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Patents, exports and technological specialization at the state level in Germany

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ABSTRACT

Germany is a highly innovative country with large regional differences, both in economic performance and innovation potential. This paper focuses on the knowledge production and technological specialization at the state level in Germany and how it affects the exports of individual states. We measured the technological specialization based on average relatedness between patent classes. We demonstrated that technological specialization increased between 1988–1992 and 1998–2002 in most German states, whereas between 2008 and 2012 it slightly declined or remained stable in all states except Saarland and Bremen. Highly innovative states, such as Bayern, as well as the least innovative Sachsen-Anhalt, belong among the most specialized states. Therefore, there is no obvious trend indicating that large specialization is related to higher innovativeness or vice versa. In accordance with other studies, we found that having a higher number of patent applications increases exports. This is especially valid at the state level. However, within the seven examined industrial categories, the relationship is weaker. Apart from patenting, we also estimated other R&D indicators such as Gross Domestic Expenditure on Research and Development (GERD), R&D personnel and technological specialization. Whilst the higher relative numbers of R&D personnel increase the volume of exports relative to regional GDP, in the case of GERD, the results were inconclusive. Furthermore, a higher technological specialization measured by average relatedness between patent classes negatively affects exports. This finding is surprising, and other measures of specialization in different regions should be tested to support it.

1. Introduction

Innovations are the driver of economic growth, as is widely acknowledged (Grossman and Helpman 1991). At the same time, innovation is extremely difficult to measure (Altenburg et al. 2008) and proxies have been used for measuring technology and innovation. In this paper, we use patents as an indicator of innovation output. Despite their limitations, patents have been widely used (Griliches 1998) and due to the industrial orientation of Germany and our focus on manufacturing exports, patents are a suitable indicator.

Exports are closely related to technology and innovation (Fagerberg 1996). Innovation is unevenly distributed due to the localized capabilities and regionally embedded know-how (Asheim and Gertler 2005). Countries and regions thus cannot produce whatever they want, they can only produce goods that they have sufficient knowledge about producing (Hausmann et al. 2011). In general, specialization contributes to economic growth, though it is essential to consider the evolutionary nature of the economic process (Martin and Sunley 2007). So far, limited attention has been paid to the question of how technological specialization affects exports.

Germany is one of the most innovative countries in the EU. Unlike many high-income countries that witnessed deindustrialization, manufacturing is still important there. The primary focus is on medium-tech industries such as machinery and transportation, although Germany is the European leader also in other areas. Despite the reunification almost thirty years ago, there are still significant regional differences between the Western and Eastern regions.

The main objective of this paper is to identify main features, trends and differences in knowledge production and technological specialization in German states. Therefore, we identify both the most innovative and the least innovative German NUTS1 regions. Further, we aim to observe the relationship between patenting activity and other R&D indicators, technological specialization and exports in German regions. To the best of our knowledge, no studies focused on the relationship between innovation, specialization and exports in German regions.

The article is structured as follows. The second section of this paper briefly summarizes existing research on specialization and the relationship between patenting and exporting. In the third section, data are described, including some basic facts about patents, and there is an explanation of the methodology. In the fourth chapter of the paper, results are shown; followed by the links between patenting and exporting. The final section concludes.

2. Literature Review – Innovation, Specialization and Exports

There is a widely accepted agreement in economic theory that innovation is crucial for economic growth (Aghion and Howitt 1990; Audretsch and Feldman 1996). Nonetheless, innovations are distributed very unevenly, and there are significant spatial differences within all geographical scales (Feldman 1994; Asheim and Gertler 2005). This is related to the localized capabilities and regionally embedded know-how within the regions (Maskell and Malmberg 1999). Regional differences were identified in techniques of production (Rigby and Essletzbichler 2007), organizational procedures (Storper 1997) as well as overall institutional quality (Rodríguez-Pose and Di Cataldo 2015).

Industrial and technological specialization has been found beneficial for urban and regional growth. Whilst Marshall (1890) stressed that specialization is more beneficial for economic growth, Jacobs (1969) emphasized the role of diversity. Both theories have been criticized particularly for ignoring the evolutionary nature of firms and regions, as they tend to ignore the processes of selection, variety and retention (Martin and Sunley 2007; Whittle and Kogler 2020). Across European regions, significant differences in innovation output have been demonstrated, though limited attention has been devoted to this topic, especially in the context of economic integration. Many empirical studies found that specialization in the EU and technological relatedness has increased (e.g. Amiti 1999; Brülhart and Träger 2003; Kogler et al. 2017).

For a long time, technology was considered as a 'black box' exogenous to the economy (Rosenberg 1982). Several empirical studies have proved that new technologies in regions have not appeared accidentally but are related to the existing economic and technological profile of regions (Hidalgo et al. 2007; Neffke et al. 2011; Boschma, Balland and Kogler 2015). With the introduction of the smart specialization concept in Europe, which aims at the identification of core competencies of regions and possible complementarities of industrial/technological fields (Forey et al. 2009), this topic has attracted significant attention. The aim of smart specialization is not to increase specialization of regions, but rather to leverage existing capabilities and identify opportunities in high value-added activities that are close to the capabilities already present in the region (Balland et al. 2020). Smart specialisation is thus widely discussed in EU regional policy (Balland et al. 2019; McCann and Ortega-Argilés 2015). In geography, as well as in other fields, the relatedness studies have attracted significant attention (e.g. Hidalgo and Hausmann 2009; Frenken et al. 2007; Boschma, Minondo and Navarro 2012).

Knowledge serves as a source of ideas for new technologies, but the value of knowledge differs. The knowledge that is easy to describe, imitate, and transfer has lower value because it is not a source of long-time economic rents (Balland et al. 2020). Nonetheless, knowledge includes social and institutional dimensions. More complex knowledge (tacit knowledge) is thus based on individual experience, it is spread based on interpersonal contact, and it is difficult to transfer across people, firms and places

(Polanyi 1966). In such a situation, measuring the distance between technologies has significant policy implications as regions can more easily diversify into activities related to their existing specialization.

Since one of this article's main goals is to identify the links between patenting activity and exports of German regions, general connections of innovation and trade should be recognized. Innovation and technology positively impact trade performance (Amable and Verspagen 1995; Fagerberg 1996, Sanyal 2004). Larger exports may also stimulate the innovation activity indicating endogeneity issues (Chang, Chen and McAleer 2013), though. Several studies have provided evidence confirming that innovation drives exports, while controlling for potential endogeneity between innovation and exports (Lachenmaier and Wößmann 2006; Frietsch et al. 2014). The role of specialization for exports is acknowledged. Export specialization contributes to economic growth (Plümper and Graff 2001). Unsurprisingly, the export specialization of a region corresponds to the knowledge specialization of the region. According to Andersson and Ejermo (2008) patterns of technology specialization have an impact on the magnitude and quality of export flows. Nonetheless, we did not find other studies focused on how technology specialization affects export value. Most studies focused on specialization of exports usually measured by Balassa revealed comparative advantage (Sejkora and Sankot 2017) or vertical/functional specialization within global value chains (e.g. Hummels et al. 2001; Timmer et al. 2015), both are based on a different approach.

There is also a relationship between the pace of innovation and export performance, which might be reflected in the whole country's competitiveness on global markets. Patents are often viewed as the output of innovation activity, although according to Griliches (1998), it is rather somewhere between the input and output, with the real output being the specific product that involves the patented technology. It is assumed that imitating new technologies takes some time, which leads to the creation of a temporary oligopolistic market. Thus, companies in technologically advanced countries are the first players on the market, and they gain a dominant position in export (Frietsch et al. 2014). A limited number of companies export and firms that export are in general larger and more productive than non-exporting companies (Bernard and Jensen 1999). Exports provide a relatively good measure of a country's technological capabilities (Hausmann, Hwang and Rodrik 2007; Vlčková 2015). There is a correlation between patenting and competitiveness on global markets and patents have a positive impact on trade performance (Wakelin 1998). German goods producers compete mostly in terms of their technology and quality rather than on price, and its export performance can primarily be explained by its innovative capacity (Blind and Jungmittag 2005). Furthermore, Germany focuses on industrial products

more than services. Such products are, in general, more often patented.

In the case of Germany, the historical orientation on manufacturing significantly affects its current R&D and innovation activities. Germany is one of the most innovative countries with the highest number of patents in Europe (Germany accounted for 14.8% of the patent applications to the EPO in 2019; EPO 2020) and above-average R&D expenditures (3.31% of GDP in 2018 against 2.02% of GDP for the EU28; OECD 2020c). According to the European Commission (2019a), Germany is classified as one of the "Strong Innovators". Furthermore, in 2011 Germany introduced the term Industrie 4.0, which refers to the intelligent networking of machines and processes for industry based on information and communication technology. Several empirical studies explored R&D and innovation in Germany (e.g. Peters 2008; Beise and Stahl 1999; Almus and Czarnitzki 2003; Leydesdorff and Fritsch 2006). Further, Suedekum (2006) focused on regional specialization and found that between 1993 and 2001 there was neither a process of regional specialization, nor one of geographical concentration of industries in Germany.

3. Data and Methodology

Since innovation is a social rather than a technical process, measuring innovation has been challenging (Pavitt 1982). The most common proxies of innovation include R&D expenditures, patents, R&D workers and innovation surveys, though all of them suffer from limitations (Archibugi and Pianta 1992). Patents have been used to investigate the technological specialization of countries and regions and for the identification of emerging/declining technologies or the relationship between industries (e.g. Archibugi and Pianta 1992). A patent is an intellectual property right issued by authorized bodies to inventors to make use of, and exploit their inventions for a limited period of time. Patents are unique in the extent of detail involved and the breadth of their geographical and historical coverage. Not all patents are innovations, and not all inventions are patentable; there are differences between sectors and countries in patenting activity (Griliches 1998; Cohen et al. 2002). In spite of that, patent-based statistics allow for measuring the inventiveness and competitiveness of countries, they might be a good predictor of economic performance in general and they are a reliable measure of innovative activity at the industrial and regional level (Acs and Audretsch 1989; OECD 2009; Bič 2007).

Data from the European Commission (2020a,b,c) and EPO (2020) are used for assessing the innovation activity in German regions. For assessing the specialization of German regions and the relationship between patenting and exporting we use patent applications from the OECD REGPAT database

(OECD 2018), which covers patent applications filed with the European Patent Office (EPO) and the Patent Corporation Treaty (PTO) relating to more than 5,500 regions across OECD and several non-OECD countries (Maraut et al. 2008). We use German states (NUTS1 level) as data on regional exports are not available on a more detailed geographical level. We follow the innovation activity based on inventors' rather than applicants' addresses as firms often apply under units located in other countries due to their specific company strategies, tax optimization and other reasons (Dischinger and Riedel 2008). We only include inventors from Germany; we use partial counts of patents if inventors from several regions (or other countries) are included. Three five-year periods are used to account for year-on-year variations: 1988–1992, 1998–2002, and 2008–2012. Using the three periods enables us to evaluate the evolution of knowledge specialization over the last three decades. As it takes some time before patents are published and data are cleaned, we do not use newer data. We use the IPC classification (121 sub-categories) and aggregate them into seven industrial categories, according to Kogler et al. (2017): electronics, instruments, chemicals, drugs and medicine, industrial process, machinery and transport, consumer, to measure the technological relatedness within these categories A patent can belong to several patent classes/categories. In such a case, partial counts are used.

One of our goals is also to assess the relationship between patenting activity, specialization and exports. We use data from the German statistical office (Statistisches Bundesamt 2018) on foreign exports from NUTS1 regions. Unfortunately, detailed data have only been available since 2008 in 30 categories. We reclassify them into seven categories to correspond with the patent categories and estimate the relationship between exports (2008–2010) and patenting activity (2013–2015) in individual Bundesländer. The time frame is chosen because it takes some time before the inventions are transformed into usable products. Ernst (2001) found that in case of European patent applications, sales increase with a time-lag of at least three years after the priority year in case of German machine tool manufacturers. Since some industries have higher time lags (e.g. pharmaceuticals) and we focus on exports, not sales, we use a five-year time lag.

For measuring specialization of regions, we use the **average knowledge relatedness score** based on Kogler, Rigby and Tucker (2013). The average knowledge measures technological similarity between all pairs of patents invented in the region divided by the number of such pairs. We use the average relatedness to compare knowledge relatedness between regions. The average knowledge relatedness for a year t and country c is calculated as:

$$AR^{tc} = \frac{\sum_j \sum_i S_{ii}^t \times D_{ii}^{t,r} + \sum_i S_{ij}^t \times 2D_{ij}^{t,r}}{N^{t,r} \times (N^{t,r} - 1)} \text{ for } i \neq j$$

S_{ij}^t indicates the knowledge relatedness between patents in classes i and j, $D_{ij}^{t,r}$ is the number of pairs of patents belonging to category i and j in a year t and region r, $N^{t,r}$ is the total number of patents in a year t and region r. A higher average relatedness score indicates higher specialization.

For estimation of the relationship between patents and other R&D indicators, we use regression models. Residues in all models are subject to the assumptions of normality and homoscedasticity. Moreover, even in models where there are multiple variables that can be related to each other, all have a "Variance Inflation Factor" of less than 10 (in Eviews, elsewhere they may have different criteria), which indicates acceptable multicollinearity between independent variables.

In the following models, we analyze the effect of patenting activity on exports, firstly across regions, and secondly across specific sectors. We perform this task utilizing a linear standard ordinary least squares equation in the following form.

$$y_i = \beta_0 + \beta_1 x_i + \varepsilon_i \tag{1}$$

Specifically,

$$\ln(exports_{2008-2012})_i = C_i + \beta_1 \ln(patent\ applications_{2003-2005})_i + \varepsilon_i \tag{2}$$

Where i signifies a specific region, and

$$exports_{2008-2012,j} = C + \beta_1 patent\ applications_{2003-2005,j} + \varepsilon_j \tag{3}$$

Where j signifies a specific sector.
We also estimated the relationship between different R&D indicators (R&D expenditure, R&D personnel, degree of specialization) and the share of exports relative to GDP in German states based on regression models in the following three equations.

$$\ln(Exports)_i = C_i + \beta_1 (patent\ applications)_i + \beta_2 (average\ relatedness)_i + \beta_3 (relative\ R\&D\ personnel)_i + \varepsilon_i \tag{4}$$

$$\left(\frac{Exports}{GDP}\right)_i = C_i + \beta_1 (log\ (patent\ applications))_i + \beta_2 (average\ relatedness)_i + \beta_3 (relative\ R\&D\ personnel)_i + \beta_4 (GERD\ to\ GDP)_i + \varepsilon_i \tag{5}$$

$$\left(\frac{Exports}{GDP}\right)_i = C_i + \beta_1 (relative\ R\&D\ personnel)_i + \beta_2 (GERD\ to\ GDP)_i + \varepsilon_i \tag{6}$$

The estimated coefficients are presented and described in section 4.3.

4. Technological Specialization in Germany and German Regions

In this section, we outline the results of the aforementioned models and primarily present differences among German NUTS1 regions in terms of their patenting activity, technological specialization and export activity.

4.1 Patents, R&D, Innovation and Technological Specialization in Germany

The number of patent applications filed worldwide has doubled in the last 20 years; it has increased to 3.3 million in 2018 (WIPO 2019a). This growth has been affected by more efficient R&D efforts, the emergence of new fields such as nanotechnology and biotechnology, in addition to more complex patent strategies (Blind et al. 2006). Computer technology dominates in patent applications, followed by electrical machinery, measurement, digital communication and medical technology (WIPO 2019a). The dramatic increase in patenting activity is related to rising innovation capabilities in emerging markets, particularly in fast-growing China (which accounted for 46.4% of total patent applications; compared with only 15% in 2008), South Korea, India and other fast-growing countries. The National Intellectual Property Administration of the People's Republic of China, together with the United States Patent and Trademark Office (USPTO), Japan Patent Office (JPO), Korean Intellectual Property Office (KIPO) and the European Patent Office (EPO), accounted for 85.3% of the world total in 2018 (WIPO 2019a: 12).

Germany has both the highest number of patent applications submitted to the European Patent Office (EPO) and triadic patent families (defined as a set of patents registered in various countries to protect the same invention, i.e. at the EPO, JPO and USPTO) within the European Union. In 2019, the total number of German applications submitted to the EPO reached 26,805, i.e. 14.8% of total applications (from all countries, including non-European countries). Relative to its population, Sweden reported the highest number of patent applications submitted to the EPO in 2019 (433 per million inhabitants), followed by Denmark (411), the Netherlands (404) and Germany (334) (EPO 2020). Germany also accounted for 8% of triadic patent families in 2018 (4,772), ranking as the fourth country after Japan with 32.6% (18,645), the USA (22.3%; 12,753) and China (9.3%; 5,323; OECD 2020a).

Germany's R&D spending is among the highest in the world. The gross domestic expenditure on R&D (GERD) has increased from 2.44% of GDP in 2005 to 3.13% in 2018, and business-financed R&D accounts for 65% of these expenditures (OECD 2020b). Germany's research and innovation also benefit from having one of the highest public-private cooperation rates (public-private co-publications and private co-funding of public R&D expenditure) in the EU (European Commission 2019a: 47). Private and public research complement each other (Beise and Stahl 1999), such as the Max Planck Society, the Frauenhofer Society and the Helmholtz Association of German Research Laboratories.
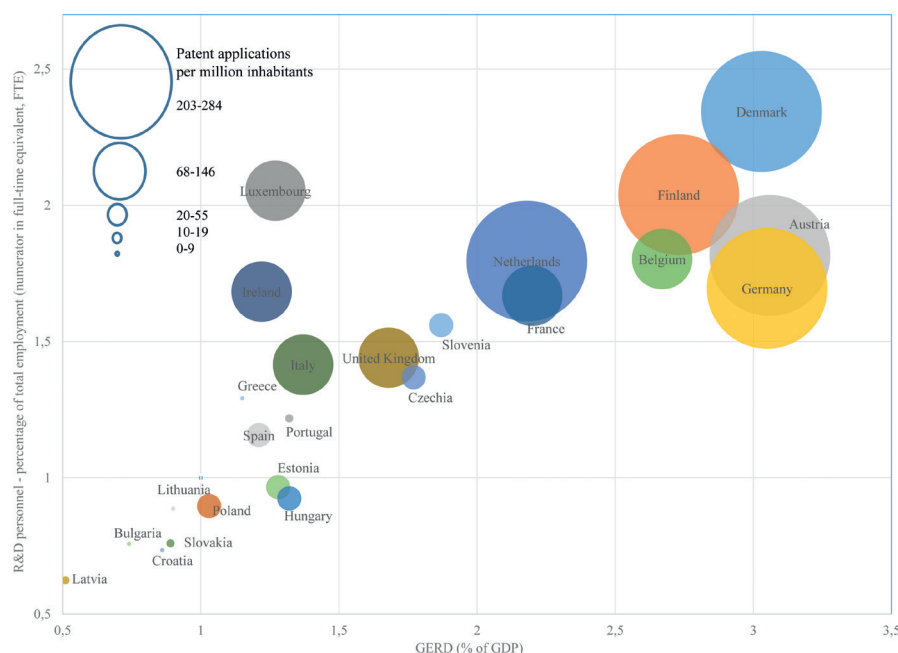

Fig. 1 R&D expenditure, R&D personnel and patent applications to the EPO in selected EU28 countries, 2017.
Source: Eurostat (2020a, 2020b); own construction.

Among the high-income economies, Germany has very strong rankings in the European Innovation Scoreboard (EIS) published by the European Commission (2020b, 2019a) and the Global Innovation Index (GII; published by the by Cornell University, INSEAD, and the WIPO). In 2018, Germany fell into the second performance group of the EIS, called "Strong Innovators" (with a 117% performance relative to the EU in 2018). Germany's performance declined slightly after 2013, particularly in comparison to Innovation Leaders in the EU (Denmark, Finland, the Netherlands, and Sweden) (European Commission 2019a: 16). As for the GII, Germany ranked 9th in 2019, and relative to GDP, it performs "well above its expected level of development". Moreover, it is very effective in translating R&D expenditures into innovation outputs, i.e. Germany has been producing many high-quality outputs (WIPO 2019b).

Germany's scientific publications are among the top 10% most-cited publications worldwide; they accounted for 5.8%, behind the United States, China and the United Kingdom (OECD 2017b). The top papers are published particularly in the automotive and health-related sectors, whilst in patents Germany displays strengths in cars, materials, aeronautics, new production technologies and energy (European Commission 2016b). For instance, the Energiewende (Energy transition) in Germany requires substantial investments, particularly in grid extension, expansion of renewable energy capacities and R&D in renewable technologies. Germany holds a very strong position from this point of view; it is the European leader in renewable energy patenting (3,684 patents in 2010–2019; Nurton 2020).

Germany also has highly skilled human resources. Especially the dual education system, which combines general transferable skills and structured learning on the job, this is supportive for providing technical skills and a strong supply of graduates. The share of STEM (science, technology, engineering and mathematics) students grew substantially between 2007 and 2017 (European Commission 2020a). On the other hand, human resources are one of the weakest innovation dimensions of today's Germany, according to the European Innovation Scoreboard (European Commission 2019a: 47), mainly because of a low share of the population with tertiary education and lifelong learning compared to that of the EU. Public expenditure on education has remained stable since 2009 (4.2% of GDP in 2015), although an increase in expenditure would be appropriate according to the European Commission (2018: 13). The attractiveness of the German research system could be higher relative to the EU average as well; in particular, the share of foreign doctorate students is rather low. Potential risks are related to an ageing population and the possibility of a scarcity of qualified human resources, mainly in engineering and science-based industries (European Commission 2016b).

