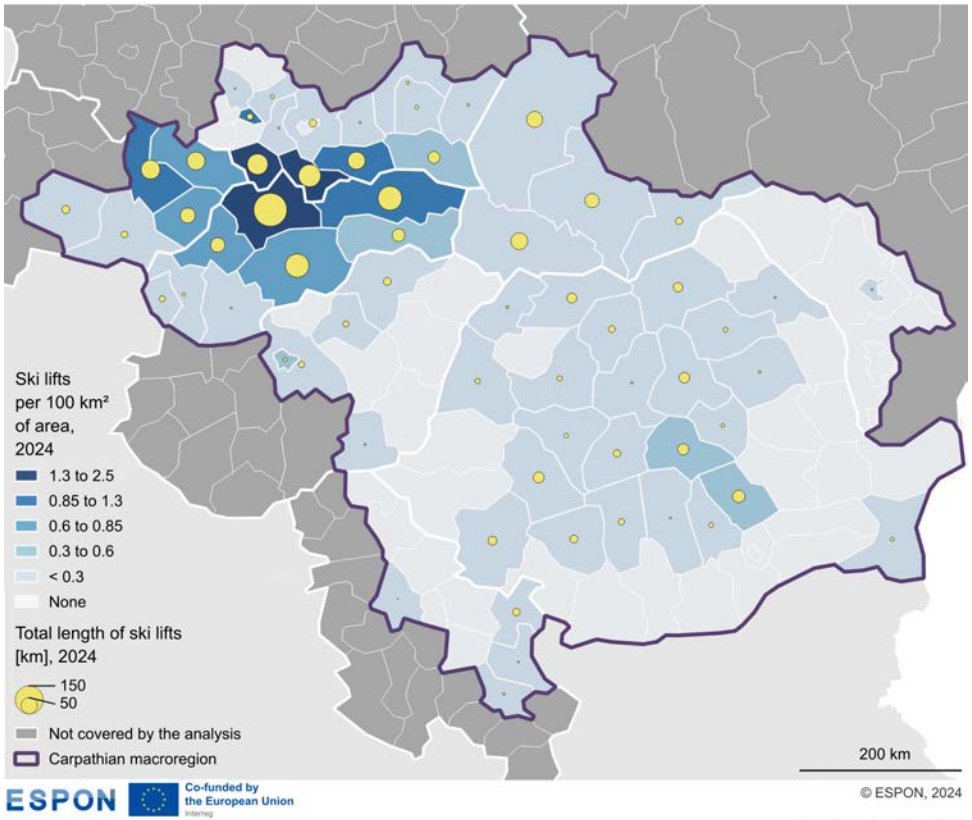
Spa towns

The Carpathian macroregion has strong wellness tourism potential, with the densest clusters in Hungary, particularly in regions like Jász-Nagykun-Szolnok, Heves, and Békés, known for their high concentration of spa resorts. This network extends across eastern Hungary, supported by natural resources like geothermal springs and thermal waters. Other notable areas include Slovakia's Vysoké Tatry, Poland's Beskid Sądecki, Romania's Covasna, and Ukraine's Zakarpatska. Many of these spa towns, such as Budapest and Sinaia, combine wellness with cultural attractions, while others, like Hévíz and Băile Tușnad, integrate nature-based tourism. Some, like Rajecké Teplice and Sárvár, cater to luxury wellness tourism.

Map 39. Density of hiking trail, 2024



Map 40. Ski infrastructure, 2024



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: OpenStreetMap
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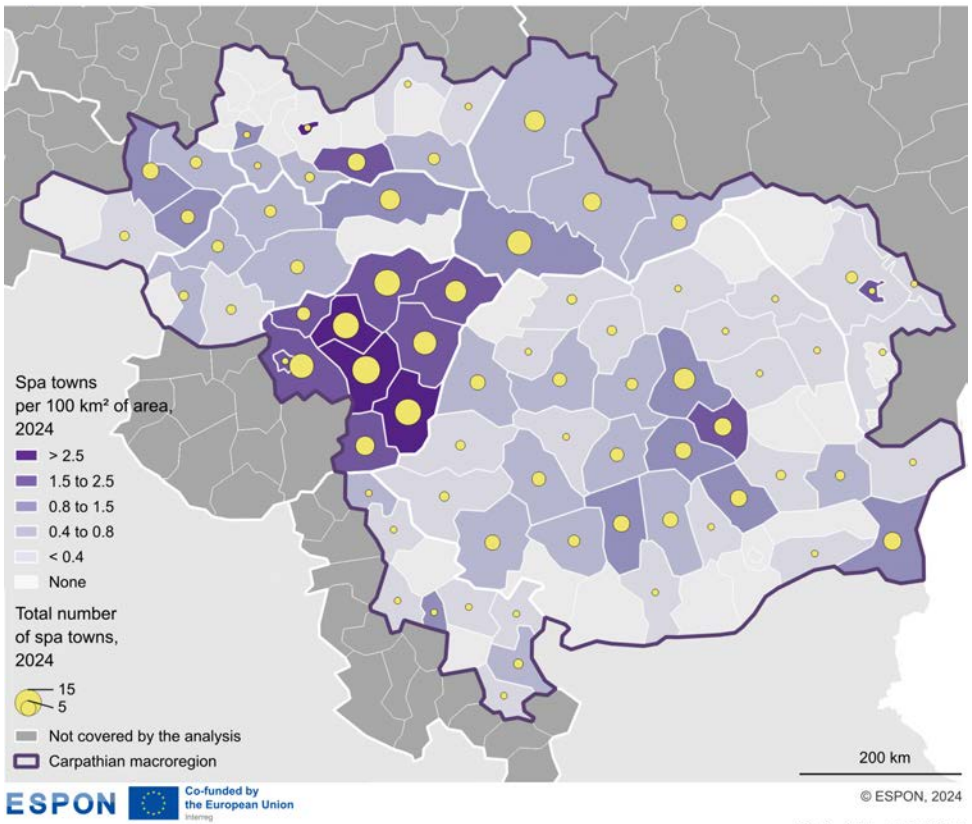
Map 41. Spa towns, 2024



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: National Tourist Boards (CZ, PL, SRB, SK, HU), Government Pages (UA), Wikipedia (MD), Silisteanu et.al, 2020 (RO)
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2.2 Demography and society

Population density and demographic structure

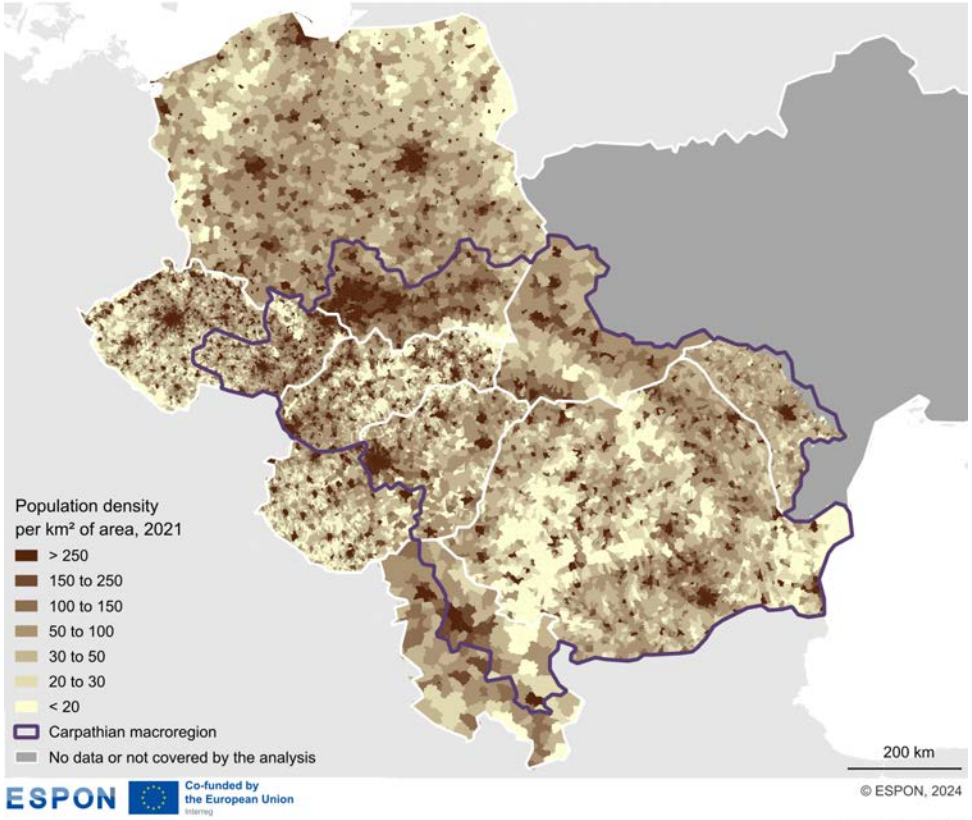
The Carpathian macroregion has a population of 57 million people that is largely due to the location of large urban centres in the mountain foothills, including capital cities such as Budapest, Bucharest and Bra-tislava. However, it should be noted that within the Carpathian macroregion there is a very high variation in population density, which is particularly well visible at the lower levels of population data aggregation.

In particular, the shape of the Carpathian mountain chain is very visible, which is due to the fact that many municipalities of mountainous areas are characterised by low population densities of no more than 20 persons per sq km. Such municipalities are characteristic especially for Romania (especially the Apuseni Mountains), but even in countries where the size of municipalities is much higher, i.e. Serbia and Ukraine, for example, mountain municipalities clearly stand out against the foothills. The situation is somewhat different in Poland, where the low population density of some of the Carpathian municipalities is due to historical reasons. This is evident only in the eastern part of the Polish Carpathians, while the western part is one of the most densely populated areas of the country.

In Slovakia, on the other hand, despite the low population density in many mountain municipalities, it is possible - especially in the eastern part of the country - to indicate the presence of densely populated areas in mountain valleys, including former mining settlements and towns, as well as Roma settlements. The mountainous border areas of the Czech Republic and Slovakia are also relatively densely populated, with the exception of municipalities covering the highest parts of the border mountain range.

The highest population density, on the other hand, characterises the foothill areas located on the outer part of the Carpathian Arc from Moravia through Silesia, Lesser Poland, Podkarpacie in Poland and Ukraine, as well as Romanian Moldavia and Wallachia. In contrast, on the inner part of the Carpathian arc, the highest density is found in the Pannonian Basin, which applies to Hungary, Slovakia, Ukraine, Romania and Serbia, as well as in some parts of the Transylvanian Highlands.

Map 42. Population densit, 2021



Territorial level: LAU
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT 2024, National censuses
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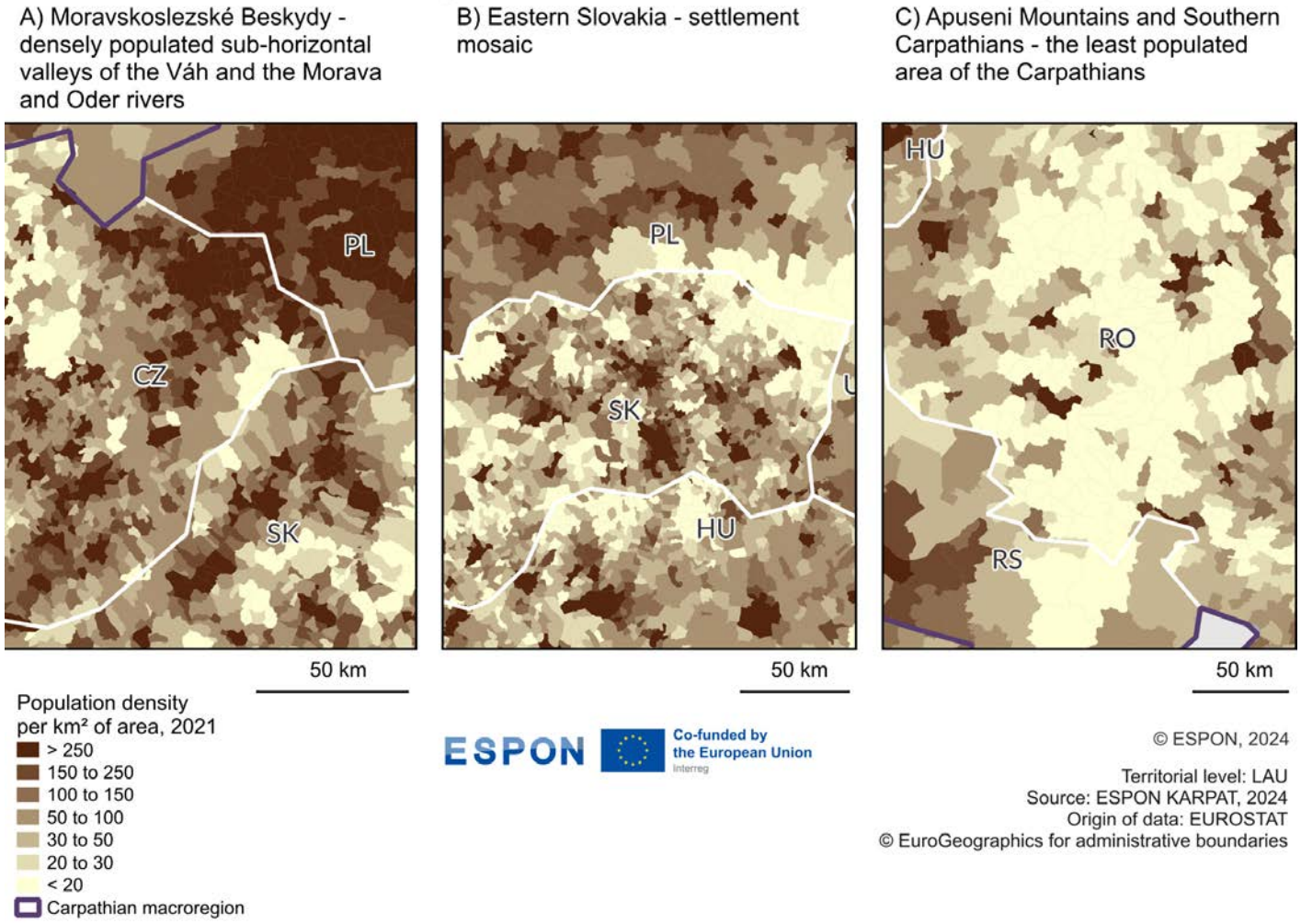
Map 43. Examples of population density differentiation, 2021



Popluation change

The population change in the macroregion's municipalities over the past two decades shows clear depopulation processes and, on the other, areas that are maintaining demographic vitality or even experiencing demographic expansio.

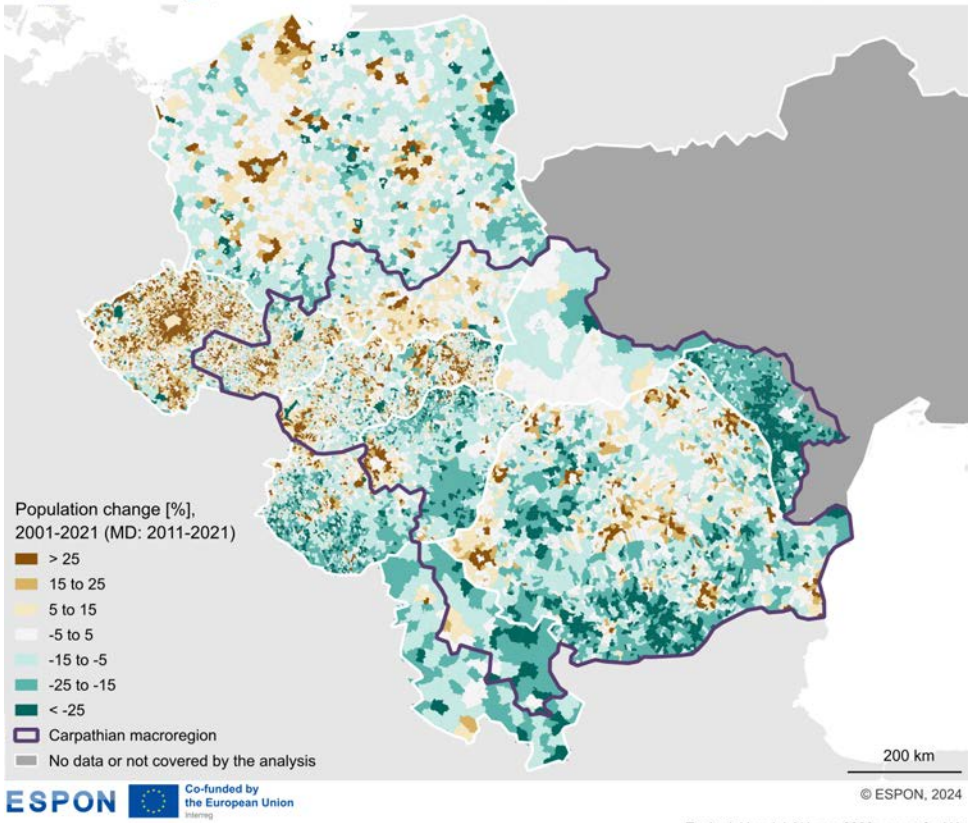
Among mountain areas, the fastest population decline was in the Apuseni Mountains in Romania. In addition to these, significant declines also occurred in the Southern Carpathians in Romania and in Serbia. The Eastern Carpathians in Romania did not experience such large losses, but were also undergoing depopulation. Such declines were also recorded in the Eastern Carpathians in Poland and Slovakia. Depopulation - albeit unevenly - also occurred in the mountainous areas of northern Hungary.

Significant population declines also affected some foothill areas, which was particularly true of Wallachia (excluding the surroundings of the large cities i.e. Bucharest, Krajowa and Pitesti) and especially its western part. The second such area was southern Hungary excluding Szeged and its surroundings.

In contrast, the Romanian part of the border region with Hungary was one of the areas where the population was growing very significantly, especially in the surroundings of the big cities, i.e. Timisoara, Oradea and Satu Mare. The situation was similar in Romanian Moldova, but with a greater contrast between population growth in the surroundings of cities such as Suceava, Iași and Bacau and a decline in most other areas of the region. There was also a clear demographic increase in eastern Slovakia, especially in the surroundings of Košice and Prešov, but also in the Poprad valley.

In Poland, the majority of municipalities recorded either population increases or maintained population levels. The most pronounced increases were in the surroundings of large cities, especially Krakow and Rzeszow, but also Nowy Sącz, Bielsko-Biała and the Nowotarska Basin. A slight depopulation affected the mountainous areas of the Czech-Slovak border region, while the suburban areas of the largest cities, i.e. Brno, Ostrava Olomouc and Zlín, recorded a clear increase in population. Bratislava, Budapest and Belgrad also experienced significant suburbanisation.

Map 44. Population change, 2000-2021

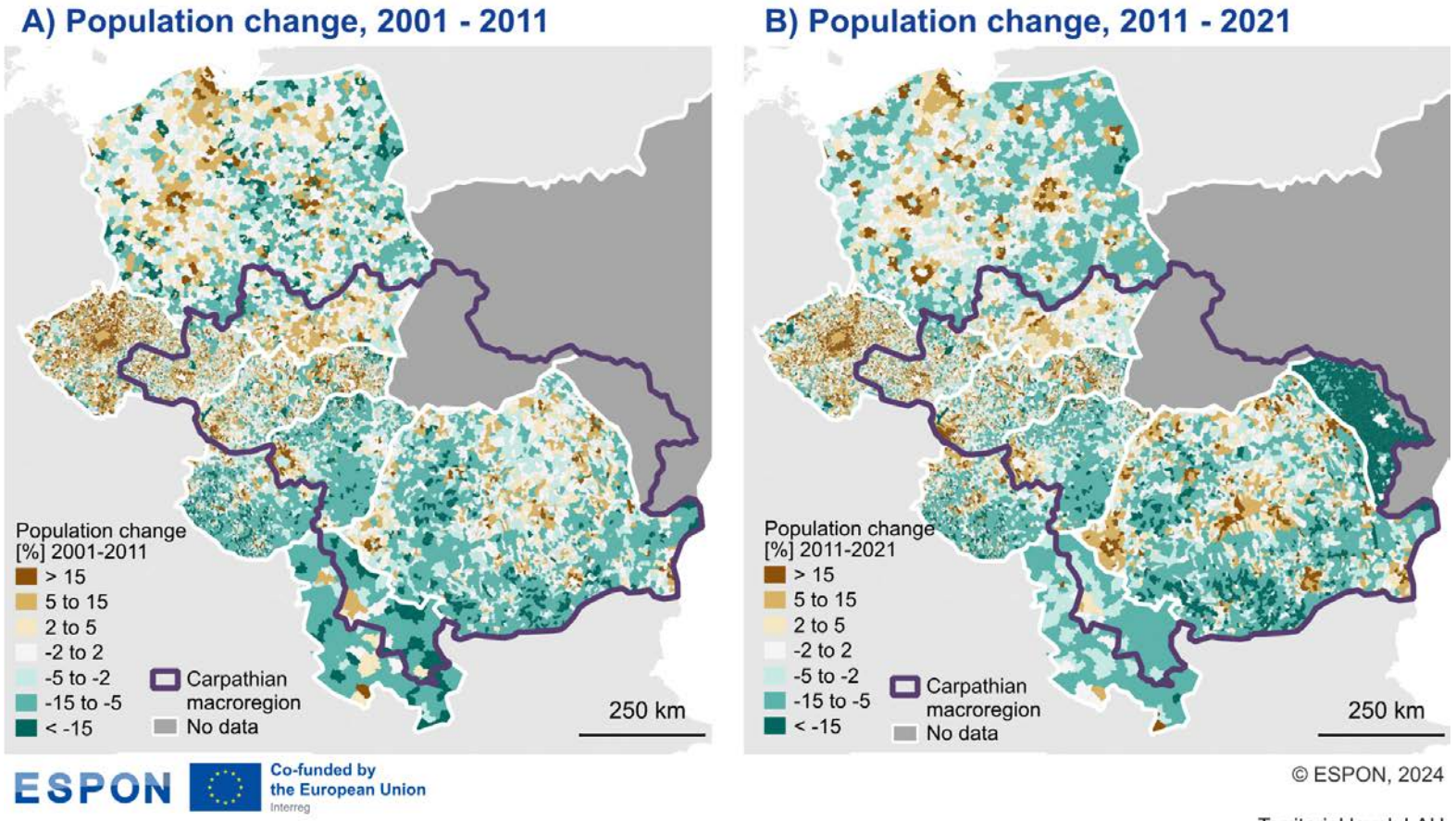


Dynamics of population change

The observed processes of population change over the last 20 years have been relatively stable in spatial terms. However, an increase in polarisation can be observed between areas of depopulation and areas of population growth, which was particularly evident in Romania. In particular, the population growth dynamics intensified in the border area with Hungary, as well as in the Transylvanian Highlands.

On the other hand, depopulation processes intensified slightly in the Krosno sub-region in Poland, the eastern part of the Banská Bystrica region in Slovakia and the Czech-Slovak border region. In contrast, some deceleration in the rate of depopulation processes occurred in Serbia, which also affected mountain-ous areas.

Map 45. Change in population between census periods, 2001-2021



ESPON Co-funded by the European Union Interreg

Territorial level: LAU
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, National censuses

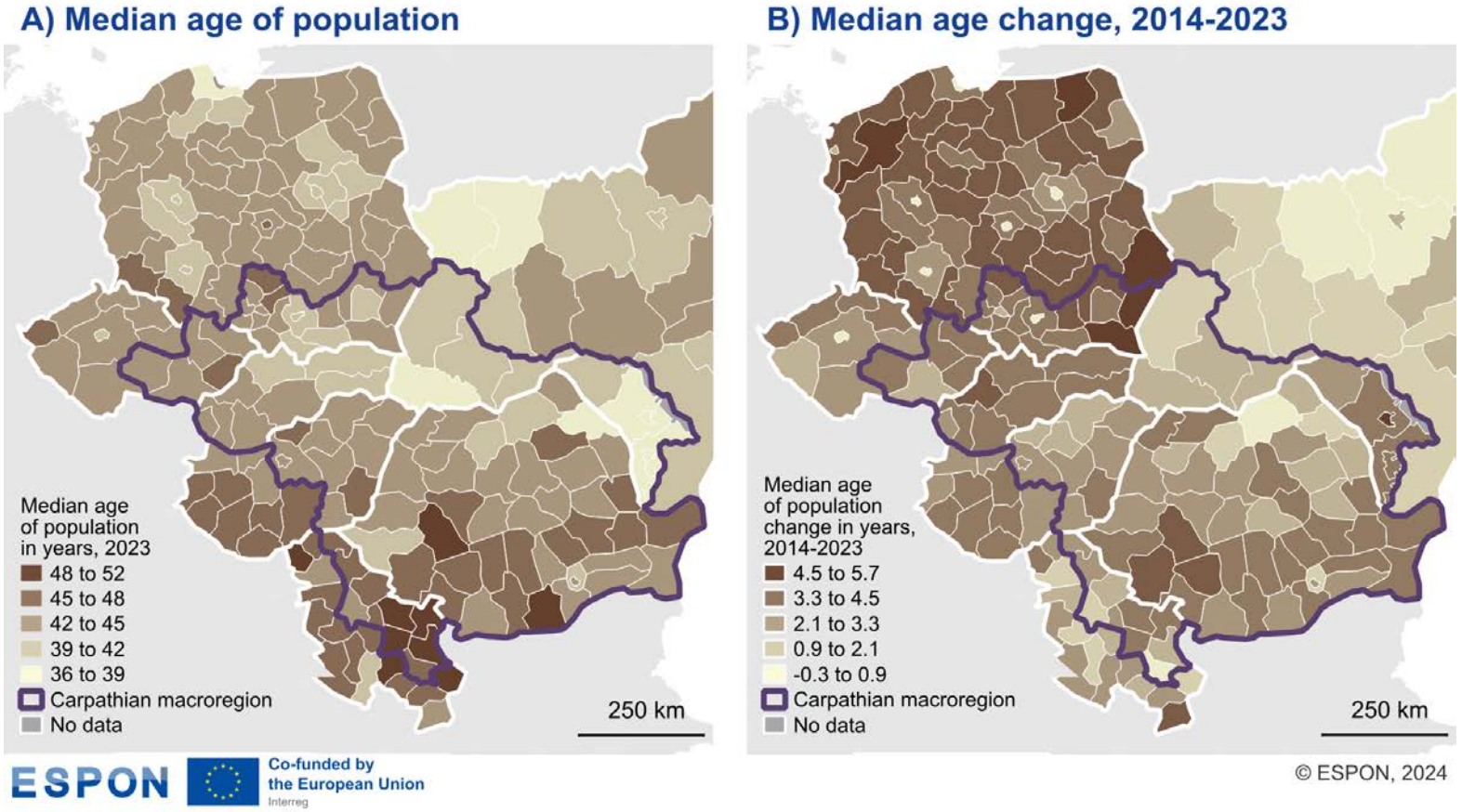
Median age

Most Carpathian countries, except Hungary, Czechia, and Romania, have younger populations than the European average. The youngest population lives in the Republic of Moldova (median 35), Slovakia (42) and Ukraine (42). Regionally, a north-south gradient in median age is evident.

The oldest populations (median age over 47) are in southern Carpathian areas of Serbia and Romania, the Danube Plain, and parts of Romanian Moldova, Silesia, Czech Moravia, and parts of Hungary and Slovakia. Younger populations are found in the Republic of Moldova, Ukraine, eastern Slovakia, Poland's Nowy Sącz subregion, Kraków and Rzeszów.

Between 2014 and 2023, the median age rose in nearly all regions due to lower birth rates and increased life expectancy. Podkarpackie saw the median age rise by over 5 years, with increases of 3+ years in other parts of Poland, Czechia, Slovakia, southern Serbia, Romania, the Republic of Moldova, and Maramureș.

Map 46. Median age, 2014-2023



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, MD & UA Statistical Offices; estimations for MD
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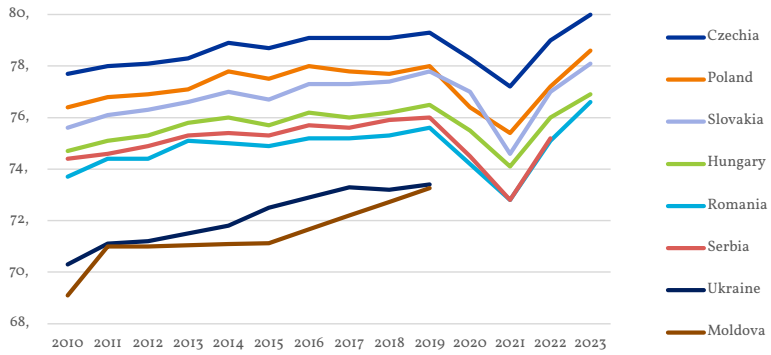
Life expectancy

Fig 2. Life expectancy at birth



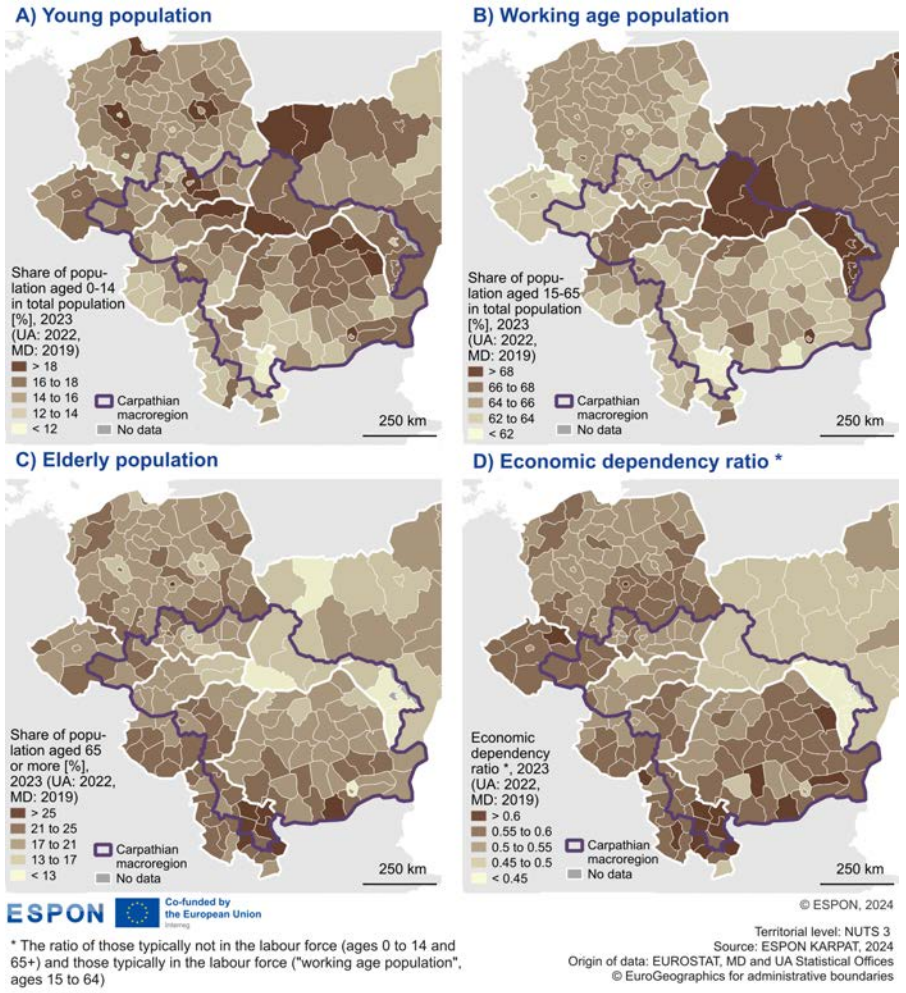
Source: own elaboration based on EUROSTAT data and WHO for the Republic of Moldova

Age structure

In some regions, youth under 15 years made up less than 13%, while the 65+ group exceeded 24%, especially in Eastern Serbian Mountains. Parts of the Carpathians, including Małopolskie, eastern Slovakia, and Romanian Moldova, had youth shares near 20%, paired with a lower post-working-age population, under 17%. The Republic's of Moldova and Ukrainian regions showed shorter life expectancy (around 73.5 years in 2019. Despite temporary COVID-19 setbacks, life expectancy rose since 2010, but gaps remain; the Czech Republic exceeded 80 years in 2023, while Hungary, Romania, and Serbia stayed below 77 years.

Population aging has increased the demographic burden, higher in Serbia, Romania, Hungary, and the Czech Republic, but lower in the Republic of Moldova, Ukraine, Slovakia, and Poland. Fertility rates, crucial for generational replacement (2.1 needed), remain below this across the Carpathians, with spatial variation.

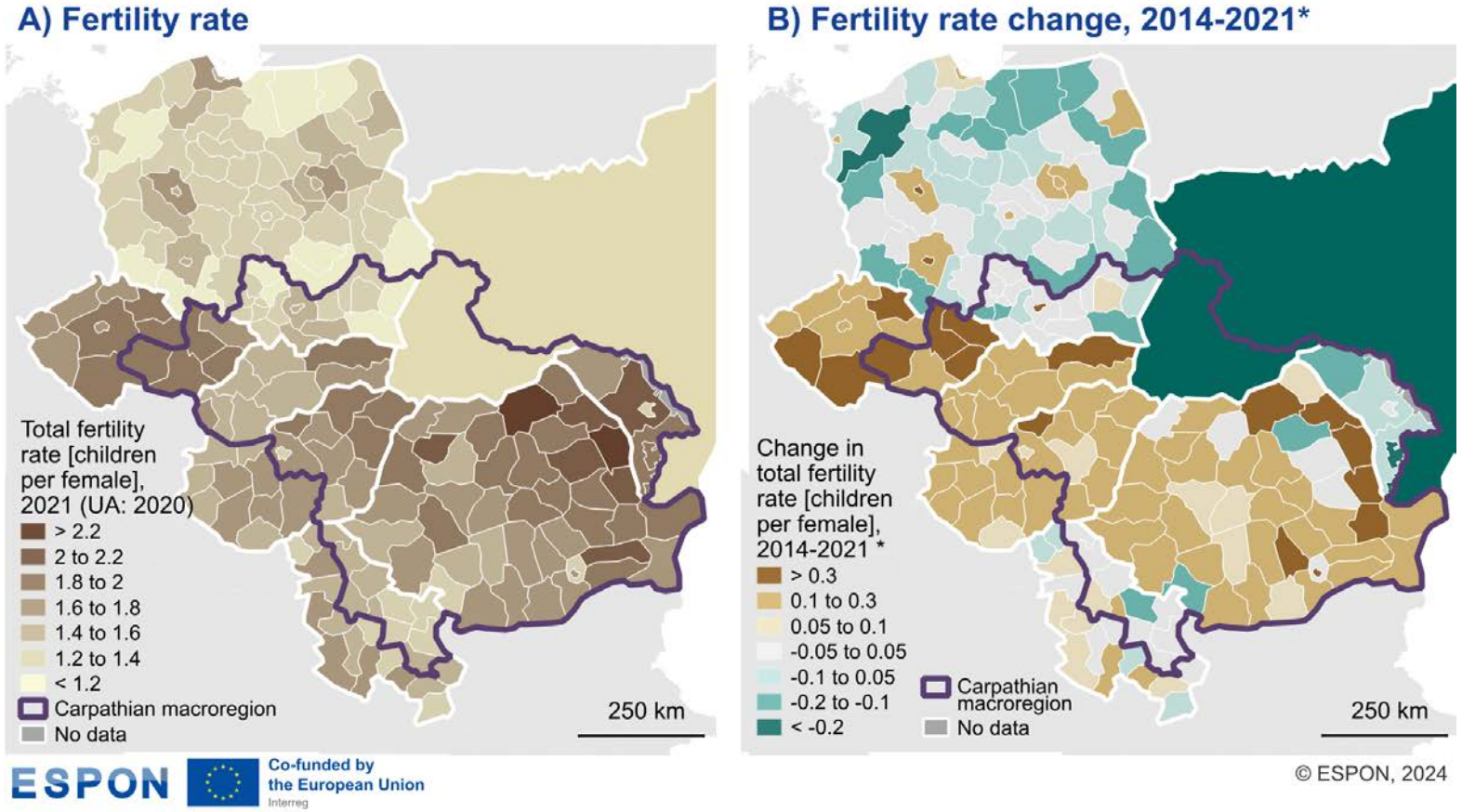
Map 47. Population age structure, 2023



Fertility

Spatially, fertility rates largely reflected the national situation, but the range of variation was even greater. Some Polish subregions (with a rate below 1.2) diverged sharply from Romanian Moldova, where the rate exceeded 2.1. Within each country, eastern Slovakia and Hungary had higher fertility rates, while in Serbia, eastern Carpathian regions had lower rates than the national average. A notable im-provement occurred across all regions of the Czech Republic, Slovakia, and Hungary, as well as most re-gions in Romania. In contrast, the dynamics in the Republic's of Moldova, Polish, and Serbian regions were notably weak-er, with only the largest urban centres showing a positive trend.

Map 48. Total fertility rate, 2014-2021



* RS: 2017-2021, UA: 2015-2020

Territorial level: NUTS3, NUTS0 for UA
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, MD and UA Statistical Offices
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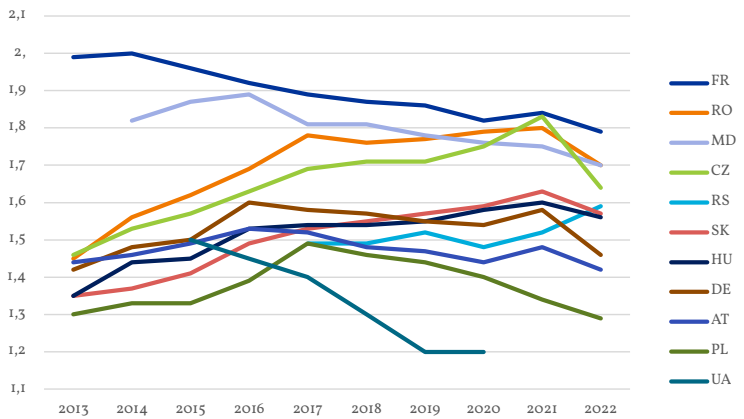
Fig 3. Total fertility rate in Carpathian Countries, 2013-2022

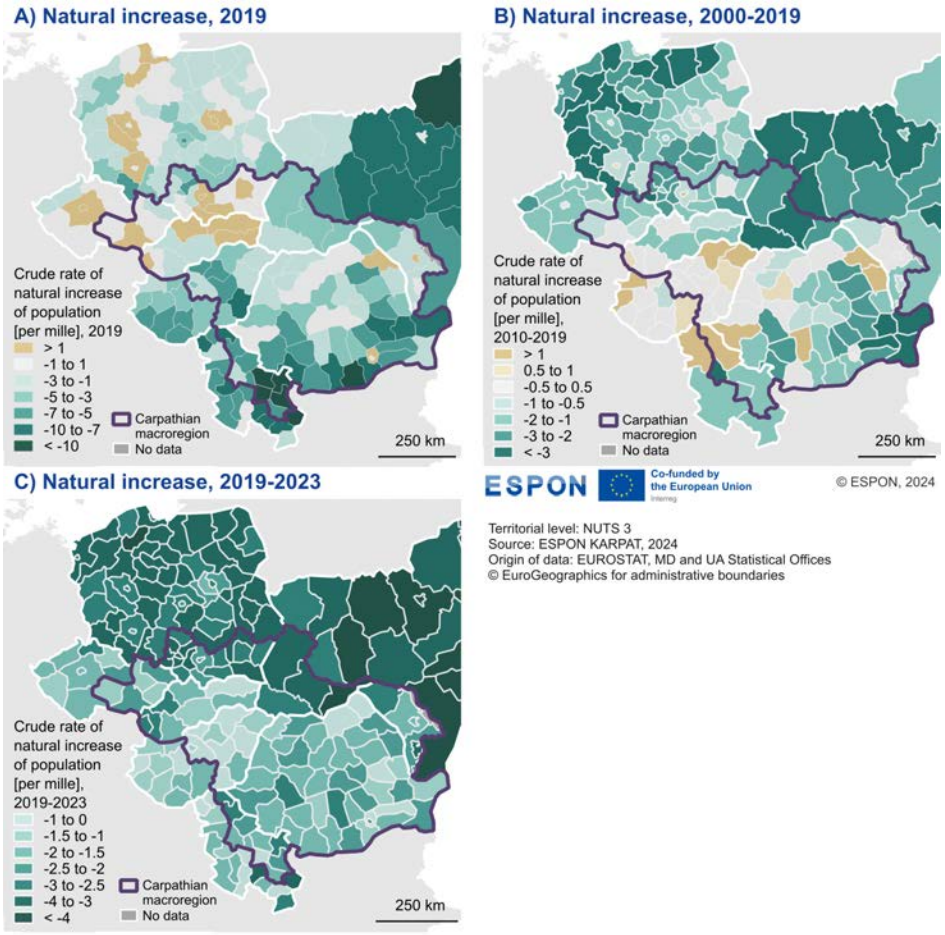


Source: own elaboration based on Eurostat

Natural increase

Natural population movement in most Carpathian countries and regions shows a clear excess of deaths over births. In 2019, exceptions included eastern and northern Slovakian regions, the Bratislava metropolitan area, Małopolskie and Podkarpackie Voivodeships in Poland, selected regions in Romanian Moldova (e.g., Iași), and Transylvania, as well as the Bucharest metropolitan area. On the opposite end, Serbian regions, as well as non-Transylvanian regions of Romania, especially in the south, experienced significant natural population decline. This trend did not significantly worsen from 2010, except for Ukrainian regions, southern Romania, and the Krosno subregion in Podkarpackie, Poland. In some re-gions, particularly northeastern Hungary and parts of Transylvania, there was a slight improvement. However, the post-pandemic period brought a natural decrease, especially visible in Ukraine, Poland, western Slovakia, and selected regions in Romania and Serbia.

