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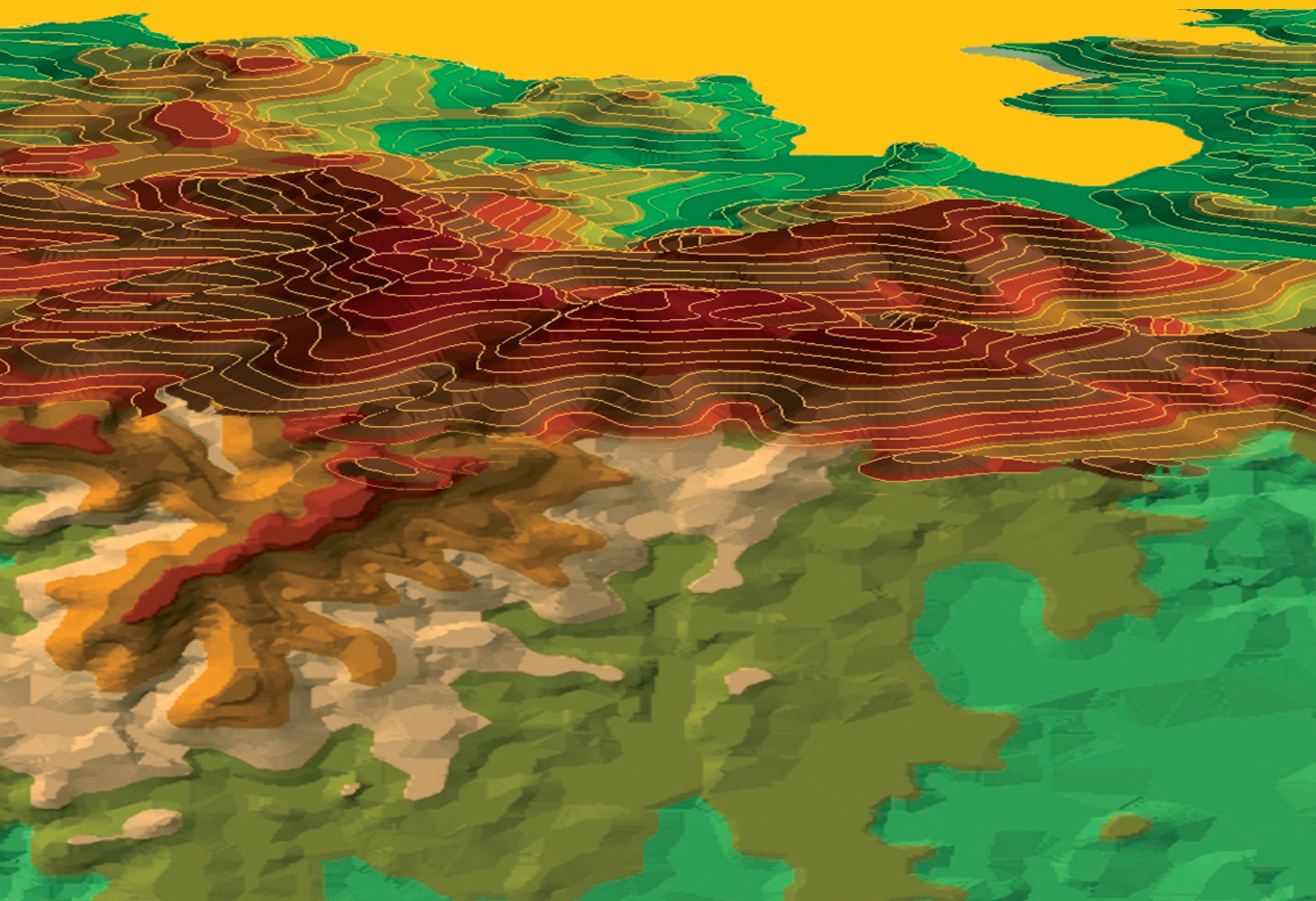

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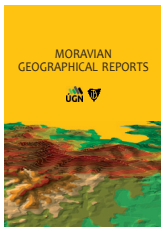

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Housing affordability, quality of life, and residential satisfaction in the Austrian cross-border suburban region of Bratislava, Slovakia

Ján VÝBOŠŤOK [a]*, Pavla ŠTEFKOVIČOVÁ [b]

Abstract

Bratislava's satellites have experienced massive development in recent years. The population of a regional centre has moved into its Slovak hinterland. However, Bratislava's cross-border suburbs have recorded spectacular population growth too. After 2008, housing in the EU became more affordable due to rising incomes and decreasing bank interest rates. Yet, the housing affordability index in the EU (and in the studied area) decreased in recent years due to increasing property prices and, more recently, a reverse tendency in bank interest rates. Through a questionnaire, we sought to establish a link between housing affordability and suburban residents' expected quality of life. We assumed that a large proportion of the population had moved here specifically for a higher quality of life (residential satisfaction) and more affordable housing. Indeed, these were among the most common reasons for moving, with a large proportion of respondents choosing at least one. The Mann-Whitney U test showed that residents who moved to the Austrian suburbs of Bratislava for affordable housing were more satisfied with living in the municipality and housing costs. The article tries to fill the gap in the literature on housing affordability in suburban areas and on the quality of life of cross-border suburban residents.

Keywords: *housing affordability, quality of suburban life, residential satisfaction, cross-border metropolitan region, suburbanisation, Bratislava, Slovakia, Austria*

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1. Introduduction

With border controls in the EU being mostly history, cross-border consumer and commercial mobility increased over time, although cross-border residential suburbanisation might still be a rarity in Europe at present. To mention a few, this list includes Luxembourg (Dörry & Decoville, 2016), Salzburg (Hamedinger, 2011; Chilla & Heugel, 2018; Štefkovičová & Koch, 2022) or the so-called Eurometropolis Lille-Kortrijk-Tournai at the French-Belgian border (Durand & Perrin, 2017). The Slovak capital, Bratislava, borders two countries which formed a single country in the past. The Bratislava granularity pulls many economically active inhabitants behind its boundaries and those of Slovakia. The Bratislava region's average annual GDP growth in recent decades was one of the most substantial across Europe (Eurostat, 2021a). It is primarily affected by the city's location within Slovakia and in transnational terms, as well as by other factors (Michálek & Výbošťok, 2019). This growth relates to migration to the city and its hinterland.

The suburbanisation processes of Bratislava started in the mid-1990s (Šveda, 2019). Consequently, their intensity slowly accelerated and affected larger and broader areas around the city. The migration into Bratislava suburbs is driven by the city-core population and the population from other Slovak regions. These groups differ in housing preferences, with the population from "the regions" preferring to live in areas with longer distances and commute times to Bratislava. The preference for housing location and quality is impacted mainly by housing (un)affordability.

Property prices in Slovakia have strongly increased in recent years (Datalan, 2022; see Fig. 1). That led to a warning from the European Systemic Risk Board (ESRB) on overpricing property prices in Slovakia and the vast indebting of households, even until retirement (Apolen, 2022). According to the letter, these factors might impact financial stability and lead to economic issues (ESRB, 2021). The increase in property prices, the de facto non-existing affordable public housing (Meyfroidt, 2017), the absence of regulations on private rental housing, and a slower increase in real incomes in the last five years have worsened housing affordability (Šveda et al., 2021, 12).

The first waves of Bratislava suburbanisation were related to a hunt for better housing and higher quality of life in rural areas (Šveda, 2019). Yet, recent migration waves to Bratislava suburbs might relate to worsening housing affordability in the city and its closest suburbs with excessive property prices (i.e. the first wave of intensive suburbanisation, according to Šuška et al., 2019).

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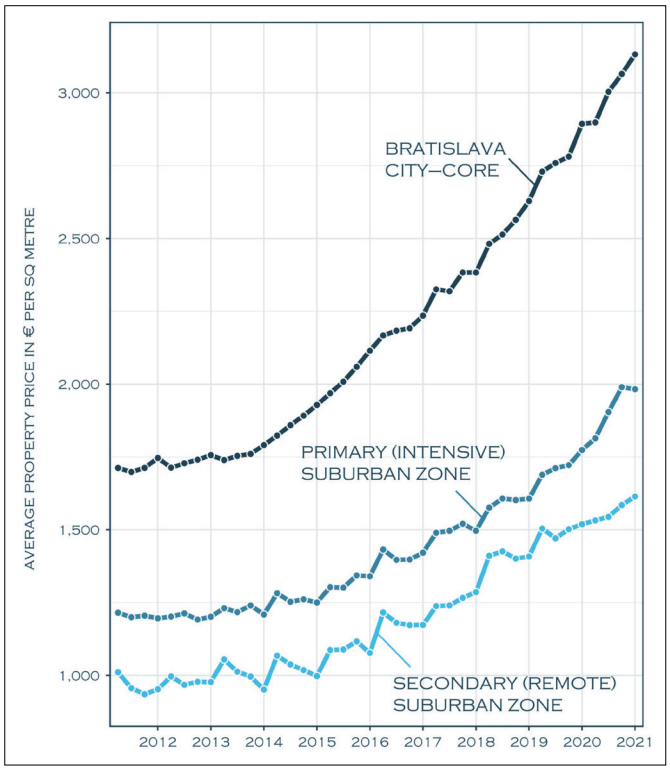

Fig. 1: The development of mean property prices in Bratislava's functional urban area (cf. Bezák, 2014) from 2012 to 2021
Note: suburban zones were delimited by Šuška et al. (2019) based on the intensity of suburbanisation processes
Source: Datalan (2022), authors' elaboration

Some historical events (particularly, the accession of Slovakia to the EU in 2004 and the Schengen area in 2007, and the abolition of border controls) engendered a new process – cross-border suburbanisation. As mentioned, Bratislava borders two countries: Hungary to the South and Austria to the West. The location of formerly peripheral municipalities (country-wise) behind the state boundaries made an instant U-turn and became a natural residential locality for Bratislava's suburban population. The peripherality was related to lower property prices and allowed the population working in Bratislava to seek affordable living in these areas even without speaking the official languages (German and Hungarian). Subsequently, some new residential localities were formed, typical for Bratislava suburbs in its Slovak hinterland.

An example is the residential locality in Rajka, Hungary, with a practically homogenous Slovak population (Balizs & Bajmócy, 2019; Šveda et al., 2020). These factors (population growth of Bratislava hinterland area, open borders) and other variables (increase in incomes, higher demand for quality living, worsening supply of estates for sale) led to a growing increase in property prices in the region of cross-border suburbanisation.

The paper aims to quantitatively evaluate selected aspects of quality of life and residential satisfaction through a housing affordability analysis in the Austrian hinterland of Bratislava. So far, this area has been analysed rather sporadically and has not even been delimited. Therefore, another objective is to contribute to the discussion on the delimitation of Bratislava's suburban area in Austria. The aim is to assess this area's current affordable housing situation and its changes after 2015. We hypothesise that housing affordability in this area would be similar to that in Bratislava and its closest suburbs in Slovakia. On the other hand, we assume that affordability decreased due to suburbanisation. Yet, we think it would not negatively affect the quality of life and residential satisfaction in this area in the short term. The obtained knowledge might not bring detailed answers to questions on Bratislava suburbanisation: it opens space for other analyses narrowly connected to the Slovak capital and its Austrian hinterland, questions at present barely evaluated.

The article starts with a brief literature review on quality of life, residential satisfaction, and housing affordability in the context of cross-border suburbanisation. Sections on the delimitation of the Austrian "hinterland" of Bratislava, data, and methodology follow. It finishes with analysing the obtained results, their interpretation, and a discussion of our findings in comparison to the international literature.

2. Housing affordability, quality of life, and residential satisfaction: A literature review

Housing affordability means, in general, the ability and possibility to live under adequate conditions with a certain quality. It is made possible by a positive household incomes-to-expenditures ratio (including the cost of living), available housing stock, certainty on financial markets, etc. According to the UN Humans Settlement Programme (UN-Habitat, 2022, 3) "an estimated 1.6 billion people live in inadequate housing conditions, without access to basic services or sanitation, and struggling to afford housing costs." Housing conditions and quality differ across countries and regions. Some authors (e.g. Stone, 2006) view housing affordability as a challenge for households and individuals when reviewing the total costs of current and potential future housing. While financial costs are the most discussed and reviewed, housing costs include various objective and subjective well-being factors. The objective factors include dwelling size, available amenities, green areas, clean air, and low noise level. The subjective include neighbourhood satisfaction, personal safety, familiar neighbours, etc. There are multiple types of affordable housing. Social housing aims to aid low-income populations, while intermediate housing serves middle-income groups that still cannot afford market-price rents (Mulliner & Maliene, 2013). These two types are based on rental housing, yet the owner-occupied housing might also be affordable, provided there are lower loan interest rates and a healthy housing-stock market. Another type of affordable housing considers the affordability for existing homeowners (Kostelecký & Vobecká, 2009).

Researchers have attempted to quantify housing affordability through various indices. A housing affordability issue was originally understood as a condition in which a household "pays more than a certain percentage of its income to obtain adequate and appropriate housing" (Hulchanski, 1995, 471). The European Union also applies this approach, which measures whether households' housing costs exceed 40% of their net monthly income in the EU-SILC survey. In the 21st century, the issue of housing affordability has become much more complex and multidimensional. In addition to the original problems, new ones are emerging that, if not addressed, could negatively affect the economic efficiency of cities and the standard of living and quality of life of their inhabitants (Haffner & Hulse, 2021). Yates (2008, 200) argues that broadly speaking, "affordability problems emerge when housing costs increase faster than household incomes." Monthly housing costs primarily include the amount of rent or loan repayments and utility prices. As discussed below, housing affordability is also affected by other costs such as childcare, nursery fees, food, etc.

In recent years, there has been a significant fall in housing loan interest rates in EU countries (European Central Bank, 2022), pushing down the cost of credit, which, together with rising incomes, has contributed to improving housing affordability. In contrast, excessive inflation, particularly in food and energy prices, pushes up prices, resulting in falling real incomes. It is also putting pressure on the European Central Bank (ECB) to

raise key interest rates, which, inevitably, leads to more expensive housing loans in the euro area. In the V4 countries that are not members of the Eurozone, interest rates increased significantly after 2020. Data valid as of 01 June 2022 show that key rates have increased from 0.25% to 5.75% (and to 7% by 16 November 2022) in the Czech Republic, from 0.6% to 5.9% (13% in November) in Hungary and from 0.1% to 5.25% (6.75% in November) in Poland (countryeconomy.com, 2022). In Slovakia, the banks have already increased their interest rates sharply up, and the ECB raised key rates up to 2%. At the end of April, average mortgage interest rates in Slovakia increased to about 1.7% p. a. (Kláseková, 2022b). By the start of December 2022, most of Slovak banks increased their interest rates for mortgages to about 4% (Kláseková, 2022a). In Austria, long-term fixations increased by 0.5–0.6 percentage points during the first quarter of 2022 according to the realtors (Draxl, 2022). The Austrian central bank data (ÖNB, 2022) show a slight increase in housing loans, mainly those with interest rates fixed for 5 and more years. Thus, energy price inflation has a double impact on housing affordability.

The issue of housing affordability is an integral part of the quality of life and its related concepts, such as life satisfaction (including residential satisfaction), happiness, or well-being of individuals and households. The concept of quality of life refers to "the qualitative parameters of human life, way of living, lifestyle and living conditions of society" (Godor & Horňák, 2010, 43). Besides favourable living conditions, quality of life is also commonly seen concerning health, individual well-being, quality of public services, or general satisfaction in terms of cognitive state (Vaishar et al., 2018). Similarly, Ira and Andráško (2007) explain that the study of quality of life is associated with concepts such as health, liveability, well-being, urban environmental quality, sustainability, satisfaction, happiness, quality of place or standard of living. Concepts such as quality of life, well-being, life satisfaction and happiness are thus closely intertwined and often difficult to distinguish (Phillips, 2006; Marans & Stimson, 2011). For example, Gerber et al. (2017) consider subjective well-being, happiness, and satisfaction as components of the quality-of-life concept. According to Cao (2016), life satisfaction is a cognitive measure of subjective well-being or quality of life. Ala-Mantila et al. (2018) consider the quality of life and happiness as measures of subjective well-being. The subjective dimension of quality of life is concerned with the quality of life from an individual's perspective, assessing satisfaction with phenomena and overall satisfaction with life (Marans, 2015).

The relation between housing affordability and the concept of quality of life is manifested by the strong influence of household income on housing quality. Quality housing affects the quality of life of household members in two ways. On the one hand, higher housing costs may be related to higher housing quality requirements. On the other hand, household members are left with fewer resources to meet other necessities of life, such as spending on food, utilities, culture, travel to work, health care and childcare, or fulfilling aspirations such as saving for retirement or emergencies, starting their own business, or pursuing higher education (Anacker, 2019). Household size and structure also play an important role in household expenditure on housing and other necessities of life. For example, a childless couple can afford to allocate more of their budget to housing than a (single parent) family with multiple children, which also needs to spend a higher share of their household expenditure on other non-housing living needs (Bentzien, 2016). It should also be noted that with the ever-increasing real estate prices in Slovakia, Europe, and elsewhere in the world in recent years (Peverini & Cavicchia, 2021), acquiring one's housing through purchase is more difficult to afford, especially for people entering the housing market for the first time, who may thus be forced to look for rental housing (Haffner & Hulse, 2021).

Factors negatively influencing the purchase of a property include lack of knowledge of the property market (price, location, condition of the property), insufficient or poor credit history, low savings to repay the loan, as well as exaggerated expectations, e.g. overestimation of one's creditworthiness (cf. National Association of Realtors, 2022, 91). People tend to buy properties when prospering in their lives, and their incomes at that time are disproportionately higher than their earning trajectories (Reid, 2013). In addition, unregistered and unrecognised income and its instability harm obtaining a housing loan. Reid (2013) found there is an optimism bias on buying over renting preference for lower-income first-time property buyers. She points out they are "unwilling to decide any downsides of the decision to own". Such downsides include possible price falls in the future or a possibility of losing a job and, therefore, income to pay the mortgage, potentially getting divorced or having a child, which also influences the household net income. These factors lead to parental borrowing in the form of upfront capital, mortgaging a second property, or loan sharing.

On the other hand, some higher-income households pay higher housing costs, not because of financial hardship but because of their own willingness to pay for decent housing (Park & Seo, 2020). Thus, they pay for a certain standard and quality of the housing unit they own or rent, however, the external environment's conditions also play an important role. According to Gou et al. (2018), an individual's quality of life depends not only on the subjective evaluation of their personal life but also on the place in which they live, which is affected by the characteristics of the residential environment. The places where people live, work, and relax represent dimensions of quality of life, generally referred to as quality of urban life – QOUL (Marans, 2015). Pacione (2003) states that the variety of meanings of the term quality of life and its use in different contexts generally relates to the environmental conditions in which people live (e.g. water and air pollution, quality of housing) or to a particular attribute (e.g. health or educational attainment). From a geographical perspective, quality of life can be defined as the interaction of human preferences and opportunities for their fulfilment within a specific geographical environment (Angelovič & Ištok, 2016).

We assume that some residents will prefer to pay higher housing costs in a better location that meets their demands and perceptions of high quality of life, for example, in terms of accessible amenities, a high proportion of green spaces, or good transport accessibility to their place of work or school. Mulligan and Carruthers (2011, 108) describe amenities as "site- or region-specific goods and services that make some locations particularly attractive for living and working. Their opposites, disamenities, make places unattractive". Amenities could be of natural origin (such as sunshine or a nice landscape) or human-created, for example, public goods and services (e. g. education), private consumption goods (e. g. restaurants), cultural institutions, transportation and communication, and social capital.

Since housing is an essential domain in people's lives, we consider its research to be an important subcomponent of research on the general concept of quality of (urban) life and life satisfaction, well-being, and happiness. In this context, therefore, we are also concerned with the concept of housing satisfaction (especially housing in the sense of living in a particular locality), the so-called residential satisfaction (for further reading on the concept of quality of urban life, see Biolek et al., 2017; for residential satisfaction, see e.g. Nguyen et al., 2018).

In environmental psychology, within the theory of place, residential satisfaction is defined as residents' feelings of gratification and pleasure in relation to living in a particular place (Bonaiuto et al., 2003). Satisfaction is often considered as a global indicator of perceived neighbourhood quality, whereby it is understood as a cognitive judgement based on the achievement

of a certain standard or desirable level of neighbourhood quality (Corrado et al., 2013). According to McCrea et al. (2011), the tendency of residents to be satisfied with the location of their housing depends on various psychological mechanisms and, at the same time, when moving to a new place to live, people tend to prefer locations that satisfy them in those aspects that are most meaningful to them. Marans and Stimson (2011) cite housing and neighbourhood satisfaction as one of several examples of subjective quality of life indicators used in quality of urban life research.

Florida et al. (2013) investigated the factors causing feelings of happiness in urban and metropolitan residents. The authors understood happiness and subjective well-being as subjective cognitive and affective evaluations of people's quality of life. According to these authors, housing represents the single biggest cost factor for most households. Based on this, it could be inferred that happiness levels would be higher in areas with more affordable and cheaper housing. Paradoxically, however, Florida et al. (2013) found that happiness levels were higher in those locations where housing was less affordable due to higher housing prices and a higher housing price-to-wage ratio. Florida et al. (2013) explained that higher housing prices tend to be in localities that are more economically productive and have a better supply of amenities. As a result, residents pay more for a higher quality of life, which affects residents' sense of happiness. The same results were found by Bursa (2021). He found that civic amenities are associated with higher residential satisfaction.

A similar conclusion was reached by Mulligan and Carruthers (2011), Anenberg and Kung (2020), Bieri (2012) and Shamsuddin and Campbell (2022). Anenberg and Kung (2020) find that rent elasticity is low and therefore infer that rental rates depend more on the level of amenities in a particular location than on the housing supply. Bieri (2012, 3) points out that "important aspects of housing quality depend on local nonmarket goods, such as local public goods and amenities tied to the location of housing, which affects the well-being of individuals and households." Therefore, Bieri (2012) further suggests that when assessing housing affordability, the various opportunities that arise for households concerning a particular housing location, such as the accessibility of jobs, environmental quality, public safety, or the quality of schools, should also be considered.

It should also be noted that cheaper housing, which low-income groups usually prefer, may be in areas with inadequate quality of amenities or higher crime rates, affecting residents' quality of life. As Bentzien (2016, 132) states, "qualitatively and quantitatively adequate housing at affordable prices for the household may only be available in a very insecure area."

The low housing price does not only result from living in a lower quality location. It also reflects the lower standard of the housing unit. When low-income households spend a significant portion of their budget on housing-related expenses, such housing may also lead to mental stress if the housing quality does not match the costs incurred (Park & Seo, 2020). Thus, the issue of housing affordability in relation to the quality of life and residential satisfaction can also be interpreted in the context of its potential impact on the health of residents.

The considerations mentioned above of diversified housing affordability according to different locations, which reflect the economic, social or environmental conditions of a given environment and are also reflected in the perceived level of quality of life of the inhabitants, however, tend to be presented in the literature mainly in the context of urban or metropolitan environments. Haffner and Hulse (2021) provide examples of studies examining the so-called suburbanisation of poverty in the US, Australia, and the UK. The cases involved low-income households forced to seek cheaper housing on the periphery of the city but further away from employment opportunities and with higher commuting costs, as housing in the centre was not affordable. In some large cities, however, middle-income households are also moving to the suburban zones due to the lack of affordable housing in their central areas (Haffner & Hulse, 2021). "Households moving to the urban fringe or adjacent rural areas face additional costs (and time) spent commuting which add to living costs" (*ibid.*, 70, Výbošťok et al., 2020).

In the case of the Austrian-Slovak cross-border suburban region, which is the subject of our study, we can find several similarities and differences. Slovak inhabitants have been moving to Austrian border municipalities in the hinterland of Bratislava, especially in the last decade, due to more affordable housing compared to the Slovak capital (Falťan & Moravanská, 2020, 9). The fact that the Iron Curtain separated the two countries for several decades contributed to the lower property prices in this part of Austria, which left the Austrian municipalities near the Austrian-Slovak border on the periphery of the state, without the possibility of significant development. The fall of the Iron Curtain in 1989, Slovakia's accession to the European Union in 2004, as well as its accession to the Schengen Agreement in 2007, resulted in the formerly peripheral municipalities suddenly becoming more and more easily accessible for housing also for Slovak inhabitants. The adoption of the Euro in Slovakia in 2009 contributed to the facilitation of labour migration between Slovakia and Austria. This fact has conditioned the suburbanisation processes of Bratislava, as well as the position of Austrian border municipalities in a certain sphere of influence of the Bratislava city region.

Due to much lower real estate prices, good transport accessibility and the presence of other factors traditionally sought after by suburban migrants (cf. Šveda, 2016), these municipalities have become attractive to an increasing number of residents moving here from Slovakia. Official data (Statistik Austria, 2022b) suggest that 85% of Slovak incomers to Kitssee since 2002 immigrated after 2010 (52% after 2015). Since 2002, almost 7,000 Slovaks migrated to the three studied districts. Overall, three out of four Slovak immigrants to the three studied districts moved in since 2011 (40% from 2017 to 2020). It should be noted, however, that the continued high demand for real estate has pushed prices up in recent years, ultimately making it progressively less affordable compared to the period at the beginning of the suburbanisation processes (Falťan & Moravanská, 2020, 8). Haffner and Hulse (2021, 72) point out "flow-on effects to residents of towns and villages surrounding big cities who are affected by higher prices associated with property purchases in their areas by metropolitan households".

3. Data and methods

3.1 Area under study

Farkas and Klobučník (2021) were among the first to delimitate the Bratislava hinterland in Austria. Their area consists of municipalities (Gemeinde) across three districts (Bezirke) bordering Bratislava – Bruck an der Leitha, Gänserndorf and Neusiedl am See – with at least 5% Slovak population.

Regarding the absence of reliable data on migration from and daily mobility to Bratislava from this area, the share of Slovaks is the most precise data on the spatial extent of Bratislava behind the state border, yet this might not be inevitably related to the Slovak capital's suburbanisation processes. A limiting factor is that the Slovak population in the researched area is undoubtedly connected with Vienna. The city's work travel area is more extensive than Bratislava's, with many Slovaks joining in a daily commute. Therefore, we consider the Vienna Aussenzone as a spatial span of Vienna suburbanisation as delimited by the KDZ – Zentrum für Verwaltungsforschung (i.e. the Centre for Administrative

Research, KDZ, 2022). The KDZ delimited 43 urban regions based on the urban/rural typology (Statistik Austria, 2021c), daily commute, and other social and demographic data in Austria.

The authors' (Farkas & Klobučník, 2021) delimitation might be agreed with – however, we propose some changes. We assume that the delimited area does not include potentially new and emerging localities of Bratislava suburban population interest. Therefore, we include the municipalities which doubled their Slovak population from 2011 to 2021 and their current (2021) share reached at least two per cent. The authors' delimited area also excludes municipalities with a travel time to Bratislava comparable to the city's daily commute within its suburban area in Slovakia. Even though the area should be continuous (compact), the municipality of Hohenau an der March is optically divided from the compact area. The Bratislava functional urban area (Fig. 2; cf. Bezák, 2014; for Bratislava daily commute area cf. Halás & Klapka, 2020) stretches to further localities connected with Austria by the Moravský Sv. Ján – Hohenau border crossing. Mobile 'phone location data (Šveda et al., 2021) show a significant number of people commuting more than 60 minutes to Bratislava daily (car ride duration from Hohenau to Bratislava is about 55 minutes). In comparison to 17 municipalities delimited by Farkas and Klobučník (2021), we have delimited 28 municipalities that might be affected by Bratislava suburban processes (see the area filled by a diagonal grid in Fig. 2). The share of Slovaks in this filtered area strongly correlates with distance from Bratislava (Spearman's $\rho = -0.81$, $p < 0.001$). The map also shows that the whole delimited area is a part of the Vienna Aussenzone.

3.2 Data and methodology

We use the so-called housing affordability index *HAI* to quantify housing affordability. The index consists of the average household creditworthiness and the mean (median) property price. The creditworthiness *CRW* comprises the monthly income after tax, social and health insurance x, and minimum monthly expenses *ME*.[1] Finally, the income is reduced by the debt-to-income ratio *DTI*, the ratio of the highest possible household credit indebtedness to monthly income. On the other hand, the monthly loan instalment *MLI* of an average-size property is measured. Its calculation is based on a property price per square metre y, average loan interest rate *IR*, and mortgage maturity length in years *MM*. The value is then lowered by the loan-to-value ratio *LTV*, the maximum amount a bank would lend to a potential borrower.

$$CRW = (x - ME \times 1.5) \times DTI$$

$$MLI = \frac{y \times \frac{IR}{12}}{1 - \frac{1}{1 + \left(\frac{IR}{12}\right)^{MM \times 12}}}$$

$$HAI = \frac{CRW}{MLI} \times LTV$$

This calculation has a few limitations. First, it uses aggregated data for the whole municipality population, and all sold properties, thus ignoring income differences within municipalities and inequality in social structure. Second, using mean property prices per municipality brings the same issue. An affluent person would look for more expensive property. Finally, operating with income levels and property prices in the same municipality evokes that a property in the municipality is being bought by someone already residing in it. These people, however, already live here and, therefore, might not need to buy another estate for a living. Despite the already published analyses on housing affordability in the Bratislava hinterland area, which included all properties suitable for a living (Šveda & Výbošťok, 2020), we decided to analyse family houses only. The reason was the data availability (data are available either for flats or houses separately). Even though the "dreamt-of" better living in one's own house might look and sound like

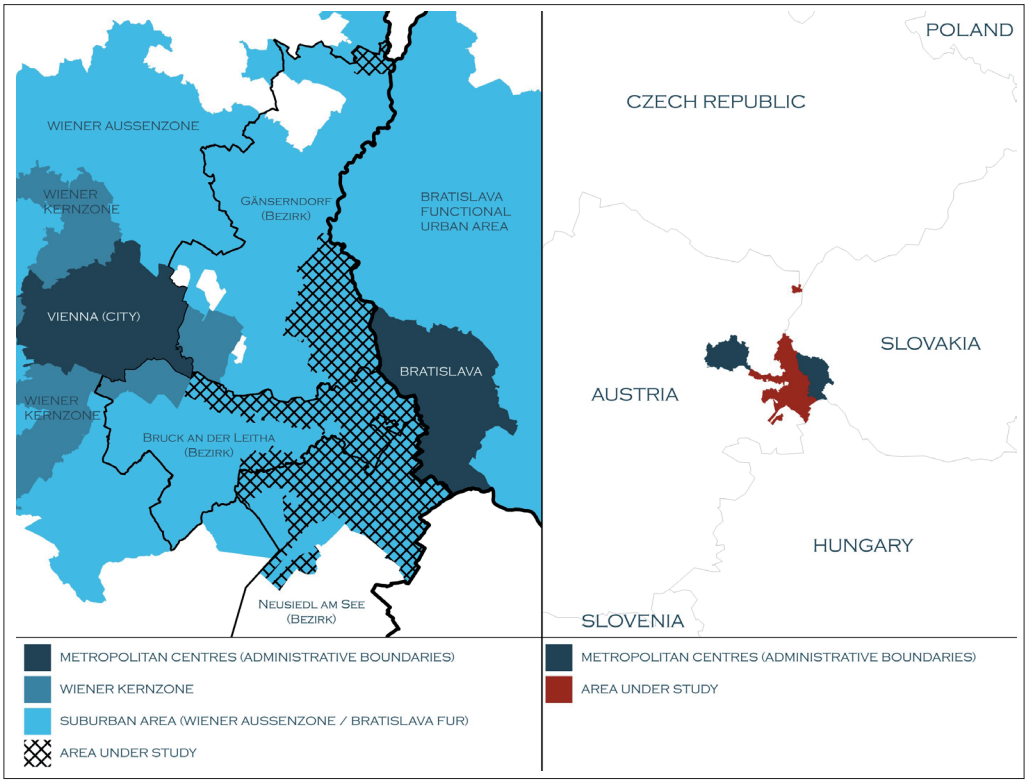

Fig. 2: Location of research area
Source: KDZ (2022), authors' elaboration

[1] In the *HAI* context, the minimum monthly expenses equal the minimum subsistence level.

a cliché (Šuška & Šveda, 2019), the number of houses (multiple-room properties, more precisely) and their construction dominates rather substantially in Bratislava suburbs (Šveda et al., 2016; Šveda, 2019; Šveda et al., 2021, 9). Despite Burgenland being one of the Austrian federal states with the highest newly built flats-to-houses ratio from 2001 to 2011, family house prices have been selected instead of flat prices. Mainly, houses with one or two flats represented 89% of all properties suitable for a living in 2011 (Statistik Austria, 2011).

As the house prices are not available at the local (municipality) level, a disaggregation through geographic conversion tables from the subregional (Bezirke) level was needed (Simpson, 2002; Madajová, 2011). This method is based on joining various groups of geographic units by a common variable (Sládeková Madajová & Hurbánek, 2016, 45–50). Therefore, we used land prices suitable for construction as such a variable (weight). As Madajová (2011) points out, an error of estimate for every final unit is as high as the value of correlation between weighted criterion and estimated data. The weighted criterion should be optimal for converting the data group and for their redistribution across source units. The used variable (land property price) satisfies both criteria (Spearman's $\rho = 0.78$, $p < 0.001$). Therefore, we assume that using this variable might predict property prices at the local level. This assumption comes from the findings of Sládeková Madajová and Hurbánek (2016), who tested multiple methods of areal data transformation.

The values of initial geographical units y_z (property price at district level) are disaggregated into predicted $\hat{y}_c$ variable for target geographical units (property price at the municipal level) using weight w_{zc} (land property price at municipality level). The formula for conversion tables is as follows:

$$\hat{y}_c = \sum_z w_{zc} y_z; w_{zc} = \frac{a_{zc}}{a_z}$$

where a_{zc} stands for land property price for areas where initial and target units intersect (for individual municipalities). At the same time, a_z goes for land property prices at the district level.

Mean loan interest rates were obtained from the ECB (2022). Specifically, an aggregated value for Austria is used. One might assume that some new immigrants from Slovakia would prefer Slovak bank services due to language issues (e.g. Šveda et al., 2020) found that a part of the Slovak population in Kittsee is having difficulties related to the German language). Though, the Slovak central bank data (The National Bank of Slovakia, Národná banka Slovenska, 2021) indicate that is not the case.

Why do we prefer analysing housing affordability through selling properties instead of renting? About 43% of all households in Austria live in rented dwellings (including sub-tenancy), with "only" 49% residing in their properties. The latter is much lower in the metropolitan region of Vienna (Friesenecker & Kazepov, 2021). It is also markedly lower than in Slovakia, where people live in their own properties on more than 90% of occasions (Eurostat, 2021b). To be precise, the value is as high as 92% in the (Slovak) Bratislava suburban area according to the latest census (Štatistický úrad SR, 2022). The value is consistent across both Bratislava suburban-intensity zones (as per Šuška et al., 2019 and Fig. 1); there are only two municipalities with at least 10% people living in rent or leased properties. Burgenland and Lower Austria, however, score above-Austrian-average values of 68.5% and 62.7%, respectively. Rents and sub-tenancies in these states are represented on about one-quarter of occasions. We also assume that an average Bratislava suburban resident would prefer to buy than to rent. This preference is quite dominant in the Slovak part of the Bratislava hinterland. According to the Austrian statistical office, the mean property size is 100 sq metres. The value used for HAI calculation is specific for a given year and federal state (Statistik Austria, 2021a).