As previous research confirmed (see Vlčková, Kaspříková and Vlčková 2018), Germany is strong in medium-high-tech industries such as engineering, automotive, chemicals, and energy technologies. There was a significant increase in patenting in *Machinery and transport* between 1988 and 2012, and in the latest period, it accounted for more than a third of all EPO applications. The category *Electronics*, *Industrial Processes* is the second-largest and accounted for about 14% of EPO applications in 2008–2012. Categories reflecting newer technologies such as *Drugs, Medicine*, *Electronics* and *Instruments* have been rising only slightly or have stagnated during the latest period. This confirms the continuing specialization of Germany in *Machinery and transport* and contrasts with the situation in the EU15 (Kogler et al. 2017).

The current high number of patents submitted to the EPO is explained by the above-average share of industries with a high patent intensity, such as transport, electrical machinery and energy, measurement, medical technology, other special machines and elements or ICT (see Table 1). In general, countries that specialize in manufacturing and ICT have a higher propensity to patent, whereas countries with large service sectors engage more in trademark protection (OECD 2013). Nevertheless, despite the enormous number of patent applications from German inventors, its global shares have been declining. Among the biggest patent applicants are famous German companies like Siemens (2,619 applications to the EPO in 2019), Robert Bosch (1,498 applications), BASF (1,366) and Continental (617; EPO 2020).

Tab. 1 German patent applications to the European patent office (EPO) – top 15 technology fields.

Technology Field	2018	2019	2019/2018
Transport	2,119	2,138	0.9%
Electrical machinery, apparatus, energy	1,987	2,076	4.5%
Measurement	1,659	1,739	4.8%
Medical technology	1,314	1,278	−2.7%
Other special machines	1,304	1,239	−5.0%
Mechanical elements	1,234	1,135	−8.0%
Computer technology	993	1,130	13.8%
Organic fine chemistry	1,101	1,123	2.0%
Civil engineering	1,029	1,034	0.5%
Engines, pumps, turbines	1,104	1,010	−8.5%
Machine tools	925	961	3.9%
Handling	1,006	936	−7.0%
Basic materials chemistry	1,044	892	−14.6%
Chemical engineering	835	822	−1.6%
Macromolecular chemistry, polymers	752	797	6.0%

Source: EPO (2020).

4.2 Regional Differences and Pattern of Specialization

The previous chapter has summarized basic trends in patenting activity and general indicators of R&D in the whole Germany. However, as mentioned

above, our main goal is to explore innovation activity in Germany at theNUTS1 regional level. At the level of Bundesländer (NUTS1), differences between the former East and West German states remain significant. Whilst between 1988 and 1992, East German states (excluding Berlin) accounted only for 1% of all patent applications to EPO, in 2008–2012 it rose to around 6%; in 2019 their share was 3.2% (excluding Berlin; EPO 2020). The differences are apparent also in other indicators (see Table 2). Patent applications are generally concentrated mainly in southern Germany; in Bayern (29.7% of total German EPO applications in 2019) followed by Baden-Württemberg (19.3%) and Nordrhein-Westfalen (19.9%). These three regions have strong industrial traditions, and their economic performance has been above the German average. Of course, there are intra-regional disparities regarding the regions' economic and innovation performance (e.g. metropolitan areas like Munich or Nuremberg versus rural areas in the east of Bavaria). The lowest patenting rates can be found in the East-German states of Sachsen-Anhalt (0.1%), Mecklenburg-Vorpommern (0.3%) and also in Bremen (0.3%).

Tab. 2 German NUTS1 regions – selected indicators.

Bundesländer	Average relatedness			Applications to the EPO (2019)		GERD (2017)	Total R&D personnel (2017)	Innovation performance (2019)
	1988–1992	1998–2002	2008–2012	Number	Share of total	% of GDP	% of active population (FTE)	EIS
Baden-Württemberg	0.036	0.039	0.038	5,169	19.3%	5.7	2.8	Innovation Leader +
Bayern	0.030	0.041	0.035	7,969	29.7%	3.1	1.8	Strong + Innovator
Berlin	0.046	0.055	0.051	746	2.8%	3.4	1.8	Innovation Leader
Brandenburg	0.061	0.052	0.040	168	0.6%	1.7	0.8	Strong Innovator
Bremen	0.153	0.045	0.051	87	0.3%	2.8	2.1	Strong Innovator
Hamburg	0.040	0.054	0.051	712	2.7%	2.2	1.8	Innovation Leader
Hessen	0.036	0.044	0.044	2,134	8.0%	2.9	1.7	Strong + Innovator
Mecklenburg-Vorpommern	0.247	0.046	0.044	75	0.3%	1.8	0.8	Strong Innovator
Niedersachsen	0.044	0.037	0.033	1,769	6.6%	3.1	1.3	Strong + Innovator
Nordrhein-Westfalen	0.030	0.030	0.029	5,322	19.9%	2.1	1.2	Strong + Innovator
Rheinland-Pfalz	0.033	0.046	0.038	1,637	6.1%	2.5	1.0	Strong + Innovator
Saarland	0.047	0.037	0.041	141	0.5%	1.8	1.0	Strong Innovator
Sachsen	0.047	0.039	0.033	399	1.5%	2.8	1.5	Strong + Innovator
Sachsen-Anhalt	0.042	0.047	0.040	24	0.1%	1.5	0.7	Strong Innovator
Schleswig-Holstein	0.047	0.047	0.037	262	1.0%	1.6	0.8	Strong Innovator
Thüringen	0.039	0.050	0.048	178	0.7%	2.2	1.1	Strong Innovator
Germany	**0.030**	**0.034**	**0.033**	**26,805**	**100%**	**3.0**	1.6	Strong Innovator

Source: EPO (2020), Eurostat (2020b); European Commission (2019a, 2019b), OECD (2017a).
Note: Eastern German states or highlighted in blue.

There are large variations between the German regions also in terms of other indicators. R&D expenditures per GDP are the highest in Baden-Württemberg (5.7% of GDP in 2017), Berlin, Bayern and Niedersachsen. They are also high in Hessen, Bremen and Sachsen (see Table 2). In terms of researchers and R&D personnel, the relative data (share of the active population) are very high in Baden-Württemberg and Bremen. High levels of R&D expenditure and a large number of R&D workers in Berlin are related to the fact that it is a capital city with many research institutions. Very low numbers are found mainly in the former East German states (Sachsen-Anhalt, Brandenburg and Mecklenburg-Vorpommern) and also in Schleswig-Holstein. According to the RIS, Baden-Württemberg, Berlin and Hamburg are the "Innovation Leaders", i.e. these regions performance is well above the EU average; they perform best on all indicators (European Commission 2019a, 2019b).

Specialization measured by average relatedness (AR) increased slightly between 1988–1992 and 2008–2012 (by approximately 10% between 1988 and 2012), but there was a slight decline between 1998–2002 and 2008–2012 (see Table 2). When exploring

individual categories, the highest AR is in *Drugs, medicine* due to the low number of patent classes in this category, and a similar situation is also in *Consumer goods*. The lowest AR score is in *Machinery and Transport,* and this score is decreasing over time, probably related to the rising number of patent applications (relatively and absolutely) in this category. There is also increasing R&D business expenditure. The highest and most rapidly increasing business R&D investment (BERD) intensity between 1995 and 2013 in Germany was in motor vehicles, trailers and other transport equipment, and it accounted for a third of total BERD.

Among German states, the most specialized based on average relatedness are the three city-states: Berlin, Bremen and Hamburg (see Table 2). The least specialized regions are Nordrhein-Westfalen, Niedersachsen and Sachsen. Low levels of specialization also occur in Bayern. Nordrhein-Westfalen and Bayern are large states with highly diversified industrial structures, whereas in Sachsen and Sachsen-Anhalt low specialization could be related to the communist history and continuing economic restructuring. The specialization increased in most states between 1988–1992 and 1998–2002. However, between 1998–2002 and 2008–2012, the specialization slightly declined or remained stable in all states except Saarland and Bremen.

The focus on med-tech manufacturing in Germany has further implications for the smart (regional) specialization. Leydesdorff and Fritsch (2006) found that in Germany medium-tech manufacturing is the main driver of a knowledge-based configuration in a regional economy. However, the economic benefits of knowledge-intensive services are more apparent at the national level because such services can be offered across regional boundaries. Nonetheless, knowledge-intensive sectors, particularly ICT, play a significant role in Industry 4.0. This will require considerable investment.

4.3 Patenting and Export Activity

Germany is the third biggest exporter in the world and the biggest one in Europe and focuses mainly on medium and high-tech exports such as cars, electro-technical products, machinery, and chemical products. Nonetheless, over the last decade, it has lost its strong market position in pharmaceuticals and the optical industries (European Commission 2016b). Despite the relatively lower share of the service sector and low productivity in services compared to other EU countries, Germany also has a high export share of knowledge-intensive services.

In this paper, we focus on the relationship between patenting activity and exports. We estimate the impact at the level of both regions and sectors. Based on the regression models, we found that there is a strong relationship between patent applications and exports. On average, a one per cent increase in patent applications within the region leads to a 0.66% increase in exports. The estimated coefficients are shown below in Table 3. This confirms the findings of previous research (e.g. Wakelin 1998; Frietsch et al. 2014).

Tab. 3 Impact of patent applications (2008–2012) on export (2003–2005).

Independent variable	Dependent variable	
	log of average regional exports 2008–2012	log of average sectoral exports 2008–2012
Constant	12.39***	14.57***
	(0.44)	(0.55)
ln(patent applications (2003-2005)	0.657***	0.004***
	(0.09)	(0.002)
F-stat	52.1***	4.41*
Adjusted R sq.	0.77	0.36

Source: own calculation and construction based on OECD (2017a) and Statistisches Bundesamt (2018)
Statistical significance indicated by an asterisk, where *** = 0.01, ** = 0.05 and * = 0.1. Standard errors in parenthesis.
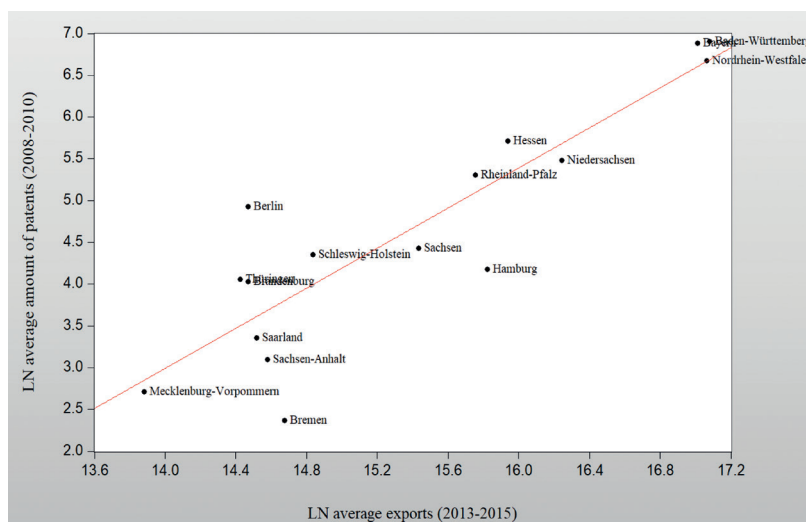
Fig. 2 The relationship between patent applications to EPO (2008–2010) and average exports (2013–2015).
Source: own calculation and construction based on OECD (2017a) and Statistisches Bundesamt (2018).

As figure 2 indicates, there are slight differences between the regions. Unsurprisingly, city-states Berlin, Bremen and Hamburg have much larger differences between estimated and actual value. This is related to the fact that R&D and services in general are concentrated in cities whereas manufacturing production and thus also exports of goods are lower in cities.

We also explored the relationship between patent applications and exports at the sectoral level (as can be seen in Table 4). The results were less significant (10% statistical significance level of the beta coefficient), and the relationship was weaker; it only explained 36% of the variability (adjusted R-squared) compared with 77% explained variability at the regional level. Within the sectors, the largest differences between estimated and actual value were in the categories of mechanical engineering, machines, transport (with higher number of patents than expected) and consumer goods, civil engineering (lower numbers of patents). This can be explained by the different patent intensities between these sectors.

Patents are not the only indicator of R&D. Not all inventions can be patented, and there are also other forms of protection such as trade secrecy (Griliches 1998; Cohen et al. 2002). Furthermore, we wanted to estimate how specialization affects exports of German states. Therefore, we also estimated the relationship between different R&D indicators (R&D expenditure, R&D personnel, degree of specialization) and the share of exports relative to GDP in German states based on regression models.

We built several regression models, some of which are included in Table 4. We found that higher numbers of R&D workers and researchers relative to active population increase exports. This is also true for patent applications, as was found in previous models. On the other hand, several models indicated that higher GERD lead to lower exports relative to GDP. However, when we used dependent variables as a log of exports, the relationship was positive. This is somewhat surprising, city-states might possibly distort the picture, and it requires further analysis. According to our models, higher specialization measured by average relatedness between patent categories affects exports negatively (see Table 4). This is rather surprising, and as there are no comparable studies, future research should focus on other measures of specialization as well as other regions.

Tab. 4 Regression models.

Dependent variable	Independent variable	Coefficient	F-stat	Adjusted R sq.
Log(Exports)	Constant	11.727*** (1.07)	18.28***	0.776
	Patent Applications	0.0002* (0.0001)		
	Average Relatedness	−63.44* (30.21)		
	Relative R&D Personnel	0.77* (0.43)		
Exports to GDP	Constant	1.01*** (0.32)	3.74**	0.423
	Log(Patent Applications)	−0.057* (0.03)		
	Average relatedness	−11.62* (5.29)		
	Relative R&D personnel	0.48*** (0.13)		
	GERD to GDP	−0.18** (0.07)		
Exports to GDP	Constant	0.29*** (0.08)	3.8**	0.27
	Relative R&D personnel	0.338** (0.13)		
	GERD to GDP	−0.15** (0.07)		

Source: own calculation and construction based on European Commission (2019a, 2019b), OECD (2017a), Statistisches Bundesamt (2018)
Statistical significance indicated by an asterisk, where *** = 0.01, ** = 0.05 and * = 0.1. Standard errors in parenthesis.

5. Conclusion

Germany is one of the most innovative countries with a strong industrial tradition. Despite the relatively large investment in R&D and large number of patents, Germany is not among the innovation leaders within the EU countries based on the European Innovation Scoreboards. In terms of patenting activity, Germany is the fourth country based on triadic patents after Japan, USA and China. Large patent activity in Germany is related to its orientation in industrial sectors with big patent intensity such as transport, machinery and ICT.

There are large differences between German states in terms of knowledge production, which can be attributed to their distinct historical development. Among the most innovative regions are Baden-Württemberg, Bayern or Berlin, at the same time the least innovative regions are Eastern German states Sachsen-Anhalt, Brandenburg and Mecklenburg-Vorpommern. The only East German state, which is highly innovative in terms of R&D expenditure, R&D or patent applications is Sachsen.

This paper is focused especially on technological specialization, which we measure based on the average relatedness in patent applications following Kogler et al. (2013). We provided evidence that the specialization increased in most states between 1988–1992 and 1998–2002, though, between 1998–2002 and 2008–2012, it slightly declined or remained stable in all states except Saarland and Bremen. The most specialized are the city-states of Berlin, Bremen and Hamburg whereas the least specialized regions are Nordrhein-Westfalen, Niedersachsen and Sachsen as well as Bayern. This could be caused by highly diversified industrial structures in the cases of Nordrhein-Westfalen and Bayern, whereas in Sachsen and Sachsen-Anhalt the communist history and continuing economic restructuring could be the cause. Therefore, there is no obvious trend indicating that large specialization would be related to higher innovativeness or vice versa.

We also estimated how patenting affects exports across German states as well as across industries. We observed that higher numbers of patent applications increase exports in line with previous research. At the level of German states, this relationship was stronger than in the case of industries, though city-states Berlin, Bremen and Hamburg have much larger differences between estimated and actual value. Apart from patenting we also estimated other R&D indicators such as GERD, R&D personnel and technological specialization. Whilst the higher relative numbers of R&D personnel increase the volume of exports relative to regional GDP, in the case of GERD the results were inconclusive. Furthermore, higher technological specialization measured by average relatedness between patent classes specialization negatively affects exports. This finding is unexpected, and in future research other measures of specialization and other regions should be tested to support this finding.

Acknowledgements

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Evolutionary trajectories of manufacturing firms in the rural Zlín Region of Czechia

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ABSTRACT

The aim of this article is to identify the most important mechanisms of rural industrial development in the context of a highly industrialized peripheral region in Central Europe. We ask if the development of rural manufacturing firms is primarily based on the activity and skills of local entrepreneurs, or whether it is driven by commercial counter-urbanization or cost-motivated inflow of (foreign direct) investment from other regions. Empirical results are based on the case study of the highly industrialized peripheral Zlín Region in Czechia. We have conducted 26 interviews with the company managers in rural municipalities of the Zlín Region. The growth of rural manufacturing firms is path-dependent, usually based on pre-existing economic activities or skills in the same or technologically related local industries. Neither commercial counter-urbanization nor inflow of foreign direct investment played a major role in the development of manufacturing firms in rural municipalities of the Zlín Region.

KEYWORDS

rural regions; manufacturing firms; restructuring; path development; firm births

1. Introduction

Particularly in the last four decades, rural regions in developed Western countries have experienced a broad diversification process of their economies. The economic structure of rural regions has been shifting from originally dominant production-based agriculture (Dinis 2006) to industry and services (Woods 2005) with a higher proportion of non-local economic linkages (Rumpel et al. 2011). These changes in rural regions are referred to as restructuring, which includes not only economic transformation, but also social change (Woods 2005).

Restructuring of economic activities may be associated with processes of diversification into related industries, upgrading of existing industries, or the emergence of completely new industries (Isaksen et al. 2019). Since the 1980s, there has been a spatial shift of manufacturing units in advanced countries (Hoggart and Paniagua 2001) from urban agglomerations to rural areas that offer lower production costs (Woods 2005). Western European trends show that while the importance of large cities for maintaining the international competitiveness of individual states is growing, up to 80% of national exports are industrial products from rural areas (Carey 2015).

Traditional rural industries linked to primary economic activities, such as the manufacturing of food, textiles, wood, and paper products are gradually supplemented with more technology-intensive manufacturing industries that are attracted by lower transportation costs and available workforce (Wiggins and Protector 2001). Companies that produce standardized products with simple inputs are often located in rural areas as well (Crone and Watts 2003). Compared to their urban counterparts, rural manufacturing firms are characterized by lower technological intensity, lower innovation activity, and higher sensitivity to the price-sensitive competition. Small and medium-sized enterprises predominate (Vaz, Morgan, and Nijkamp 2006), although the presence of large firms/branch plants in the manufacturing industry or standardized business services is not exceptional (Sonn and Lee 2012).

The relocation of manufacturing firms from cities to the countryside is spatially selective. First, manufacturing firms move to the metropolitan hinterland (commercial suburbanization) and in the next phases into the countryside (commercial counter-urbanization) (Bosworth and Finke 2019). These mechanisms are usually cost-motivated by an inflow of investment from elsewhere. The third mechanism we called as an endogenous mechanism and we describe it below.

The paper aims to assess the relevance of traditional hypotheses of rural industrialization (North 1998; Kalantiradis 2005) for the path development of manufacturing bases in Central European rural regions. The research questions are:

1) Which factors and mechanisms shaped the evolutionary trajectories of manufacturing firms in rural areas of the Zlín Region?
2) To what extent has the manufacturing development in rural areas of the Zlín region been driven by
   a) endogenous sources and entrepreneurial activity of local actors origin,
   b) relocation of production capacities from regional urban cores due to lack of land or other production factors in cities,
   c) cost-oriented investments from other regions/states, or
   d) commercial suburbanization followed by residential counter-urbanization.

We base our assumptions on a case study from the Zlín Region, which is characterized by a high degree of industrialization compared to other European regions, the highest share of manufacturing in the employment rate amongst all Czech regions, the second-highest share of manufacturing in employment in rural municipalities (Business Register 2017), diversified economy at the regional level and high density of small and medium-sized manufacturing enterprises in rural areas. Industry in the Zlín Region has historically developed in various ways: an exogenously-driven development (e.g. state-controlled relocation and development of the arms industry for strategic reasons) and since 1989 the inflow of foreign direct investment) and endogenously-driven development: e.g. the establishment of Baťa company and subsequent expansion of footwear from which other industries spun off. The Zlín Region, therefore, provides a lot of valuable material for the study of path development of rural manufacturing firms.

In the next section, we will present the factors and mechanisms of path development of manufacturing firms in the countryside. Then, we briefly characterize the restructuring of industry in Czechia and the Zlín Region to provide some context. The fourth section describes data sources and methods, while the fifth section empirical findings, including the company profiles. The sixth section discusses the findings of other authors, and the seventh provides a summary and implications.

2. Factors and mechanisms of path development of manufacturing firms in the countryside

A number of firms in rural areas are also established by extra-regional actors in various ways: foreign-direct investment, commercial suburbanization, counter-urbanization, or are based on externally acquired knowledge. Counter-urbanization means the development of the rural economy driven by immigration from urban areas (Píša 2020; Píša and Hruška 2019).

The essence of this process is a transformation of rural community throw new exogenously led entrepreneurial opportunities associated with rural in-migrants (Bosworth and Finke 2019). It also possible throw the inflow of foreign investment multinational companies and it often cost-motivated and locally disembedded (Perkmann 2006; Trippl et al. 2018). We can talk about *path importation* (see below for definition).

This process is also described by North (1998), who deals with five possible explanations of manufacturing and other non-agricultural activities relocation:

1. The hypothesis of residential preferences emphasizes the role of soft factors (Slach et al. 2013) such as housing, recreation possibilities, and natural environment, which attract future residents and founders of rural manufacturing companies. In this context, Píša (2020) and Píša and Hruška (2019) talks about the entrepreneurial migration (*counterurbanization*), where migrants are motivated by a countryside idyll.

   The next four North's (1998) explanations are linked by cost motived inflow of investment:

2. The constrained locations hypothesis works with the presumption of a growing demand for land, as current industrial, automated, capital-intensive production requires increasingly larger areas that are more available in rural municipalities than in densely populated cities. This process is known as commercial suburbanization.