Map 49. Natural increase of population, 2000-2022



Migrations

Russia's unprovoked invasion of Ukraine on February 24, 2022, caused thousands of civilian casualties, widespread destruction, and displaced millions. By June 2024, around 4.3 million Ukrainians in EU countries were under temporary protection, mostly in Germany (1.35 million), Poland (0.95 million), and the Czech Republic (350,000). Per capita, the Republic of Moldova led with 50 refugees per 1,000 residents, followed by the Czech Republic, Lithuania, and Poland. The Carpathian countries, excluding Ukraine, hosted 1.65 million refugees, with Slovakia having over 20 per 1,000 residents, while Hungary and Serbia had about 4.0, and Romania 8.5 per 1,000.

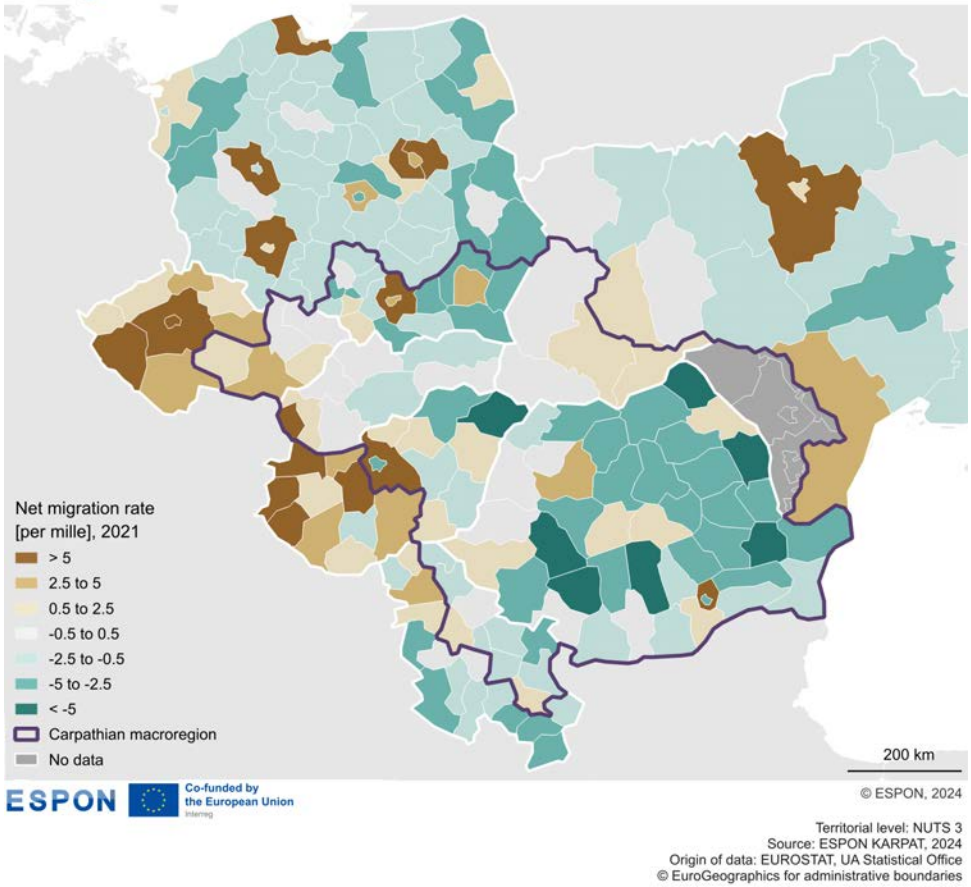
Most migration to the EU occurred early in the war, stabilizing by 2023. Refugee numbers rose in Germany (40%), Romania (60%), and countries like Cyprus and Slovakia, while declining in Bulgaria, the Czech Republic, and Austria. Within Ukraine, Carpathian regions received 530,000 internally displaced persons by mid-2023, including 273,000 in the Lviv region.

The long-term effects of war-related migration on the Carpathian countries and Ukraine depend on the war's duration. Prolonged conflict could lead to many refugees and internally displaced persons settling permanently, affecting the demographic landscape of these regions.

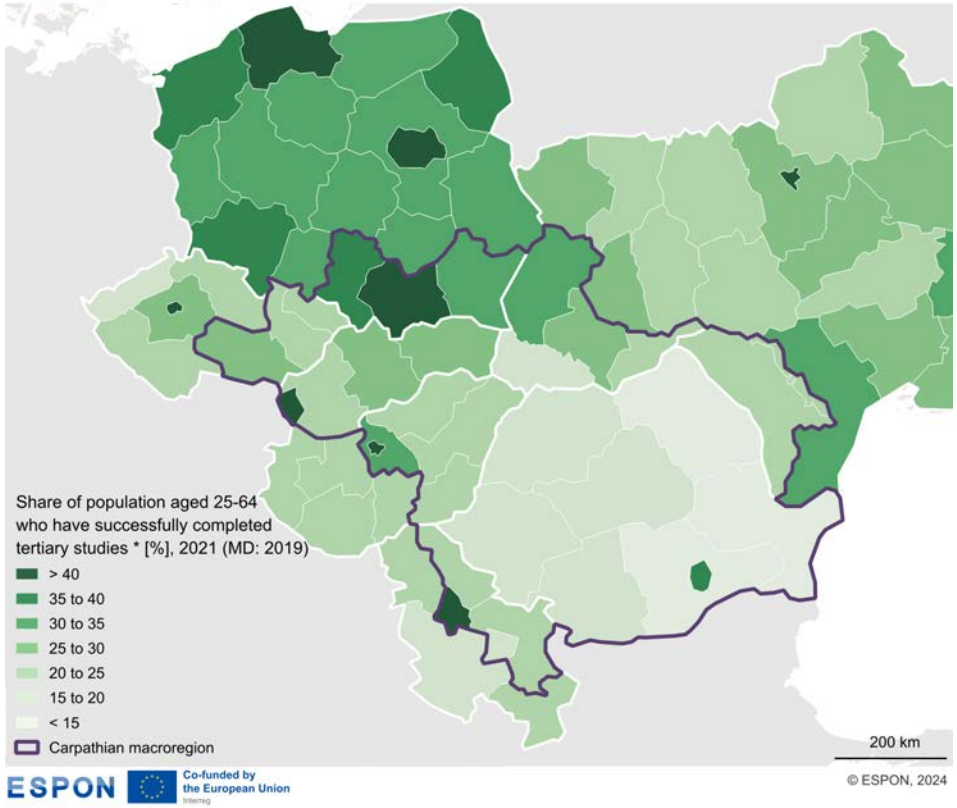
Education and human capital

Metropolitan regions, centered around the largest cities in the region, play a particularly significant role in the accumulation of human capital. Areas around Warsaw, Kyiv, Prague, Budapest, and Bratislava have notably high shares of the population with higher education, exceeding 50%. In contrast, in most regions of Romania, the share of educated people does not exceed 17%. There is also significant territorial variation, though with a different geographical distribution, regarding adult participation in education in the Carpathian region. While the strong position of capital areas (Warsaw, Bratislava, Prague) is evident in this regard as well, particularly low – about 1% – adult education participation rates are notable in Ukraine and the Republic of Moldova

Map 50. Net migration rate, 2021



Map 51. Share of population with higher education, 2021



* higher education degree

Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, UA LFS, UA Census, UNESCO Institute for Statistics
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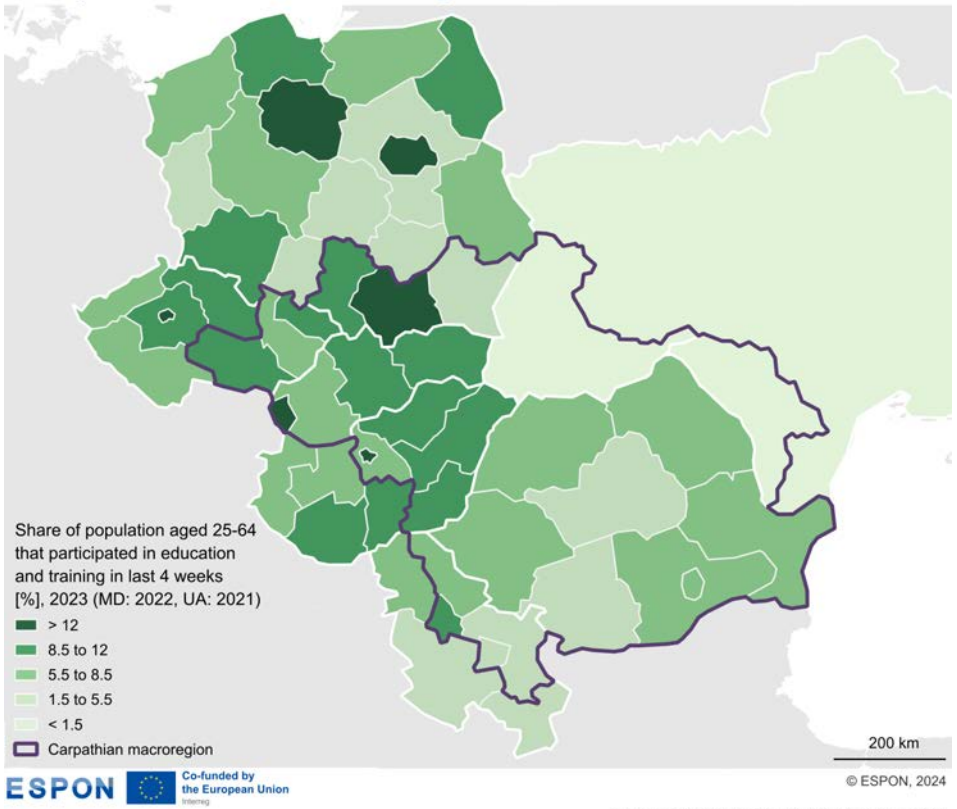
Map 52. Participation rate in education and training, 2023



Territorial level: NUTS 2, NUTS 0 for UA and MD
Source: ESPON KARPAT, 2024
Origin of data: Eurostat, Labour Force Survey Ukraine for UA,
European Training Foundation for MD
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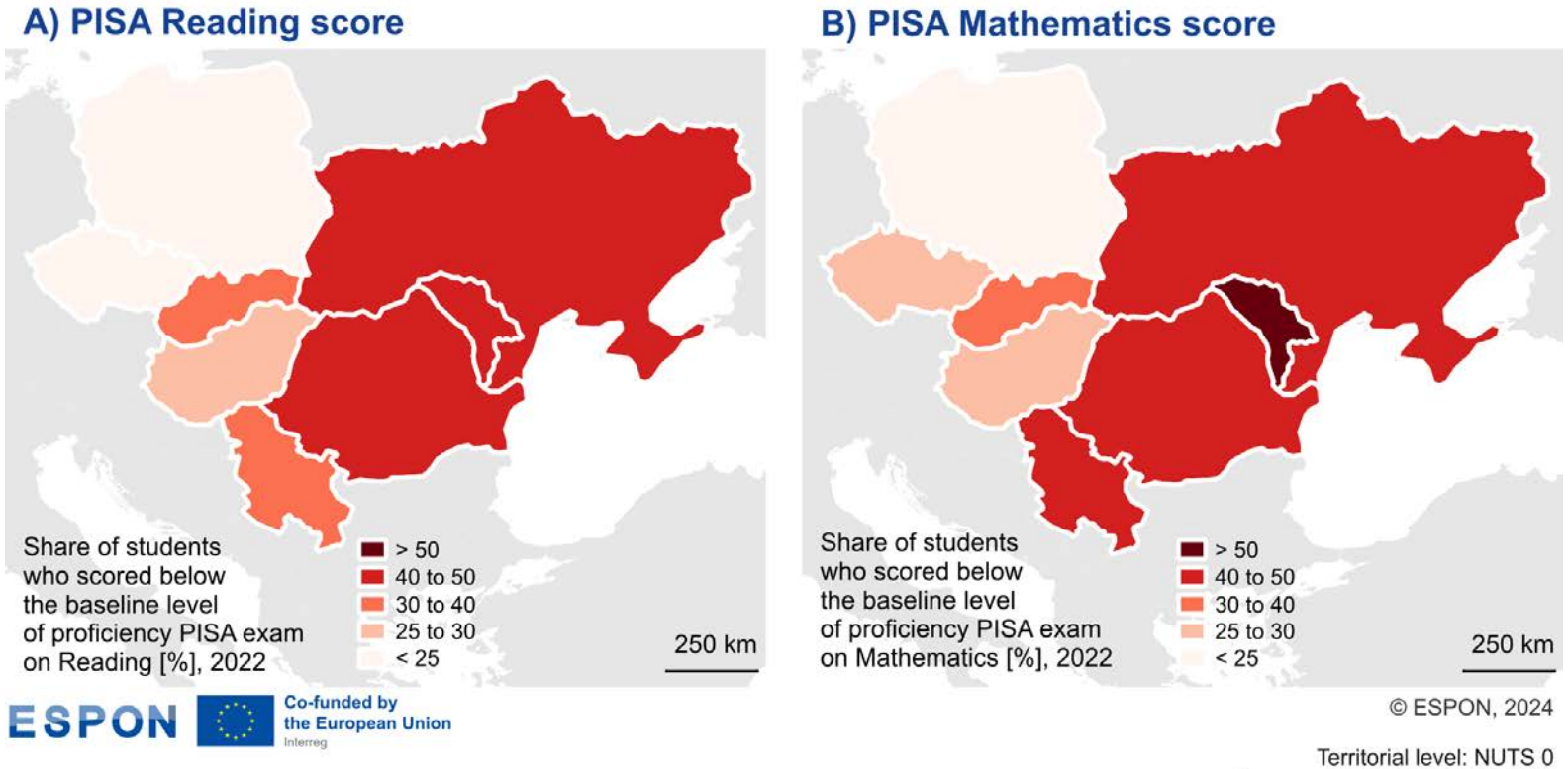
PISA results

The share of students achieving results below the basic level in mathematics and reading is in the countries belonging to the Carpathian region shows variation.

The best results in this regard are achieved by students in Poland and the Czech Republic, where low-skill students constitute less than 25% of all students. The situation is particularly unfavorable in the Republic of Moldova, where 55% of students do not meet the basic proficiency requirements in mathematics.

Map 53. Percent of students who scored below the baseline level of proficiency PISA exam, 2022



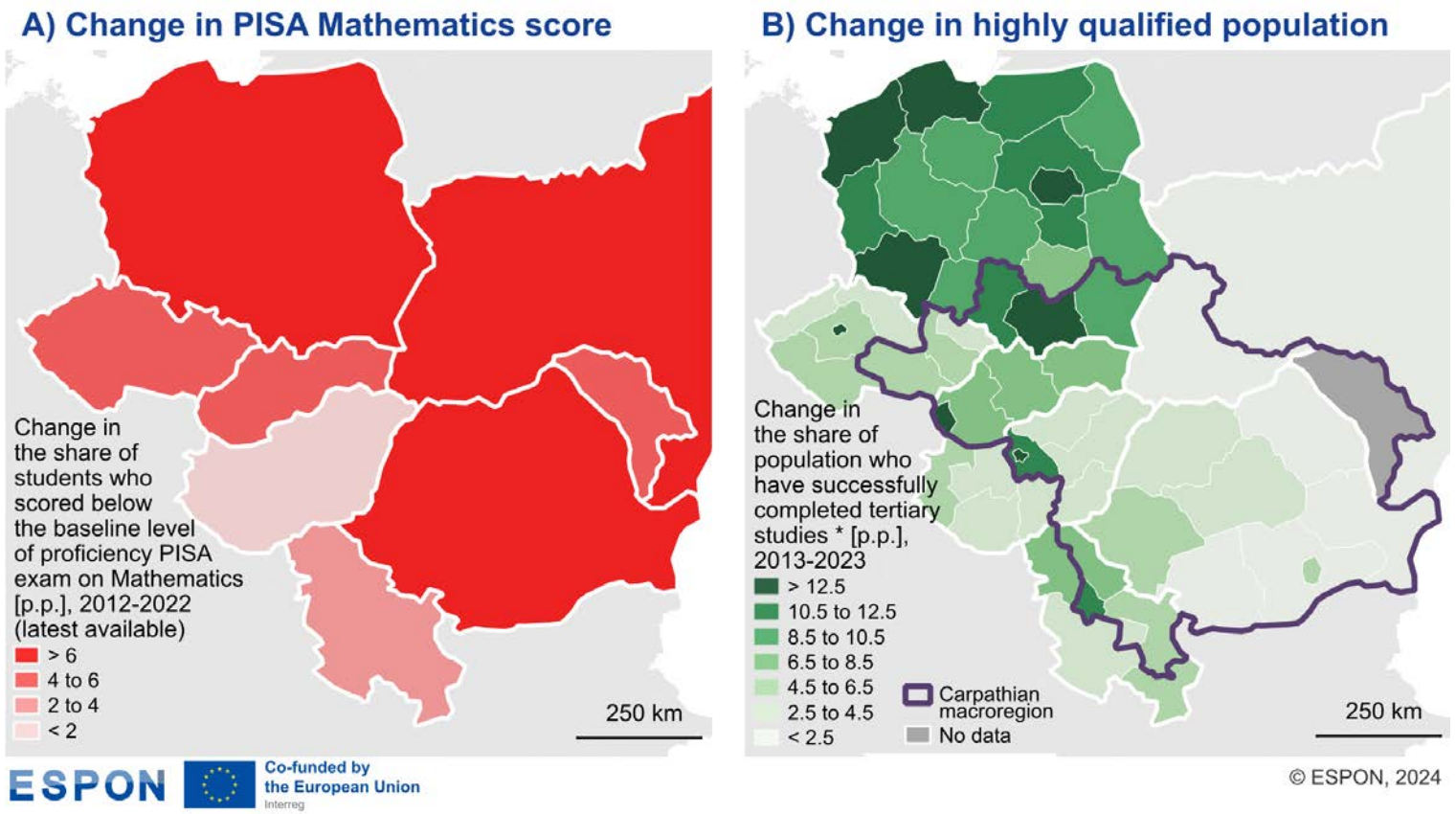
Territorial level: NUTS 0
Source: ESPON KARPAT, 2024
Origin of data: OECD - PISA Programme

Human capital change

Over the past decade, the proportion of the population who successfully completed tertiary education has increased across nearly all Carpathian regions, though the extent of this growth varied significantly. The most notable improvement—exceeding 10 percentage points—was observed in southern Poland and Slovakia. In contrast, educational attainment rates remained largely unchanged in parts of Romania and Ukraine within the Carpathian region.

Regarding student performance in mathematics under the PISA program, the share of low-achievers rose markedly between 2012 and 2022. While the primary driver of this negative trend was the disruptive impact of the COVID-19 pandemic on education, the growing educational inequalities are nonetheless a cause for concern. The largest rise in the proportion of low-achieving students occurred in Poland and Romania, while the figures remained relatively stable in Hungary and Serbia.

Map 54. Human capital change,2013-2023



Territorial level: A - NUTS 0; B - NUTS 2, NUTS 0 for UA, MD
Source: ESPON KARPAT, 2024
Origin of data: A - OECD PISA Programme, B - Eurostat, MD, UA
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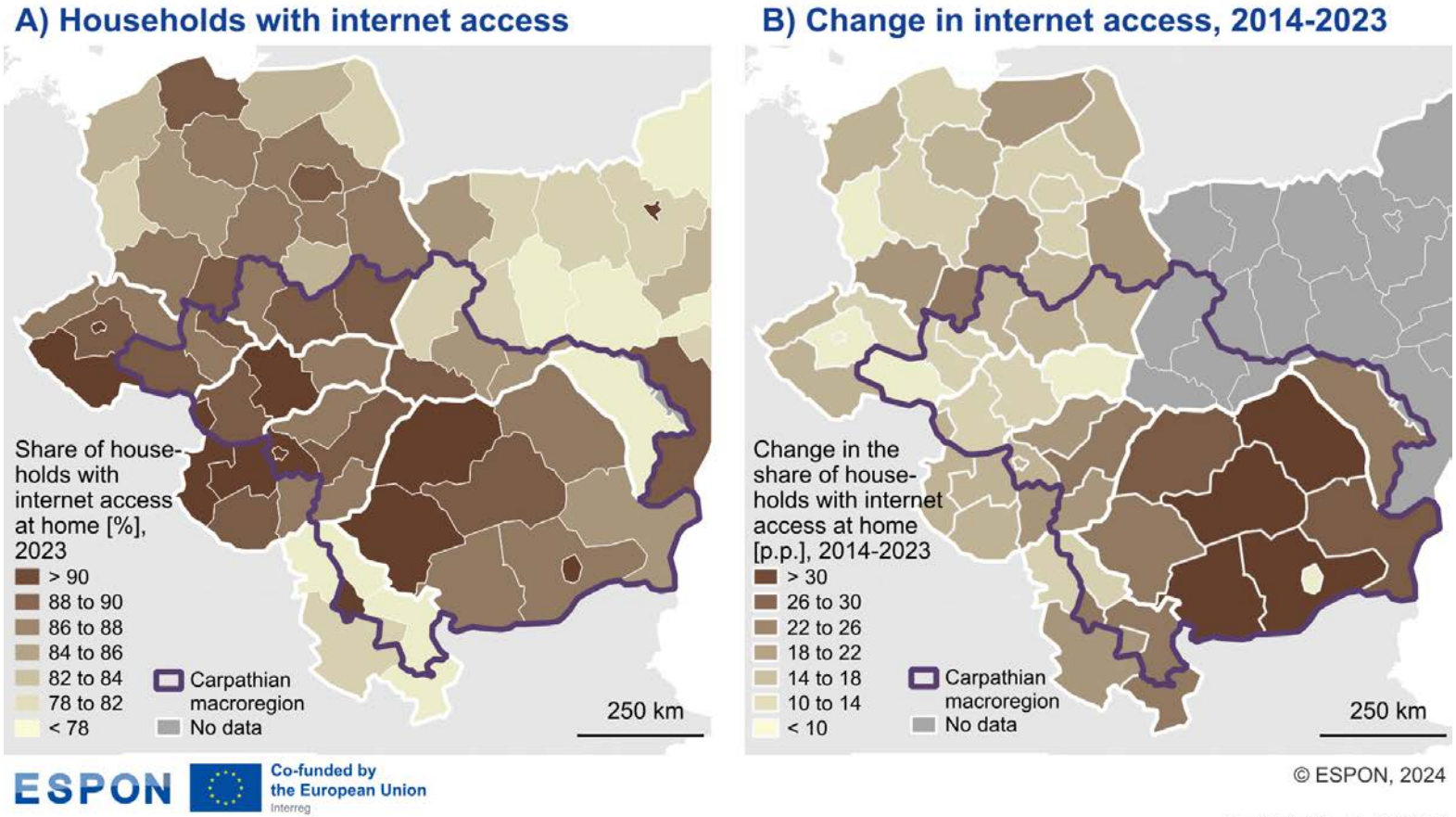
Information society

Two key indicators reveal the entrepreneurial potential of the information society in the Carpathian macroregion. Household internet access rates are high, exceeding 90% in urbanized areas like Budapest, Bratislava, București-Ilfov, Belgrade, and parts of Romania and Zakarpattia, Ukraine. Less developed regions, such as Western Ukraine and the Republic of Moldova, lag due to limited telecommunication infrastructure and low investment, though EU programs help mitigate this in member states.

Romania, excluding București-Ilfov, saw the greatest internet access growth in recent years, with increases over 30 percentage points. However, this growth may slow as regions near saturation. Northern Serbia and Western Slovakia remain behind, with limited progress in closing the gap due to geographic and investment challenges.

Map 55. Households with internet access, 2014-2023



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Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: A - Eurostat, UA, RS, MD Statistical Office
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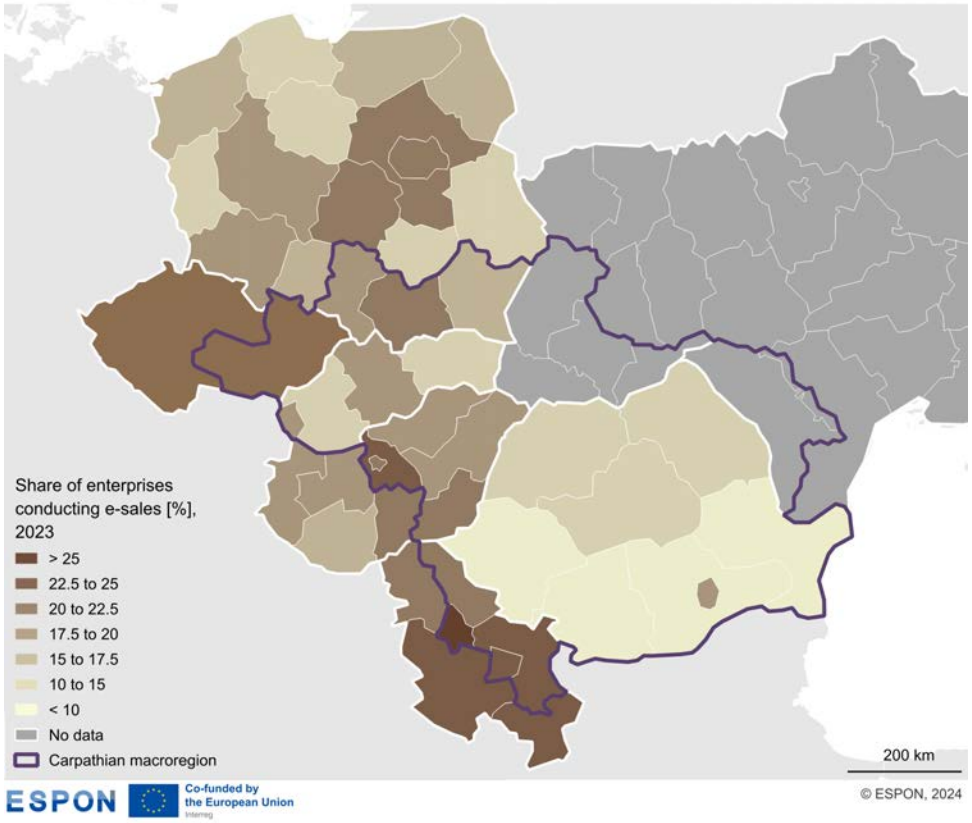
E-commerce

The proportion of firms engaging in web sales remains relatively low across the Carpathian macroregion, with a noticeable west-east pattern. Belgrade leads the way, and Serbia stands out as the leader, achieving the highest share of companies conducting sales via websites, apps, or marketplaces (35.2%). The metropolitan area of Budapest also achieves high results, comparable to other Serbian regions but not to Belgrade. Czech regions and Poland's Małopolskie region reach 20%. Following them are the capitals of Bratislava and Bucharest, Stredné Slovensko in Slovakia and Śląskie in Poland, recording appoximately 18%. In contrast, most other regions in Romania and Slovakia show underdeveloped e-commerce services, reflecting their nascent stage of digital business adoption.

Challenges for the Carpathian macroregion remain in developing digitalisation in mountainous, agricultural, and peripheral areas, where dispersed settlements and low population density significantly increase the costs of infrastructure investments. Monitoring digital indicators is further hindered by the lack of consistent methodologies and differences in data standards, requiring greater coordination between countries.

Map 56. Enterprises with web sales, 2023



Territorial level: NUTS 2, NUTS 0 for CZ
Source: ESPON KARPAT, 2024
Origin of data: Eurostat, RS Statistical Office
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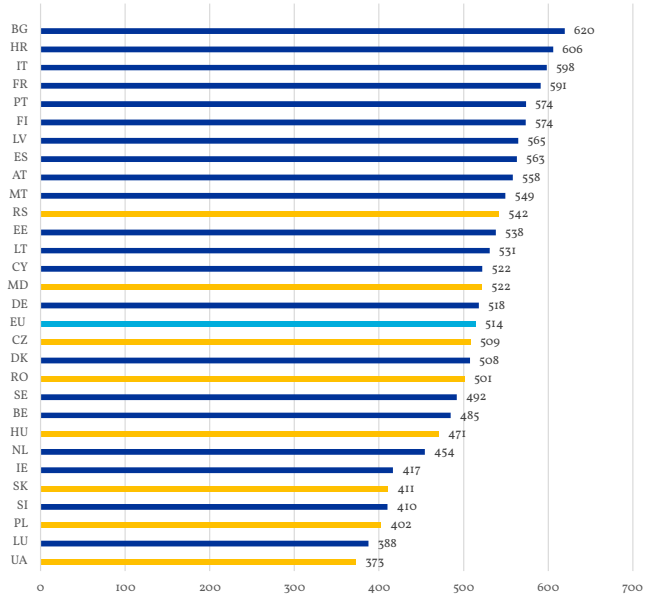
Housing

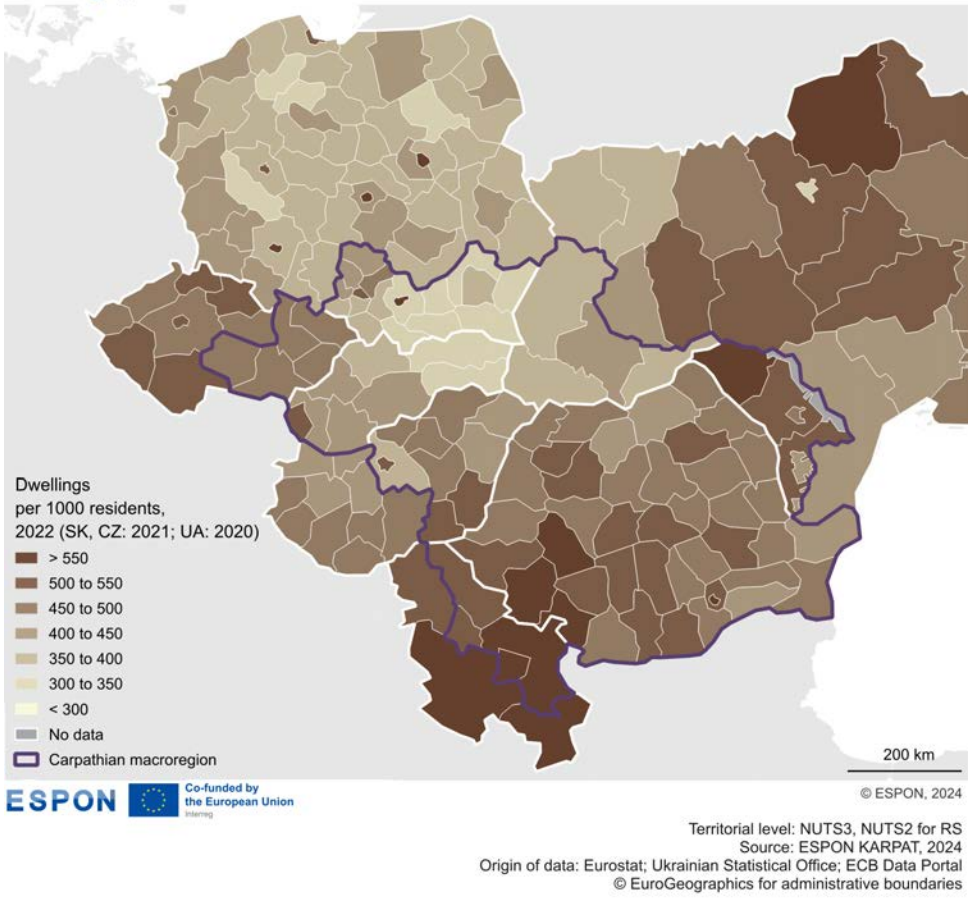
In some Carpathian regions, the numbers are lower than the national averages. Higher dwelling densities per 1,000 inhabitants are typically found in major cities and agglomerations, such as Budapest (521), Cracow (546), and the Bratislavský region (528). In contrast, lower densities are observed in peri-urban areas like Pest (378) and the Krakowski region (331), as well as in rural or mountainous regions such as the Prešovský region in Slovakia (325) and the Nowosądecki region in Poland (301). Higher dwelling stock per 1,000 inhabitants is concentrated in the southern part of the Carpathian macroregion, including south-western Romania and north-eastern Serbia. Lower dwelling densities are observed in the northern areas, such as the Polish and Ukrainian Carpathians and eastern Slovakia.

Fig 4. Dwellings per 1000 inhabitants, 2022



* for Ukraine 2021. Source: own elaboration based on OECD Affordable Housing Database, State Statistics Service of Ukraine, National Bureau of Statistics of the Republic of Moldova and Statistical Office of the Republic of Serbia.

Map 57. Dwelling stock per 1000 residents, 2022



Compared to EU average of 16.8%, Carpathian countries have some of the highest overcrowding rates in Europe, with Serbia at 50%, Ukraine at 49%, and Romania at 40%. The Czech Republic, the most economically developed country in the macroregion, has the lowest share of overcrowded households at 15%, which is below the EU average, followed by Hungary at 17%.

Fig 5. Overcrowding rate, 2022

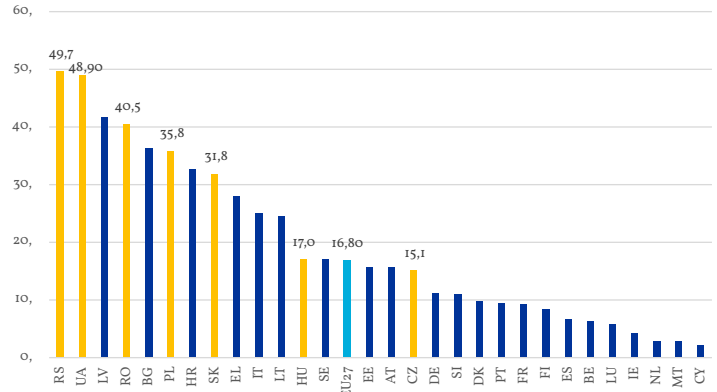
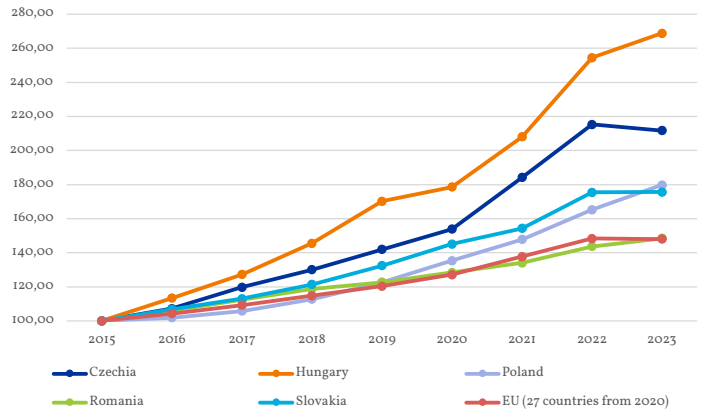
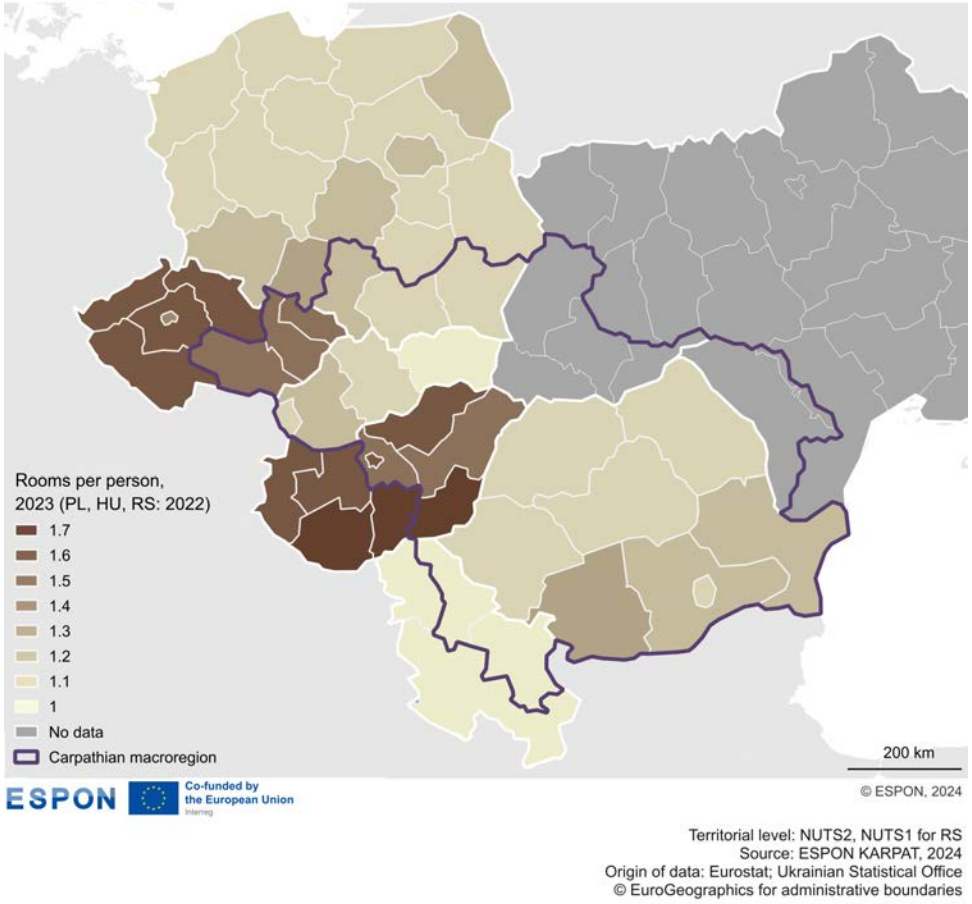


Fig 6. Annual house price index [2015 = 100]



Source: own elaboration based on Eurostat and Ukrainian Statistical Office

Map 58. Rooms per person, 2023



Territorial level: NUTS2, NUTS1 for RS
Source: ESPON KARPAT, 2024
Origin of data: Eurostat; Ukrainian Statistical Office
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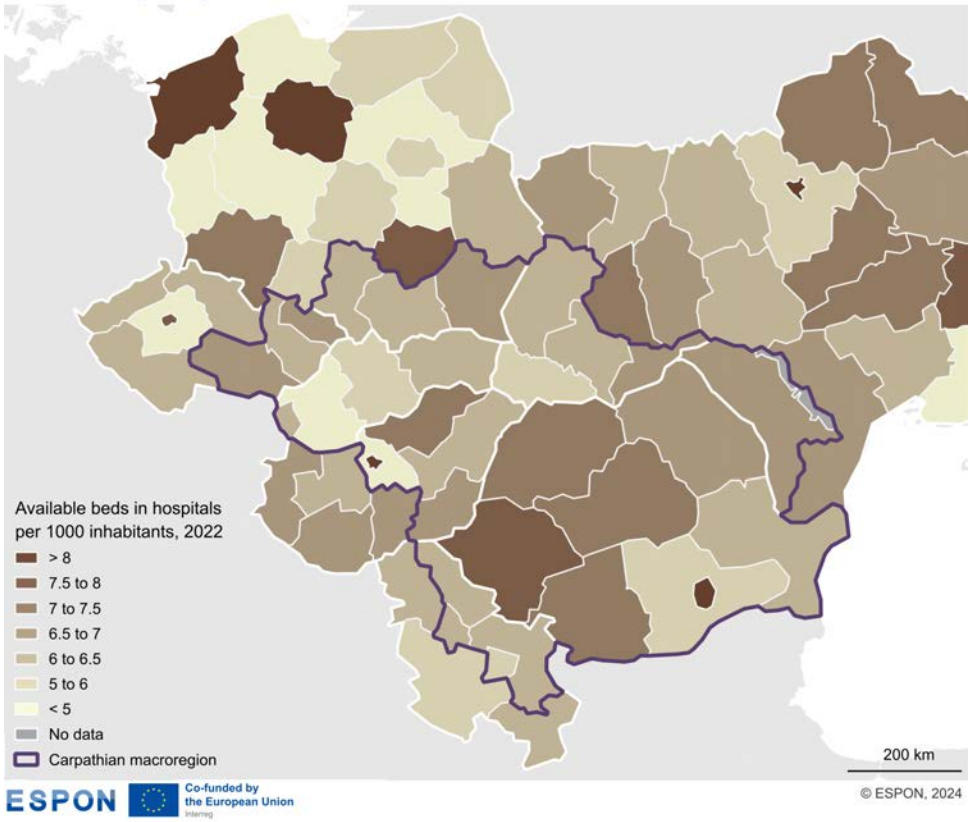
Health

In terms of the availability of hospital beds, the Carpathian macroregion is better equipped than Western and Northern European countries. The average number of hospital beds per 1000 inhabitants in 2022 for the EU-27 area is approaching 5.2, while it ranges from 5.7 in Slovakia to almost 7.3 in Romania.