In addition to the analysis of housing affordability, we also investigated selected aspects of the quality of life of inhabitants of the Austrian border region of Bratislava in relation to housing based on our own questionnaire survey. The online survey was carried out in January 2021 to determine the residential satisfaction of the inhabitants of the districts of Neusiedl am See, Bruck an der Leitha, and Gänserndorf and involved a total of 205 respondents, 151 of whom were of Slovak nationality. For the purposes of the research in this study, we selected three samples of Slovak nationality only – either all 151 respondents (Tab.1), or samples from the municipalities with the largest number of respondents: 50 respondents from Hainburg an der Donau and 50 respondents from Kittsee that represent approximately 0.7% and 1.5% of their total population as of 2021, respectively, and 2.5% and 3.2% of their Slovak inhabitants, respectively. We chose a sample focusing on Slovak respondents because we were interested in assessing the satisfaction of immigrant Slovak residents with selected attributes of the residential environment in relation to their quality of life, which we would subsequently analyse in relation to their possible impact on housing affordability. The sample is not representative as the questionnaire was distributed online through social networks. Its purpose, however, was to connect with as many of the residents of the region, especially Slovaks, as possible, and any interested adult resident could participate.

Consequently, we statistically analysed respondents' answers to questions regarding their overall satisfaction with living in the municipality and specific neighbourhood, as well as their satisfaction with selected environmental and social attributes of their living environment. Knowing residents' subjective attitudes towards factors of their residential environment based on their expressed satisfaction can help discover issues that need to be improved to ensure a better quality of life for residents (Štefkovičová & Koch, 2022). Respondents were asked to express their satisfaction on a Likert-type scale ranging from "very dissatisfied" to "very satisfied". In the analysis, we focused primarily on the housing costs and various (dis)amenities, such as general assessment of civic amenities, the overall appearance of the neighbourhood, green areas and their maintenance, cleanliness of public spaces, the noise in the environment, traffic intensity, or feelings of personal safety. The actual scales have been validated through a pilot study that we conducted before the official survey dissemination, with the aim to confirm the face- and content validity and improve the readability of the questionnaire.

For these attributes, we calculated Kendall's tau-b correlation coefficients to see if the environmental and social attributes of housing are related to the overall rating of their satisfaction with living in Hainburg an der Donau or Kittsee. The non-parametric Kendall's tau-b correlation coefficient was used because the variables were measured at the ordinal level. We also checked the correlations using Spearman's correlation coefficient, which can

Category	Description	Respondents (N)	Respondents (%)
Gender	Men	47	31.1
	Women	104	68.9
Age	20–29	12	7.9
	30–39	65	43.0
	40–49	51	33.7
	50–59	16	10.6
	≥ 60	7	4.7
Gross income (€/month)	≤ 999	4	2.9
	1,000–1,999	25	18.0
	2,000–2,999	30	21.6
	3,000–3,999	32	23.0
	≥ 4,000	48	34.5
Household size		3.14 (mean)	1.352 (std.dev.)

Tab. 1: The descriptive statistics of the sample
Source: authors' survey

be applied to ordinal data, too. Kendall's tau-b is more appropriate to use in the case of having small data sets with many tied ranks, however, as it can provide more accurate generalisations (Field, 2018).

In addition, we asked about Slovak residents' motives for moving to the Austrian suburban municipalities. By using the Mann-Whitney U test[2] we have statistically tested whether the motive of looking for "an affordable real estate offer (house, apartment, land)" was later fulfilled by residents' satisfaction with living in the particular municipality and neighbourhood, as well as satisfaction with housing costs, i.e. whether people, whose one of the reasons for moving to Austrian suburban municipalities was more affordable housing, were truly satisfied with living in the municipality, in the neighbourhood, and with housing costs afterwards in comparison with those people who did not express such reason.

4. Result

4.1 Housing becomes less affordable

The Global Residential Cities Index by Knight Frank (2022; Fig. 3) shows that property prices in Bratislava rose with higher intensity (in relative terms) than in Vienna. Both cities (especially Bratislava) recorded an extremely high increase after the initial Covid-19 breakout and the first worldwide economic lockdown in the spring of 2020. That strengthens the claim that properties close to Bratislava might be notably affected by suburbanisation processes even in the cross-border region. Arguably, the housing affordability of "Slovak" municipalities in Austria would be influenced by the realty market in Bratislava.

Figure 4 shows the ever-increasing values of disaggregated house prices within the three studied districts. The municipalities of these districts were divided into multiple categories: Bratislava hinterland, Vienna hinterland (Wiener Aussenzone), Vienna city-core (Wiener Kernzone), and other municipalities (that is, an area outside of the suburban sphere of both cities). The municipalities which are part of multiple categories are put into all-inclusive categories. Therefore, the visual shows that suburban processes substantially impact property prices and their increase in this area. It can also be seen that the municipalities with a higher share of the ethnic Slovak population significantly affect house prices. Apart from Vienna and municipalities closely adjacent to Vienna (Wiener Kernzone), the municipalities in the Bratislava hinterland have been increasing most rapidly in terms of property prices. We are still determining why property prices in municipalities outside Vienna and Bratislava suburban areas decreased (all these municipalities are located near Neusiedler See). The reason might be an initial "shock" of the pandemic and a chance to get some physical money back from selling the property. Another explanation might be that the Slovak or Hungarian populations were selling the properties and returning to their home country due to pandemic-related border-crossing measures. It might also be influenced by its remote location from Vienna and Bratislava and, therefore, lower attractiveness for suburban residents of these cities looking for high-quality and affordable housing. We currently need more data on this issue, however, and to exhaustively answer this question is far beyond this study's objectives. The small number of observations (municipalities) included in this category might also affect the shakiness of its development. Therefore, it might be influenced by the small number of properties sold.

Although property prices grew excessively, an increase in income and a decrease in loan interest rates after the financial crisis from 2007 to 2009 led to better (higher) housing affordability in Bratislava and its hinterland (Šveda et al., 2021, 12). In recent years housing affordability has stalled, and since 2020 it has even decreased. The same development is evident in the Austrian hinterland of Bratislava (Fig. 5).

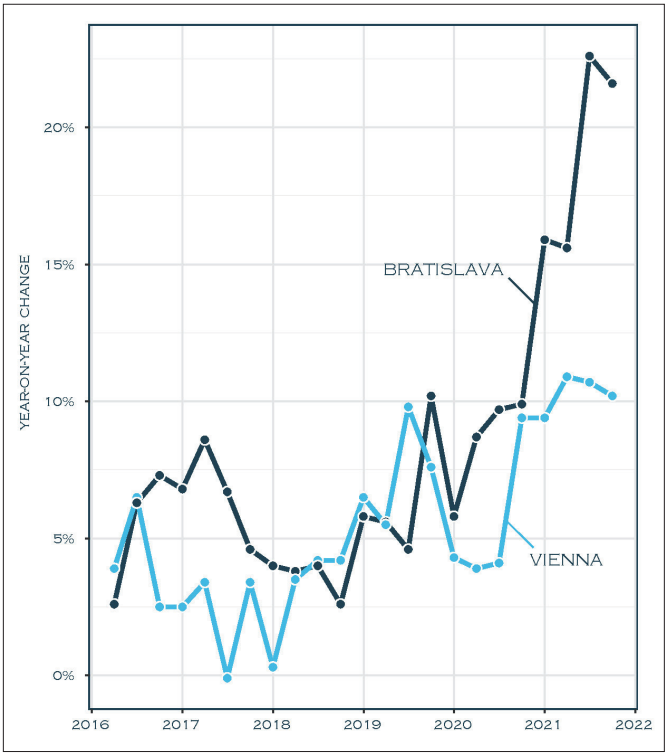

Fig. 3: Year-on-year property prices change in Bratislava and Vienna from 2016 to 2021. Source: Knight Frank (2022), authors' elaboration

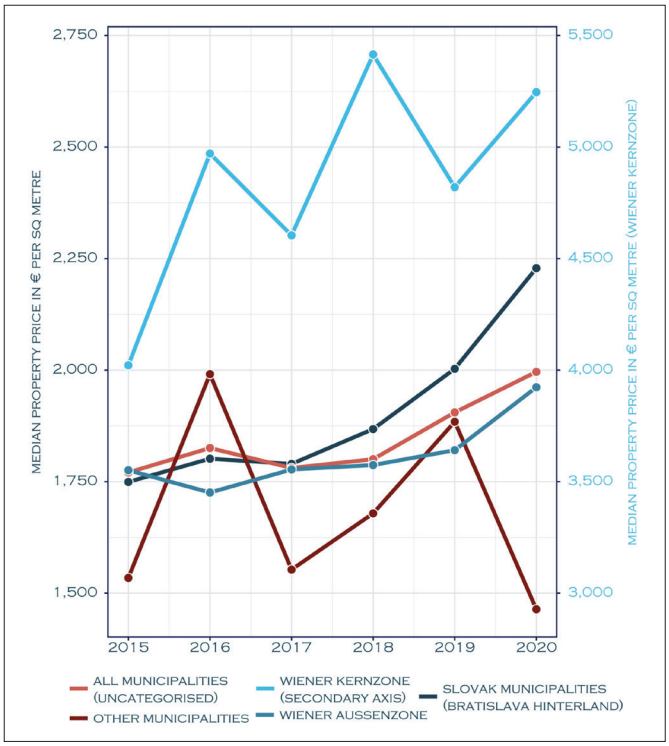

Fig. 4: Median estimated closing prices for family houses in the municipalities of the Bruck/Leitha, Gänserndorf, and Neusiedl/See districts from 2015 to 2020
Source: authors' calculations based on Statistik Austria (2021b) data

[2] Mann–Whitney U test (also called the Wilcoxon rank-sum test) tests for a statistically significant difference between two groups with non-normally distributed values or different variances (Fay & Proschan, 2010).

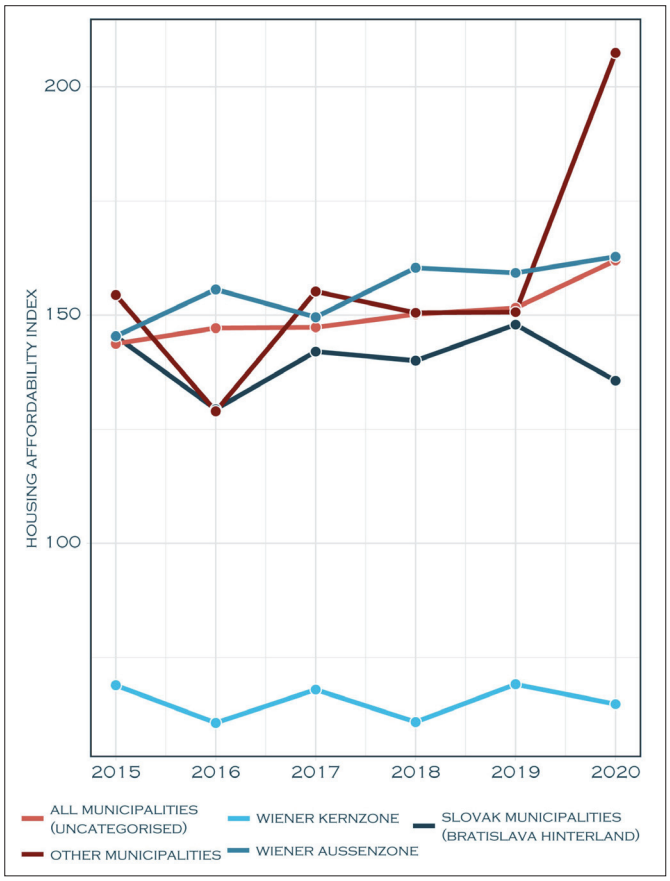

Fig. 5: The development of the housing affordability index in the defined (sub-)urban categories from 2015 to 2020
Source: authors' calculations based on Statistik Austria (2021b, 2022a) data

On the other hand, this development is spatially differentiated. In recent years, the housing in this area (Bratislava suburban zone) has been affordable, but Vienna's and Bratislava's suburbanisation processes change that pattern. An increase in average income did not reach the levels of increasing estate prices and eventually led to a decrease in housing affordability (Fig. 6). The figure shows Kittsee as a municipality with one of the lowest housing affordability values in 2020 (HAI = 77.8; the only ones with lower values are Fischamend, close to Vienna, Neusiedl am See, a regional administrative and tourism centre, and its neighbour Parndorf).

Despite still being unfavourable, however, housing affordability in Kittsee has seen an increase in recent years. Such a pattern (increase) might be seen across the Neusiedl am See district. The incomes in the district are very high, and the property prices do not reach those of the Bruck an der Leitha and Gänserndorf districts (where housing affordability decreased).

4.2 Quality of life and satisfaction with living in the cross-border suburban area

Next, we analysed the strength of association of satisfaction assessment of living in a particular municipality and neighbourhood with several environmental and social attributes of the residential environment as expressed by respondents from Hainburg an der Donau and Kittsee, using Kendall's tau-b correlation coefficient (see Tabs. 2 and 3).

In the case of respondents from Hainburg an der Donau (Tab. 2), the correlation coefficients were found to be statistically significant for all pairs of attribute ratings examined, except for ratings of satisfaction with living in the municipality and traffic intensity. A strong positive relationship between satisfaction with the overall appearance of the neighbourhood and satisfaction with living in the municipality as well as in the neighbourhood, suggests that respondents who were satisfied with living in their

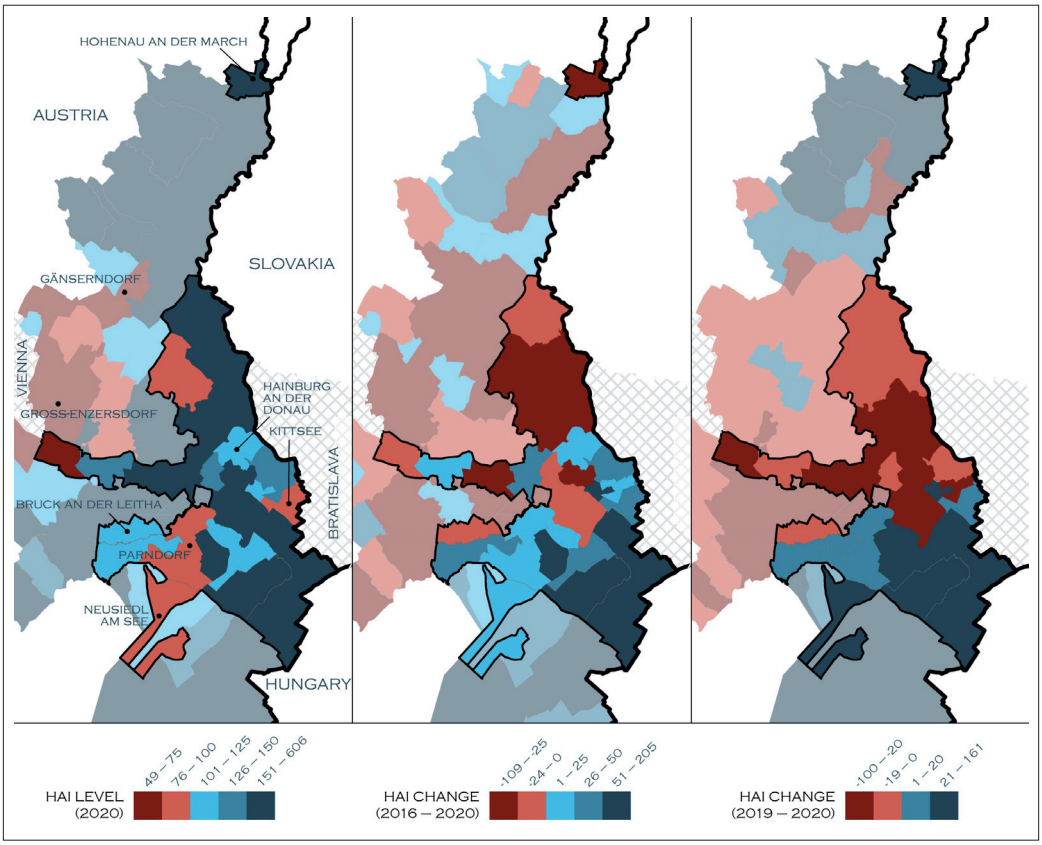

Fig. 6: Level and changes of housing affordability index in the municipalities of the Bruck/Leitha, Gänserndorf, and Neusiedl/See districts
Note: Opacity was decreased for municipalities outside the Bratislava suburban area but within the three districts studied
Source: authors' calculations based on Statistik Austria (2021b; 2022a) data

Satisfaction with		Overall appearance of the neighbourhood	Green areas and their maintenance	Cleanliness of public spaces	Noise in the environment	Traffic intensity	Personal safety	Civic amenities	Housing costs
Living in the municipality	τb	0.650***	0.387**	0.324*	0.358**	0.247	0.426**	0.258*	0.379**
	Sig.	< 0.001	0.004	0.014	0.006	0.054	0.002	0.049	0.003
	N	50	50	50	50	49	50	50	50
Living in the neighbourhood	τb	0.678***	0.429**	0.412**	0.415**	0.315*	0.573***	0.278*	0.300*
	Sig.	< 0.001	0.001	0.002	0.001	0.014	< 0.001	0.033	0.18
	N	50	50	50	50	49	50	50	50

Tab. 2: Kendall's tau-b correlation coefficients for assessments of satisfaction with living in a municipality and a neighbourhood, and satisfaction with selected attributes of the residential environment as expressed by respondents from Hainburg an der Donau
Note: τb = Kendall's tau-b; N = number of respondents; correlations significant at the (2-tailed) 0.001 (***), 0.01 (**), 0.05 (*) level
Source: authors' calculations

Satisfaction with		Overall appearance of the neighbourhood	Green areas and their maintenance	Cleanliness of public spaces	Noise in the environment	Traffic intensity	Personal safety	Civic amenities	Housing costs
Living in the municipality	τb	0.286*	0.337**	0.181	0.304*	0.262*	0.341*	0.438**	0.335**
	Sig.	0.030	0.009	0.169	0.017	0.037	0.010	0.001	0.008
	N	50	50	50	50	50	50	50	50
Living in the neighbourhood	τb	0.361**	0.248*	0.260*	0.293*	0.311*	0.304*	0.148	0.410***
	Sig.	0.005	0.048	0.042	0.018	0.011	0.018	0.255	<0.001
	N	50	50	50	50	50	50	50	50

Tab. 3: Kendall's tau-b correlation coefficients for assessments of satisfaction with living in a municipality and a neighbourhood, and satisfaction with selected attributes of the residential environment as expressed by respondents from Kittsee
Note: τb = Kendall's tau-b; N = number of respondents; correlations significant at the (2-tailed) 0.001 (***), 0.01 (**), 0.05 (*) level
Source: authors' calculations

residential environment were also satisfied with the general neighbourhood aesthetics. A relatively large effect was found with the relationship between both levels of the residential environment (municipality and neighbourhood) and a feeling of personal safety. A medium effect was observed with the relationships between the satisfaction with the residential environment and green areas and their maintenance, the cleanliness of public spaces, the noise in the environment, and housing costs. Although the correlation between satisfaction with civic amenities and the residential environment was significant, the effect was rather small, similar to the correlation between satisfaction with living in the neighbourhood and traffic intensity.

The values of Kendall's tau-b correlation coefficients for satisfaction assessments with their residential environment and its attributes by respondents from Kittsee (Tab. 3) represent a much smaller effect in most observed relationships than the same assessments by respondents from Hainburg an der Donau (Tab. 2). This does not necessarily mean that respondents from Kittsee were less satisfied with the environmental attributes assessed. A relatively medium effect was observed only with the correlation coefficients between satisfaction with living in the particular residential environment and satisfaction with civic amenities and housing costs.

Finally, we wanted to find out whether there is a difference in satisfaction levels regarding housing between two groups of Slovak respondents – those who, in their intention to move, also looked at the affordability of housing, and those, for whom this issue was not important. Because the dependent variables were ordinal, we performed a non-parametric Mann-Whitney U test to compare the satisfaction levels of the two groups on three different aspects. The first group of respondents are those that expressed the affordable real estate offer (house, apartment, land) as a motive for the residential decision to move to the Austrian suburbs of Bratislava (marked as "Yes" in Tab. 4, i.e. affordable housing "seekers"). For respondents from the second group, such a motive was not relevant (marked as "No" in Tab. 4, i.e. affordable housing "non-seekers").

As regards the satisfaction with living in the municipality, affordable-housing-seekers (N = 64) have higher mean ranks (86.88) than non-seekers (67.99; N = 87), U = 2,087.5, p = 0.003, r = – 0.24, which was a statistically significant difference and, according to Morgan et al. (2020), is a small to medium effect size (an effect size was calculated as $r = Z / \sqrt{N}$). Similarly, a statistically significant difference can be observed in the mean ranks of seekers (86.54) and non-seekers (67.28) on satisfaction with housing costs, U = 2,045.5, p = 0.005, r = – 0,23, which is a small to medium effect size. The two groups did not show a statistically significant difference in satisfaction with living in the neighbourhood, with mean ranks of 73.24 and 79.76, respectively, and U = 2,543.5, p = 0.310, and r = – 0.08 (Tab. 5).

5. Discussion and conclusions

Housing affordability in the Austrian hinterland of Bratislava has recently stalled and in 2020, it dropped substantially. It was partially affected by lower wage growth (about one tenth increase

	Affordable real estate offer [1]	N	Mean Rank	Sum of Ranks
Satisfaction with living in the municipality	No	87	67.99	5,915.50
	Yes	64	86.88	5,560.50
	Total	151		
Satisfaction with living in the neighbourhood	No	87	73.24	6,371.50
	Yes	64	79.76	5,104.50
	Total	151		
Satisfaction with housing costs	No	86	67.28	5,786.50
	Yes	64	86.54	5,538.50
	Total	150		

Tab. 4: Mann-Whitney U test – ranks (Note: [1]Affordable real estate offer (house, apartment, land) as a motive for residential decision) Source: authors' calculations

	Satisfaction with living in the municipality	Satisfaction with living in the neighbourhood	Satisfaction with housing costs
Mann-Whitney U	2,087.50	2,543.50	2,045.50
Wilcoxon W	5,915.50	6,371.50	5,786.50
Z	− 2.985	− 1.016	− 2.803
Asymp. Sig. (2-tailed)	0.003	0.310	0.005

Tab. 5: Mann-Whitney U test – test statistics (Note: Grouping variable: affordable real estate (house, apartment, land) offer as a motive for residential decision). Source: authors' calculations

from 2016 to 2020). That affirms the questionnaire results by Falťan and Moravanská (2020, 11), who found that less than 2% of respondents (Kittsee incomers) were looking for financially-affordable housing in this location. The unprecedented increase in house prices in the corona-crisis period led to a further deterioration of the property and housing market.

As a result of the anti-pandemic measures, we are witnessing a significant rise in inflation across the Eurozone, well above a sustainable 2%. The Russian aggression in Ukraine is pushing inflation even higher, and the pressure from the refugee wave may mean further house price rises in this region. Rising inflation pressures national central banks and the ECB to raise key interest rates. Moreover, inflation pushes construction material prices up, slowing housing construction down. The improvement in housing affordability after 2008 in Slovakia and the Bratislava region was mainly due to a significant reduction in interest rates on housing loans. A halt in their reduction has led to a reversal of this trend. Key interest rates have risen sharply in neighbouring countries (the Czech Republic, Hungary, and Poland). The ECB is still waiting for interest rate hikes, but banks in Slovakia, Austria and other Eurozone countries have started making mortgages more expensive.

Quality of life is interlinked with housing affordability, as housing affordability influences the perceived quality of life. Simultaneously, the prerequisites for a satisfactory residential environment that, to an extent, influence the perception of subjective quality of life, impact housing affordability (cf. Bieri, 2012; Florida et al., 2013; Anenberg & Kung, 2020). Slovak residents who moved to the Austrian suburbs of Bratislava intending to find affordable housing according to their wishes, were generally more satisfied with living in their municipality and housing costs than residents for whom this motive was irrelevant. It should be noted, however, that although the search for more affordable housing was one of the most common motives for many Slovak residents to move to the Austrian suburbs of Bratislava, it was outweighed by the motive of seeking a higher quality of life and better-quality housing in a quiet rural and aesthetically appealing environment close to a large city (cf. Šveda et al., 2020; Štefkovičová & Koch, 2022).

A higher reported quality of life from the perspective of residential satisfaction is also related to the attributes of the residential environment (cf. Biolek et al., 2017; Nguyen et al., 2018; Bursa, 2021), such as its overall aesthetics and cleanliness, amount of greenery, perceived safety, the noise in the environment, or the presence of quality civic amenities. Provided the environment has the required quality of these attributes, it becomes more pleasant to live in. The demand for housing in attractive locations also pushes house prices and impacts housing affordability. On the other hand, residents are usually willing to pay a premium price to live in an environment that meets their needs. If residents pay more than a third of their net income in housing costs, however, housing becomes less affordable and can mean financial hardship (Shamsuddin & Campbell, 2022).

Although the research results may not provide exhaustive findings on housing affordability, quality of life, and residential satisfaction in the (cross-)border suburban region of Bratislava; they might be useful for decision-makers in providing quality rental housing. The National Bank of Slovakia (Apolen, 2022) has announced the regulation of silver mortgages, which the borrowers repay until retirement age. Although this may reduce upward pressure on house prices in the Slovak hinterland of Bratislava, it will, on the contrary, also reduce the affordability of housing for some social classes. Therefore, affordable rental housing should be an adequate substitute for selected population groups who cannot afford homeownership.

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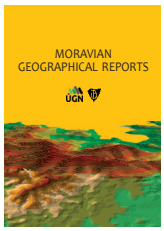

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Changeability of transport behaviour in a large city from the perspective of working days and Sundays: The case of Łódź, Poland

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Abstract

The transport behaviour of Lodz residents with a view to constructing a balanced traffic model to include both private and public transport is examined in this paper. A survey was conducted among 6,000 Łódź citizens using mixed-mode techniques: CAWI and CATI: respondents were asked to complete a travel log for the previous day and the previous Sunday. This served as a basis for further analyses, performed with PTV simulation software, following a four-step model. The main results of the study are presented, including the mobility rate of Łódź residents, the motivations and duration of journeys, and the division of transport tasks into workdays and Sundays, indicating that a higher private carload is typical for home-other and other-home trips on Sundays compared to working days. The number of home to work and work-home trips via private cars is higher for working days compared to Sundays. Furthermore, the simulated traffic load of the public transport system is much higher for working days compared to Sundays. A higher percentage of non-motorised trips and longer trip duration are found to be common for Sundays as well.

Keywords: *transport behaviour, macroscale traffic model, survey research, Łódź, Poland*

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1. Introduction

Numerous modern cities face challenges from the negative effects of human activity, including those directly related to traffic, mostly private cars. Not only does road transport generate noise and pollute the air, but it also results in congestion, parking issues, and accidents (Proost & Van Dender, 2001). Before the 1990s, successive infrastructural investments were introduced to reduce the negative effects of traffic, especially congestion. These proved to be not very effective, however, and, as a result, they have been superseded by traffic forecasting (Wismans et al., 2014). Traffic models constitute a mathematical representation of the structure of transport demand based on research into travel behaviour within a given territorial unit. Traffic model tools are currently applied in, among others, transport studies for the diagnosis of transport system performance, traffic forecasts for specified strategic initiatives, and transport-related studies for investment projects (Boarnet & Sarmiento, 1998; Barceló, 2010). The actual description of a transport system is quite challenging, due to the high complexity of transport subsystems and correlations between their individual components (e.g. time). This is where traffic models come into play, with mathematical models providing a sufficiently accurate representation of a given transport system (Fielbaum et. al., 2017).

The development of traffic models is enhanced by the collection of relevant data that describe transport needs, journeys taken, and the operations of the transport system itself (Meyer, 2016). The volume and detail of these data are determined by the structure of the traffic model for a given area and the scope of the project it is intended to serve. Surveys on residents' mobility within a given province, metropolitan area or city are key elements in the process of building traffic models (Karoń & Mikulski, 2013).

The significance of these results for the development of the social sciences, social and economic geography, as well as spatial development, is difficult to be overstated. The accomplishment of this research project fills a gap concerning the characteristics of

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transport behaviours of Łódź inhabitants. The analyses carried out using the questionnaire survey were a necessary supplement to the set of quantitative data collected so far in the literature (including the spatial and temporal structure of vehicle traffic), concerning the functioning of the Łódź transport system. They made it possible to learn the travel motivations undertaken by people in spatial terms and at a certain time, using the modes of transport chosen by them. The conducted survey studies belong to the only reliable sources of knowledge that comprehensively provide knowledge about the demand for transport services. Nowadays, conducting extensive social research is considered one of the basic elements of creating transport policy. The obtained data can be used in prognostic analyses of the development of the transport system in order to meet, for example, the requirements related to sustainable urban transport.

This paper analyses the transport behaviour of residents in the City of Łódź (Poland), with a view to building a balanced traffic model for private and public transport. To conduct a detailed analysis of transport behaviour, the study included travel logs (one for a weekday, and one for a Sunday) to provide an insight into the routines of journey-takers and to indicate their main destinations (Stopher, 1992; Axhausen et. al., 2002). As there has yet to be a traffic model for Łódź, this study may be considered quite innovative. According to the 2020 TomTom Traffic Index, Łódź was the most congested Polish city (Rogulski & Badyda, 2021), thus, the construction of a mathematical model for the city is seen as vital for both traffic management and the planning of new investments. Since congestion of the transport system translates into the irregular operations of the public transport system (which is taken into account by the residents), it is imperative to introduce and then systematically monitor and revise strategies and practices to reduce the demand for car travel. The decision-making process when selecting a given mode of transport is based on many variables, hence, it is vital to create traffic models that considers people's mobility needs and behaviour (mobility management). Importantly, however, each city possesses unique conditions that impact the trips within its boundaries. For this reason, a traffic model requires an individual approach for each given city.

2. Theoretical background

Transport behaviour is defined as the actions (variously motivated) taken in a specific space and time to travel using a particular mode of transport, and is determined by social, economic, spatial and organisational factors. Research on transport behaviour in developed countries began in the mid-twentieth century. Liepmann (1945) explored the correlation between travel time and cost, and modal selection through the analyses of commuter data, while the very first researchers to investigate the relationship between land use and transport behaviour were Mitchell and Rapkin (1954). Concepts of transport behaviour evolved to include analyses of mode choice (Ben-Akiva & Lerman, 1985; Sayed & Razavi, 2000) and the impact of land use and urban design on transport behaviour (Handy, 1996; Kockelman, 1997; Boarnet & Crane, 2001). The development of theories on transport behaviour has led to the emergence of mathematical models for the selection of the mode of transport based on the economic measurement of satisfaction, i.e. maximisation of satisfaction resulting from its usability. These models have formed the basis of studies by a number of researchers, including Boarnet and Crane (2001). They are based on the idea that the choice of where one resides depends on the location of the workplace and the other potential destinations that satisfy our needs. This in turn impacts our transport behaviour.

The transport behaviours of city residents and the factors that affect them have long been the subject of scientific research (e.g. Bruns & Matthees, 2019; De Vos et. al., 2018; Cao & Ermagun, 2017; Stevens, 2017) and field studies (e.g. Transport Behaviour among Residents of Large Cities, 2021). The findings of such studies enhance mobility management, urban planning and infrastructure development, both technical and public. The dominant types of research are empirical studies that link travel decisions (e.g. choice of transport mode) to land-use, transport infrastructure, socio-demographic and personal traits and preferences. Theoretical work is also emerging where authors attempt to formulate universal models that encompass the above (e.g. Van Acker et al., 2010).

In Poland, an increased interest in this issue came relatively late. It is only in the last two decades that publications and studies on the subject began to emerge, though still relatively few when compared to other urban issues researched. It is, therefore, reasonable to conduct analyses on various dimensions of transport behaviour among city dwellers in Poland to enrich the global scientific output with the local perspective and to contribute to the international discussion on this topic.

Expanding knowledge on the preferences of road users is a prerequisite in the process of shaping their transport behaviour, the main aim of which is to provide a fast, safe, efficient, and environmentally friendly transport system that addresses the needs of the various social groups. As shown by numerous studies, people's transport behaviour is largely determined by the place of residence (e.g. van de Coevering et. al., 2018; Wang & Lin, 2017; De Vos & Witlox, 2016; Ewing & Cervero, 2010; Cao et. al., 2009). Residents of areas close to the city centre – densely built-up districts with diverse facilities and a well-developed public transport system – are more likely to eschew owning a car, being instead more willing to walk, cycle or use public transport (De Vos et. al., 2018; De Vos & Witlox, 2013; Ewing & Cervero, 2010). In turn, residents of sparsely populated areas with low-density housing and poorer access to public transport and necessary amenities, are less likely to use public transport and therefore have to rely on the car.

A key factor affecting the mobility decisions of residents is the nature of the local transport system. The level of accessibility and the quality of the transport infrastructure dictate choices in terms of modes of transport, number of daily trips and directions of travel. Residents of residential areas located in close proximity to public transport tend to use public transport services far more frequently than residents of areas more distant from such infrastructures (Lane, 2008; Hass-Klau & Crampton, 2002; Gadziński & Radzimski, 2015).

The authors suggest that understanding of the factors that affect transport behaviour is an important element when developing and improving public transport services. Before deciding whether to opt for public transport, people consider whether the vehicles run on schedule, if they can travel without having to change, if they feel safe on the vehicles and at the stops, and how easily accessible the stops are. The authors also feel, however, that determinants of a psychosocial nature are equally important, including personal routines, preferences and currently-promoted pro-environmental attitudes.

Demographic changes and socio-economic development have impacted residents' transport behaviour to the detriment of their environment. The ever-increasing number of cars results in higher exhaust and noise emissions, traffic congestion, and reduced road safety. This poses a challenge to authorities, who must continuously attempt to improve the efficiency of the city's transport system (Wójcik, 2020). Any research effort which addresses this issue and provides guidelines for the necessary changes in cities therefore will be not only a contribution to the theoretical development of the field, but may also facilitate the process of changing transport systems in cities for the better.

Residents of large cities usually display greater mobility than those living in small towns and villages, mainly due to the increased density of travel destinations, their location, and the distance between them. This is why a considerably larger number of analytical studies focus on the residents of large cities, including this article. The results on mobility in Lodz enable comparative analyses with other urban centres, and complement research projects that have already been undertaken in this area.

3. Area under study

Łódź is a large city, whose population – according to the 2020 data provided by the Central Statistical Office – amounted to 672,185 residents, including 55.73% people of working age, 29% of post-working age and 15.27% of pre-working age. The highest population density is recorded in the city centre (defined as the area within the boundaries of the ring railway) (Fig. 1).

The spatial mobility of the population is impacted, *inter alia*, by the land use within the boundaries of a given area, which makes the analysis of the transport system (Fig. 1), land use, including the location of recreational facilities, parks, and public buildings (Fig. 2), particularly important. International, national and regional roads, as well as the ring railway line run within the city limits. Due to its specific (ring-shaped) course, however, the latter remains outside of the major factors that shape the public transport in the city.

In Łódź, the overall travel volume is dominated by non-pedestrian trips (87.67%), particularly by private cars (both on working days and Sundays). This can be partly attributed to the city being at the centre of its region, and far from other large urban centres. As a result, Łódź residents display high mobility – mainly for work purposes. Importantly, the standards of the services provided by the city's public transport system fail to meet the expectations of the general public (Borowska-Stefańska et al., 2020).