3. The filter-down hypothesis is based on the product life cycle theory (Vernon 1966) and explains rural industrialization by a firm's efforts to reduce their costs of standardized production. The relocation of production from urban to rural areas is typical rather for routine and less knowledge-intensive assembly activities (North 1998; Kalantaridis 2005).

4. The production cost hypothesis assumes that firms are trying to locate production in places with low land and labour costs (North 1998), i.e. in rural regions, among others. The remoteness of rural regions and limited external economies of scale offset low costs associated with lower wages and more affordable real estate (Kilkenny 2010).

5. The capital restructuring hypothesis emphasizes the importance of advanced technologies and models of production organization. These have made it possible to relocate parts of the production process from urban agglomerations to rural areas, where companies capitalize on lower personnel costs and weaker trade union organization of the labour force (North 1998). Firms benefit from the experience gained in the city, where they often have economic ties (Mayer et al. 2016) while taking advantage of rural production factors.

Exogenous mechanisms are important especially in regions with limited internal resources, small economic base, narrow specialization: "thin regions" (Isaksen 2014). Entrepreneurs in these regions use local knowledge mainly for incremental innovations, while radical innovations are aquired mostly by extra-regional links (Mayer et al. 2016).

While exogenous mechanisms may affect rural manufacturing development significantly, rural firms are mostly established endogenously: by local entrepreneurs, their knowledge and experience, which was often gained in other local manufacturing firms in technologically related industries (Isaksen and Trippl 2017; Maskell Malmberg 1999). Mechanisms for the development of economic activities ("path development") in rural areas and non-metropolitan regions are, compared to metropolitan regions, much more significantly embedded in a historical development trajectory of regional economies, local institutions (Martin and Sunley 2006), and inherited industrial structure (Ženka et al. 2015). Therefore, diversification or upgrading of local economic structure and the development of new industries are often based on a combination of new and existing knowledge (Trippl et al. 2018), which refers to the history of industrial production in the region, including local technical education, workers' skills, and locally embedded informal "institutions" (Isaksen et al. 2019). These (often) locally uniques pieces of knowledge can be then used by potential entrepreneurs when starting their own businesses (Furlan and Cainelli 2020). We are thus referring to the influence of tacit knowledge and skills that are unique and available in a specific region, which leads to the strengthening of local specialization (Maskell and Malmberg 2007) and path extension. Firms established as spin-offs (branching of existing firms) have a higher ability to react and orient themselves in the local market environment, both in terms of supply and demand, compared to firms established without a prior connection (Mayer et al. 2016).

Another endogenous factor in setting up businesses in the countryside is also the residence of the founder of new businesses (Isaksen 2014). Potential entrepreneurs set up new firms where they live and work (or close), drawing on existing local skills and social networks (Isaksen and Trippl 2017). We are referring to the concept of social capital, which includes social networks, contacts, civic norms, and values that represent intangible advantages formed by personal ties and links developed based on trust and long-term relationships (Pileček and Jančák 2010), such as informal relationships between suppliers, customers or local institutions. The advantages in the home region are related to the use of information from a familiar environment and established networks. In addition, family members and/or acquaintances are often recruited as employees, thus intersecting social and economic relationships (Cannarella and Piccioni 2011).

The above-mentioned development mechanisms are influenced by the conditions and specifics of

individual regions and may occur in different sectors or industries simultaneously (Isaksen 2014), however, they cannot be understood as continuous phases of the development of the industrial structure in the regions. The question is which mechanisms discussed above are the most common and which mechanisms most influence the current location and sectoral structure of the industry in rural municipalities. The table below simplifies the discussed mechanisms and processes in path development.

Tab. 1 Path development mechanisms.

Mechanism	Main processes
Path branching	This is the establishment of new economic activities/firms/industries through branching from existing local industrial specializations: either inside a firm or through a spin-off, establishment of a new firm. Changes in the economic structure are not significant, as new companies do business in the same or related industries as the original company.
Path extension	Continual development of existing industries, based on scale economies and incremental innovations. Overall, there is a small change in the regional economic structure, as the long-term continuity of the region's original specialization is evident.
Path upgrading	New production processes and technologies are being introduced into regional industries. There are development and accumulation of skills. As a result, there are new combinations of products or services with higher added value. Rather than the development of new industries, there is the strengthening of the competitiveness of existing ones.
Path diversification	Based on innovative combinations of existing and new (both local and external) knowledge, new technologically related industries are emerging.
Path creation	In the regional economy, a new sector is growing, for example, through the commercialization of scientific research activities, which are often the result of chance or accident. The formation and development of new industries in a region are conditioned by the availability and quality of local production factors.
Path importation	Localization of new industries in a region through the inflow of investment, qualified employees, or establishing collaboration with companies outside the region.

Sources: Author's own design, based on Isaksen et al. 2019; Gjelsvik and Trippl 2018; Isaksen et al. 2018; Grillitsch et al. 2016.

3. Historical development and restructuring of industry in the Zlín Region

Agricultural production prevailed in the region until the second half of the 19th century. The industrial structure in this period was influenced by physical and geographical conditions. On the one hand, there

were agriculture-related manufactories (confectioneries, distilleries), but also industries related to wood surpluses in mountainous areas (Bednář 1970). An important milestone was the establishment of the Baťa factory and its subsidiary plants in Otrokovice, Napajedla, and Chropyně (Kunc 2006), which helped to develop a specialization in the footwear industry. The footwear related industries such as the rubber industry and later the plastics industry later spun off. The current sectoral structure is also influenced by socialist industrialization when new companies were established in the region (e.g. Dyas in Uherský Ostroh). As a result of the expansion of existing armaments companies and due to the strategic location of the area (Česká Zbrojovka in Uherský Brod and Vsetín), the branches of this company were localized in the region. There were also some other branches of major companies active in the metalworking, plastics and electrical industries such as Avia Letňany – Let Kunovice, Autopal in Hluk, Agrostroj in Napajedla, Gumárny Zubří, Tesla in Valašské Meziříčí and Rožnov pod Radhoštěm (Kunc 2006; Bartoš 1982), and the chemical industry (relocation of Deza).

In the interwar period, there was a need to form industrial districts of cooperating firms in the above-mentioned industries, which were characterized by a very intensive division of labour at the regional level (for theoretical aspects of the process see Zoričák et al. 2021). Although in the socialist era there was a major change in the organization of industrial production (Rumpel et al. 2011) that weakened local and regional economic linkages, high spatial concentration of manufacturing firms in some industries sectors (especially in the metalworking and plastics industry) in the Zlín Region persisted and fundamentally influenced the development of rural manufacturing firms in the transformation period.

In the 1990s, the restructuring process began in Czechia. The period before 1989 was characterized by a relatively high employment rate in the agricultural sector, which was also due to non-agricultural activities of the so-called "associated production of unified agricultural cooperatives" and state-owned farms. These were mainly light industrial production activities or construction work. Total employment in agriculture reached up to 7% of the economically active population in the early 1990s. In the period of transformation after 1989, there was a reduction in agriculture associated with drop-in employment to one third under the same production (Bičík and Jančák 2005). There were changes in ownership relations with secondary and tertiary activities of so-called "associated production" starting to spin off (Jančák et al. 2019), which significantly affected today's economic structure in the countryside. It is a common practice that these established firms are still often located in the former premises of agricultural cooperatives (Hruška and Czapiewski 2015).

Not only Zlín Region, but all Czech rural regions are now one of the most industrialized regions in the European Union (Vaishar and Šťastná 2019), where manufacturing is significantly represented not only in regional hubs but also in rural communities (Figure 1). The most important industry in Czech rural regions is the manufacture of fabricated metal products (Figure 2), which accounts for a higher share of employment in the rural municipalities of the Zlín Region than in the rural municipalities of Czechia. The specialization of the sectoral structure in administrative districts of municipalities with extended powers AD MEP) is expressed by the localization quotient. The values of the localization quotient can be found in Table 2.
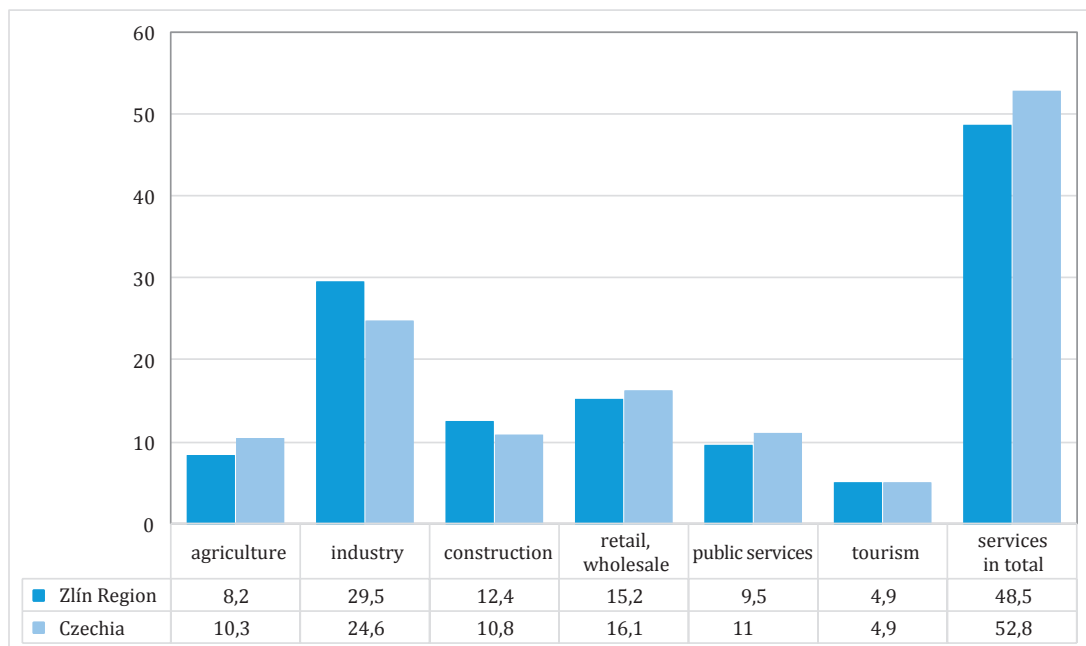

	agriculture	industry	construction	retail, wholesale	public services	tourism	services in total
Zlín Region	8,2	29,5	12,4	15,2	9,5	4,9	48,5
Czechia	10,3	24,6	10,8	16,1	11	4,9	52,8

Fig. 1 Sectoral structure of employment in rural communities of Czechia and the Zlín Region in 2017 (%).

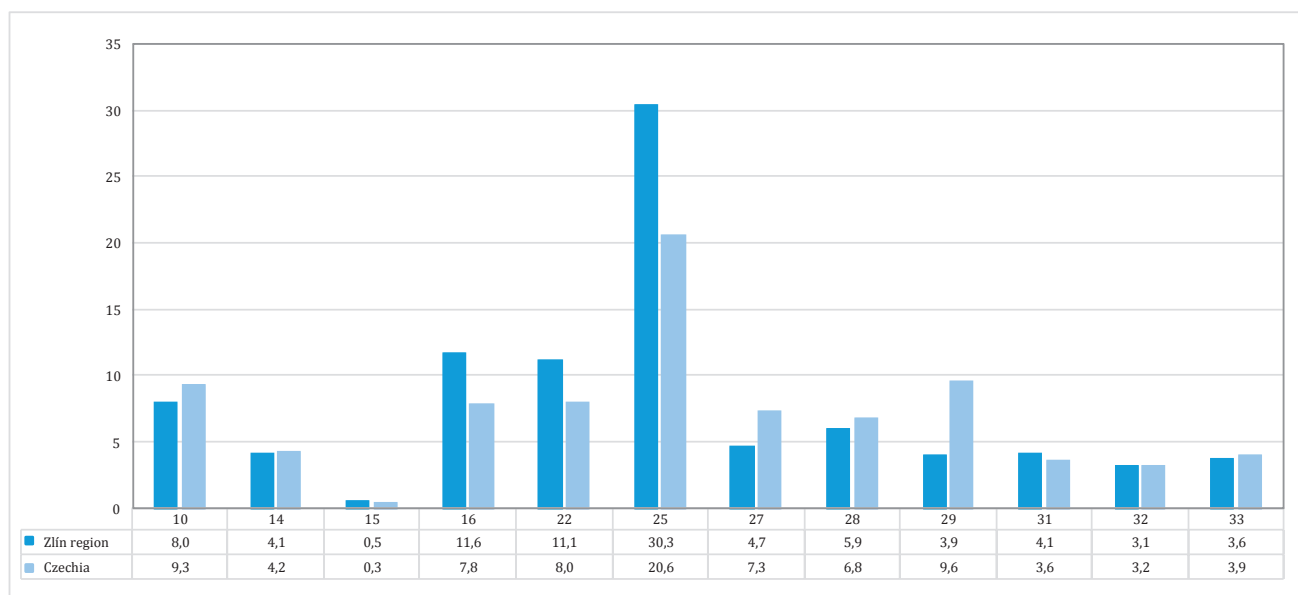Source: Business Register 2017; Authors' own design.

	10	14	15	16	22	25	27	28	29	31	32	33
Zlín region	8,0	4,1	0,5	11,6	11,1	30,3	4,7	5,9	3,9	4,1	3,1	3,6
Czechia	9,3	4,2	0,3	7,8	8,0	20,6	7,3	6,8	9,6	3,6	3,2	3,9

Fig. 2 Sectoral structure of employment in manufacturing in rural municipalities of Czechia and the Zlín Region in 2017 (%).

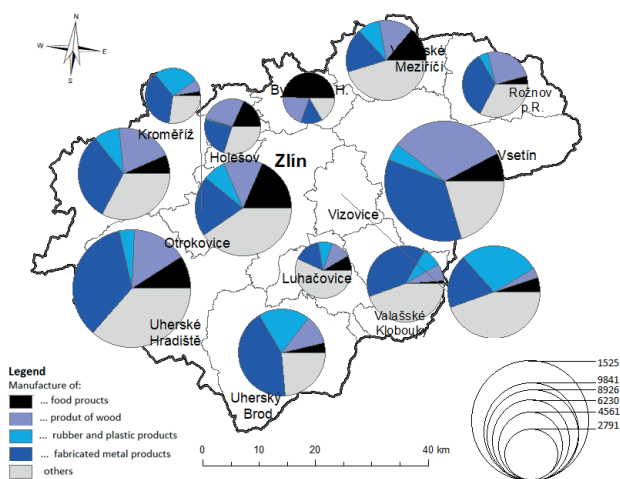Source: Business Register; Authors' own design.

Note: An employment rate was calculated as the share of manufacturing in total industrial employment (CZ-NACE in the range of 10–33). Due to the negligible share of employment, the graph does not include sectors with employment below 3% in the Zlín Region. 10 – food-processing, 14 – textile, 15 – footwear, 16 – woodworking, 22 – plastics, 25 – metalworking, 27 – electrical, 28 – engineering, 29 – manufacture of motor vehicles, 31 – manufacture of furniture, 32 – other, 33 – repairs and mounting.

Tab. 2 Localization quotient (LQ) in rural areas of the Zlín Region (2017).

AD MEP	10	14	15	16	22	25	26	27	28	29	31	32	33	Other
Bystřice pod Hostýnem														
Holešov														
Kroměříž														
Luhačovice														
Otrokovice														
Rožnov pod Radhoštěm														
Uherské Hradiště														
Uherský Brod														
Valašské Klobouky														
Valašské Meziříčí														
Vizovice														
Vsetín														
Zlín														

Source: Business Register, Authors' own calculation

Note: LQ = 6.1 (maximum) (dark blue), LQ > 2 (blue), LQ = 1–1.99 (light blue), LQ < 1 (white); Other: It includes other industries according to NACE rev. 2.0.

The value of the localization quotient shows that almost all rural areas of the Zlín Region are the most specialized in the metalworking industry (NACE 25). Only the AD MEP Bystřice pod Hostýnem shows a low LQ value due to a high specialization in the food-processing industry and the AD MEP Luhačovice, which is a spa town with a high employment rate in services. Local industry is dominated by the production of machinery and equipment. The regions show a higher degree of specialization in traditional manufacturing industries, namely the textile industry (NACE 14), leather (NACE 15), and wood processing (NACE 16 and 31). The main reason is mostly the historical tradition of this business and physical and geographical conditions.

Fig. 3 Employment structure in rural communities of the Zlín Region (2017).

Source: Authors' own design based on Business Register 2017.

4. Data and methods

To meet the aim of this paper, we selected rural municipalities of the Zlín Region, which were determined based on a descriptive definition. The population criterion of 3,000 applied in the Act on Municipalities No. 128/2000 Coll., was used as an upper limit of the population size. Subsequently, rural municipalities were aggregated into AD MEPs. The Register of Economic Subjects from the Czech Statistical Office and the Business Register from the Ministry of Finance was used to identify firms in rural municipalities. The firms were selected according to the NACE rev. 2.0 classification, with the following defined categories: agriculture, incl. forestry and fishing, manufacturing, and services. The paper focuses on manufacturing, which was defined based on the same classification using codes in the range of 10–33. The rural manufacturing companies chosen as relevant were those that had manufacturing listed in the Business Register in the first place. To measure the degree of specialization of the structure, we constructed a localization quotient, i.e. the share of a particular industry in the region's employment divided by the share of the same in employment in the national economy, i.e. Czechia. A value is higher than 1 means a higher specialization in the particular than the state (Hamalová et al. 1997).

Further, we used a semi-structured interview with the company representatives as a key source of primary data. In the period 2016–2019, we conducted a total of 26 personal interviews. In the first part, we asked about the basic identification characteristics and it is the main source for this research:
– the year of birth,
– mode of the establishment (a newly established firm, a spin-off or branching from a local firm (same or different industry), a spin-off and branching from an external firm (same or different industry); a subsidiary of a company from district town or another locality)
– main production portfolio and their innovation and modification,
– number of employees,
– the firm's educational structure.

The second part of the questions focused on geographical aspects of production, i.e. what hierarchical level their supplier-customer ties reach and also where their biggest competitors are located. We distinguished several hierarchical levels – district rural/urban part, region, Central Europe, Europe, and the world. The last part of the interview focused on the company's sources of competitiveness and innovation activities. If necessary, we asked for an explanation. Many answers thus arose from a non-standardized interview with the respondent.

We used intentional sampling to select the firms for an interview. The aim was not to cover all manufacturing industries but to include traditional industries in which the Zlín Region has long specialized, such as the metalworking, food-processing, and leather industries. Our intention was not to obtain a representative sample that would allow the implementation of

inference statistical methods and characterize the distribution of statistical attributes in the population of rural industrial companies. We have tried to contribute to the understanding of the mechanism of establishment and development of industrial companies in rural areas by revealing the relations in the territory and empirically observed trajectories.

Company names have been changed for research purposes. The distribution of the surveyed companies is shown in Figure 4. The methods of descriptive statistics and subsequently the qualitative content analysis of the interviews (see Elo et al. 2014) were used. From a methodological aspect, the paper presents the so-called "theory-confirming case study" (for the classical typology of case studies see Lijphart 1971). In the Central European context, the Zlín Region can be understood as a 'most-likely case' (Seawnght and Gerring 2008) of a region with a high potential for the endogenous establishment and development of the rural industry. The hypothesis is therefore the dominance of an endogenous way of establishment of rural manufacturing firms.
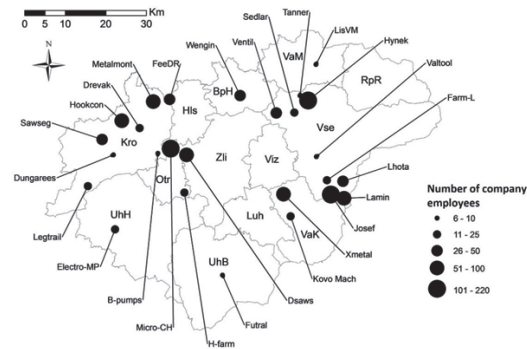

Fig. 4 Distribution of interviewed firms in the Zlín Region.
Source: Authors' own design based on the questionnaire survey.

The next section is separated into two parts. The first is a short introduction to the questionaries firm, while the second is the core of this article, providing empirical results and summarizes the interview. Finally, we compare our results with initial expectations and answer the research questions.

Tab. 3 Brief introduction of the companies that participated in the questionnaire survey.

Company name	Year of establishment	NACE	Main products	Company establishment
Valtool	2014	25	components for the automotive industry	The company was established by former employees of a nearby large, industrial firm active in the same industry. It started to produce the product of the original firm, which had it only as a sideline activity. Based on the knowledge and know-how, this company made it its main product and acquired customers thanks to their previous contacts.
Farm-L	1995	15	dairy products	A traditional food-processing company that builds upon an agricultural tradition in the local community and dates back to the 1960s, when the first collective farm was established. It was created thanks to agricultural transformation, i.e. redemption of ownership interests.
Dungarees	2003	14	work clothes, textiles for hospitals, packaging for weapons	The manufacture of work clothes was newly started in the place of the company owner's residence (in the basement of a family home) without any employees. In 2003, it moved to a nearby building of a food-processing firm, which was in a desolate technical condition.
B-pump	2000		repair and sale of pumps	The company was established from associated production in the area of the former collective farm in Hostišová near Zlín, where it rented a property. Subsequently, the owners purchased their production facility in Kvasice.
Legtrail	1997	25	parts of trailers and semi-trailers made of iron	The location and establishment of the company were influenced by the available premises – the founders used the abandoned former collective farm premises. This company was established in the locality without a direct former connection.
FeeDR	1992	10	compound feed	The company was established in 1992 from the original mixer and feed dryer in the production site of the collective farm in Němčice. The owner started his business with one employee and gradually reconstructed the agricultural building in a desolate condition.
LisVM	2007	25	spare parts for press machines	The company was established in the current location thanks to Prague investors (including the current owner). At first, it was located in the owner's residence, but due to unsatisfactory manufacturing conditions, he moved production to an unused building, which previously served a retail business. Thanks to his machines and equipment, the firm can flexibly respond to demand and adjust a manufacturing program.
Josef	1990	10	meat and sausage processing	This company was established as a new business in 1990 (natural person) based on many years of experience of the founder in the field. Thanks to high demand, there has been an increase in capacity and employment and an expansion of production associated with meat and sausages. The company is now a legal entity.