At the regional level, the situation is more differentiated (Map 59). One of the visible patterns is a higher accumulation of hospital beds in the capital regions (except for Poland) with a simultaneous lower level in some neighbouring regions, as it happens in the case of Budapest and Pest (the highest and the lowest number of hospital beds per 1000 inhabitants in Hungary). Compared to 2010, the number of available beds per 1000 inhabitants is decreasing in the Czech, Hungarian (except for Dél-Alföld), Polish, Slovakian, and Ukrainian Carpathian NUTS 2 units and increasing in the Romanian and Serbian (apart from the City of Belgrade) ones. In this context, it should be noted that over the comparable period, avoidable hospital admission rates fell significantly in Poland and Slovakia (OECD 2023), which constitutes an improvement in the quality and organization of health care, as some chronic diseases should be treated mainly in primary care. The number of beds also declined as a result of greater use of daycare and shorter hospital stays.

Map 59. Beds in hospitals per 1000 habitants, 2022



Territorial level: NUTS2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, UA, MD Statistical Offices
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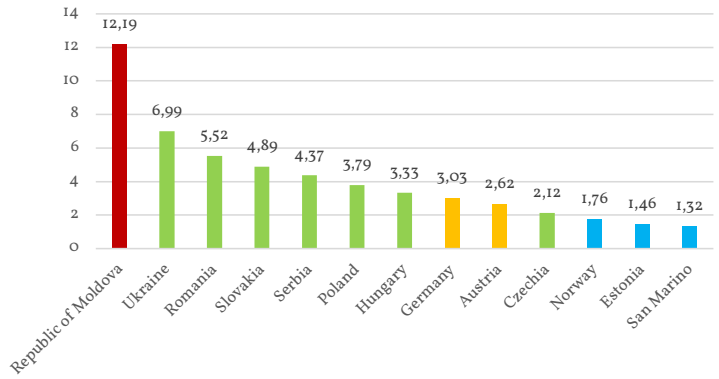
In the case of the availability of doctors, the relation to the results for most EU countries is the opposite of that for the availability of hospital beds: with the exception of the Czech Republic and the Republic of Moldova, the number of doctors per 1000 inhabitants in the Carpathian countries in 2022 is lower than the EU average, with the lowest value recorded in Serbia. At the NUTS2 level, capital regions with specialised centres of supra-local importance have the highest number of doctors per 1000 inhabitants (Map 60). The situation in the Carpathian regions is comparable to the rest of the national territory and, in the case of Ukraine (except Zakarpatska), better. The value of the indicator at NUTS2 level in the Carpathian areas has increased over the last decade (except for City of Belgrade and Bratislavský kraj - in the last data series; no comparable data are available for Ukraine). It can therefore be assumed that there has been an improvement in this respect. Apart from the doctors, the shortages in other medical personnel are noted - the number of nurses per 1000 inhabitants in most Carpathian countries being lower than the European Union average.

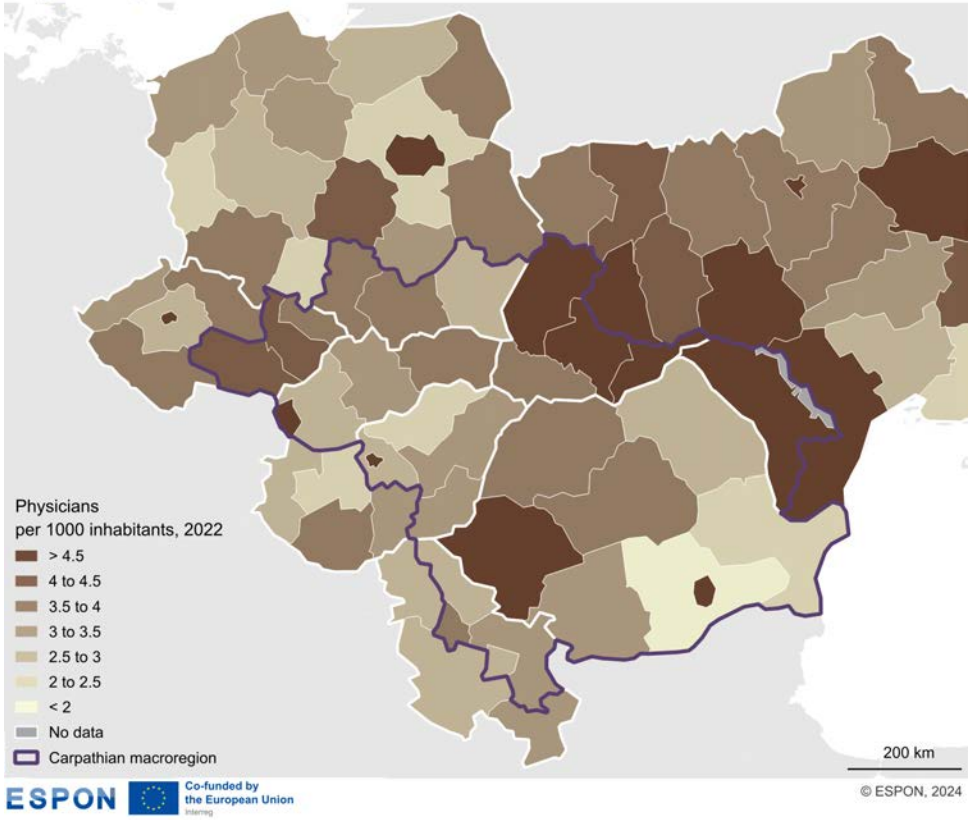
Fig 7. Infant mortality rate (per 1000 live births), 2022



Source: own elaboration based on WHO data.

In the case of infant mortality, the Carpathian countries (except for the Czech Republic) observe higher rates than the EU countries, the highest in the capital regions (according to Eurostat data Causes of death - infant mortality rate by NUTS 2 region of occurrence, 3-year average, for 2021). The figure in the Republic of Moldova is the worst in Europe, almost 10 times higher than the lowest value recorded in European countries in 2022.

Map 60. Physicians per 1000 inhabitants, 2022



Territorial level: NUTS2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, UA, MD Statistical Offices
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Mobility

Public transport systems in cities depend primarily on the size of the individual centre. In large cities, including capital cities, the transport offer and network of lines is very extensive. In Budapest and Bucharest, residents have metro, trams, trolleybuses and buses at their disposal. Also in regional and sub-regional centres, a tram or trolleybus network is much more common than in Western European cities. Only the smallest centres are served exclusively by bus transport. Here, public transport is often combined with regional transport.

In addition to the availability of different modes of transport, public transport systems are characterised by great variation in quality. In the eastern part of the study area, despite progressive investments, public transport often faces financial problems. Local budgets are limited which results in a large backlog of maintenance of infrastructure - especially trolleybuses and trams. Rolling stock investments are also very limited. An additional problem for public transport in cities with lower budgets and less EU support is the lack of intermodal integration, outdated information ticketing systems and low frequencies that limit competitiveness with cars.

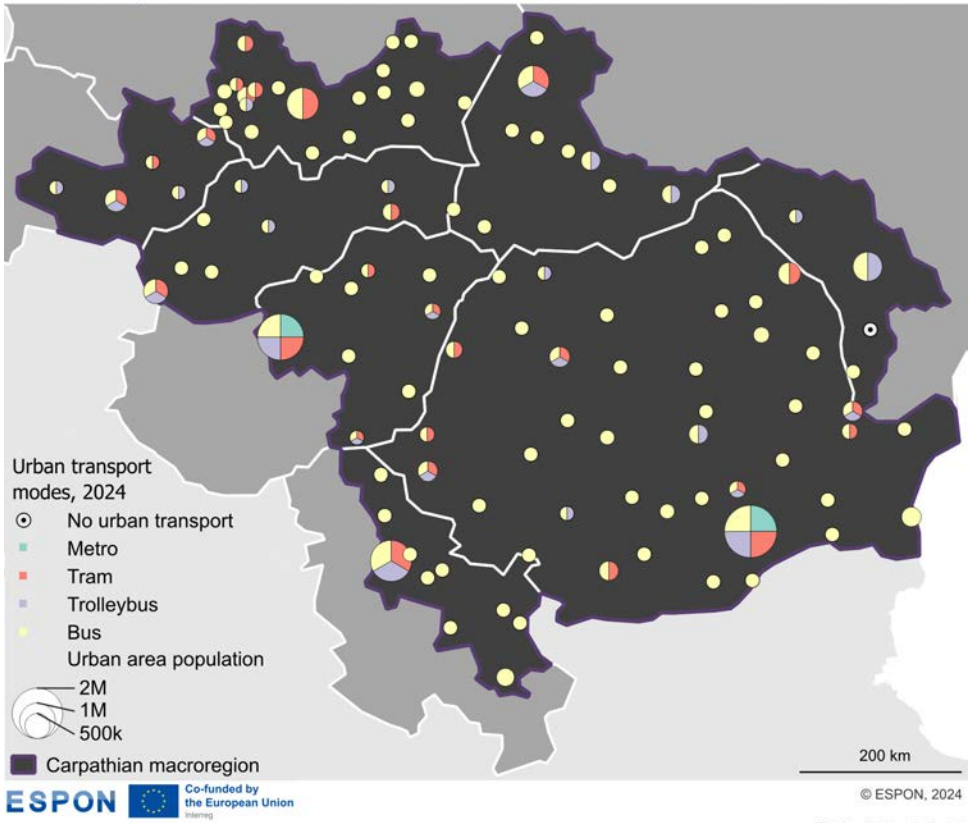
Intercity transport in the Carpathians varies greatly by country and region. Despite road network growth, rail and bus transport remain vital, especially in long-distance travel, due to historical reliance on rail before modern roads. Large and medium-sized cities typically offer international connections, while smaller cities are seeing gradual improvements, driven by tourism.

In southern Poland, cities like Krakow, Rzeszow, and Przemyśl have strong international rail and bus links, including routes to Ukraine, Hungary, and the Czech Republic, with services from providers like FlixBus. Slovakia's rail network connects Bratislava to major cities like Prague, Budapest, and Krakow, while buses link mountainous regions with neighboring countries.

Ukraine's western cities, such as Lviv and Ivano-Frankivsk, offer convenient rail and bus connections to Poland, Slovakia, and Hungary. Lviv serves as a transport hub, while smaller cities like Uzhhorod have limited but regular links.

In Romania, Carpathian cities have rail and bus connections to Hungary, Ukraine, and Slovakia, though less intensively than major hubs like Bucharest or Timisoara.

Map 61. Urban transport modes, 2024



Territorial level: Point
Source: ESPON KARPAT, 2024
Origin of data: Timetables
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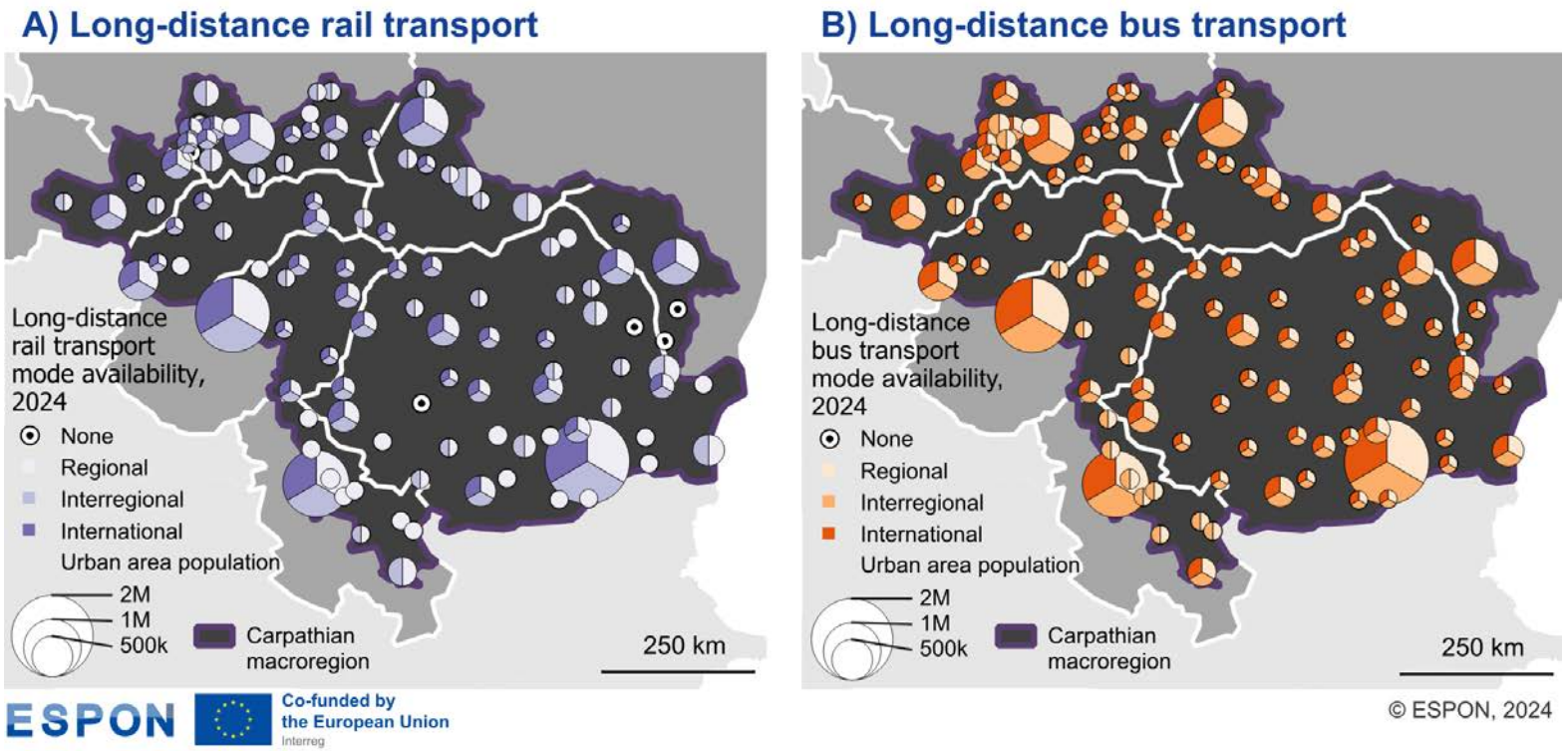
Map 62. Long-distance ground transport availability in main cities, 2024



Territorial level: Points
Source: ESPON KARPAT, 2024
Origin of data: Timetables
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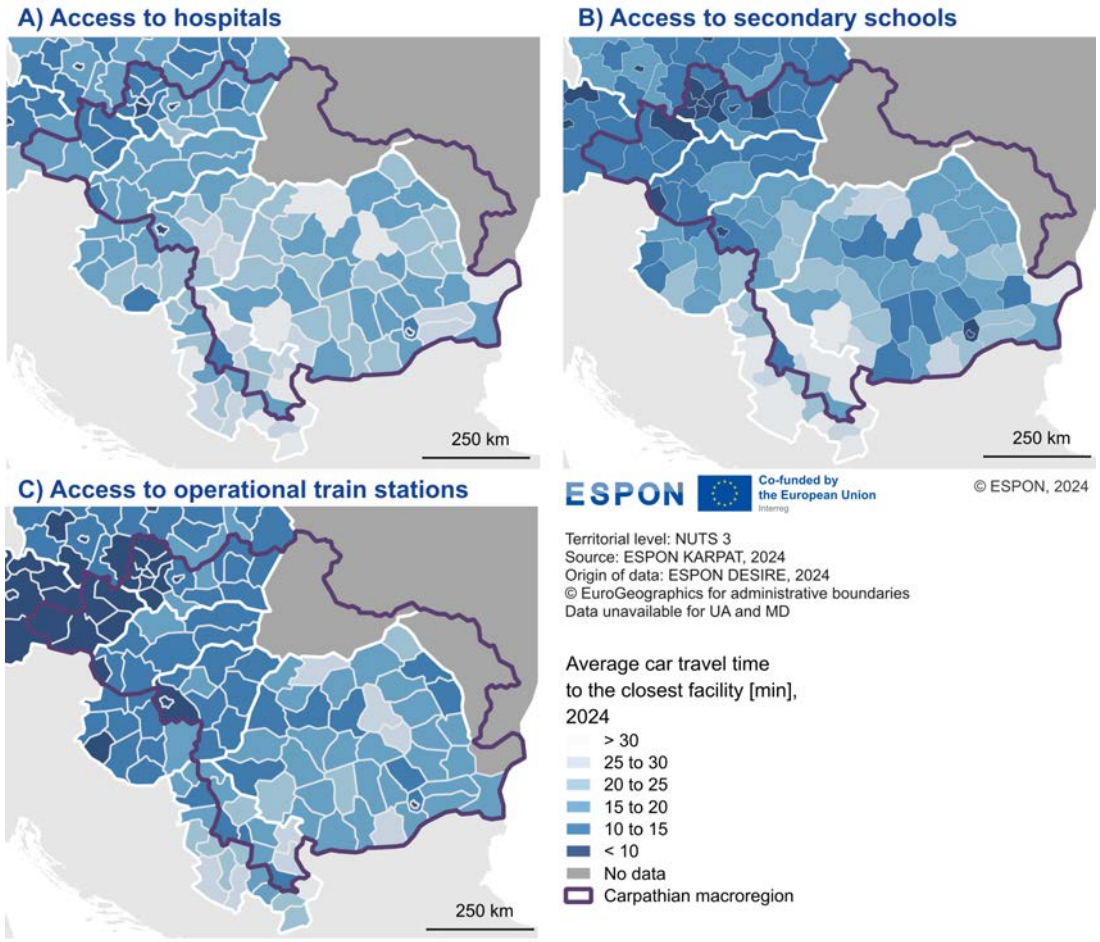
Accessibility of public services

Spatiotemporal access to essential services, such as hospitals or schools, is an important factor of population well-being and economic development. The level of access is determined by the transport infrastructure and the existence of nearby facilities. Providing good levels of access is thus particularly challenging in rural, sparsely populated, and mountainous areas that constitute a sizable part of the Carpathian macroregion. Low levels of access constitute a risk for regional development due to their direct and indirect association with lower quality of life, higher costs of transport, poorer economic performance, lower tax revenues, and outmigration. These associations are part of feedback loops that stimulate further marginalisation and the loss of population in peripheral areas.

Spatiotemporal accessibility to services like: hospitals, secondary schools, and train stations is measured as the distance to the closest facility in each category. The measures are derived from grid-level data from the ESPON DESIRE project.

The lowest accessibility levels are observed in parts of Romania - particularly the mountainous areas, such as Caraș-Severin, Harghita, Bistrița-Năsăud, or Maramureș, as well as Tulcea located in the Danube Delta – and parts of Serbia, including Borska, Zaječarska and Braničevska oblast. Additionally, other Romanian parts of Southern and Eastern Carpathians are marked with high levels of remoteness even if it does not translate into low average levels of access in their respective NUTS3 regions. The impact of the Carpathian mountains on service access is less pronounced in Poland and Slovakia, although some mountainous areas also have relatively long travel times to facilities an constitute inner peripheries (ESPON DESIRE, 2024). The highest levels of accessibility are observed in the highly urbanized and densely populated areas of Bucharest in Romania, Belgrade in Serbia, Budapest in Hungary, Bratislava in Slovakia, Olomoucky and Moravian-Silesian regions in Czechia, and the Upper Silesia and Cracow in Poland. Compared to other countries and regions, Czech Republic and the Upper Silesian region in Poland have the highest level of access to operational train stations.

Map 63. Access to facilities and remoteness levels, 2024

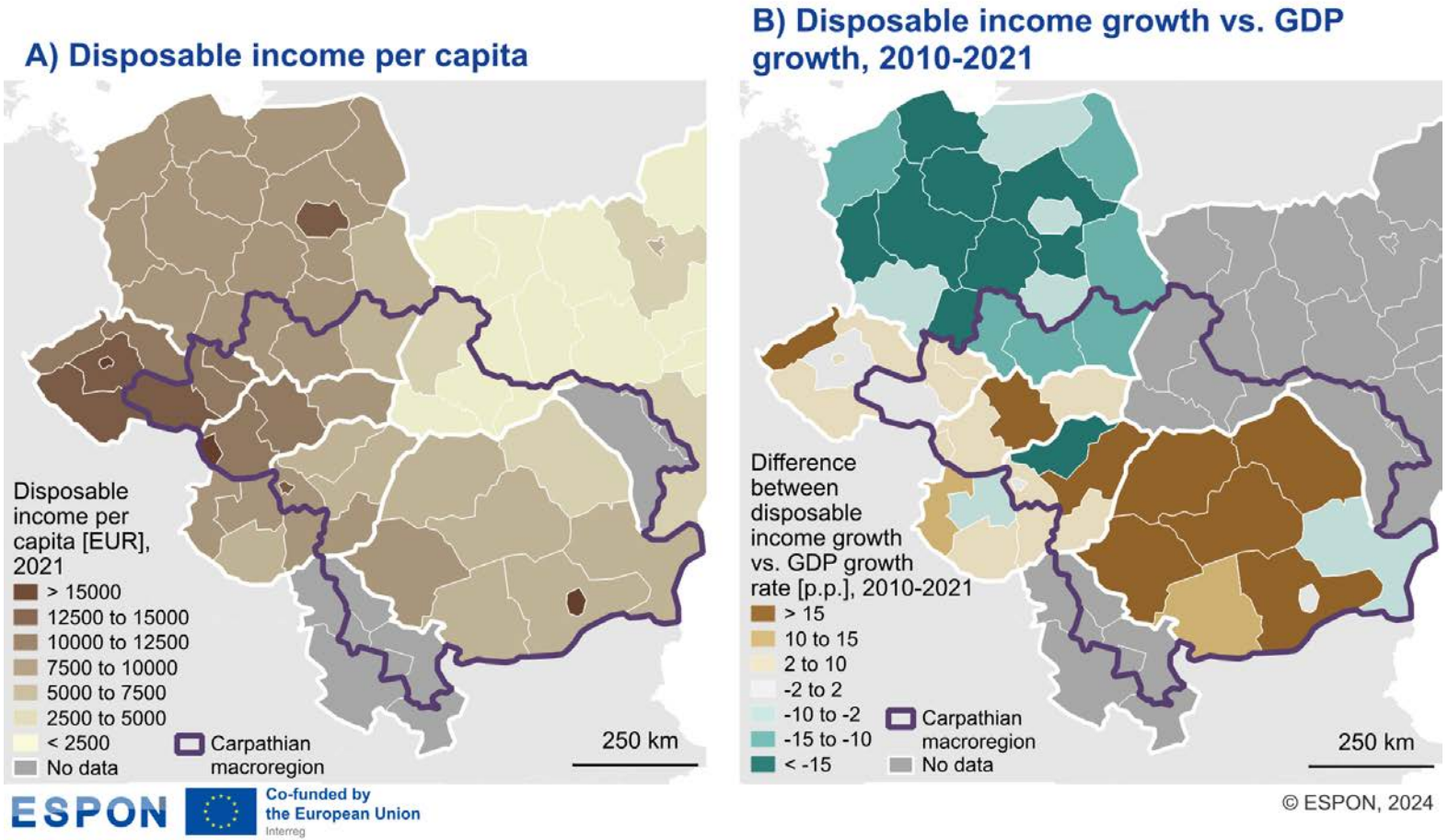


Wealth and social capital

When converted to EUR, the Carpathian macroregion shows notable positive outliers, including the Czech regions and western Slovakian regions, as well as the Bucharest and Budapest capital regions. A relatively high level of wealth is also observed in the Polish Śląskie and Mazovicekie voivodhsips, Timișoara region in Romania and Szeged region in Hungary. Incomes are significantly lower in Eastern Hungary and other Romanian regions, especially Moldova. The poorest regions, are EU candidate countries, particularly Ukrainian regions excluding Lviv Oblast.

Disposable income growth has lagged behind GDP per capita in most Romanian regions (except Bucharest), parts of Hungary, and Slovakia, where disposable income growth outpaced GDP growth by over 15%. Other regions in Slovakia, Hungary, and Czechia also saw higher income growth.

Map 64. Disposable income per capita, 2010-2021



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, UA, MD Statistical Offices
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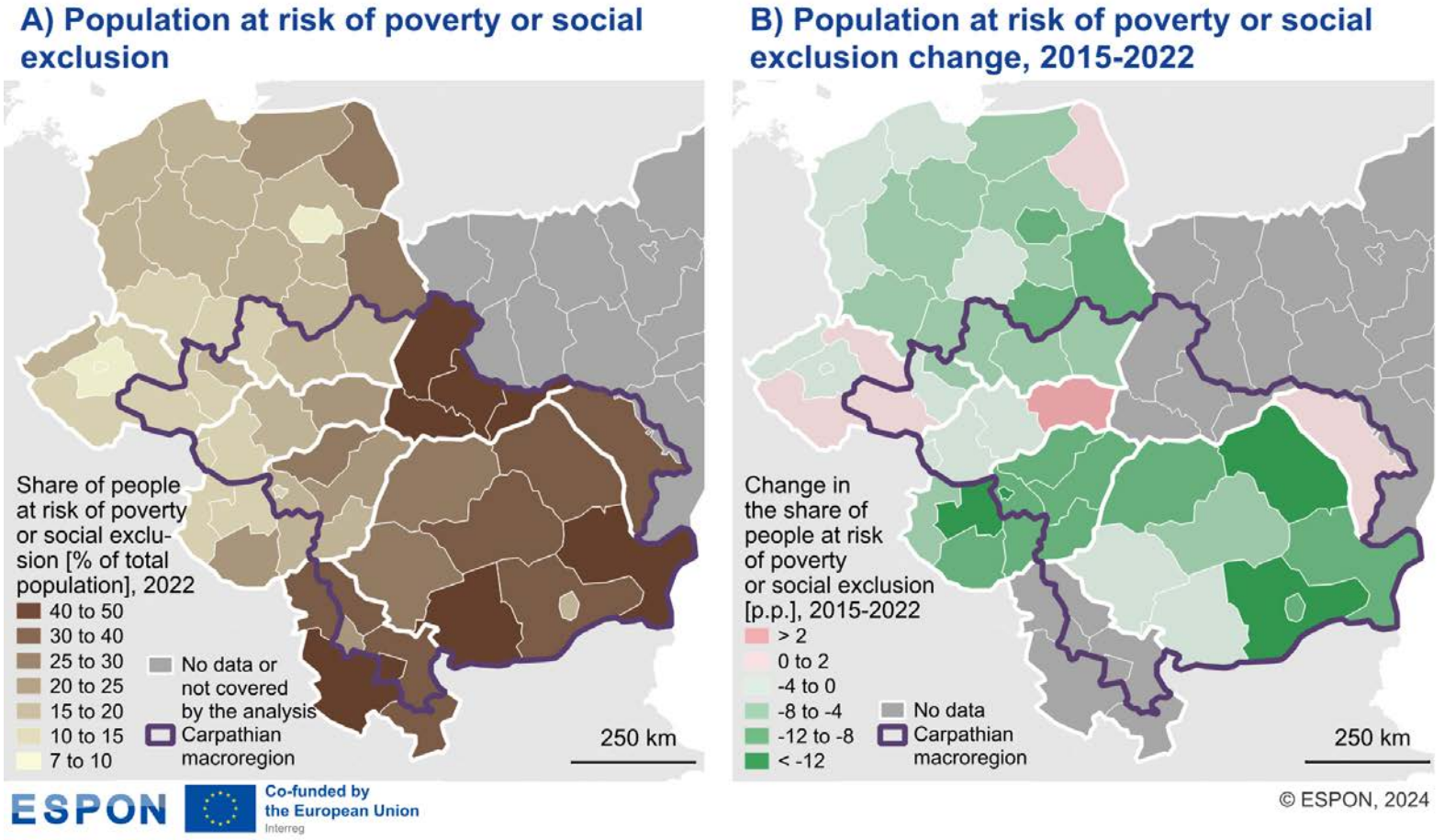
Poverty and social exclusion

Socio-economic deprivation remained high in the Carpathian macroregion, affecting up to half of residents in some areas, especially in southern and eastern Romania (excluding Bucharest) and EU candidate countries. Over a quarter of the population faced deprivation in other Romanian regions, as well as eastern Hungary and Slovakia.

In contrast, Czech regions, western Slovakia, and Poland's Śląskie voivodeship had lower deprivation levels, though about 15% of residents were still affected. Many areas, particularly in Hungary and parts of Romania, saw improvement, with deprivation rates dropping by over 10 percentage points from 2015 to 2022.

Map 65. Population of risk of poverty or social exclusion, 2015-2022



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: A) EUROSTAT, UA and RS - estimations;
B) EUROSTAT, no data for UA and RS
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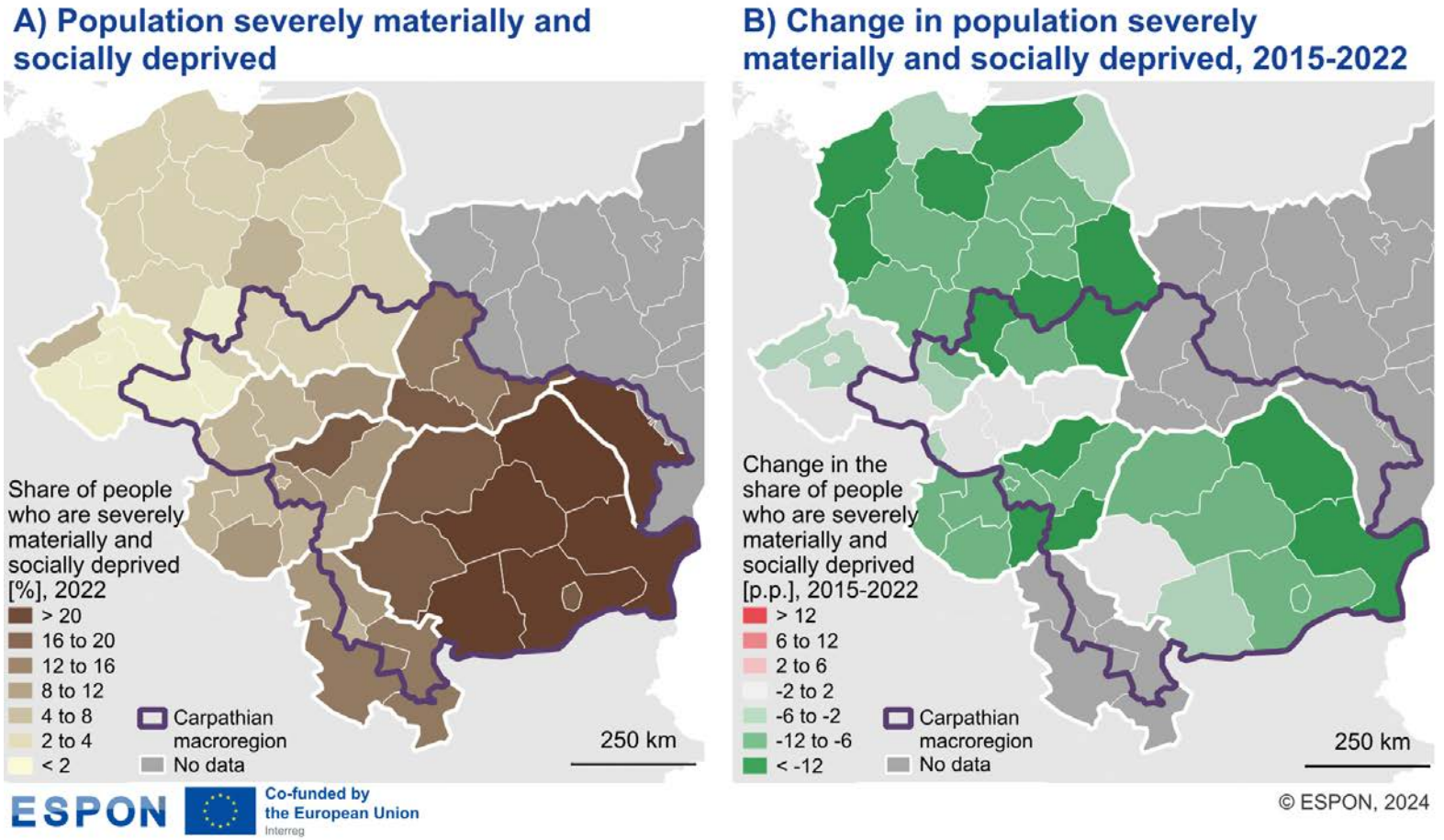
Material deprivation

The indicator for severe poverty and deprivation closely aligned with broader socio-economic deprivation but had lower values. Romanian regions were worst affected, with one in four residents severely impacted. Northern Hungary, eastern Slovakia, and other Hungarian regions (excluding Budapest) also faced significant challenges.

In contrast, Czech regions and Poland's Małopolskie voivodeship experienced much lower levels of severe deprivation. Significant improvements were seen in Polish, Romanian, and Hungarian regions during the period, driven by favorable economic conditions and targeted social programs.

Map 66. Population severely materially and socially deprived, 2015-2022



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: A) EUROSTAT; UA, RS - estimations; B) EUROSTAT
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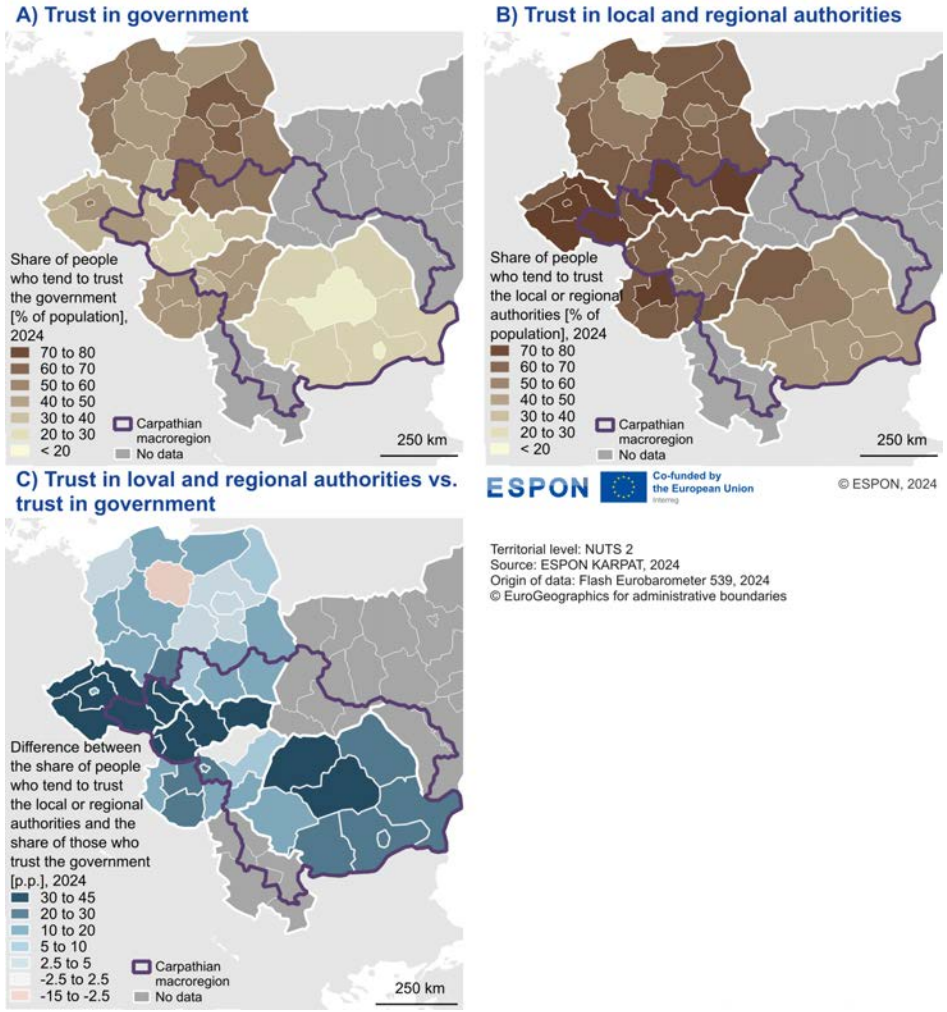
Trust to authorities

Carpathian macroregion can be characterised by high social trust towards local and regional authorities with disparities along the West-East axis ranging from 70-40% contrasted by alarmingly low trust towards the governments, especially in Romania and Slovakia.

The trust towards local and regional authorities in the macroregion is dominantly higher in comparison to trust towards national governments. It is especially the case in Moravia, Czechia, Slovakian regions of Východné, Stredné, Západné and capital region as well as Romanian Nord-Vest and Centru, where trust towards local and regional authorities averages 60% whereas the one towards the govern-ment scores below 30%. The most "trusting" regions are Podkarpackie, Małopolskie and Silesia in Poland and overall lowest levels of trust in public authorities can be noted in South-Eastern Romania with the capital region scoring the lowest. Similarly low trust towards regional authorities scoring below 50% for both national and regional level is noted in Hungarian regions of Észak-Magyarország and Észak-Alföld.

Comparison of these maps indicates firstly that, trust in local and regional authorities tends to be higher than trust in central governments across most of the region, particularly in Poland, Czechia, and Slovakia, where the difference often exceeds 20 pp. Secondly, the disparity in trust levels is geographically uneven, with western Poland and central Czechia showing the strongest preference for local authorities, while parts of Romania and Hungary exhibit more balanced trust or even slightly higher trust in central governments. Thirdly, the maps reveal a broader trend of regional variation in governance trust, suggesting that localised governance structures are perceived as more reliable or responsive in many areas, likely reflecting historical, cultural, or institutional differences across these countries. Finally, observed differences in the territorial distribution of trust constitute an implication for approaches based on the principle of subsidiarity in future public interventions. On the other hand, they indicate the need to strengthen public trust in government institutions in the entire Carpathian macroregion.

Map 67. Trust to government and local and regional authorities, 2024

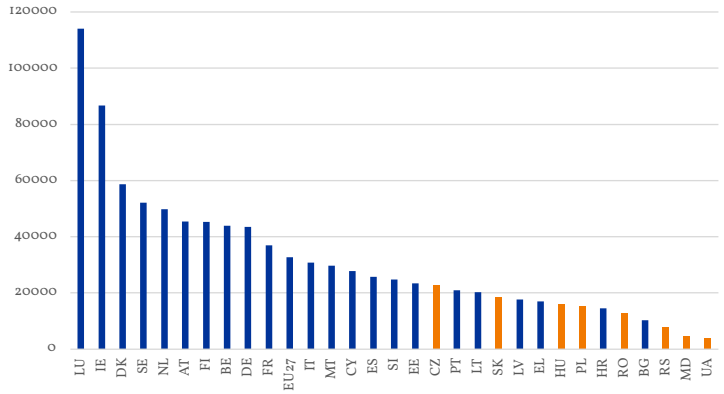


2.3 Economy, science and investments

Economic development and structure

The most developed country in the Macroregion, the Czech Republic, still below the EU average in terms of GDP per capita in EUR (70%). The GDP per capita of Ukraine and the Republic of Moldova, reached only 10-15% of the EU average.