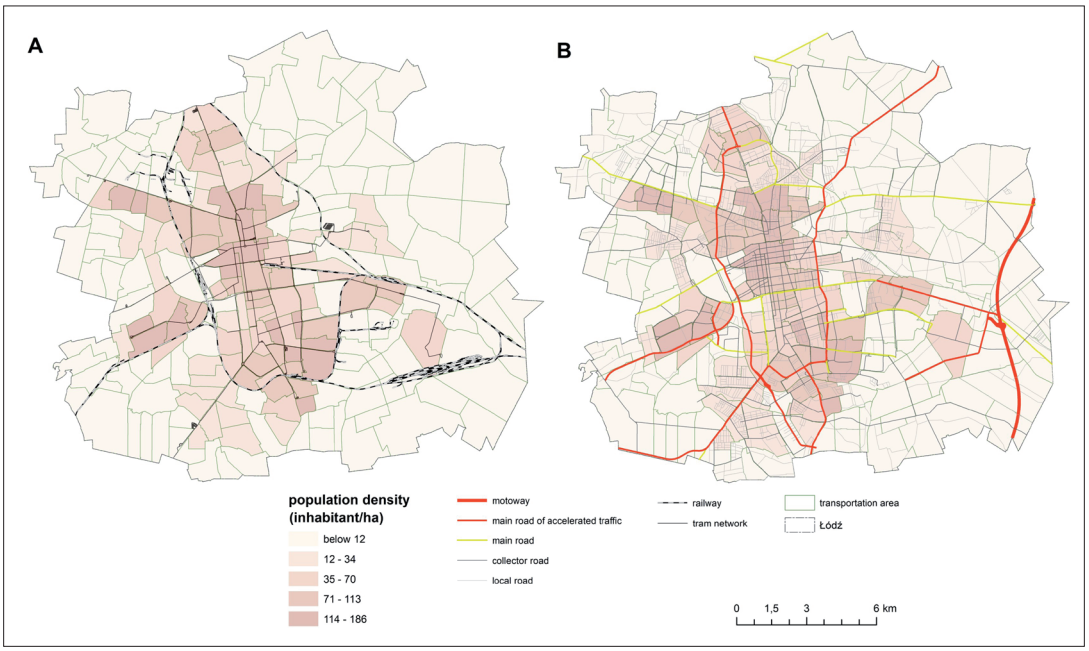

Fig. 1: Railway (A) and road (B) infrastructure and population density in Łódź
Source: authors' elaboration based on data from City Hall

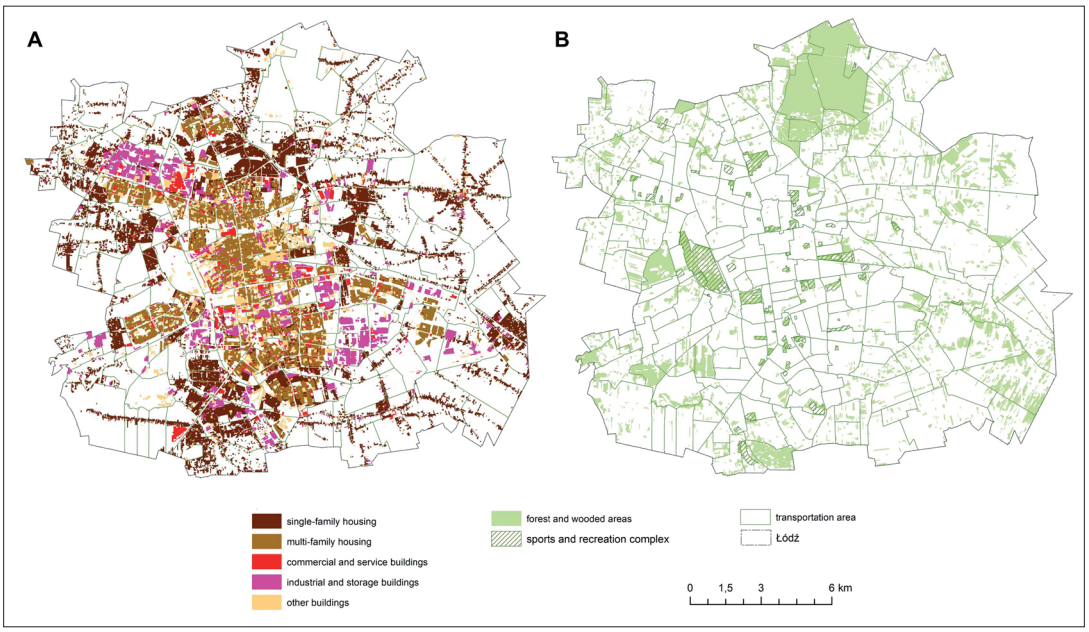

Fig. 2: Distribution of housing (A), green areas and recreational facilities, including sports (B) in Łódź
Source: authors' elaboration based on data from Database of Topographic Objects.

The spatial distribution of residential and industrial areas as well as retail and service-related facilities is an important factor when transport needs are analysed. In areas that are dense and mixed-use, the resulting short distances between the places of residence, work, education and leisure favour the bicycle as a commonly chosen means of transport (Rixey, 2013). In Łódź, however, the dominant type of land use is residential (single- and multi-family housing), with industrial facilities being primarily located outside the city centre (in the north-west and south), whereas retail and service-related facilities are predominantly located in the city centre (Fig. 2).

4. Research methods

The entire research procedure is captured in the following Flow Chart (Fig. 3).

4.1 Questionnaire survey

To analyse the transport behaviour of Łódź residents – without which data a traffic model for the city could not be developed – the authors conducted a survey using a mixed-mode technique that combined CAWI (Computer Assisted Web Interviewing) and CATI (Computer Assisted Telephone Interviewing). The development of a model is impossible without access to a variety of data, including that on transport needs, trips taken, and the operation of the transport system itself (Meyer, 2016). The questionnaire was meticulously designed and pre-tested through a pilot study conducted among Łódź residents in the autumn of 2018.

The actual survey involved 6,118 residents of Łódź, aged 13+ (4,220 respondents interviewed with the CATI technique; 1,898 secondary school students with the CAWI technique). The sample was representative with respect to the city's population aged 13+ and place of residence (covering the various districts of Łódź) and included slightly more than the 1% of the city's total population within the age bracket – that is the sample size (the number of questionnaires completed) that should be the minimum for large Polish cities. This corresponds to the recommendations for survey coverage in studies conducted on cities with similar demographic potential found in other parts of the world (Button & Hensher, 2005; Horbachov et al., 2022). The surveys were conducted during selected weeks in October, November and early December 2021, from Tuesday to Saturday, but asked about the last workday and last Sunday. These periods were chosen as they were devoid of any anomalies that could impact the analysed behaviour while retaining all travel motivations and the typical frequency of trips related to them. As the research was conducted during the pandemic, however, the technique of Computer-Assisted Personal Interviews (CAPI) had to be abandoned to reach the highest possible number of respondents.

The actual survey questionnaire consisted of three parts: (1) the respondent's socio-demographic characteristics; (2) questions on consumer behaviour, both prior to 2017 and today; and (3) a travel log. This paper discusses the data from two of these sections, the first and the last. The opening section contained the details of the respondent and their household. The interviewees were asked about, or filled in, data regarding: gender, age, address of residence (postal code or street), type of housing, education, driving licence, primary occupation, and economic sector of employment. The next part concerned the whole household and data on the number of household residents, the number of children under 6, monthly net income per capita, and the number of bicycles, motorcycles, mopeds, and cars, if any. The analytical results of shopping-related transport behaviour compiled on the basis of the respondents' answers to questions in section 2, are presented, *inter alia*, in Borowska-Stefańska et al., 2022a and Borowska-Stefańska et al., 2022b.

The final section consisted of two travel logs, where the respondent was asked about trips taken during the preceding Sunday and the weekday prior to answering the survey. If no trips were taken on these days, they were to specify the reason behind it. Those respondents who travelled on the chosen days provided the number of trips, their origins and destinations, and the transport mode used. If these included public transport, they were also requested to specify whether there was a need to change the form of transport or transfer to another route but on the same form of transport within the city limits (and if so, how many times), and how long it took them to reach the first transport mode during a given trip. In addition, the travel log also requested that the respondents indicate whether they travelled alone and whether there were children under 6 among the passengers.

The research presented herein focuses on the period of the global COVID-19, which obviously had a significant impact on daily activities, including transport behaviour. The results

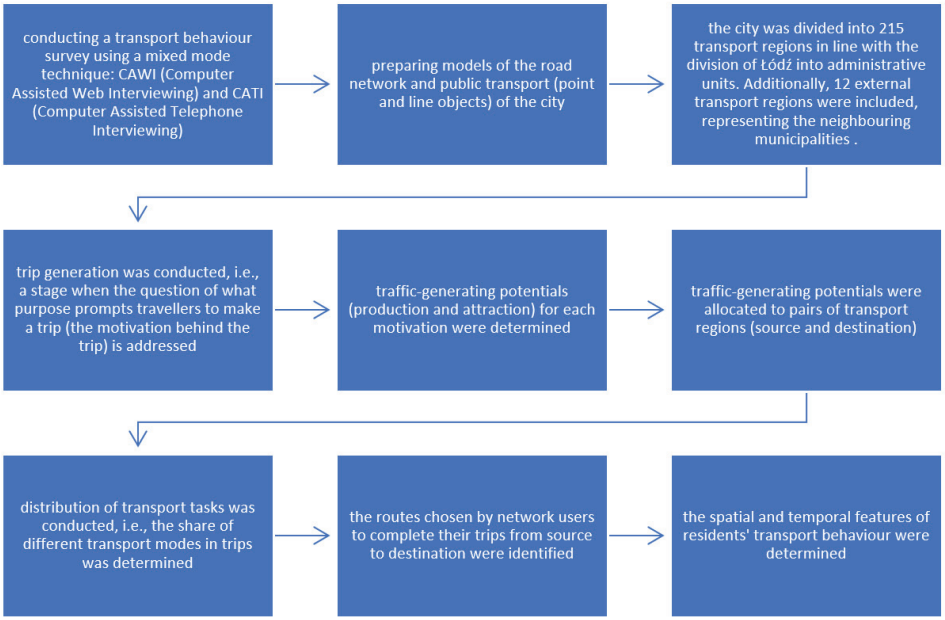

Fig. 3: A simplified plan of the research procedure
Source: authors' elaboration

presented in this paper can constitute a valid point of reference for analyses conducted at that particular time, capturing the actual changes in this matter. The existing studies clearly show that there was a significantly lower propensity to travel during the pandemic, which relates to public transport in particular (Bartuska et. al., 2022; Shibayama et. al, 2021). Previous studies of the transport system in Łódź covering the pandemic period clearly indicate a definite reduction in the spatial mobility of the city's inhabitants in the early days of the pandemic (spring 2020). This mainly stemmed from the mobility restrictions introduced in March 2020 and residents' fear of the new disease. Following an initial, dramatic drop in mobility, the situation changed towards increasing volumes later observed in both public and individual transport. Subsequent pandemic-related legal restrictions on mobility had a lesser impact on the observed traffic in the city, which stabilised in late 2020, albeit at lower levels than in 2019 (Borowska-Stefańska et al., 2022a). This study was conducted over six months after the period of observations cited above, at a time when the pandemic restrictions were becoming less severe and had an increasingly lower impact on residents' mobility (the restrictions in force at the time the questionnaire study was conducted, involved wearing masks indoors and limited access to certain services).

4.2 The local traffic model

Once the road network with public transport models (point and linear objects) of the city had been prepared (along with the parameters required for the subsequent traffic distribution), it was possible to conduct the following stages in line with the four-step approach (implemented entirely using the PTV Visum software). Step one was trip generation, i.e. the stage when it is necessary to determine what purpose motivates the road network users to make a trip. The study incorporated all motivations for using the urban transport system (and listed in the travel log), which were then aggregated to the following types of trips: home-work, work-home, home-education, education-home, home-other, other-home, or unrelated to home. Thus, it was necessary to determine the traffic generating potentials (generation and attraction) for each trip. The most applied trip generation model is the linear regression model, also referred to as a multiple regression model (Cordera et al., 2017; Schneider et al., 2015). For traffic generation, the model usually contains the demographic and socio-economic profile of the population within a given transport region, while for attraction, it is the properties of land use and development. With regards to the motivation behind commuting to work, it could be the number of the employees and jobs, or the number of business entities.

The second step is the spatial distribution of trips, which is simply the distribution of traffic generating potentials between pairs of transport origins and destinations. The result is an origin-destination matrix (O-D matrix), with a size corresponding to the number of transport regions graphically represented on a map of the transport system.

The third step involves a modal split which determines the percentage of the trips. There is a primary split, performed during the generation of trips, and a secondary split, following the spatial distribution of trips and resulting from a number of factors (distance, travel time, etc.) that are considered by the journey-taker. The selection of the transport mode is a complex process, conditioned by such factors as access to a private car or public transport, household income, perception of the comfort and convenience of the options available, trip motivation, and individual preferences regarding mobility behaviour. Once identified, it provides a basis for defining the dimensions of transport networks (density and capacity of the street network, density and capability of the public transport network, etc.), and for options that would alter mobility behaviour, e.g. measures taken to lower the percentage of private car journeys (Sawicki et al., 2016; Fierek & Zak, 2012; Bovy & Stern, 2012). The modal split applied in this study took into account both pedestrian and non-pedestrian trips. The former include trips made by non-motorised means of transport, e.g. bicycles and scooters, while for non-pedestrian travel, private cars and public transport (buses, trams, and trains) were modelled.

The final step is the distribution of traffic (user equilibrium) over the network. This is when the route taken by the users of the road network to travel from a given origin to destination is determined. The number of vehicles (and passengers) utilising a given section of the transport network (road, street, public transport line, etc.) is specified. Decisions may then be made on the type of intersection or hub, the dimension of road structures, how to plan traffic management, assess traffic conditions, and even strategically plan for situations that may occur in the future.

Regarding the data sources applied to build the supply model, the authors utilised the network data provided by geodetic and cartographic documentation centres, OpenStreetMap resources, and data retrieved from local authorities (the local public transport authority). To model the road network, road classes (motorway, fast traffic trunk road, main road, service road, local road, access road, other road) were assigned, with an additional division into grade-separated road segments, sections of increased or decreased capacity, and sections where traffic-calming measures have been installed. The course of tram and rail tracks was also taken into account. With respect to public transport, all bus, tram, and railway (the Łódź agglomeration railway) lines operating in Łódź were also taken into consideration, including night and replacement service. Depending on the period modelled, only those lines that were operational at a given time are represented in the simulations. All fixed components of the local public transport infrastructure (stops, terminuses, and stations) were also incorporated. Their distribution over the local public transport network required the network of stops to be recreated as a system of nodes. This was conducted in line with the following algorithm. First, the stops in Łódź were clustered using the criterion of spatial proximity, e.g. clusters may consist of stops on opposite sides of the street where a passenger can start a journey in two directions, or stops located at a particular junction where a journey is usually possible in more than two directions. When a given stop was not in close proximity to others, it was considered a single-spot cluster. Next, each stop from a given cluster received a cluster identification number. Then, based on the geographical coordinates of the stops within a given cluster, points with coordinates constituting their arithmetic mean were generated. These points were given both a cluster identification number and an ID for each stop within the cluster. As a result, a system of points and nodes was obtained that constituted a true representation of the fixed components of the transport network, and, at the same time, a simplification of its visualisation and the accommodation of further analyses, which included the construction of a graph.

The city was divided into 215 transport regions that corresponded to the official division into administrative districts. Additionally, 12 external transport regions were included, representing the municipalities neighbouring Łódź. External users were never excluded from the traffic model. Both employees commuting to and from Łódź were taken into account (based on the matrix data from the Central Statistical Office) while other travel motivations from neighbouring municipalities were also modelled. Moreover, transit traffic through Łódź, e.g. via the section of the A1 motorway (running along the eastern outskirts of the city) was also taken into account. The inclusion of outward source, inward source and transit journeys made the modelling process considerably more realistic. Demographic and socio-economic data was retrieved from public statistical data (e.g. the Central Statistical Office) and from the city authorities, pursuant

to cooperative research agreements. The features of transport behaviour displayed by Łódź residents that are necessary for the construction of a macro-simulation model and its subsequent calibration were acquired through the questionnaire survey, as described in section 4.1. The authors also applied the results of traffic measurements taken automatically by the city's intelligent transport system (induction loops and ANPR cameras). With regard to the modelling of trip generation (demand model), the following attributes of the traffic regions were taken into consideration: total population, populations of working and school age, the number and capacity of schools, commercial and industrial facilities, and grocery and non-grocery shops. Generation of external traffic was additionally expanded with the matrix data on commuting provided by the Central Statistical Office, while data on traffic flows within the urban section of the A1 motorway was retrieved from the records in the 2020/2021 General Traffic Measurement by the General Directorate for National Roads and Motorways.

5. Results and discussion

5.1 The number and motivations behind trips, and reasons for not travelling

The study showed that mobility (defined as the average number of trips by a resident of Łódź per day) was low, amounting to 1.37 on weekdays and 0.82 on Sundays. The average mobility in Łódź was considerably lower than in the Krakow metropolitan area (2.02 trips on average made by Krakow residents, and 1.66 trips made by residents of neighbouring municipalities) (Szarata, 2015), Warsaw (1.99 trips per day) (Jacyna et al., 2016), the Poznan agglomeration (1.83 trips a day), and in the city of Poznan itself (Gadziński, 2016), the Pomeranian Province excluding the Tri-City (1.9 trips a day) (Jamroz et. al., 2014), Wroclaw (1.7 trips per day), and Gdansk (2.1 trips per day) (Gadziński & Goras, 2019). The observations recorded in Łódź were also noticeably lower than in previous years: 1.91 trips per day in 1974 (Gadziński & Goras, 2019), 2.13 trips in 1995 (Wójcik, 2020), 2.4 trips in 2013 (City Office, 2013), and 2.2 trips in 2014 (City Office, 2014). In all likelihood, the overall low mobility may have been due to the COVID-19 pandemic and the resultant changes in mobility among the population (increase in remote working, etc.) (Engle et al., 2020; Martin & Bergmann, 2021; Schlosser et al., 2020; Tarkowski et al., 2020). As shown by Borowska-Stefańska et al. (2022a), even though the effect of reduced mobility in Łódź was most conspicuous in the initial phase of the pandemic, a decrease in the load on the road network was also observed in its final period (when the questionnaire survey was conducted). In addition to the pandemic, the reduced mobility of Łódź residents on Sundays was also impacted by Sunday retail restrictions, the mobility-reducing effects of which are observable in the various transport subsystems in Łódź (Borowska-Stefańska et al., 2022a, Borowska-Stefańska et al., 2022b).

Economic accessibility to means of transport among Łódź residents remains at a threshold at which people would refrain from travelling due to lack of funds. The majority of respondents, however, explained that any decision not to travel was due to either no necessity, health issues, or legal restrictions related to the quarantine. A relatively large percentage of Łódź residents did not travel to work since they could perform their duties at home. As for Sundays, unfavourable weather conditions and guests at home were frequently indicated by Łódź citizens as the reasons behind their decision not to travel (Fig. 4).

Travel motivations of Łódź residents vary depending on the day of the week when trips were made. On weekdays, necessary trips dominate (slightly over 50% of all trips motivated by commuting to school or work), which is in line with other Polish cities (Szarata, 2015). By contrast, the percentage of necessary trips on Sundays drops to no more than 10%. On weekdays, optional trips are made mainly to shopping centres (15.4%), other shopping locations (6.3%) or commercial facilities (4.5%), followed by trips related to socialising (5.3%) and recreation (4.1%). The large percentages of shopping trips and visits to shopping centres are consistent with global findings (Zhang et al., 2021). In the UK, approximately 20% of all trips originating from home are related to shopping motivations (Guy, 2009), whereas in Poland, 10.2% of all trips are shopping-related (9.6% of all weekday trips and 14.2% of weekend trips), while in the Łódź Province this percentage amounts to 9.5% (9% on weekdays and 12.7% at weekends), and in the city of Łódź alone, to 8.2% (annually 37 trips per capita) (Central Statistical Office, 2015). Sunday retail restrictions, which affect shopping centres, are reflected in the increased percentage of trips made to visit these facilities on weekdays, with an increase in the share of shopping trips to locations other than the centres being observed on Sundays. More than one in four Sunday trips in Łódź is for social purposes, almost one in five for recreational activities, while almost one in ten is for religious needs (Tab. 1). When juxtaposed against the national average, the latter is relatively low, which is confirmed in the statistics published by the Institute of Catholic Church Statistics (ISKK, 2021) for the Łódź Archdiocese on the exceptionally low percentage of dominicantes in the parishes around Łódź.

The average multi-stage journey in Łódź consists of two trips, irrespective of whether it involves walking or another transport mode. For workdays, however, there is a noticeable increase in the percentage of journeys consisting of more than two stages (Fig. 5). The highest car traffic, regardless of the trip motivation, is recorded on the road network within the city's inner ring road network of streets and roads (an elliptical system with the meridionally elongated ellipse axis formed by national roads No. 91, 14, and 72), the main east-west road axis, and the arteries connecting the aforementioned ring road to distally-located neighbourhoods: the residential districts of Retkinia, Teofilow and Widzew, etc. (see Figs. 6 and 7). It was found that a higher private car load was typical for home-other and other-home trips

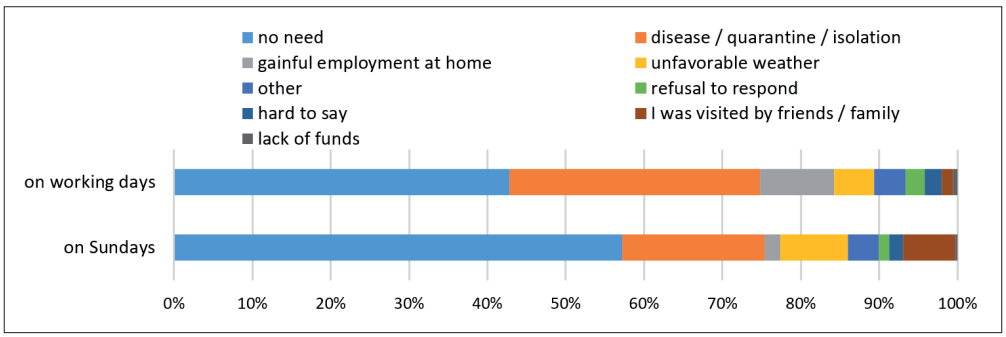

Fig. 4: Reasons for not travelling on weekdays and Sundays in Łódź in 2021
Source: authors' survey

Travel motivations	Working days (%)	Sundays (%)
Purpose related to paid work outside the home	42.4	8.9
Purpose related to shopping in a shopping and service centre	15.4	5.0
School or education purpose	8.4	0.2
Driving, escorting other people	6.6	1.9
Using the service sector (e.g. hairdresser, doctor, bank)	6.3	0.9
Social purpose (visiting friends or family in their home)	5.3	28.4
Purpose related to purchases at facilities not covered by trade restrictions	4.5	8.1
Purpose related to recreation / hobby / sport	4.1	18.6
Household matters	1.5	1.2
Entertainment and cultural purpose	0.9	5.2
Visit to a gastronomic establishment	0.8	4.2
Purpose related to religion	0.6	9.9
Motivation related to learning at the level of higher education	0.4	0.3
Purpose related to paid work at home	0.4	0.2
Tourism-related purpose	0.2	2.1
Other	1.6	3.6
Hard to say/don't remember	0.4	0.9
Refusal to respond	0.3	0.2

Tab. 1: Travel motivations on weekdays and Sundays in Łódź in 2021
Source: authors' survey

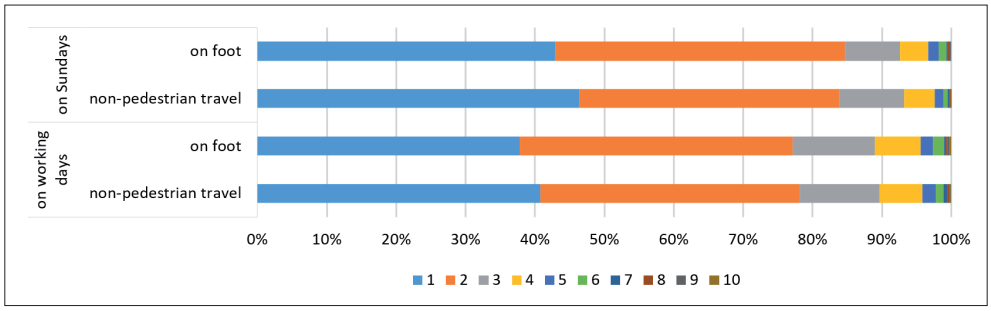

Fig. 5: The proportion of each multi-stage journey in Lodz dependent on the number of trips against the total number of multi-stage journeys on weekdays and Sundays, categorised as pedestrian and non-pedestrian trips in 2021
Source: authors' survey

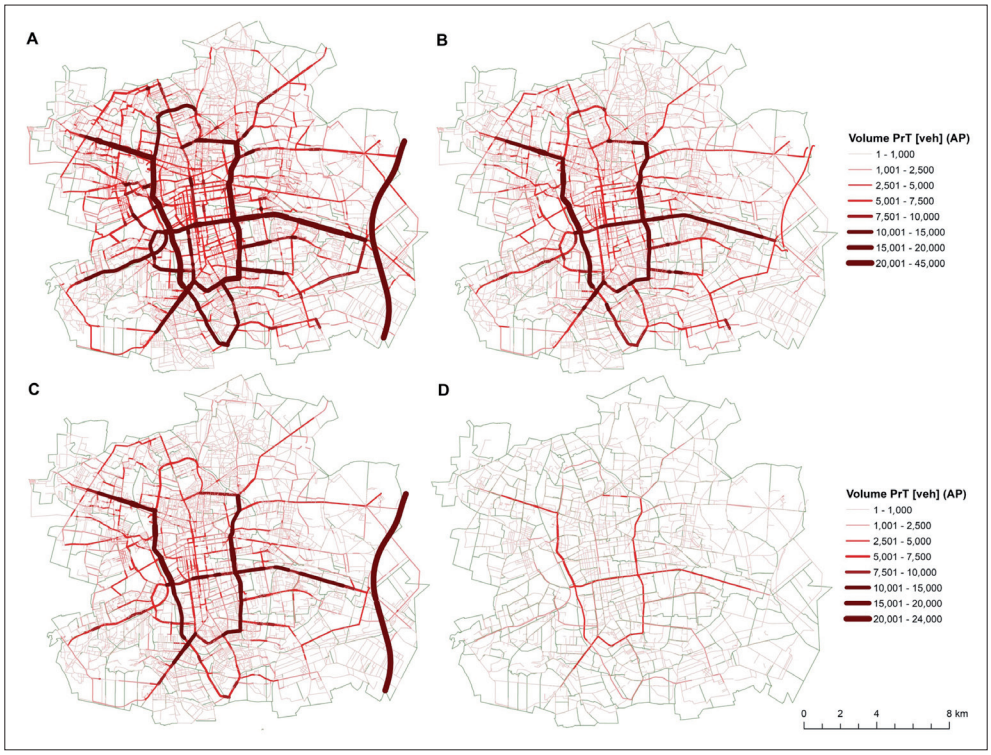

Fig. 6: Flows of private car traffic on the urban road network on weekdays (AB) and Sundays (CD), all internal, origin-external trips, origin-destination and transit trips (AC) and home-work and work-home trips (BD) in Łódź in 2021
Source: authors' survey

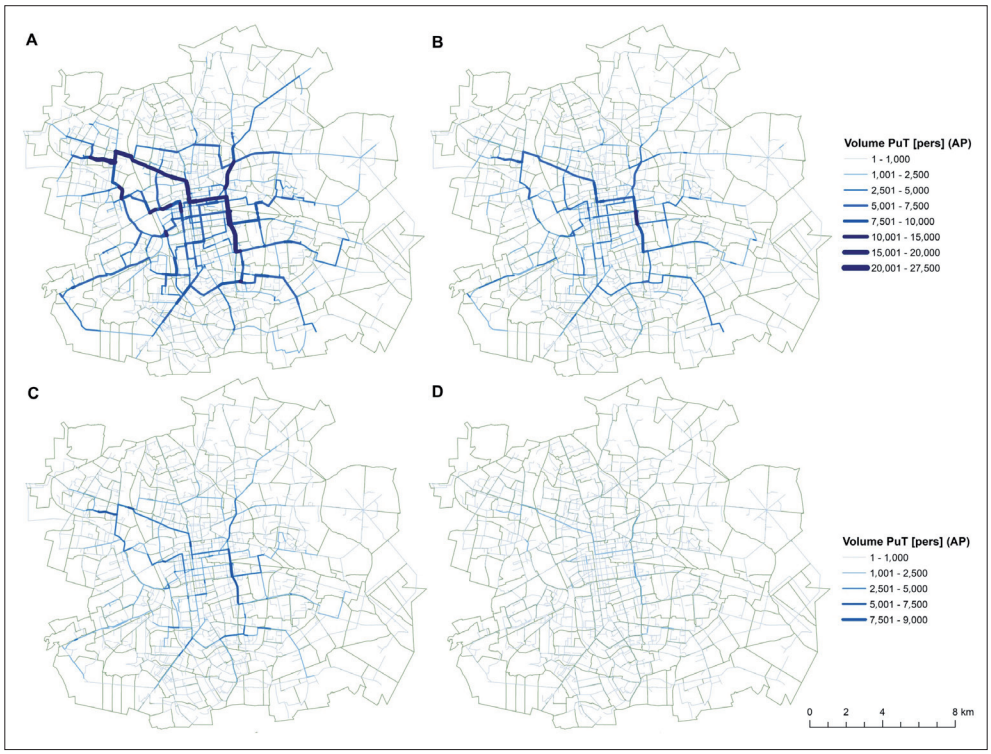

Fig. 7: Numbers and directions of passengers using the urban public transport system in Łódź on weekdays (AB) and Sundays (CD), all internal, origin-external trips, origin-destination and transit trips (AC) and home-work and work-home trips (BD) in 2021
Source: authors' survey

on Sundays compared to working days. The number of home-work and work-home trips using private cars, however, was higher for working days compared to Sundays. The simulated load of the public transport system reveals major traffic flows along the NW-SE axes (Figs. 6 and 7). Furthermore, the simulated traffic load of the public transport system was much higher for working days compared to Sundays (A1–A4).

5.2 Temporal properties of trips

The results of the study indicate considerable diversity in the reasons that travelling is undertaken. While most initial trips made by local residents on weekdays are for commuting to work (54.6%), or less frequently to schools (10.7%) and shopping centres (10.2%), on Sundays Łódź citizens usually make their initial trip to visit family and friends (25.5%), or to satisfy recreational (18.6%) and religious (11.7%) needs, whereas commuting to work accounts for 10.5% of initial trips on Sundays. Diversity is also observed with regards to the time when the initial trip begins, the mode of transport chosen – with a high percentage of trips not involving motorised transport on Sundays (Fig. 8) – and trip duration (a higher percentage of longer trips: Fig. 9). These temporal properties concur with the distribution of daily traffic recorded by inductive loop detectors in 2016 (Kowalski & Wiśniewski, 2017). Investigation of the initial trips on the days in question indicates that Łódź citizens generally use those means of transport that are easily accessible in their temporal dimension (see Tab. 2 below).

5.3 The modal split

The majority of trips in Łódź are made by private car (Tab. 3). These findings differ substantially from the results of studies on the modal structure conducted in Łódź in 1994 (52% public transport, 27% walking, 20% car, and 1% bicycle) (Wójcik, 2020), in 2013 (respectively: 45%, 27%, 25%, and 2%) (City Office, 2013), and in 2014 (respectively: 40%, 39%, 30%, and 3% (including motorcycles)) (City Office, 2014). It is difficult to unequivocally indicate to what extent this high share of car trips is a lasting phenomenon and to what degree it has been temporarily intensified by the pandemic, where people were trying to avoid close contact with crowds. Nevertheless, the aforementioned historical data renders it possible to observe that there is a tendency for an increasing percentage of passenger cars in the daily transport of the city. This modal split of trips in Łódź is extremely unfavourable for the development of sustainable urban transport. The high percentage of passenger cars in daily mobility and the limited role of public transport clearly differentiate Lodz from other large cities in Poland (Fig. 10). Moreover, the high congestion on the roads in Łódź (Borowska-Stefańska et al., 2021) is also partially due to low car occupancy (on working days it is 1.27 persons/vehicle and on Sundays it is 2.01 persons/vehicle), which – given the high share of private cars in the total number of trips – has a profound impact on the efficiency of the road and street transport subsystem (Borowska-Stefańska et al., 2019). The low car occupancy is not a phenomenon specifically attributable to Łódź when compared to other Polish cities (Dębowska-Mróz & Zawisza, 2018; Dudek, 2016).