Company name	Year of establishment	NACE	Main products	Company establishment
Lamin	1991	22	plastics, composites, plastic covers for machines	This medium-sized company was established in direct connection to a local company, which has been active in the region since 1985 and produced plastic parts for rail vehicles. This company was bought by the current company in 1991 and since then it has expanded it with its technologies.
Ventil	2000	28	fans and covers for machines in the textile and food-processing industry	The company was established in the locality without prior connection. Thanks to the expansion of production, there has also been an increase in the number of employees and the construction of a new assembly hall in recent years. This company's product is so unique that it has no competition even on a global level.
Hynek	1989	25	painted surfaces of industrial products	It is a medium-sized enterprise in Czech ownership. The company was founded in 1989 by a former employee of paint shops in industrial companies, who already unofficially earned extra money by painting older cars during socialism. The company has expanded rapidly in the last decade, increased the number of employees fivefold, and has become the largest custom paint shop in Czechia.
H-farm	2005	20	medical devices	The company was created by selling an existing company in the same industry. However, it was originally a natural person. The company is engaged in the production of medical devices and there has only been an expansion of the offer, not a change in production.
Futral	1993		weapons, ammunition	The company was established in the locality without any previous connection and its production is focused on the manufacture of backpacks and cases.
Sedlar	1992	15	saddlery products, upholstered components for the automotive industry	The company was established in 1992 by nine saddlers working in a collective farm in the associated production of work gloves, which has a forty-year tradition in the local community. At that time, the company had 170 employees (80 in manufacturing of gloves), however, the company was gradually forced to reduce the number of employees mainly due to intense price-based competition from India and other Asian countries.
Drevak	1999	16	joinery production	The company was newly established in the given locality based on previous experience in the field and tends to serve the local market.
KovoMach	2014	25	metalworking	This company was originally established as a natural person, the founder of which was a former employee of an ammunition factory. The company has changed its form into a limited liability company in 2014 and its production remains the same.
Mealmont	1995	25	assembly halls	This company is a spin-off from a nearby engineering company where the founder had previously worked. Today, the company has two production facilities.
Sawseg	2005	25	segment saws	The company has a direct connection to the production, which has been in the locality since 1948. Thanks to the privatization of a former state enterprise, two independent, highly specialized companies have been established, which are located in the same production facilities and cooperate until today. Sawseg is part of a German-Dutch company.
Lhota	1951	15	meat production	It is another agricultural company from the region, which was founded without a direct former connection already in 1951. In the past, they were only engaged in primary production.
Tanner	1992	15	processing of bovine skins	The company has no history in the rural community of Jablůnka; it builds upon the tradition of tanning in the region. The main products are not primarily intended for the end consumer, as it manufactures semi-finished products for shoe, bag, belt, and haberdashery companies.
Electro-MP	2009	27	public lighting	The company was newly founded by local entrepreneurs. The main localization factor was the knowledge of the region.
Hookcon	2000	28	container carriers	The company's history began in 1990 when it was spun off from a local company in the same industry. In 1995, a major decision was made, by which the sales and service organization dealing with the sale, assembly, and service of superstructures were transformed into a manufacturer of truck superstructures specializing in container carriers and dumpers.
Wengin	2007	25	components for production lines	The company was established as completely new in the region. Important localization factors were available premises, proximity to suppliers, and available qualified workforce.

Company name	Year of establishment	NACE	Main products	Company establishment
Dsaws	1992	25	saw blades for wood	This company was founded as completely new in the place of the founder's residence, where it manufactures components for the production of another company. It adapts the products to the customer's specifications and has its own development center.
Xmetal	1992	28	spare parts for trainsets	The company was founded thanks to the available production facilities as completely new to the location.
Micro-CH	1993	22	microtubes for electronic industry	This company was established as completely new in the given location thanks to the proximity to suppliers and suitable transport and technical infrastructure. This company is part of the global manufacturer of the same name based in the USA.

5. Results

The first part of the result is basic information about firms to provide context about the companies surveyed. A total of 26 manufacturing firms in the rural areas of the Zlín Region were contacted. They were mostly small and medium-sized enterprises. Only three of the companies we addressed had more than 100 employees. Overall, these are long-existing companies, as evidenced by their age – they were established mainly in the first half of the 1990s. The interviewed firms do not have a problem with employee turnover and in the monitored period, they felt a shortage of manpower. These firms are embedded in the region and employ (mostly less educated) people from the surrounding area. The more employees a firm has, the higher the level of education, especially in firm management.

The product portfolio consists mostly of low value-added and labour-intensive products, based on traditional industries. Most companies changed their production portfolio during their existence, which in most cases were incremental innovations of existing production. The questionnaire survey shows that companies have more suppliers and customers and are not dependent on one key supplier and customer and thus this factor was not a major localization factor in the establishment of the company. In terms of production volume, the most significant purchases and sales were at the regional level (59%).

The questionnaire survey shows that such companies do not perceive any competition at the local level. Over the last five years, the interviewed firms have applied the most process innovations (e.g. purchases of new machines, obtaining a quality certificate) and product innovations. Firms also stated that there is a lack of demand for new products, often due to stable customers of their standardized products.

In the second part of our paper, we will deal in more detail with the origin of rural manufacturing firms. Almost all firms show some historical connection, whether the education typical for the region or the experience gained due to previous employment. The second important mechanism of the firm establishment was the independence of associated productions, i.e. by spinning off the existing part of the production.

The most numerous groups are companies established by spin-offs from existing local or regional companies (46% of the contacted firms). This is in line with the path branching development mechanism. This method of establishment is typical for the first half of the 1990s. Respondents answered most frequently that companies were established due to their spin-off in the same industry. In most cases, these were processes within an ongoing optimization of the firm, namely gaining independence by partial divisions of firms and associated agricultural production of collective farms. The direct continuity of agricultural cooperatives was referred to by the three firms contacted, especially in the food-processing industry, where the owners either purchased ownership shares and continued in the same production or after the stabilization of transformation processes continued the original manufacturing program.

A key factor in establishing firms is previous employment because respondents stated that the firm's founder was previously employed in the same or similar economic activity. Thanks to this, there is a path extension development mechanism in the rural areas of the Zlín Region. This trend was confirmed mainly by respondents from the metalworking industry. Thanks to previous employment in large engineering companies in the region, five respondents started their own business. It was often originally a business of natural persons, which was later transformed into a larger firm. The connection to the *long tradition of production and knowledge in the region* was reflected in two firms dealing with leather processing. The last example of the firm establishment thanks to previous knowledge and its good example of path upgrading is a paintshop firm, whose founder was trained in the field and then officially worked in industrial paint shops, and at the same time earned extra money as a painter of older vehicles. After quitting industrial paint shops, he first started his automobile paint shop (entrepreneur), from which a small paint shop developed, followed by the largest custom paint shop in Czechia, which processes components for the world's leading car manufacturers and aircraft manufacturers. This firm has been in operation as a legal entity since 2008, when it was taken over by

the owner's son who has expanded production, giving jobs to more people.

In the case of a spin-off of firms from another industry (19%), a connection to tacit local knowledge was again demonstrated, as well as a spin-off from the same industry. This refers to an experience gained from the *associated production* of collective farms when the firm later changed its production portfolio. A firm engaged in the production of upholstered components for a major Czech company, which was founded by nine saddlers, can illustrate this type of experience. The original portfolio involved leather gloves, but due to competition from Asian countries, the production program needed to change. The original dominant glove production was reduced to specialize in the production of components, using the previous technological equipment and know-how.

The connection to an external firm in another industry was demonstrated by only one of the interviewed companies when the owner started the production of weapons and textile machines after the bankrupt company and their current production represents only piece metalworking.

Firms that have been newly established in the region (31%) can be divided into two groups. The first group is firms active in the food-processing industry, which have been operating in the region for a long time and have a well-established tradition. The second group of firms was established around 2000 and manufactures specific industrial products (e.g. components for trailers and semi-trailers, components for production lines, parts for press machines). The reason for the establishment of these firms was available land, often brownfields of collective farms, knowledge of the region and the current regional activity of entrepreneurs, or the proximity of their permanent residence. The firm establishment due to the proximity of a supplier was proven in only one firm active in the electrical industry.

In the sample of contacted companies, no firm was identified that would be established by opening a branch or by building a plant-based on the inflow of foreign direct investment. Neither the commercial counter-urbanization nor the cost-motivated FDI-driven relocation of companies is not a relevant mechanism for rural areas in the Zlín region. Local rural manufacturing firms are therefore exclusively domestic. An exception may be two companies – a metalworking company that was established thanks to the capital from another Czech region (the capital city of Prague) and originally a Czech company producing segment saws, which was bought by a German-Dutch company.

The availability of land and buildings in a given locality shows as a key localization factor in the countryside. Most firms use the premises of former collective farms; some have reconstructed them, creating small industrial zones. Another important factor and the reason for the company establishment in rural areas was the origin of the company owner or the existence of a close customer. Half of the companies have an owner from the Zlín Region.

6. Discussion

Empirical findings have shown that the classical hypotheses of rural industrialization according to North (1998) are not very relevant for the explanation of the establishment and development of rural manufacturing farms in the Zlín Region, and it is so for several reasons. The hypotheses are rooted in the American context and are tied to a broader concept of the countryside, which also includes non-metropolitan towns, not just rural communities. They primarily explain the relocation of industrial firms from large metropolitan cities to a wide hinterland, and not from small/medium-sized towns to rural communities, which is the case of the Zlín Region. The hypotheses mainly affect general trends of the relocation of industrial companies from urban agglomerations to rural regions and have a limited ability to capture individual trajectories of the development of individual firms.

In the Zlín Region (and probably most of the Czech and Central European non-metropolitan regions), counter-urbanization has not yet played a very important role in the establishment of rural manufacturing firms (unlike the USA or Western European countries – see Bosworth and Finke 2019). The results of our empirical survey have not shown that rural manufacturing firms are established by immigrants from urban agglomerations who move to the countryside for a better-quality environment and amenities. According to Píša's research (2020), the peripheral areas of the Zlín Region are among the business-growing municipalities that are declining in terms of migration. The inner rural areas of the Zlín Region have a positive migration balance and a favorable balance of housing construction, but there is no development of business activities. This is confirmed by the findings of Ženka et al. (2021), who identified the Zlín Region as a highly industrialized export periphery.

We also did not find any support for the related hypotheses of capital restructuring (see Kalantaridis 2005): the surveyed rural enterprises focus on custom production of a craft nature rather than on large-scale production of standardized products. The closest is the hypothesis of constrained locations and production cost (North 1998): available real estate was an important localization factor, although it cannot be said that companies in the cities and towns of the Zlín Region would face unavailability or high real estate prices. Although many rural regions in Czechia can be simply described as regions with a significant position of production plants of multinational corporations (branch plant regions) according to the typology of rural economies by Woods (2013), for the Zlín

Region this characteristic is due to the strong position of domestic SMEs (and despite the presence of some major international plants in urban areas) not very relevant.

However, the main reason for the limited relevance of the above hypotheses is the fact that most of the surveyed firms were established endogenously (in line with Maskell, Malberg's assumptions 1999): they were started by local entrepreneurs as spin-offs from existing local businesses in the same or related industries or also without any connection to the previous activity in the locality. The most relevant mechanisms of rural manufacturing development are path extension and path branching from local sources. The location of newly-established firms in the Zlín Region was significantly affected by the company founder's residence. The importance of the owner's residence also coincides with Isaksen's conclusions (2014). Tacit local knowledge had a major influence on the establishment of new companies, which is in line with the findings of Egedy et al. (2015) and Isaksen et al. (2019). At the same time, the authors identified personal relationships and networks as a fundamental mechanism in the development of (rural) entrepreneurial activities, as also evidenced by our findings.

The results confirm the statement of Ženka et al. (2017) on the key role of diversification in technologically related to the development of non-metropolitan, in this case, rural regions. However, due to a low level of cooperation and mutual learning between companies at the local level and many other barriers to innovation activities typical of the Central European context (Květoň and Blažek 2018), the branching process is not accompanied by the development of completely new industries, products, and technologies. The inertia of the structure and product spectrum of firms from the socialist period is very strong, which is in line with the results of the Slach research from the peripheral Jeseník microregion (see Slach in Rumpel et al. 2011). This is true for most Central European rural and non-metropolitan regions (Ženka et al. 2015).

In terms of path development mechanisms, this case study mainly deals with a path extension (Isaksen et al. 2019), because in the development of new industrial activities we can only observe a combination of existing knowledge using incremental innovations, which is consistent with Isaksen's conclusions (2014). There are no significant internal changes in the economic structure, as the newly established firms build on the history and knowledge of the region (in agreement with Eder and Trippl 2019).

7. Conclusion

Based on a case study of 26 firms from the Zlín Region, the paper aimed to empirically contribute to the study of the establishment and development of manufacturing firms in rural communities. The endogenous method of the establishment of companies, which were for the most part founded by local entrepreneurs, completely prevails. In most cases, a strong link to the previous specialization of a rural municipality or a regional center was demonstrated. Firms were often established in direct connection with traditional enterprises established during the socialist or interwar period, some of which were set up by former employees who used knowledge and contacts acquired there. As a rule, manufacturing firms built on previous rural economic activities in the locality or the surrounding area, whereas the frequent method of the establishment was the spin-off of associated industrial production from the activities of former collective farms. Based on these findings, we can conclude that path branching and path extension were the most important mechanism of rural manufacturing development in the Zlín Region. Path upgrading is very limited and depends mostly on the capabilities of individual companies. We did not find any significant effect of commercial counter-urbanization or foreign capital. Firms that were newly established in the region without prior connection had a highly specialized portfolio of products, focusing on market niches.

Finally, we can summarize that there are few external impulses in rural municipalities in the Zlín Region that can bring fundamental innovations starting the development of complete news. The topic for further research is to carry out a similar type of research in other types of regions: metropolitan hinterlands of large cities and old industrial regions.

Acknowledgements

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The unevenly absorbed and induced intra-regional Facebook adoption in Western Ukraine

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ABSTRACT

This paper aims to reveal and explain the spatial pattern of Facebook adoption in Western Ukraine. It discusses how to trace the fragmented nature of social networking services' (SNS) penetration at the intra-regional level using Facebook data analysis. This study has confirmed the expectation that in Western Ukraine Facebook adoption is predominantly an urban phenomenon, but with some peculiarities depending on the local context. The largest cities and regional centers attract the highest number of users, while peripheral and the economically least developed places have the lowest Facebook penetration rate. However, there are some areas with a higher number of Facebook adopters caused by a specific rural settlement system and the location in the Carpathians with no large cities 'pulling' the audience. The spatial pattern of Facebook adoption in Western Ukraine is an intricate and intertwined mosaic of 'SNS hubs' and peripheries, suggesting a 'digital differentiation' rather than a 'digital divide'.

1. Introduction

In recent years, the fast development of technologies has brought a range of new opportunities and at the same time disappointments to different people and communities. Connectivity and accessibility have grown significantly and one can travel longer distances faster than ever before. However, in many cases, travelling has become less necessary due to the virtual communication. Social networking services facilitated contacts between spatially remote and culturally distinctive areas. Use of social networking services such as Facebook, Twitter, Instagram, Telegram, TikTok, etc. has become commonplace in everyday life for different aims – communication, business, entertainment, obtaining information, etc. The integrating of social networking services and mobile phones with the Global Positioning System (GPS) allows users to facilitate the search for people and things in the real (physical) world, to localize the content they create. Social networking services contain spatial data on the location of users and their links with friends.

Moores (2012) emphasizes that some existing approaches have mistakenly associated SNS use with placelessness (Moores 2012). The ways in which people adopt and use Facebook reflect their cultural norms and practices (Hong and Na 2018). 'Absorbing' entire countries and regions, Facebook becomes a global cultural trait. But within individual regions, its adoption is uneven and caused by various factors. Moreover, in some countries Facebook 'meets' with considerable influence of the regional SNS. Thus, the population of Ukraine was at the 'frontline' of influence and intersection of global and post-Soviet (Russian-produced) SNS. But Russian aggression and further sanctions towards Russian SNS companies in Ukraine led to the prioritizing Facebook and inducing its penetration. That is, the global trend of 'absorption' of Ukraine's regions by Facebook was accelerated by the ban on Russian SNSs (VKontakte, Odnoklassniki) from May 2017 in accordance with the Presidential Decree "On the Implementation of Personal Special Economic and Other Restrictive Measures (Sanctions)" (President Ukraine 2017) widely known as the "Decree on the ban of Russian sites and social networks." Just before the Russian aggression, the number of Ukrainian Facebook users was only 3.2 million (Yandex 2014), and after it increased to 8.3 million (PlusOne 2019). Thus, to some extent, Facebook has become a symbol of pro-European and VKontakte of pro-Russian orientation. As a result, Facebook gained new users more easily and quickly in the least Russian-oriented Western Ukraine (StatCounter 2021). However, the rate of Facebook penetration into the region varies significantly at the level of administrative districts (rayons) and settlements.

In Ukraine, social networking services are studied mostly by sociologists with focuses on the impact on society, age effects (first of all children and adolescents), use of the SNS in political technologies, education and training. In some cases, the media publish reviews on various quantitative technical characteristics of the SNS performed by IT specialists. Such studies mostly do not consider the spatial aspects or cover them superficially.

In geographical studies, SNS rather are not considered properly. There are some geographical aspects in the surveys "Review of Social Networking Services and Twitter in Ukraine ..." (Yandex 2014), "Facebook and Instagram in Ukraine (September 2019)" (PlusOne 2019). Also, there are some investigations of the spatial features of SNS use under the armed conflict in Eastern Ukraine (Dobysh 2019), the distribution of social networking services in Ukraine (Puhach and Mytchuk 2017) and some regions (Puhach and Mytchuk 2018; Puhach and Maister 2020; Puhach at al. 2020). However, there are no detailed studies of the SNS adoption among the population at the intra-regional and local levels.

While the topic of Facebook geographies is not new, studies of place-based Facebook adoption in Ukraine, especially at the intra-regional level, are overlooked. This research is aimed at overcoming this shortcoming. Therefore, the paper aims to illuminate the spatial pattern of Facebook adoption in Western Ukraine. The main research questions are following. How to trace the fragmentation of Facebook penetration at the intra-regional level using Facebook data analysis? What are the main drivers of Facebook adoption in Western Ukraine?

2. Stepping to Facebook geography

In the last decades, human geography undergoes changes in terms of expanding the research field. Virtual geography, cyber geography, and Internet geography are on the rise, focusing on the locational dimensions in physical space, relying on the data at numerous geographical scales (cities, regions, countries), and reflecting the rate of adoption and use of the Internet, mobile phones, and other communications media and technologies (Kellerman 2016).

A number of researchers emphasize that social relations are better understood through the networks rather than totals (aggregates) (Castells 1996; Bingham 1999). According to Kellerman (2016), the geography of cyberspace consists of the geographical aspects of websites and communication platforms. Social networks including Facebook are relatively new phenomenon in the field of social relations, realized on the basis of the World Wide Web and mobile telephony. Social communications seemingly have covered the whole world, but with essential disparities and distinctive signs of socio-spatial injustice.

Geographers study the Internet and virtual spaces from the late 1990s, although these researches were sporadic and even now geographical researches on whether and how the Internet changing the ways in which social relations, social spaces and identities are produced remain quite small in number (Horton and Kraftl 2014). The most of them are based on two key concepts of cyberspace and network society. The first one was coined by the science fiction writer William Gibson in his novel "Neuromancer" (Gibson 1984), but was later widely used by scholars. The second concept was proposed by Castells to designate a new spatial form of society organization (Castells 1996). According to Warf (2013), this was one of the most productive interpretations of the Internet, which prevents technological determinism.

Cyberspace has ceased to be just a word, instead it has been viewed as a full-fledged subject of research, "which is everywhere" (Bingham 1999). Later, along with the cyberspace, the 'virtual space' concept also became widespread. Some researchers identify them as the same, others point to their differences. Subsequently, the "Internet space" also entered into circulation. Kellerman (2016) hierarchically arranges these terms. Virtual space as the widest entity includes various cyber and non-cyber spaces, and cyber space, in turn, include Internet space.

The "explosion of the Internet" stimulated the development of the geographies of cyberspace (Warf 2006a). Kitchin (1998) identified the set of the geographies of cyberspace subdivisions – economic, social, cultural, political geographies of cyberspace. Regarding the geographies of cyberspace, he emphasized that 1) cyberspatial communication challenges both the traditional ideas concerning mass communication and forms of communication; 2) cyberspace interaction blurs modernistic dualisms, such as virtuality with reality and technology with nature; 3) cyberspace transforms space-time relations and creates new social spaces that lack the formal qualities of geographic spaces (Kitchin 1998). The third statement is the most important for geographers.

The geography of the Internet (Internet geography, or cybergeography) is distinguished as a separate branch of the geography of communications (Tranos 2013). At the same time, Tranos distinguishes the social geography of the Internet, which is divided into political, cultural and economic geography of the Internet (Ibid.). Virtual geography in a broad view studies the spatial aspects of information and communication technologies, including the Internet and SNS in particular. It reflects a heterogeneous combination of material and symbolic relationships (Crampton 2006).