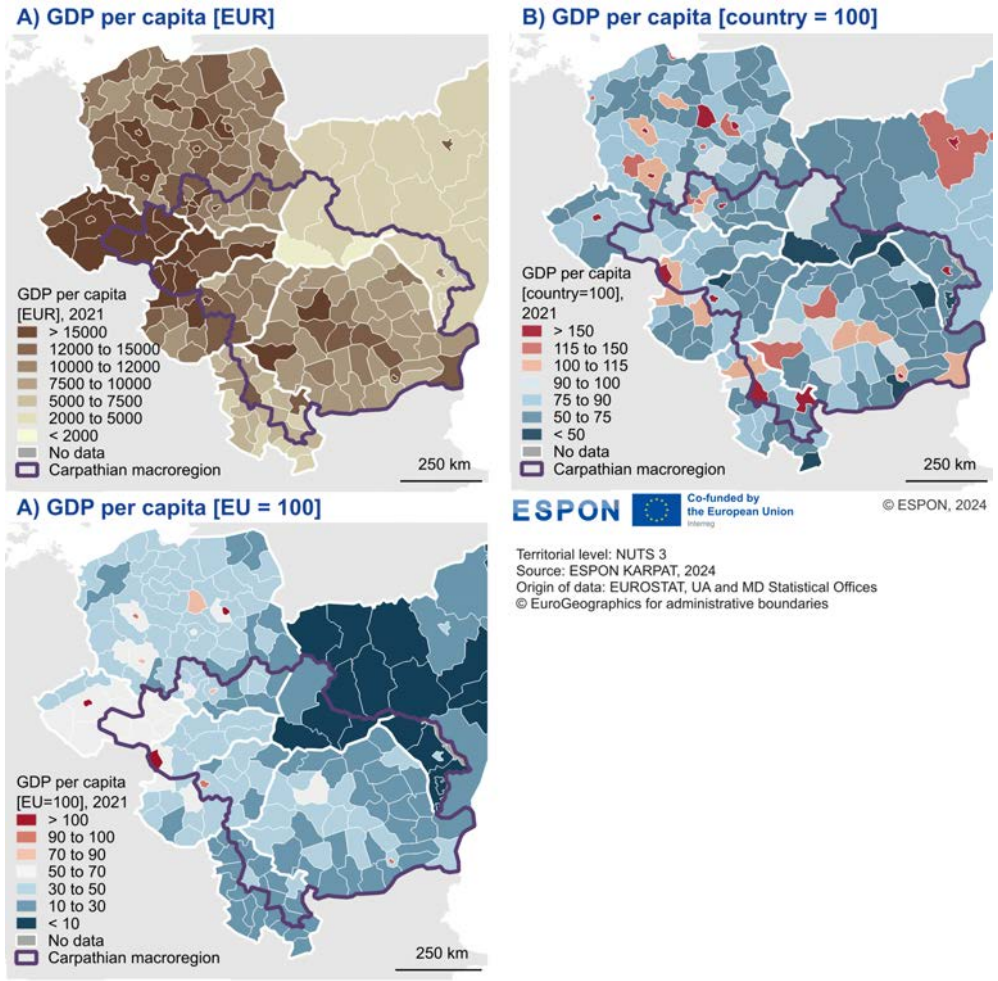
Fig 8. GDP per capita in EUR in the Carpathian countries and other EU countries [2021]



Source: own elaboration based on Eurostat

Major cities like Kraków, Katowice, Cluj, and Timișoara show high GDP per capita, reflecting a metropolis vs. non-metropolitan divide. Peripheral areas, including mountain regions and Slovakia's Prešov Region, lag behind. Transport corridors, such as Romania's Cluj-Bucharest axis, also influence disparities. Capital regions dominate GDP per capita across all countries. Most regions remain under 50% of the EU average GDP per capita. Only a few large cities exceed 70%, with Bratislava surpassing the EU average.

Map 68. GDP per capita, 2021

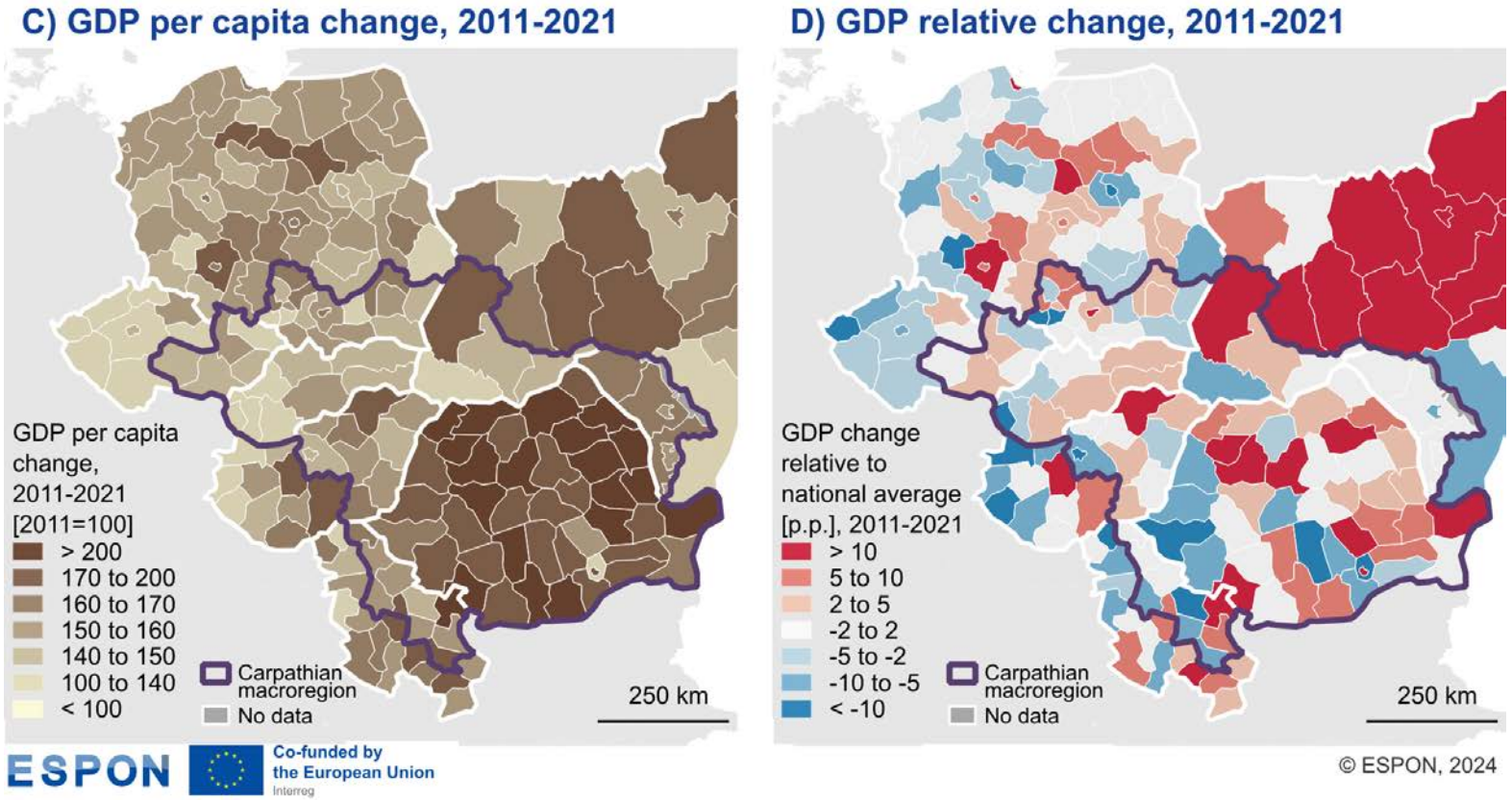


Economic growth

Over the past decade, Romanian regions experienced the fastest GDP per capita growth, with income levels rising by 70% in most areas. Similar growth occurred in Serbia's Borski region (due to copper and gold mining), Lviv Oblast, and Hungary's Miskolc region. In contrast, growth was slower in the most developed areas, such as western Slovakia, Silesia in the Czech Republic and Poland, and Ukraine's Zakarpattia Oblast.

Regional growth compared to national averages varied widely. Some Carpathian regions outpaced their national averages, while others regressed, highlighting the influence of specific industries, large production facilities, and new investments.

Map 69. Dynamics of GDP per capita, 2011-2021



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, UA, MD Statistical Offices
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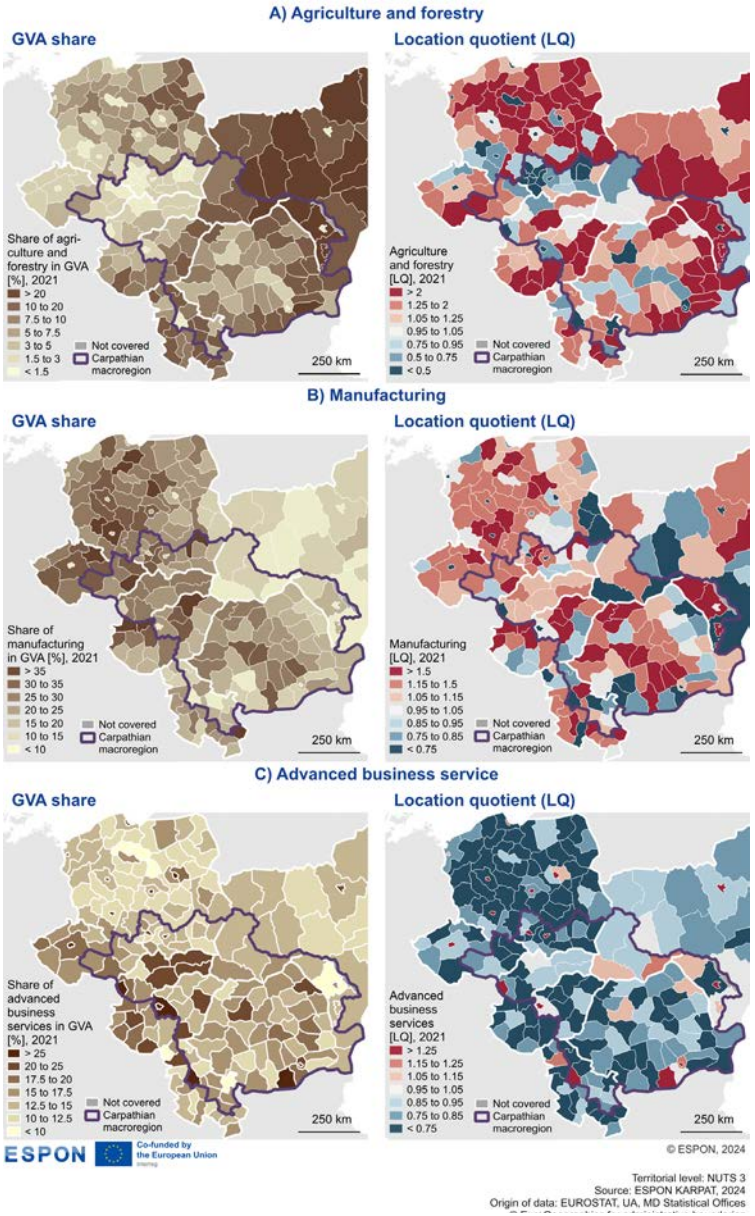
Map 70. Economic structure of regions, 2021

Economic structure

One of the reasons for the varied development levels was the distinct differences in the economic struc-ture of the regions within the Carpathian macroregion. For instance, Carpathian regions in Poland and Slovakia were notable for their low share of agriculture in the creation of gross value added, whereas Ukrainian regions were significantly dependent on this sector. Simultaneously, the degree of agricultural specialisation (LQ) in these regions was low in both cases. A high share of agriculture in gross value added also characterised the Republic;s of Moldova regions, southern Hungarian regions, as well as the submontane areas of Wallachia and Moldavia in Romania.

The significance of industrial processing in the economies of Carpathian regions was also highly varied regionally. This variation was evident even within individual countries, resulting, among other factors, from the presence of large industrial centres located in submontane areas, such as Silesia and the Central Industrial District in Poland, Silesia and Moravia in the Czech Republic, northern Hungary, selected parts of Transylvania, as well as Banat and Maramureș in Romania, and the northern Republic of Moldova.

Meanwhile, advanced business services played an important role in the economic structure of regions in central and eastern Slovakia, beyond the main urban centres of the macroregion, although their level of specialization still significantly lagged behind that of the Bratislava metropolitan area. This confirmed the general rule that major urban centres served as hubs providing these services to the surrounding agricultural and transit regions.



Labour market

The Carpathian countries differed significantly in terms of employment rates and unemployment rates, especially when compared to the EU average. On one hand, the Visegrad Group countries (except Slovakia) had a relatively favourable labour market situation, illustrated by high employment rates and low unemployment rates. On the other hand, countries outside the EU had much worse labour market conditions, with indicators similar to those of Southern European countries like Greece, Italy, and Spain. The Republic of Moldova, in particular, had a low employment rate, although its unemployment rate was relatively low. Similarly, in Romania, despite a relatively low employment rate, the unemployment rate was close to the EU average.

The situation of regions within the Carpathian macroregion did not significantly differ from the national averages in terms of employment rates. In terms of unemployment rates, some regions stand out with visibly worse conditions, such as the Zakarpattia Oblast in Ukraine, and regions in southern Serbia and eastern Slovakia. Some Carpathian regions in Poland, Czech Republic, and Romania have some of the lowest unemployment rates in their respective countries.

A clear issue was that some Carpathian regions struggled with the structural problem of long-term unemployment. This primarily affected Slovak regions, the Moravian-Silesian region in Czech Republic, and some Romanian regions, with a lesser extent affecting Hungarian regions.

The labour market situation in the Carpathian countries changed in response to significant political-economic events and external shocks. The accession of some macroregion countries to the EU between 2004 and 2006, along with the period of economic prosperity before 2008, led to a substantial reduction in unemployment rates. However, during the post-crisis period, unemployment rates rose again but did not reach their previous record levels. Starting from 2013, there was a period of declining unemployment rates in all countries (except Ukraine and with stable conditions in the Republic of Moldova), which was only slightly hindered during the pandemic period.

Map 71. Labour market situation, 2023

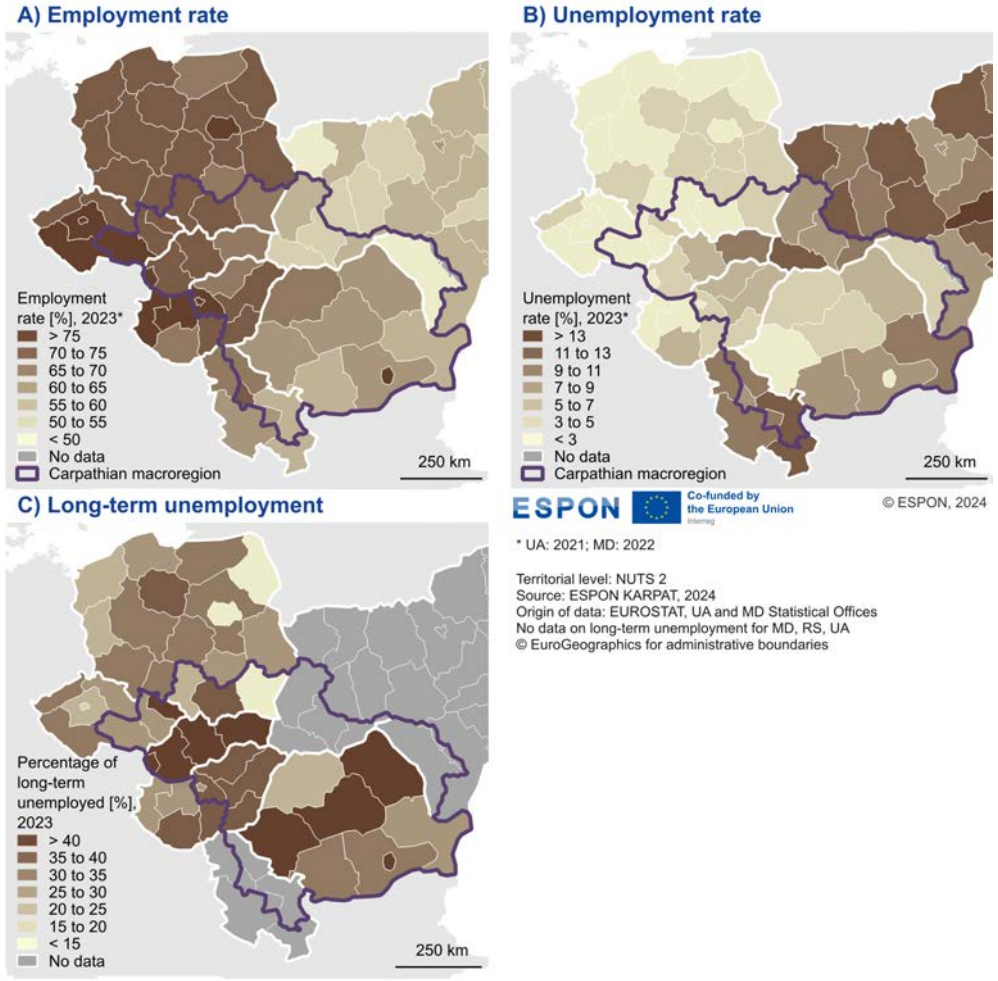
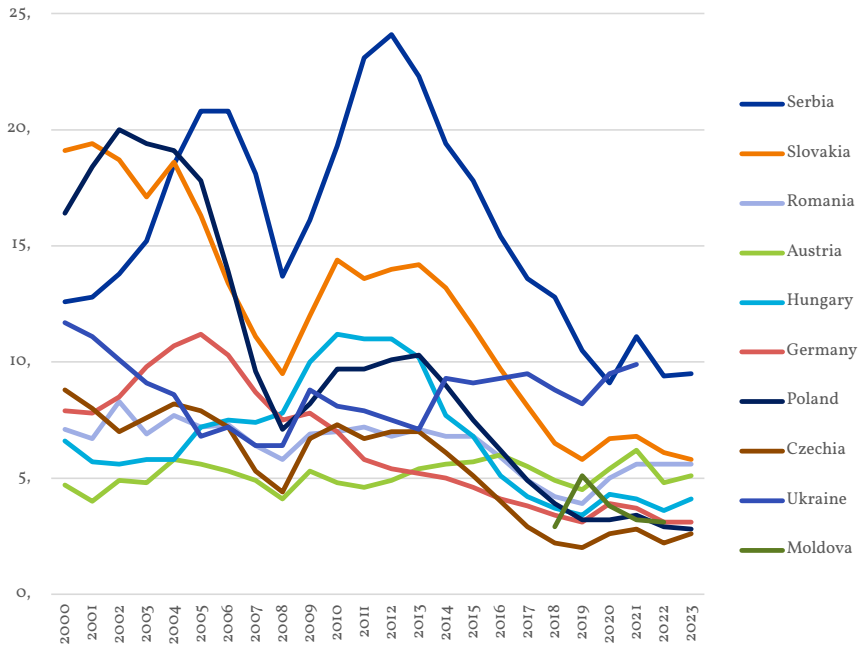


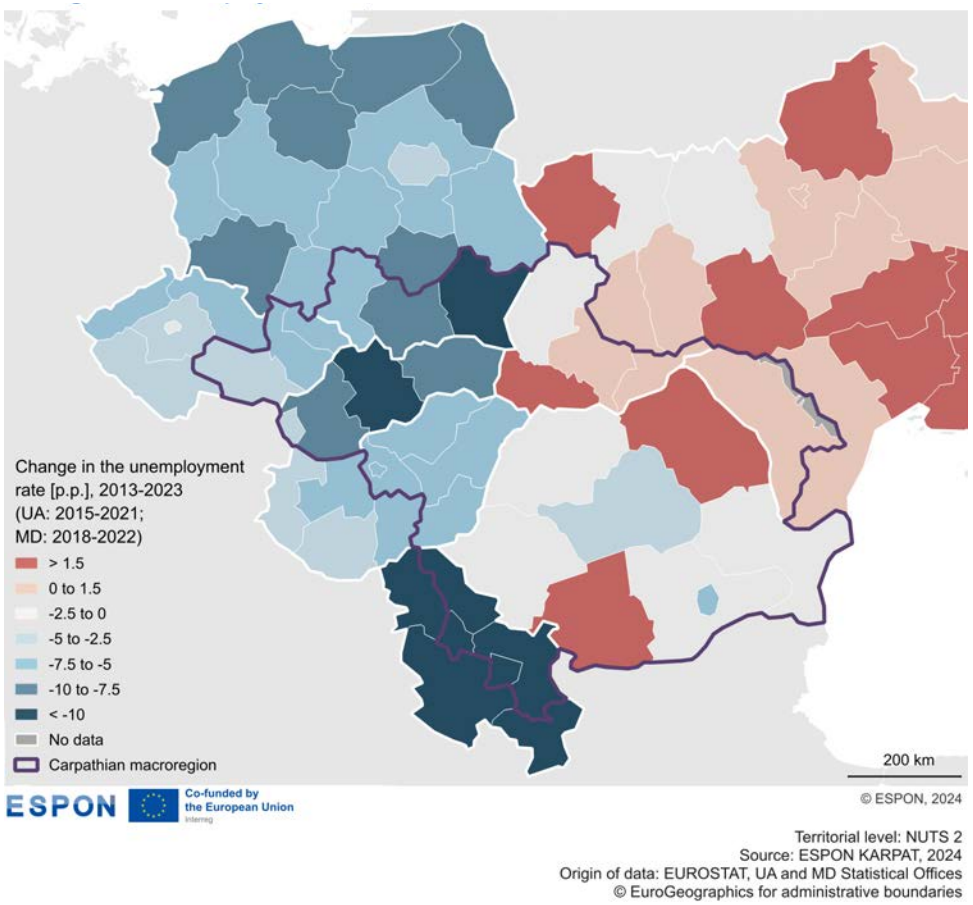
Fig 9. Unemployment rate in the Carpathian countries and in Austria and Germany [2000-2023]



Source: own elaboration based on Eurostat

After 2013, there was a particularly pronounced decline in the unemployment rate in the Carpathian regions of Serbia, Poland (including Podkarpacie) and Slovakia (central part of the country). A more moderate decline was also recorded in the Hungarian and Czech regions. In Romania, the situation varied regionally. The unemployment rate fell in Bucharest and the central region, while the situation was relatively stable in the rest of the country, with two regions (NE and SW) experiencing a worsening of the labour market situation. Ukraine and the Republic of Moldova recorded increases, which, especially in the first case, could be derived from the Russian annexation of Crimea and parts of Donbass in 2014, which worsened the investment climate. The largest increase in the unemployment rate in Ukraine took place in the Transcarpathian region, but Lviv and Chernivtsi regions did not suffer significantly in terms of the labour market situation.

Map 72. Change in the unemployment rate, 2013-2023

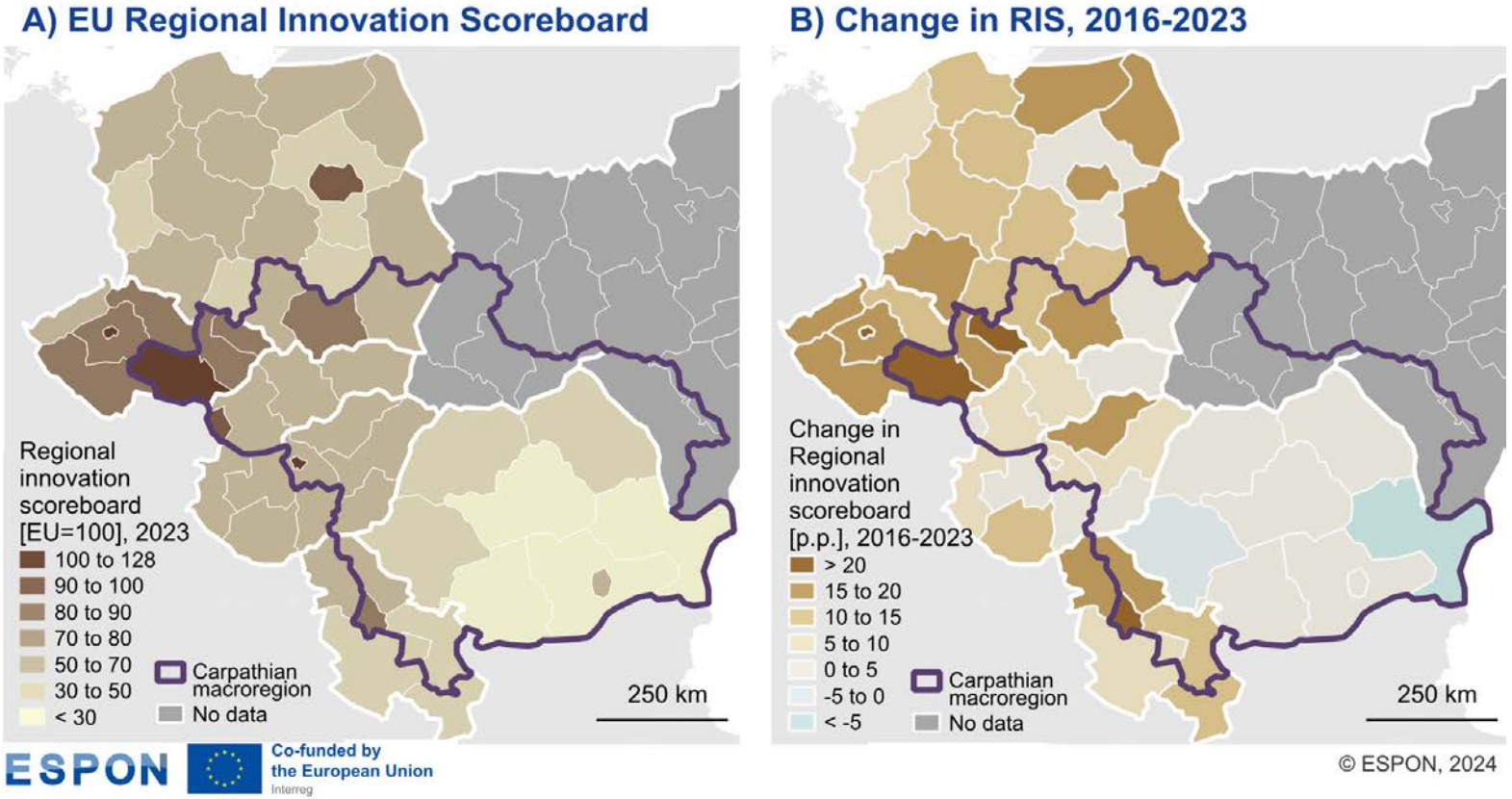


Science and innovativeness

Carpathian regions perform relatively weakly, with no region achieving European Innovation Leader status. The performance indicator ranges from about 19 in Sud-Vest Oltenia and Sud-Est to 101 in Budapest and Jihovýchod. Budapest and Brno are Strong Innovators, while regions like Bratislava, Belgrade, and Kraków are Moderate Innovators. Three-quarters of regions are Emerging Innovators, with Romanian regions showing the weakest performance, except Bucharest.

From 2016 to 2023, Carpathian regions generally underperformed compared to Europe. Performance changes ranged from -7.2 percentage points in Sud-Vest Oltenia to +25 in Moravskoslezsko. While better-performing regions often showed faster improvement, there is no clear pattern between performance and change in the Carpathian region or Europe.

Map 73. Regional innovation scoreboard, 2016-2023



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: Regional Innovation Scoreboard
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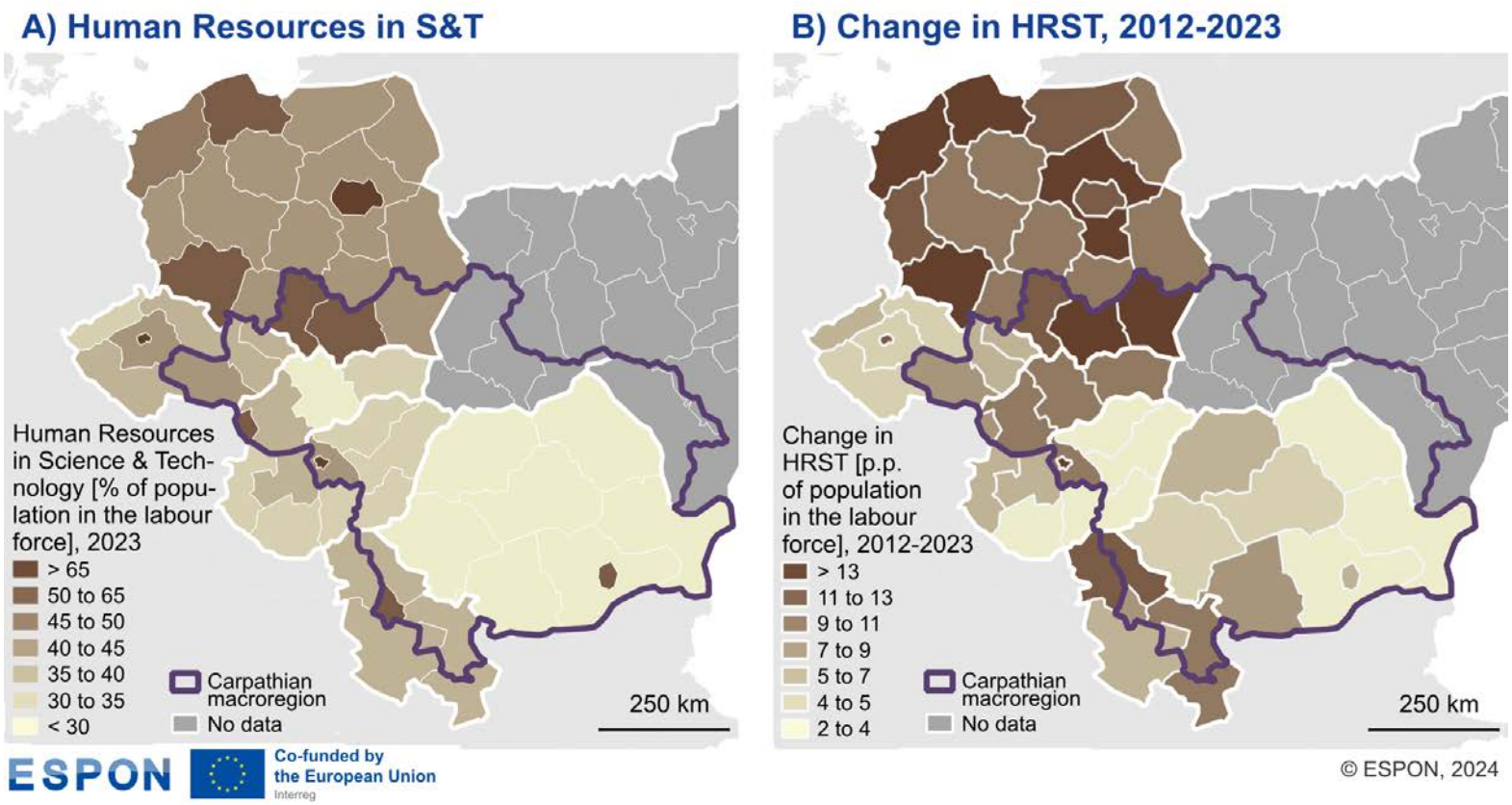
Human resources in S&T

The central and northern Carpathian macroregion shows high concentrations of HRST in urban and industrial centers, with Budapest (68.7%) and Bratislavský kraj (64.9%) leading. These areas outpace their surroundings, benefiting from strong R&D infrastructure. Poland's Małopolskie (54.1%), Śląskie (50.7%), and Podkarpackie (44.3%) also highlight northern dominance, along with Belgrade (53.3%) and București-Ilfov (52.5%).

The Republic of Moldova, western Ukraine, eastern Hungary, and southern Romania have the weakest HRST levels (21%-33%). HRST growth is highest in Małopolskie, Budapest, northern Serbia, and Slovakia, driven by increased investments in human capital. Eastern Hungary and Romania show minimal growth, reflecting persistent challenges. This creates a clear division, with capitals and northern areas as HRST hubs, while structural issues in other regions likely sustain the disparity.

Map 74. Human Resources in Science & Technology, 2012-2023



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, no data for MD and UA
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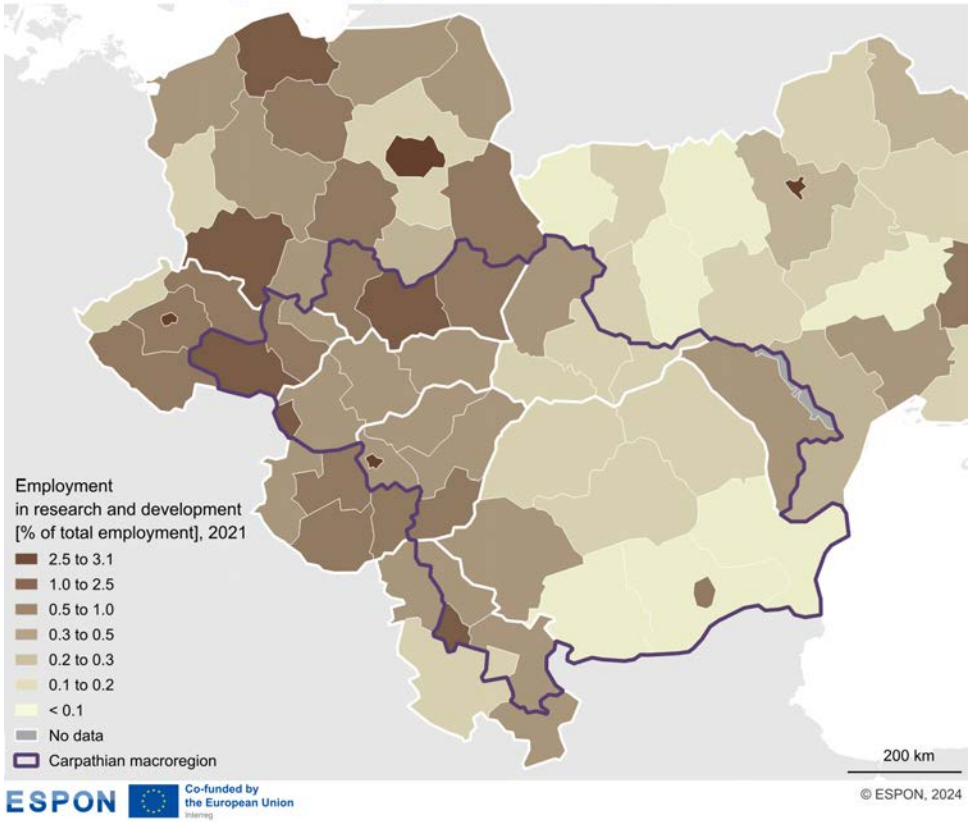
R&D employment

The distribution of R&D employment in the Carpathian macroregion highlights its importance as a key element of human resources in science and technology (HRST), directly contributing to the region's capaci-ty to support innovation and technological advancement. Despite its critical role, R&D employment re-mains scarce across much of the macroregion, with only a few areas demonstrating higher concentrations of specialised human capital. The highest levels of R&D employment are recorded in Budapest (3.07%), Bratislavský kraj (2.43%), and Małopolskie (1.45%), reflecting the strong concentration of skilled labour in capital cities and northern industrial regions.

Other notable clusters, such as Belgrade (1.16%) and Ji-hovýchod in Czechia (1.34%), emphasise the role of regional centres in sustaining scientific and technolog-ical talent. In contrast, the Republic of Moldova, western Ukraine, and eastern and southern Romania exhibit the lowest levels of R&D employment (ranging from 0.06% to 0.40%), indicating a limited pool of human resources dedicated to research and development. This shortage highlights significant gaps in the availability of skilled labour, constraining the ability of these regions to expand their scientific workforce.

The spatial distribution of R&D employment closely follows the pattern of HRST, clustering in capital re-gions and northern industrial zones. However, the narrower range of values (0.06% to 3.07%) gives the impression of a more even distribution of human resources across the macroregion, masking disparities at the local level. While capital cities remain dominant in attracting and retaining talent for R&D, peripheral regions, particularly Romania, the Republic of Moldova, and Ukraine, struggle to develop and sustain the human capital necessary to drive innovation

Map 75. Research and Development Employment, 2021



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, UA and MD Statistical Offices
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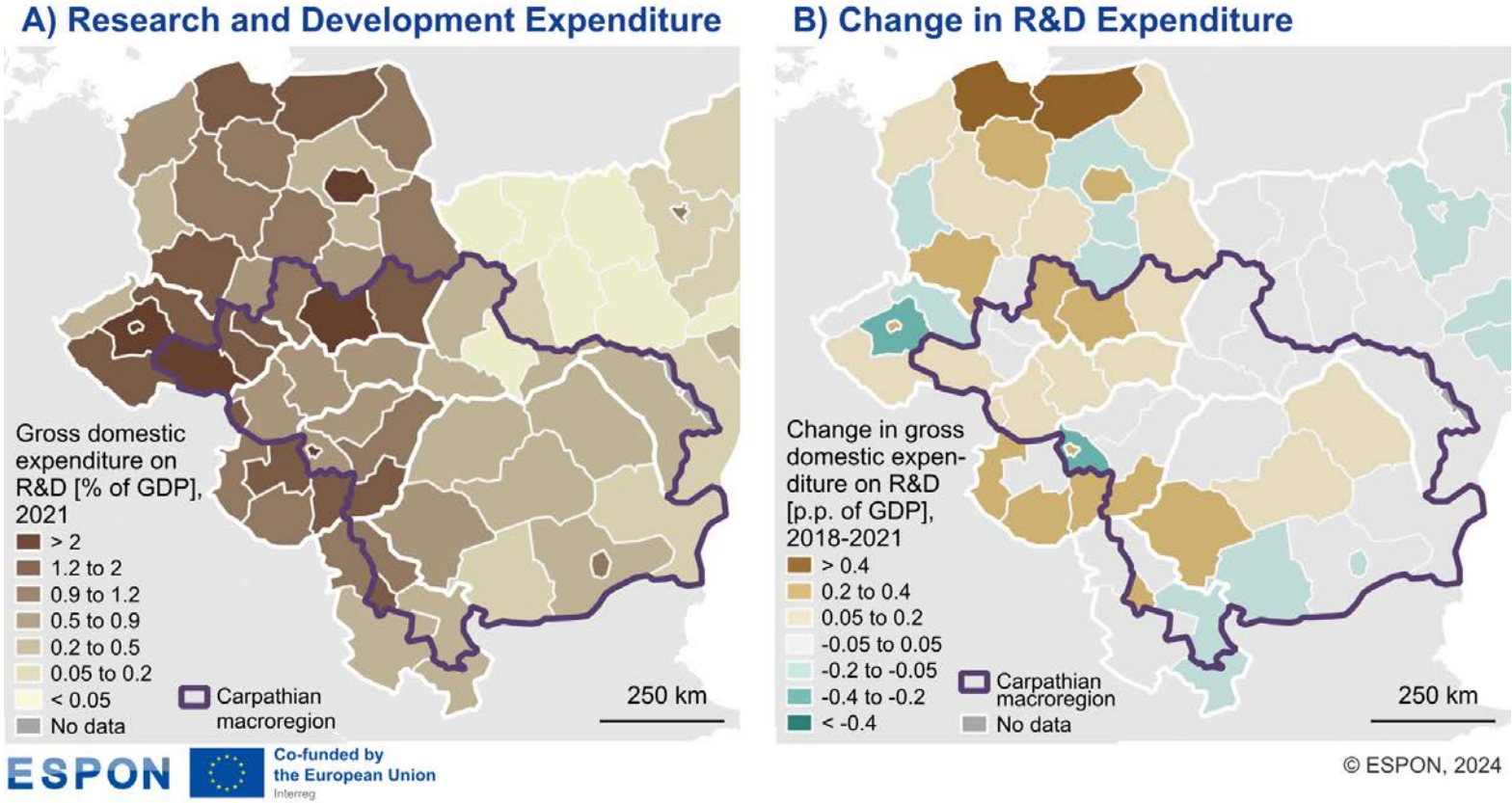
R&D expenditures

Levels of research and development expenditure (GERD) across the Carpathian macroregion show highest expenditures in regions with strong scientific centers and innovation ecosystems, often supported by advanced industries or international corporations. Notable regions include Małopolskie (2.51%) and Podkarpackie (1.29%) in Poland, Jihovýchod (2.52%) and Střední Čechy (1.58%) in the Czech Republic, and Budapest (2.76%) and Dél-Alföld (1.37%) in Hungary.