Mode of Transport	Working Days				Sundays			
	up to 5 minutes	5–10 minutes	10–15 minutes	over 15 minutes	up to 5 minutes	5–10 minutes	10–15 minutes	over 15 minutes
car	96.5%	2.3%	0.5%	0.7%	94.2%	3.9%	0.9%	0.9%
city bus	49.9%	33.2%	13.7%	3.2%	56.0%	33.0%	9.0%	2.0%
tram	52.7%	37.8%	7.9%	1.7%	59.3%	33.0%	6.6%	1.1%

Tab. 2: Walking time to the first transport mode on weekdays and Sundays in Łódź by selected mode of transport in 2021
Source: authors' survey

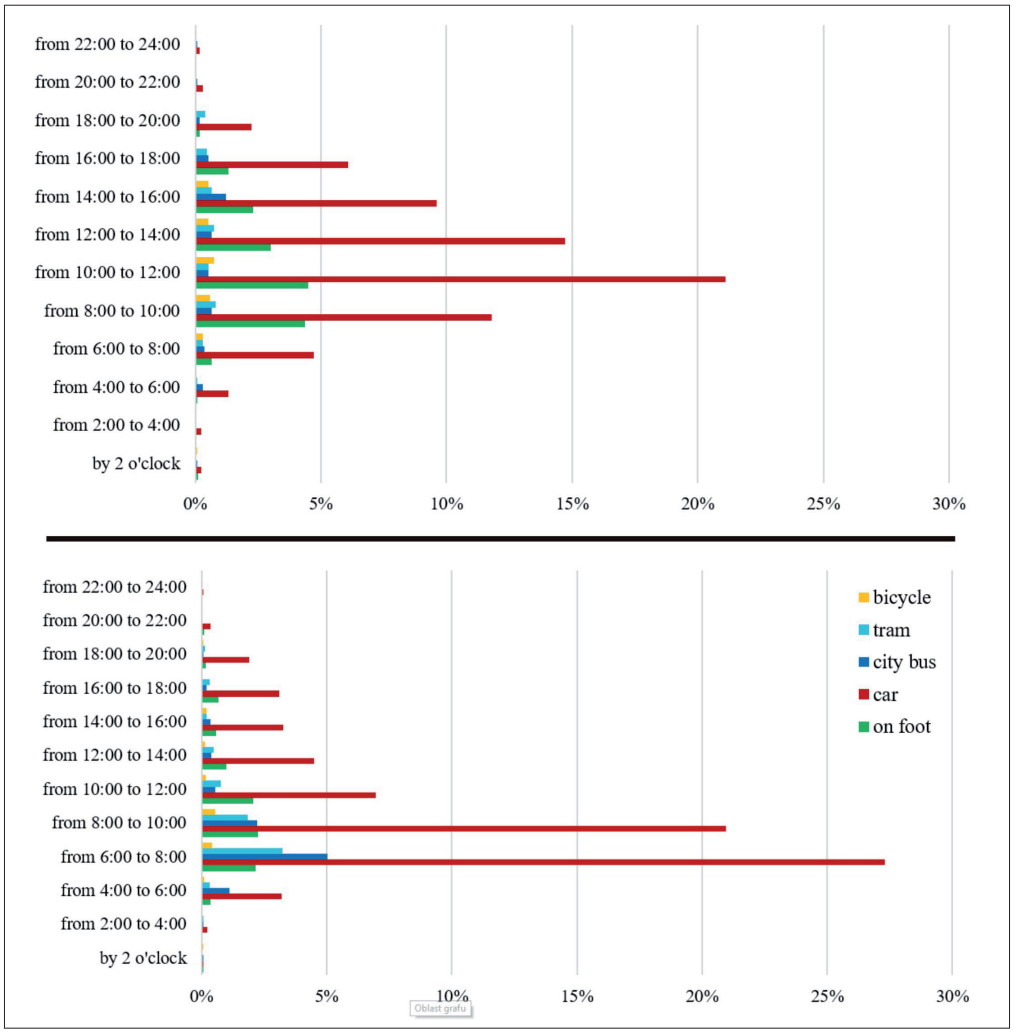

Fig. 8: Temporal differentiation of starting times in Łódź for the initial journey on Sundays (top) and weekdays (bottom) in2021, by selected modes of transport. Source: authors' survey

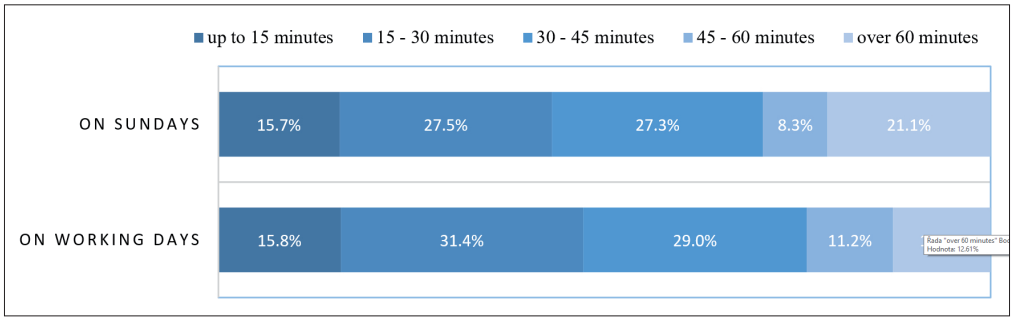

Fig. 9: The structure of trips made on weekdays and Sundays in Łódź in 2021 by trip duration
Source: authors' survey

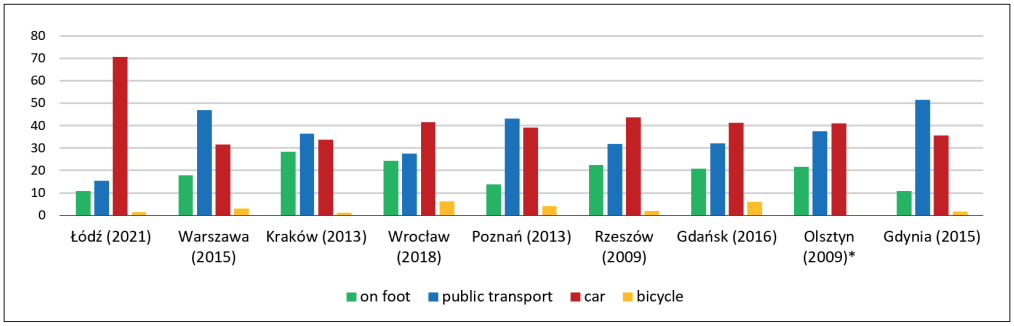

*Fig. 10: The modal split of trips on workdays in selected cities in Poland (Note: *no bike share specified in the surveyed modal split)*
Sources: authors' elaboration based on our research; Szarata (2015); Jacyna et al. (2016); Gadziński (2016); Gadziński and Goras (2019)

Transport mode	Working days (%)	Sundays (%)
Car (as a driver)	65.18	54.61
Only on foot	10.80	16.79
City bus	9.00	4.14
Tram	6.36	3.75
Car (as a passenger)	5.49	15.98
Private bike	1.35	2.13
Taxi or Uber	0.56	0.79
Railway – other	0.24	0.43
Agglomeration railway	0.23	0.30
Interurban bus or coach	0.21	0.20
Motorcycle, scooter, moped	0.18	0.28
Regular special communication	0.11	0.10
Public e-scooter	0.07	0.04
Private scooter	0.04	0.02
Airplane	0.02	0.10
Public bike	0.01	0.10
Refusal to respond	0.14	0.22

Tab. 3: The modal split of trips made on weekdays and Sundays in Łódź in 2021
Source: authors' survey

The share of car use for the most frequent necessary and optional trips made in Łódź is even greater than its percentage within the overall number of journeys. The high proportion of cars in the modal structure of shopping trips is not unique to Łódź when compared to other European cities, with British studies indicating the leading role of the car as the mode of transport chosen for shopping trips (over 62%; and even higher for grocery shopping: 76%) (Guy, 2009). What remains puzzling and worth further analyses is the fact that cars are so commonly used for commuting to work. The modal split of trips in Łódź motivated by employment outside the home is dominated by individual car transport – 82.5%, with 10% for public transport. In the case of shopping and visits to shopping centres, however, the share of individual car transport drops to 65.5%, while the share of trips made by public transport vehicles reaches 23.4%.

6. Conclusions

Conducted in 2021, this study on the transport behaviour of Łódź residents reveals the impact of the implemented Sunday retail restrictions on shopping trips, while importantly, also showing the 'tail-end' of the COVID-19 pandemic. The results were utilised to create a traffic model for the city of Łódź, which – despite being a large urban centre with severe transport issues (e.g. congestion) – possessed no tool of this type (indispensable when performing transport analyses). The results clearly indicate that both the Sunday retail restrictions and the pandemic have had an impact on the travel behaviour of Łódź residents. Similar conclusions regarding changes in mobility in the era of the COVID-19 pandemic come from studies in other cities, countries, or continents (Tarkowski et al., 2020; Batty et al., 2021; Pászto et al., 2021; Simunek, 2021). With respect to the retail restrictions, however, this effect is most evident for shopping trips, which are now made on weekdays or Saturdays instead of Sundays. Moreover, the structure of Sunday trips has changed, as some people have completely stopped travelling on this day, while others have changed their motivations (from shopping in malls to socialising, etc.). Unfortunately, there is still a lack of analyses on the nature of the impact of restrictions in retail trade on mobility. The pandemic, on the other hand, has mainly affected working-day travel (primarily commuting to workplaces), with remote working becoming more popular.

The results of the study can be applied, for instance, to conduct comparative analyses of the impact that the COVID-19 pandemic has had on residents' long-term transport behaviour. The main aim could be to establish whether these changes are permanent or temporary, which would allow the city's transport policies to be more effectively adapted to the challenges of sustainable urban mobility. For the City of Łódź itself, this is all very important, as there has been a noticeable increase in trips in recent years by private means of transport, with a concurrent drop in the popularity of public transport. In this context, the Łódź transport system is very sensitive to further changes in the modal division. Shifts in the modal division towards more frequent use of the car in everyday travel as a result of the pandemic are observed in many parts of the world. As indicated by De Haas et al. (2020) or Jenelius and Cebecauer (2020), for example, because of the pandemic, there was an increase in the use of private cars and non-motorized means of transport (cycling, walking). This was at the expense of public transport, in particular in terms of everyday mobility. Although urban mobility is local in nature, the universality of these changes means that the lack of an appropriate response to this phenomenon may have global consequences, and in this context it may be more difficult to achieve the effects of sustainable mobility (Okraszewska et al., 2018).

The main patterns of changes in the traffic density of the city's road network for individual motivations are determined by the key properties of the trips made for a given motivation. Increases and decreases in the number of vehicles or passenger flows for working days and Sundays typically affect sections of the road network that extend beyond the boundaries of the city district where the traffic generation takes place. This primarily stems from the fact that commuting to work is mainly composed of short trips. Since there is a relatively short distance and travel time between the origin and destination of the trip, there is a spatially limited range of efficient routes. Such distinct changes in vehicle-kilometres are not observed for other motivations when simulating working days and Sunday traffic. Instead, there is a flattening of the increase in vehicle-kilometres. This relationship is not linear, but it is conditioned by a number of factors whose impact varies greatly depending on the motivations and areas of the city. This variability applies to both the transport and land-use components. It is only when these determinants are superimposed that they result in changes in the distribution of traffic over the road network and in the volume of vehicle-kilometres. As regards the transport component, it is not so much the exposure of a particular section of the network that is crucial, but its importance for the implementation of trips for a particular motivation that are taken across the transport regions in the area covered by the simulation. Thus, the aforementioned flattening results from the fact that the volume of the traffic deferred due to a general reduction in the number of trips is reduced. What matters greatly for the simulation of the spatial distribution of changes in the load on the road network is the type of data used to distribute the traffic on the network. The application of matrix data on actual trips motivated by commuting clearly limits the spatial extent of the occurrence of changes in the load of the road network when compared to the model-based approach.

This study of the transport behaviour of the population on working days and Sundays involves the analysis of two extremely complex phenomena. These are of interest to specialists in many scientific fields, and, therefore, should be subject to modelling to ensure that – despite their complexity – they remain predictable, and thus, that their variability can be studied against the labile properties of the system where they operate. Models that map the road network, the variability of car speeds, and the travel paths of people commuting to work make it possible to incorporate multiple factors into the study, along with the complexity of the urban spatial scope. One must also bear in mind, however, that the results obtained from the analyses conducted by using these models may be burdened with the weaknesses typical for them. Even though the focus was solely on transport behaviour, with

no dedicated research on social or economic backgrounds, the analysed properties of changes in behaviour between working days and Sundays returns a wide range of results. Conducting extensive direct research is considered in most countries as one of the basic elements of creating transport policy and is a precondition for rational spending of public funds (Dziedzic & Szarata, 2014). In the case of research related to the transport behaviour of residents of a large city, the research period selected in the work was particularly important, because it was associated with two factors affecting it – on the one hand, it was the Trade Act and on the other hand, the pandemic. This is important because the pandemic is a global phenomenon – so its impact on transport behaviour and the conclusions drawn from it can be used not only in the city where the research was conducted. The same, although on a smaller scale, applies to research related to Sunday retail restrictions. In Europe, some countries also have such restrictions (Genakos & Danchev, 2015) and there is still little research on their impact on the mobility of the population.

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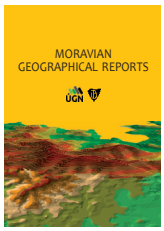

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Public transport accessibility and spatial exclusion in Roma settlements: A case study of three regions in Eastern Slovakia

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Abstract

Spatial isolation and social exclusion of some of the Roma communities have been a long-term issue in specific Slovakia regions. Along with some other factors, these may contribute to poor access to labour markets for Roma residents of such communities. As public transport acts as an important means of mobility of socially excluded residents, we consider the quality and accessibility of the public transport network as an important element that can impact on the spatially isolated Roma's ability to reach labour markets, as well as services, education, etc. Based on our empirical evidence, this paper aims to provide a better understanding and analysis of the social exclusion of segregated Roma neighbourhoods in the context of spatial exclusion and transport disadvantage related to public transportation accessibility. We tried to focus on physical accessibility of public transport points for the communities, as well as on the quality and frequency of public transport services available at these points for residents of Roma communities. Our research covered three different regions of Eastern Slovakia, where the concentration of Roma communities is high compared to the rest of the country.

Keywords: *social exclusion, transport disadvantage, public transport, Roma settlements, segregated communities, labour markets, Slovakia*

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1. Introduction: Specifics of the Roma population

All attempts to estimate the current numbers of the Roma in Slovakia result in hazy numbers, usually between 400 and 600 thousand. A more realistic picture of the Roma population size is presented by the Atlas of Roma Communities 2013 (see Mušinka, et al., 2014), with a qualified estimate, according to which there are over 400 thousand Roma in Slovakia.

Spatial segregation is one of the key issues concerning the Roma population in Slovakia. The phenomenon of segregation of Roma communities is a frequent problem in various countries (see e.g. Lancione, 2019; Magazzini & Piemontese, 2016; Rosa, 2016). According to Maestri (2019), segregation is not only produced by the intertwinement of globalisation, changes in the labour market and neoliberal policies that lead to a disinvestment in social policies for most marginalised categories, it is also shaped by the role of civil society actors, increasingly so in times of crisis and welfare restructuring. In accordance with the statement of Maestri and Vitale (2017), they are often internal actors who do not develop demands for change and direction towards the integration and empowerment of Roma.

The spatial isolation of Roma has a major impact on the eradication of poverty and social exclusion. Related to spatial isolation, poor transport accessibility may be a serious barrier in the process of social inclusion of the Roma in Slovakia. The opportunity to reach places of education, services and employment, plays a key role in the integration of the poor Roma living in socially excluded localities.

A very specific feature of the Roma population's spatial distribution in Slovakia is their residence in homogeneous ethnic settlements, named Roma communities, described by Rusnáková and Pollák (2012, 258) as follows:

> "...it is a settlement (spatially delimited), resided by Roma (or predominantly by Roma). It is part of a town (hence lacks its own self-government), but often isolated from the built-up area (by distance or a barrier, such as a river, railway, etc.) or within the built-up area (Roma street, Roma neighborhood), formed in a relatively autonomous socio-cultural structure."

According to Matlovičová et al. (2012), the concentrated communities are home to 53.5% of all Roma, while the rest of them are dispersed within the dominant Slovak ethnic population in mixed neighbourhoods. A growing share of the Roma living in concentrations within the built-up areas of towns and segregated communities has been observed. In 1988, these communities embraced only 14,988 inhabitants, but they witnessed 127,429 persons in 2000 and 190,950 residents in 2010 (Matlovičová et al. 2012). In 2013, the Roma communities mapping identified 803 Roma concentrations (in 583 municipalities) with 215,555

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Roma residents. Out of 2,890 of Slovakia's municipalities, 1,070 are occupied by the Roma. Most of Slovakia's Roma population has been concentrated in the eastern part of the country (Rochovská & Rusnáková, 2018).

Many authors have drawn attention to the fact that the Roma in Slovakia are among the poorest groups in the Slovak population and the problems associated with poverty and social disadvantage affect many of them (Radičová, 2001; Rusnáková & Rochovská, 2014, 2016; Filadelfiová & Gerbery, 2012; Filadelfiová, 2013). The Roma population, being an at-risk-of-poverty group, has been also explicitly mentioned in the political documents and action plans of the Slovak Republic focused on the suppression of poverty or social exclusion, such as the Strategy of the Slovak Republic for Integration of Roma up to 2020 (2011). In 2018, the first EU statistics survey on income and living conditions (EU-SILC) focused on marginalised Roma communities was carried out (see Grauzelová & Markovič, 2018). This survey has confirmed that poverty and material deprivation in marginalised Roma communities is more frequent and more intensive compared to the Non-Roma majority population of Slovakia. According to the above-mentioned documents, the Roma ethnic group combines several disadvantages linked to demographic conditions, poverty generated by unemployment, poverty caused by low-skilled and low-paid work, or lack of education and discrimination (Strategy... 2011).

The most miserable conditions are certainly observed in the segregated Roma communities. Lacking elementary infrastructure in the segregated settlements and spatial isolation of the Roma from the majority are exacerbated by their political, economic and cultural isolation. Households in the segregated Roma communities, have poor access to basic assets, which reinforces their poverty and social exclusion. Part of the Roma population living in segregated settlements is considered to be the most exposed to risk of poverty, social exclusion and discrimination. Džambazovič (2007) defines segregated communities as settlements located outside resident municipalities. According to this author, these are settlements formed by concentrated dwellings located far from the village or town, or even separated by a barrier. While integrated and separate neighbourhoods are typical manifestations of relative poverty, segregated settlements are indications of absolute poverty. Although there is no generally accurate definition of the term Roma settlement (Rusnáková & Rochovská, 2014, 2016), it can be stated that these are ethnically homogeneous settlements, segregated not only spatially but also socially. Among the most common characteristics of such settlements, numerous authors (Filadelfiová et al., 2006; Kráľovská, 2006; Vaňo & Mészáros, 2004; Radičová et al., 2004; Vašečka & Džambazovič, 2000, and others) mention difficult conditions for access to fundamental services – education, housing, health, employment, access to services, adequate income. Well-known problems of the residents of Roma settlements include poor housing associated with complicated land ownership, poorer health compared to the Non-Roma majority population, poor education levels and qualifications, limited access to basic infrastructure (e.g. drinking water, see Rochovská et al., 2021). There are several disadvantages associated with the inhabitants of Roma settlements, including poverty generated by unemployment, poverty caused by lack of education or linked to demographic conditions and discrimination (Mušinka et al., 2014).

This brings us to the issue of the social exclusion of segregated Roma communities of Eastern Slovakia as the target group of our analysis. Džambazovič and Gerbery (2005) emphasise that social exclusion leads to a reduction in opportunities to participate in society, to social isolation and separation from society. Poverty of the Roma is strongly related to social exclusion, which stems from a combination of historical, cultural, social and spatial factors (Džambazovič & Jurásková, 2002). Within the spatial dimension of social exclusion, many studies point to mobility-related and/or transport-related factors of social exclusion (see e.g. Kenyon et al., 2002; Percy-Smith, 2000; Cass et al., 2005; Delbosc & Currie, 2011) and the transport disadvantages (Kamruzzaman & Hine, 2011) of certain communities. In contrast, we find no specific attention focused on the quality of public transport services in any of the documents dealing with Slovakia's segregated Roma population inclusion. Also, as shown below, Slovakia's regional authorities whose competences include the regional public transport network coverage, do not reflect the specifics of segregated Roma communities. There are some reports on community transportation organised by local authorities in some municipalities but these refer mostly to school kids' transportation to schools. They are not supported by any systematic tools, however, and so they depend purely on the financial capacities of the municipalities.

Our research motivations stem from the assumption that poor public transport accessibility and transport disadvantage might be one of the barriers affecting the Roma communities's poor access to labour markets, education, health care, services etc. Based on that, we attempt to answer the following three questions:

1. What is the walking distance to public transport (PT) stops or stations in Roma communities?;
2. What is the quality of public transport serviceability of the PT stops located in/close to Roma communities? What is the frequency of PT services to the nearest regional centre at peak/off-peak day-times?; and
3. Is there a relationship between the PT availability/quality and the geographical location of the Roma community settlement? Will the quality of PT be worse in the spatially most segregated (i.e. "out-of-the-village") Roma settlements?

Our research area covered the three NUTS4 (LAU1) units of Rožňava, Spišská Nová Ves and Vranov nad Topľou (see Fig. 2). These regions are located in eastern part of Slovakia and belong to regions with very high concentrations of Roma communities (see Rochovská & Rusnáková, 2018, more details in Methodology part).

Besides, our ambition is to identify the Roma communities which may be referred to as "public transport deserts". Due to limited data availability, compared to what Jiao (2017) or Aman and Smith-Colin (2020) consider as transit deserts or public-transport deserts, our approach will be a little different (see Methodology).

In the following part of the paper, the role of transport and mobility is explained in the context of social exclusion. Data sources and methods used in our approach are described in a separate section where also specific data on Roma population mapping in Slovakia are introduced. The following parts include results, interpretation, discussion and conclusions.

2. Theoretical background: Spatial exclusion and transport disadvantage

Since the beginning of the 21st century, social exclusion has become one of the key concepts sheltered by the social policies in the European Union. This has been deeply incorporated into national, regional and local social inclusion policies within the EU.

In our understanding and in accordance with the document Strategy of equality, inclusion and participation of Roma until 2030 (2021), inclusion means enabling every citizen, especially the most disadvantaged, to fully participate in society, including the possibility of employment. Inclusion is underpinned by the principles of equal opportunities, fairness, cooperation and solidarity, with diversity seen as an opportunity to enrich society as a whole. Society adapts to the diversity of all its members, which

includes policies promoting equal access to public services and full civic participation in decision-making. Integration is a process of blurring differences and creating equal opportunities, in which the inclusion of disadvantaged citizens or groups of citizens into society is a manifestation of solidarity, tolerance and acceptance of differences.

Generally, social exclusion is perceived as a systematic process of marginalisation, isolation and weakening of social ties, which is evident at the level of the individual as well as at the level of social groups. Exclusion means failure to participate in a normal way of social life (Strobel, 1996). For example, Levitas et al. (2007, 9) define exclusion as "the lack or denial of resources, rights, goods and services, and the inability to participate in the normal relationships and activities, available to the majority of people in a society, whether in economic, social, cultural or political arenas".

Authors focusing on social exclusion describe several dimensions to which social exclusion applies. We should mention Percy-Smith (2000), who outlines seven different dimensions of social exclusion (economic, social, political, neighbourhood, individual, spatial group), as well as Mareš (2002) with very similarly named six dimensions, and also Kenyon et al. (2002), who identified nine dimensions (added extra mobility and temporal dimension). Although the identified dimensions are partially different, all the authors agree on the existence and importance of spatial exclusion as a specific dimension. The spatial dimension of social exclusion is often emphasised in the policies, as individuals and communities may be excluded in both social (vertical) as well as spatial (horizontal) ways (Mareš et al., 2008). Khan (2012, 5) emphasised the spatial dimension of social exclusion linked with a policy focus on those living in 'deprived areas', where poor housing, inadequate social services, weak political voice and lack of decent work all combine to create an experience of marginalisation. Legros and Lièvre (2019) point to the fact that although the Roma may seem fairly well integrated in housing terms, this relative spatial integration does not necessarily translate into meaningful neighbourhood interaction. Rather, neighbourhood relations are often characterised by racism, stigmatisation and intolerance of Roma cultural practices, with these sentiments equally apparent in the formal educational setting.

According Percy-Smith (2000), the spatial dimension of exclusion typically results in large numbers of disadvantaged people living together in a decaying area. Disadvantaged individuals who live there often become subject to further exclusionary process, including not only total lack of local servicies, but also being discriminated against by employers. The most significant form of exclusion, however, is involuntary spatial exclusion. Life in segregated areas is not usually chosen by its inhabitants and due to its strong link to the poverty of these places, it is not in the power of these inhabitants to change the nature of the area nor to leave it (Filčák & Stager, 2014; Berescu et al., 2012).

The role of transport, mobility and accessibility in relation to social exclusion has been clearly described by Kenyon et al. (2002), identifying poor mobility and poor ability to use transport networks to access the necessary resources (work or education, services, social networks, etc.) as one of the dimensions of social exclusion (in addition to, for example, the economic, social, political or institutional dimensions). Cass et al. (2005, 542) state that "... access (to networks, etc.) and social exclusion are interconnected through a common perception in which resources (money, car, etc.) are necessary to achieve goals." The importance of space as a barrier that generates the cost of overcoming the distance to these essential resources is pointed out in the work of Schönfelder and Axhausen (2003), but also by Levinson (1998) in the context of commuting to work. Traffic-related social exclusion is partly a result of current spatial development and spatial planning in modern society, as pointed out by Kenyon et al. (2002), who state that social exclusion is, among others, the result of limited availability of opportunities, services and social networks, due to fully or partially limited mobility in society and an environment developed on the assumption of high mobility. In this context, many works speak literally of the transport disadvantage of certain communities or individuals (see e. g. Kamruzzaman & Hine, 2011). According to Rosier and McDonald (2011), transport-related exclusion may also be defined as difficulties in accessing transport due to price, poor physical availability or availability of services.

Respecting the importance of mobility, the accessibility of high-quality transport infrastructure may not always be decisive, as empirical studies suggest that mobility requirements and the capability to use this transport infrastructure are also important (Schönfelder & Axhausen, 2003; Jaroš, 2017). For example, proximity to the motorway is not a solution for socially excluded poor communities with low car ownership or individuals without the ability to drive (e. g. the disabled, the elderly, poor families without a car).

Jaroš (2017) points to social and transportation aspects affecting transport-related exclusion (see Fig. 1). This author states that accessibility affects the 'external frameworks' of transport-related exclusion. The main factors here include the distance of the location (exposed character) and transport (in)accessibility of the location. On the other hand, mobility (individual or personal capability to be mobile) predetermines the 'internal conditionality' of transport exclusion. It also depends on the specific mobility needs of every individual.

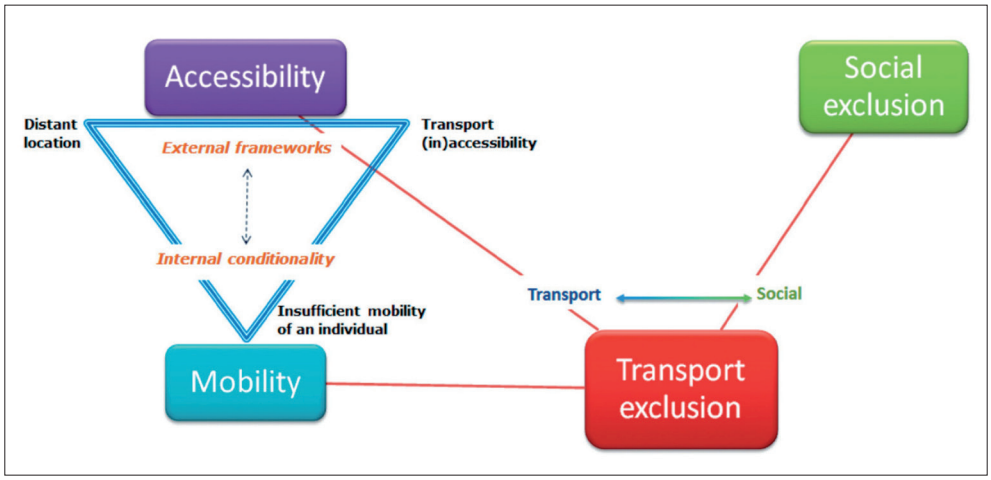

Fig. 1: Transport exclusion – transport and social aspects; internal conditionality and external frameworks
Source: Jaroš (2017, 257)

As described by many (Levinson, 1998; Kenyon et al., 2002; Horňák, 2012; Jaroš, 2017), the spatial design of landscape inhabited by humans and generally the geographical organisation of society, are among the key elements affecting the scale of transport- and mobility-related social exclusion. In a society where work (as the main source of income) is considered one of the most important assets of households or individuals (Stenning et al., 2010; Rusnáková et al., 2015; Holubová et al., 2021), access to jobs is a decisive driver to social inclusion. Therefore, accessibility of jobs within geographical space has been a research subject of numerous studies (Levinson, 1998; Ong & Blumenberg, 1998; Partridge et al., 2010; Delbosc & Currie, 2011, etc.), very often approached as a distance between places of residence and places of jobs (Michniak, 2008; Grengs, 2010; Cheng & Bertolini, 2013; Ďurček et al., 2020). In Central European conditions, we find interesting attempts to evaluate the accessibility of jobs via the transportation costs (see Horák & Šeděnková, 2005; Ivan, 2009, 2010; Horňák, 2012).

As far as commuting to work is discussed, apart from other modes of transportation, the passenger car and public transportation are frequently perceived as the most decisive transport modes in a society organised within a modern landscape (Hensher & Reyes, 2000; Kawabata & Shen, 2007; Ivan, 2010; Horňák, 2012; Trembošová & Kohutiar, 2022).

Although public transportation is rather well developed in most of the EU countries, the Central European territory shows some peculiarities stemming from either specific features of the population distribution in some regions (e. g. so-called scattered settlement in the Carpathians generating obstacles for an effective public transportation), or collapsing public transport supply as a consequence of the post-socialist public transport sectors' transition (see e. g. Pucher & Buehler, 2005; Taczanowski, 2015; Marada & Květoň; 2016, Seidenglanz et al., 2015). In most post-socialist countries, public transport has witnessed a considerable fall within the modal split of passenger transport, mirroring the modal split trends observable in Western Europe (Król et al., 2018; Horňák et al., 2013; Michniak, 2018). According to Eurostat databases, the share of public transport of the total passenger transport performances dropped to between 20–30% in Poland, the Czech Republic, Slovakia or Hungary by 2017 (Energy, Transport and Environment Statistics, 2020).

Nevertheless, in some environments public transport still plays a crucial role in everyday mobility (such as in large cities or in communities with limited affordability of the passenger car, (see e. g. Temelová et al., 2011; Horňák & Rochovská, 2014). We agree with Preston and Rajé (2007) who indicate that in communities with high mobility demands but with poor individual mobility equipment (e. g. due to poor economic conditions of households or due to urban design hampering the use of passenger cars), public transport may play a crucial role as a means of everyday mobility. There has been no specific research done on the segregated Roma communities' household motorisation rate in Slovakia so far, so we can only suppose that the rate of car ownership is probably very low in these communities due to poor economic conditions (Rochovská & Rusnáková, 2018; Kahanec et al., 2020). This brings us to a conclusion that in spite of the obvious drawbacks of public transport systems (growing fees, discomfort or trip chaining: see Nutley, 1998; Hensher & Reyes, 2000; Rietveld et al., 2001; Marada & Květoň, 2010; Horňák, 2012), for Roma communities in Eastern Slovakia public transport will be the main means of transport for commuting to work, schools, health-care centres and so on.

3. Data and research methods

As mentioned in the introduction, the research question relates to the theory of social exclusion and is mainly based on spatial social exclusion and related transport accessibility, the lack of which subsequently affects the availability of the labour market, schooling, health care and other services. Through the three research questions, we will focus on quality of public transport services in or close to Roma communities and explore the relationship between public transport availability and quality and the geographical location of the Roma community settlements.

One of the main input data resources was the comprehensive database of the Atlas of Roma Communities (2019), identifying municipalities with Roma population communities (i. e. municipalities with Roma communities with a minimum of 30 residents or municipalities with a minimum of 30% of Roma population). Besides, other information sources were used to analyse the level of transport inaccessbility of settlements in marginalised Roma communities in our research areas. Three districts (identical to three NUTS4/LAU1 units of Rožňava, Spišská Nová Ves and Vranov nad Topľou, see Fig. 2) located in the eastern part of Slovakia were selected for our research purposes. The selection of these territorial units covers areas belonging to regions with the highest detected concentrations of Roma populations in the country (see Mušinka et al., 2014; Rusnáková & Rochovská, 2018; Filčák & Škobla, 2021), but also reflects the focus of some other project research activities carried out in the same regions (Šatara et al., 2020; Havírová & Šatara, 2020; Rigová et al., 2021).

According to the Atlas of Roma Communties (2019), the locations of individual Roma population concentrations in Slovakia were divided into the following three categories:

1. I – settlement within the municipality;
2. II – settlement at the margin of the municipality; and
3. III –settlement outside the municipality (segregated).

In the resource database, the above-mentioned categories of Roma population concentrations reflect geographical location variability and levels of spatial integration of particular Roma communities into respective settlement structures. The Atlas of Roma Communities (2019) represents the 3rd generation of Roma population mapping in Slovakia, with well-developed and detailed methodology of Roma communities' location typology. Therefore, we can fully accept the typology of Roma communities delivered by this resource document. Basically, the Roma settlements located within the municipality (category I) are well integrated into a municipality's organism and its built-up territory. Conversely, the settlements located outside (category III) are remote from the main municipality structure, dispersed far (often more than 1,000 m) from the built-up area, thus presumably disconnected from the infrastructure, often without a paved road or pathway, with poor or no access to pipelines (see Atlas of Roma Communities, 2019; Rochovská et al., 2021). According to the methodology of the source database of the Atlas but also to other studies (e.g. Rochovská & Rusnáková, 2018 or Rusnáková & Rochovská, 2014), the Roma communities listed in category III can be considered as segregated Roma communities. This categorisation in the Atlas of Roma Communities (2019) assisted us to design our research questions (see Introduction, above). We can assume that general living conditions (including access to infrastructure and public transport) are the worst in category III (segregated Roma communities), representing spatially isolated and segregated communities from the main municipality structures. On the other hand, category I of the Roma communities is supposed to be well integrated within the urbanised environment, with relatively comfortable access to public transport networks.

In our research areas, 116 Roma concentrations were identified by the Atlas of Roma Communities (2019). The location typology of these communities within the settlement environment shows a slight prevalence of category II of Roma communities located on the outskirts of the municipality structures (see Tab. 1).

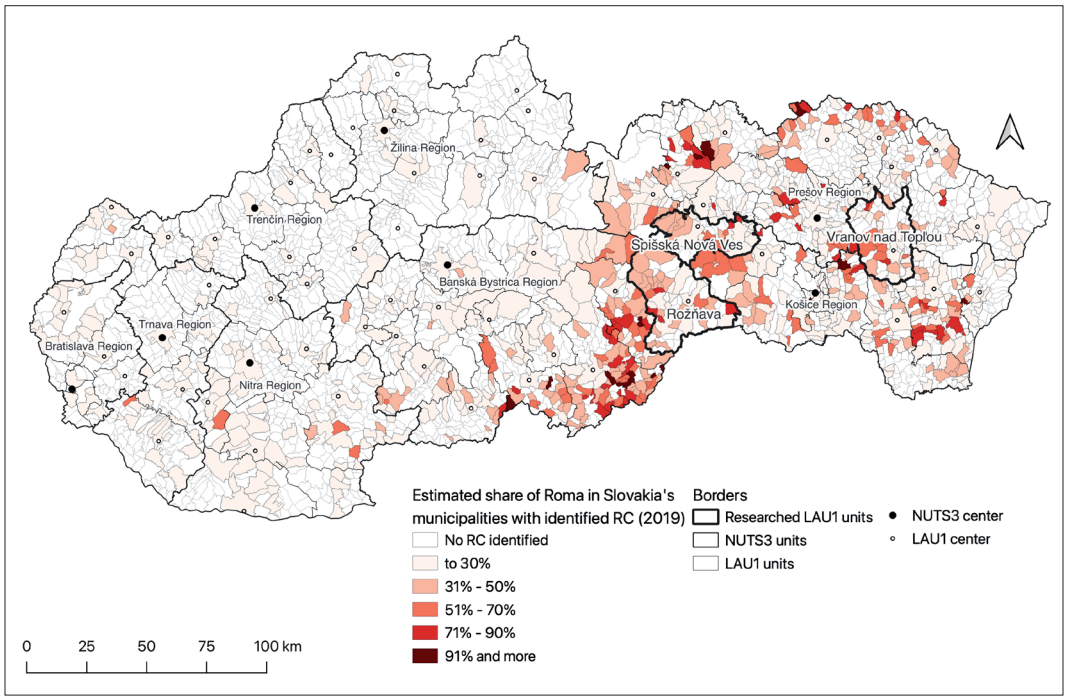

Fig. 2: Spatial distribution of Roma in Slovakia with geographical position of researched areas
Notes: RC = Roma communities. Data on Roma population only cover municipalities identified by the Atlas of Roma Communities (2019), i.e. municipalities with Roma communities with a minimum of 30 residents or municipalities with a minimum 30% of Roma population.
Source: authors' elaboration based on data from Atlas of Roma Communities (2019), zbgis.skgeodesy.sk

LAU1 Region	Inside the municipality (category I)	On the outskirts of the municipality (category II)	Outside the municipality (segregated, category III)
Vranov nad Topľou	8	24	9
Spišská Nová Ves	3	21	9
Rožňava	8	24	10
TOTAL	19	69	28

Tab. 1: Location categories of the Roma communities in the research areas
Source: Atlas of Roma Communities (2019)

In our analysis, we tried to identify the level of public transport accessibility. Firstly, walking distance (in metres) from the centre of a particular Roma settlement to the nearest public bus stop was mapped. This parameter reflects spatial variability of public transport infrastructure accessibility within municipalities at a micro-level. As shown below, this affects especially Roma communities living apart from the main municipality urban structures. Accessibility of public transport points (stops, stations) is an important element of public transport use probability (see Kraft, 2016 or Ivan et al., 2019). In our case, this indicator was measured for each individual Roma community manually through www.google.com/maps, with walking set as the transport mode for searching the optimum shortest walking pathways to the nearest bus station. In disputable cases, map databases of zbgis.skgeodesy.sk and mapa.zoznam.sk as well as the Street View service of Google Maps database, were applied to clarify pathway routing where Google satellite layers were not clear. Estimation of walking distance was based on Google Maps online tracking tool used to track the distance between the respective Roma community settlement's geometric centre and the nearest regional bus stop or station. Within this step, quality of the walking infrastructure (paved and unpaved pathways and access roads) was mapped, too.