In this study, we propose to go further and talk about Facebook geography as a part of virtual geography. Facebook can be considered as not only an object of study but also a source (Rogers 2013). We can identify different dimensions of Facebook geography. On the one hand, it focuses on the study of (virtual) Facebook spaces, the formation of virtual social communities, their communication, and mutual perception. On the other hand, it gives the opportunity to look at the real (physical) spaces and places through the lens of Facebook adoption and penetration on different geographical scales (countries, regions, cities). Moreover, Facebook data allows us to study not only 'standard' demographics of users, but also gives a chance to scope the post-demographics in social networking platforms, while the interest has shifted from the traditional demographics of race, ethnicity, age, income, and educational level to tastes, interests, favorites, groups, accepted invitations, installed apps, and other information that comprises an online profile (Rogers 2013). A lot of previously unexplored information about social network users is now available for study. The geographical investigations of SNS push a new approach of 'spatial postdemographics'.

3. Place-based Facebook adoption and use

With the 'advent' of Internet (virtual) space, scholars discuss the "death of distance", "the decline of geography" and consider these spaces as 'spaceless' (in terms of the geographic nature of the space), 'placeless', decentralized, equally accessible, and so on. However, a number of researchers (Crampton 2006; Kitchin 1998; Tranos 2013; Warf 2013, etc.) have proven that Internet spaces have a "distinct geography" (Crampton 2006), and the Internet is characterized by spatiality (Tranos 2013). As Warf (2013) notes, the realities of adoption and using the Internet are in the fact that it is closely interconnected with the regional, national and local political systems, economy and culture, and Facebook geography is caused by the spatiality of the world socio-economic systems. Moreover, they can be both a result and a cause of uneven socio-economic development, 'digital divide' and 'digital inequality'. At the same time, studies of the Internet use tend to show that technology does not always radically change the way people communicate (Horton and Kraftl 2014).

Boellstorff (2016) emphasizes false opposition between the virtual (digital, online) and real. And a new era in the Internet research no longer concerns itself with the divide between the real and the virtual (Rogers 2013). Moores (2017) asserts that we do not live in a placeless culture or in anything close to it, and physical settings are now augmented by a digital network of information that is organized according to the user's location. Facebook is not a separate specific (virtual) world, but has already been embedded deeply in daily lives of the users (Hong and Na 2018).

The current stage of the Internet development with the advent of IP-to-geo technology some scholars consider as the "revenge of geography" on cyberspace, and even more dramatic formulation of the "death of cyberspace", "the end of the virtual" (Rogers 2013; Miller and Slater 2000). Facebook now routinely knows a user's geographical location, and acts upon the knowledge, increasingly became less placeless, if it ever was (Rogers 2013). Facebook is actively involved in place-making practice by creating a "density of meaning" for places in both the virtual and real worlds (Moores 2012, 2017). Different companies and institutions create accounts in Facebook to promote their goods, services, and activities primarily in the certain spatial unit of the real (physical) world. The same way, individuals through their personal accounts represent themselves. Jordaan and Heerden (2017) findings highlight the fact that Facebook is a part of users' lives and daily routine, and it contributes to their identity construction, entertainment, and relationship value.

Kitchin (1998) suggests that geography remains the first in the study of cyberspace because cyberspace does not create an alternative world, but exists in a symbiotic relationship with physical space. "Cyberspaces are dependent upon spatial fixity, they are embodied spaces and access is unevenly distributed" (Kitchin 1998: 403). Internet spaces are produced in the socio-political conditions of physical spaces, but, in turn, they simultaneously impact on material geographies (Crampton 2006). In the age when more and more aspects of everyday life are connected with electronic infrastructure, theoretical views have gone beyond the simplified dichotomy of 'online' and 'offline', physical and virtual are increasingly influencing each other (Warf 2006b). For instance, Tóth et al. (2021) demonstrate that urban topology (significant distances, physical barriers, or spatially concentrated amenities) is related to social network fragmentation and latter in turn compounds income inequality over time.

Spread of the SNS is a driver of the both increasing opportunities and spatial inequalities. In some countries it contributes to expanding opportunities for more vulnerable (marginalized) social groups and economic growth, while in others it strengthens existing "hierarchies of the wealth and power", causing significant "information asymmetries" (Warf 2013). New technology produces inequalities while not everybody can afford new technological devices (Paasi 2003).

The idea of 'digital divide' suggests that a high level of Internet access is more typical for higher-income societies, and vice versa, a low level is a feature of the lower-income societies. Economic development prompts access to the network, and access to the network propels economic development (Adams 2006). Although the 'digital divide' remains, it is gradually changing between and within countries, manifesting at different spatial scales (Warf 2013, 2017). Moreover, the 'digital divide' in different countries differs markedly in the degree of manifestation, causes and results (Warf 2013: 40). The concepts of accessibility and use of the Internet are rather ambiguous, in particular in terms of access (e.g., the Internet access at home, school, cafe or work). Therefore, instead of a simple dichotomy of accessibility/inaccessibility, Warf (2017) suggests to think of a "gradation of levels of access" (Warf 2017).

Facebook adoption and use is essentially dependent on local context. A number of studies were aimed to find the main drivers of the spatial distribution of Internet networks. Thus, Warf (2013) concludes that the "uneven spatiality" of the Internet is caused by many factors – differences in income, literacy, demographic structure (especially age structure), gender relations, telecommunications policy, and government censorship. This unevenness creates the geography of cyberspace, which is multi-scale in nature (Warf 2013). Tranos (2013) emphasizes on macroeconomic conditions (especially market size), urbanization and 'world city-ness', location (coastal and border regions) as the significant factors which affect the uneven distribution of Internet infrastructure in Europe.

Wide literature is devoted to the study of spatial distribution and spatial patterns of the SNS users location and interaction (Ter Wal and Boschma 2009; Glückler and Doreian 2016; Menezes and Roth 2017; Borge-Holthoefer et al. 2011; Sui and Goodchild 2011; Andris 2016), and the role of distance in the SNS spread and network users social connections (Bailey et al. 2018; Lengyel et al. 2015; Laniado et al. 2017). Takhteyev et al. (2012) shows the impact of distance, national borders, language and frequency of air travel on the formation of social ties in Twitter. Moreover, administrative boundaries continue to exist in the virtual world of social networking service. Social connectedness recreates the contours of the administrative-territorial division, and virtual connections are mostly a duplication of communications in the real (physical) world (Bailey et al. 2018).

4. Data and methodology

The geography of the virtual spaces is 'a vague concept', thus lacking clear and systematic methodologies for its analysis and interpretation (Kellerman 2016). The SNS can be analyzed in terms of their spatial extent, degree of connectivity, directorial bias, and regional concentration (Pitzl 2004). Moreover, individual SNS such as Facebook can be a powerful research tool to investigate how the ways in which people perceive and use it reflect their cultural norms and practices (Hong and Na 2018), and to understand its penetration at different spatial scales.

An empirical research of the SNS is challenged by the unavailability of extensive and representative data on the users of different social networking services by certain age, social groups or territorial units. Some recent spatial studies addressed the social networking services as Facebook, LinkedIn, Twitter or Instagram are based on anonymous data from the SNS. Usually these data obtained through collaboration with teams that include, for instance, Facebook employees. However, there is a certain limit to the number of researchers who will be able to work with the data from social media through such collaboration. Such circumstances determine demand for a new approach to study social networking services that will allow collecting data by anyone independently from the social media managements decisions.

There are some difficulties with the collection of primary data regarding SNS users. First, user accounts are personal information that company is not entitled to disclose without the owner consent. Remember the recent Facebook-related scandals on the use of personal data in the political technologies during the US presidential election and Brexit (BBC 2018; Sanders and Patterson 2019; Wong and Morris 2018). Second, SNSs are transformed into large-scale corporate-controlled financial and business projects with revenues related to the size of the network. Since, services often overestimate the number of their own users. Third, the same user can have multiple accounts, some of them of little or none use for some reason. Fourth, many bots, i.e. special programs that carry out certain actions through an interface designed for users, are hidden under some SNS accounts. Based on the above, we can talk only about the estimated number of SNS users.

Our research methodology is not something completely new. There are many works on social media marketing (SMM) and applied methods of their use (e.g. AdEspresso 2020). It based on the open data estimated by Facebook and presented under the category "People who live in this location", where location is set by the location on Facebook users' profiles and confirmed by their IP address. In doing so, we focused on assessing the extent of Facebook adoption, but without analyzing the connectivity of individual users and locations, because the data used do not have a network structure.

To assess the number of Facebook users, we have used the targeting tool, an advertising mechanism that allows picking out from the total Internet audience only the portion of visitors or target audience that fits certain criteria (Facebook 2020). The main criterion is the territorial coverage (AdEspresso 2020). To do this, we followed "Advertising – Create an Ad – Reach – Set Up Ad Account" at the Facebook page. In the Placements section "Edit Placements" was selected. Only "Facebook" was chosen among "Platforms." In the Audience section, we set the parameters "People who live in this location", "Age" from 13 to 65+, and "Gender" – "All". In the map window ("Locations"), the territorial units were allocated by their names. For districts (rayons) we used the search by postal codes (Postal codes of Ukraine 2020). In cases when service provides unreliable data (e.g., the number of users less than 1000), the "Drop Pin" tool was used – the district area was 'covered' with circles of different radius.

The data were collected for all local territorial units (rayons) of seven Western Ukrainian regions – Volyn, Zakarpattia, Ivano-Frankivsk, Lviv, Rivne, Ternopil, Chernivtsi. These Ukraine's regions later than others became a part of the USSR, characterised by some common culture traits, vigorous pro-European sentiments, and closer links with the EU countries.

Data on the number of SNS users in Western Ukraine was collected in the late January 2020. In addition to the total number of users, we suggest to use *Facebook penetration rate* ($Psns_i$, in %):

$$Psns_i = (N_i / P_i) \times 100\%, \qquad (1)$$

where N_i – the number of Facebook users in district i (thousand people); P_i – total population of the district i (thousand people). The data on population size (as of October 1, 2019) was collected from the official web-sites of the regional departments of the State Statistics Service of Ukraine (2020).

5. Facebook adoption in Western Ukraine: large cities matter

Facebook is one of the largest segments of the Internet with total number of users exceeding 2.7 billion people (Zephoria 2020) and the most popular social networking services in Ukraine (Research & Branding Group 2020). Its average monthly audience in Ukraine is 14.0 million users (Facebook 2020), i.e. it covers one third (33.4%) of the country's population (as of early 2020). There are 3.45 mln Facebook users in Western Ukraine, or 37.3% of the region's population, and 24.7% of all Ukrainian network users. The share of Western Ukraine in the country's population is 22.1%, that is, Facebook penetration rate in the region is higher than average in Ukraine. This is in line with our previous researches which found an increasing Facebook penetration rate in Ukraine from east to west.

The number of users is relatively proportional to the population size at the district level (districts and cities of regional subordination), as evidenced by statistically significant Spearman's r = 0.43 with the p-value less than 0.05 (while Pearson's r = 0.94, p < 0.01). At the regional level, the largest number of users is in Lviv (1.0 mln), Ivano-Frankivsk (0.5 mln), Zakarpattia (0.49 mln) regions, and the least is in Chernivtsi region (0.3 mln) (Table 1).

Tab. 1 Western Ukraine: Population, urbanization, Facebook users and penetration (2020).

	Regions							Western Ukraine
	Volyn	Zakarpattia	Ivano-Frankivsk	Lviv	Rivne	Ternopil	Chernivtsi	
Population								
size (1,000 people)	1032.2	1254.3	1368.8	2513.8	1153.7	1039.7	901.9	9264.4
share in Ukraine (%)	2.5	3.0	3.3	6.0	2.8	2.5	2.2	22.1
Urbanization (%)	52.2	37.1	44.2	61.0	47.5	45.3	43.2	49.1
Facebook users								
number (1,000 people)	363.9	488.0	517.4	1038.8	376.8	374.7	294.0	345.3
share in Ukraine (%)	2.6	3.5	3.7	7.4	2.7	2.7	2.1	24.7
share of regional center in the region's audience (%)	49.5	20.5	38.7	62.6	58.4	50.7	81.6	18.8
share of cities of regional subordination in the region's audience (%)	75.6	40.8	59.5	81.7	71.4	65.4	84.3	69.4
Penetration rate (%)								
region	35.3	38.9	37.8	41.3	32.7	36.0	32.6	37.3
regional center	82.9	86.9	76.1	86.0	89.4	85.2	90.0	85.2
second city	76.1	80.4	59.0	55.2	35.5	101.2	74.2	90.0
third city	35.9	50.6	66.9	48.9	72.0	57.6	-	76.1
fourth city	59.9	58.5	66.9	65.3	45.9	73.8	-	89.4
cities of regional subordination	63.7	65.7	57.7	57.8	60.7	79.4	82.1	64.0
districts	13.5	25.9	23.8	14.9	12.3	18.6	7.1	16.7

Source: Authors' calculations using data (Facebook 2020; State Statistical Services of Ukraine 2020).

One can see a distinct trend towards the concentration of most accounts registration in the largest cities. Thus, the main regional and sub-regional centers (cities with the status of regional subordination) in Western Ukraine cover 69.4% of the users. Among regions, this indicator varies from 40.8% in Zakarpattia region to 84.3% in Chernivtsi region (Table 1). The most of accounts are registered in the regional centers Lviv (0.65 mln), Chernivtsi, Rivne, Ivano-Frankivsk (more than 0.2 mln), and Ternopil, Lutsk, Uzhhorod (more than 0.1 mln) (Figure 1). The largest city of Lviv covers 18.8% of Facebook audience in Western Ukraine. Regional centers cover from 20.5% (Zakarpattia region) to 81.6% (Chernivtsi region) users of the respective regions. This is to some extent related with the settlement pattern and concentration of socio-economic activity. So, social networking services are mainly an urban phenomenon, which is gradually spreading its influence on the suburbia and further to rural areas. This is in line with Warf (2017) conclusion on the significant predominance of the Internet development in large cities.

In terms of audience size, other cities are far behind the regional centers. Yet among them there are also some 'sub-leaders' as Mukachevo, Drohobych, Kovel, Kolomyia (more than 40 thsd. of users). These are powerful socio-economic centers of a subregional level, the 'focuses of life' for neighboring districts.

The number of Facebook users by districts varies significantly, and in general it is proportional to the population number. However, there is essentially lower number of accounts in the districts adjacent to the cities of regional subordination. This is especially evident for Lviv, the largest city in Western Ukraine, and to a lesser extent for Chernivtsi and Ternopil (Figure 1). One of explanation is that the data on Facebook users in large cities includes suburban ones. It is especially notable in the case of Lviv and Chernivtsi, where neighboring rural settlements are served by the city's Internet providers. Also, suburban users who are working in the main cities get access to the Internet via corporate networks, or wi-fi in trade and entertainment centers, and other public networks. That is, Facebook algorithms fix this set of mobility as the same settlement. This explains somewhat inflated number of users in the large cities and the smaller number in suburban districts.

Against the background of distinct leading centres, one can see some areas with higher number of Facebook users (with audience over 20 thsd.) in Zakarpattia (Tyachiv, Vynohradiv, Irshava, Rakhiv, Khust districts), Ivano-Frankivsk (Nadvirna, Kosiv, Rozhniativ,
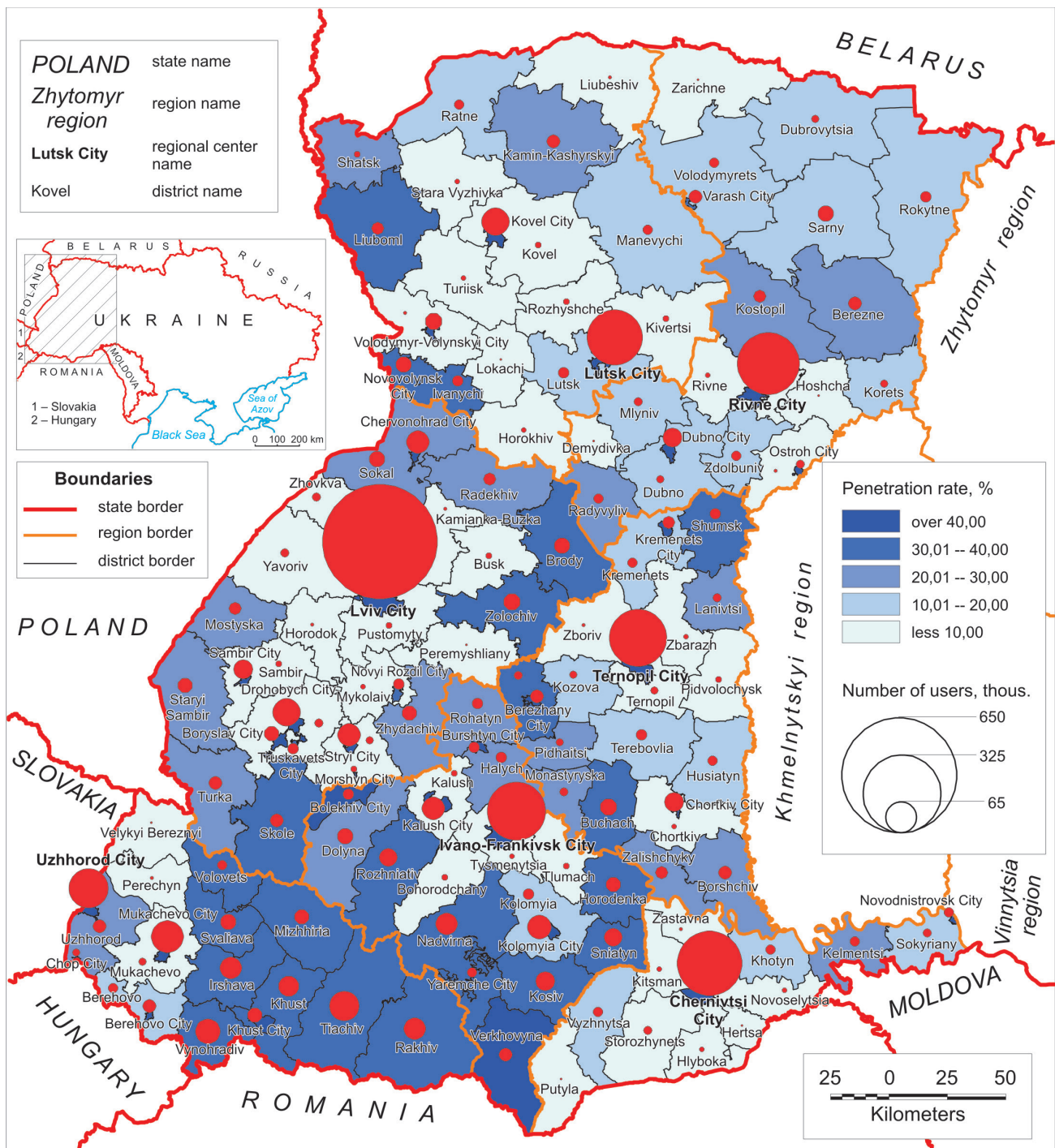
Fig. 1 Facebook adoption in Western Ukraine.

Sniatyn districts), Lviv (Zolochiv district), and Ternopil (Buchach district) regions. It caused by the specific rural settlements system, "pulling effect" of the large cities, and location in the Carpathians, as well.

On the contrary, the districts with the largest population size in Western Ukraine adjacent to the main socio-economic centres have a far smaller audience (Yavoriv, Pustomyty, Zhovkva districts in Lviv region, Mukachevo district in Zakarpattia region, Kalush, Kolomyia districts in Ivano-Frankivsk region, Sarny, Rivne districts in Rivne region, and Storozhynets

district in Chernivtsi region) (Figure 1). These districts have a polarized structure comprising areas with growing population in the settlements immediately adjacent to the main centres and identified by Facebook tools as a part of the city, and distinct shrinking areas.

The districts with the lowest number of Facebook adopters (with less than two thousand users) can be divided into two groups: 1) districts adjacent to the cities of regional subordination, and 2) areas with a low population number and peripheral

disadvantageous location. The backward 'Facebook periphery' consists of a set of rural settlements with no wired Internet, and with the signal of mobile networks which does not allow convenient use of social networks. Urbanization rate in Western Ukraine is relatively low (49.1%). In many rural settlements, especially in the peripheral parts of the regions, there is no wired Internet, and the signal of mobile networks does not allow convenient use of social networks. That is, the hierarchical character of Facebook adoption is observed.

6. Uneven Facebook penetration: drivers of the intra-regional fragmentation

The number of Facebook users is an important indicator to understand spatial variation in SNS adoption among population. However, the penetration rate was used to trace the intra-regional peculiarities and to explain the complicated spatial mosaic of Facebook adopters absorbed by social networking global trend and induced by geopolitical conflict.

In Western Ukraine, the total Facebook penetration rate is of 37.3%, which is slightly higher than the average in Ukraine (33.4%). This is expected, given the more pro-European orientation of the region's population with a much weaker nostalgia for the Soviet past and an attachment to post-Soviet social networking. After the ban on Russian SNS in 2017 (President of Ukraine 2017), the population of Western Ukraine quickly switched to the global SNSs, first of all Facebook.

Facebook penetration in Ukraine is characterized by two features. First, the penetration rate is increasing from the east to the west. Second, the higher level of socio-economic development, the higher penetration rate (Puhach and Mytchuk 2017). The same pattern can be traced in the case of Western Ukraine at the regional level. The lowest penetration rate of SNS was recorded in the eastern part (in Chernivtsi and Rivne regions with 32.6% and 32.7% respectively), and the highest one in the western part (in Lviv and Zakarpattia regions with 41.3% and 38.9% respectively). At the same time, the most developed Lviv region has the highest level of Facebook penetration. The relatively high penetration rate (37.8%) is observed in next developed (Ivano-Frankivsk) region (Table 1). The high Facebook penetration rate in Zakarpattia region can be additionally explained by intensive communications with neighboring states (Hungary, Slovakia and Romania), first of all because of the family ties and labour migration. Cross-border communication via social networking services is free and therefore an alternative to mobile phone communication.

Facebook penetration rate at first sight is weakly associated with population size. That is, the large population number is a prerequisite but not the main driver of the social networks penetration. The more essential are socio-economic factors and settlement pattern. However, the demographics impact should not be completely ignored. To a large extent, impact of infrastructural underpinnings, in particular broadband Internet and mobile penetration in the region is associated with settlement pattern and economic development with higher access in cities and more developed districts (Dubov and Ozhevan 2013; Kvitka and Mazur 2019).