High GERD areas are often surrounded by weaker regions, such as Pest around Budapest, Západné Slovensko near Bratislava, and Sud-Muntenia by Bucharest. Many Romanian and Ukrainian regions, excluding their capitals, show the lowest GERD levels, reflecting disparities in innovation capacity across the macroregion.

Map 76. Gross domestic expenditure on R&D, 2018-2021



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, UA and MD Statistical Offices
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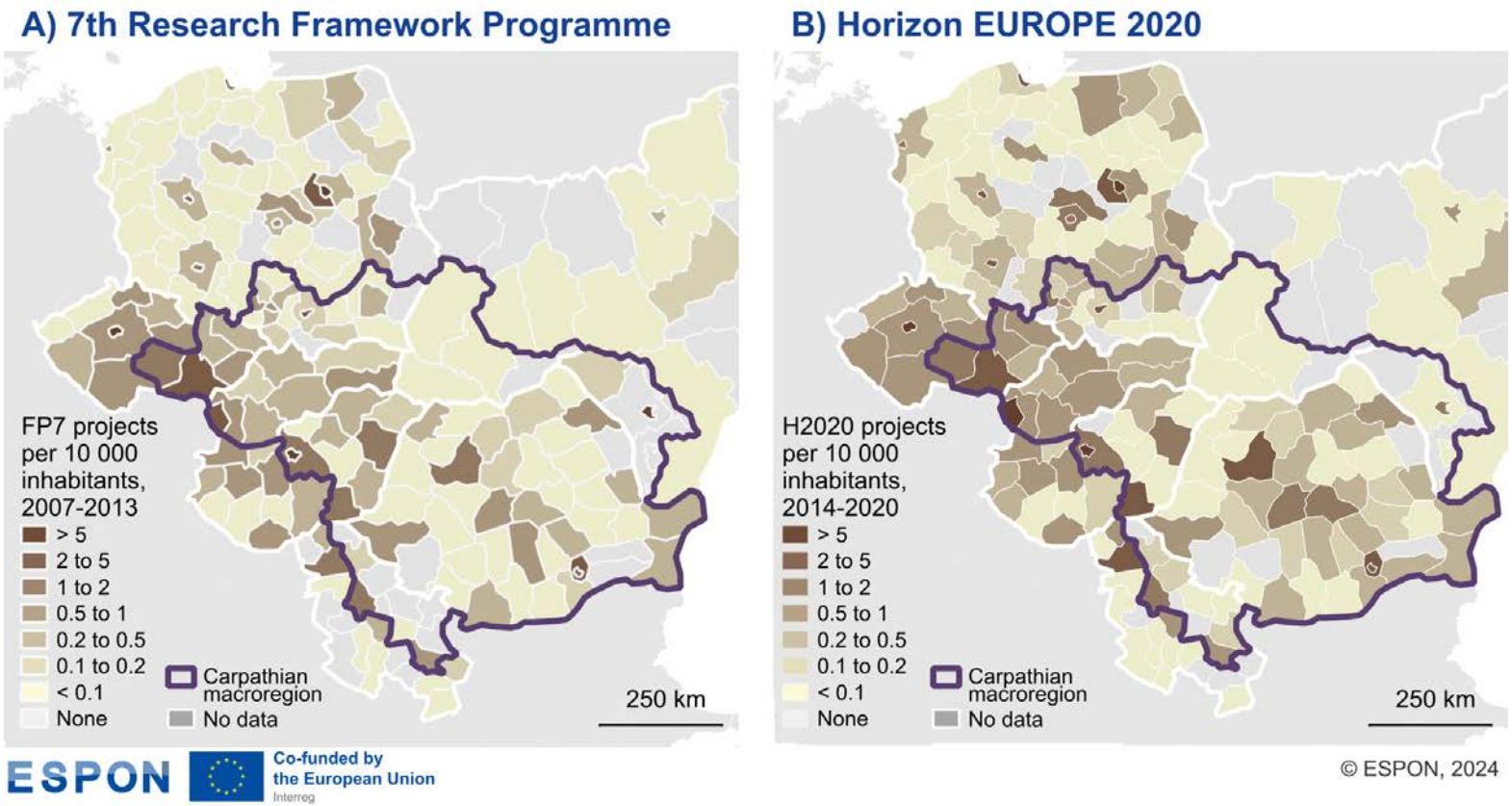
Science

Participation in the EU 7th Framework Programme (FP7) and Horizon 2020 indicates the Carpathian Macroregion's ability to collaborate internationally and secure funding for R&D. However, the region records some of the lowest participation and funding levels in the EU-27. In FP7, there were 4,263 participations, and in Horizon 2020, 5,342, though multiple regions could join the same project, leading to multiple counts. It's important to note that participation alone doesn't reflect the quality or impact of collaboration. A deeper analysis of leadership roles, engagement, and contributions is needed to assess the effectiveness of regional institutions in these networks.

Map 77. European Research Projects, 2007-2020



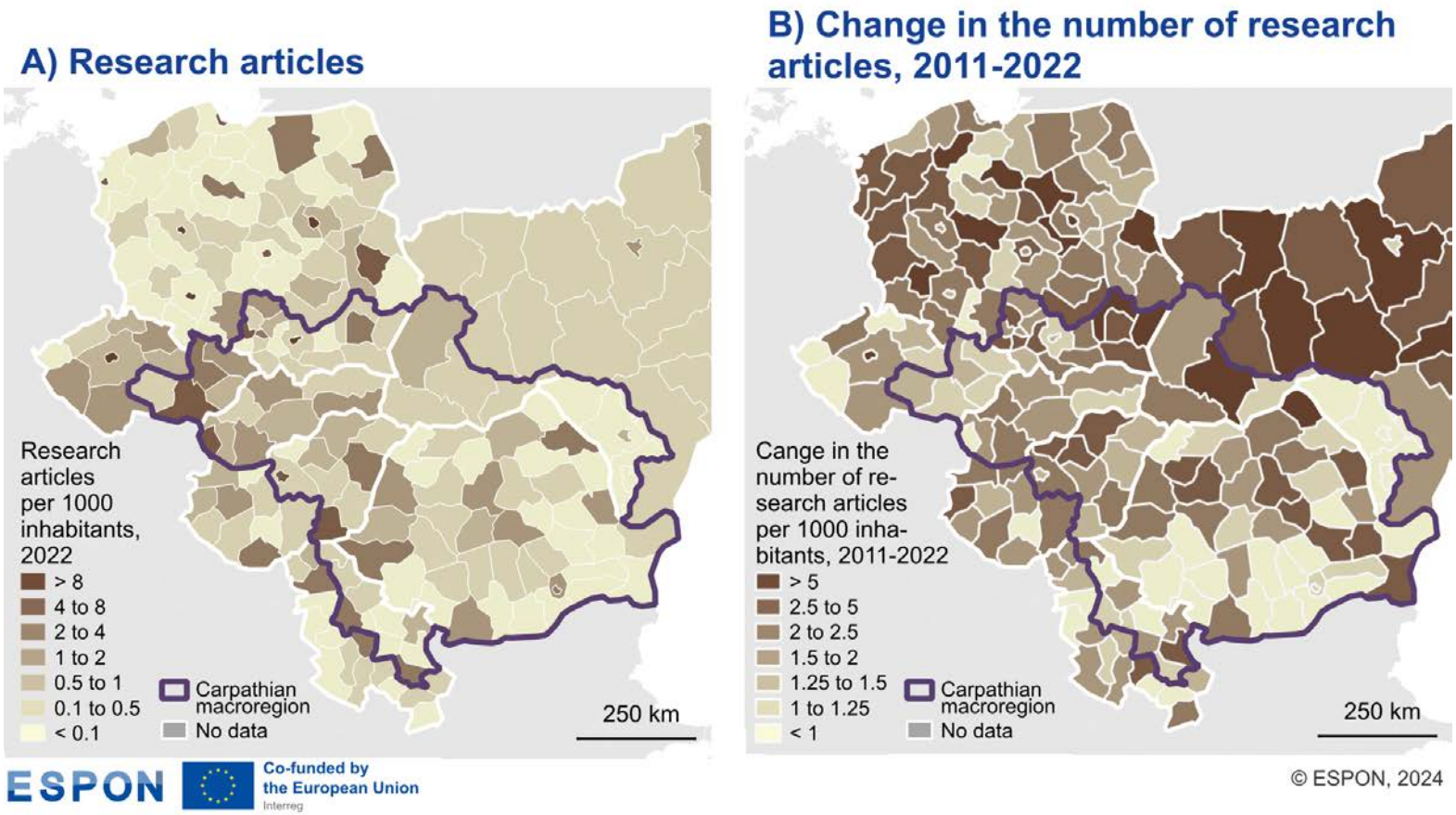
ESPON Co-funded by the European Union Interreg

Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: CORDIS

Scientific articles

The Carpathian Macroregion's scholarly output is minimal in Europe, with significant interregional disparities in scientific productivity, as shown by publications per capita in 2022. The range between the highest (Kraków, 10.2) and lowest-performing regions (some in southern and eastern Romania, Hungary, Serbia, and the Republic of Moldova) is stark. Scientific activity is concentrated in established academic centres, especially in capitals like Budapest, Bratislava, București, and Belgrade, and non-capital hubs like Gliwice and Szeged. Over the past 11 years, scientific disparities have persisted, with some regions showing notable growth in output, reflecting positive momentum despite initial weaknesses.

Map 78. Research papers, 2011-2022



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: Web of Science
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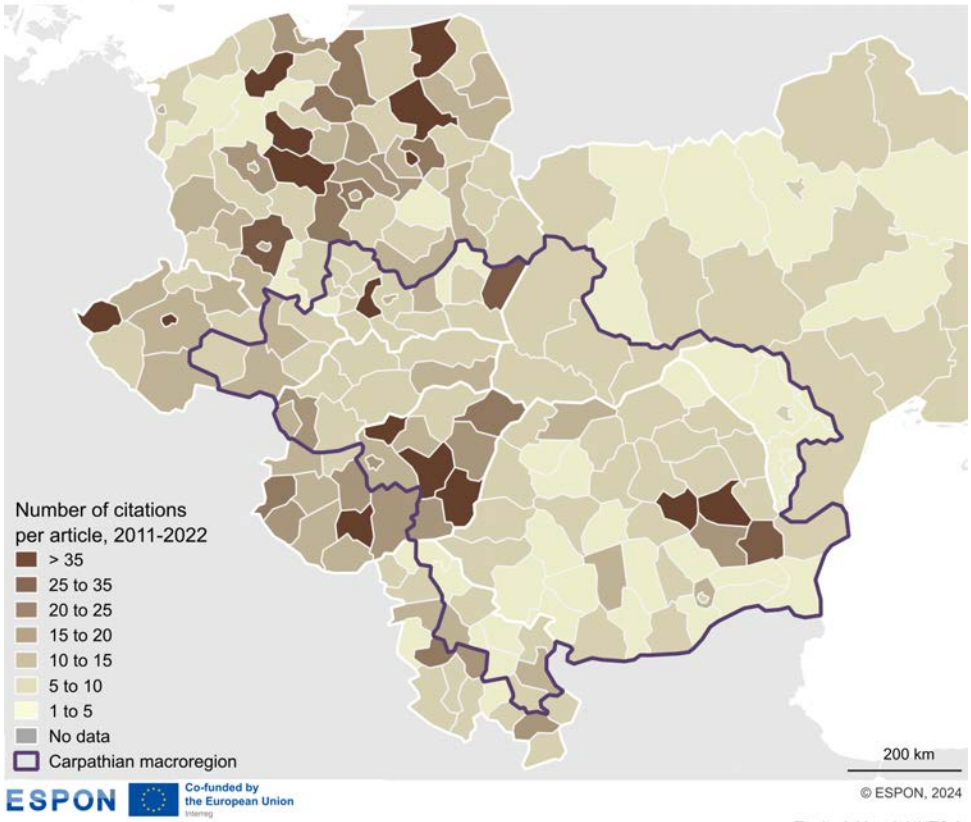
Citations of articles

Citations of scientific publications, reflecting how frequently other authors reference a paper, are a valua-ble measure of the quality and impact of scientific research. However, this indicator must be used cautiously, as factors unrelated to the actual scientific value, such as self-citations, contextual citations, or network effects, may play a role. Moreover, citation patterns are discipline-specific, and due to the predominance of English-language publications in databases like WoS, they often disregard local scientific output (Olechnicka et al., 2019) .

The average level of citations in the Carpathian Macroregion varies significantly. The highest values are observed in the Romanian region of Vrancea (72.5 citations per article published between 2011 and 2022). Notably, the leading regions in terms of citations often have low scientific output. In contrast, regions with substantial scientific output achieve relatively high, though not the highest, citation rates, with between 10 and 16 citations per article. Examples include Szeged, Budapest, Debrecen, Olomouc, Kraków, Brno, and Bratislava. However, this ranking does not align with the regions with the largest publication output, highlighting a discrepancy between scientific output and impact. At the lower end of the spectrum are the southwestern Romanian regions and the Republic of Moldova, where the average number of citations remains below 3.5 per article, with the lowest values recorded in the Romanian Olt and Regiunea Centru in the Republic of Moldova (NUTS 3) regions (1.6 citations per article).

Map 79. Citation index, 2011-2022

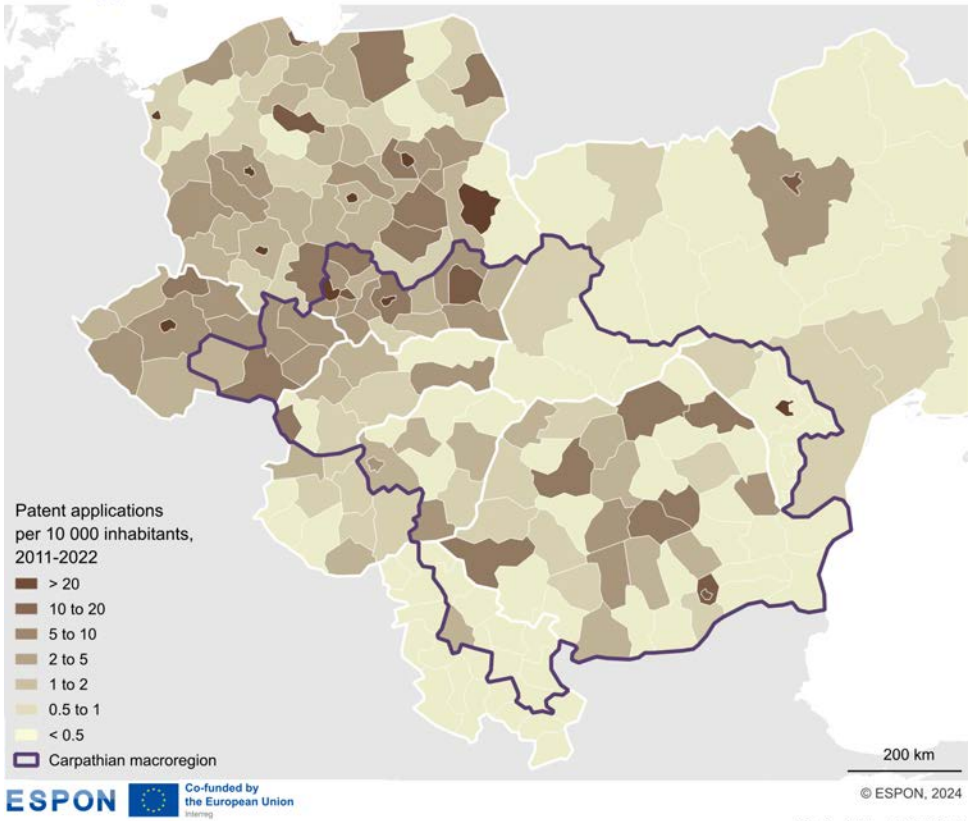


Patents

The spatial concentration of patent activity across the Carpathian region is uneven. The relative patent application is highest in the northern parts of the macroregion (Polish NUTS 3 regions: Gliwice, Kraków, Kato-wice, Rzeszów), in the capital of the Republic of Moldova, as well as in scattered Romanian regions (Ilfov, Brașov, Covasna, Cluj, Timiș, Iași, Suceava), with the Bucharest metropolitan area playing a prominent role.

There are significant spatial disparities, indicating that some regions are more specialised in scientific activities, which typically contribute to innovation and development over the long term. In contrast, others focus on research and development activities closer to market-oriented applications of developed solutions. The spatial pattern of patent activity is more spatially concentrated, particularly in Polish and dispersed Romanian regions. In contrast, the publication pattern highlights the dominant role of capital cities and strong academic centers.

Map 80. Patent applications, 2011-2022



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: PATSTAT
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Typology of scientiffic hubs

There are four categories of regions through comparing the number of patents and publications relative to the average values for the Carpathian region.

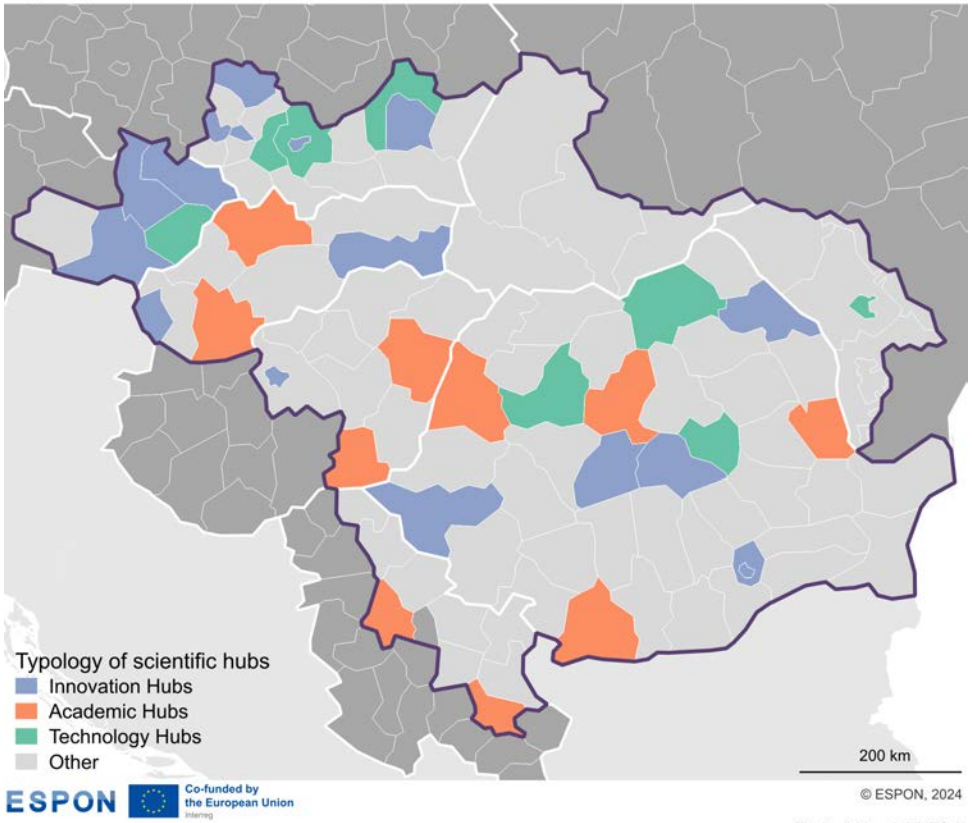
The first category Innovation Hubs includes the leaders of science and innovation in the Carpathians, distinguished by both high patent activity and a significant number of scientific publications. These regions include Hungarian (Budapest), Czech (Jihomoravský kraj, Olomoucký kraj, Moravskoslezský kraj), Polish (Miasto Kraków, Częstochowski, Gliwicki, Katowicki, Rzeszowski), Romanian (Brașov, Sibiu, Iași, București, Ilfov, Timiș) and Slovak regions (Bratislavský kraj, Košický kraj). An excellent example is the Gliwicki region, which achieved the highest deviation in patents at +1207.7% above the average and out-standing publication results at +468.3% above the average.

The second category Technology Hubs consists of regions oriented toward practical innovation, present-ing high patent activity and relatively low scientific output. These regions include Czech (Zlínský kraj), Polish (Krakowski, Oświęcimski, Tarnobrzeski), Romanian (Cluj, Covasna, Suceava) and the Republic's of Moldova (Municipiul Chișinău). An exemplary case is Chișinău in the Republic of Moldova, where the number of patents exceeded the average by +438.3%, while the publication indicator remained 32.1% below the average. The spatial distribution of these regions is more dispersed, covering industrial and economically specific areas such as the Republic of Moldova and certain Romanian regions.

The third category Academic Hubs includes academic regions characterised by strong publication indica-tors and low patent activity. These regions include Hungarian (Hajdú-Bihar, Csongrád-Csanád), Romanian (Bihor, Mureș, Galați, Dolj), Slovak (Nitriansky kraj, Žilinský kraj) and Serbian regions (City of Belgrade, Nišavska oblast). An example is Nitriansky Kraj in Slovakia, where the publication indicator was 26.1% above the average, while the number of patents remained 56.5% below the average. These regions are mainly located in the southern Carpathians, in smaller academic centers or on the outskirts of metropoli-tan areas, suggesting a greater focus on basic research rather than commercialisation activities.

The largest group, Others, comprises 67 regions with low results in both patent activity and scientific pub-lications, indicating limited potential in both aspects, science and innovation. These regions are widely dispersed across the Carpathians, with a particular concentration in economically less developed eastern and southern areas.

Map 81. Typology of scientific hubs, 2022



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: European Patent Office and Web of Science
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Map 82. Specialisation of regions based on patents – factor analysis, 2022

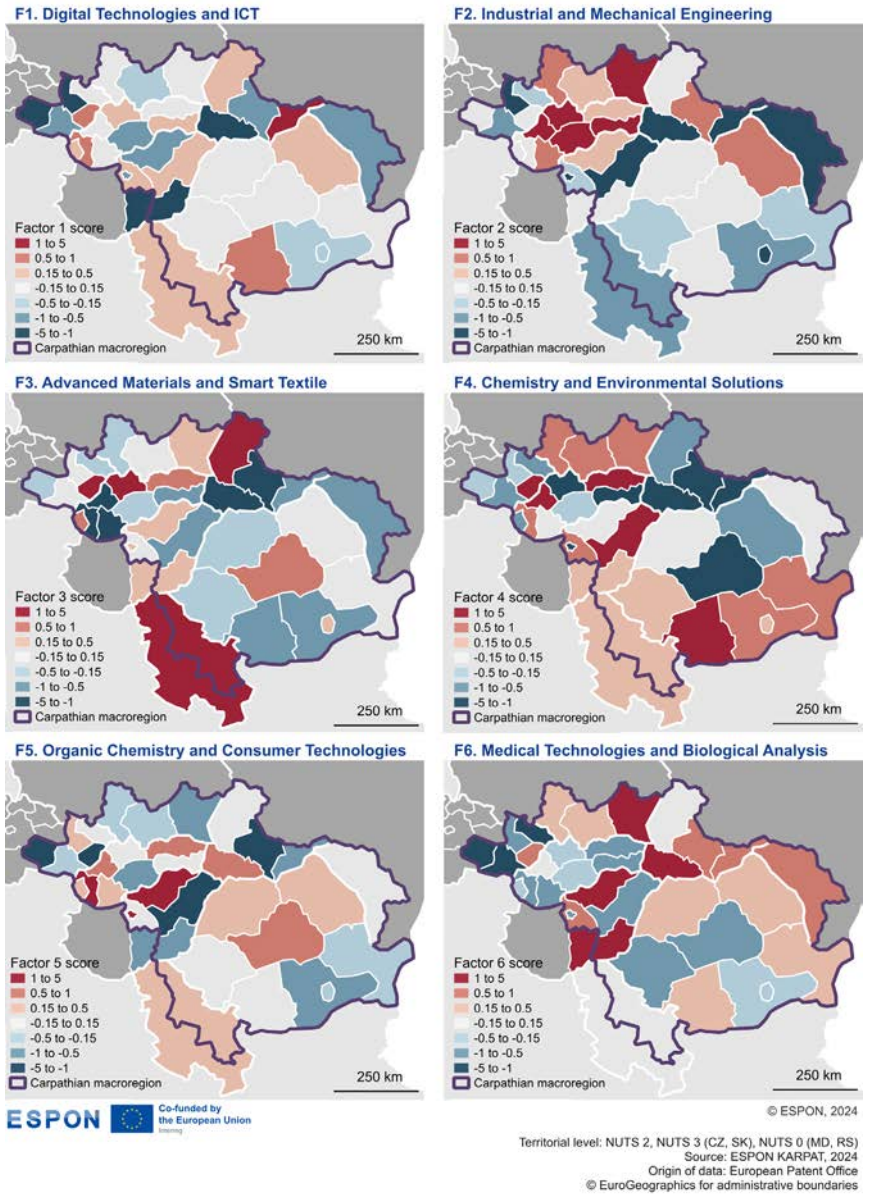
Smart specialisations

The analysis of patents and publications in the Carpathian macroregion reveals a diverse and fragmented scientific and technological specialisation landscape with no dominant field. Biomedicine emerges as a notable sector, with Biomedical Sciences, Clinical Medicine, and Molecular Research prominent in publications and Medical Technologies and Biological Analysis reflected in patents. This highlights the region's strength in health-related research and medical technologies.

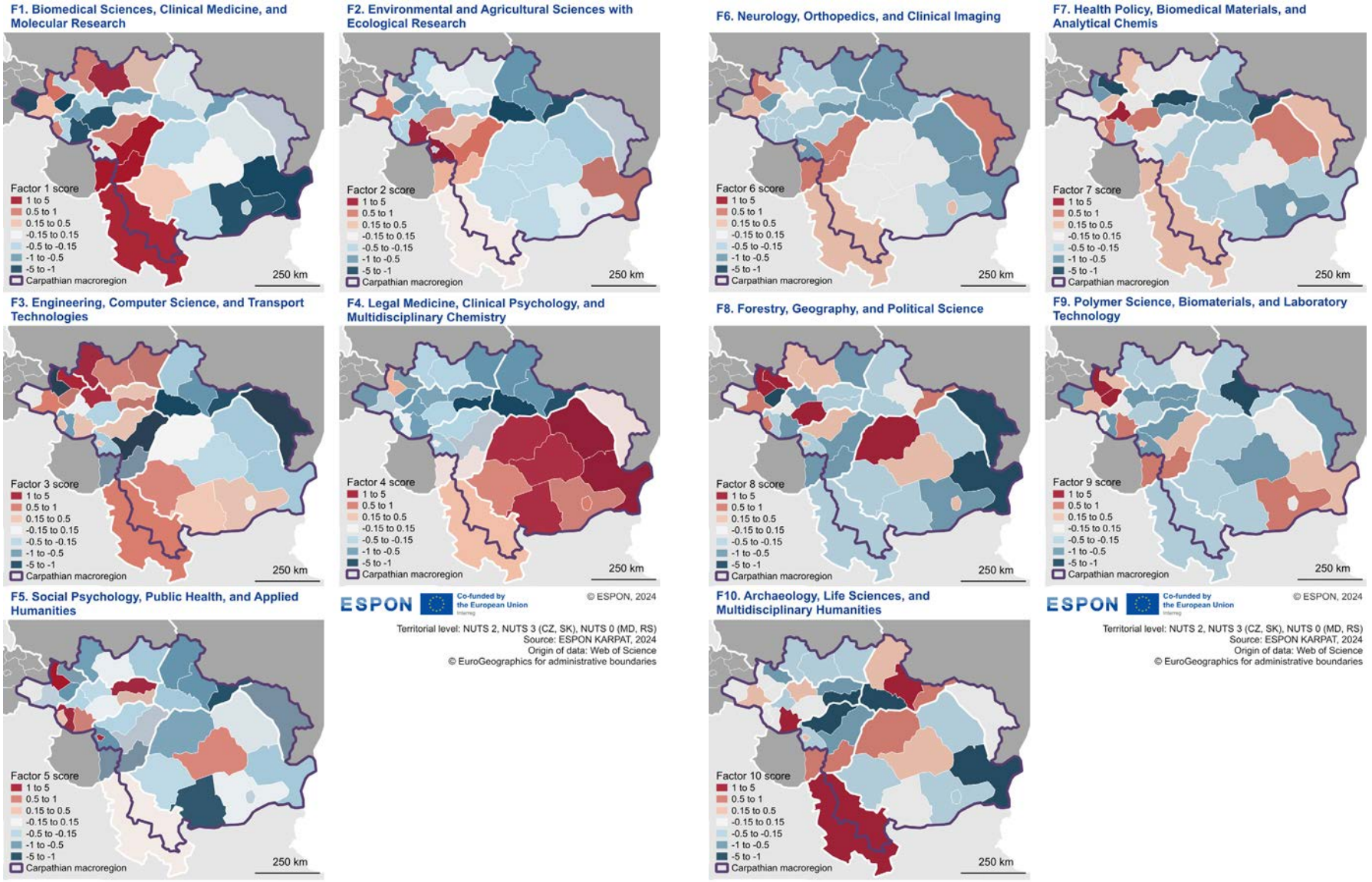
The results suggest potential interdisciplinarity, with overlapping fields across natural, social, and technological sciences. However, this coexistence, observed in factor analysis, points to parallel development rather than fully integrated progress, indicating that scientific and technological advances unfold at varying scales and paces without a clear thematic leader.

A key distinction emerges between patents and publications: patents emphasise industrial strengths in Industrial and Mechanical Engineering and Advanced Materials and Smart Textiles, reflecting the region's industrial roots, while publications prioritise environmental and agricultural sciences, driven by the Carpathians' ecological and agricultural importance.

Despite the strong academic focus on environmental research, patent activity in ecology and agriculture remains low, suggesting limited technological innovation. This contrast indicates that while biodiversity protection and ecosystem research are well-represented in publications, they have yet to translate into patents or industrial applications.



Map 83. Specialisation of regions based on scientific publications – factor analysis, 2022

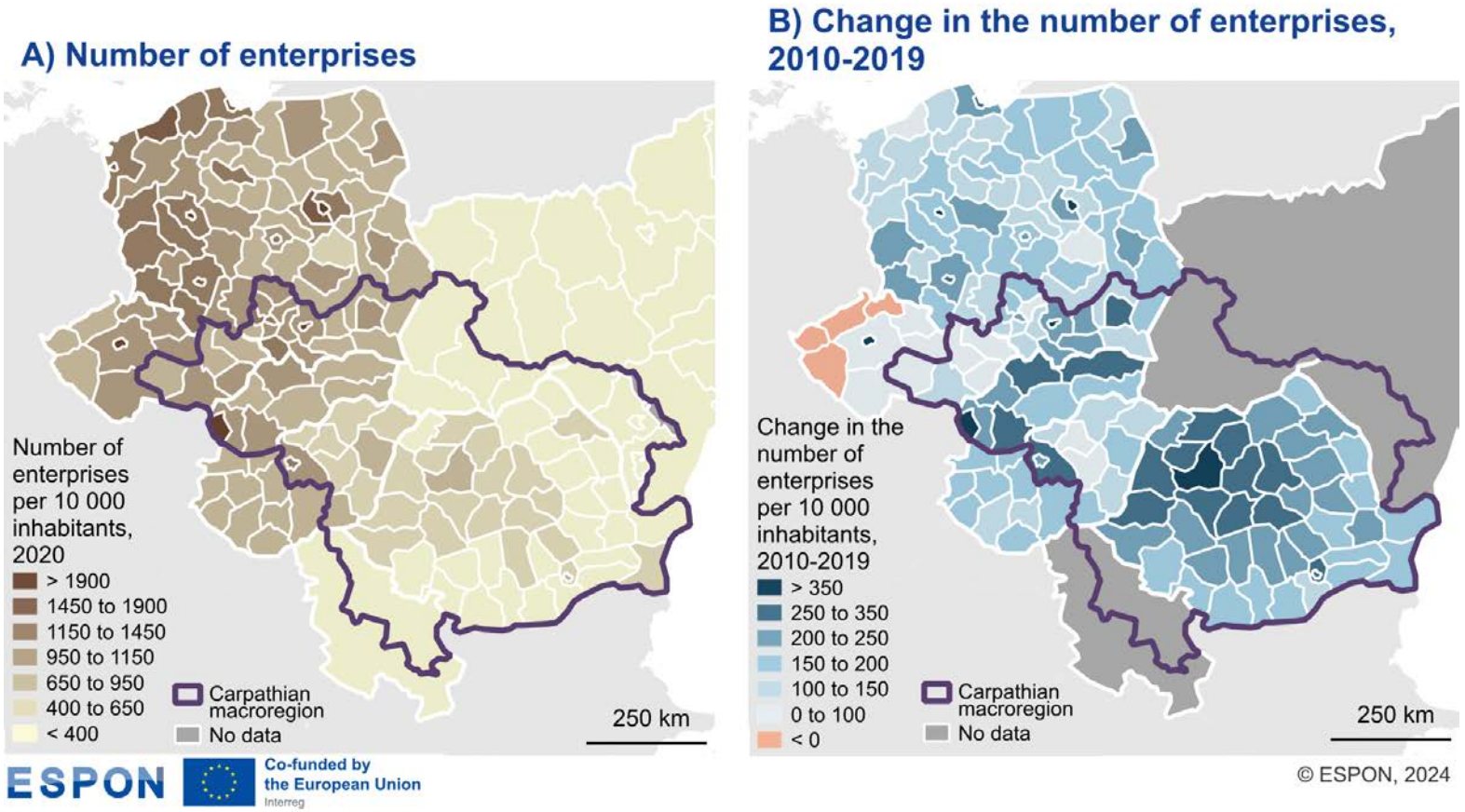


Entrepreneurship

The distribution of enterprises per 10,000 residents across the region demonstrates significant disparities. Polish, Czech and Slovak regions perform well, with numerous urban and industrial areas with high regional economic activity. In comparison, Romania and its southern and north-eastern regions lag significantly, with the exception of București, which recorded nearly 800 enterprises per 10,000 residents.

The number of enterprises per 10,000 residents increased in all Carpathian macroregion NUTS3 regions between 2010 and 2020, indicating a rise in entrepreneurial activity across the area. The most precipitous increases were observed in the metropolitan areas of Bratislavský kraj, Kraków and Cluj. The lowest rates of increase were observed in regions with saturated enterprise landscape, such as the Czech Republic's and Silesia in Poland.

Map 84. Entrepreneurship, 2010-2019



Territorial level: A - NUTS 3, NUTS 0 for RS; B - NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: A - EUROSTAT, UA and MD Statistical Offices; B - EUROSTAT

Structure of enterprises sector

Highest levels of industrial enterpreneurship can be observed in eastern Romania, southern Poland, and southers Hungary with location quotients (LQ) exceeding 1.5 in Romania's Harghita, Neamț, and Covasna, Hungary's Jász-Nagykun-Szolnok, and Poland's Częstochowski.

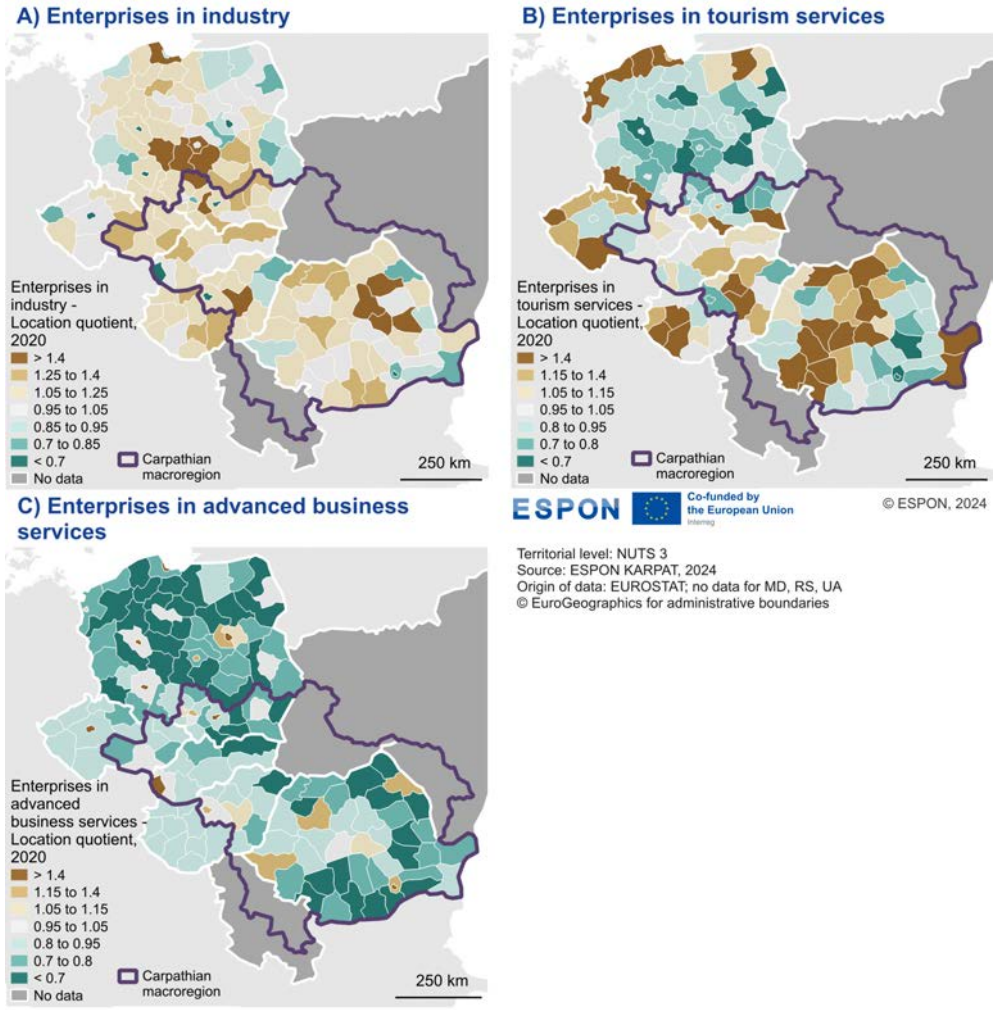
In contrast, the low levels of industrial activity are observed in major urban centres such as Budapest, Kraków, Bratislava, and București, all with LQ values below 0.7, reflecting their service-oriented economies. Low LQs were also recorded in Romania's Constanța, mostly comprising a sea resort, and Poland's Katowicki, which has shifted away from its coal-based industrial legacy. In Hungary, the lowest level of entrepreneurship in industry was observed in the Szabolcs-Szatmár-Bereg region bordering Ukraine.

In terms of tourism services the highest LQ, exceeding 4, was recorded in Poland's Nowotarski region, home to Zakopane, the country's most recognisable mountain resort. In Romania, the sea resort regions of Tulcea and Constanța showed LQs nearing 2. Higher LQs in tourism services are also present in Suceava, Caras-Severin and areas in Eastern and Southern Romania, Eastern Hungary (Heves and Jász-Nagykun-Szolnok) and Krośnieński and Bielski in Poland. The lowest tourist LQs, around 0.5, were observed in București and Ilfov, as well as in southern Polish regions such as Tarnowski and Rzeszowski (0.7).

The share of advanced services in the economy demonstrates a strong concentration in metropolitan and urban areas across the Carpathian macroregion. The highest LQs, exceeding 1.5, were recorded in București, Bratislava, and Krakow, followed by Budapest and Romania's second-largest city of Cluj. The lowest LQs for advanced business services were observed in peripheral regions, i.e. Poland's Nowotarski and Hungary's Szabolcs-Szatmár-Bereg, respectively, both hovering around 0.5. Romanian regions like Vaslui, Teleorman, and Vrancea, which are among the poorest in the country, also recorded LQs of 0.6 or lower.