Secondly, the frequency of direct bus services connecting the identified nearest available stops with the nearest regional urban centre (i. e. regional nodal centre) per working day was detected. This parameter reflects the quality of regional labour-market accessibility by public transport from the respective municipalities. It is important to emphasise that the regional sustainable mobility plans (mentioned elsewhere in the text) cover only the municipality level of the public transportation capacities. As mentioned above, however, the accessibility of public transport at municipality level may vary a lot, hence the two levels of parameters. According to numerous studies (see Levinson, 1998; Hine, 2009; Kamruzzaman & Hine, 2011, etc.), despite the growing importance of individual automobility (due to passenger car availability improvement) in welfare societies, the role of public transportation for everyday mobility purposes is still crucial for lower-class communities. This is specifically true in postsocialist countries such as Slovakia or the Czech Republic (Seidenglanz, 2007; Temelová et al., 2011; Horňák et al., 2016; Květoň et al., 2017), where some communities are largely dependent on public transportation due to their insufficient household incomes or other obstacles causing an unaffordability of family car ownership. Public railway transport was not taken into account here, as the railway network density in the research areas is quite low compared to public bus-transport network, and railway stations are typically too far from any Roma community identified in these areas.

In our approach, the towns of Rožňava, Spišská Nová Ves and Vranov nad Topľou were considered the regional urban centres of the respective districts in focus. To analyse the frequency of bus services operated between the Roma communities and these commuting centres (bi-directionally), we identified the total number of bus connections departing from specific bus stops, and specifically the number of connections to the nearest commuting urban centre. In general, we included all direct bus services during rush hours

(between 7–9 a.m. and also between 2–5 p.m.) and outside rush hours (i.e. excluding the times mentioned above). The number of bus connections was counted manually using the database of www.cp.sk. The counting of bus connections was referred to October 7th, 2020 (Wednesday, a common working day).

The final step included a typology of the Roma communities in focus by public-transport accessibility level. To assess the public-transport accessibility in a more complex way, a scoring method assigning value-points to each of the Roma communities was applied. Seindenglanz (2007) uses a similar method in his work, dividing the position of rural municipalities according to the quality of transport accessibility, based on the transport position indicator. He defined this indicator as the value that was assigned to a municipality on the basis of the equipment of the transport infrastructure. A similar method was used by Aman and Smith-Collin (2020), who determined a comprehensive public transit accessibility (CPTA) score, on the basis of which they could identify areas with low transport supply. In both studies, the authors determined the conditions under which the monitored areas could be divided into different types. The conditions within our typology are listed in Table 2. Based on the weighted arithmetic average score of individual indicators, we were able to determine 5 types of transport inaccessbility levels. The weights of the weighted arithmetic average are listed also in Table 2.

It is necessary to mention that the official database of the Atlas of Roma Communities (2019) available online does not cover accurate information on population size of individual Roma communities, since numbers of residents is considered as sensitive information. Therefore, only numbers of dwellings were applied to indicate the size of respective communities.

Indicator	Condition	Score	Weight
Distance of settlement and bus stop	0–400 m	1	25%
	400–600 m	2	
	600–800 m	3	
	800–1,000 m	4	
	more than 1,000 m	5	
Number of bus services (to centre of district) between 7–9 a.m. and also between 2–5 p.m.	more than 12 services	1	50%
	7–12 services	2	
	4–6 services	3	
	1–3 services	4	
	0 services	5	
Number of bus services (to centre of district) excluding the time from 7–9 a.m. and also between 2–5 p.m.	more than 12 services	1	25%
	7–12 services	2	
	4–6 services	3	
	1–3 services	4	
	0 services	5	

Tab. 2: An overview of input indicators and their weights in the synthetic evaluation of public transport accessibility
Source: authors' elaboration

4. Public-transport accessibility in Roma communities – evidence from data

A detailed analysis on existing walking infrastructure within Slovakia's Roma communities has never been published, although the Atlas of Roma communities (2019) indicates some improvements in paved walking and driving infrastructure. Our own mapping shows that out of the total of 116 Roma communities in focus, 97% are equipped with paved access road and 77% with paved side-walk or a path along the paved access road.

Generally, the accessibility of public transport infrastructure (the nearest bus stop) is acceptable in most of the surveyed communities (see Tab. 3). Only in 7 communities the distance to the bus stop reaches over 1 km.

Figure 3 shows that the walking distance to the nearest bus stop corresponds with the location type of the Roma community. Almost 90% of all analysed Roma settlements located inside the built-up area of the municipality (17/19 settlements), are situated up to 600 m from the nearest bus stop. On the other hand, the worst walking accessibility of public transport is generally detected in Roma communities located outside of the built-up areas. Although the accessibility indicator varies throughout the districts in focus (see Fig. 4), we may conclude that the location of a Roma community within the municipality's urban structure affects the public transport infrastructure walking accessibility significantly.

We also tried to analyse the relationships between location of the Roma community within municipalities and the number of bus services to/from the nearest regional centre per day. Figure 5 shows some differences between these three types of settlements.

Distance to the nearest BUS stop	Number of Roma communities
up to 400 m	52
401–1,000 m	57
over 1,000 m (max. 1,450 m)	7
TOTAL	116

Tab. 3: Roma communities in Rožňava, Spišská Nová Ves and Vranov nad Topľou regions by walking distance to the nearest bus stop
Source: authors' research based on Atlas of Roma Communities (2019), www.google.com/maps, zbgis.skgeodesy.sk, mapa.zoznam.sk

As expected, the highest frequencies of direct bus services (12 or more public bus services/24 hours) were detected in the case of Roma communities integrated inside the municipalities. In more than 70% of Roma communities well-integrated inside the municipalities, we detected more than 6 public bus connections to the regional centre per day. This value (6 services/24 hours in each direction) is generally recommended as the lowest acceptable scale of public-transport serviceability set for inhabited municipalities by the regional transportation policy documents called sustainable mobility plans (see Košický samosprávny kraj 2020 and Prešovský samosprávny kraj 2020). The most striking was the absence of public transport services linking some of the Roma communities with regional centres. Although not seen in relative numbers (see Fig. 5), the highest absolute number of zero bus connections was found in communities lying on the outskirts of municipalities. We can also state that the worse the Roma community position within the municipality, the poorer the public bus services' quality. The above-mentioned regional sustainable mobility plans do not specifically consider the segregated Roma population communities with apparently lower individual mobility levels. Also, these

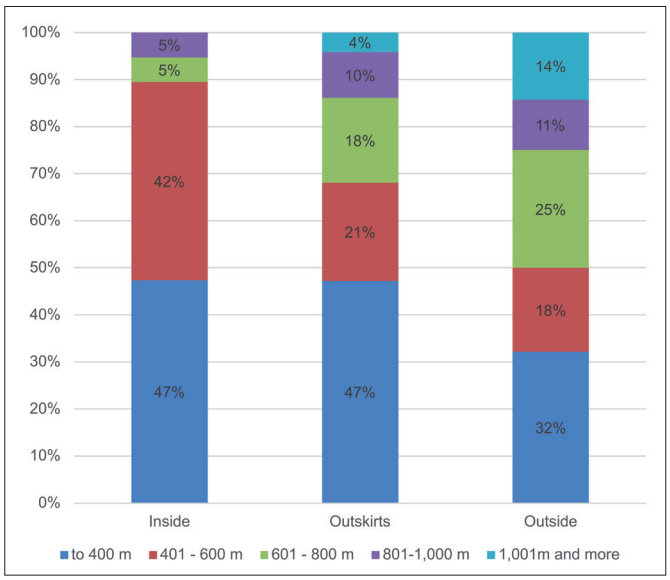

Fig. 3: Walking distance to the nearest bus stop from Roma communities by location type (inside, outskirts or outside the built-up areas of communities, summation of Roma communities in Rožňava, Spišská Nová Ves and Vranov nad Topľou regions)
Source: authors' research based on Atlas of Roma Communities (2019), www.google.com/maps, zbgis.skgeodesy.sk, mapa.zoznam.sk

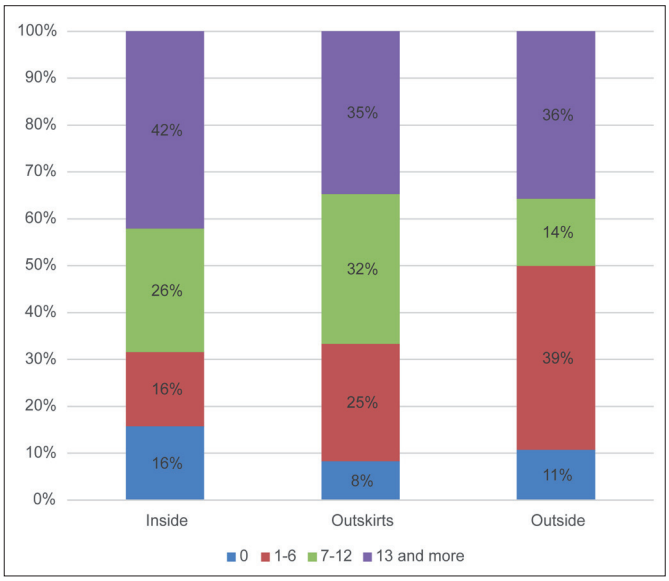

Fig. 5: Frequency of bus services between Roma communities and the nearest regional centre/24 hours (by Roma communities' location type, cummulative data on Rožňava, Spišská Nová Ves and Vranov nad Topľou districts)
Source: authors' calculations and elaboration based on data from Atlas of Roma Communities (2019) and www.cp.hnonline.sk

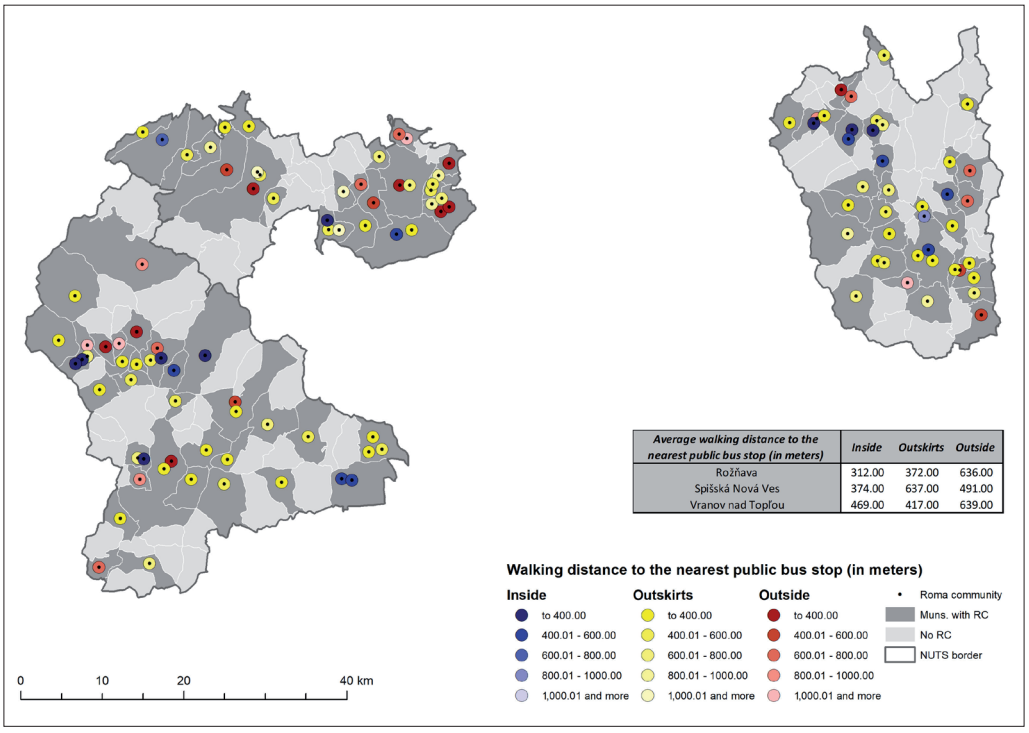

Fig. 4: Walking distance to the nearest public bus stop from Roma communities in districts of Rožňava, Spišská Nová Ves and Vranov nad Topľou
Source: authors' calculations and elaboration based on data from Atlas of Roma Communities (2019), www.google.com/maps, zbgis.skgeodesy.sk, mapa.zoznam.sk

documents' recommendations on public-transport frequency and capacity generally meet needs of municipalities as the lowest territorial units. Therefore, they can hardly respect individual micro-location specifics and comunities residing apart from core parts of municipalities.

Figure 6 shows that there are numerous large (in terms of number of dwellings) Roma communities with low daily frequencies of bus services to/from the nearest regional centre. In each district, however, we find several Roma communities (of various location types) with no direct bus service to the nearest regional centre, which indicates a very poor public transport accessibility. These were generally rather small communities (usually up to 50 dwellings) located in municipalities in most of the cases on the periphery of the district and therefore far away from the nearest regional commuting centre. Six of such communities (out of 12 communities) are situated on the outskirts of municipalities.

To express a general level of public transport accessibility in Roma communities in the research areas, we carried out a typology of all analysed communities. This typology is based on a synthesis of three input indicators described in the methodology part of this paper. This approach allows us to present a few conclusions (see Fig. 7). First, the closer to the regional centre, the

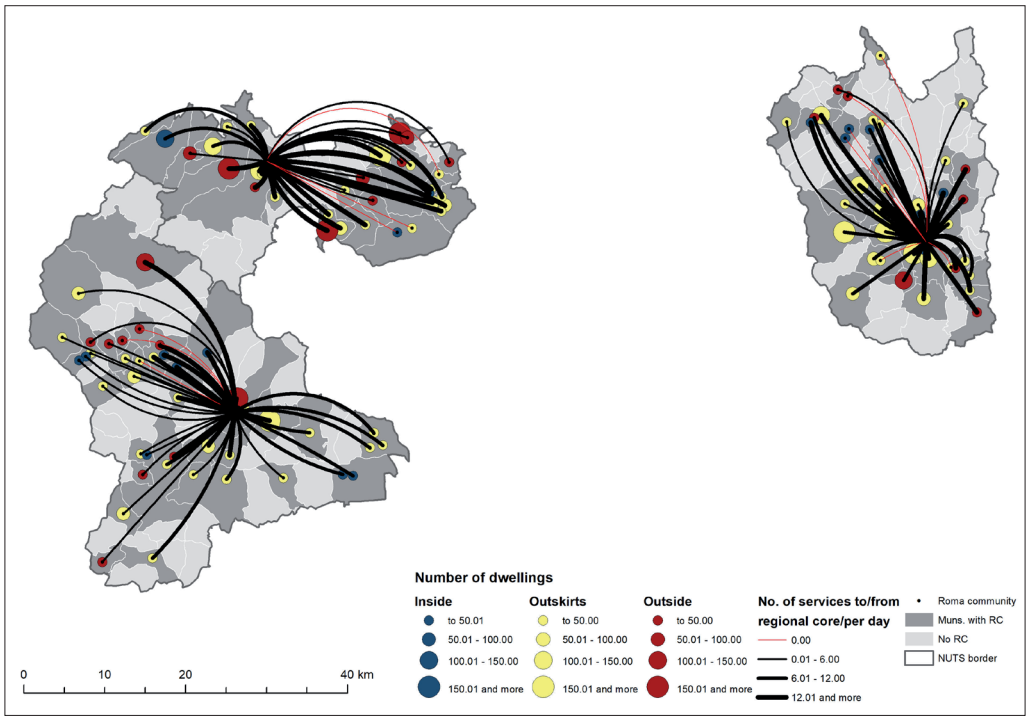

Fig. 6: Frequency of bus services between Roma communities and the nearest regional centre/per 24 hours (by Roma communities' location type and size based on number of dwellings, data on Rožňava, Spišská Nová Ves and Vranov nad Topľou districts)
Source: authors' calculations and elaboration based on data from Atlas of Roma Communities (2019) and www.cp.hnonline.sk, www.google.com/maps, zbgis.skgeodesy.sk, mapa.zoznam.sk

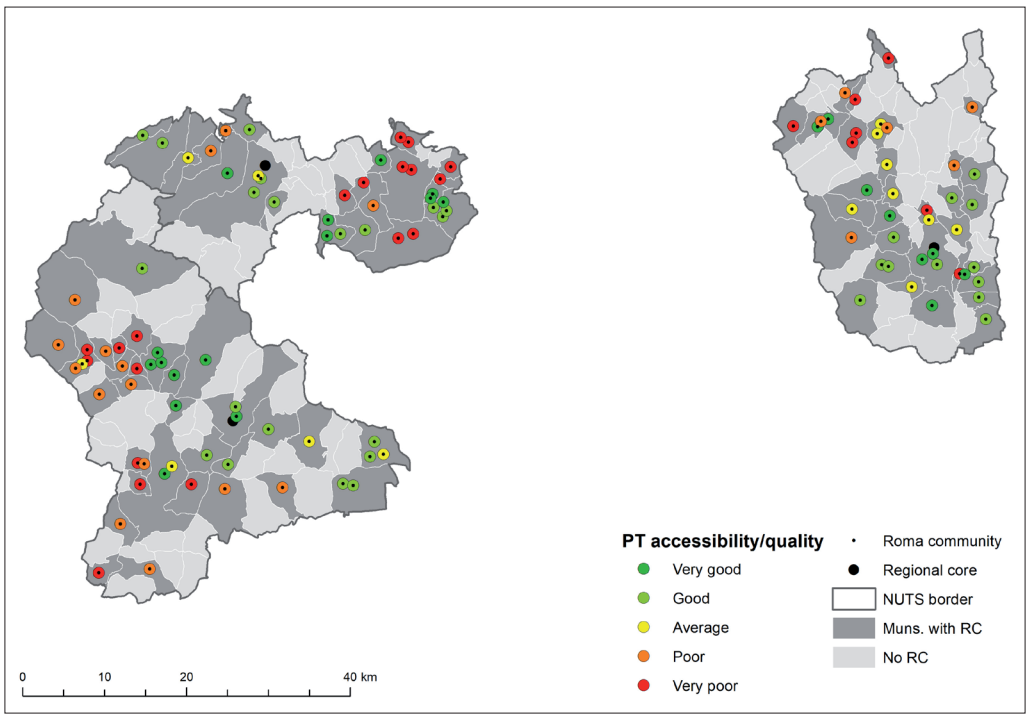

Fig. 7: Typology of Roma communities by accessibility and quality of public transport (in Rožňava, Spišská Nová Ves and Vranov nad Topľou districts)
Source: authors' calculations and elaboration based on data from Atlas of Roma Communities (2019) and www.cp.hnonline.sk, www.google.com/maps, zbgis.skgeodesy.sk, mapa.zoznam.sk

higher the general level of public transport accessibility in Roma communities. Second, a spatial clustering of Roma communities with very poor general public transport accessiblity is rarely to be seen in our research areas. For instance, we find a higher concentration of communities with poor level of public transport in the western part of Rožňava district or the eastern part of Spišská Nová Ves district. We can assume that poor public transport quality and accessibility are based mainly on local conditions (distant public transport stops, poor services to regional centres). Third, the categories of Roma settlement with "poor" and "very poor" public transport accessibility can be described as excluded or even heavily excluded from the public transport networks. We should emphasise, however, that most of such Roma communities are not too large in size (maximum of 50 dwellings). Figure 8 offers a more general picture summarising the data covering the three research areas (districts) into a clearly illustrative chart.

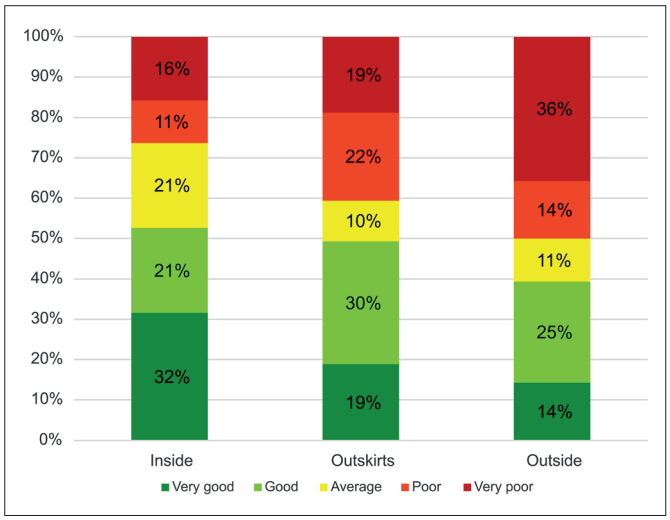

Fig. 8: Public transport accessibility in Roma communities by location type (relative share of individual types of Roma communities, cumulative data on Rožňava, Spišská Nová Ves and Vranov nad Topľou districts) Source: authors' calculations and elaboration based on data from Atlas of Roma Communities (2019) and www.cp.hnonline.sk

Thus, respecting the regional peculiarities described above, it is clear that the worse the location of a Roma community within the municipality, the worse the public transport accessibility. In other words, the Roma communities being segregated (i. e. outskirts type of location, category III of Roma communities) from the main urban structure of the municipality suffer from poor or even very poor accessibility of public transport networks, with all consequences on their social exclusion.

5. Discussion

Our approach to the public transportation accessibility for Roma community residents is based on a combination of indicators assessing both the accessibility of the public transport network for communities and the quality of public transport services within the network. The utilisation of methods and tools conventional for recent transport geography research is to reveal transport disadvantages and inequalities in access to public transport (a similar approach was applied, e.g. by Križan & Tolmáči, 2008; Bocarejo & Oviedo, 2012; Kraft, 2016; Květoň et al., 2017; Šťastná & Vaishar, 2017; Ivan et al., 2019; Stępniak et al., 2019; Curtis et al., 2019), and allows us to identify accurate levels of public transport networks inaccessibility from the view of the geographical environment and regional and/or local conditions. We do understand, however, that the assessment of public transport accessibility and quality is only a part of the very complex issues of social exclusion faced by Roma communities.

We also understand that public transportation is only one of the segments of mobility means, along with walking, use of a bicycle or a motocycle, passenger car use, etc. As indicated by some of the previous studies, public transport may not necessarily be a key means of mobility in Roma communities. Hluško (2020) claims that in some Roma communities the importance of individual mobility (including the car and walking mobility) may be much higher compared to utilisation of public transport in commuting to work. It is difficult, however, to judge whether this is a result of geographical inaccessibility to the public transport network or fares being too expensive for local Roma residents, as no specific research on Roma communities' mobility preferences has been carried out in Slovakia so far. It is also very difficult to estimate the car ownership rate in these communities, since no statistics on passenger car stock at local (or even micro-local) level are available in the country. There are numerous studies (e. g. Michálek & Veselovská, 2015; Rusnáková, 2015 or Rochovská & Rusnáková, 2018) indicating a low car-ownership rate in households in segregated Roma communities. This seems to be slightly in contrast with findings of Hluško (2020). The latter author, for example, argues that high preferences of Roma communities' residents for passenger car utilisation in every-day mobility only refers to carpooling, while individually driven cars seems to be less frequent than public transportation use.

Links between public transport accessibility and the social exclusion of Roma communities may also be a subject of dispute, unless we reveal real preferences of households and individuals for transportation modes. Transport mode preferences are hard to predict as they depend on numerous factors, such as economic conditions and income, subjective preferences, purpose of journey, weather and many other circumstances (see Dolinayová, 2011). No similar research has been done in Roma communities in Slovakia at present.

Nevertheless, based on the literature cited above, we can claim that due to the affordability of fares in regional public transport in Slovakia, the willingness to use public transport means for regular mobility should be rather high among Roma communities. We must emphasise, however, that in many cases an inaccessibility or poor quality of regional public transport may not be the key in access to a regional labour market. As described by many (e.g. Michálek & Veselovská, 2015; Rochovská & Rusnáková, 2018; Šatara et al., 2020), economic conditions and regional labour markets in Slovakia's regions with high Roma population concentrations are in most cases rather poor and too underdeveloped to offer enough opportunities for low-skilled and low-educated Roma residents from segregated communities. Therefore, many Roma residents probably prefer car-driving or carpooling to reach more distant labour markets (in other Slovak regions or even abroad), being inaccessible by regional public transport networks. Along with Kenyon et al. (2002) or Šťastná and Vaishar (2017), we understand that regional public transport still plays a crucial role in access to education, health-care services, food or social life.

Our findings suggest that some of the Roma communities in our research area may resemble of what Jiao and Dillivan (2013), Jiao (2017), Jiao and Cai (2020), Aman and Smith-Colin (2020) or Jiao (2017) identified as public transit deserts. The identification of Roma communities with poor or very poor accessibility of public transport networks presented above could be an effective argument justifying any attempt to define some of the Roma communities as public transport deserts. To identify public transport deserts in any geographical environment, Aman and Smith-Colin (2020) suggest to recognise not only public transport accessibility but also mobility demands and specifically public transport demands, which could help reveal how much the lack of an efficient public transportation is an issue for the respective community. From what has been published, however, so far we know very little about the mobility demands of the people of Roma communities in Slovakia.

6. Conclusions

Many residents of Roma communities in Slovakia reportedly face several disadvantages in access to labour markets or basic services (Vašečka & Džambazovič, 2000; Rochovská & Rusnáková, 2018). Transport disadvantage is surely only one of the elements of the Roma population's social exclusion within the Slovak society. Lacking any profound recent study on mobility behaviour, transport opportunities and preferences or motorisation of Roma households and communities, we focused on public transport accessibility in Roma communities in three regions of Eastern Slovakia. Emphasising that this situation might be specific in various regions of the country, based on our research we can conclude the following:

- Walking distance accessibility of public (bus) transport infrastructure points differs from place to place but it is generally worse in spatially segregated Roma communities (of category III) located often in secluded locations (often in rural environment with sparsely distributed paved-road infrastructure);
- The quality and frequency of public transport services at the bus stops accessible from Roma population communities do sometimes not meet basic standards set for regional public transport serviceability, especially if we consider access to the nearest regional centre (nodal centre); again, this parameter is generally worse for Roma communities located outside the built-up structures of municipalities (category III); and
- Roma communities with poor or very poor accessibility to public transport networks (caused by both poor access to public transport points or poor serviceability) can be found in each of the three regions in focus; but we should emphasise that such communities are mostly smaller or middle-sized, while larger Roma communities usually witness better public-transport accessibility conditions.

A better coordination between all relevant actors (public transport operators, self-governing regions, municipalities, as well as authorities responsible for segregated Roma communities' social inclusion in the country) might help improve the issue. Here, we must emhpasise that so far there is a lack of specific attention focused on Roma communities (especially those segregated) in the public transportation policy documents (the so-called Sustainable Mobility Plans) approved by regional authorities. For many living in these communities, public transportation represents the only means of mobility and the only way how to reach regional labour markets.

Future research should cover mobility needs in segregated Roma communities to better understand the transport preferences and role of mobility means in communities being at transport disadvantage. Such research might enable one to optimise the policies coping with barriers lying between poor segregated communities and the Non-Roma majority society in Slovakia. According to research results by Claps and Vitale (2011), long-term policies, not merely repressive ones, but also allowing different options, may contribute to the possibility for these communities to escape from marginalisation and segregation.

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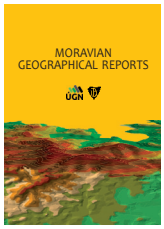

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Changes in the services of general interest in mountainous areas in Poland over the period 1988–2020: Their types, dynamics and driving forces

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Abstract

Changes in the services of general interest (SGI) of peripheral locations in the depopulating mountainous areas in Poland, in the context of their socio-economic transformation over the period 1988–2020, are discussed in this contribution. A total of 13 SGI of different importance, scope and purpose, both social and economic, were analysed in the study (e.g. basic health centres, libraries, pharmacies, post offices, primary schools). The institutions were categorised according to the target groups of beneficiaries: residents and tourists. The research was mainly based on the analysis of statistical data using basic statistical methods. This research revealed that the SGI has been declining in quantitative terms, particularly in rural areas, and the service facilities have become concentrated mainly in towns and in some villages with tourist infrastructure. In general, access to SGI in rural areas has become more difficult with exceptions for settlements with developed tourist functions. The number of and access to SGI is largely related to the number of inhabitants of a given settlement, its location, and the development of the tourist functions there.

Keywords: *services of general interest (SGI), mountainous areas, depopulation, tourism, Kłodzko region, Poland*

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1. Introduction

Contemporary man-made space is constantly transforming, with different courses, directions, and effects (Berkel & Verburg, 2011). The specificity of these processes depends on many different factors, and the course of changes varies on a national, regional, and even local scale. Different dynamics of demographic, socio-economic, functional, and spatial changes occur in the countries of Western Europe (O'Rourke, 2006), in the Mediterranean countries (Collantes & Pinilla, 2011; Di Figlia, 2016) or in Central and Eastern Europe (Kučera & Chromý, 2012; Bezák & Mitchley, 2014; Skokanová et al., 2016). The diversification of these processes is related to both environmental factors and the various political and economic histories of individual areas.

In recent years, a particularly strong polarisation of socio-economic changes at the interface between the city and the countryside and, more broadly, between the centre and the periphery has been observed worldwide (Schmidt, 2007; Pénzes, 2013; McDonagh et al., 2016). One of the effects of the observed changes is a transformation of types, number and access to the services of general interest (SGI) of individual areas. These changes are particularly visible in depopulating and peripheral areas (Christiaanse, 2020; Merino & Prats, 2020).

The aim of this article is to analyse changes in the SGI in peripheral locations of the depopulating mountainous area in Poland in the context of socio-economic transformations over the period 1988–2020. The Kłodzko region was selected as the case study because it represents a so-called 'problem area' (Eberhardt, 1989; Ciok, 1991; Bański, 2008), due to its peripheral location, mountainous topography, and a long-lasting depopulation process. The time scope of this study captures changes in the SGI and access to facilities across two different political and economic systems: during the period of communism and a centrally controlled economy (1988) and in the times of democracy and free market economy (2020).

This study analysed the SGI and access to facilities at the level of individual settlements according to two target groups (for residents and visitors), who are the main beneficiaries of the analysed services.

The specific research questions were formulated as follows:

1. What kind of changes in the SGI have occurred in the Kłodzko region over the period 1988–2020 and how was the access to facilities impacted?
2. What was the spatial distribution of the changes in the SGI?

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3. Are there any specific trends in the SGI and access to facilities in the two target groups (residents and visitors)?
4. What are the driving forces and effects of the changes in SGI?

2. Theoretical background

The conducted study is a part of a broader international discussion on services of general interest (SGI). The concept of SGI is defined in the literature in a variety of ways. For example, in the Green Paper on Services of General Interest, the European Commission points out that different historical, economic, cultural, and political developments can lead to diverse terms and definitions across the Member States. Thus, the definition of SGI can vary from country to country and from region to region (Marques da Costa et al., 2013). The European Commission has defined SGI as "market and non-market services which public authorities class as being of general interest and subject to specific public service obligations" (CEC, 2003).

The definition proposed by the EC underlines a distinctive characteristic of SGI, namely the obligation to provide such services even in places where the level of demand is not sufficient to ensure that such services are efficient and cost-effective. Thus, public authorities are obliged to provide SGI within certain parameters of quality, availability, accessibility and affordability, in order to ensure that such services are fully accessible to everyone (Marques da Costa et al., 2013).

There are many different approaches and concepts in SGI research. Attention is paid, among others, to the impact of SGI on territorial cohesion (Stępniak & Rosik, 2013; Malý, 2016; Gruber, et al., 2017), regional development (Shorn & Humer, 2021), demographics (Gruber et al., 2013), or socio-economic development (Malý, 2016).

The SGI and access to facilities in each area are one of the basic measures to explore and describe the quality of life in the contemporary world (Brereton et al., 2011; Farmer et al., 2012; Neumeier, 2016). Access to institutions and facilities providing various types of services is of particular importance for the residents of peripheral rural areas situated far from the main communication routes or regional growth centres, in which various barriers of development persist (such as physiographical barriers typical for mountainous areas). In the international debate on rural depopulation, attention is drawn to the problem of providing services in such areas and their impact on the quality of life of the residents. This type of research has been undertaken: inter alia, in Ireland, with a focus on the role of access to health care and public transport facilities in determining the quality of life of residents of rural areas (Brereton et al., 2011); in Scotland, where the lack of access to health care in rural areas was found to contribute to and fuel numerous social protests (Farmer et al., 2012); in Germany, where special attention was paid to the general tendency to concentrate the basic services (including petrol stations) in larger towns at the expense of small settlements and its impact on the deterioration of the quality of life of the local residents (Neumeier, 2016); and in the Netherlands, where the analyses of the reduction of SGI in depopulating areas focused particularly on people with low mobility, whose quality of life was most affected by the shrinking SGI in rural areas (Christiaanse, 2020).

It is usually assumed that the decline in population goes hand in hand with a decline in the infrastructure and services available in each location. The shrinking SGI in rural areas and its concentration in towns/cities is a common phenomenon not just in depopulating areas (Christiaanse, 2020). This trend can be attributed to the desire to combine the economies of scale and the advantages of agglomeration with the depopulation process, accompanied by a decreasing number of people who use the facilities (most often in small villages) (Elshof et al., 2014; Christiaanse, 2020). This may also be related to the rapid increase in the mobility of European citizens made possible by the development of individual and public transport (Hine & Kamruzzaman, 2012). The available research data revealed, for example, that in the Netherlands, a decrease in the number of institutions can have an even bigger impact on mobility and the economies of scale than a decrease in the number of residents (Steenbekkers & Vermeij, 2013; van Dam et al., 2006). In this context, it is particularly important to explore changes in the SGI and the access to institutions in peripheral depopulating areas.

The changes in SGI should also be related to their impact on local and regional development. The general transformation trends and development paths are determined mainly by exogenous factors operating on a global and regional scale, such as the EU programs, global market, and national spatial development policies (Strijker, 2005; Berkel & Verburg, 2011; Sánchez-Zamora et al., 2014). However, the final effects and scale of changes are strongly influenced by local conditions, which results in a large spatial differentiation in the development/regression of individual settlements (Gellrich et al., 2007; Berkel & Verburg, 2011; McLeman, 2011; Sørensen, 2018). Polarisation in the level of development within regions is often the consequence of the complexity and diversity of economic processes and their driving forces (Batzing et al. 1996; Sánchez-Zamora et al., 2014).

Economic theories referring to contemporary endogenous growth factors argue that the differences in the level of development in individual countries (regions or municipalities) can be attributed to differences in the institutional facilities, and that the SGI is one of the drivers of economic development (Merino & Prats, 2020). The development of a region is influenced both by the number of institutions, and, primarily, by the type and quality of SGI, along with transport availability. The reduction in access to SGI together with the progressive transport-related exclusion of people using these services affect not only the quality of life of the residents, but also the growth potential of the municipality/village. The areas particularly at risk are mainly peripheral areas in developing countries, where the mobility of the population is still low (Guzik & Kołoś, 2021).

Transport-related social exclusion and the resulting SGI exclusion of residents with low levels of personal mobility, such as the elderly, children, or people with low incomes, is often discussed in the literature, especially if the reduction in SGI increases the distance to the basic services (Woods, 2005; Smoyer-Tomic et al., 2006; Christiaanse, 2020). The main facilities providing services to these vulnerable social groups include shops, preschools, primary schools, health centres, or pharmacies. For example, the threshold distance in the USA is 10 miles (ca. 16 km) (Morton & Blanchard, 2007), in Germany – 15 minutes by car (Neumeier, 2016), and 5 km in the Netherlands (Christiaanse, 2020).