Facebook penetration in Western Ukraine at the intra-regional level is more fragmented. The main areas with the highest penetration rate are the large cities, but also some districts and towns. The penetration rate in the regional centres is on average 85.2% with the highest values in Chernivtsi (90.0%) and Rivne (89.4%) (Table 1). This can be explained by the settlement system morphology and the presence (or absence) of other centers in the region. Thus, in Chernivtsi region there are no other significant economic centers except Chernivtsi. Vice versa, the relatively lower penetration rate in Ivano-Frankivsk is due to sub-regional centers of Kalush and Kolomyia.

Moreover, the highest penetration rate of Facebook in Western Ukraine is not in the regional center, but in the town of Chortkiv, where Facebook audience is more than population number (101.2%). This is likely due to the fact that Chortkiv includes Facebook users of the surrounding villages, as well as the urban village of Zavodske.

Among other cities, a rival of the regional centre Mukachevo, a relatively fast growing second-order city Sambir and a national-wide transport hub Kovel are characterized by the highest level of Facebook penetration (more than 75%) and higher socio-economic activity as well.

The lowest Facebook penetration rate (less than 36%) is recorded in the mining centers Novovolynsk and Novyi Rozdil, a nuclear power station site Varash, and tourist centres Yaremche and Truskavets. It can be explained by their weak connections with the surrounding rural area and some disadvantages caused by their non-administrative centres status.

The penetration rate of the second most populated cities in Western Ukraine regions is averages 68.8% and varies from 35.5% (Varash in Rivne region) to 101.2% (Chortkiv in Ternopil region). The penetration rate of the third most populated city is on average 55.3% and ranges from 35.9% (Novovolynsk in Volyn region) to 72.0% (Dubno in Rivne region). And Facebook penetration rate of the fourth most populated city is on average 61.7% and varies from 45.9% (Ostroh in Rivne region) to 73.8% (Berezhany in Ternopil region) (Table 1).

Thus, the size of the city is not the main driver of Facebook penetration. Interestingly, the fourth cities in Western Ukraine regions have a higher penetration

rate than the third ones. This indicates transformation processes in the economy and the settlement pattern.

The ranking of second-order administrative-territorial units (districts and cities of regional subordination) by Facebook penetration rate shows that the cities of regional subordination are located at the top of the rating. They have 1–28, 30, 35, 37–39, 41 rank positions. Even the lowest in the ranking Truskavets (34.9%, 41st position) is much higher than the median value (there are 141 administrative-territorial units of the second rank in Western Ukraine).

The penetration rate of the social networking service in (mostly rural) districts is much lower than in cities, averaging only 16.7% (Table 1). The highest level is in Zakarpattia (25.9%) and Ivano-Frankivsk (23.8%) regions with dense networks of rural settlements. The majority of districts with higher penetration rate (over 30%) are located in the same regions. The cities of Chernivtsi and Rivne have a strong dominance in their regions, so there is no district with a high penetration rate here.

Interestingly, all districts with a relatively high penetration rate are located in the peripheral parts of the regions, at a distance from and with weaker connections with the regional centres, i.e. they are not in the 'shadow' of the regional centers. Since the targeting advertising mechanism was used to determine the number of users by territorial criteria, these districts have, although not a large, but their own 'SNS market'. The lowest Facebook penetration rate (5% and below) can be found mostly in Chernivtsi, Lviv and Rivne regions' districts with a high concentration of users in the regional centers (Figure 1). They can be divided into two groups: 1) districts adjacent to the cities of regional subordination (which users are identified by Facebook as the centres' dwellers), and 2) agricultural, rural districts with a peripheral disadvantageous location and low level of socio-economic development.

The social networking services penetration rate in rural areas is significantly far behind urban settlements. However, in recent years the penetration of the Internet, and 3G and 4G mobile technologies into rural areas is growing (at least in large and medium-sized rural settlements). This could change the spatial pattern of Facebook adoption and penetration in the nearest future.

7. Limitations

Findings from this study need to be interpreted with some caution due to biases in Facebook data and specifics of settlement pattern and administrative division in Western Ukraine.

Facebook targeting tool picking out from the total Internet audience only target audience that fits location criteria causes some discrepancy that makes the data on users not directly linkable to population data.

This leads to (artificial) underrepresentation of Facebook penetration rates in sub-urban districts while overrepresentation penetration in central cities. To some extent, this limits intra-regional level analysis and could not be seen as a genuine factor driving Facebook penetration.

The low number of users in the districts adjacent to the cities of regional subordination is explained by the peculiarities of the settlement system in Western Ukraine. Ukraine had an outdated (inherited from the USSR) scheme of administrative-territorial division. City limits have not been revised (changed) for about 40 years. Nowadays, cities have sprawled beyond their official boundaries, and the rural settlements adjacent to the city have turned into mostly residential areas ('dormitories') with small businesses and service and leisure facilities. These districts often do not have their own administrative centres. For example, all institutions and departments of Lutsk district state administration are located in the city of Lutsk. In such areas there are no large cities and sharply predominant rural population. Socio-economic life in these districts is highly polarized. They include the developed part, which is directly adjacent to the city (or to the main highways), and the declining periphery. That is, we assume that large cities are actually much larger than administratively defined, and Facebook's algorithms interpret suburban residents as city's users.

Also, data used in this research do not have a network structure which is an additional limitation with respect to their use for other social network analysis.

8. Conclusions

This paper is aimed to better understand a spatial pattern of Facebook adoption among Western Ukraine population and trace which places are becoming 'SNS hubs' and which ones remain impenetrable to social networks.

In order to assess social networking services adoption at the intra-regional level we suggest to use Facebook targeting tool and calculate the penetration rate.

Western Ukraine is a macro-region bordering the EU and supposedly more prone for global SNS penetration and 'escape' from Russia-produced and controlled SNS. Thus, Facebook is deeply embedding in region users' daily lives and contribute to their identity construction (Jordaan and Heerden 2017).

This study confirms our expectation that Facebook adoption is predominantly urban phenomenon in Western Ukraine which indicated by both users concentration and network penetration. The largest cities, regional centers expectedly attract the highest number and cover for about half of Facebook users. The main regional center Lviv is also the main center in terms of SNS users' concentration with almost one fifth of all Facebook users in Western Ukraine. High concentration of users near the state borders is poorly

traced. This is not in line with Tranos (2013) findings concerning positive effect of border regions. Instead, there are some areas with higher number of Facebook adopters caused by specific rural settlements system and location in the Carpathians with no large cities 'pulling' the audience.

Facebook penetration in Western Ukraine is more complicated and fragmented. In the most of cities it is much higher than in rural districts, but all districts with a relatively high penetration rate are located in the peripheral parts of the regions, at a distance from and with weaker connections with the region-al centres. Districts neighbouring regional centrres and cities of regional subordination have a far small-er number of users and a low Facebook penetration rate. Although it should be noted that this is related to specifics of users location identifying procedure, when despite the formal administrative boundaries users from the nearest to regional centres settlements (which in fact are the part of the cities) are considered as cities' users, and the rest of the suburban districts accordingly have low adoption and penetration rate. We suggest that the places with the lowest Facebook penetration rate are periphery in both virtual (in terms of Facebook adoption) and physical (in terms of economic development) spaces.

To summing up, what does the case of Western Ukraine show? Facebook adoption is a result of simul-taneous tendencies of places 'absorbing' by global SNS and people's geopolitically caused inducing to reject post-Soviet social networks. However, at the intra-regional level we revealed some specifics, such as a distinct east-west gradient and a number of urban centers of Facebook users concentration. Along with the regional centers, there are some relatively distant areas with a higher level of penetration. The spatial pattern of Facebook adoption in Western Ukraine is an intricate and intertwined mosaic of 'SNS hubs' and periphery, yet 'digital differentiation' rather than 'dig-ital divide' (Warf 2017).

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Gender differentials in poverty among migrants in rural border communities of Oyo state, Nigeria

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ABSTRACT

The study examined relative poverty among migrant men and women in rural border communities of the Oyo State. Three rural border settlements were randomly selected in Atisbo and Saki-west Local Government Areas (LGAs) of Oyo State. Two hundred and four (204) questionnaires were administered to the father and mother in 102 migrant households and 198 questionnaires were retrieved for analysis. Using Principal Component Analysis (PCA), the study revealed that women have a higher poverty level than men. Also, the Principal Component Analysis revealed that the high loadings of factors on component one (Dwelling Conditions), for both men and women, imply inadequate living conditions. This indicates the need for improved dwelling conditions for the migrants and also the need to focus on gender-based poverty interventions especially among females, as they are more affected by poverty.

1. Introduction

Poverty has been described from different dimensions, for example, World Bank (1990) viewed poverty as the inability to attain a minimum standard of living. Sen (1999) described poverty as the failure to achieve basic capabilities such as being adequately nourished, living a healthy life, possessing skills for economic and social life participation, and allowance to take part in community activities. It is also described as lack of access to health, school, employment, and clean water (DFID 2005 and Chambers 2006). Poverty is also seen as a mindset, a perception of what rural poor have of themselves, the local community, the society, and the country as a whole (IFAD 2007).

Gender is an integral and very important part of any poverty study. IFAD (2007) described gender and rural poverty as a process within which human beings develop and exhibit social and behavioral patterns that shape their actions and relationships within and outside their homes and communities. In studying poverty, it is necessary to integrate gender dimension into it. In other words, it is very important to study poverty in line with gender and gender relations. Gender is defined as different social roles men and women play and the power relations between them (Lyimo-Macha and Mdoe 2002) while gender relations are the opportunities, constraints, and impacts of change as they affect men and women. It is also a determinant of how communities, households, and institutions are organized, how decisions are made, and how resources are used. This means the application of traditional gender relations to poverty implies differentiation in poverty between men and women.

Poverty is very severe in rural areas (IFAD 2007). One of the reasons for this is linked to non-existent or limited social services and infrastructure in the areas. Rural border areas are like many other rural communities in Nigeria. Popoola and Speak (2018) explained that most rural border communities of Nigeria are neglected with limited access to amenities and facilities. They are therefore underdeveloped as other rural communities in Nigeria. However, despite the poor condition of the border communities, many migrants (especially those from the neighbouring countries) are still resident in the border communities. In rural communities, most migrants are faced with lots of challenges such as difficulties in getting good jobs, poorer living conditions, discrimination, and limited access to better opportunities (FAO 2019). International Organization for Migration (IOM) 2019 asserted that migrants often lack effective protection from harm and are also characterized with fewer rights such as the right to work, housing, and health among others. United Nations (2013) emphasized the protection of migrants' rights in destination countries. The policy states that "all migrants and their families irrespective of their migratory status have series of rights in their destination countries." Adequate standard of living is one of the migrants' rights and must be put into consideration during border studies.

Although previous studies have offered substantial insight on poverty issues (Gweshengwe and Hassan 2020; Chen and Pan 2019; Koehler 2017; Ogbonna et al. 2012; Chambers 2007), yet there has been little concerted effort to incorporate gender into poverty studies. Also, understanding gender is core in the poverty context because poverty studies have traditionally emphasized the power relation between men and women as well as the differences in social roles that men and women play. In addition, studies from Asia countries have argued that the experiences of migrant men and women vary and most of the variations are due to the role, behaviour, and relationships that the society assigns to and expects from a man and a woman (Strachan at al. 2015; Yichao and Di 2017; Hao et al. 2021). Nonetheless, this might be different in Sub-Saharan African countries due to cultural and political differences. Besides, there is a dearth of information on poverty studies using gender framework in rural border communities of Nigeria.

From the foregoing, it is very important to examine poverty variation of migrants in rural border communities. However, this might be more explained by gender. This study aims to investigate poverty among migrants in rural border communities of Oyo State, Nigeria. This was with the purpose of highlighting the implications of such variations between the genders in the study area. In achieving the aim, the research provides answers to the following questions: 1) What is the poverty level of men and women in the study area? 2) Is there any significant difference in poverty level among men and women? 3) Is there any variation in the poverty level of men and women across the settlements in the study area.

2. Literature Review

Many studies have been done on Border communities (Jawando et al. 2012; Awumbila 2015; Popoola et al. 2017; Nkoroi 2015; Apata et al. 2010, Anyebe 2017). However, studies on gender and poverty in rural border communities of developing countries like Nigeria are scanty in literature. For instance, Jawando et al. (2012) examined survival strategies of women in informal cross-border trading along Lagos-seme Border Axis. The study revealed that women faced a lot of challenges in trying to transport their goods from customs officials and other security agents. Despite these difficulties, they still engage in this informal trade along this border.

Also, Popoola et al. (2017) investigated gender analysis of cross-border migration in rural border communities of Ipokia Local government area, Ogun State, Nigeria. The study shows that good access to land, commerce, and better income reasons were the major considerations for choosing destination area by

male migrants while good access to land, marriage, to join family members and better income were the considerations for choosing destination area by female migrants in Nigeria. The study concluded that despite the increase in cross-border migration in the study area, patterns and reasons for cross-border migration vary between men and women.

Also, other studies (Makinwa-Adebusoye 1994; Fapohunda 2012; Ogbonna et al. 2012; Adeyonu and Oni 2014) that addressed the issue of gender and poverty did not focus on rural border region especially rural border region of Nigeria. Makinwa-Adebusoye (1994) assessed women migrants in Nigeria. The study discovered that women, as well as men, do migrate for the same reasons – mainly to seek remunerative employment in order to meet personal as well as socially ascribed financial obligations to children and relatives. Other reasons that were added by the study include the need to further education or for learning a trade as an apprentice. The study concluded that the importance of migration to family survival at the place of origin facilitates the migratory process and adjustment to the new destination. Usman (2015) examined women and poverty in Nigeria. The study argued that, although women contribute greatly to societal growth and development, they have continued to suffer unjustly in the precarious condition of poverty due to their underprivileged class position in society. The study concluded that unless some drastic steps were urgently taken to eradicate poverty in the country, its perpetuity may have future catastrophic consequences. Anyebe (2017) examined gender differential and poverty amongst women in Nigeria. The study revealed that only a very tiny proportion of women do get into commanding heights of national life for which higher education is a prerequisite. The study recommended that education for women and girls at all levels should aim at reversing the trend of gender discrimination by ensuring full empowerment of women in the true sense of raising their status. Although the above literature provided some sound footings to this study on gender and migration in border communities, issues of gender and poverty have not been properly documented.

Also, studies on poverty Alaye-Ogan (2008), Ayoade and Adeola (2012), Fadare and Gasu (2011) and Ogbonna et al. (2012) have little or no gender perspectives to them. For instance, Alaye-Ogan (2008) assessed rural poverty among women in Nigeria, using Abuja Satellite Communities as a case study. The findings of the research revealed that rural women in Nigeria were more prone to poverty. The study also showed that poverty is multidimensional in nature and recommended that any effective strategy to tackle it must be multi-dimensional to be effective. This study however only focussed on women, Thus making it inadequate for better comparison between men and women. Similarly, the study of poverty in the hinterlands of Ede, Nigeria by Fadare and Gasu (2011) was based on the assessment of household poverty status and the important indicators that explained the variation in the poverty status. The study revealed that the combinations of the various factors (Agric-business, Environmental impact, Health factors, and Environmental Awareness) constituted the indicators that gave the most appropriate explanations underlying the variation of relative poverty among the households in the region. This study did not assess the poverty status and indicators by gender. Ayoade and Adeola (2012) examined the effects of poverty on rural households in Orire Local Government Area of Oyo State, Nigeria. The findings of the study revealed that the major effects of poverty on rural households were the low standard of living and low-income level. Ogbonna et al. (2012) examined the factors influencing households' exit from poverty as a guide for policy intervention in the increase in yam production among yam-producing household heads. The paper discovered that the determinants of poverty were level of education, membership of farmer's group, yam production experience, and participation in the agricultural workshop. These factors significantly decreased poverty but the household dependency ratio was discovered to increase poverty. However, their evaluations were not done along gender lines. Studies on poverty must therefore see households and communities as gendered units in which women and men have different sets of interests.

3. The study area

The study areas are situated in Oyo State South-Western Nigeria. Oyo State was created in February 1976 by the Federal Military Government of Nigeria. The State covers an area of approximately 35,743 square kilometers. It is located between latitudes 7°22′ and 7°40′ North of the Equator and longitudes 3°53′ and 4°10′ East of the Greenwich. It is bounded in the south by Ogun State, in the north by Kwara State, in the west it is partly bounded by Ogun State and partly by the Republic of Benin, while in the East by Osun State (Figure 1). Oyo State has thirty-three (33) local government areas out of which Saki-west and Atisbo local government areas selected for this study are located. Atisbo and Saki – west LGAs were selected for this study because they share boundary with other countries (Figure 2).

Rural border communities selected for this study are located in Atisbo and Saki West Local government areas. The rural border communities are typical rural settings with the majority of the settlements having less than 20,000 populations, and the economic activity predominantly agrarian. The major occupation of the people in the communities is arable farming. Other livelihood activities in the areas are trading, smuggling activities. One of the peculiarities of the border area is the culturally heterogeneous nature

of the area. Therefore, for the purpose of this study, migrants selected in the rural border areas of Oyo State were used to investigate and show the gender variations in poverty in selected rural border communities of Oyo state. The location of Oyo State in the context of Nigeria is shown in Figure 1.

4. Methodology

Extensive reconnaissance survey of two borders Local Government Area (LGA) that made-up the only border LGA in Oyo State was carried out. This provided a direct opportunity to identify major settlements with higher proportion of migrants. The primary data used in this research were sourced through field survey that was conducted with questionnaire administration, interview, and field observation. One set of questionnaires was used to obtain relevant data from a father and mother in each household. The questionnaire contains questions that were used for collecting only the information required for the computation of the global multidimensional poverty index (Alkire et al. 2020).

The research made use of primary data. The primary data were obtained through questionnaire administered in the selected rural border communities of Oyo State, South-Western Nigeria (SWN) using a multistage sampling technique. In the first stage, two local government areas were purposively selected in the state based on their closeness to the border (Saki west and Atisbo in Oyo State) as shown in Figure 2. The second stage involved the random selection of three rural border settlements in each of the selected local government areas. In the third stage, migrant households were selected through snowball sampling approach (Naderifar et al. 2017). This approach was used to ensure that only migrants were selected for this research. The procedure involved the selection of the first migrant. The selected migrant later referred the researcher to another migrant who is not from the community. This procedure continues until the researcher had administered questionnaire on all the contacts. At the end of the questionnaire administration, a total of one hundred and two (102) migrant households were surveyed and two hundred and three (203) questionnaires were administered to father and mother in each selected household. Where the two (father and mother) were not available, either of the two was also sufficient for the study. One hundred and ninety-eight (198) questionnaires were retrieved for the analysis. Data collected through questionnaires were focused on the living condition of a father and mother in each household.

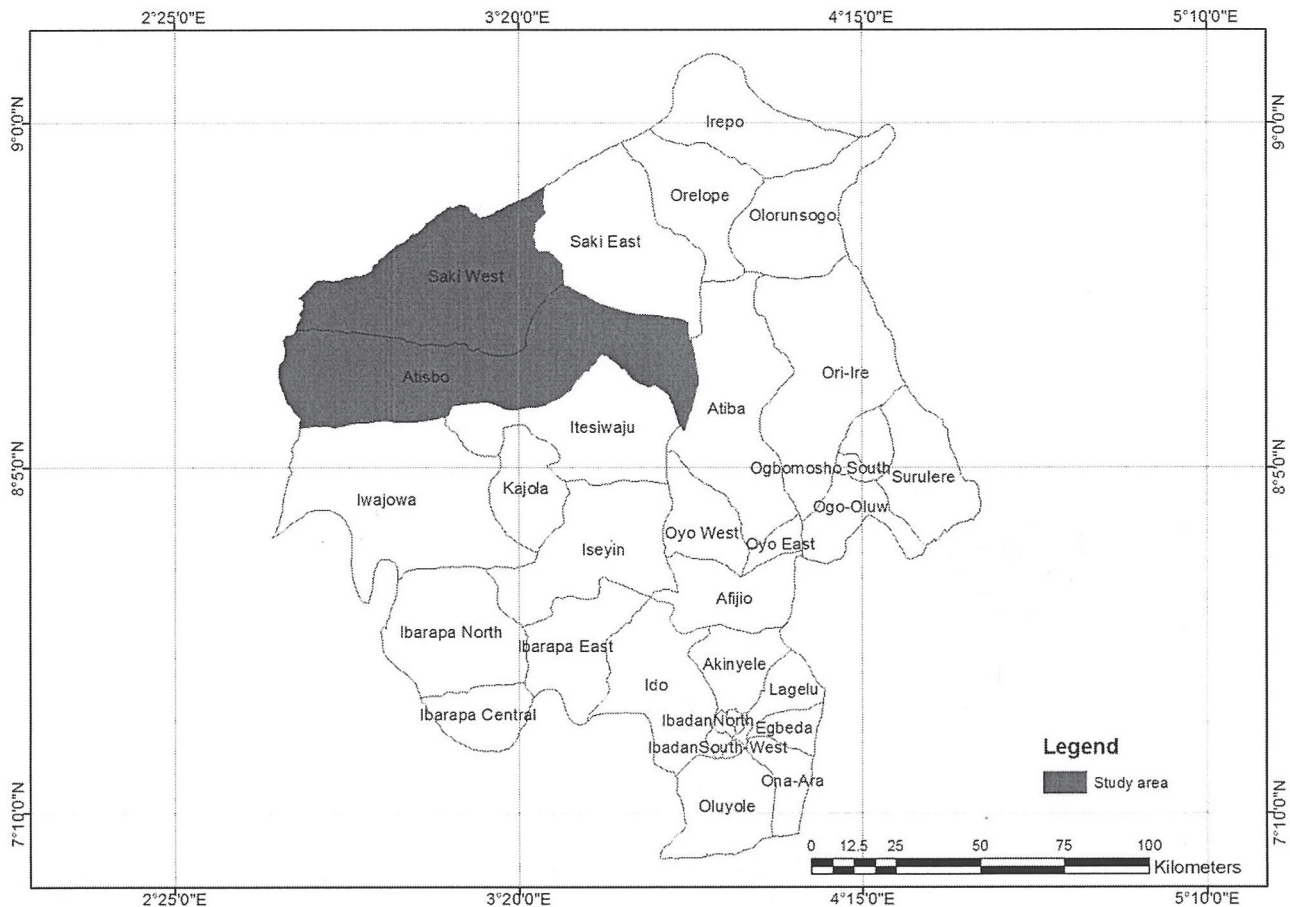**Fig. 1** Location of Oyo in the context of Nigeria.