* a) industry (NACE, Section B-E), b) tourism services (NACE, Section I) c) advanced business services (NACE, Section J-N)

Map 85. Entrepreneurship Specialisation in Selected Branches, 2020

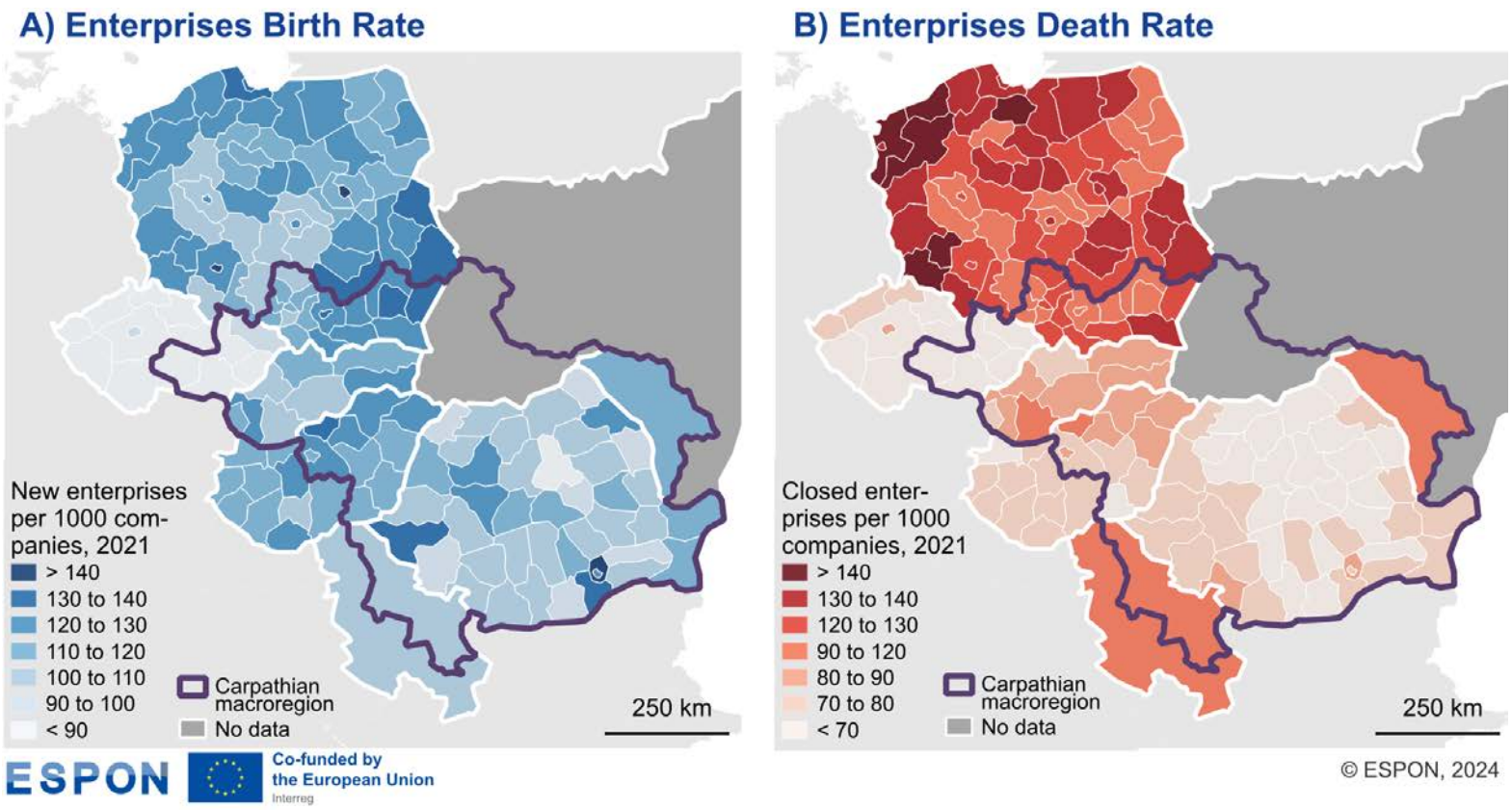


Business demographics

The highest enterprise birth rates in the macroregion were observed in Poland, Hungary, and Romania, with București Rzeszowski and Kraków standing out for their high values. The importance of the proximity of major urban centres is evident, influencing the development of entrepreneurship in the metropolitan regions. The lowest business birth rates were observed in Czech Republic and some regions of Romania, including the border ones.

The highest enterprise closure rates were observed in Poland, with values reaching up to 130 closures per 1,000 companies in regions such as Krośnieński at the border with Slovakia. These figures, juxtaposed with their exceptionally high birth rates, suggest a volatile business environment characterised by significant turnover and limited long-term stability for enterprises. The lowest closure rates, oscillating around 50 closures per 1,000 companies, were found in Romania and Czech Republic.

Map 86. Business Demography, 2021



Territorial level: NUTS 3, NUTS 0 for RS, MD, UA
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT; PL, UA, MD, RS statistical offices
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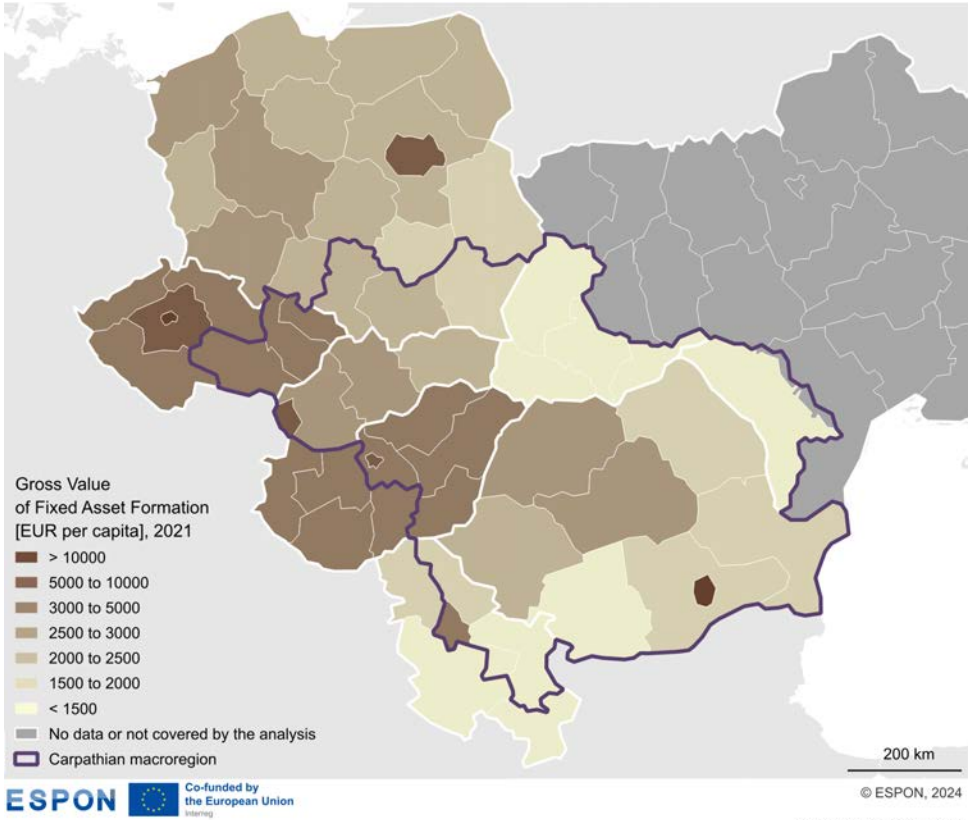
Investments and business environment

Investment and business incentive issues play a crucial role in shaping the economic development and wealth levels of regions, making them an essential element of analysis for the Carpathian macroregion. The per capita value of fixed assets and the structure of sectoral investments enable an assessment of the economic advancement level and its capacity to absorb new investments, directly impacting the quality of life for residents and economic growth prospects. Increased investment levels, particularly in the form of foreign direct investment and special economic zones, support job creation, infrastructure modernization, and the introduction of innovative solutions, which in turn enhance the region's attractiveness to further investors. Concurrently, business incentive policies and institutional support are important as they help to equalize development disparities, especially in peripheral areas, stimulating growth and counteracting stagnation.

The value of fixed assets in enterprises is one of the key indicators of economic development. This aspect is typically strongly linked — especially in international comparisons using fixed asset valuations in EUR — with the overall level of regional affluence measured by GDP per capita. Based on this indicator, regions in the Carpathian macroregion differ significantly in their investment levels, with Czech and Hungarian regions standing out positively, while Ukrainian, the Republic's of Moldova, and selected Romanian and Serbian regions lag behind in investment. In Poland, Slovakia, and Romania, a west-east disparity in fixed asset values is evident.

Map 87. Gross Value of Fixed Assets Formation, 2021



Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT, UA and MD Statistical Offices
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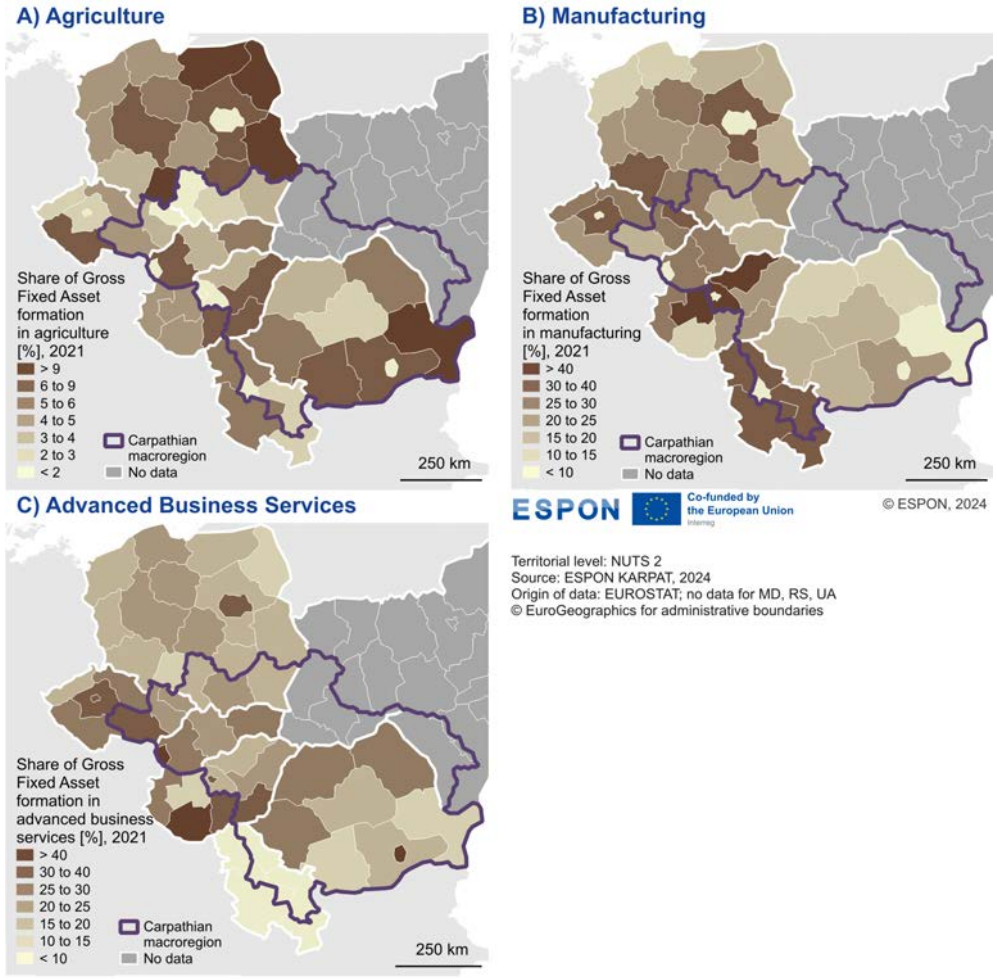
Structure of fixed assets

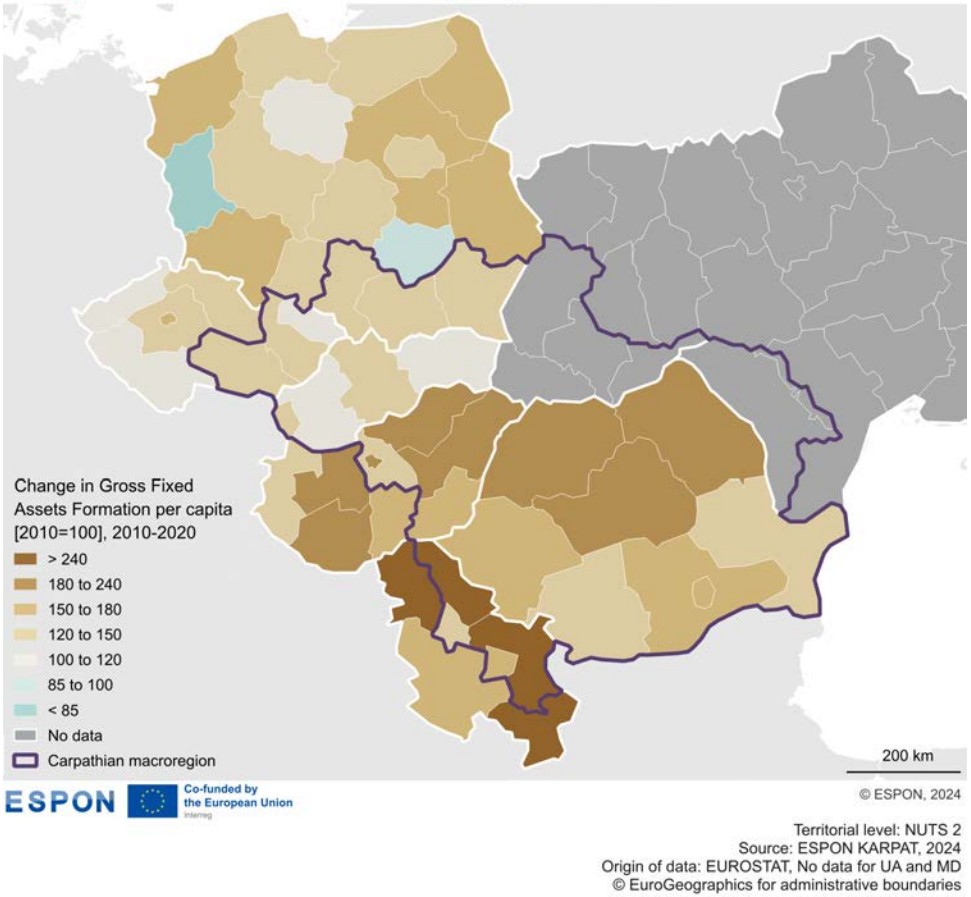
The structure of fixed assets can also indicate the importance of various sectors in a region's economy. For instance, the significance of agriculture, as derived from this analysis, was relatively high in select Romanian regions, particularly in Wallachia, as well as in parts of Hungary and Slovakia, which may indicate the high intensity of agricultural production. Conversely, in Polish regions within the macroregion, agriculture's share in the fixed asset structure was low, linked to the fragmentation of farms, which, unlike in other CEE countries, did not experience widespread agricultural collectivization after World War II. A similar situation occurred in parts of Transylvania and the mountainous regions of Serbia, where agricultural fragmentation was also relatively high. In terms of industrialization, regions in the northwest of the macroregion, particularly northern Hungary, stood out. Meanwhile, the strictly urban regions of Bratislava, Budapest, and Bucharest were intensively invested in advanced business services. This resulted in a high share of this sector in the fixed asset structure and simultaneous low shares of agriculture and industry. Besides these cities, the significant share of advanced business services also applied to regions hosting the largest urban centres of the macroregion, visible in Romania, Slovakia, and, to a lesser extent, Poland.

Over the last decade, growth in the gross value of fixed assets per capita was particularly evident in Serbia, as well as in Romania — especially in its northern regions — and in eastern Hungary. A relative decline was observed in Polish, Slovak, and Czech regions, which may indicate that under the conditions of rapid economic growth experienced by these countries, there has been an increase in the efficiency of using existing fixed assets. In Poland and the Czech Republic, this was accompanied by a relative increase in the importance of fixed assets in the production sector, while in Slovakia, Romania, and Hungary, the importance of advanced business services grew.

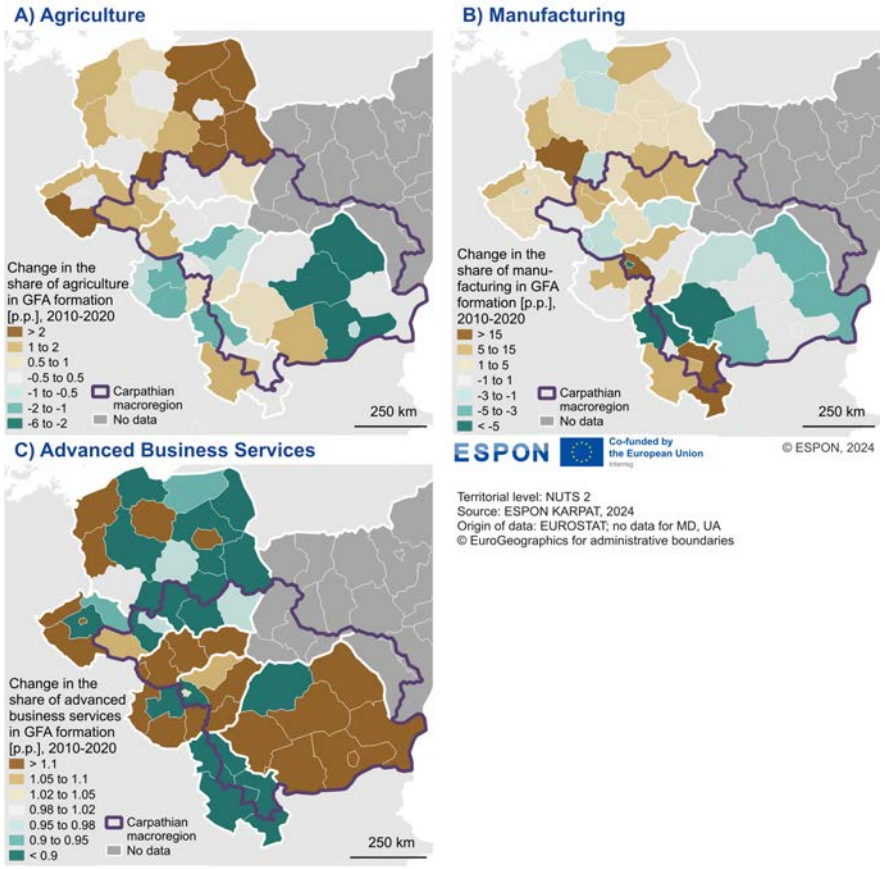
Map 88. Structure of Gross Fixed Assets Formation, 2021



Map 89. Change in Gross Fixed Assets Formation per capita, 2010–2020



Map 90. Change in the Structure of Gross Fixed Assets formation, 2010–2020



Foreign direct investment

Foreign investment in the Carpathian macroregion is concentrated in major urban centers like Bratislava, Budapest, and Bucharest. However, these capital regions may overstate foreign investment, as companies often register there but operate in other areas. Peripheral regions, such as eastern Poland, Slovakia, Hungary, and southern Serbia, attract less foreign capital, partly due to limited transport accessibility. Industrial regions with high fixed asset values and skilled labor, such as Silesia and northern Hungary, are more attractive to investors. Ukrainian regions see the least foreign investment, largely due to ongoing Russian aggression since 2014.

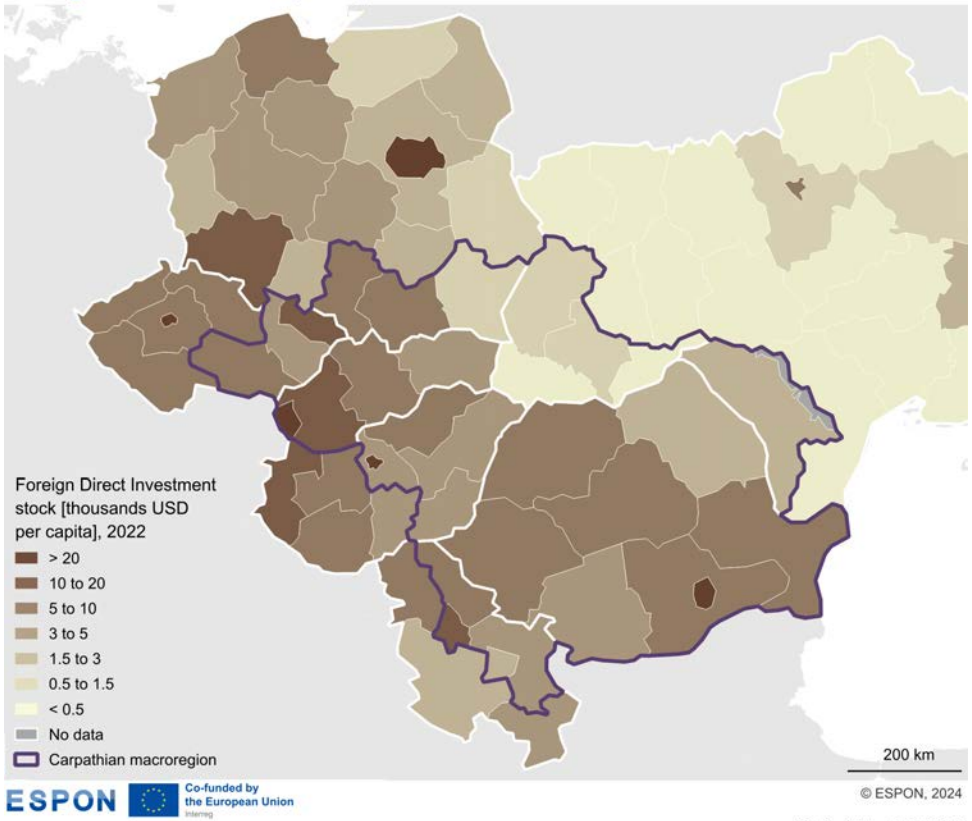
Regional aid cellings

Investment incentives and improved institutional environments have spurred foreign investments in Carpathian countries. Special economic zones and EU membership (2004-2006) enhanced support systems for investments, now more regional and less location-specific. Public aid levels are tied to regional affluence. Business park sizes serve as key indicators of regional investment potential, with the largest parks found in major cities like Bratislava, Belgrade, Budapest, and Chișinău. Cross-border regions tend to have smaller parks, reflecting fewer development opportunities. While investment land availability doesn't greatly vary, mountainous regions face growth barriers.

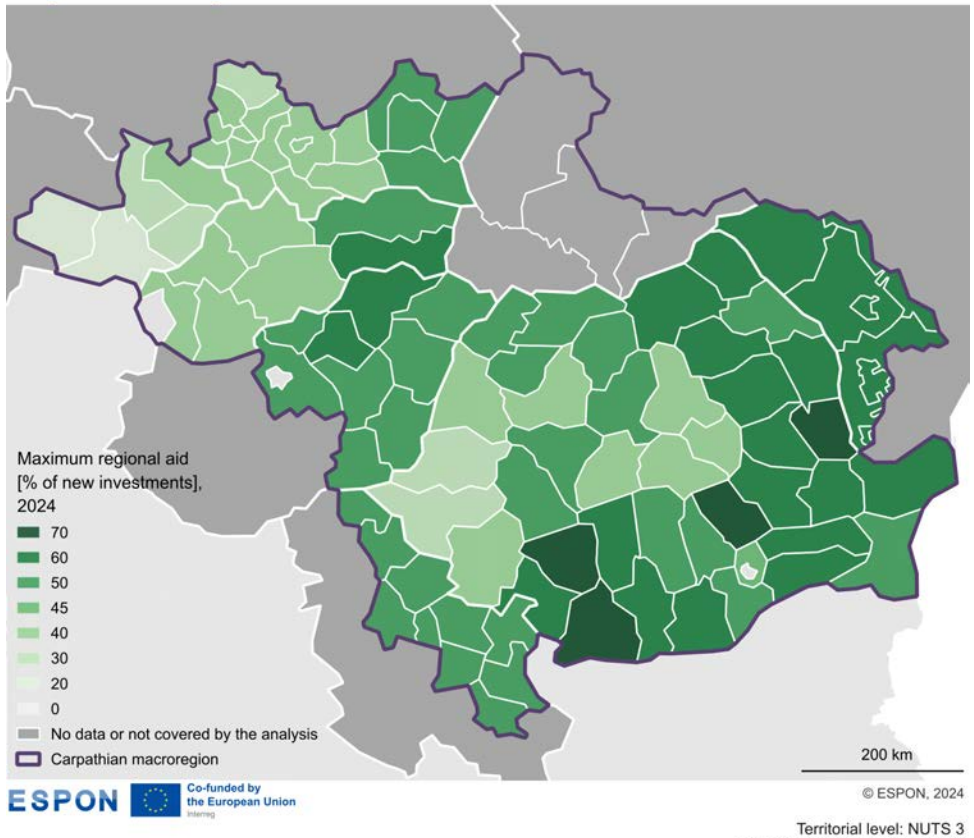
Quality of governance

The institutional environment, measured by the European Government Quality Index (EQI), shows that Carpathian regions generally have lower governance quality compared to the EU average, with the best conditions in the Czech Republic and Slovakia, and the worst in Serbia and Ukraine. Over the last decade, governance has improved in Romania and parts of the Czech Republic and Poland, while Hungary, southeastern Poland, and eastern Slovakia experienced declines.

Map 91. Foreign Direct Investment per Capita, 2022



Map 92. Regional aid celling, 2024



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: European Commission
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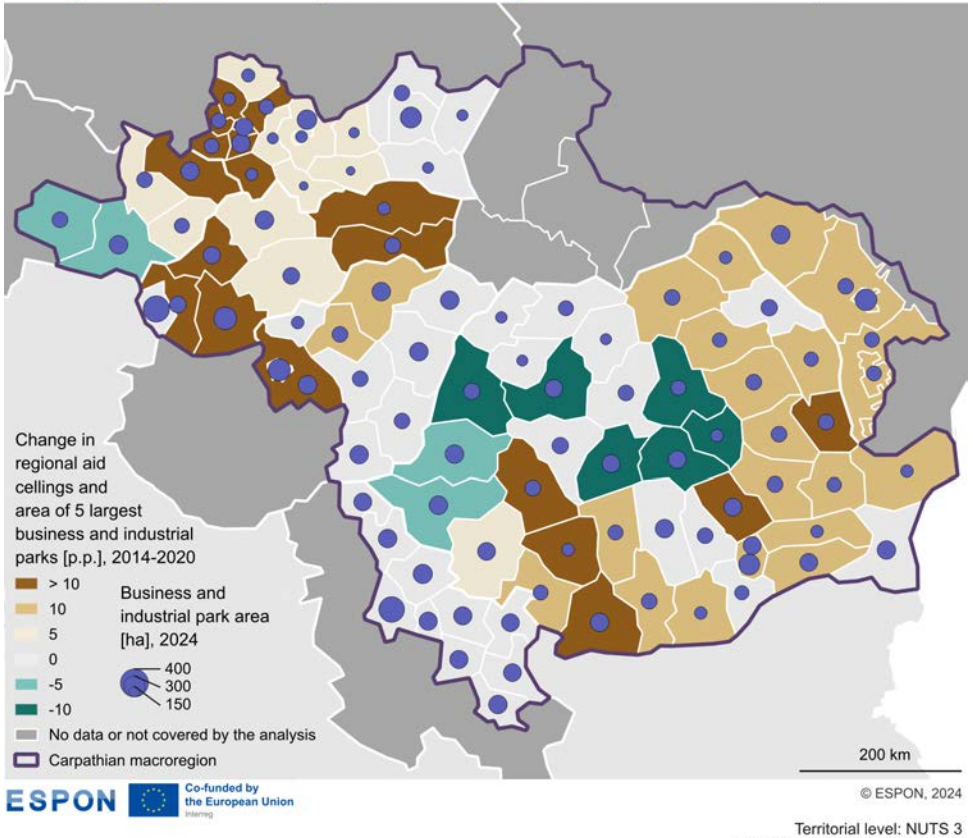
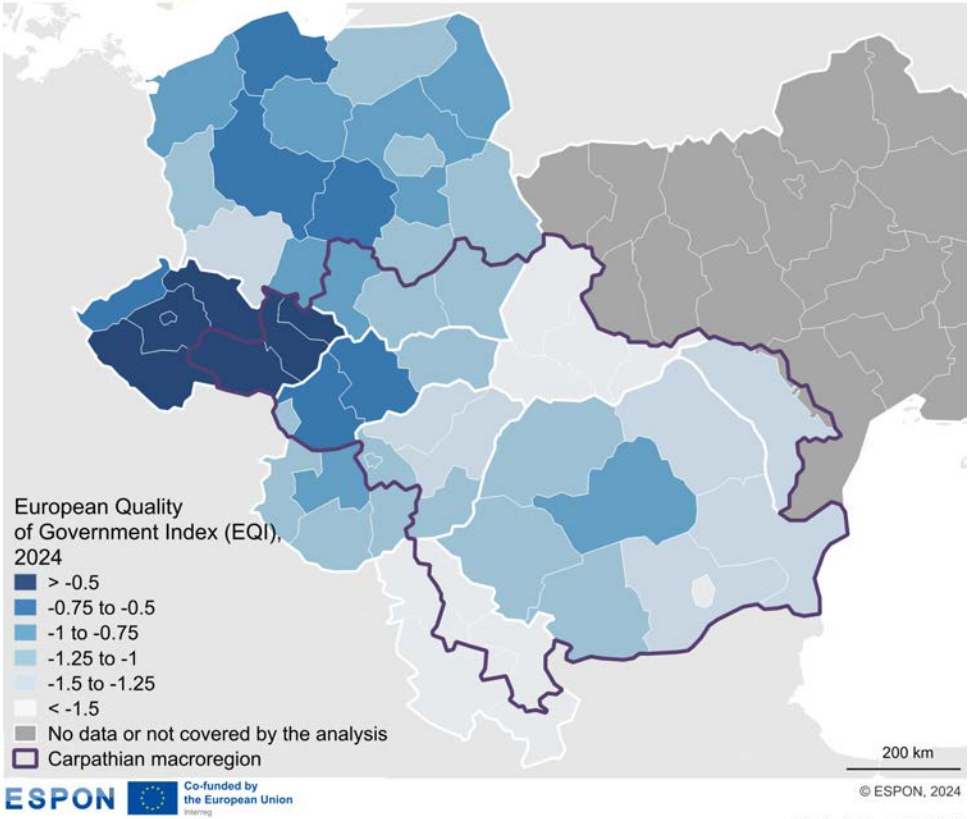
Map 93. Change in regional aid cellings and area of 5 largest business parks, 2011-2023



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: European Commission,
National and regional websites on business parks
© EuroGeographics for administrative boundaries

Map 94. European Quality of Government Index (EQI), 2024



* based on citizens' perception of health, education and policing

Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT; Estimations for UA, RS and MD; estimations for RS and UA based on Corruption Index at country level
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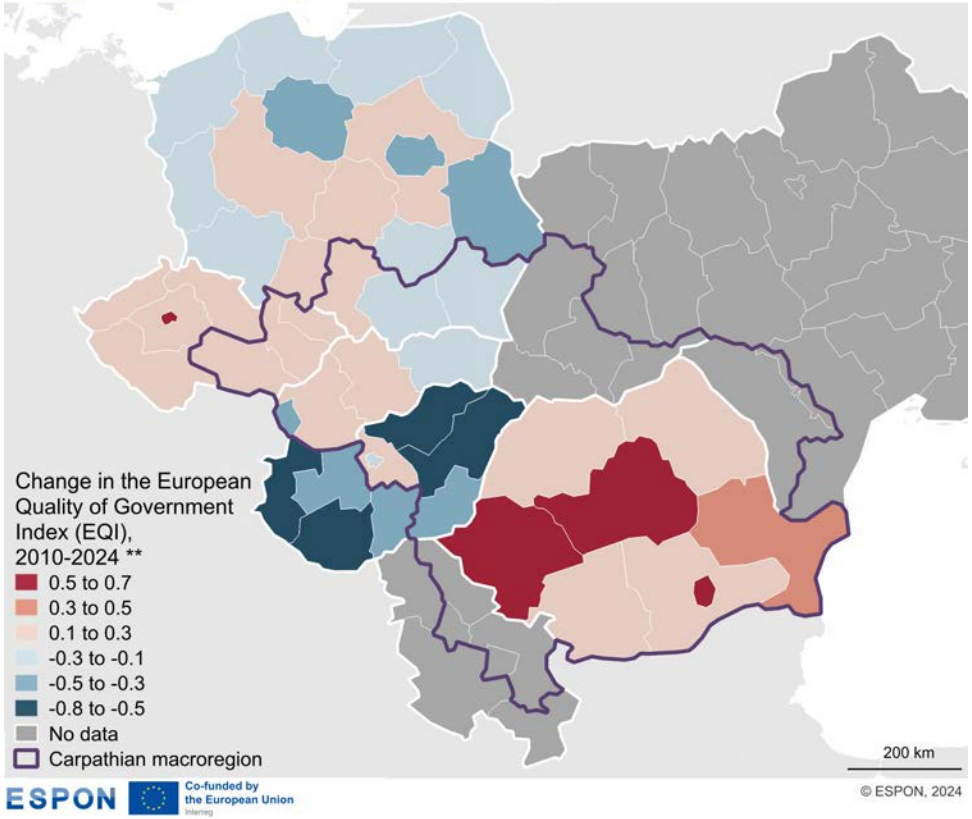
Map 95. Change of Quality of Government Index 2000-2024



* based on citizens' perception of health, education and policing
** comparison between periods 2000-2013 and 2021-2024

Territorial level: NUTS 2
Source: ESPON KARPAT, 2024
Origin of data: EUROSTAT; No data for MD, UA and RS
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3

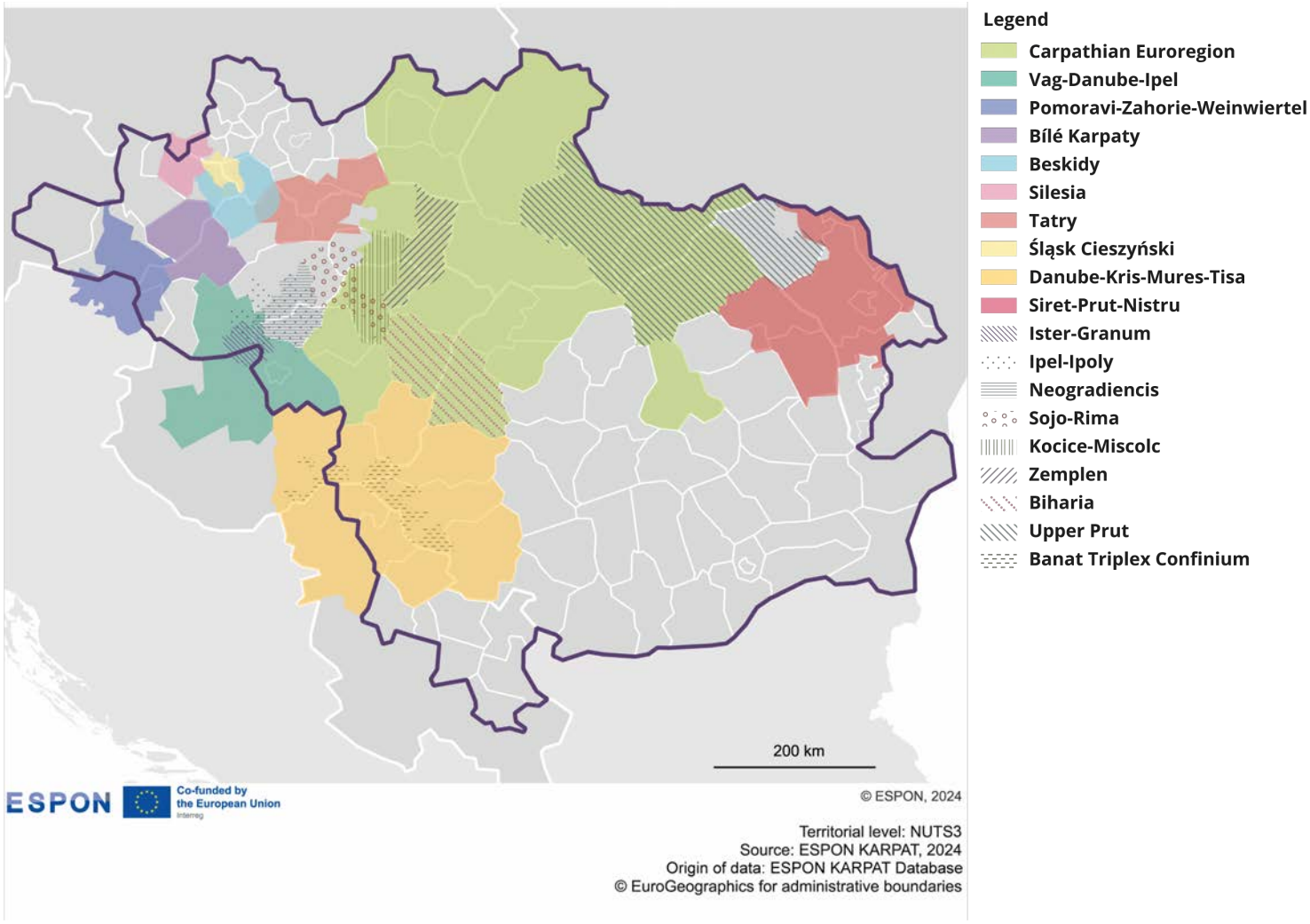
Territorial cooperation: structures and practices

3.1 Cooperation structures

Euroregions

The majority of Euroregions located in the Carpathian area have a bilateral cross-border form of cooperation. Out of 19 Euroregions 12 (63%) cover territories from two member states and 6 (31%) Euroregions integrate 3 member states. Carpathian Euroregion is the only one, which is the largest and the longest operating structure located across the borders of 5 countries including Poland, Ukraine, Slovakia, Hungary, and Romania. Although the Carpathian Euroregion has developed professional cross-border governing bodies across local, supra-local and sub-states levels, the spatial stretching between 19 regional units in 5 countries reaching over 500 km distances causes many challenges in multilateral contacts.

Map 96. Euroregions in the Carpathian macroregion, 2024

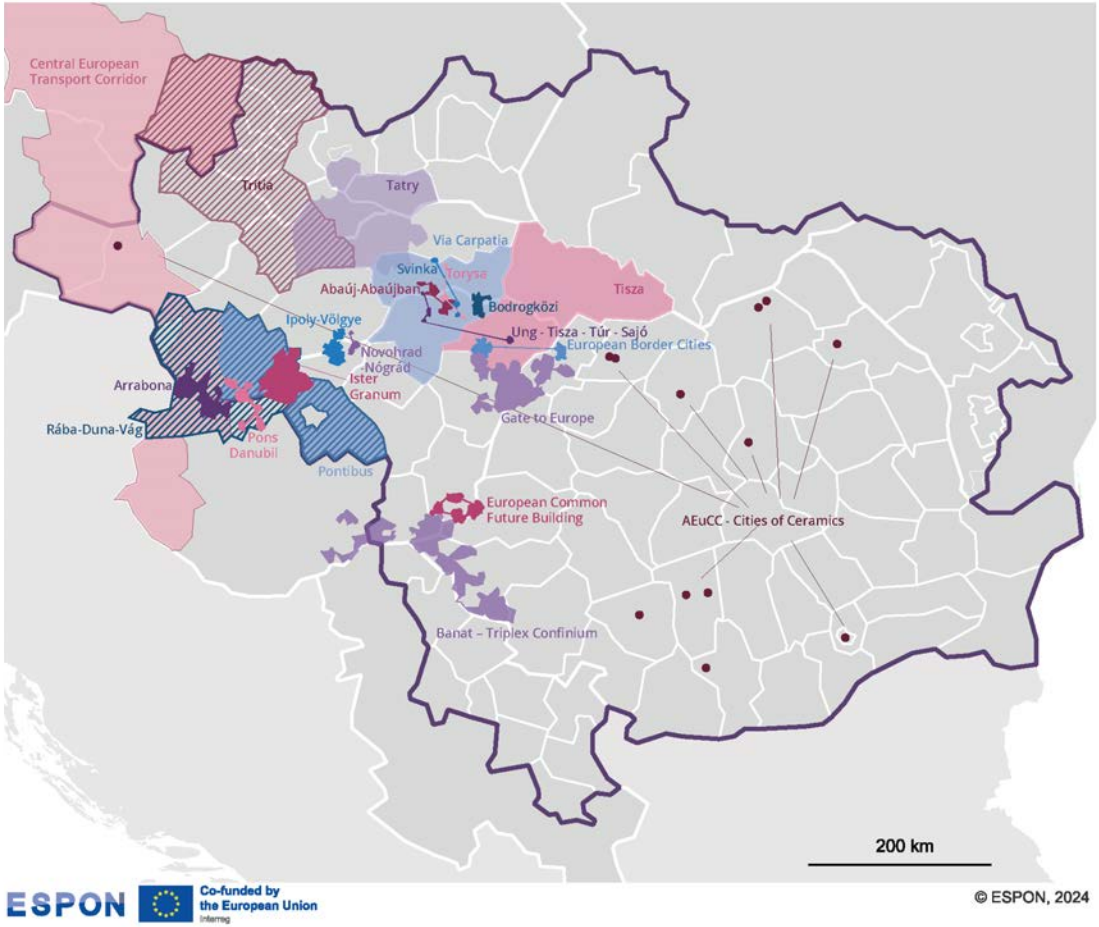


European Groupings of Territorial Cooperations (EGTC)

The territorial spread of EGTC in the Carpathian countries is largely associated with cultural and historical background of cooperating municipalities. However, the financial support provided by the European institutions is a very important trigger of EGTC proliferation. By 2023 in the Carpathian macroregion 29 EGTCs have been created. The dynamic of EGTC formation shows that this process started in 2008, when the first 2 EGTC (Tatry, Ister-Granum) were established by converting Euroregions into an EGTC formula.