There are numerous discussions in the literature about the causes of changes in the SGI in a given area (Fassmann et al., 2015). The numerous and diverse contemporary processes and factors impact the changes in SGI, as identified by Humer et al., 2015. They include, among others, demography (Gruber et al., 2015), the economic crisis (Velasco, 2015) or territorial challenges (Jóhannesson, 2015). Although many of these problems are similar across EU member states, the individual states respond to these problems differently according to their social model (Marques da Costa et al., 2015). The changes to the SGI themselves are also assessed in various ways (see Littke and Rauhaut, 2013). Due to the complexity of the subject, in our article we focus on the investigation of the quantitative and spatial characteristics of SGI changes, their relation to various factors (diverse target groups, location of the settlement, number of inhabitants, level of tourism development), as well we try to identify their main driving forces related to changes in the socio-economic context during the analysed period. The assessment of

the impact of the SGI changes on the life quality of the residents is only briefly addressed, as it was outside of the main scope of the conducted research. Additional social, qualitative studies are needed to fully address these issues and they would form a separate research topic.

3. Data and methods

3.1 Study area

The Kłodzko region is equivalent to the administrative unit of the Kłodzko Poviat (County), which is in south-western Poland, in the Sudetes (Fig. 1), with a total area of 1,643 square km and a population of almost 150,000 people. There are 188 settlements in this area, of which 11 have the status of a town, and 177 are villages. The region was subject to long term depopulation (from the end of the 19th century), which intensified in the post-World War II period and continues nowadays (Szymanowski & Latocha, 2021). Because of this strong depopulation and its peripheral location in a borderland, many authors have classified this region as a 'problem area' (Eberhardt, 1989; Ciok, 1991; Bański, 2008). Recently, an intensified development of tourism has been observed in this region, however, which can be perceived as a potential remedy to overcome the previous socio-economic crisis. The number of tourists visiting this region has been steadily increasing. According to the Central Statistical Office (CSO) in Poland, the number of tourists in this area was 1.053 million in 2003, and in 2020 it increased to 1.996 million visitors (CSO, 2022). The development of tourism in the Kłodzko region contributed to the limitation of negative socioeconomic processes in the area and, in the case of some villages, even to the reversal of these trends, which might testify to rural revival (Szmytkie et al., 2022).

3.2 Methodology

The analysis uses data on changes in the population and SGI in the individual settlements of the Kłodzko region over the period 1988–2020. The data for baseline values is based on the National Census of 1988. Data for the final timepoint was obtained from the PESEL database (Universal Electronic System for Population Registration) and from a review of various internet resources (e.g. official websites of individual towns and communes from which information about the availability of individual facilities and services was collected). The presented data show whether a given institution is in each city, and not how many facilities of the same institution are in the city. Additionally, field surveys helped to compile an inventory of SGI facilities in the study area.

This analysis included a total of 13 different services of global interest (SGI), which were divided into two groups: services for residents and for both visitors and residents (Tab. 1). This division was based on the authors' long-term research experience and observations in the studied region. The SGI were divided according to their target groups to identify the possible relationship between the development of tourism and the change in the SGI and access to facilities in settlements where tourist movement has significantly increased in recent years. In legal-normative terms, the selected facilities are a mixture of "Services of General Economic Interest" and "Social Service of General Interest" (Fassman, 2015).

The choice of SGI for this research was largely driven by the availability of databases, in addition to internet queries and field research. Obviously, the importance of individual service facilities and their impact on the quality of life of the residents of rural areas is not uniform across countries. Facilities that are essential for the residents, especially in rural areas, usually include: grocery stores, primary schools, and primary care physicians

For residents	For visitors and residents
basic health centres	accommodation
financial institutions	cultural centres
fire brigades	grocery stores
libraries	pharmacies
preschools	post offices
primary schools	restaurants and bars
rural housewives' clubs	

Tab. 1: List of SGI facilities selected for analysis
Sources: authors' elaboration

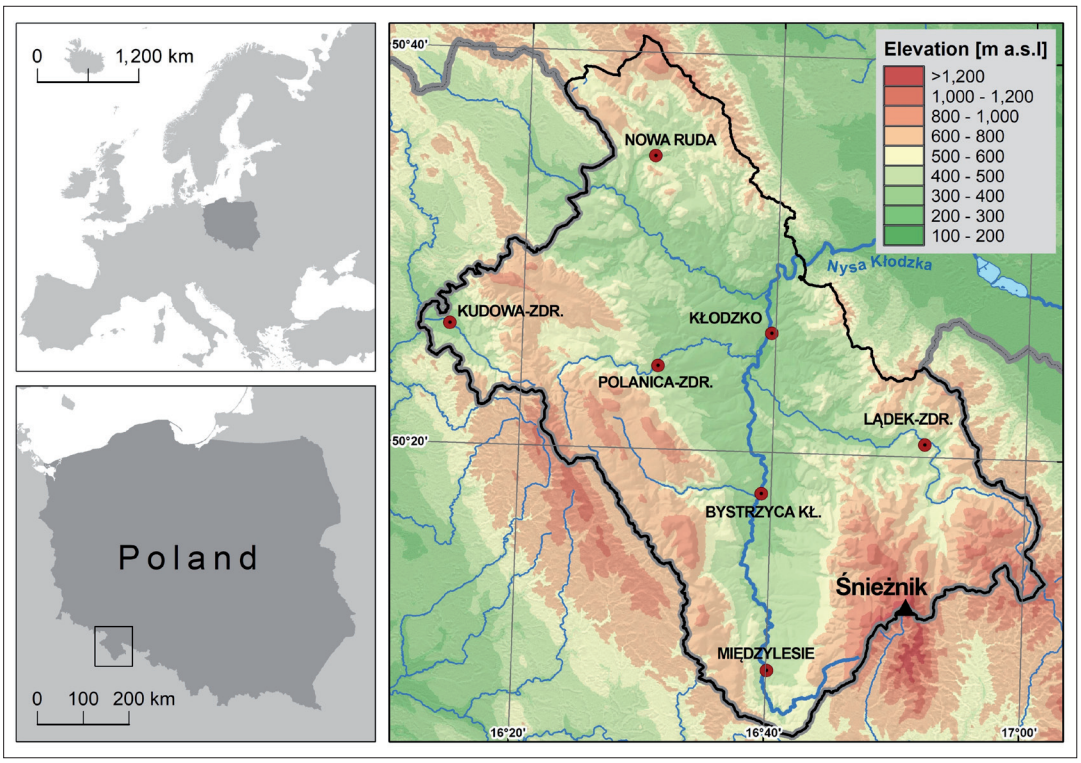

Fig. 1: Research area: general location, topography, and most important cities
Sources: authors' elaboration

(Paddison & Calderwood, 2007). As noted by Christiaanse (2020), the importance of other types of facilities is controversial and is largely related to the cultural conditions prevailing in each region. For example, post offices in Great Britain, libraries and banks in Sweden, and a town hall and ATMs in the Netherlands are considered essential facilities in their respective countries.

We are aware, that comparing SGI facilities at different time intervals may arouse controversy. The same facilities in 1988 may have played a completely different role in terms of the need for services they provide and their quality in 2020. For example, the present role of internet access to various services or the role of delivery men instead of personal visits to the post office should not be omitted. In the mountainous peripheral areas, however, both the role of delivery men and the coverage of internet or cell phones is hindered by the natural conditions, mainly by the topography. Moreover, there are no official data on the internet/cell phones coverage in the individual villages; however, during the field surveys the residents have often complained about the problems related to that issue. Being aware of the above-mentioned constraints, the observed changes in SGI were interpreted mainly in terms of their quantity.

To get a better insight into the analysed trends, this article also explores the potential relationship between SGI and selected factors, such as population size, elevation, and the development of tourist functions as measured by the number of bed places (a settlement with at least 100 bed places is considered a tourist resort).

Nearest neighbour analysis was used to estimate the access to facilities. It assumes that, if there is no service facility of a given type (such as a post office) in a particular settlement, the residents usually travel to the nearest settlement, i.e. a village/town located at the shortest distance using a public road, to get access to services. Based on this assumption, the average, minimum and maximum distance to a given SGI facility from each village was calculated, along with changes in these distances over the period 1988–2020. The analyses were performed using the ArcGIS Pro computer software.

4. Results

4.1 Demographic changes

The population of the Kłodzko region decreased from 183,106 to 149,781 residents (18.2%) over the period 1988–2020. The urban population decreased from 118,226 to 94,081 residents (20.4%), while the rural population decreased from 64,880 to 55,700 residents (14.1%). In the study period, the available data indicates that the depopulation process of the Kłodzko region has deepened and has become more dynamic (Tab. 2). The local population decreased in 139 out of 188 settlements of the study area (73.9%), including all towns; the population did not change in two settlements; statistical data were missing for 16 settlements (for 1988 and/or 2020), and an increase in the population was recorded in only 31 (16.5%) settlements.

Area	Population change [%]						Demographic trends according to the number of settlements (1988–2020)				
	1988–2000		2000–2020		1988–2020		increase	decrease	no change	no data	total
	in general	per year	in general	per year	in general	per year					
urban area	– 2.0	– 0.17	– 18.8	– 0.94	– 20.4	– 0.64	0	11	0	0	11
rural area	– 7.2	– 0.60	– 7.5	– 0.38	– 14.1	– 0.44	31	128	2	16	177
Kłodzko region	– 3.8	– 0.32	– 15.0	– 0.75	– 18.2	– 0.57	31	139	2	16	188

Tab. 2: The dynamics of population changes in the Kłodzko region between 1988 and 2020
Source: authors' elaboration according to the National Census (1988) and the PESEL database (2020)

The spatial distribution of population in the Kłodzko region was relatively highly diversified in 2020. The population of the study area was concentrated mainly in towns (62.8% of the total), around the two largest towns: Kłodzko – the administrative capital of the region (24,574 residents) and Nowa Ruda (20,896 residents) (Fig. 2A).

On the one hand, the largest population losses over the period 1988–2020 were recorded mainly in the largest towns of the study area: Nowa Ruda (– 6,644) and Kłodzko (– 5,537). On the other hand, the highest population growth was recorded in rural settlements in the vicinity of these towns. Depopulation was most notable in settlements located in the southern part of the region, in mountainous and foothill areas (Fig. 2B).

4.2 Changes in the SGI

The number of SGI facilities in the Kłodzko region decreased from 762 to 672 (11.8%) between 1988 and 2020 (Tab. 3). SGI has shrunk mainly in rural areas, where the number of facilities decreased by 17.8%. In urban areas, the number of SGI facilities increased by 25.5%. Tourist resorts also recorded an increase of SGI facilities (6.6%). Interestingly, the number of SGI facilities for residents decreased (28.1%) and for visitors and residents increased (11.0%). Similar trends were recorded in changes in the number of SGI facilities per 1,000 inhabitants (Tab. 3).

Despite the general tendency to reduce the SGI in rural areas, 47 villages recorded an increase in the number of SGI facilities. Combined with the increase in SGI in all regional towns, there was a total of 58 settlements in the Kłodzko region (30.9%) where an increase in the number of SGI facilities was recorded between 1988 and 2020. Still, their number decreased in 82 settlements (43.6%), and it did not change in 48 settlements (Tab. 3).

The SGI of individual settlements varied over time and was largely determined by the type of facilities, the type of settlements (urban/rural), and the target group of beneficiaries.

In 2020, SGI facilities such as accommodation and grocery stores were the most common in the Kłodzko region. The least common SGI facilities were cultural centres, post offices, pharmacies, and health care centres (Tab. 4).

In 2020, each town had all the analysed SGI facilities except for rural housewives' clubs (except for Międzylesie), which is quite understandable as regards the specific nature of these organisations. In rural areas, facilities such as accommodation and grocery stores are the most common. SGI facilities such as cultural centres, post offices, pharmacies, and health centres were the least common in rural areas (Tab. 4).

Between 1988 and 2020 a significant increase was noticed in the share of settlements with accommodation facilities (+ 45.7 pp), financial institutions (+ 16.0 pp), and restaurants and bars (+ 14.9 pp). A shrinking number of the SGI is the dominating trend, however. The largest decrease in the share of settlements with given SGI facilities was recorded for libraries (– 25.5 pp), grocery stores (– 25.0 pp), preschools (– 17.0 pp), and primary schools (– 16.0 pp). The changes in the SGI were particularly noticeable in the rural areas.

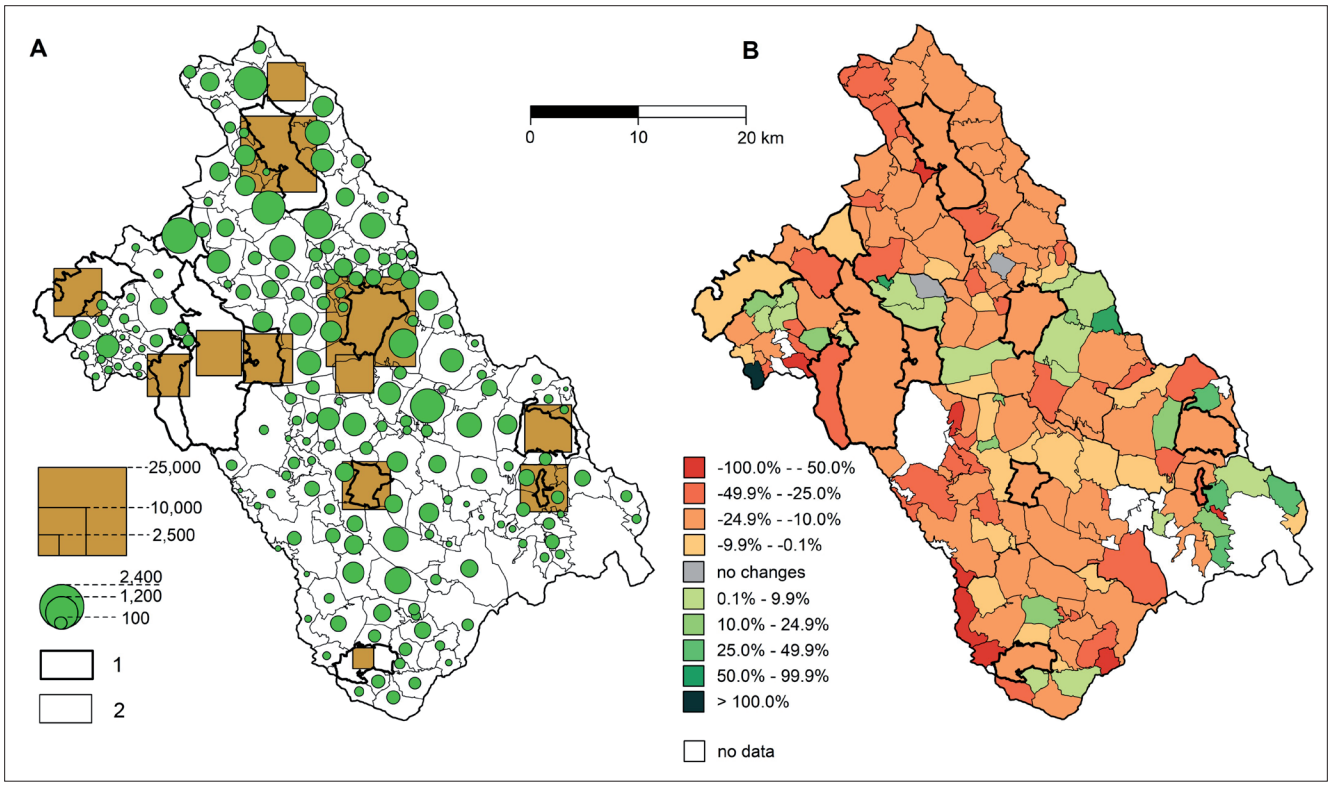

Fig. 2: Population in 2020 (A) and the dynamics of population changes over the period 1988–2020 (B) in individual settlements of the Kłodzko region (Notes: Types of districts: 1 – urban, 2 – rural).
Sources: authors' elaboration

Areas / type of SGI	SGI facilities			Average number of SGI facilities per type of location per 1,000 inhabitants			SGI provision / number of settlements (1988–2020)				
	1988	2020	1988–2020	1988	2020	1988–2020	increase	decrease	no change	no data	total
urban area	106	133	+ 25.5%	0.90	1.41	+ 56.7%	11	0	0	0	11
rural area	656	539	– 17.8%	10.11	9.68	– 4.3%	47	82	48	0	177
tourist resort	272	290	+ 6.6%	2.31	2.61	+ 13.3%	17	17	19	0	53
SGI for residents	445	320	– 28.1%	2.43	2.14	– 12.1%	27	88	73	0	188
SGI for visitors and residents	317	352	+ 11.0%	1.73	2.35	+ 35.7%	71	53	64	0	188
Kłodzko region	762	672	– 1.8%	4.16	4.49	– 7.8%	58	82	48	0	188

Tab. 3: The dynamics of SGI facilities in the Kłodzko region per 1,000 inhabitants between 1988 and 2020
Source: authors' research, according to the National Census (1988)

Area / SGI facilities / year	Urban area		Rural area		Kłodzko region	
	2020	1988–2020	2020	1988–2020	2020	1988–2020
basic health centres (1)	100.0%	–	8.5%	– 2.3 p.p.	13.8%	– 2.1 p.p.
financial institutions (1)	100.0%	–	25.4%	+ 16.9 p.p.	29.8%	+ 16.0 p.p.
fire brigades (1)	100.0%	–	28.2%	– 15.3 p.p.	32.4%	– 8.5 p.p.
library (1)	100.0%	–	16.9%	– 27.1 p.p.	21.8%	– 25.5 p.p.
preschools (1)	100.0%	–	11.9%	– 18.1 p.p.	17.0%	– 17.0 p.p.
primary schools (1)	100.0%	–	13.6%	– 16.9 p.p.	18.6%	– 16.0 p.p.
rural housewives' club (1)	9.1%	+ 9.1 p.p.	38.4%	– 14.7 p.p.	36.7%	– 13.3 p.p.
accommodation (2)	100.0%	–	74.6%	+ 48.6 p.p.	76.1%	+ 45.7 p.p.
cultural centres (2)	100.0%	–	1.7%	– 5.1 p.p.	7.4%	– 2.7 p.p.
grocery (2)	100.0%	–	40.1%	– 26.6 p.p.	43.6%	– 25.0 p.p.
pharmacies (2)	100.0%	–	6.2%	– 0.6 p.p.	11.7%	– 0.5 p.p.
post office (2)	100.0%	–	5.6%	– 14.7 p.p.	11.2%	– 13.8 p.p.
restaurants and bars (2)	100.0%	–	33.3%	+15.8 p.p.	37.2%	+ 14.9 p.p.
for residents (1)	100.0%	–	54.8%	– 9.6 p.p.	57.5%	– 9.0 p.p.
for visitors and residents (2)	100.0%	–	81.9%	+ 9.6 p.p.	83.0%	+9.0 p.p.

Tab. 4: Change in the percentage of settlements with given SGI facilities in the Kłodzko region between 1988 and 2020 (Notes: 1 – residents, 2 – visitors and residents). Sources: authors' elaboration

As far as the target groups served by the given SGI are concerned, there are more facilities intended to serve both visitors and residents in all the settlements (83.0% of settlements have at least one such facility) rather than SGI facilities intended for local residents only (53.5% adequately). Moreover, between 1988 and 2020, the number of SGI facilities intended for residents dwindled (a decrease by 9.0 pp). It was particularly noticeable in rural settlements. There was however a general increase in the number of SGI facilities intended for visitors and residents (Tab. 4).

In terms of the number of SGI facilities per settlement in 2020, settlements with either 1 or 2 types of facilities prevailed (74 villages; 39.4% of the total number of settlements). Settlements with 3 to 5 SGI facilities were also relatively common (48; 25.5%). There were 66 settlements (35.1%) which, due to the large number of facilities, can be classified as local centres (with more than 6 SGI facilities), of which 18 had 6 to 8 facilities, 9 had 9 to 11 facilities, and 14 localities (including all towns) had 12 or 13 facilities. 25 settlements (13.3%) had no SGI facilities (Fig. 3A).

Over the period 1988–2020, the highest increase in SGI was observed in towns and in some villages located within their impact zone, especially in the vicinity of the spa-towns and other tourist centres. A significant loss of SGI can be seen especially in the central and southern parts of the study region (Fig. 3B).

4.3 The relationship between the SGI and selected factors referring to settlements

4.3.1 Number of residents

The number of residents and the number of SGI facilities per settlement are clearly correlated. The fewer residents, the fewer SGI facilities located in a settlement. Settlements with up to 500 residents were particularly disfavored in terms of SGI, with an average of 1.96 facilities per settlement in 2020. These institutions included: accommodation facilities (in 73.4% of settlements with up to 500 residents), rural housewives' clubs (28.8%), and grocery stores (27.3%). Out of 139 settlements with a population of up to 500 residents, there was no post office in any one settlement, and there was a single settlement with: a cultural centre, a healthcare centre, two settlements with a pharmacy, and three with a preschool, a primary school, and a library.

This negative situation has deepened between 1988 and 2020. The smallest settlements with up to 100 residents were most disadvantaged in terms of the SGI – the average number of SGI facilities per settlement decreased by 20.2% in the period 1988–2000. Contrarily, in the largest settlements, with more than 3,000 residents, the number of SGI facilities per settlement increased by 4.6% (Tab. 5).

Among the smallest settlements with up to 100 residents, the following SGI facilities became less numerous: libraries (from 11 settlements in 1988 to none in 2020); voluntary fire brigades (from 7 to 1); shops (from 20 to 5); post offices (from 2 to 0); and health centres (from 1 to 0). The only facilities that were newly established in the smallest settlements were restaurants and bars (from 3 in 1988 to 10 in 2020), accommodation facilities (from 15 to 44), and rural housewives' clubs (from 7 to 9).

4.3.2 Elevation above sea level

The same correlation was identified between the location of the settlement (its average height above sea level) and the number of SGI facilities per settlement. In general, the higher the altitude, the lower the level of SGI. This correlation was particularly evident for settlements located over 600 m a.s.l. (Tab. 6).

Between 1988 and 2020, the SGI decreased, particularly in settlements located at an altitude of 400–500 m (decrease by 21.1%), 300–400 m (by 13.3%) and 700–800 m (by 12.6%) a.s.l. Interestingly, there was an increase in SGI in settlements located at an altitude of 600–700 m (increase by 10.8%) and 800–900 m a.s.l., which was mainly attributed to the development of tourist functions. The most spectacular examples include Bolesławów (644.5 m a.s.l.) or the Sienna ski-resort (839 m a.s.l.).

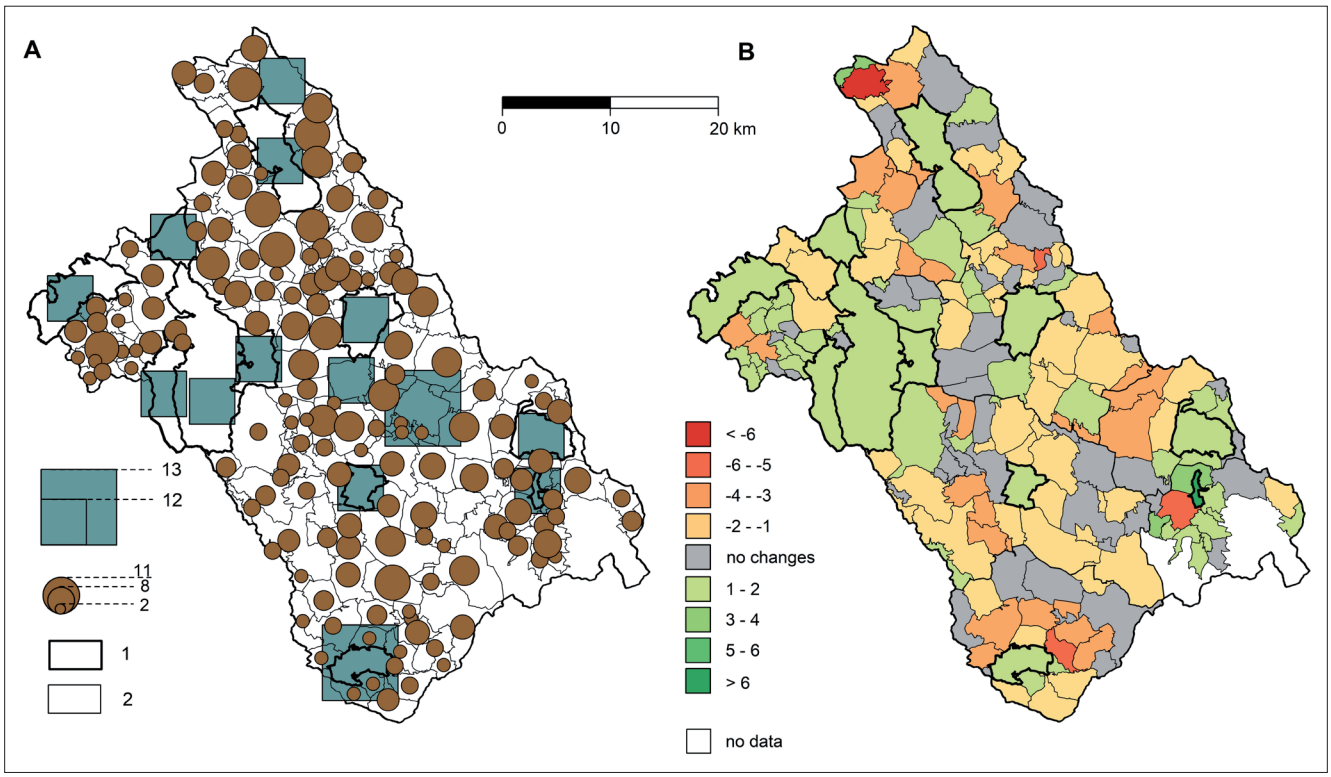

Fig. 3: Number of SGI facilities in 2020 (A) and its change over the period 1988–2020 (B) in individual settlements of the Kłodzko region
Note: Types of districts: 1 – urban, 2 – rural
Sources: authors' elaboration

Year/residents	1988			2020			1998–2020		
	locations	SGI facilities	average	locations	SGI facilities	average	locations	SGI facilities	average
< 100	52	67	1.29	70	72	1.03	+ 34.6%	+ 7.5%	– 20.2%
100–200	31	77	2.48	33	73	2.21	+ 6.5%	+ 5.2%	– 10.9%
200–500	39	167	4.28	36	134	3.72	– 7.7%	– 19.8%	– 13.1%
500–1,000	22	159	7.23	24	157	6.54	+ 9.1%	– 1.3%	– 9.5%
1,000–3,000	17	172	10.12	13	135	10.38	– 23.5%	– 21.5%	+ 2.6%
> 3,000	11	118	10.73	9	101	11.22	– 18.2%	– 14.4%	+ 4.6%
no data	16	2	0.13	3	0	0.00	– 81.3%	– 100%	– 100%

Tab. 5: The dynamics of SGI facilities according to the size of settlements in the Kłodzko region between 1988 and 2020 Source: authors' research, according to the National Census (1988)

m a.s.l.	Number of locations	Number of SGI facilities		Average number of facilities per location		Change (1988–2020)
		1988	2020	1988	2020	
300–400 m	40	216	187	5.40	4.68	– 13.3%
400–500 m	50	284	224	5.68	4.48	– 21.1%
500–600 m	37	150	143	4.05	3.86	– 4.7%
600–700 m	39	65	72	1.67	1.85	+ 10.8%
700–800 m	18	47	41	2.61	2.28	– 12.6%
800–900 m	4	0	5	0.00	1.25	–
525.5 m (avg.)	188	762	672	4.05	3.57	– 8.1%

Tab. 6: The dynamics of SGI facilities according to elevation in the Kłodzko region between 1988 and 2020 Source: authors' research, according to the National Census (1988)

4.3.3 Number of bed places

There is also an apparent correlation between the number of SGI facilities and the development of tourism in each settlement, as evidenced by the number of bed places. Settlements with 100 or more bed places were characterised with a better SGI access than an average settlement across the study area (Tab. 7).

There were 32 tourist resorts (a settlement with at least 100 bed places) in the Kłodzko region in 1988 and 53 in 2020. The SGI in tourist resorts decreased significantly between 1988 and 2020 (especially in settlements with a population of up to 1,000). Interestingly, the reduction in SGI in tourist resorts was greater than in an average settlement of the region. Nevertheless, the number of SGI facilities in tourist resorts was still higher than in other non-tourist settlements (see Tab. 7).

In 2020, the following SGI facilities were found most often in tourist resorts: accommodation facilities (100.0% of tourist resorts); restaurants and bars (60.4%); and grocery stores (58.5%). The least common types of institutions operating in tourist resorts included cultural centres (22.6%), pharmacies and post offices (26.4%). Between 1988 and 2020, in tourist resorts the following types of service facilities decreased: post office (from 18 to 14), library (from 24 to 20), preschool (from 20 to 17), and primary school (21 to 18).

4.3.4 Access to institutions

The average distance to be travelled to a SGI facility was 3.72 km in 2020 and – compared to 1988 – it increased by nearly 0.28 km. The access to SGI has substantially improved in the towns and worsened in rural areas (Tab. 8). The average distance to an individual SGI facility varied over time and correlated with the type of locality. Cultural centres, post offices, pharmacies, health centres, preschools, and primary schools were the least available facilities in the Kłodzko region in 2020 (Tab. 9). The shortest route was to accommodation facilities and tourism service providers. Between 1988 and 2020, the main improvements were identified in the access to accommodation facilities, financial institutions, and restaurants and bars. In contrast the access to post offices, libraries, preschools, primary schools, and grocery stores deteriorated.

Between 1988 and 2020 the following SGI facilities became less available in rural areas: post offices, libraries, preschools, primary schools, and grocery stores. Conversely, the access to accommodation facilities, financial institutions, and restaurants and bars has significantly improved (Tab. 9).

When analysing the availability of individual SGI facilities in towns/villages, extreme cases should also be considered. For examples, the residents of Spalona village must travel

Year/people	1988		2020		Change (1988–2020)	
	Kłodzko region	tourist resort*	Kłodzko region	tourist resort	Kłodzko region	tourist resort
< 100	1.29	3.40	1.03	1.57	– 20.2%	– 53.8%
100–200	2.48	3.67	2.21	2.83	– 10.9%	– 22.9%
200–500	4.28	5.00	3.72	4.00	– 13.1%	– 20.0%
500–1,000	7.23	8.00	6.54	6.38	– 9.5%	– 20.3%
1,000–3,000	10.12	10.67	10.38	11.75	+ 2.6%	+ 10.1%
> 3,000	10.73	10.88	11.22	12.00	+ 4.6%	+ 10.3%
average	4.05	7.71	3.57	5.53	– 11.9%	– 28.3%

*Tab. 7: The change in average number of SGI facilities in all settlements and in tourist resorts according to population size over the period 1988–2020 (Note: * locations with 100 and more bed places). Source: authors' research study according to the National Census (1988)*

more than 20 km to a preschool or pharmacy, the residents of Wójtowice village have to travel over 18 km to a primary school and a health centre, and Piaskowice village is located over 16 km from a financial institution, a grocery store, a community centre, or a fire brigade (Tab. 9). The access to the basic service facilities was highly homogenous throughout the region in terms of the type of services provided. Facilities serving only the residents were less available than facilities dedicated to both visitors and residents, but these differences were insignificant.

The availability of both types of SGI facilities generally decreased between 1988 and 2020. The availability of SGI facilities intended for residents, however, decreased two or three times more than the access to facilities intended for both visitors and residents. The towns are the only areas where access to both these types of facilities improved (Tab. 10).

5. Discussion

As in other areas of Europe (Christiaanse, 2020), changes in the SGI in the Kłodzko region between 1988 and 2020 involved mainly its shrinking in rural areas in favour of more concentrated service facilities in the towns. These pan-European processes result in a very low level of SGI in villages, particularly in villages with small population numbers (Neumeier, 2016; Westlund & Pichler, 2012). The Kłodzko region is no different. In 2020, there were 70 villages with up to 100 residents in the study area, each with only 1.03 out of 13 analysed SGI. As a result, the residents had insufficient access to SGI facilities, including basic services.

Many SGI facilities were closed in villages and relocated to towns, which raises legitimate concerns about access to services for rural residents (Paddison & Calderwood, 2007). The availability of SGI facilities in rural areas of the Kłodzko region decreased by 9.9% over the period 1988–2020, and residents must travel 3.72 km on average to get to a facility which is absent in their place

Areas	Average distance			
	1988	2020	1988–2020	
urban area	1,195.2 m	371.5 m	− 823.7 m	− 68.9%
rural area	3,574.4 m	3,928.6 m	+ 354.2 m	+ 9.9%
Kłodzko region	3,435.2 m	3,720.5 m	+ 285.3 m	+ 8.3%

Tab. 8: The average distance to SGI facilities in the Kłodzko region in 1988 and 2020. Sources: authors' elaboration

Area/SGI facilities/year		Urban area [m]		Rural area [m]		Kłodzko region [m]	
		2020	1988–2020	2020	1988–2020	2020	1988–2020
basic health centres (1)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	4,993.0	+ 270.5	4,700.9	+ 254.7
	max.	0.0	–	18,024.5	− 2,560.6	18,024.5	− 2,560.6
financial institutions (1)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	3,682.9	− 1,670.8	3,467.4	− 1,573.0
	max.	0.0	–	16,424.7	− 11,543.9	16,424.7	− 11,543.9
fire brigades (1)	min.	0.0	− 3,048.3	0.0	–	0.0	–
	average	0.0	− 4,614.7	3,241.0	+ 661.4	3,051.3	+ 352.6
	max.	0.0	− 5,909.6	16,424.7	+ 1,789.5	16,424.7	+ 1,789.5
library (1)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	3,951.0	+ 1,475.0	3,719.8	+ 1,388.7
	max.	0.0	–	16,424.7	+ 3,485.6	16,424.7	+ 3,485.6
preschools (1)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	4,642.1	+ 1,450.2	4,370.5	+ 1,365.4
	max.	0.0	–	20,585.1	+ 4,160.4	20,585.1	+ 4,160.4
primary schools (1)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	4,511.4	+ 1,431.7	4,247.4	+ 1,347.9
	max.	0.0	–	18,024.5	− 1,599.8	18,024.5	− 1,599.8
accommodation (2)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	936.2	− 2,511.1	881.5	− 2,364.9
	max.	0.0	–	6,843.2	− 7,600.0	6,843.2	− 7,600.0
cultural centres (2)	min.	0.0	0.0	0.0	–	0.0	–
	average	0.0	− 4,981.0	5,927.8	+ 417.0	5,581.0	+ 101.1
	max.	0.0	− 21,068.7	16,424.7	− 1,774.2	16,424.7	− 1,774.2
grocery (2)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	2,455.9	+ 1,195.4	2,312.2	+ 1,125.4
	max.	0.0	–	16,424.7	+ 4,112.4	16,424.7	+ 4,112.4
pharmacies (2)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	5,703.8	+ 361.2	5,370.1	+ 340.1
	max.	0.0	–	20,585.1	–	20,585.1	–
post office (2)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	5,643.2	+ 2,186.5	5,313.0	+ 2,058.6
	max.	0.0	–	15,340.2	+ 419.0	15,759.2	+ 419.0
restaurants and bars (2)	min.	0.0	–	0.0	–	0.0	–
	average	0.0	–	2,837.1	− 1,101.6	2,671.1	− 1,037.1
	max.	0.0	–	13,845.8	− 12,239.7	13,845.8	− 12,239.7
rural housewives' club (1)	min.	0.0	− 2,178.3	0.0	–	0.0	–
	average	5,942.0	− 1,112.8	2,546.3	+ 440.2	2,679.8	+ 349.4
	max.	12,384.0	− 2,185.3	14,285.7	− 349.5	14,285.7	− 349.5

Tab. 9: Average, minimum and maximum distance to SGI facilities in the Kłodzko region in 1988 and 2020 (Notes: 1 – residents, 2 – visitors and residents). Sources: authors' elaboration

Areas	Average distance to the SGI facilities for:							
	Residents				Visitors and residents			
	1988	2020	1988–2020		1988	2020	1988–2020	
urban area	1,508.1 m	689.9 m	– 818.8 m	– 54.3%	841.8 m	0.0 m	– 841.8 m	– 100.0%
rural area	3,358.5 m	3,938.2 m	+ 579.7 m	+ 17.3%	3,600.9 m	3,917.3 m	+ 316.4 m	+ 8.8%
Kłodzko region	3,250.2 m	3,748.2 m	+ 497.0 m	+ 15.3%	3,483.3 m	3,688.1 m	+ 204.9 m	+ 5.9%

Tab. 10: Average distance to SGI facilities dedicated to residents and both visitors and residents in the Kłodzko region in 1988 and 2020
Sources: authors' elaboration

of residence. In this context, the SGI appears satisfactory in the study area, however, an average value is provided and, additionally, the area is mountainous, which makes travelling more difficult. In extreme cases, some residents must travel more than 15–20 km to get to services important for residents, such as a pharmacy, preschool, primary school, or health centre. Although there are school buses operating in the area, they are dedicated to school children only and they do not solve the problem of access to SGI for other inhabitants.