Fig. 2 Location of Atisbo and Saki West Local Government Areas in the context of Oyo State.

The instrument for the interview was a self-administered questionnaire. Open-ended as well as semi-structured questions were formed to extract information from the respondents. The questions were properly revised by a specialist to know the applicability of the question in determining the indicators that were established in the literature before it was administered to the respondents. The questionnaire was administered face to face with the respondent.

The final instrument has three sections: (a) standard of living (b) health and (c) education. The first set of questions captured the standard of living of the respondents. Standard of living was assessed by asking respondents about their annual income; the number of relative that depends on them. Respondents were then asked about their source of farm labour. Respondents were also asked about different materials that are being used for house construction; materials for Roofing; materials for floor and sources of indoor illumination. The second set of questions asked respondents about the method of treating their health and the number of meals per day. The third set of questions were on education. Respondents were asked about the number of years spent in school. All the questions were semi-structured and were obtained as continuous variables.

5. Material

This paper presents the findings of an empirical research study designed to investigate variations in the poverty level of men and women. In doing so, the researchers sought to document different indicators in measuring poverty levels. An assessment of the dimension of poverty was based on the works of International Fund for Agricultural Development (IFAD) (2014), Alkire and Foster (2011), Alkire and Sumner (2013), Oxford Poverty and Human Development Initiative (OPHI) (2018), United Nations Development Programme and Oxford Poverty (UNDP) and OPHI (2020). IFAD (2014) identifies some proxies for measuring poverty levels from academic literature and several other organizations. These include food and nutrition security; domestic water supply; health and health care; sanitation and hygiene; housing, clothing, and energy; education; farm assets; non-farm assets; exposure and resilience to shocks; gender and social equality. OPHI (2018) regrouped these dimensions into three dimensions of poverty, namely: Health (nutrition and child mortality), Education (years of schooling and school attendance), Living standard (cooking fuel, sanitation, drinking water, electricity, housing, and assets). The regrouped dimension of poverty was adopted by UNDP and OPHI

(2020) to develop global MPI in charting pathways out of multidimensional poverty to achieve the SDGs. The consolidated indicator as adopted by UNDP and OPHI (2020) is therefore considered for this study. Below are the number of variables for establishing poverty levels (Table 1).

Tab. 1 Indicators of measuring multidimensional poverty.

S/N	Dimensions of Poverty	Indicator	Details
1	Health	Treatment of health	Ways of treating their health
		Number of meals per day	Number of meals per day
2	Education	Year of schooling	Number of years spent completing schooling
3	Living standard	Annual income	The total amount of money received in a year
		Number of relative dependents	Number of the relative that depends on them
		Source of farm labour	Sources of farm labour
		Materials used for house construction	Different materials that are being used for house construction
		Materials for roofing	Types of material that is used for roofing
		Materials for floor	Types of material that is used for floor
		Source of illumination	Sources of indoor illumination

Source: Adapted from UNDP and OPHI (2020)

6. Data Analysis

Data obtained were analyzed using a number of analytic methods from the SPSS package like Inferential statistics (such as Principal Component Analysis, t-test, and ANOVA) and Descriptive statistics (such as frequencies, percentages, and bar graph). Descriptive statistics were used to analyze the poverty grouping by gender and poverty levels of men and women across the border settlements. Principal component analysis (PCA) was used to establish relative poverty index and poverty classes of (low, medium, and high) that were differentiated by gender as used by Henry et al. (2003). ANOVA and t-test were used to test differences in the average poverty score between males and females as well as the differences in poverty index of males and females across the settlements through the formulation of the hypothesis (Oladehinde et al. 2017).

In this study, two hypotheses were formulated. The first hypothesis states that "There is no significant difference in the poverty level among men and women" while the second hypothesis states that "There no variation in the poverty level of men and women across the settlements in the study area". The first hypothesis was determined through the use of t-test while ANOVA was used to determine the second hypothesis.

7. Results and discussions

This study examined poverty among migrant men and women in rural border communities of Oyo State, Nigeria. There are many indicators for measuring the poverty level of men and women. This study considered 10 indicators and are categorized under health (methods of treatment and number of meals per day), education (years of schooling), and living standard (annual income, number of dependent relatives, materials for construction, roofing materials, floor materials, sources of illumination, and sources of farm labour). Principal component analysis (PCA) was used to show the underlying component that is calculated. It was further used to represent a linear combination of the indicator variables used in the model. The results of the PCA model include four tables: the component rotated matrix, the common variance table, the communalities table, and the Kaiser-Meyer-Olkin (KMO-Bartlett) test.

The Kaiser-Meyer-Olkin measure of sampling adequacy is an index for comparing the magnitudes of observed correlation coefficients with the magnitudes of partially correlated coefficients. The smaller the value of the index, the less appropriate the model while scores of 0.50 are considered poor, above 0.60 are acceptable, above 0.70 are good, above 0.80 are commendable and above 0.90 are exceptional (Henry et al. 2003; Ahadzie et al. 2008).

Tables 2 and 3 show the results of the Kaiser-Meyer-Olkin-Bartlett's test of sampling adequacy with value of 0.610 for men and 0.679 for women which are within the acceptable range for the well-specified model.

Tab. 2 KMO and Bartlett's test table (Men).

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.610
Bartlett's Test of Sphericity	Approx. Chi-Square	236.703
	Df	45
	Sig.	.000

Source: Computer output

Tab. 3 KMO and Bartlett's test table (Women).

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.679
Bartlett's Test of Sphericity	Approx. Chi-Square	233.443
	Df	45
	Sig.	.000

Source: Computer output

The size of communalities represents the strength of the linear association among variables and components and it is a very important test of the appropriateness of the poverty model. Henry et al. (2003) explained that Communalities indicate how the indicators combine to identify different components. The value of communalities ranges between 0 and 1 and higher observed values represent a greater share of common variance which is explained by the extracted components. Table 4 showed that communalities range in value from 0.314 and 0.742 for men and 0.322 and 0.835 for women are considered to fall within an acceptable range (0 and 1). 0.314 and 0.322 being the least values and 0.742 and 0.835 being the highest value of communalities in Table 4. This represents a greater share of common variance. Variables with high values were well represented in the common factor space while variables with low values were not well represented. All the indicators proved highly explanatory of the poverty components shown in Table 4.

Tab. 4 Communalities.

	MALE		FEMALE	
	Initial	Extraction	Initial	Extraction
Annual income	1.000	.526	1.000	.697
Number of dependent relatives	1.000	.656	1.000	.470
Materials for construction	1.000	.742	1.000	.807
Roofing materials	1.000	.703	1.000	.835
Floor materials	1.000	.628	1.000	.736
Source of illuminations	1.000	.605	1.000	.460
Method of treatment	1.000	.520	1.000	.483
Years of schooling	1.000	.314	1.000	.442
Number of meals per days	1.000	.634	1.000	.322
Source of farm labour	1.000	.538	1.000	.346

Extraction method: Principal component analysis
Source: Computer output

Table 5 and 6 showed four-level components of PCA with Eigenvalues greater than 1.0 extracted using the factor loading of 0.50 as the benchmark of explained "Common Variance" to be considered representative of a common underlying dimension. The size of an Eigenvalue represents the amount of variance in the PCA explained by the component, hence the larger the Eigenvalue, the more that component is explained by the model's indicators (Henry et al. 2003). In other words, the first four components of PCA with eigenvalues

Tab. 5 Total variance explained for men.

Component	Initial eigen values			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	2.811	28.114	28.114	2.811	28.114	28.114
2	1.815	18.146	46.260	1.815	18.146	46.260
3	1.238	12.383	58.642	1.238	12.383	58.642
4	1.019	10.186	68.828	1.019	10.186	68.828
5	.733	7.326	76.154			
6	.654	6.536	82.689			
7	.585	5.853	88.542			
8	.487	4.865	93.407			
9	..440	4.402	97.809			
10	.219	2.191	100.000			

Extraction method: Principal component analysis
Source: Computer output

Tab. 6 Total variance explained for women.

Component	Initial eigen values			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	2.944	29.441	29.441	2.944	29.441	29.441
2	1.508	15.084	44.524	1.508	15.084	44.524
3	1.146	11.457	55.981	1.146	11.457	55.981
4	1.069	10.686	66.667	1.069	10.686	66.667
5	.922	9.221	75.888			
6	.727	7.267	83.155			
7	.645	6.453	89.608			
8	.526	5.258	94.866			
9	.304	3.039	97.904			
10	.210	2.096	100.000			

Extraction method: Principal component analysis
Source: Computer output

greater than 1 as seen in Tables 5 and 6, account for high variance while those components with an eigenvalue of less than 1 account for less variance. The total variance explained by each component extracted in Table 5 (men) and Table 6 (women) are as follows: the first components in the two tables in this case the poverty index explains 28% of total variance for men and 28% of total variance for women; second 18.1% for men and 15% for women; third 12.4% for men and 11.5% for women; fourth 10.2% for men and 10.7% for women. Also, the cumulative percentage of variance for Tables 6 (68.8%) and Table 7 (66.7%) accounted for by the current and preceding principal components shows that all variance is considered to be true and common variance (because it is principal component analyzed). Therefore, the variables are taken to be measured without error, so there is no error variance.

The most critical for determining the composition of the poverty index is the component rotated matrix shown in Table 7 for both males and females. This is because it consists of an index showing the coefficients' combination for each component called the "component loadings" which is the most important determinant for developing a poverty index. Components-loading coefficients represent the amount of correlation between the component variable and the indicator variable (Henry et al. 2003). Table 7 showed the result of the rotated component matrix for indicator measurements of men and women in the study area. The absolute value of the coefficients for each indicator represents the degree of correlation between the component and the indicator. Therefore, large absolute values indicate a high level of correlation, while low values indicate a lower level of correlation. Positive coefficients indicate the direction of the relationship between the indicator and the relative wealth of the household, hence as the value of the indicator increases, so does the value of the component which in this case is the relative wealth of households. Negative coefficients indicate an inverse

relationship between the indicator and the relative wealth of the household.

Results of principal components analysis (Table 7), showing the significant components loadings of 0.50 and above in explaining indicators of poverty shows that for men, five factors loaded on Component 1: Materials for wall construction (0.662), Flooring materials (−0.661), Roofing materials (0.694), Sleeping materials (0.533) and Source of Illumination (0.720) and are tagged Dwelling condition. For women, four factors loaded on Component 1: Materials for wall construction (0.800), Flooring materials (−0.798), Roofing materials (0.834), and Source of Illumination (0.588) and are tagged Dwelling condition. This accounted for 28% for men and 29% for women of the total variance explained.

Component 2 had three factor loadings for men and women. They are for men: Number of Dependent relatives (0.574), Method of treatment (−0.513), Number of meals per day (0.705) and are tagged Quality of life which accounted for 18.2% of the total variance explained; for women: Number of dependent relatives (0.560), Method of treatment (−0.555), Sleeping material (−0.517). This accounts for 15.1% of the total variance explained and is also named Quality of life.

Component 3 had two factor loadings for men. They are Annual income (−.509) and Source of farm Labour (0.706). This is tagged Economic condition and it accounted for 12.4% of the total variance explained. However, there is only one factor loading for women (Income (0.731) and this accounts for 11.5% of the total variance explained, and it is also named Economic condition.

Component 4 had one factor loading each for men, Year of schooling (0.649) which accounted for 10.2% of the total variance explained, and women, Source of farm labour (0.509) which accounted for 10.7% of the total variance explained. The factor loadings were not tagged because they did not show any clear-cut pattern.

Tab. 7 Rotated component matrix for men and women.

	Component							
	MEN				WOMEN			
	1	2	3	4	1	2	3	4
Annual income	−.347	.384	**−.509**	.476	−.252	.313	**.731**	.255
Number of dependent relatives	−.419	**.574**	.388	−.178	−.348	**.560**	.188	.430
Wall materials	**.662**	.400	−.380	−.110	**.800**	.390	.123	−.061
Roofing materials	**.694**	.430	−.193	.−086	**.834**	.363	−.094	−.028
Floor materials	**−.661**	−.431	−.067	−.051	**−.798**	−.259	−.178	−.067
Source of illuminations	**.720**	.084	.281	−.241	**.588**	−.315	−.123	.123
Method of treatment	.487	**−.513**	.142	−.151	.329	**−.555**	−.258	.392
Year of schooling	**.533**	−.171	.004	**.649**	.342	**−.517**	.242	.390
Number of meals per day	−.302	**.705**	.215	−.029	−.334	.192	−.417	.480
Source of farm labour	.168	.109	**.706**	.485	.324	.189	−.453	**.509**

Extraction method: Principal component analysis
Rotation method: Varimax with Kaiser normalization
Source: Author's survey

The combinations of the various factors named above accounted for 68.8% of the total variance explained for Men and 66.7% for Women. This constitutes the combinations of indicators that gave the most appropriate explanations to the underlying relative poverty variation between men and women in the study area.

In determining the poverty status of men and women in the study area, poverty index was used. This according to Henry et al. (2003) is a tool to measure the extent to which a household is worse off or better off compared to other households. The poverty index created through principal component extraction assigned poverty ranking scores to each household automatically. The lower the score, the poorer the household relative to all others with higher scores. The ranking made use of 33.3% to define the poorest group. The cut-off score for each tercile defines the limit of each poverty group (Henry et al. 2003). Since 198 men and women were the sampled population, then there should

be approximately at least 33 men and 32 women in each group as shown in the frequency distribution in Table 8. The ranking revealed that more than two-thirds of the men and women population fell between middle and high poverty groups in the study area.

Independent T-test as presented in Table 9 was used to test the hypothesis, which states that there is no significant difference in the poverty level among men and women. The test compared the difference in means of poverty scores and men and women. The independent sample t-test result as shown in Table 9 shows that the t-value of 4.098 and 4.131 is significant at 0.05. A probability of 0.000 indicates that there is a significant difference between the poverty level between men and women in the study area. Thus, the hypothesis which states that there is a significant difference among men and women is accepted. This implied that the poverty level among men and women differs by gender in the study area.

Tab. 8 Frequency distribution of poverty groupings by gender.

Poverty grouping	Men	Cumulative percent (men)	Women	Cumulative percent (women)	Total
Low	33 (36.0%)	32.7	32 (33.0%)	33.0	65 (34.5%)
Middle	34 (32.0%)	66.3	33 (34.0%)	67.0	67 (33.0%)
High	34 (32.0%)	100.0	32 (33.0%)	100.0	66 (33.5%)
Total	101 (100.0%)		97 (100.0%)		198 (100%)

Tab. 9 Independent t-test of poverty groupings by gender.

TOWN			t-test for equality of means						
			t	Df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
								Lower	Upper
OYO	POVINDEX	Equal variances assumed	4.098	236	.000	.47408259	.11568023	−.70198038	−.24618481
		Equal variances not assumed	4.131	221.6	.000	.47408259	.11475052	−.70022426	−.24794093

Source: Author's survey

Figure 3 and Table 10 reflected the poverty levels of men and women by settlements in Atisbo local government area of Oyo state. This was done by cross-tabulating poverty groupings by gender and selected rural settlements in Atisbo local government area of Oyo state. In Opaba settlement, 20.4% of the respondents had a low poverty level. 6.1% were males while 14.3% were females. This set of people had a steady income and their earnings were better than the predominant farmers. 55.9% had medium poverty level, 28.6% were females and 27.3%were males. Also, 22.4% of the females had high poverty levels of while1.3% of the males had high poverty levels. The majority of the respondents that had middle poverty levels were predominantly dependent on farming as their means of livelihood. Most of the farmers in this area owned and operated nearby commercial farms. Their cultivation equipment was machines (tractors), hoes, and cutlasses which form the major farm implements. Poultry farming and animal husbandry were also widely practiced by the farmers. Those that had high poverty levels were petty traders dominated by women.

In Babanla settlement, 40.4% of the respondents had a low poverty level. 26.9% were males while 13.5% were females. 13.4% had medium poverty level, 7.7% were males while 5.7% were females. 46.1% had a high poverty level, 11.5% were males while 34.6% were females. It is assumed that most of the respondents with low poverty levels were migrants who are majorly into smuggling activities. This was observed from the fairly used vehicles parked in their compounds with foreign plate numbers indicating their smuggling activities. Also, many of the migrants in this area are traders and secondary farmers who are economically active.

Also, in Budowule settlement, the majority of the respondents (67.6%) had a very high poverty level. 30.8% were males while 36.8% were females. 16.9% of the respondents had medium poverty level, 8.5% were males while 8.4% of the respondents were females. The remaining 15.5% had a low poverty level. 13.4% were males while 2.1% were females. The majority of the migrants here are elderly. They have a high poverty level because these sets of people were weak physically and they were also economically inactive.
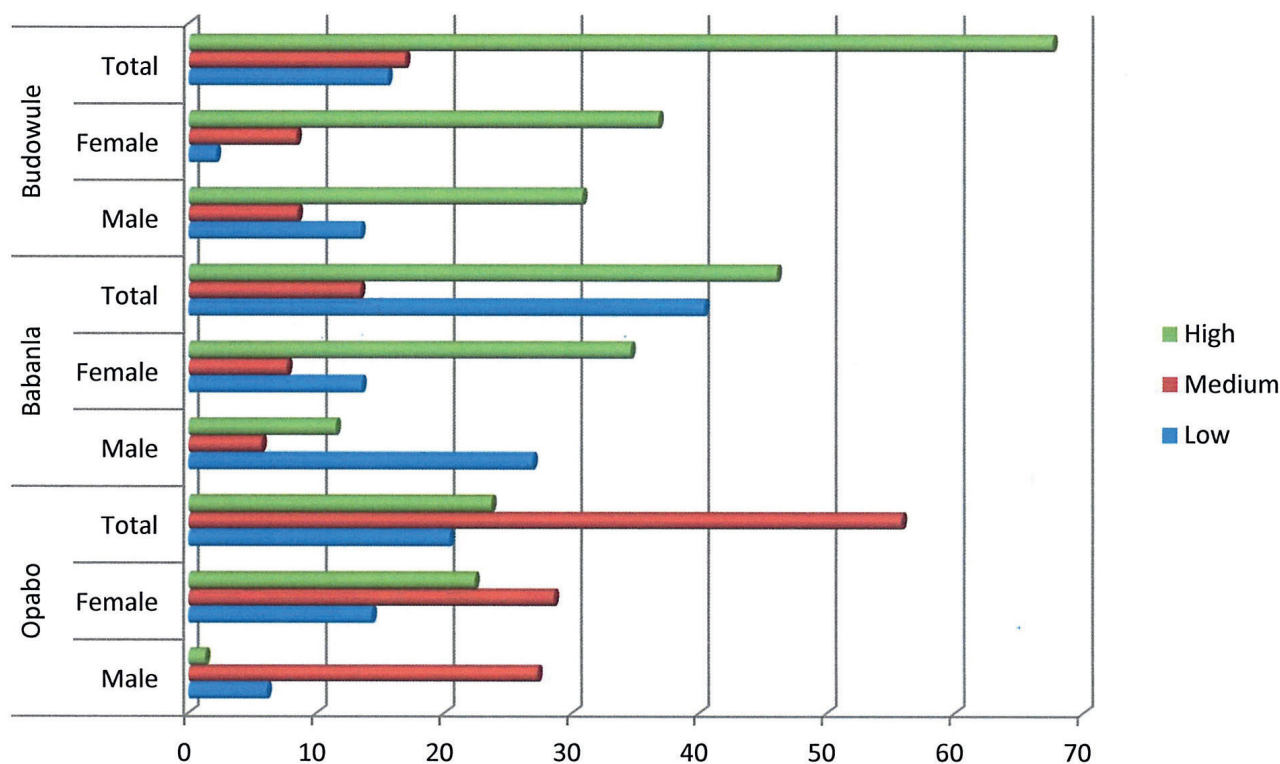
Fig. 3 Poverty levels of men and women in the selected rural communities of Atisbo local government area.

Source: Author's survey

Tab. 10 Poverty levels of men and women in the rural border communities of Atisbo and Saki west LGA of Oyo State.

LGA	Settlement	Gender	Poverty level			Total
			Low	Medium	High	
Atisbo	Opaba	Male	6.1	27.3	1.3	34.7
		Female	14.3	28.6	22.4	65.3
		Total	20.4	55.9	23.7	100.0
	Babanla	Male	26.9	5.7	11.6	44.2
		Female	13.5	7.7	34.6	55.8
		Total	40.4	13.4	46.1	100.0
	Budowule	Male	13.4	8.5	30.8	52.7
		Female	2.1	8.4	36.8	47.3
		Total	15.5	16.9	67.6	100.0
Saki west	Okerete	Male	28.6	30.7	6.7	6.7
		Female	2.0	14.3	18.4	18.4
		Total	30.6	45.0	25.1	25.1
	Aiyemojuba	Male	10.0	22.5	15.0	47.5
		Female	7.5	17.5	27.5	52.5
		Total	17.5	40.0	42.5	100.0
	Abata gbooro	Male	34.7	12.7	6.7	54.1
		Female	1.7	3.5	40.7	45.9
		Total	36.4	16.2	47.4	100.0

Source: Author's survey

Figure 4 and Table 10 reflect the poverty levels of migrant men and women in the selected rural border communities of Saki west local government area of Oyo state. This was done by cross-tabulating poverty groupings by gender and selected rural settlements in Saki west local government area of Oyo state. In Okerete settlement, 30.6% of the respondents had a low poverty level. 28.6% were males while 2.0% were females. 45% had medium poverty level, 30.7% were males while 14.3% were females. Also, 25.1% had a high poverty level, 6.7% were males and 18.4% were females. This may likely be because the migrants in this settlement enjoyed their nearness to the neighbouring country (Benin Republic). For instance, most of the migrants have direct opportunity of crossing the border without any barrier, hence improving their poverty status.