One of the main goal of EGTCs created in the Carpathian area is to reduce economic and geographic marginalisation by developing infrastructural, cultural, economic, and environment initiatives. This scope of goals largely correlates with the main areas of cooperation declared by the majority of EGTC located in the Carpathian macroregion.

Map 97. European Groupings of Territorial Cooperations (EGTC) in Carpathian macroregion, 2024

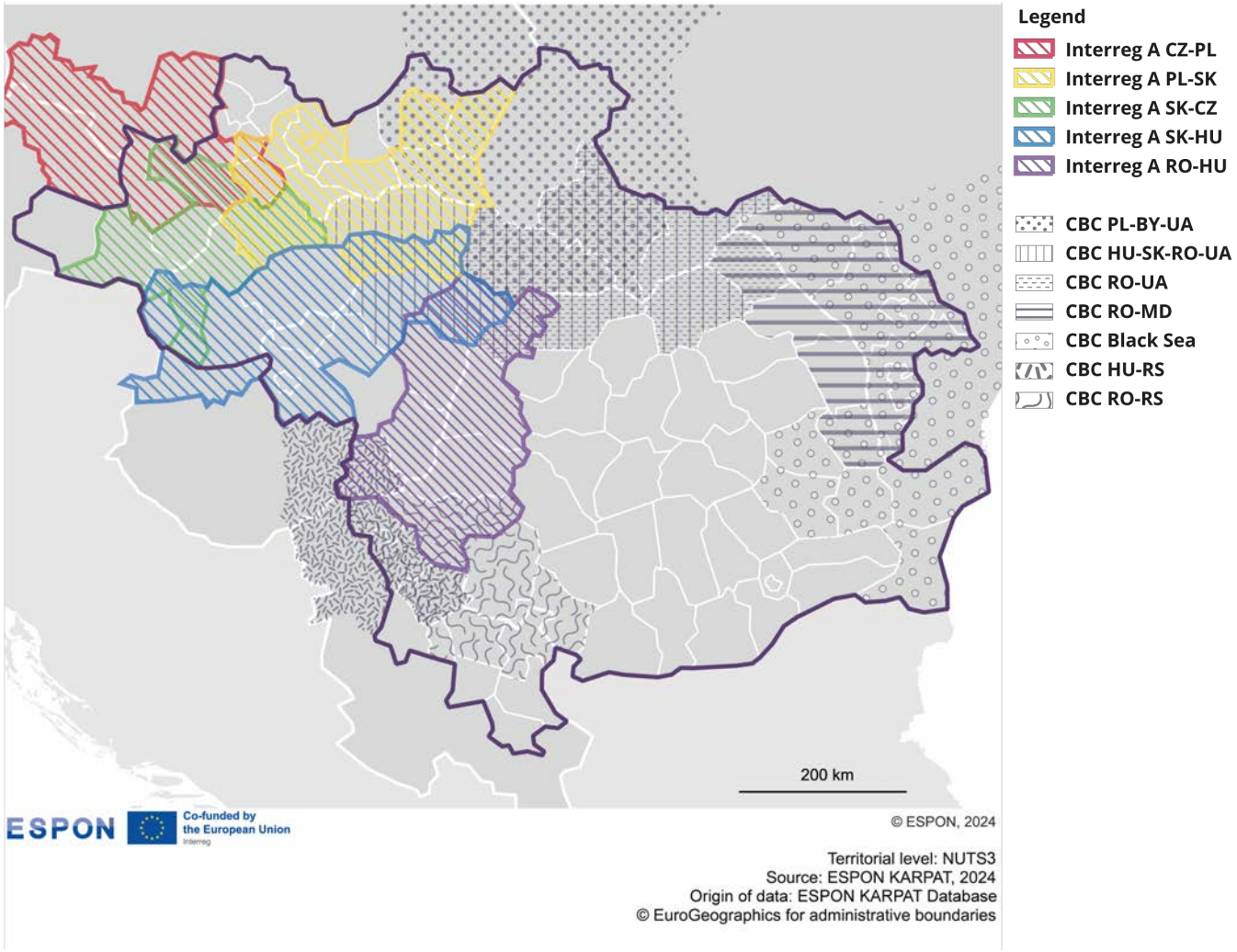


Interreg CBC programs

Interreg programmes offer a range of frameworks in multi-level governance bringing together actors from the public, private and NGO sectors. Map 98 reveals a complex and interconnected network of eligible areas with 5 Interreg A programmes between EU member states and 7 Interreg CBC programmes covering also candidate countries like Ukraine, Serbia and the Republic of Moldova. Interreg programmes are mportant triggers of cross-border consolidation in the Carpathian macroregion.

On the other hand, this map highlights the need for territorial cooperation programs in the regions that are are not eligible for CBC programmes, especially south-eastern parts of Carpatian mountains.

Map 98. Interreg cooperation structures in Carpathian macroregion, 2014-2020

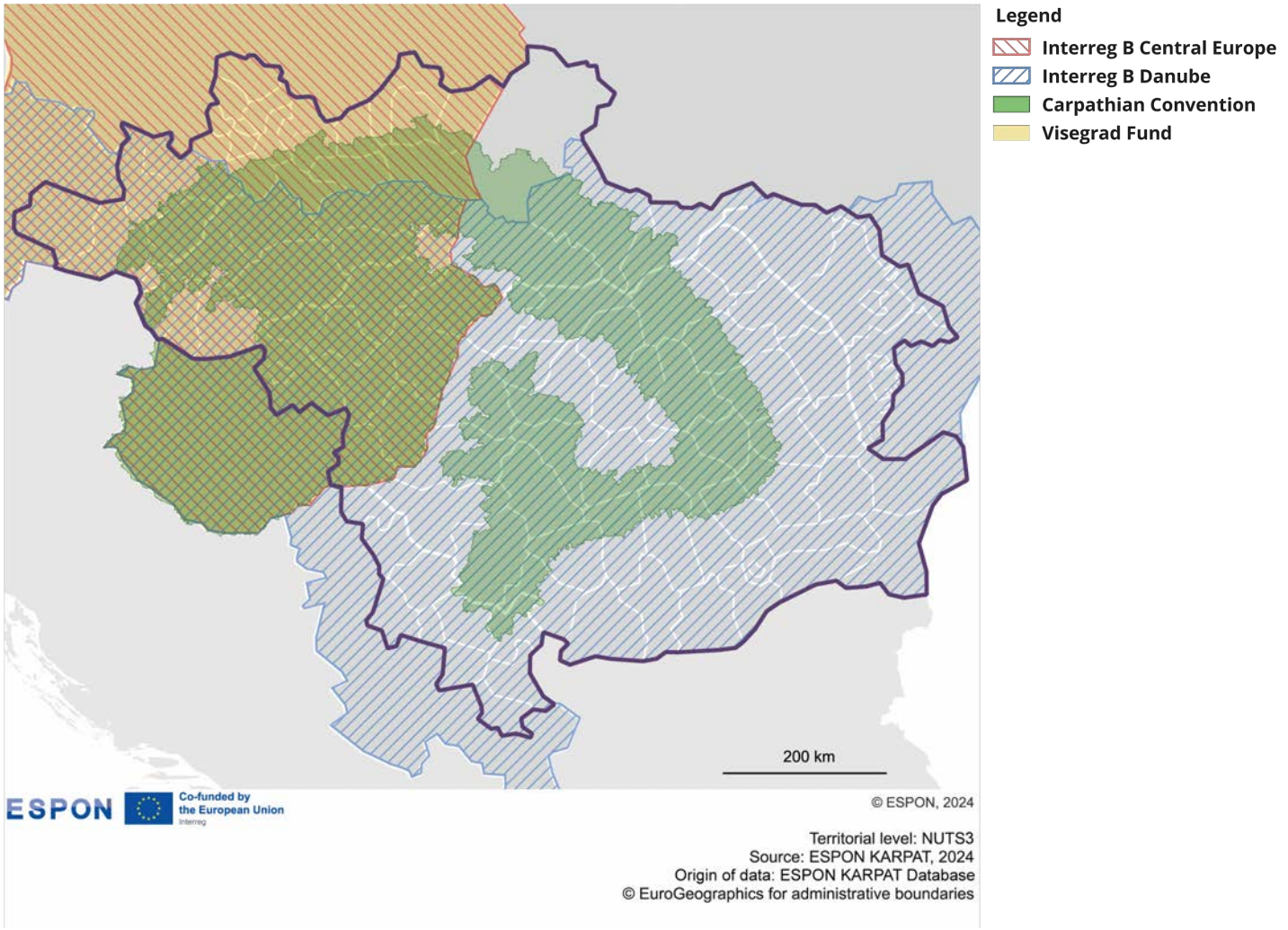


Transnational level

Interreg programs transnational strand B are crucial instruments for transnational cooperation in the Carpathian macroregion. They allow large entities without joint borders to work together and develop networks of cooperation. There is no unified program that would include the whole Macroregion. Interreg Central Europe unites the northwestern regiona and overlaps with the Visegrad Fund. Interreg Danube integrates the southeaster regions, however, excludes Polish partners and Lviv region. This division weakens the potential for cooperation, especially in relation to the specificity of mountain areas.

International Visegrad Fund (IVF) was established in 2000 by Czechia, Slovakia, Hungary, and Poland (V4 countries) and is governed by Ministers of Foreign Affairs of the V4 countries. Carpathian Convention is a multilateral environmental agreement signed in 2003 and ratified in 2006 by seven countries of the Carpathian Mountains, i.e. Czechia, Slovakia, Poland, Hungary, Romania, Serbia, and Ukraine.

Map 99. Transnational programs and initiatives in the Carpathian macroregion, 2014-2020



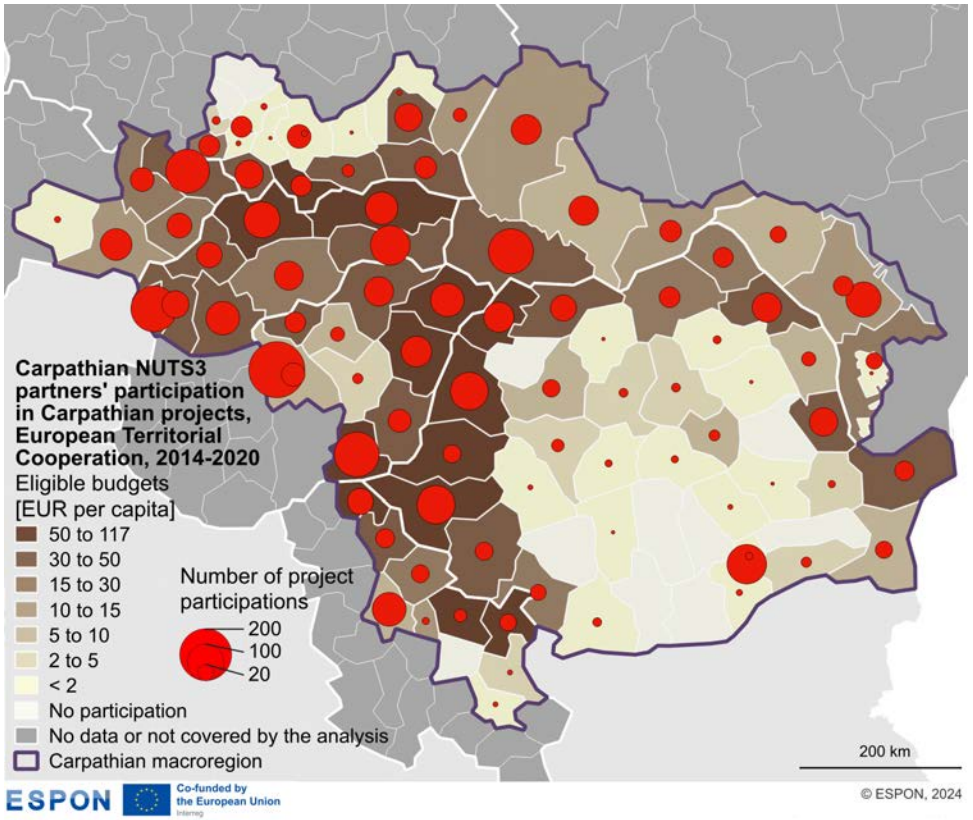
3.2 Cooperation practices

Interreg programmes

The total expenditure of the Carpathian projects (all project partners) amounted to about 1,76 billion EUR (with about 1,47 billion EUR of the EU funding). The share of the Carpathian NUTS3 partners in the eligible budget accounted for around 1,27 billion EUR (87% of this sum coming from CBC projects, 11% from trans-national and around 1,6% from interregional projects as they involved more partners from outside the Carpathian macro-region). Throughout the programming period, some regions received support exceed-ing EUR 30 per capita, particularly along the Romanian-Hungarian and Polish-Slovak borders, as well as in selected areas of the Romanian-Serbian border. Although such calculated support was lower in the case of Ukrainian and the Republic's of Moldova regions, it is important to note that, given the lack of access to other European funds and the lower level of economic development (and public investment), this funding could have been crucial for the development of cross-border cooperation and regional economies.

CBC projects (Interreg A) were the most common type of project, accounting for around 79 % of Carpathian projects (1069 projects for the amount of 1,02 billion EUR, 69% of total EU funding), followed by transnational projects (Interreg B) (15% of projects - 209 projects, 25% of total EU funding) and interregional projects (Interrrg C) (83 projects, 6% of projects and total EU funding). The high share of CBC projects in cooperation can be seen on the map (Map. 106), which shows a higher intensity of collaboration along all national borders (e.g. well visible in Romania). This is related to eligibility criteria that prefers support for beneficiaries located in the direct vicinity to the border (NUTS3 region). For transnational and interregional projects, national capitals stand out in terms of the number of project partners that is visible, especially in the case of Budapest and Bratislava.

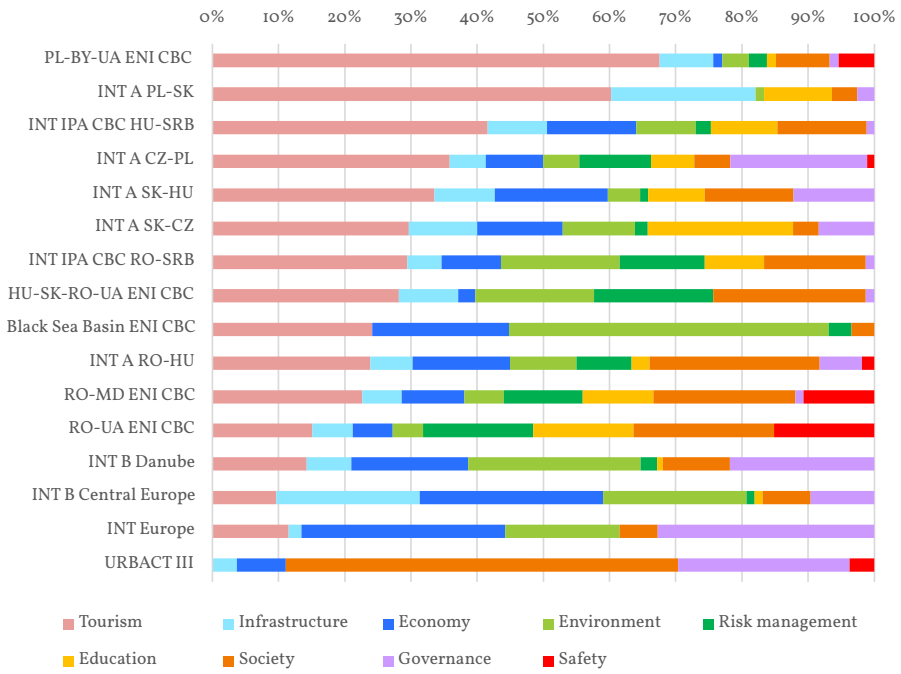
Map 100. Project participations and budgets shares of Carpathian projects, 2014-2020



Themes of cooperation

The most significant number of Carpathian projects and the largest part of the budget were dedicated to the theme of tourism. Projects in the thematic areas of society and economy were the next most numerous. Projects in the thematic areas of infrastructure, safety, and environment were the most expensive in terms of average EU funding per project. The part of projects dedicated to tourism accounted for more than half of the Carpathian projects in some programmes. However, there were also initiatives with a larger share of the social, environmental, or economic areas (while the projects within the ESPON programme focused on governance issues).

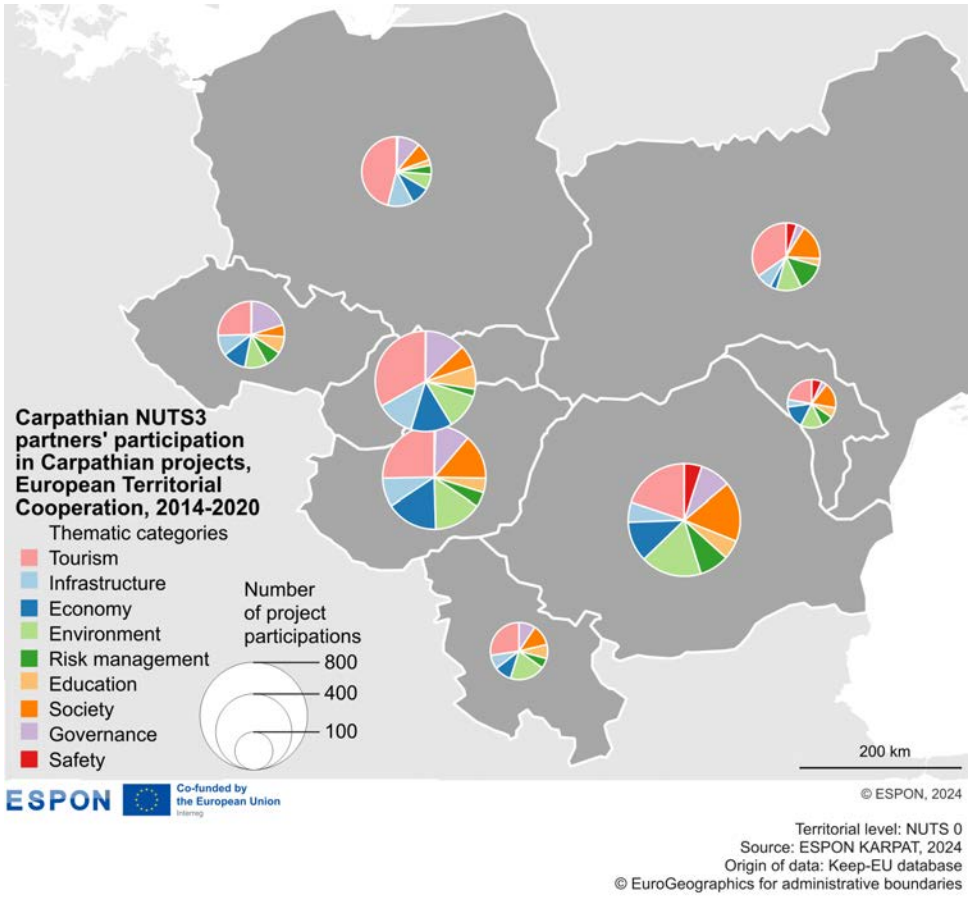
Fig 10. Thematic areas of Carpathian projects in Interreg programmes, 2014-2020



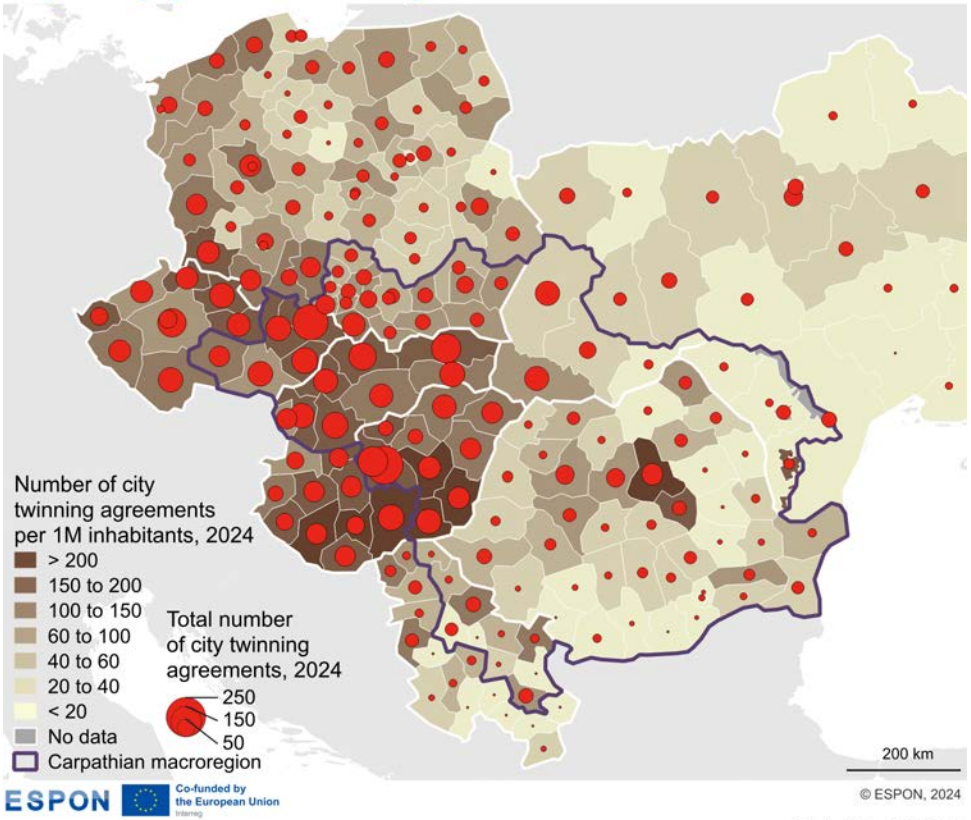
Source: own elaboration based on keep.eu

* Programmes with less than 5 projects were excluded from the chart.

Map 101. Carpathian Projects thematic categories by countries, 2014-2020



Map 102. City twinning agreements breakdown by NUTS3 regions, 2024



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: Based on Wikipedia Web Scraping
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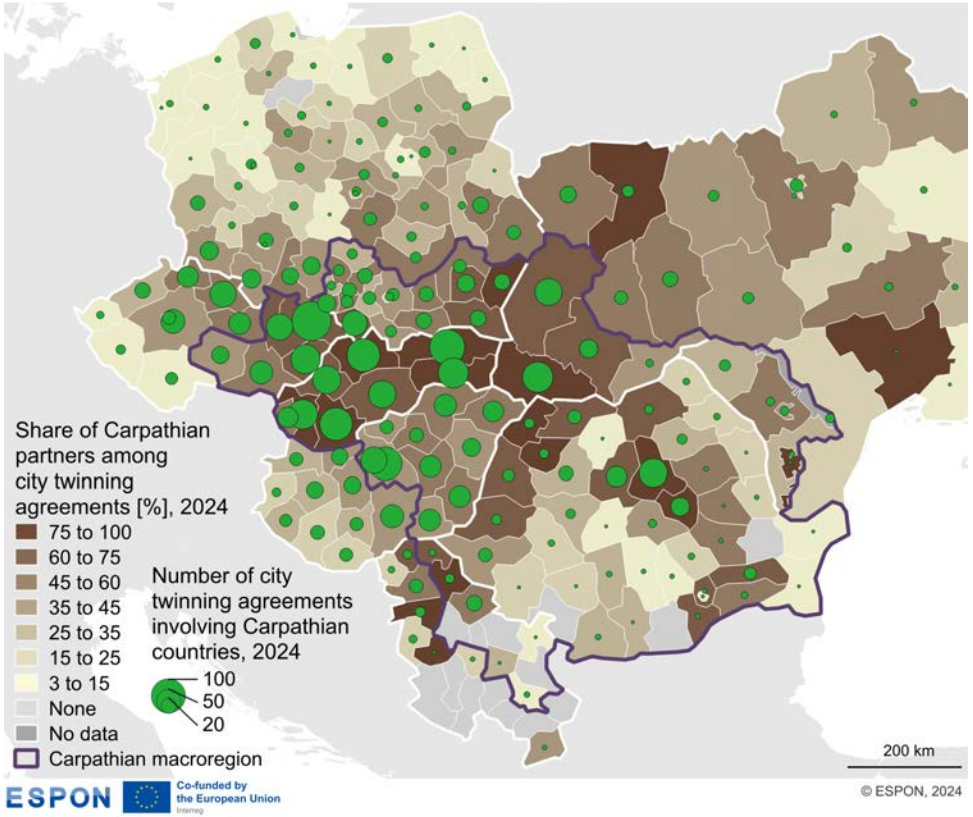
Map 103. City twinning agreements within the Carpathian countries, 2024



Territorial level: NUTS 3
Source: ESPON KARPAT, 2024
Origin of data: Based on Wikipedia Web Scraping
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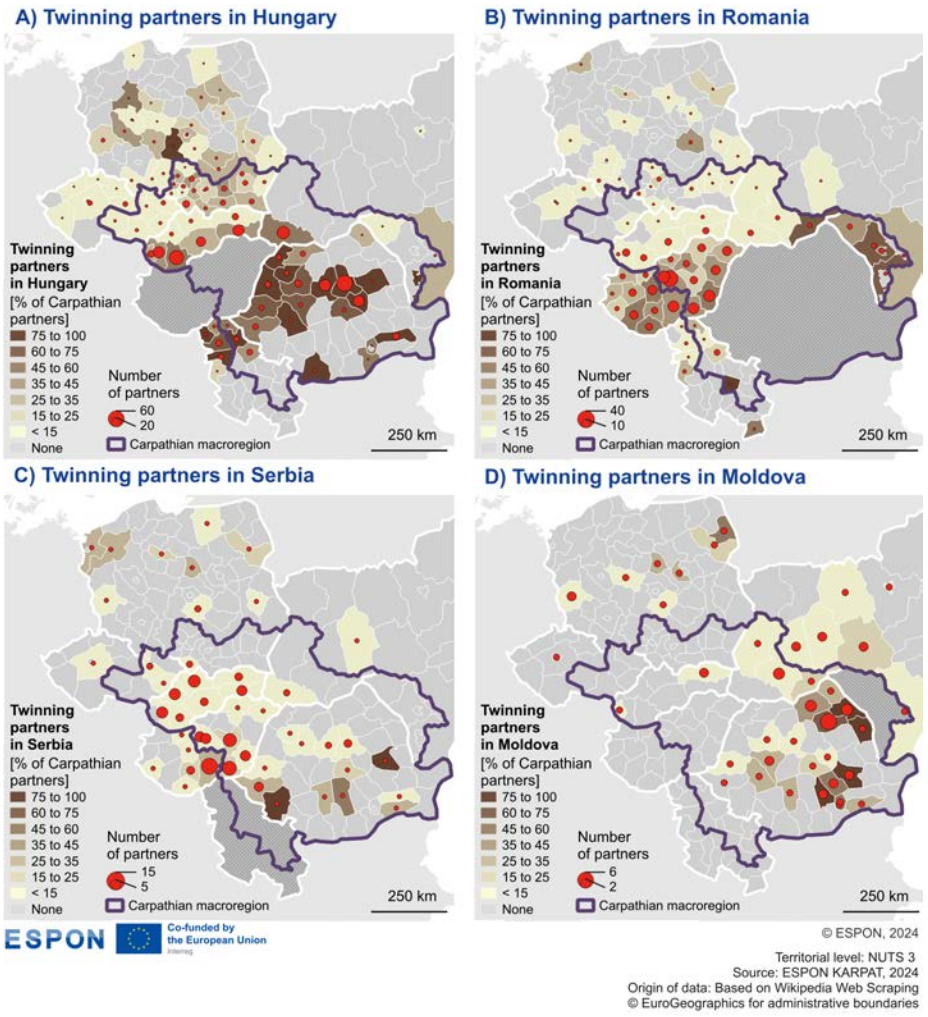
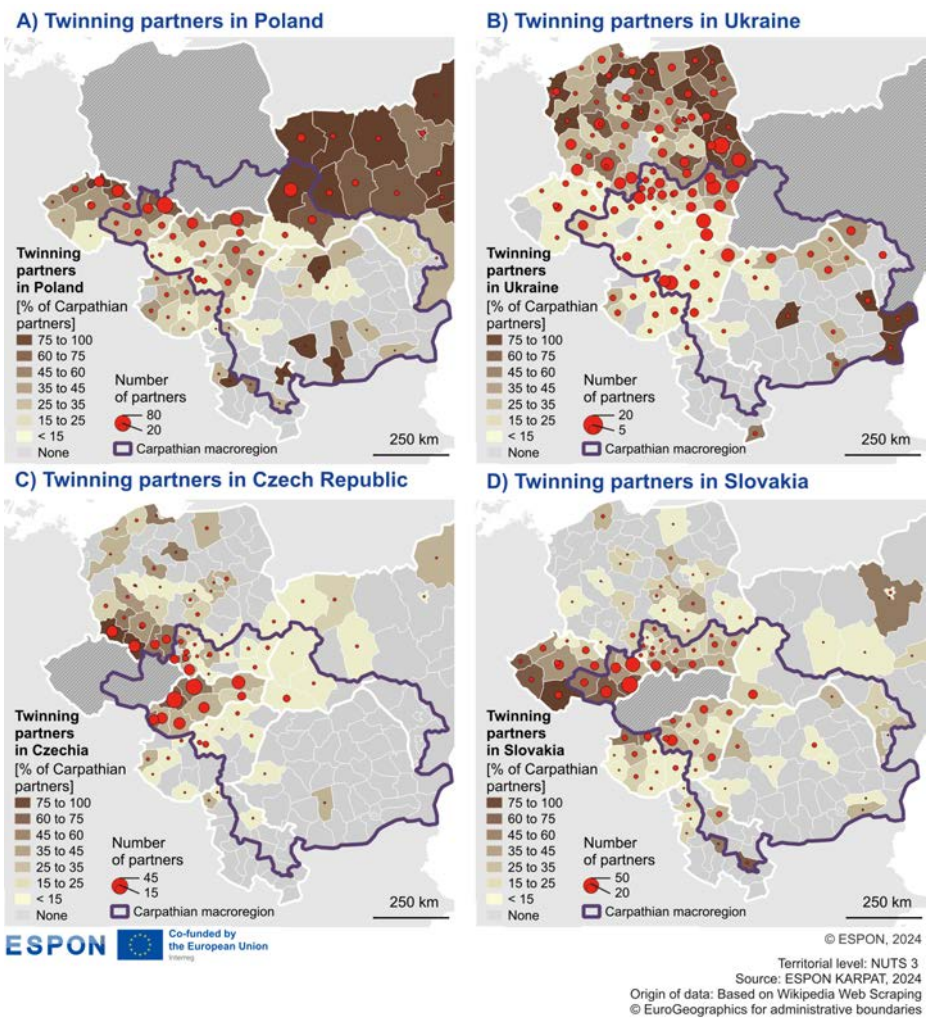
Map 104. City twinning agreements within each of the Carpathian countries, 2024



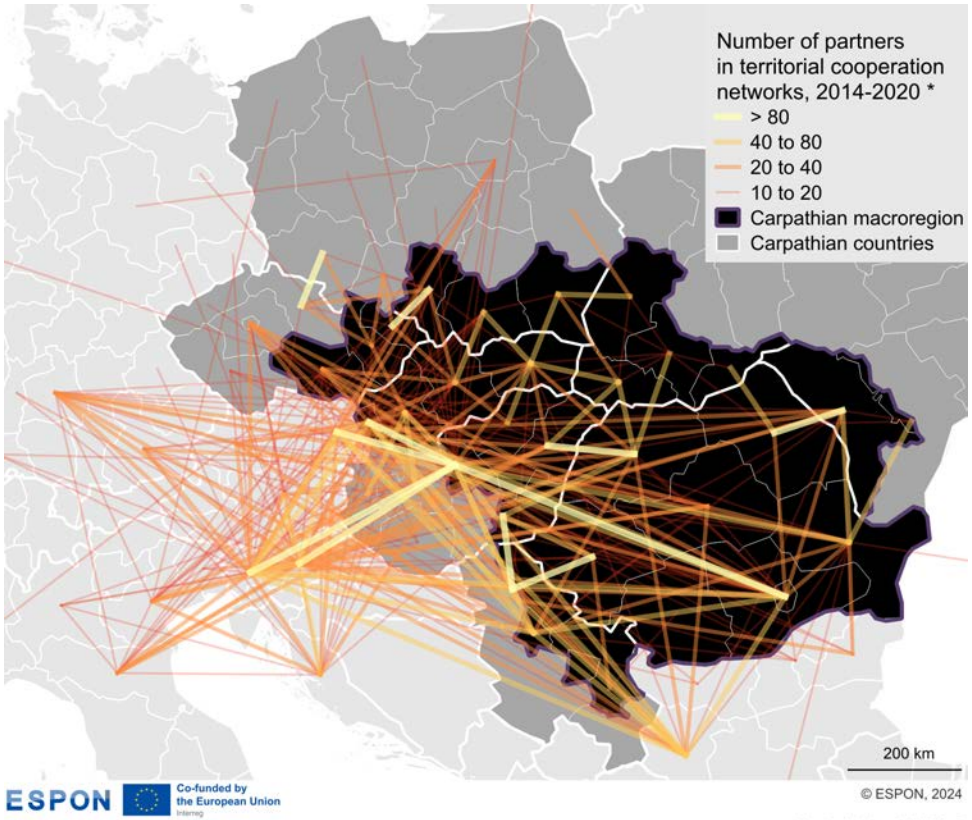


Networks of cooperation

Budapest, Bratislava, Bucharest-Ilfov are dominant collaboration hubs in the Carpathian macroregion with strong connections to the nearby Vienna. These regions serve as central nodes with high numbers of connections as major drivers of regional cooperation. Del-Alföld, Nord-Vest, and Vest also exhibit strong connectivity, acting as secondary hubs that link peripheral regions to the core network. The collaboration network is strongest in the central and western parts of the macroregion, particularly in Hungary, Slovakia and Romania. Eastern and southeastern parts have weaker participation in projects (e.g., Ukraine, the Republic of Moldova and peripheral Romanian regions). There are strong cross-border connections, particularly between Hungary, Slovakia, Romania, and Serbia. This network reflects a highly interconnected and clustered system with strong collaborative dynamics.

The network is densely connected in the core, indicating a strong level of collaboration among central regions, while peripheral regions have fewer and weaker connections. The absence of directionality in the edges suggests mutual collaboration rather than dominance or unilateral influence. On average each region is connected to 20 others suggesting robust connectivity and active participation in partnerships. The modularity score of 0.357 shows moderate community structure, with distinct clusters of regions collaborating though inter-cluster links, significant for broader integration. The high clustering coefficient (0.806) demonstrates a high level of local interconnectedness, with over 80% of a region's neighbours also collaborating with each other. This suggests strong local partnerships and cohesive regional clusters.