As demonstrated in the analysis, the availability of the SGI in rural areas of the Kłodzko region has decreased, and the distance to these facilities has often increased from several hundred metres to almost 2 km on average but reaching more than 20 km in extreme cases.

The number and access to the SGI in Poland is relatively low (Bański, 2015; Kamińska, 2015; Heffner, 2017), and after 1989 it deteriorated even further, especially in rural areas (Petryszyn, 2006; Herczyński & Sobotka, 2014). The analysis covering the period 1988–2020, however, revealed that there were no large-scale changes in the number of the analysed SGI facilities (Tabs. 3 and 8). What mattered is the type of facilities that disappeared, as they mainly provided basic services intended especially for the residents (preschools, primary schools, libraries, and health centres).

It proved impossible to indicate a clear correlation between depopulation and changes in SGI, as these processes mutually drive one another. On the one hand, the decline in population correlates with a decline in the infrastructure and services in rural areas (Haartsen et al., 2014; Christiaanse, 2020). On the other hand, a regression in infrastructure and services may contribute to population decline. Caution should be exercised in assessing this correlation because the causes of depopulation in many European regions are highly complex and ambiguous (Merino & Prats, 2020; Szymanowski & Latocha, 2021), and may involve various demographic (Westhoek et al., 2006; Coleman & Rowthorn, 2011; Wiest et al., 2011), psychosocial (Paniagua, 2002a; Stockdale, 2002), environmental (Willian & Jobes, 1990; Gare & Arran, 1995), and economic factors (Commins, 1978; Pezzini, 2001; Paniagua, 2002b). One should agree with the statement by E. Gruber et al. (2015), however, that changing population sizes as well as changing population structures have produced new patterns of SGI demands and needs with different regional characteristics which are a challenge for public institutions.

The same applies to the impact of political and economic changes on the SGI in the Kłodzko region. In terms of their numbers, little has changed, but there are significant differences in the types of SGI provided in 1988 and nowadays. In the communist system with a centrally controlled economy, the social services dedicated to residents (grocery stores, post offices, libraries, health centres, preschools, schools) were much more available than in the democratic system with a free market economy. Currently, SGI facilities that serve mainly visitors, such as accommodation facilities, restaurants, and bars, etc. are more available than in 1988. This can be attributed to, inter alia, the ownership structure of individual facilities; for example, the State Treasury attempted to cut the operating costs of the state-run facilities dedicated to residents, which became less available. In turn, the number of SGI facilities intended for both visitors and residents increased as these services operate mainly in the private sector, which can respond better to changes taking place in the market, including the declining number of consumers.

The development of tourism, particularly in rural areas, was another factor that has fuelled the gradual change in the type of SGI facilities in the Kłodzko region over the past 30 years. It entailed the development of facilities focused on the target group – visitors (and residents) at the expense of facilities focused on providing services only for residents (Tabs. 4 and 9).

The location of the settlement (elevation a.s.l.) and the development of tourism (as measured by the number of bed places) were also found to have a possible impact on changes in the SGI. Settlements situated over 600 m above sea level have much scarcer SGI than other settlements in the study area. This correlation did not apply to high-altitude villages focused on tourism, however, in which a recent increase in service facilities was noted. This confirms that the development of tourism may contribute to the socio-economic recovery of problem and peripheral areas (Frederick, 1993; Gannon, 1994; Briedenhann & Wickens, 2004; Hummelbrunner & Miglbauer, 1994; Salvatore et al., 2018). It can be concluded that the tourist resorts are characterised by a better SGI than non-tourist localities with a similar number of residents. Tourist resorts with 100 or more bed places, depending on the population size, generally had a dozen or several dozen percentage points more SGI facilities than the average for the region. The development of tourism goes hand in hand with the development of the SGI and is one of the few factors that may slow down the reduction of the SGI facilities' accessibility. Nevertheless, the research by J. Malý (2015) suggests that the association of SGI access with the level of development should not be overestimated. Therefore, one should be careful with an unequivocal assessment of the impact of the studied phenomenon on socio-economic development in the Kłodzko region.

6. Conclusion

The study of the SGI in the Kłodzko region over the period 1988–2020 provides data mainly on the quantitative and – indirectly – qualitative nature of this phenomenon. The following factors have been identified as having impact on the changes in the SGI: the settlement type and status; population number; scale of depopulation; elevation; development of tourism; and political and economic changes. The conclusions drawn from this type of research are of practical use and can be helpful in the development of policies and strategies for preventing the depopulation of mountain rural areas, and more broadly – for managing and supporting the development of peripheral regions. The study of changes in the SGI provides a diagnosis of the local conditions and offers useful tool for management and planning, which is advocated by many authors, in particular as regards peripheral rural areas (e.g. Berkel & Verburg, 2011; Sørensen, 2018; Li et al., 2019).

The results might be interpreted as the progressing deterioration of life quality of the residents in the study area, especially in the smallest and remote villages, which is in line with findings in other peripheral regions (e. g. Cheshire, 2006; Christiaanse, 2020). The changes in SGI facilities dedicated to providing services to visitors, however, allow for a conclusion that tourism development might support the increase in access to SGI or at least its stabilisation. Although the services in tourist resorts are dedicated mainly to visitors, the residents can indirectly benefit from their impact as the economic situation is generally improved in such settlements (new jobs, business potential, etc.). To better understand the identified processes and their actual role in improving or deteriorating the life quality of residents and visitors in the analysed settlements, further studies on social perceptions of the SGI changes are recommended.

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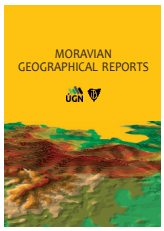

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Spatial changes in the Hungarian and Slovenian cattle sector before and after accession to the European Union

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Abstract

A comparative analysis of the spatial transformation of two different farm-size cattle systems, in Hungary and Slovenia, is presented in this paper. Concentration, mobility, and spatial autocorrelation measures are used to study spatial cattle-stock distribution and their changes over time, as well as spatial cattle-stock clustering using data from two agricultural censuses. Results confirm the decline in cattle stock on large-size farms in Hungary and on small-size farms in Slovenia, with a relative increase in the importance of medium-size farms in both countries. The decline and spatial changes in cattle stock are greater in Hungary than in Slovenia. Hungarian cattle clusters are concentrated in flat areas with medium- and large-size largely commercial farms, whilst in Slovenia they predominate in mainly hilly grassland and partly corn-silage areas on small and some medium-size family farms. Such specific cattle clustering is linked to geographical and farm-size structural characteristics that can also be linked to agricultural-policy-measure-related support for cattle and dairy, associated with less-favoured or disadvantaged-area status linked to geographical and structural land and farm characteristics typical of Slovenian mountain and particularly hilly areas. These spatial changes in the cattle sector have socioeconomic, land use, and environmental implications in terms of ecological sustainability and rural livelihoods.

Keywords: *spatial cattle stock clustering, spatial concentration, spatial mobility, spatial autocorrelation, Hungary, Slovenia*

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1. Introduction

The EU is one of the world's leading producers, consumers, and traders of beef meat and dairy products (Greenwood, 2021; Smeets Kristkova et al., 2015; Bojnec and Fertő, 2014a, 2014b; European Communities, 2006). According to recent reports by the Directorate-General for Agriculture and Rural Development (European Commission, 2020; Peyraud et al., 2020), the livestock sector, especially milk and beef production, contributes substantially to the European economy and rural areas. Furthermore, the EU is the leading exporter of dairy products, having maintained a continuous trade surplus over the past decades. Beef also contributes significantly to the EU's international livestock trade, although the trade balance for beef shows a deficit (Chatellier, 2021; Bojnec & Fertő, 2014a, 2014b).

Like other livestock sectors, dairy and beef production can significantly impact the development and employment level in rural areas (Lika, 2021). For example, the livestock sector can support the economic and wellbeing of remote, hilly, and mountainous rural communities (Bettencourt et al., 2015; Pecher et al., 2017).

Meanwhile, from the nutritional point of view, dairy products, and beef play an important role in meeting the protein needs of Europeans (European Commission, 2019; Westhoek et al., 2015), while the EU's dairy sector also plays an important role in the global supply of high quality and safe dairy proteins (Lagrange et al., 2015).

Besides the factors discussed above, another strand of literature deals with the spatial distribution of different regional and territorial economic, social, and environmental factors and other phenomena. Bone et al. (2013) developed a GIS-based risk rating for forest-insect outbreaks using aerial overview surveys and the local Moran's I statistic. Stürck et al. (2015) investigated land-use change and the spatio-temporal dynamics of regulating ecosystem services in Europe using long historical data. Csonka et al. (2021) analysed concentration and spatial autocorrelation in the Hungarian and Slovenian pig sector. For the above reasons, it would be useful to study the spatial distribution of cattle and its change, but while such methods have been used for other farm-based sectors, there are only a few studies on cattle. The related literature is limited to North American and Western European countries.

The objective of the article is to analyse spatial changes in the Hungarian and Slovenian cattle sector after accession to the EU in 2004. The selection of these two neighbouring countries is interesting and relevant because of their different agricultural,

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farm structure, and spatial geographical characteristics. More specifically, we aim to answer the following three research questions. First, how did spatial concentration and the spatial mobility of cattle populations evolve in Hungary and Slovenia between the two censuses of agricultural holdings before (2000) and after (2010) accession to the EU? Second, can the presence of clustering effects be identified in either or both countries? Third whether some nexus can be detected between farm-size structural transformations and spatial distributions in the cattle sector?

We use Markov transition probability matrices to identify the spatial mobility of the cattle stock between 2000 and 2010. In addition, we contribute novel empirical results regarding the spatial distribution and transformation of cattle stock in Hungary and Slovenia, with associated spatial socio-economic implications.

The structure of the rest of this paper is as follows: the following section provides a literature review. The third section provides an overview of Hungarian and Slovenian cattle sector and farm structure. The fourth section briefly presents data and methods. Next, we illustrate country-level results and compare them. The penultimate section discusses the results and derives policy implications. The final section concludes.

2. Theoretical background

The economic and social contributions of livestock farming depend to a large extent on the territories where they are based (Peyraud et al., 2020). According to Hercule et al. (2017), globally- or locally integrated livestock farming should be analysed in a spatial context, to include ecological, technical, and social specificities. Neumann et al. (2009) show that beef and dairy cattle are the most important livestock types in terms of total numbers and economic value, thus it is crucial to explore the spatial distribution and determinants thereof of cattle farming.

Despite its importance, only a small number of studies have addressed this topic. Ievoli et al. (2017) reveal that spatial agglomeration externalities have a positive effect on the spatial pattern of milk production in the Molise region of Italy. Arfa et al. (2009), Weersink et al. (2005), Isik (2004), Mosnier and Wieck (2010), Neumann et al. (2009) also provide evidence of the existence of agglomeration externalities and spatial dependence in the dairy sector. Other studies (Baltenweck & Staal, 2000; Läpple et al., 2017; Lewis et al., 2011; Skevas, 2020; Skevas & Oude Lansink, 2020; Yang & Sharp, 2017) provide evidence that spatial externalities affect positively the adoption of efficient or sustainable technologies and practices on dairy farms. Similar, but more scanty findings (Bowman et al., 2012; Deblitz et al., 2008; Hua et al., 2018; Rodriguez et al., 2013; Vittis, 2019) can be found about the spatial pattern of beef production. Hinojosa et al. (2019) highlight for the presence of geographical heterogeneity in mountain grasslands dynamics in the Austrian-Italian Tyrol region. In short, research underlies the importance of spatial distribution in the dairy sector, including factor endowment, market potential, and spatial agglomeration externalities.

Research has developed on the spatial dynamics of cattle farming in Central and Eastern European (CEE) countries showing the spatial transformation of the cattle sector in relation with the implementation of the Common Agricultural Policy (CAP), following the accession of CEE countries to the EU. The topic is particularly important given that since the last decade of the twentieth century, the agriculture of CEE countries has been undergoing continuous structural transformation. Since 2004, several countries in the region have also joined the EU in stages. In the new EU Member States, the restructuring of agriculture has been driven and contributed to by processes associated with the Single European Market and the CAP – and cattle farming is no exception (Némethová et al., 2014). Cattle farms in new Member States from CEE countries (EU-13) have a lower survival probability due to their smaller average scale and smaller share of total EU production (Ihle et al., 2017). Consequently, deep structural change in the sector has been inevitable during the first decade of the twenty-first century. The main characteristics, processes, and determinants of this structural transition are well-documented in the literature (e.g. Ihle et al., 2017; Kuipers et al., 2013; Cochrane & Jorgji, 2013). The spatial dimensions of the CEE cattle farming transition, however, remain less explored, except for a (non-EU) study by Nivievskyi (2009), who found significant spatial dependency in pure efficiency and technological components of total factor productivity in Ukrainian dairy farms, supporting the neighbouring farms effect on efficiency and technological progress.

3. Data and methodology

For our empirical analysis, we use data from the Hungarian and the Slovenian Central Statistical Offices. Cattle-stock data (in heads) are based on the Agricultural Censuses in 2000 and 2010 at local administrative unit (LAU) level, comparable with the Nomenclature of territorial units for statistics (NUTS) classification. Until 2016, two levels of LAU existed: the upper LAU level 1, formerly NUTS level 4, and the lower LAU level 2, formerly NUTS level 5, consisted of municipalities or equivalent units in the EU Member States. We use the pre-2007 NUTS classification for technical reasons, with LAU-2 for Slovenia and LAU-1 for Hungary as the observation units. Agricultural and other policies can affect cattle farming implemented at these levels in the two countries: for example, due to spatial farm type specialisation or if the territory is situated in Less Favoured Areas for agricultural production as eligible for specific subsidies or other budgetary support. In Hungary, 175 district/microregions are investigated, and in Slovenia 192 municipalities out of 212 municipalities due to the exclusion of 20 LAUs with urban status and without cattle production. For Hungary, only Budapest had to be excluded for similar reasons. Furthermore, Budapest, as the capital and an urban area with a high density of population, was by definition not classified as a LAU-1 district in the Hungarian administrative system (see more details on comparability issues in Csonka et al., 2021). We refer to the observation units as "local administrative units" (LAU) for simplicity.

We are interested in different dimensions of the spatial distribution of cattle stocks – inequality trends, cattle stock growth, and cattle stock mobility. Thus, we apply methodological tools from the income inequality literature. First, we focus on the spatial concentration of cattle production using Gini coefficients. Because the Gini indices may hide different spatial distribution of cattle stock, we present the Lorenz Curves. In addition, we investigate the dynamics of spatial concentration over time employing the Gini decomposition methodology.

Following Jenkins and van Kerm (2006) we decompose the change in the single Gini index – $G(v)$ – using the formulas below:

$$\Delta G(v) = R(v) - P(v), \quad (1)$$

where $$R(v) = G_0(v) - G_1^0(v) \quad (2)$$

and $$P(v) = G_1(v) - G_1^0(v). \quad (3)$$

where $G_1^0(v)$ is the generalised Gini concentration index for final year 2010, based on the ranking of the initial year 2000 $G_0(v)$. The value of $P(v)$ can be interpreted as a measure of the progressivity of cattle population growth, while the value of $R(v)$ can be interpreted as a mobility index based on re-ranking. Equation (1)

expresses that inequality is progressive with an increase in the cattle population, assuming that it is not offset by simultaneous mobility. If the cattle stock increases between beginning and end periods, and the value of P(v) is greater than zero, implying that the cattle stock is more concentrated in the "poor" (smaller cattle stock) than the "rich" (larger cattle stock) units: this is called pro-poor growth. If *P(v)* is less than zero, then cattle growth is more strongly concentrated in "rich" than in "poor" units. In our case, when the cattle stock does not rise but declines, we identify an increase in the "poor" stock when losses are less concentrated among the "poor" territorial units compared to the "rich" ones.

Second, we employ Markov transition probability matrices to identify the spatial persistence and mobility of cattle stock between 2000 and 2010. A Markov matrix is a square matrix with all nonnegative entries, and where the sum of the entries down any rows is 1. A Markov matrix shows all possible states, and between states, and they show the transition rate, which is the probability of moving from one state to another per unit of time. We classify data into quartiles based on the size of cattle stock. Transition matrices show the probability of passing from one quartile to another between the starting year (2000) and the end year (2010). The diagonal elements of the Markov matrix show the probability that a particular cell at the start of the period will have the same status at the end of the period. The eigenvalues of a Markov matrix provide important information about the long-term behaviour of linear systems. The determinant of a Markov matrix can be interpreted as putting bound on how good the system is at preserving information about its initial state. The degree of mobility in patterns of cattle production can be summarised using different mobility indices from the income inequality literature. To check the robustness of our results we applied four different mobility indices for each country. These indices are functions of the transition matrix $P_{K\times K}$ between two time periods. Indices derived from the transition matrix combine the elements on the main diagonal (Shorrocks, 1978): they consider the average "jump" of income classes (Bartholomew, 1973); they account for the second-largest eigenvalues (Sommers & Conlisk, 1979) or the determinant of the matrix itself (Shorrocks, 1978). Higher indices imply higher mobility. The formulas for the mobility indices are as follows:

$$\text{M1 Prais (trace): } (K-1)^{-1}\{K-\text{trace}(P)\} \tag{4}$$

$$\text{M2 Bartholomew: } \{K(K-1)\}^{-1}\Sigma_i\Sigma_j\, p_{ij}\,|i-j| \tag{5}$$

$$\text{M3 Eigenvalue2: } 1-|\text{2nd largest eigenvalue} \tag{6}$$

$$\text{M4 Determinant: } 1-|\det(P)| \tag{7}$$

Finally, to investigate the spatial dimension of the cattle sector, different spatial autocorrelation measures are used for each country. Spatial autocorrelation measures provide information about the overall level of clustering in the cattle sector (i.e. global spatial autocorrelation, Moran's I, and local neighbour match test) and its spatial representation in the form of local clusters (i.e. local indicators of spatial association [LISA] cluster maps).

Global and local Moran's I indices were used to investigate the spatial distribution in terms of spatial association patterns, such as global spatial association and local spatial association. Global Moran's I index reveals the clusters or dispersion of a given variable in terms of space, describing the overall spatial characteristics of a variable across observation (LAU) units (Zhang et al., 2016). Global Moran's I index is defined as:

$$I=\frac{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{\sum_{i=1}^{n}\sum_{j=1}^{n}w_{ij}(x_i-\bar{x})^2}=\frac{\sum_{i=1}^{n}\sum_{j\neq i}^{n}w_{ij}(x_i-\bar{x})(x_j-\bar{x})}{S^2\sum_{i=1}^{n}\sum_{j\neq i}^{n}w_{ij}} \tag{8}$$

where n denotes the number of LAUs; x_i and x_j are the natural logarithms of cattle population (heads) in LAUs i and j, respectively; and w_{ij} is an element of the spatial weight matrix (more specifically, a row-standardised queen contiguity weights matrix) and refers to an adjacent relationship between LAUs i and j. The elements of the matrix are calculated using the following rules (before row-standardisation):

$$w_{ij}=1 \text{ if } \text{bnd(i)}\cap\text{bnd(j)}\neq\varnothing, \tag{9a}$$

$$w_{ij}=0, \text{ if } \text{bnd(i)}\cap\text{bnd(j)}=\varnothing, \tag{9b}$$

where *bnd(i)* and *bnd(j)* denote the set of boundary points of units i and j, respectively. In other words, the queen contiguity matrix defines two LAU's as neighbours if they share a common edge or common vertex. Hence, queen contiguity is more permissive than the so-called rook contiguity matrix, which defines neighbours solely in terms of common edge. Spatial weight matrices can also be defined by other methods, e.g. based on distance. This latter option, however, is more appropriate in the case of point observation units (about spatial weight matrices see more in Zhou and Lin, 2008).

In our case, since we use a row-standardised contiguity matrix with all elements non-negative, the values of Moran's I range from -1 to $+1$. Negative values indicate negative spatial autocorrelation (dispersion), while positive values represent positive autocorrelation (clustering). Values close to zero, more precisely, values around $-1/(n-1)$, represent a random spatial pattern (Moran, 1950): while global Moran's statistics, as described above, are used to test the spatial autocorrelation for the whole sample, local Moran's I test and quantifies the partial autocorrelation for each observation unit. For the ith unit, local Moran's I is defined as (Anselin, 1995):

$$I_i=\frac{(x_i-\bar{x})}{{S_i}^2}\sum_{j=1}^{n}w_{ij}(x_j-\bar{x}), \tag{10}$$

where

$${S_i}^2=\frac{\sum_{j=1}^{n}(x_j-\bar{x})^2}{n-1}-\bar{x}^2. \tag{11}$$

LAUs with positive local Moran's I values can be classified as spatial clusters. Two types of spatial cluster can be distinguished:

- high-high clusters (high value in a high-value neighbourhood),
- low-low clusters (low values in a low-value neighbourhood).

Negative local Moran's I values identify spatial outliers, including

- high-low outliers (high value in a low-value neighbourhood),
- low-high outliers (low value in a high-value neighbourhood).

Note, that the reference to high and low is relative to the mean of the variable and should not be interpreted in an absolute sense.

To check the change in spatial autocorrelation over time, differential Moran's I was used at both global and local levels. Differential Moran's I measures spatial autocorrelation to the variable $y_{i,t}-y_{i,t-1}$, where t and $t-1$ represent two different periods (i.e. the current year and base year). In other words, using differential Moran's I we measure the correlation of the change in a variable over time between a given spatial unit and its neighbours. For more details on differential autocorrelation, see Anselin (2019) and Ghodousi et al. (2020).

The statistical/computational significance of the global and local Moran's I and differential Moran's I were tested using permutation tests based on 999 permutations. By running 999 permutations, the pseudo p-value can be estimated with a precision of one thousandth (0.001). We reject the null hypothesis of spatial randomness if the pseudo p-value is equal to or less than 5 percent.

Two variables are used in the spatial autocorrelation estimation: cattle stock (number of heads) as a proxy of cattle farming, and average size of cattle farms (amount of cattle heads/number of cattle farms) as a proxy for farm structure.

The spatial clusters and outliers explored by local Moran's I and differential local Moran's I statistics are visualised by LISA-maps (LISA: local indicator of spatial autocorrelation). These maps display the different types of significant spatial clusters or outliers in different colours. Three LISA maps per country and per variable were produced using GeoDa and ArcMap software: one for 2000, one for 2010 and a differential map for changes between 2000 and 2010. To explore the multi-attribute similarity of adjacent spatial units, we apply the Local Neighbour Match Test based on cattle stock and average farm size following Anselin and Lin (2020). The match test assesses the extent of overlap between the k-nearest neighbours of a given spatial unit in geographical space and in the multi-attribute (multi-variable) space. We adjust the value of k-set as close as possible to the average number of neighbours defined by the spatial weight matrix used in Moran's I statistics. Considering that the average number of neighbours is 5.38 for Hungary and 5.22 for Slovenia, the appropriate k-set value is five. Euclidian distances were used to determine both the geographical and the multi-attribute neighbour sets. The significant overlap between each LAU's geographic and multi-attribute neighbourhood sets was tested using a 5 percent threshold for the p-value. We visualised the degree of overlap by a cardinality map, where each location indicates how many neighbours the two sets have in common. The number of common neighbours in the two sets is indicated on the maps by different shades of green (the darker the shade, the greater the number of common neighbours). Matched neighbours are also connected by a red line on the maps.

4. Results

Cattle stock in both countries declined during the period under analysis in Hungary from 805 thousand in 2000 to 682 thousand in 2010 (– 15.3%), whilst in Slovenia from 494 thousand to 470 thousand (– 4.9%). The cattle population stabilised in Slovenia after 2007 (Fig. 1).

The structure of the cattle sector is different in Hungary and Slovenia (Eurostat, 2020a, 2020c). In Hungary, large farms predominate, with the proportion of farms with 500 or more cattle heads being over 50%. In contrast, small farms are predominant in Slovenia, where the proportion of farms with fewer than 50 head of cattle ranged between 82 and 90 percent in the period considered. Despite the structural differences, similar structural transformations can be observed in both countries, although the scale of the latter is different. The distribution of farm size has involved an increase in middle-size farms in both countries. The share of farms with less than 50 livestock units and above 500 livestock units has declined, while the proportion of farms with a size of between 50 and 500 livestock units has increased.

Table 1 confirms decline in the cattle stock both in Hungary and Slovenia between 2000 and 2010. In Slovenia, however, we can observe an increase in the maximum size of cattle stock per municipality.

Our research question is how this farm-size structural transformation has translated into changes in the spatial distribution of the sector.

4.1 Spatial concentration in cattle sector

Spatial inequality is graphically illustrated with Lorenz-curves. Figure 2 shows that inequality has increased slightly in both countries. The shape of the Lorenz curves is rather similar in Hungary and Slovenia.

To analyse the dynamics of spatial concentration we use the Gini decomposition methodology (Tab. 2). The values of the initial (year zero = 2000) and final (year one = 2010) single-parameter Gini coefficients show that both the Hungarian and Slovenian cattle sectors were spatially concentrated in 2000, and that this inequality had further strengthened by 2010. The concentration coefficients increased despite the declining total cattle population. The growth ratios of Gini values were similar in both countries (7.6% for Hungary and 5.6% for Slovenia). There are significant

	Obs.	Mean	Std. dev.	Min.	Max.
Hungary					
Cattle in 2000	175	4,834.96	4,008.93	179	20,921
Cattle in 2010	175	3,985.59	3,646.96	51	18,673
Slovenia					
Cattle in 2000	192	2,475.47	2,134.91	22	11,365
Cattle in 2010	192	2,332.29	2,149.13	6	12,081

Tab. 1: Descriptive statistics of cattle stock in Hungary and Slovenia
Source: authors' calculations based on Hungarian Central Statistical Office (2022) and Statistical Office of the Republic of Slovenia (2022)

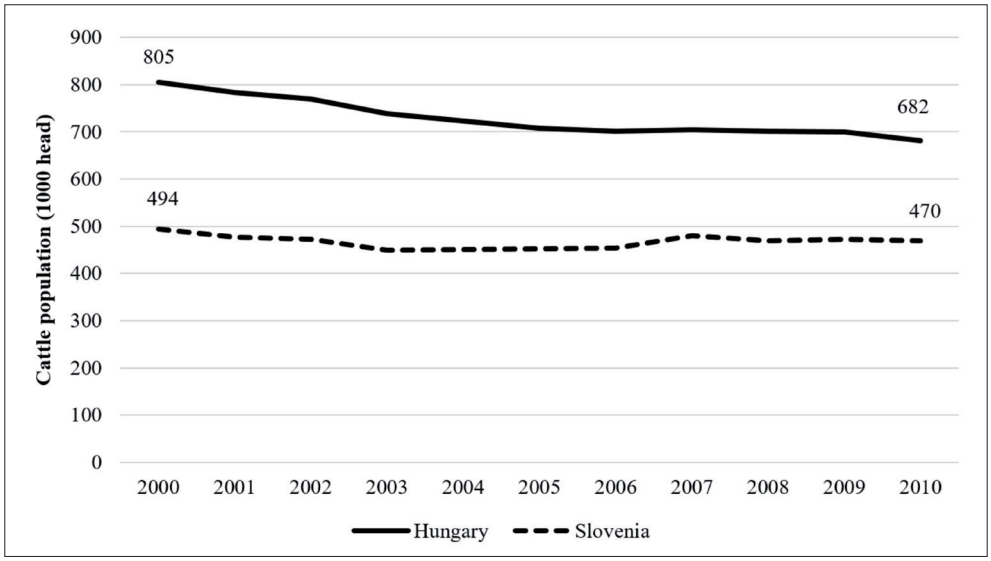

Fig. 1: Evolution of cattle stock in Hungary and Slovenia between 2000 and 2010
Source: authors' construction based on Eurostat (2020b)

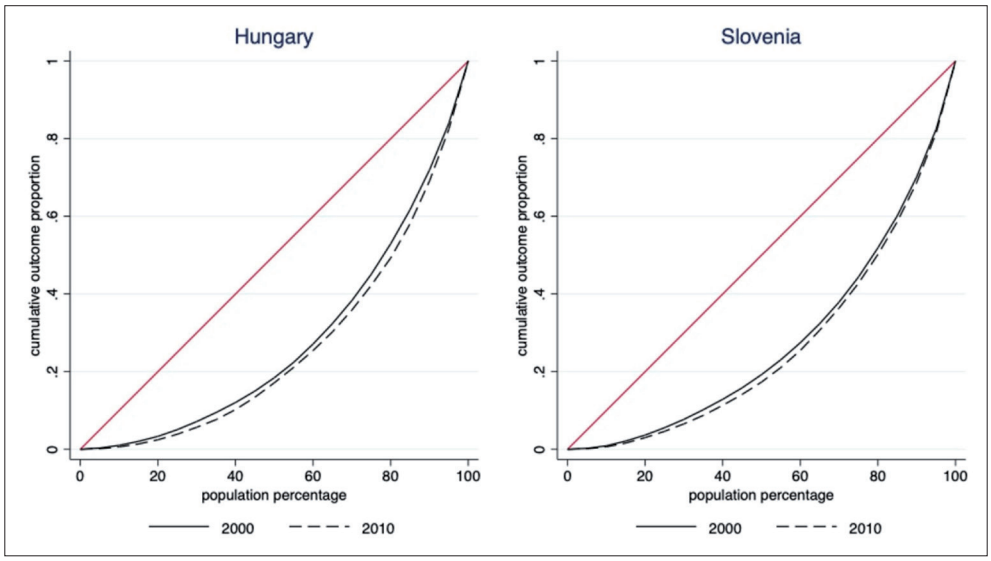

Fig. 2: Lorenz curves for the Hungarian and Slovenian cattle sector
Source: authors' calculations

differences in the nature and internal components of similar changes in concentration. In the case of Hungary, the positive value of the P-component indicates that the decline in the cattle population tended to affect 'richer' LAUs with a larger cattle herd in the initial period. Based on the P-component, spatial reallocation would therefore have essentially involved a 'pro-poor' inequality-reducing process. On the other hand, the value of the R-component eroded and even overrode this smoothing effect. The increase in concentration in Hungary was due to a high degree of reranking between LAUs. This suggests that the mobilisable resources of cattle farming have increased in some spatial units at the cost of other spatial units. In Slovenia, the reverse has happened: the smaller percentage of the R-component implies that the resources of cattle farming are less mobilisable, leading to smaller changes in concentration. On the other hand, the P-component is negative, which indicates a 'pro-rich' spatial transition. In other words, the LAUs with a small initial cattle population were the losers of the structural change, and the 'pro-rich' process intensified the increase in concentration in the Slovenian cattle sector.

The Markov transition probability matrices confirm the Gini decomposition results and their interpretation (Tab. 3). The diagonal elements of the Markov matrix are lower for Hungary than for Slovenia, indicating that there is a lower probability that each regional unit will remain in the same size category at the beginning of the period and at the end of the period. This implies that cattle farming in Hungary has been characterised by significantly higher spatial mobility. Specifically, a shift in the position of LAUs was observed between the two middle (Q3 and Q4) quartiles, in contrast to the quartiles with the largest (Q4) and smallest (Q1) stock. It is possible that in the former areas, path-dependency and resource constraints were less limiting for spatial mobility, opening the possibility of regional competition for resources, which eventually led to an intensive territorial re-ranking process.

For Slovenia, the Markov matrices show lack of mobility and strong long-term territoriality of cattle farming. The spatial units in the lower quartiles changed position less frequently than in Hungary. There has been some degree of reallocation between Q3 and Q4 – which initially had a larger cattle stock – consistently with the pro-rich nature of spatial concentration in this country.

The mobility indices reveal that the spatial mobility of the cattle sector is greater in Hungary than in Slovenia regardless of the indicator considered (Tab. 4). All mobility indices confirmed the higher values for Hungary than for Slovenia. This is consistent with the greater spatial cattle mobility in Hungary *vis-à-vis* the lesser mobility and stronger persistence of the cattle-stock spatial distribution in Slovenia.

4.2 Spatial association of cattle distribution

Finally, we investigate the spatial association of the cattle stock distribution. The values of Moran's I are quite low but significant in both countries and periods, revealing the existence of weak

Components	Hungary	Slovenia
Initial Gini	0.442	0.444
Final Gini	0.476	0.469
Change	0.034	0.025
R-component	0.046	0.009
P-component	0.012	– 0.016
Change of R and P-component as percentage of the initial Gini		
Gini	7.6	5.6
R-component	10.4	2.1
P-component	2.7	– 3.5

Tab. 2: Gini decomposition of change in spatial concentration between 2000 and 2010. Source: authors' calculations

	Hungary			
Quartiles	Q1	Q2	Q3	Q4
Q1	0.80	0.20	0.00	0.00
Q2	0.16	0.61	0.23	0.00
Q3	0.05	0.18	0.61	0.16
Q4	0.00	0.00	0.16	0.84
	Slovenia			
Quartiles	Q1	Q2	Q3	Q4
Q1	0.83	0.17	0.00	0.00
Q2	0.15	0.75	0.10	0.00
Q3	0.00	0.08	0.81	0.10
Q4	0.02	0.00	0.08	0.90

Tab. 3: Markov transition probability matrices: mobility of cattle stock among the LAUs in Hungary and Slovenia (2000–2010)
Source: authors' estimations

	Hungary	Slovenia
M1 Shorrock/Prais	0.380	0.236
M2 Bartholomew	0.099	0.063
M3 Second largest eigenvalue	0.372	0.226
M4 Determinant index	0.803	0.575

Tab. 4: Mobility indices of Hungary and Slovenia
Source: authors' estimations

spatial dependence in cattle distribution (Tab. 5). The values of Moran's I suggest that spatial dependence is somewhat higher in Hungary. This can be explained mainly by the larger farm size and technological differences: in Hungary, cattle farming is dominated by large-scale, industrial, and equipment-intensive dairy production, whereas in Slovenia, the smaller average farm size is accompanied by a higher proportion of pasture-based, extensive cattle farming (Bojnec & Fertő, 2021; Fertő et al., 2021).

Our results highlight two key points. First, the degree of global autocorrelation changed in both countries to the same extent (about 12%), but in the opposite direction during the analysed period. Again, the reason for this lies in technology. In the Hungarian cattle sector, there are fewer constraints to the geographical movement of sectoral capital. The Hungarian cattle sector is dominated by technology-intensive dairy farms. The growth of cattle stock in intensive dairy farms is less constrained by available land, the rotation rate of breeding animals is higher and the withdrawal of capital from production is easier than, for example, in the case of grazing farms. As a result, the concentration of farm structure is due to the establishment of new, or expansion of, existing dairy farms within the neighbourhoods with initially smaller cattle populations. This result is also consistent with the re-ranking nature of the spatial transformation.

During the restructuring process, due to the high degree of mobility of resources, some spatial units were able to significantly increase their relative position in the sector, thereby weakening the impact of old spatial clusters. Another reason for the reduction in spatial dependence is the sharp decline in Hungarian cattle stock which also led to a reduction in the clustering potential. In turn, the increased spatial-association dependence of Slovenian cattle farming is in line with the pro-rich nature of spatial concentration in this country. The presence of grassland-based extensive systems has resulted in less spatial mobility of cattle farming. Consequently, the concentration of farm structure has naturally been accompanied by an increase in the spatial dependence and clustering of the cattle stock.

Second, the values of differential Moran's I for both countries show that the change in the cattle stock of LAUs is weak but significantly related to the change in the stock of neighbouring areas. This is of interest because differential spatial autocorrelation over time is less likely to be driven solely by geography than the static spatial autocorrelation discussed above. Thus, based on the significant differential Moran's I for cattle stock, we can hypothesise that socio-economic factors (such as technological and knowledge spillovers, ownership overlaps, resource pools, sales, and procurement cooperation) are relevant in the background of spatial clustering.

For the average farm size, our global autocorrelation estimates are consistent with the results for the cattle stock, except for the differential Moran's I statistic, which is not significant. Thus, the change in the spatial distribution of the average farm size does not show spatial clustering, so that, in contrast to the evolution of the cattle stock, geographical proximity or spatial spillover does not play a role in the temporal dynamics of the farm structure.

Table 6 shows that the cattle stock and the average farm size at LAU level are weakly and positively correlated. The positive correlation indicates that there are more cattle heads where farms are larger and less cattle heads where farms are smaller. Small farms can be equally spatially concentrated but not enough to counteract this the positive correlation. These statements are also supported by the fact that in both periods we estimated higher coefficients for Hungary than for Slovenia.

Country	Global Moran's I		Differential Global Moran's I
	2000	2010	2000–2010
	Cattle Stock		
Hungary	0.287***	0.252***	0.148***
Slovenia	0.201***	0.224***	0.152***
	Average farm size		
Hungary	0.225***	0.145***	0.072
Slovenia	0.151***	0.283***	0.045

Tab. 5: Global Moran's I indices cattle stock at the LAUa level
*Note: a Local administrative unit (LAU); *** The significance level (pseudo p) of I is 1%. Source: authors' estimation*

Country /Period	2000	2010
Hungary	0.331***	0.410***
Slovenia	0.290***	0.288***

Tab. 6: Pairwise correlations between cattle stock and average farm size at Local Administrative Unit level
*Note: *** The significance level (p) of Pearson's r is 1%*
Source: authors' calculations

4.2.1 Spatial changes in the Hungarian cattle sector

Now we turn to the investigation of local autocorrelation to identify clusters within the global pattern in Hungary using LISA cluster maps. Figure 3 shows that high-high clusters of cattle farming are primarily found in the plain areas of Hungary, while low-low clusters are concentrated in the hilly/mountain regions.

In the initial period (Fig. 3a), two larger high-high cluster cores can be distinguished: one in the eastern and south-eastern part of the country, in the Southern Great Plain region, and the other in the north-western part. In addition, there are two other non-contiguous cluster-core LAUs in the central part of the country.

Looking at the final period (Fig. 3b) and the differential map (Fig. 3c), it is clearly visible that the cluster area in Central Hungary, which was previously of negligible importance, has grown significantly. The region's unique advancement can be explained not only by its flat topography and excellent soil conditions, but also by its excellent transport infrastructure, as well as its proximity to the capital (Budapest) as a receiving market and as a technology or as knowledge transfer centre.

Large Low-Low clusters are mainly found in the north-north-eastern mountains of the country (Figs. 3a and 3b). In these regions, the potential for intensive dairy production is limited, especially due to the high costs of feed supply and manure spreading. However, by 2010, the extent of this Low-Low cluster had decreased slightly, and a High-Low outlier appeared in the mountains. This shows that geographical constraints can be overcome to some extent in the cattle sector. In summary, in Hungary the most important driver of spatial clustering is the topography and the related economic geography (e.g. soil quality and the presence of large contiguous agricultural areas). At the same time, the results of the dynamic (cross-time) analysis of spatial autocorrelation show that during the period of structural transition, agglomeration benefits and spillover effects known from the new economic geography theory have become also important drivers of clustering (Krugman, 1991; Chandra, 2022). The emergence of new cluster areas is also a sign of the exploitation of previously under-utilised local resources.

Figure 4 shows that the location of the High-High and Low-Low clusters of average farm size overlaps only marginally with the same cluster types of cattle stock, despite the positive correlation between the two variables. The explanation is that in the western part of Hungary, with its more fragmented topography and settlement structure, economies of scale in the farm level are more important. As a result, LAUs in this region contain a small number of farms with a size that is a positive outlier compared

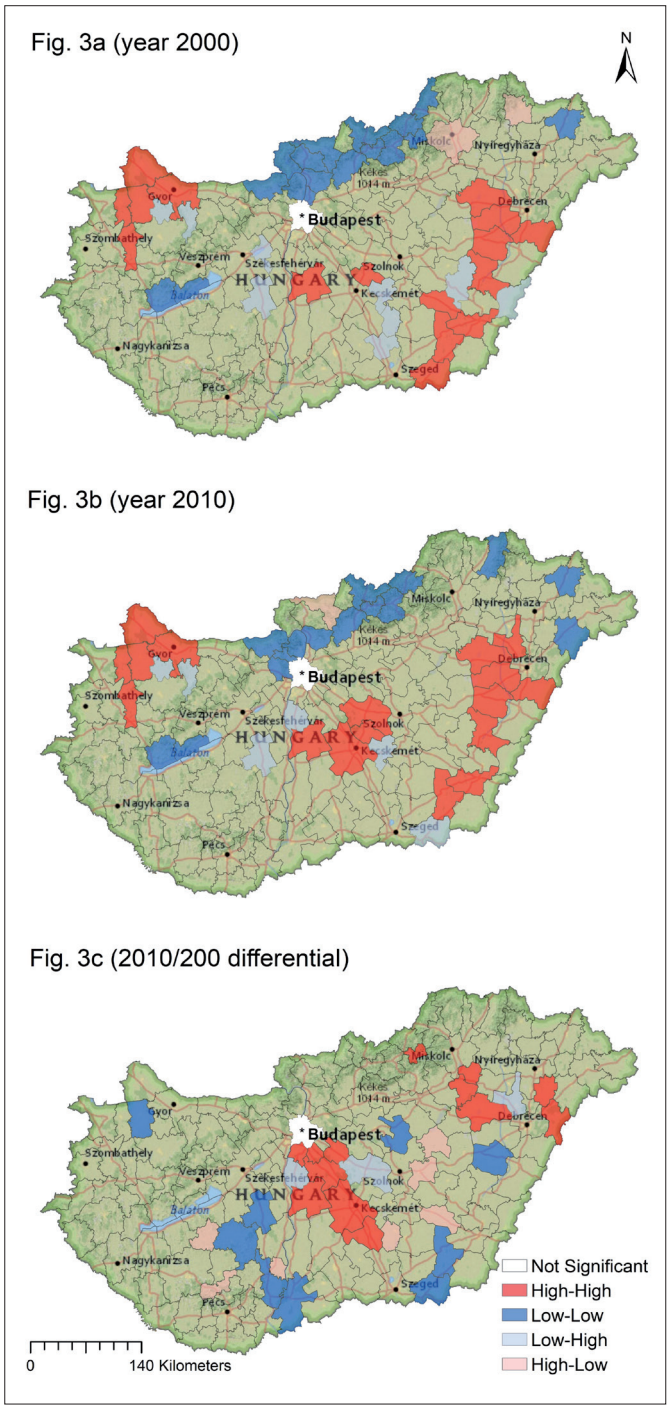

Fig. 3: Univariate and differential LISA cluster maps for Hungarian cattle stock, 2000 and 2010
Source: authors' elaboration

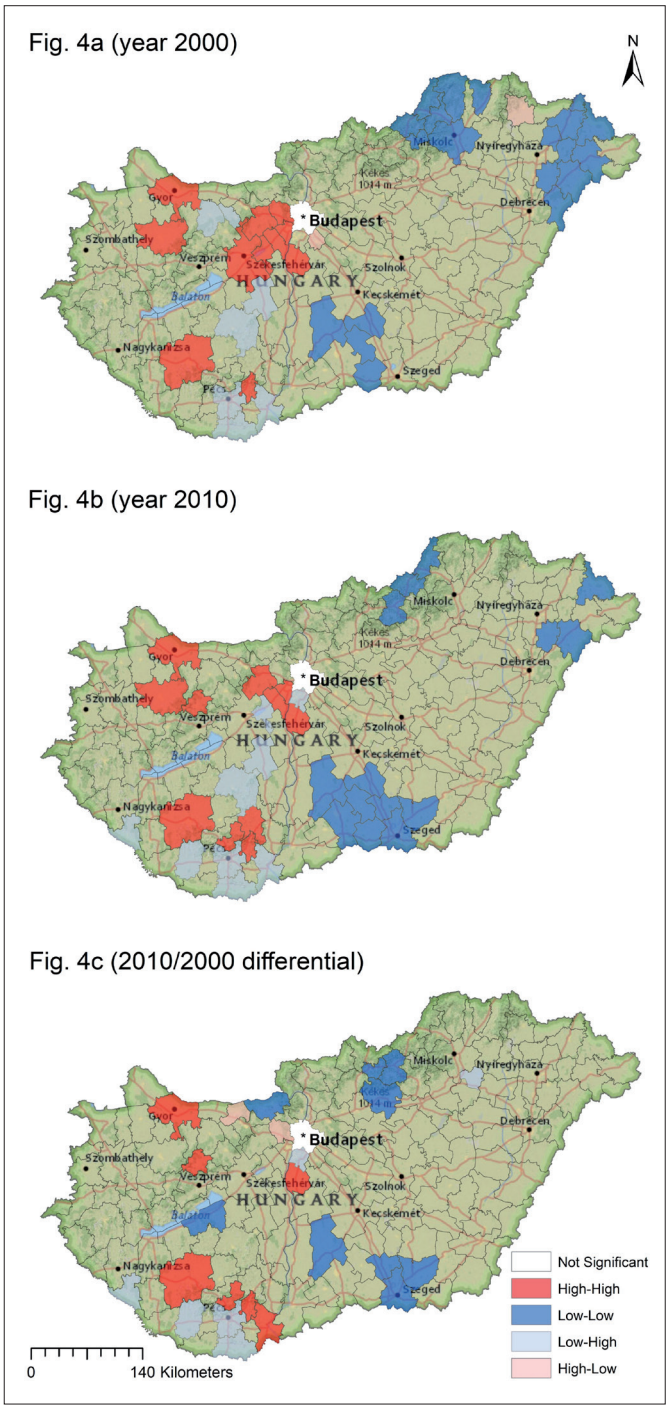

Fig. 4: Univariate and differential LISA cluster maps for Hungarian average cattle farm size, 2000 and 2010
Source: authors' elaboration

to the average. The Low-Low clusters on the eastern side of the country overlap with Natura 2000 sites and/or nature reserves. The special regulation of these areas leads to the trend towards smaller farm sizes in livestock farming.

Finally, we present the local neighbour match test (Fig. 5). The test essentially answers the question whether the geographically neighbouring LAUs are also "neighbours" in terms of the multivariate cattle farming profile (based on cattle stock and average farm size). On the maps, the dark green colours indicate LAUs that have neighbours with similar profiles. The darker the colouring of the LAU, the greater the number of neighbours with similar profiles. The test results show that in both periods, over a quarter of LAUs have neighbours with similar profiles. These areas are in different areas of the country. Again, these results show that geographical proximity and neighbour-neighbour relationships influence, albeit to a relatively small extent, the spatial structure of cattle farming in Hungary.

4.2.2 Spatial changes in the Slovenian cattle sector

Figures 6a and 6b shows that the Slovenian High-High clusters of cattle stock are located rather in the central part of the country (Inner, Upper and Lower Carniola). These clusters cover the flat valley corridors, but also extend to the mountainous areas around the valleys. These areas are home to both intensive dairy production and extensive, mountainous cattle farming. The cluster areas are also characterised by their geographical proximity to the receiving market and agglomeration zones (e.g. Ljubljana) and their relative proximity to major roads. The clusters of stock change shown on

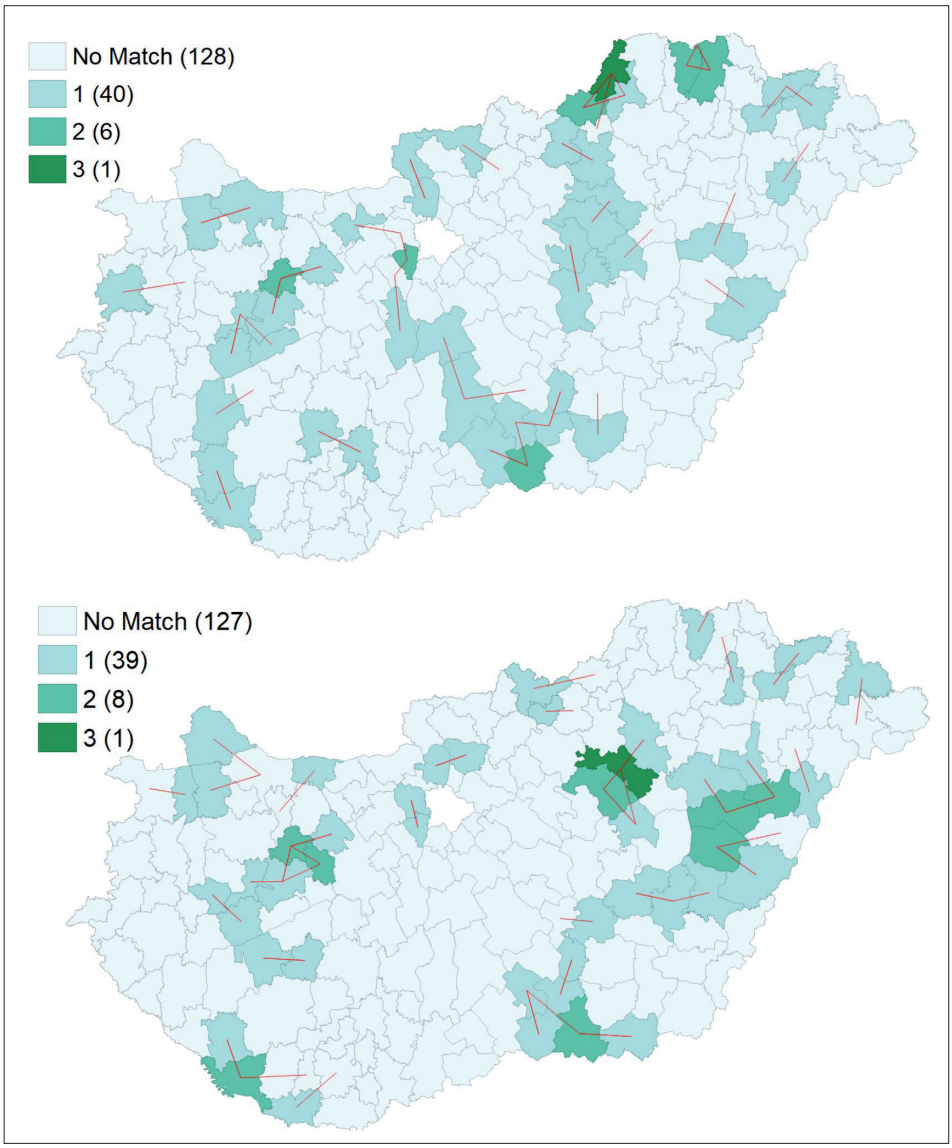

Fig. 5: Matching local neighbours by cattle stock and average farm size in Hungary in 2000 (above) and 2010 (below)
Note: The red lines represent the matched neighbours. Source: authors' elaboration

the differential map (Fig. 6c) have similar characteristics: they cover valley-mountain systems, are relatively close to the two largest cities in the country (Ljubljana and Maribor), and are crossed by major roads. In contrast to Hungary, the location of clusters has remained virtually unchanged during the structural transition. The structural shifts and concentration processes in the country's cattle sector did not essentially affect the spatial pattern and spatial dependence of the cattle stock. In addition, this may partly be explained by the fact that Slovenia has a larger proportion of extensive, pasture-based beef and dairy farming systems. This finding is in line with conclusions of Hinojosa et al. (2016) regarding place attachment as a factor of mountain farming permanence in the French Southern Alps, and to a lesser extent with Pecher et al. (2017) regarding agricultural landscapes between intensification and abandonment in a central-Alpine cross-border region. The land dependency of extensive farming systems and the immobility of resources result in the preservation of the spatial distribution of farms and livestock.

The High-High clusters of average farm size only become visible in Slovenia with the rise in farm concentration by 2010 (Fig. 7b). This shows that structural change has a spatially distributional impact on the farm structure of Slovenian cattle farming. The spatial intensity of the increase in farm size (Fig. 7c) was clearly highest in the eastern, flat part of the country (Podravska and Pomurje regions). Along the Italian border, a large Low-Low cluster is visible (Figs. 7a and 7b), which remains unchanged over time. The economy of the two most affected border regions (New Gorizia and Coastal-Karst) is mainly determined by the tertiary sector, including tourism. Within the emerging Low-Low cluster, mountain livestock farming is almost exclusively characterised by grazing livestock, which is naturally associated with smaller farm sizes. In the southern lowland areas, the mixture with the Mediterranean climate is more favourable to fruit growing, so that cattle farming does not have a high concentration of farm sizes.

Regarding the effect of geographical proximity on the similarity of the cattle herding profile in Slovenia (Fig. 8), results are like Hungary: almost 30% of LAUs have neighbours with similar profiles. Examples of the profile-shaping effect of geographical proximity can be found in different parts of the country, regardless of topography.

5. Discussion and implications

We investigated the spatial concentration and spatial mobility of cattle stock in Hungary and Slovenia between the 2000 and 2010 censuses of agricultural holdings. Mobility and clustering effects were identified. The Gini decomposition, Lorenz curves, and other concentration measures were used to study the spatial

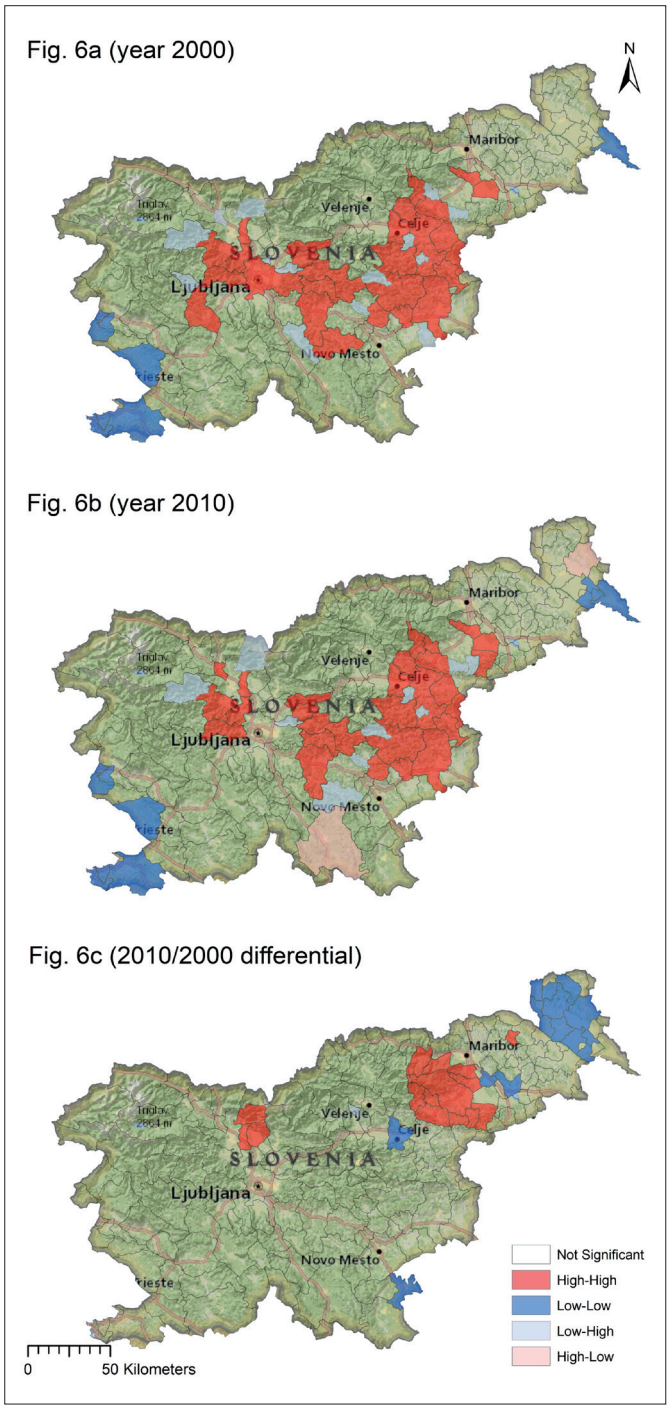

Fig. 6: Univariate and differential LISA cluster maps for the Slovenian cattle stock, 2000 and 2010
Source: authors' elaboration

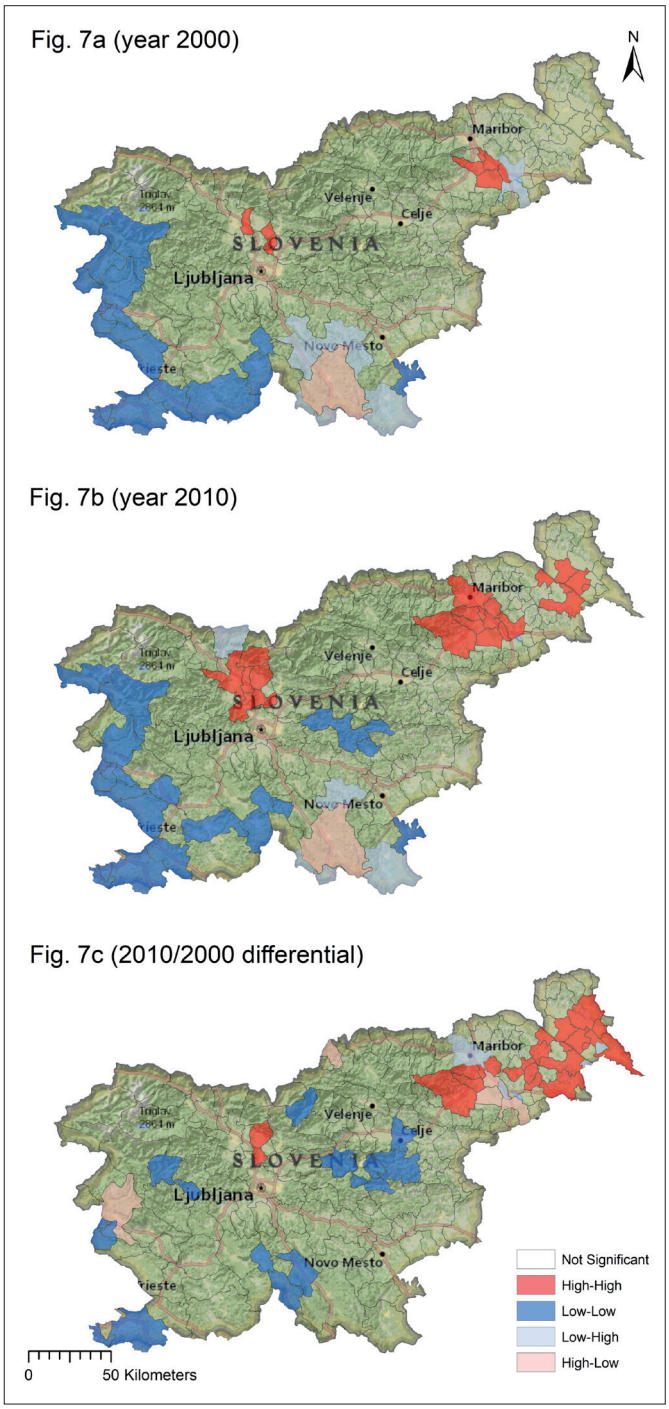

Fig. 7: Univariate and differential LISA cluster maps for the Slovenian average cattle farm size, 2000 and 2010
Source: authors' elaboration

concentration of cattle stock. They confirmed that cattle stock is spatially concentrated. The Markov transition probability matrices and mobility indices showed that cattle-stock spatial mobility in Hungary is greater than in Slovenia irrespective of the measures applied. One reason for these development patterns is the more rapidly declining cattle stock in the former than in the latter country. Finally, LISA/local Moran's I cluster maps clearly confirmed the strengthening of clustering effects, that are more robust for the Slovenian than for the Hungarian cattle stock.

These findings are relevant for science, policy, and practice. Regarding the science, we showed how applied spatial methods can be used to detect relevant spatial economic, social, and other spatially distributed phenomena. Regarding policy, based on the empirical results the study allows one to draw implications regarding the complex story of the restructuring of the cattle sector in terms of land-cover and land-use changes (see also Fuchs et al., 2015). Finally, there are practical implications for cattle and dairy farm businesses and rural areas.

Before EU accession in 2004, the cattle sector in Hungary and Slovenia was declining; it has been later declining further in the former and stabilising in the latter country with the introduction of CAP measures. In Slovenia, cattle with dairy on small- and medium-size family farms are the most important forms of livestock production specialisation and some of the most important farming activities (Bojnec, 2017). A striking finding is that the cattle sector in Slovenia shrank in plain areas where crop production is dominant and persisted in less-favoured hilly areas with grassland pasture during the grazing period and hay from

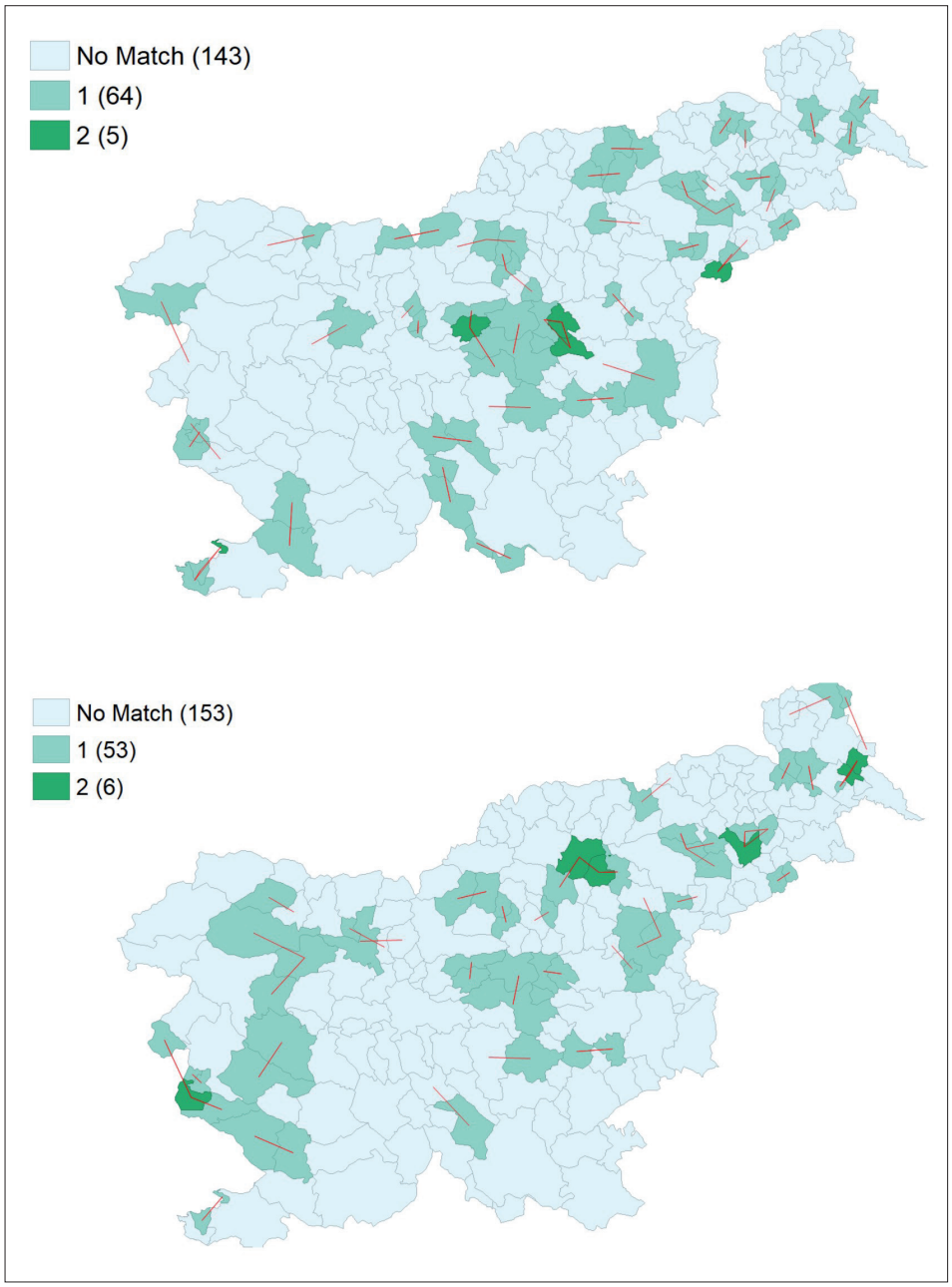

Fig. 8: Matching local neighbours by cattle stock and average farm size in Slovenia in 2000 (above) and 2010 (below)
Note: The red lines represent the matched neighbours. Source: authors' elaboration

meadows and grass, maize, and similar silage in the non-grazing period (Greenwood, 2021). On the other hand, the cattle sector in Hungary in general, as well as its spatial distribution and changes, were more volatile, with a different distribution of cattle stock by farm-size category, and a declining role for large-size commercial farms with more than 500 livestock units. Unlike the different farm-size and spatial distribution, the patterns of development are similar in the two countries, with a decline in small- and large-size farms and an increase in medium-size farms between 50 and 500 LSU. Despite similar farm-size patterns (an increase in medium-size cattle farms), the size gaps between LAUs remained large, and the spatial changes are geographically different. This spatial heterogeneity may be an issue for later research that seeks to explain the drivers of spatial transformation and changes in the cattle sector.

The results are in line, however, with those of Neumann et al. (2009), who argue that the spatial dimension of cattle farming reveals new socio-economic and environmental linkages that are important for rural regions. It has been argued on the spatial patterns of production linkages between the developments of rural regions and rural firms/farms. These linkages can be important for the local economy in small towns. In addition, the role of small and medium-sized industrial towns and their manufacturing can be important in rural transformation developments (Courtney et al., 2008; Bole et al., 2020; Ženka et al., 2021). These village-town linkages and their spillover effects can explain the decline in the number of cattle and dairy farms in both in Hungary and Slovenia, particularly due to the exit of smaller cattle and dairy farms and the substitution of cattle and dairy farming with crop farming. Interestingly, this process has been more frequent in plain geographical areas where there are better opportunities for a substitution of labour with mechanisation in crop production.

Moreover, our study confirms the relevance of clustering effects and spatial externalities in cattle industries undergoing major structural change in the CEE region. This means that the findings about the spatial dynamics of cattle farming in the USA and EU-15 countries (Weersink et al., 2005; Neumann et al., 2009; Ievoli et al., 2017) can be further developed and extended to countries

with a transforming and restructuring agriculture. In contrast to previous studies, our research also reveals that spatial dependence are stronger in areas with a higher proportion of intensive cattle farming systems. In such locations, spillover effects may also be significant even in livestock sectors assumed to be relatively immobile. This finding is also in line with the finding of Hruška and Píša (2019) for Czechia, that there are winning and losing rural localities following post-socialist economic restructuring.

In accord with Santeramo (2020), Peyraud et al. (2020), and Hercule et al. (2017), our research suggests that the environmental regulation of the cattle sector should have different content from country to country, and regional strategies consider the spatial clusters associated with the industry are required to adequately address the environmental disadvantages and benefits of the sector. In countries with a more static spatial pattern of cattle farming (such as in Slovenia) greater emphasis should be placed on land-oriented regulatory instruments (e.g. greening measures). In countries with a more spatially mobile cattle farming sector, like Hungary, animal-based measures are essential. This can be a challenging issue for the development of cattle and dairy farming in some peripheral and remote areas (Pénzes & Demeter, 2021). While the intensification of conventional livestock farming has caused environmental degradation and animal welfare problems, building diversity and resilience through farm multifunctionality is also possible (Tamásy, 2013). A greening policy orientation has been also supported by CAP measures, such as agri-environmental schemes (Unay-Gailhard & Bojnec, 2015, 2016), with attendant side effects on the creation and maintenance of farm and rural employment (Unay-Gailhard & Bojnec, 2019) and farm and rural entrepreneurship, particularly involving young women on family farms (Unay-Gailhard & Bojnec, 2021). Understanding spatial changes in the cattle sector, along with their employment and other socioeconomic, land use, and environmental implications, is an issue for research in the future.

6. Conclusion

This article contributes novel empirical findings to the applied geography literature with its focus on spatial transformations in the cattle sector in Hungary and Slovenia. The cattle and dairy sector is important for both the supply and demand side of local rural economies and contributes to local employment and the cultural landscape. Interestingly, the cattle stock and number of cattle farms shrunk more in the plains of Hungary and plain areas in Slovenia, whilst its survival potential was identified in specific hilly areas in Slovenia with extensive cattle stock, increasing the clustering of cattle-stock concentration. Changes in cattle stock were linked to cattle-farm growth from small-size to medium-size in Slovenia and cattle-farm decline from large-size to medium-size in Hungary. The relatively stronger variation in the Hungarian cattle stock was confirmed with mobility and concentration measures. Despite the cattle-stock and cattle-farm transformation trends towards an increase in medium-size farms, it is unrealistic to expect strong convergence in cattle and dairy farm-size between the countries.

Farm size, in association with farm ownership and operation (the prevailing family farming in Slovenia and corporate farming in Hungary), and dairy processing, may be among the crucial drivers of the cattle-sector transformation and be responsible for the intensive clustering effects. In addition to geographical, farm-size, and operational farm and dairy processing structural characteristics, the specific nature of cattle concentration and clustering may also be linked to CAP measures for cattle and dairy. When new 2020 census data become available, the latter may be an issue for research as CAP support may have implications for farming in less favoured 'disadvantaged' areas (such as the farms typical of Slovenian mountain and hilly areas, and partly for Hungarian Less Favoured Areas), and for the competitiveness of farming in flat areas that are more common in Hungary but also exist in Slovenia. An additional opportunity would be to use the most recent 2020 agricultural census data, where available, and combine them with different potential drivers of the spatial transformation in the cattle and diary sector.

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MORAVIAN GEOGRAPHICAL REPORTS

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