Map 105. Territorial cooperation networks in Carpathian macroregion and beyond, 2014-2020



4

Annex

Map number	Map title	Methodology note	Page
5.	Protected areas in NUTS3 regions, 2023	Protected areas are the main policy tool for the protection of natural environments and biodiversity, as well as the subject of key policy targets, including the UE Biodiversity Strategy for 2030 aim of putting 30% of EU's land and sea areas under protection. Protected areas have varying levels of protection, as represented by the IUCN typology. Class I & II of the 6-class IUCN typology are two of the most strict protection regimes that are most effective in biodiversity protection. At the sime time, these two classes are aligned with the EU Biodiversity Strategy for 2030 goal of putting under strict protection at least 10% of the EU's land and sea areas. Calculated as: the sum of non overlapping land protected areas of IUCN class I or II in region i.	17
6.	Biodiversity hotspots in Natura 2000 protected sites, 2023	The Natura 2000 network is a coordinated EU-wide system of protected areas aimed at conserving Europe's most valuable and threatened habitats and species under the Birds and Habitats Directives. On average, Natura 2000 sites cover 20.0% of NUTS 3 regions in the Carpathian area – slightly above the EU-wide average of 18.6%. Biodiversity hotspots are regions with exceptionally high levels of species richness that are also under significant threat from human activities. They are critical for conservation efforts at larger spatial scales, because they provide a refuge for species most at risk of extinction. The 15 major biodiversity hotspots are located mostly in Slovakia and Romania (six sites in each country). The value of a given Natura 2000 site for conservation of the species concerned was translated to numerical value according to the following formula: excellent = 3, good = 2, significant = 1, population not significant or non-existent = 0. The final index for each site was calculated as a sum of individual assessments for 5 species, i.e. : Rosalia Alpina, Canis Lupus, Aquila chrysaetos, Dicranum viride, and Bombina variegata. Scores ranged from 0 to 15, with 15 denoting that the site achieved the excellent conservation value rating for all five species.C12	17
7.	Air pollution, 2023	Air pollution is the leading environmental health risk in Europe, with the fine particulate matter PM2.5 having the widest negative impacts - translated to over 100 thousands premature deaths attributed to its excessive levels in Czechia, Hungary, Poland, Romania, Slovakia and Serbia combined. The revised WHO air quality guidelines recommended that the annual average PM2.5 concentration should not exceed 5 $\mu g/m^3$ to ensure a safe and healthy environment. The actual PM2.5 levels in the Carpathian region range from 10 to 30 $\mu g/m^3$. Calucalted as the maximum PM2.5 annual average concentration reported for a grid cell falling within the region i. Based on satellite-derived PM2.5 annual concentration data, assessed in the 0.01° × 0.01° grid for the entire world. The V5.GL.04 model of the Atmospheric Composition Analysis Group was used, and the 2022 data.	18
8.	Agriculture land use, 2018	Land use reflects the importance of various types of agricultural activities. The share of arable land indicates the potential significance of cereals farming systems. The high share of meadows and pastures may point to well-developed animal husbandry. The high share of vineyards highlight the wine industry's presence and potential for wine tourism. The high share of orchards suggest potential relevance for agri-food industries based on fruit harvesting.	19
9.	Livestock population, 2022	High bovine density, inculuding dairy cows, usually reflects intensive milk production, specialised and mechanised farming, high forage demand, and strong links to the dairy industry.High sheep density is typically linked to extensive farming on marginal lands, use of poor pastures, traditional grazing practices, and low market orientation with mostly local or subsistence production.	20
10.	Mineral extraction sites, 2018	A high share of mineral extraction sites may indicate a strong presence of extractive industries, resulting in significant land transformation and the emergence of post-industrial or transitional landscapes.	21
11.	Forest cover, 2023	The size of the forest cover indicates the prevalence of forest-based ecosystems services, both direct and indirect (i.e. supporting services), with a key role played for maintaining biodiversity and providing space for primary productivity. The indicator in the region varies significantly, with the most forested areas reaching over 50% of the forest cover. The least forested regions are located mostly outside of the core Carpathian area, or in the vicinity of major urban centres (Kraków, Bratislava).	22
12.	Tree cover change, 2000-2020	The net tree cover change shows the change in areas suited for providing forest-based ecosystem services over the 2000-2020 period. Forest areas are expanding most rapidly in regions with low initial forest cover (the low base effect) outside the Carpathian core, mostly in Hungary and southeastern Romania. Conversely, a decline in forest cover is affecting Slovakia and Czechia.	22
13.	Energy production by source, 2023	The electricity mix is a crucial indicator of the transformation of energy systems towards sustainability, allowing to analyze the utilization of various types of fossil fuels and renewable sources of energy. High share of coal translates to high carbon intensity of economy, which is the case of Poland, Serbia, but also natural gas-reliant Moldova. The transition to renewable sources is the most advanced in Romania (42% of electricity production derived from renewables) and Serbia, i.e. the countries with large hydropower.	24
14.	Electric energy production: power plants and renewable energy potential, 2023	The map shows the distribution and capacity of existing power plants—coal, gas, hydro, nuclear, and wind—alongside the untapped renewable energy potential across the NUTS3 regions. It reveals a concentration of high-capacity fossil fuel power plants in the northern part of the Carpathian macroregion, while regions in the southeast show the highest renewable energy potential, based mainly on the opportunities for the solar PV installations in the rural areas.	24

Map number	Map title	Methodology note	Page
15.	CO2 emission from fossil sources, 2023	The map presents annual per capita CO_2 emissions from fossil fuel sources across the Carpathian macroregion, calculated using a 0.1° x 0.1° emission grid and aggregated to NUTS2 regions. The regional average stands at 5.1 tons of CO_2 per capita—about two-thirds of the EU-27 average. The data reflects only production-based emissions and thus exclude carbon embedded in interregional trade flows.	25
16.	Share of population exposed to harmful climate impacts, 2023	The map illustrates projected human exposure to climate extremes by 2050 under a 2°C global warming scenario, highlighting the varying risks of flooding, storms, water stress, and wildfires across the region. The most vulnerable areas—particularly in Hungary and southern Romania—face heightened exposure due to water scarcity	25
17.	Potential Functional Urban Areas, 2022	Potential Functional Urban Areas (FUAs) can be defined as zones of influence surrounding a central city, based on the distance of municipalities from the urban core. The larger the city, the wider its functional reach, reflecting commuting patterns, service access, and economic linkages.A classification of Potential Functional Urban Areas (FUAs) based on the total population of both the urban core and its surrounding zone of influence reflects not only the demographic scale but also the potential functional role of each area, such as the capacity to perform metropolitan, regional, or subregional functions. The underlying assumption is that the greater the combined population, the broader the functional reach and the more complex the urban functions.The classification of PFUA polycentricity reflects internal spatial structure, using the share of the core city in the overall PFUA population as a proxy for urban concentration.	26
18.	Role of cities and functional urban areas in settlement system, 2021	The role of the largest PFUA within the regional settlement system was illustrated by its share in the total population of the given region. This indicator reflects the concentration of population and urban functions, with a higher share indicating a dominant role of the PFUA in shaping regional development patterns, service provision, and spatial organisation.Share of population in local territorial units with more than 10,000 inhabitants in the total population of a given region is used as a proxy for the level of urbanisation. Number of local territorial units with more than 10,000 inhabitants per 1,000 sq km; serves as an indicator of the spatial density of significant population centres and the intensity of urban settlement patterns within a region.	27
19.	Location of airports and passenger traffic, 2023	The annual number of passengers carried (including departures and arrivals) retrieved from Eurostat's ""Air passenger transport by type of schedule, transport coverage and main airports (avia_paoa)"" database. Where unavailable at Eurostat, data sourced from Wikipedia (based on national or airport-level statistics). Passengers carried: all passengers on a particular flight (with one flight number) counted once only and not repeatedly on each individual stage of that flight. All revenue and non-revenue passengers whose journey begins or terminates at the reporting airport and transfer passengers joining or leaving the flight at the reporting airport. Excludes direct transit passengers. Airport locations from https://github.com/mborsetti/airportsdata	28
20.	Airport accessibility by car, 2004-2023	Airport accessibility index (AAI) was calculated for each LAU centroid based on the driving distance to 5 closest airports (using roads dataset from RRG for 2004, 2014, 2024) and airport attractiveness measured as the number of passengers served in 2004, 2014, 2024 sourced from EUROSTAT and Wikipedia. The decay of attractiveness with increasing distance is modelled with an exponential function (based on method from Rosik).	29
21.	Railway network, 2024	Map shows lines under the management of national railway infrastructure managers	30
22.	Density of railway network, 2024	Network density illustrates the level of infrastructure development and accessibility. Calculated as: length of railway lines divided by area of NUTS3.	31
23.	Intermetropolitan connectivity by train, 2024	This indicator measures intermetropolitan connectivity by road within the Carpathian macroregion, based on average travel speed between selected urban centres. It is calculated as the ratio of road distance to estimated car travel time, reflecting the efficiency of road infrastructure and accessibility for individual motorised transport. In the accompanying map visualisation, the width of lines connecting cities is proportional to their gravitational interaction—calculated using the combined population of each city's PFUA and the distance between them. This approach highlights not only physical connectivity but also the potential intensity of functional relations between metropolitan areas.	32
24.	Interborder connectivity by train, 2024	The map shows the number of train connections crossing the border daily, divided into long-distance and regional traffic. The map shows the location of railway border crossings with the number of connections served, broken down into long-distance and regional traffic.	32
25.	Transcarpathian rail accessibility, 2024	The map shows schematically the sections of railway lines connecting towns on the opposite side of the mountain chain and the commercial speeds of the trains determined by the running time and the length of the railway line and straight line distance.	33
26.	Road infrastructure,2004-2023	This map illustrates the development of road infrastructure in the Carpathian Macroregion between 2004 and 2023, with a focus on motorways and expressways	34

Map number	Map title	Methodology note	Page
27.	Density of road network, 2023	This indicator reflects the density of high-capacity road infrastructure within a given region, expressed as the total length of motorways and expressways per 1,000 km². It serves as a proxy for transport accessibility and infrastructure development, particularly in terms of regional connectivity and mobility potential. Higher values indicate a greater intensity of investment in road infrastructure and improved conditions for interregional flows of people and goods. This indicator captures the overall density of the main road network within a region, including motorways, expressways, primary and secondary roads. It is expressed as the total length of these roads per 1,000 km² and reflects the general availability of road infrastructure, with implications for regional accessibility, local mobility, and spatial connectivity. Higher values suggest a more extensive and potentially better-integrated road network supporting economic and social interactions across the territory.	35
28.	Intermetropolitan connectivity by car, 2024	This indicator measures intermetropolitan connectivity by road within the Carpathian macroregion, based on average travel speed between selected urban centres. It is calculated as the ratio of road distance to estimated car travel time, reflecting the efficiency of road infrastructure and accessibility for individual motorised transport. In the accompanying map visualisation, the width of lines connecting cities is proportional to their gravitational interaction—calculated using the combined population of each city's PFUA and the distance between them. This approach highlights not only physical connectivity but also the potential intensity of functional relations between metropolitan areas.	36
29.	Transcarpathian road accessibility, 2024	This indicator measures intermetropolitan connectivity by road across the Carpathian macroregion, focusing on selected pairs of cities located on opposite sides of the Carpathian mountain chain. It is calculated as the ratio of road distance to estimated car travel time, providing insight into the effectiveness of transboundary road infrastructure and cross-mountain accessibility for individual motorised transport. It is calculated as the ratio of euclidean distance to estimated car travel time, providing insight into the effectiveness of transboundary road infrastructure and cross-mountain accessibility for individual motorised transport.	37
30.	TEN-T network in Europe, 2024	This map presents the spatial layout of the Trans-European Transport Network (TEN-T) in Carpathian macroregion, encompassing both the core and comprehensive network layers. It visualises major corridors and infrastructure components—road, rail, inland waterways, ports, and airports—that are strategically designated to strengthen connectivity, territorial cohesion, and economic integration within the EU and neighbouring countries. The map highlights the geographic coverage of the TEN-T network and the role of key urban nodes and cross-border links in supporting transnational mobility and the functioning of the market.	38
31.	National road freight transport loadings, 2022	This map ilustrate the size and intensity of road freight transport in relation to the population size of a given region. It is calculated as the volume of freight loaded onto road transport vehicles (in thousand tonnes) per capita. The indicator provides insight into the economic profile of a region, particularly the scale of production, logistics activity, and transport demand generated locally. Higher values suggest greater freight-generating capacity and a stronger role in national supply chains.	39
32.	National road freight transport loadings - change, 2018-2022	This indicator measures the relative change in the volume of national road freight transport loadings over the period 2018–2022. It reflects the dynamics of freight-generating activity at the regional level and serves as a proxy for economic shifts, production trends, and changes in logistics intensity. Positive values indicate growth in road-based freight movements, while negative values may signal industrial decline, modal shifts, or economic restructuring.	39
33.	UNESCO heritage objects and their recognisability, 2024	This map illustrates the density of UNESCO World Heritage Sites across the Carpathian region, normalized per 10,000 square kilometres. By accounting for spatial distribution rather than raw counts, this indicator highlights regions with a particularly high concentration of globally recognised cultural heritage. Such density serves as a spatial proxy for international cultural visibility and heritage richness relative to territory size, offering insight into territorial patterns of global cultural value designation.	40
34.	Selected heritage sites related to defensive architecture and their recognisability, 2024	This indicator displays the density of selected heritage sites related to defensive architecture, such as castles and fortifications, per 1,000 square kilometers. This map presents a selection of the most significant historical heritage sites in the Carpathian region, including castles, selected palaces (often built upon or inspired by earlier fortifications), and other prominent defensive structures. The selection was based on web scraping techniques, using the number of online reviews as a proxy for public recognition and cultural value. These sites, dispersed throughout the Carpathians, reflect centuries of political, military, and cultural transformations in Central and Eastern Europe. This approach offers a data-driven perspective on cultural landscape patterns and the spatial visibility of heritage across the macroregion.	41
35.	Tourist arrivals, 2019	This indicator reflects the intensity of tourist activity in relation to the resident population of a given region. It measures the number of arrivals at tourist accommodation establishments per 1,000 inhabitants, providing insight into the role of tourism in the local economy and the pressure it may exert on public services and infrastructure. Higher values indicate regions with significant tourism flows relative to their population size, often corresponding to attractive natural, cultural, or recreational destinations.	42
36.	Change in number of nights spent at tourist accommodation establishments, 2012-2023	This indicator shows the relative change in the number of nights spent at tourist accommodation establishments. It reflects the growth or decline in overnight tourism activity prior to the COVID-19 pandemic. The indicator serves as a proxy for the dynamics of tourism development in a region, highlighting trends in demand, attractiveness, and the evolving role of tourism in the local economy. It also reflects the impact of the COVID-19 pandemic and the subsequent recovery or transformation of tourism activity in the region. The indicator helps assess the resilience and adaptation of local tourism sectors in the face of external shocks and shifting travel behaviours.	43

Map number	Map title	Methodology note	Page
37.	Tourist accommodation capacity, 2022	This indicator represents the capacity of the tourism sector in relation to the resident population, expressed as the number of bedplaces available in tourist accommodation establishments per 1,000 inhabitants. It serves as a proxy for the level of tourism infrastructure development and the potential to host visitors. Higher values indicate regions with a strong orientation toward tourism and a greater ability to accommodate large numbers of tourists relative to the local population.	44
38.	Tourist attractions - and their recognisability, 2024	This indicator reflects touristic visibility through user engagement on Google Maps in 2024. The map shows the density of reviews of tourist attractions per square kilometer,the number of reviews per 1,000 residents, and the total number of reviews — offering a combined view of spatial tourism concentration, relative popularity, and overall review volume.	45
39.	Density of hiking trail, 2024	This map visualises the density of formal hiking trails across the Carpathian macroregion, expressed as kilometres of trail per 10 square kilometres. High values indicate areas where walking infrastructure is particularly developed, reflecting both touristic accessibility and the integration of the landscape into outdoor recreational culture.	46
40.	Ski infrastructure, 2024	This map highlights the density of ski lift infrastructure across the Carpathian macroregion, providing insight into the intensity of winter sports development. The number of lifts per 100 square kilometers serves as a proxy for regional tourism investment, terrain accessibility, and recreational economic activity. By measuring the total horizontal distance covered by ski lifts, this indicator reflects the scale and reach of skiing infrastructure beyond simple lift count. Longer total lift lengths often correlate with higher terrain capacity and developed ski tourism zones.	47
41.	Spa towns, 2024	This map illustrates the spatial density of spa towns in the Carpathian macroregion, expressed per 1,000 square kilometres. As long-standing hubs of health tourism and regional identity, spa towns offer valuable insight into historical and contemporary wellness economies. High density reflects regions where natural mineral resources and health infrastructure intersect with tourism and cultural heritage.	47
42.	Population densit, 2021	This indicator represents the average number of people living per square kilometre of land area in a given local administrative unit. It is a fundamental measure of spatial population distribution, widely used in demographic, urban, and environmental analyses. Higher values indicate more densely populated areas, often corresponding to urban centres, while lower values are typical for rural or mountainous regions.	48
44.	Population change, 2000-2021	This indicator shows the percentage change in the total population of a given region between the years 2001 and 2021 (2020 in Ukraine). It reflects long-term demographic trends, including natural population change, migration flows, and urbanisation or depopulation processes. Positive values indicate population growth, while negative values suggest demographic decline, which may have implications for regional development, service provision, and labour markets.	50
45.	Change in population between census periods, 2001-2021	This indicator shows the percentage change in the total population of a given region between the years 2001 and 2021. It reflects long-term demographic trends, including natural population change, migration flows, and urbanisation or depopulation processes. Positive values indicate population growth, while negative values suggest demographic decline, which may have implications for regional development, service provision, and labour markets.	51
46.	Median age, 2014-2023	Median age represents the age that divides the population of a given region into two numerically equal groups: half of the population is younger, and half is older than this value. It is a key demographic indicator used to assess population ageing, generational structure, and long-term demographic trends. Higher median age typically indicates an ageing population, which may have implications for the labour market, healthcare demand, and social policy. An increase in median age indicates a growing share of older individuals in the population, often due to declining birth rates, increasing life expectancy, and outward migration of younger people. This trend has important implications for regional labour supply, healthcare needs, and social services.	52
47.	Population age structure, 2023	Share of the population aged 0 to 14 years in the total population of a given region.Higher values indicate a relatively young population, which may suggest potential for long-term demographic renewal, while lower values may point to ageing and population decline. Share of people aged 15 to 64 years in the total population relects size of working-age population and is crucial for evaluating labour market dynamics, economic productivity, and the dependency ratio. Higher values indicate a larger workforce, which can support economic growth, while lower values may indicate a shrinking working-age population, which could challenge economic sustainability. Last component is a key measure of population ageing and is widely used to assess social, economic, and healthcare-related challenges associated with an ageing society. Higher values indicate a greater demographic burden on the working-age population and increasing demand for age-related services and support systems.	53

Map number	Map title	Methodology note	Page
48.	Total fertility rate, 2014-2021	The total fertility rate (TFR) represents the average number of children a woman would have over her lifetime based on current age-specific fertility rates. It is a key demographic indicator used to assess population reproduction levels. A TFR of approximately 2.1 is considered the replacement level in developed countries—ensuring long-term population stability in the absence of migration. Lower values indicate sub-replacement fertility, often associated with ageing populations and future demographic decline. Total fertility rate (TFR), expressed as the difference in the average number of children per woman between two reference years. It reflects shifts in reproductive behaviour, social norms, economic conditions, and family policies. A declining TFR may signal demographic ageing and future population shrinkage, while an increase may indicate improved conditions for family formation and childbearing.	54
49.	Natural increase of population, 2000-2022	The crude rate of natural population change represents the net difference between the number of births and deaths in a given year, expressed per 1,000 inhabitants. It reflects the natural demographic dynamics of a region, excluding migration. A positive value indicates natural population growth, while a negative value signals natural decline, often linked to low fertility rates and population ageing. This indicator is essential for assessing demographic sustainability at national and regional levels.	55
50.	Net migration rate, 2021	The net migration rate indicates the balance between the number of immigrants and emigrants in a given region or country, expressed per 1,000 inhabitants. It reflects the demographic impact of migration flows on population change. A positive value indicates net in-migration, suggesting the region is gaining population through migration, while a negative value indicates net out-migration. This indicator is essential for understanding population dynamics, labour mobility, and the attractiveness or push factors of specific territories.	56
51.	Share of population with higher education, 2021	This indicator shows the percent of population with higher education degree. Since there is no comprehensive measure of human capital, one covering all its aspects, educational attainment of population is frequently used as an useful approximation. High share of tertiary educated population is considered as a sign of high human capital potential of a region	57
52.	Participation rate in education and training, 2023	The indicator on adult participation in learning refers to the age group 25 to 64. The numerator refers to persons in 25-64 age group who stated that they received education or training in the last four weeks. The denominator consists of the total population of the same age group, excluding those who did not answer to the question 'participation in education and training	57
53.	Percent of students who scored below the baseline level of proficiency PISA exam, 2022	Percent of students who score below the baseline level of proficiency (Level 2) on the PISA reading / mathematics scale.	58
54.	Human capital change, 2013-2023	This indicator represents a change in the share of population with_higher education between 2013 and 2023. It may be considered as a change in human capital potential over the period of 10 years.	59
55.	Households with internet access, 2014-2023	This indicator measures the share of households with internet access at their place of residence. It reflects the level of basic digital infrastructure and inclusion within the population. Higher values indicate broader access to digital services and greater potential for participation in the information society. Change in the share of households with internet access at home indicates whether access to digital infrastructure improved or deteriorated during a given period. It reflects shifts in digital inclusion and connectivity at the household level.	60
56.	Enterprises with web sales, 2023	Share of enterprises that conduct sales via websites, apps, or online marketplaces. It reflects the level of digitalisation in business operations and the adoption of e-commerce. Higher values indicate greater integration of digital channels into commercial activity.	61
57.	Dwelling stock per 1000 residents, 2022	This indicator reflects the number of residential dwellings by NUTS region relative to its population size, expressed as the total number of dwellings per 1,000 residents. Higher values may suggest greater housing availability and possibly better living conditions, while lower values might indicate housing shortages or less developed housing infrastructure. This indicator is useful for assessing housing density and trends in residential development across regions.	62
58.	Rooms per person, 2023	This indicator measures the average number of rooms available per person within a region, serving as a proxy for the size of housing and the potential for overcrowding. A higher value typically indicates more spacious living conditions, while lower values may signal overcrowded living conditions, where multiple individuals share fewer rooms.	63
59.	Beds in hospitals per 1000 habitants, 2022	The map shows the distribution of available hospital beds (beds regularly maintained and staffed and immediately available for the care of admitted patients, both occupied and unoccupied), calculated at the NUTS2 level. It reflects the availability of the infrastructural healthcare resources. The darker the colour on the map, the higher the number of available hospital beds per 1000 inhabitants.	64

Map number	Map title	Methodology note	Page
60.	Physicians per 1000 inhabitants, 2022	The indicator measuring the number of physicians per 1000 inhabitants belongs to a set of key indicators used to evaluate the main components of health systems; it illustrates the availability of healthcare professionals. Wherever possible, the concept of "practising" physicians is applied, meaning medical doctors who provide services directly to patients. The indicator is calculated at the NUTS2 level; darker colours on the map indicate higher numbers of physicians per 1000 inhabitants. Capital regions with specialised centres of supra-local importance tend to have the highest number of doctors.	65
61.	Urban transport modes, 2024	The diversity of transport modes illustrates the level of infrastructure development and the range of mobility choices	66
62.	Long-distance ground transport availability in main cities, 2024	The map shows the availability of regional, intercity within-country and international rail services based on current timetables as well as the availability of bus connections on regional, intercity within the country and international services established on the basis of current timetables	67
63.	Access to facilities and remoteness levels, 2024	Access to hospitals measured as the average travel time to the closest hospital in minutes by means of transport. Measure of access derived from ESPON DESIRE project, calculated in 2.5 x 2.5 km grid cells, as travel time by given means of transport to the nearest service facility (hospital) using road network from OpenStreetMap and service locations from ESPON PROFECY updated dataset. Grid-level measures were aggregated to NUTS3 regions by 1) calculating an average value in LAUs and 2) calculating a weighted average in NUTS using LAU population as weight	68
64.	Disposable income per capita, 2010-2021	Disposable income per capita represents the average amount of income available to an individual after taxes and social contributions have been deducted and social benefits added. Expressed in euros, it reflects the material living standards and purchasing power of the population. This indicator is widely used to assess household well-being, regional disparities, and economic development levels. Higher values indicate greater individual financial capacity to consume, save, or invest.This indicator compares the cumulative growth of disposable income per capita with GDP growth per capita over the period 2010–2021. Expressed as a difference in percentage points, it highlights whether income growth at the household level has kept pace with overall economic expansion. A positive value indicates that disposable income grew faster than GDP per capita, suggesting improved income distribution or social transfers, while a negative value may point to growing inequality or a disconnect between economic growth and household well-being.	69
65.	Population of risk of poverty or social exclusion, 2015-2022	This indicator measures the share of the population at risk of poverty or social exclusion, according to the EU-defined AROPE criteria	70
66.	Population severely materially and socially deprived, 2015-2022	This indicator measures the percentage of the population experiencing severe material and social deprivation, based on their inability to afford a set of essential items and activities considered necessary for an adequate standard of living. It reflects deep social exclusion and poverty by capturing both economic and social dimensions of deprivation. Higher values indicate greater vulnerability and unmet basic needs within the population, serving as a key measure for monitoring social cohesion and targeting support policies.	71
67.	Trust to government and local and regional authorities, 2024	This indicator measures to which extent people tend to trust or not trust the government. The data is collected in the European-wide public opinion survery in EU regions by Eurobarometer. On average 41% citizens of EU regions tend to trust national governments. Any score over that treshold means that citizens of particular region are more likely to trust that policy-making and implementation as well as integrity of national authorities and political system is rather trustworthy. Any score below 41% indicates lower trust in national public autorities and therefore lowel levels of social capital on citizen vs. national political system axis.This indicator measures to which extent people tend to trust or not trust local and regional authorities. The data is collected in the European-wide public opinion survery in EU regions by Eurobarometer. On average 58% citizens of EU regions tend to trust national governments. Any score over that treshold means that citizens of particular region are more likely to trust that policy-making and implementation as well as integrity of regional and local authorities is rather trustworthy. Any score below 58% indicates lower trust in regional and local autorities and therefore lowel levels of social capital on citizen vs. sub-national political system axis.This indicator reflects the proportion of citizens in a given region who express higher trust in local and regional authorities compared to national government institutions. A higher value in this indicator suggests that people in the region view local and regional governance structures as more credible, responsive, or effective than national authorities. This imbalance in trust can indicate that citizens feel more connected to, and represented by, their sub-national institutions, potentially due to perceived better service delivery, proximity, or alignment with local needs and values. A lower value may point to a more balanced or even reversed trust dynamic, where national institutions are either equally or more trusted than local/regional ones. This indicator offers insight into the vertical distribution of institutional trust within regions, and serves as a proxy for assessing where social capital and perceived legitimacy are stronger—at the national or sub-national level.	72
68.	GDP per capita, 2021	Gross domestic product (GDP) at market prices is the final result of the production activity of resident producer units. Regional GDP per capita was relativised to the national average (set at 100), which allows for the identification of regions that are more or less developed within a given country. The regional GDP per capita was compared to the EU average, showing the position of the region from a European perspective.	73

Map number	***Map title***	***Methodology note***	***Page***
69.	*Dynamics of GDP per capita, 2011-2021*	*The growth of GDP per capita expressed in EUR over the period 2011–2021, with the value in the base year set at 100. This means, for example, that a 50% increase in regional GDP per capita corresponds to a value of 150.The growth of GDP per capita expressed in EUR over the period 2011–2021 was compared to the respective average national growth of GDP per capita over the period 2011–2021. If the value was above 0, it indicates that the development level of the given region increased faster than the national average. If it was below 0,*	*74*
70.	*Economic structure of regions, 2021*	*The share of agriculture, forestry and fishing (NACE A) i in generating gross value added as a percentage share, which indicates their importance in regional economy.The share of manufacturing (NACE A) i in generating gross value added as a percentage share, which indicates their importance in regional economy.The share of advanced business services (NACE N-K i.e. financial and insurance activities (K), real estate activities (L), professional, scientific and technical activities (M); administrative and support service activities(N)) in generating gross value added as a percentage share, which indicates their importance in regional economy.The Location Quotient (LQ) is a measure used to assess the degree of specialisation of a region in a particular industry or economic sector. It compares the share of a given sector in the regional economy to its share in the national economy. LQ > 1 means the sector is more important in the region than in the country overall – the region is specialised in this sector. LQ = 1 indicates the sector's importance in the region is equal to the national average. LQ < 1 means the sector is less important in the region than at the national level.The Location Quotient (LQ) is a measure used to assess the degree of specialisation of a region in a particular industry or economic sector. It compares the share of a given sector in the regional economy to its share in the national economy. LQ > 1 means the sector is more important in the region than in the country overall – the region is specialised in this sector. LQ = 1 indicates the sector's importance in the region is equal to the national average. LQ < 1 means the sector is less important in the region than at the national level.The Location Quotient (LQ) is a measure used to assess the degree of specialisation of a region in a particular industry or economic sector. It compares the share of a given sector in the regional economy to its share in the national economy. LQ > 1 means the sector is more important in the region than in the country overall – the region is specialised in this sector. LQ = 1 indicates the sector's importance in the region is equal to the national average. LQ < 1 means the sector is less important in the region than at the national level.*	*75*
71.	*Labour market situation, 2023*	*Employment rate as defined by the Labour Force Survey, referring to residents aged 15–64. The higher the rate, the larger the share of the population participating in the labour market.The unemployment rate according to the LFS, i.e. the share of people who did not work during the reference week, but actively sought employment in the past four weeks and were available to start work in the near future, in relation to the total economically active population. The higher the rate, the greater the difficulty in finding employment. Long-term unemployed (according to the LFS) are persons who meet the standard definition of unemployment (i.e. without work during the reference week, actively seeking a job in the past four weeks, and available to start within the next two weeks) and who have been unemployed for 12 months or more. A high rate indicates social challenges related to the existence of a large group of people excluded from the labour market.*	*76*
72.	*Change in the unemployment rate, 2013-2023*	*A change in the unemployment rate indicates whether the labour market situation improved or deteriorated during a given period.*	*77*
73.	*Regional innovation scoreboard, 2016-2023*	*This indicator reflects the overall innovation performance of a region relative to the EU average, based on the Regional Innovation Scoreboard (RIS) published by the European Commission. Expressed with the EU average set to 100, it provides a composite measure of innovation capacity across several dimensions, including human capital, research systems, innovation activity, and economic effects. The indicator also incorporates the change in relative innovation performance over time, calculated as the percentage difference between the region's 2023 score and the EU average in 2016. This dynamic component illustrates whether regions are catching up with or lagging behind the EU benchmark over the medium term.This chart visualises two dimensions of regional innovation performance: the relative RIS score in 2023 (with EU = 100) and the change in performance between 2016 and 2023, expressed as a percentage difference relative to the EU average in 2016. The first dimension shows the current innovation level of each region in a comparable format, while the second captures the dynamics of change over time. Together, these two metrics provide a basis for identifying regional trajectories*	*78*
74.	*Human Resources in Science & Technology, 2012-2023*	*Share of the population aged 25–64 with either tertiary education in S&T or/and employment in S&T occupations. It reflects a region's human capital base for innovation and knowledge-driven growth. Higher values indicate a stronger capacity to support research, development, and advanced technological activities.This indicator shows whether the share of human resources in science and technology increased or decreased during a given period. It reflects shifts in the availability of knowledge-intensive human capital.*	*79*
75.	*Research and Development Employment, 2021*	*Share of researchers in total employment, expressed in full-time equivalents (FTE). It captures the relative intensity of R&D activity within the labour market and reflects a region's capacity for knowledge creation and innovation. Higher values indicate a stronger concentration of research personnel relative to the size of the workforce.*	*80*
76.	*Gross domestic expenditure on R&D, 2018-2021*	*Share of gross domestic expenditure on research and development (all R&D activities funded by the public, private, and higher education sectors) in relation to a region's gross domestic product. It reflects the intensity of R&D investment in the overall economy. Higher values indicate a stronger commitment to knowledge-driven growth and innovation-based development.Change in the R&D investment intensity in the economy. It reflects shifts in the priority given to research and development within overall economic activity.*	*81*

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77.	European Research Projects, 2007-2020	Number of participations in research projects funded under the EU's 7th Framework Programme (CORDIS) per 10,000 inhabitants. It reflects the historical research engagement of regions in European collaborative R&D schemes. A higher value indicates a greater degree of integration into the EU research landscape.Number of participations in Horizon Europe research and innovation projects (CORDIS) per 10,000 inhabitants. It captures the current level of involvement of regions in EU-funded R&D activities and their access to transnational research networks. A higher value reflects stronger international collaboration and capacity to attract EU research funding.	82
78.	Research papers, 2011-2022	Number of scientific articles published by authors affiliated with a given region, expressed per 1,000 inhabitants. It reflects the intensity of research activity relative to population size and provides insight into the region's scientific output and publication capacity. Data are sourced from the Web of Science (WoS) database.Change in the number of scientific articles per 1,000 inhabitants indicates whether research output relative to population size increased or decreased during a given period. It reflects trends in scientific productivity and regional publication dynamics.	83
79.	Citation index, 2011-2022	Average number of citations per publication in a given region, normalised by the average citation count per publication across all regions in the reference period. It reflects the relative citation impact of regional scientific output. A value above 1 indicates that, on average, publications from the region are cited more frequently than the multi-regional baseline. The indicator is based on data from the Web of Science (WoS) .	84
80.	Patent applications, 2011-2022	Number of patent applications filed with the European Patent Office (EPO) by inventors affiliated with a given region, expressed per 10,000 inhabitants. It reflects the region's capacity for technological innovation and the formalisation of inventive activity. Data are sourced from the PATSTAT	85
81.	Typology of scientific hubs, 2022	This typology classifies NUTS-3 regions into four groups based on whether their patent (PATSTAT) and publication (Web of Science) intensity per capita is above or below the average: Innovation Hubs (above average in both), Technology Hubs (high patents, low publications), Academic Hubs (high publications, low patents), and Others (below average in both).	86
82.	Specialisation of regions based on patents – factor analysis, 2022	This indicator explores the technological specialisation of regions based on patent activity using factor analysis. Patent data are grouped by technological fields, and multivariate statistical methods are applied to identify underlying patterns of regional innovation profiles. Factor analysis reduces the complexity of patent distributions by extracting dominant dimensions of specialisation, such as engineering, digital technologies, or biotechnologies. The resulting factor scores illustrate how regions align with specific technological domains, enabling typologies of innovation-driven development and highlighting regional strengths or gaps in the knowledge economy.	87
83.	Specialisation of regions based on scientific publications – factor analysis, 2022	This indicator analyses the scientific specialisation of regions based on the thematic structure of scientific publications. Using factor analysis, regional publication data across various scientific disciplines are statistically grouped to identify dominant research profiles. The method reduces complex publication patterns into a limited number of latent dimensions—such as life sciences, physical sciences, engineering, or social sciences—which reflect the underlying structure of regional research activity. Resulting factor scores indicate the relative alignment of each region with specific scientific domains, allowing for the classification of regions by research intensity and thematic focus.	88
84.	Entrepreneurship, 2010-2019	This indicator looks into how many businesses are in a certain country vis-a-vis the total number of people represented as the number of enterprises per ten thousand people This indicator gives an insight into how the number of enterprises changed in the period between 2010 and 2019, calculated by the difference in the share of enterprises per 10,000 people between the two years	89
85.	Entrepreneurship Specialisation in Selected Branches, 2020	By means of a location quotient of tourism enteprises, this indicator examines to what extent a specific region relies on industry. By means of a location quotient of tourism enteprises, this indicator examines to what extent a specific region relies on tourism. By means of a location quotient of tourism enteprises, this indicator examines to what extent a specific region relies on advanced business services.	90
86.	Business Demography, 2021	The birth rate of enterprises investigates how many new businesses are established. A high birth rate may suggest favourable conditions for setting up a business. The death rate of enterprises investigates how many of the existing businesses are closed down. A high death rate may suggest unfavourable conditions for running a business.	91
87.	Gross Value of Fixed Assets per Capita, 2021	Gross Fixed Capital Formation (GFCF) is a national accounts indicator that measures the value of acquisitions of new or existing fixed assets (such as buildings, machinery, equipment, infrastructure), minus disposals. It reflects investment in fixed assets used in the production of goods and services for more than one year.	92
88.	Structure of Gross Fixed Assets Formation, 2021	The share of gross fixed assets formation in agriculture, forestry and fishing (NACE A) in total gross fixed assets formation, which indicates the importance of sector in regional economy. The share of gross fixed assets formation in manufacturing (NACE C) in total gross fixed assets formation, which indicates their importance of sector in regional economy. The share of gross fixed assets formation in advanced business services (NACE N-K i.e. financial and insurance activities (K), real estate activities (L), professional, scientific and technical activities (M); administrative and support service activities(N)) in total gross fixed assets formation, which indicates their importance of sector in regional economy.	93

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89.	Change in Gross Fixed Assets Formation per capita, 2010–2020	This indicator tracks the change in Gross Fixed Capital Formation (GFCF) per capita between 2010 and 2020, using 2010 as the base year (2010 = 100). It reflects investment dynamics in physical assets such as infrastructure, machinery, and buildings, relative to the population size. As a key component of economic development, an increase in GFCF per capita indicates rising investment intensity, while a decline may signal stagnation or reduced capacity for long-term growth.	94
90.	Change in the Structure of Gross Fixed Assets formation, 2010–2020	This indicator reflects the change in the share of in agriculture, forestry and fishing (NACE A) in total gross fixed capital formation (GFCF) per capita between 2010 and 2020, expressed in percentage points. It illustrates shifts in the sectoral structure of investment and the relative importance of agriculture in capital formation over time. A decreasing share may indicate a declining role of agriculture in the investment landscape, while an increasing share suggests growing capital intensity and policy or market-driven support for the sector. This indicator shows the change in the share of manufacturing (NACE C) in total gross fixed capital formation (GFCF) per capita between 2010 and 2020, expressed in percentage points. It reflects structural shifts in investment patterns and the evolving role of manufacturing in regional or national economies. An increase in this share suggests rising capital intensity and strategic investment in the industrial base, while a decline may indicate deindustrialisation, saturation, or reallocation of investment to other sectors. This indicator measures the change in the share of advanced business services in total gross fixed capital formation (GFCF) per capita between 2010 and 2020, expressed in percentage points. Advanced business services are defined according to NACE Rev. 2 sections K to N, including financial and insurance activities (K), real estate (L), professional, scientific and technical activities (M), and administrative and support services (N). An increasing share indicates a structural shift toward a service-based and knowledge-driven economy, with rising investments in intangible assets, innovation, and high-value services. A decreasing share may reflect stagnation in business service development or reallocation of capital to other sectors.	94
91.	Foreign Direct Investment per Capita, 2022	This indicator represents the stock of inward Foreign Direct Investment (FDI) per capita, expressed in thousands of US dollars. It reflects the cumulative value of foreign investments in a given territory relative to its population size, serving as a proxy for international capital integration, investment attractiveness, and the role of foreign ownership in the regional economy. National-level FDI stock data were obtained from UNCTAD and regionally downscaled using allocation keys based on the ESPON project The World in Europe: Global FDI Flows towards Europe. The regionalisation accounts for spatial investment patterns and aims to approximate subnational FDI distribution in the absence of harmonised regional statistics.	95
92.	Regional aid celling, 2024	This value represents the maximum allowed regional aid ceiling. Higher regional aid ceiling suggests the region might be economically underserved and it needs more stimuli for potential investments.	96
93.	Change in regional aid cellings and area of 5 largest business parks, 2011-2023	This value collates the change in the regional aid ceiling and the area of five largest business parks. This indicator looks into the area of the 5 largest business parks in a given region. A larger value suggests more pro-entrepreneurial activity of a region.	96
94.	European Quality of Government Index (EQI), 2024	The European Quality of Government Index (EQI) measures citizens' perceptions and experiences of the quality, impartiality, and corruption levels in public services across European regions. Compiled by the Quality of Government Institute (University of Gothenburg), the index is based on representative survey data and covers three main dimensions: quality of public services (education, healthcare, law enforcement), impartiality of service delivery, and perceived corruption. The EQI is a composite indicator that enables comparisons of institutional performance at the subnational level, offering valuable insights into regional governance and its impact on development and trust in institutions.	97
95.	Change of Quality of Government Index 2000-2024	This indicator compares regional scores of the European Quality of Government Index (EQI) between two reference periods: 2000–2013 and 2021–2024. It captures long-term shifts in perceived quality, impartiality, and corruption levels in public service delivery across European regions. The EQI is based on citizen surveys and aggregates experiences with education, healthcare, law enforcement, and general governance. By comparing the average scores across these two periods, the indicator highlights regional trajectories of institutional improvement or deterioration. Positive values reflect enhanced governance quality over time, while negative values indicate growing governance challenges. The analysis provides a valuable input for assessing the territorial dimension of institutional convergence or divergence within the EU.	97
100.	Project participations and budgets shares of Carpathian projects, 2014-2020	The map shows the number of Carpathian NUTS3 project participations in Carpathian projects (represented by the size of the circles) and the values of Carpathian partners' budgets in those projects calculated per capita (the darker the colour, the higher the value). Together, they illustrate the Carpathian cooperation within the Interreg framework: the level of engagement of Carpathian local actors and the significance of the financial contribution.	104
101.	Carpathian Projects thematic categories by countries, 2014-2020	The map illustrates the number of participations of the Carpathian NUTS3 actors in the 2014-2020 Interreg Carpathian projects. The size of a circle reflects the number of Carpathian NUTS3 project participations in a country. The different colours represent various thematic categories of Carpathian projects. For each country, the map shows the level of participation in Carpathian projects within the European Territorial Cooperation and shares of thematic categories in it.	105

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102.	City twinning agreements breakdown by NUTS3 regions, 2024	This map shows the number and intensity of formal city twinning agreements established between local governments. Twinning arrangements are institutional partnerships that promote cultural exchange, mutual learning, and international cooperation, often supported by EU programmes or bilateral initiatives. A higher number of twinning agreements per capita suggests stronger international engagement, openness to cross-border collaboration, and participation in transnational networks at the local level.	106
103.	City twinning agreements within the Carpathian countries, 2024	This map shows the number and share of city twinning agreements that involve partner located in the Carpathian countries, expressed as a percentage of all recorded twinning agreements. It reflects the level of cross-border and interregional engagement of Carpathian localities within European cooperation networks. A higher share indicates a strong presence of Carpathian actors in international municipal diplomacy and cultural exchange initiatives.	106
104.	City twinning agreements within each of the Carpathian countries, 2024	This indicator captures the extent of cross-border twinning cooperation between local authorities in the Carpathian macroregion, with a focus on partnerships involving particular country's cities. It measures, for each NUTS-3 region in Carpathian countries other than in the analysed country, the number and share of twinning agreements that include at least one partner from a given country . The share reflects the proportion of partnerships directed toward given country relative to twinning connections of a given region with all Carpathian countries. A higher share indicates stronger bilateral engagement with given country, pointing to cultural, historical, or functional ties within the macroregion.	107
105.	Territorial cooperation networks in Carpathian Macroregion and beyond, 2014-2020	This map visualises the intensity of territorial cooperation across the Carpathian Macroregion and adjacent areas during the 2014–2020 EU programming period, measured by the number of project partners participating in funded cooperation initiatives. Based on network analysis of collaborative ties between NUTS2 regions, the map captures the scale and spread of institutional engagement in cross-border and transnational cooperation. High values indicate hubs of activity and connectivity, reflecting both institutional capacity and the strategic importance of regional actors within the broader European territorial cooperation landscape.	108

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