In Aiyemojuba settlement, 40% of the respondents had medium poverty level. 22.5% were males while 17.5% were females. 42.5% had a high poverty level, 15% were males while 27.5% were females. 17.5% had a low poverty level, 10% were males while 7.5% were females. This pattern might be because the respondents are at a distant location to the border towns and also the deplorable condition of the road which limited their products to their village and thus denied them the accessibility of the farm inputs and sale of their products. Also, in Abata gbooro settlement, 47.4% of the respondents had

a high poverty level. 40.7% were females and 6.7% were males. 36.4% had a low poverty level, 34.7% were males while 1.7% were females. The remaining 17.1% of the respondents had medium poverty level, 12.7% were males while 3.5% were females. The reason for the high poverty level may likely be because their settlement has been cut off due to bad roads, thereby inhibiting effective transportation of goods and persons to and from the market. This invariably affected the rate at which farm products get spoilt and the result is a low income to the migrants.

ANOVA analysis in Table 11 was used to test the second hypothesis, which states that there no variation in the poverty level of men and women across the settlements in the study area. The result shows whether there is significant variation in the poverty level of men and women across the settlements. The ANOVA result as presented in Table 11 shows that the f-value of 33.718 is significant at 0.05. A probability of 0.000 indicates that there is significant variation in the poverty level of men and women across the settlement. Hence, the hypothesis which states that there is significant variation in the poverty level of men and women across the settlements is accepted. This implied that the poverty level of men and women across the settlement varies in the study area. One of the reasons for this variation may be due to differences in the status of the settlement.
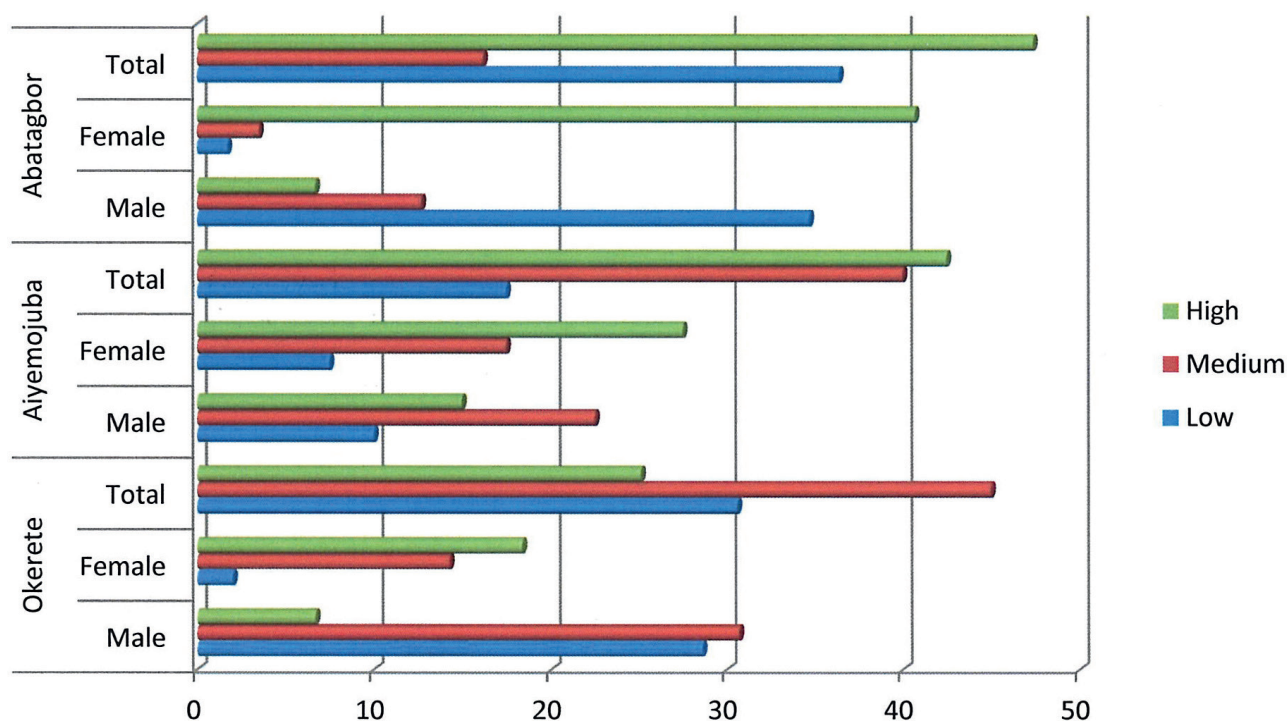
Fig. 4 Poverty levels of men and women in the rural border communities Saki west.

Source: Author's survey

Tab. 11 ANOVA analysis showing variation in poverty level across the settlements.

POVINDEX					
Across the Settlements	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
OYO	Between Groups	67.129	5	13.426	33.718	.000
	Within Groups	76.450	192	.398		
	Total	143.579	197			

Source: Author's Survey

8. Conclusion and Recommendation

The study determined the extent of poverty between men and women in the selected rural border communities of Oyo State using poverty index created through principal component analysis. The study revealed there were variations in the poverty levels of men and women and these variations were further shown across the selected rural border communities. It was also evident in the study that women have high poverty levels than men in the study area. The results of the t-test show that there is a significant difference in the poverty scores between men and women. It was discovered that there is significant variation in the poverty level of men and women across the settlements. By implications, it means it will be possible to distinguish between those with low poverty levels from high poverty levels in the area. This is necessary for poverty interventions as it may not be possible to target all the poor at once. Also, there is need to focus on gender-based poverty interventions especially among females in all the settlements as they have been found to be more affected by poverty than males in this study.

Also, the high loadings of factors on components one for men and women which were tagged Dwelling Conditions indicates poor housing condition. The study suggested the need to improve the dwelling conditions of the migrants for instance by using modern building materials for their houses. Also, rural housing programs where people are trained in the act of using modern materials to build houses should be encouraged. In addition, cooperative societies and community-based housing cooperatives should be established in order to enable rural border residents to have access to loans, credit facilities, and building materials to build their own homes.

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Survey on economic considerations and decisions of key geodata providers and users in Czech public administration

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ABSTRACT

This paper presents the results of an empirical economic data-based survey of the costs and revenues of geographical data and Web services across public administration in Czechia. The survey was composed of questionnaires and interviews. The data was collected from the 19 biggest public producers of geographical information and 25 organizations that use geographical information. The results focus on the economic consequences of data opening, splitting finances within public administration bodies, the prioritization of activities related to geographical information, licensing issues and life cycle planning etc. We also consider user opinions on the restrictions on the (re)use of geographical information of public administration, including open data.

KEYWORDS

economic survey; finances allocation; geospatial life cycle; spatial data infrastructure; open data

1. Introduction

It is obvious that geographic data have become an invaluable commodity and play a major role in all aspects of society (Klinkenberg 2003). It is, therefore, logical to address the issue of the economic value of geographical information in the scope of geoinformatics/geographic information science (Krek and Frank 2000; Goodchild 2003; National Research Council 2004; Crompvoets et al. 2010; Hošková-Mayerová et al. 2013; Crompvoets and Broucker 2015; Johnson et al. 2017; Pashova and Bandrova 2017; Coumans 2018; Lü et al. 2019; Craglia and Pogorzelska 2020).

To sum up, value of geographic information is a commonly addressed topic within as well as beyond the geographic community. The research is designed through questionnaires, commonly at a moderated workshop or similar events (ANZLIC 2010a, 2010b). A challenge remains in providing a more complete picture based on empirical economic data together with findings from questionnaires and discussions. Empirical economic data are scarce due to the following reasons. As the first, investments and revenues to geographic information are not explicitly separated from other kinds of data. As the second, investments and revenues to geographic information may differ significantly in time. A longer time extent than one year is required to see a picture without distortions due to a specific year. As the third, it seems difficult to obtain a comprehensive view based on empirical economic data from providers, distributors or users of geographic information.

The overall objective of this paper was therefore to provide a comprehensive economically-based picture of geographic information management in the Czech public administration. The study was conducted in 2016 while taking into account empirical economic data within a time frame between 2011 and 2015. Processing of all the inputs was performed in 2016. However, the results of the study were only de-classified in 2020 as they contain sensitive economic data. This paper, therefore, brings reflection of research performed between 2016 and 2020 and discusses the changes between the results obtained within our study. Nevertheless, the obtained results seem unique across the world even after five years as no similar study with five-years empirical economic data on geographic information was not performed till then.

Situation in Czechia in 2016 was analyzed from two sides: (1) from the producer's point of view and (2) the user's point of view. The authors of this paper conducted a survey on economic considerations and decisions of key data providers within the Czech public administration. The main motivation was to collect data on costs and revenues from 19 of the most important producers of geographical information within the Czech public administration, as well as from the 25 biggest users of geographical information (both commercial and public administration). Information on

the 'playground' (i.e. the available budget) were also taken into account.

Our questionnaire survey was conceived as exploratory research, no precise hypotheses have been established in advance. Due to the main goal and general approach described above, following research question (RQ) were defined:

1. The producer's point of view: "What (economic) decision(s) influenced the process of creating, maintaining and providing geographic data?"
2. The user's point of view: "What geographic data, with respect to their license, do their main consumers prefer and really use?"
3. Information on the 'playground': "What was the size of the market with geodata created within the public administration, i.e. the available budget?"

This paper is structured as follows to address the above-mentioned research questions:

– Section 2 analyses the state-of-the-art in research of economic aspects of geographic information.
– Section 3 deals with methodology, with an emphasis on questionnaires and their application.
– Section 4 presents results obtained from conducted surveys focused on answering given research questions.
– Section 5 discusses the outcomes of the presented research with an emphasis on comparisons with the situation abroad, and in the context of international activities.
– Section 6 summarizes ongoing work with respect to the main achievements.

In the presented paper, we use the term 'geographic data' as data iselves, that are only a set symbols that represent measurements of phenomena, including location (DiBiase 2021). Geographic data can be treated as a commodity in the limited sense of acquisition or sale (Dasgupta 2013). On the other hand, we use the term 'geographic information' as geographic data and services related to them. In general, information is data that has been selected or created in response to a question (Di Biase 2021) and it is a problem to determine the monetary value of the geographic information (Dasgupta 2013).

2. Related work

There are several studies with various approaches to assessing the economic value of geographical data. For example, Castelein (2010) measures the economic value of geographical data in the Netherlands in terms of employment, turnover, activities, and the market. OXERA (1999) describes the approach to estimating the economic contribution of Ordnance Survey (OS) in Great Britain. They found that OS contributed 2–20% gross value added in relevant sectors of the national economy (utilities, local government and transport). Genovese et al. (2010) used the value chain concept to assess the value of geographical information in Quebec, Canada.

The cost-benefit analysis (CBA) is a common method related to the economic value of geographical data, especially in the case of forecasting (Pick 2005; Obermeyer 2008). CBA is employed in a countless number of domains, programmes, projects and applications. In the domain of geographical information, CBA is usually used for estimating future costs and potential benefits (e.g. Gillespie 2000). Frank (2001) applied CBA on topographic surveying in Austria and found that topographic data contributed € 100 Mil. to private sector activities. The methodology used to calculate benefits is based on OXERA's (1999) gross value-added approach. Similarly, Halsing et al. (2004) performed CBA of the National Map, produced by the U.S. Geological Survey (USGS). Halsing et al. (2004) also developed a simulation model "NB-Sim" to estimate the number of application implementations occurring each year to calculate the value. The net present value of a fully implemented version of the National Map is over $ 2 billion. Cetl et al. (2008) applied CBA on future improvements of the entire NSDI (National Spatial Data Infrastructure) in Croatia.

However, empirical statistics regarding the value of geographical information, both in terms of the cost and benefit, are often missing. Without empirical economic data, the geographical community tends to provide descriptive cost-benefit considerations as for example in Toth and Smits (2009). It is then difficult to convince members of other communities, including politicians and policy makers, of the importance of geographical information. Some studies using real economic numbers are rare; some of these include e.g. ANZLIC (2010a, 2010b), DEWBERRY (2011) and Craglia et al. (2012).

ANZLIC (2010a, 2010b) describes CBA conducted in respect of fundamental data (topographic maps and orthophoto) in Australia. In this case, CBA constituted the second stage of the assessment addressing the effects of four variants of pricing models. The following sources were used as input data for the quantitative part of the analysis: materials by government agencies, previous estimates in the literature, and annual reports of agencies. Specifically, the economic aspects of four fundamental data sets were analysed: Western Australia topographic data, Western Australia aerial photography, Victorian topographic data and Geoscience Australia topographic data (1 : 250,000). The total cost of these datasets ranges from $ 2,873,000 (Western Australia topographic data) to $ 13,292,000 (Geoscience Australia topographic data), while production and maintenance costs of these datasets range from 88.5 to 99.9% of the total costs (ANZLIC 2010b).

The CBA provided in DEWBERRY (2011) report on USGS National Enhanced Elevation Assessment included both tangible and intangible benefits. This report defined business uses in 34 federal agencies, as well as in other private and non-profit organisations. Data were collected through online questionnaires, interviews and workshops with key managers and elevation data users. The assessment results provide significant evidence that an enhanced elevation program in the US could provide estimated net benefits between $ 116 Mil. and $ 620 Mil. per year.

Craglia et al. (2012) addressed the economic aspects of geographical data in the context of Environmental Impact Assessments (EIAs), Strategic Environmental Assessments (SEAs) and INfrastructure for SPatial InfoRmation in Europe (INSPIRE) Directive (Directive 2007/2/ES). This study analysed the results of online survey, which was conducted in 2009 across the European Union (EU) and included 128 respondents from 21 countries. Results showed that problems persist and additional costs due to data access problems were at least € 150 Mil. Based on the conducted survey, Craglia et al. (2012) assumed that the annual average number of EIAs and SEAs in the EU27 far exceeded the estimated 24,000, implying that there should be savings far greater than € 150 Mil. per year.

More recently, national mapping organisations from 11 European countries realised a EuroSDR project to explore the economic value of 3D geographic information in 2017. For the investigated cases, the cost-benefit ratio of 3D to 2D geographic information was found to be about 3:1, but the calculated financial benefits were rather circumstantial (Coumans, 2018). Deloitte (2018) investigated socio-economic impacts of Open European Location Services (ELS). They identified positive impacts of open ELS on geo-spatial information market data-economy, in general. These conclusions are based on 21 questionnaire replies (10 of them from Spain) and they are not substantiated by any empirical numbers.

In summary, economic analyses of geographical information seem to share the following features:
1. Empirical economic numbers are missing in the majority of analysed sources. In several cases, the CBA method attempts to forecast the future, i.e. empirical economic numbers are not applicable. The related studies mostly conclude with lists describing the benefits and challenges and/or general recommendations.
2. The geographical information community seems to have had the greatest interest in the cost-benefit consideration at the beginning of the new millennium. Publications after 2012 appear to be rather scarce.
3. The majority of relevant studies take into account only a single product, most typically topographic maps or orthophoto. A comprehensive perspective cutting across various topics is not available.

3. Methodology

The primary aim of the presented research was to find consistent answers to particular research questions

related to value of geographical information across public administration in one country. In total, 31 bodies[1] of public administration within the Czechia were chosen since they represented the most important producers, re-producers and users of geographical information. The commercial subjects were a part of the discussions on value of geographical information, however, not a direct participants of the conducted survey.

Our surveys aimed at several aspects more or less tightly connected to economic value of geographical information. The primary interest was to discover what is the structure of a budget allocated to geographical information; both externally and internally. The external point of view dealt with the way how finances are allocated between an organisation – to geographical information and beyond as well in fiscal year. The internal point of view discovered the structure of allocated finances: to data production, data maintenance, Web services development and maintenances, revenues for selling the geographical data/services. The last primary interest aimed at identification of barriers on geographical data/services use from a confrontation of user's and producer's perspectives. Among others, the authors are aware that many of the questions raised are not purely economic ones as they are also closely related to policy and political decisions.

Two questionnaires were devised during April 2016 through collaboration between the authors' team, three related research projects running in parallel, and the Czech Ministry of Interior. Questionnaires were made in line with the consensus reached between the Czech Ministry of Interior, Czech Technological Agency (as a financing body of the project) and principal investigators of the project. It was also emphasised that questionnaires should not remain the only method for data (re-)producers as it has to be accompanied with iterative in-depth discussions.

The structure of the questionnaires originated from: (1) requirements of the Czech Ministry of Interior, (2) feedback with representatives from the European Commission, Directorate General Joint Research Centre, to become at least partially compliant to the survey of Craglia et al. (2014), (3) life-cycle of geographic information as defined by the Stages of the Geospatial Data Lifecycle (FGDC 2010). Both questionnaires are presented in the Appendixes.

The rationales of the two questionnaires were as follows:

The questionnaire for geographical information producers (Appendix 1, available at https://doi.org/10.14712/23361980.2021.12), comprising 25 questions, was sent to 31 bodies of Czech public administration who were the biggest producers and re-producers of geographical information. The

questionnaire was pre-completed by a (re-)producer and later on completed during personal interviews with respondents at their premises in order to increase the veracity of the collected answers. Financial information was requested by the Czech Ministry of Interior for years 2011–2015. Moreover, written and collectively finalised answers were compared with other sources of information, e.g. metadata from the national geoportal or information available from INSPIRE monitoring and reporting (European Commission 2017). In total, 19 bodies of public administration, i.e. 61%, participated, while 12 bodies, i.e. 39%, did not provide any feedback. All the (re-)producers were invited for two workshops (see below) to further discuss, update and/or clarify their positions.

The questionnaire for users of geographical information (Appendix 2, available at https://doi.org/10.14712/23361980.2021.12), comprising 14 questions, was intended to ascertain the users' points of view regarding geographical information. This second questionnaire was presented to 60 organisations, mostly commercial and research companies. In total, 25 completed questionnaires were returned, equating to 42% of the organisations approached. Though this may see a low figure at first glance, the respondents comprised the biggest commercial companies, as well as the Czech Armed Forces. The questionnaire for users of geographical information was, in contrast to the first questionnaire, not verified by personal interview nor against other sources of information to reach as broad an audience as possible.

Two one day workshops were organised by the Czech Ministry of Interior to further process and clarify the obtained results as well as the whole economic-based picture. These workshops were used for a confrontation of user's and producer's perspectives as both groups were invited and discussed together. Workshops as another method of investigation were applied similarly to ANZLIC (2010a, 2010b).

Both questionnaires were answered between 1 May 2016 and 30 September 2016. All respondents had the opportunity to revise their previous answer(s) up to the end of the survey. The project had the support of the Czech Ministry of Interior, which allowed the collection of detailed answers including figures concerning both civil and military budgets. Both questionnaires were developed as structured ones; however, free text additions to any question were also collected in order to obtain information that was as detailed as possible.

The economic values from questionnaires were analyzed using methods of descriptive statistics. Simple statistical measures were used including means, medians, standard deviation, range and interquartile range for five years time extent for each (re-)producer of geographic information. Aggregated form was also provided for: (1) all the (re-)producers of geographic information, (2) for civil and military national mapping organisations and (3) all the (re-)producers

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1 The groups of 19 key data providers and 25 biggest users of geographical information partly overlaps.

of geographic information except for civil and military national mapping organisations. Results were expressed through common types of graphs, from pie charts to box-plots.

Results of the questionnaire for geographical information producers were, where possible, also compared with results obtained during INSPIRE Public Consultations between December 2013 and February 2014 (Craglia et al. 2014) in order to compare the national status with the European/international one. The European insight comes from 698 completed replies from more than 30 countries, including 27 within the EU, 3 in the European Economic Area, 4 other European countries and 2 replies from US/Canada. As the last, the information discovered within this study was also compared to the world-wide similar research conducted between 2016 and 2020.

4. Results and interpretations

4.1 Available budget between 2011 and 2015

The information on year-to-year budget available within the five years preceding the survey was understood as ground information. The average annual budget provided information on the 'size of the playground' for geographical information (re)production within public administration. The five-years perspective demonstrates the stability of funding available for geographical information over time.

The available budget for geographical information between 2011 and 2015 in 19 bodies of public administration in Czechia equalled € 1.2 billion. The financial support was stable and increasing in time, with annual support between € 210 and € 270 Mil., while the average annual value was € 239 Mil.

Detailed empirical economic data were not available after 2016 to provide a credible basis for more up-to-date information, including trend analysis in longer term. The outcomes of the 2016 study are considered by the Ministry of Interior as crucial still in 2021. The Czech (national) Strategy of Geographical Information Infrastructure is being revised in 2021 to, among others, reflect the results of the study presented within this paper (Kubátová 2017).

4.2 The data (re)producer point of view

The first set of questions in the questionnaire for geographic information (re-)producers concerned geographical data and services discoverability and availability, since they represent a bridge between geographical information (re-)producers and users. It has been proved that the discoverability of geographical information increased significantly within 2011–2015 as a result of requirements set for metadata and discovery services, as defined in the EU INSPIRE Directive (Directive 2007/2/ES and Řezník

2013). The majority of metadata, i.e. 44%, were available in INSPIRE-structured XML format. This figure may appear low since the European survey in 2014 found that about 58% of metadata was according to the INSPIRE requirements (40% INSPIRE compliant, 18% partially INSPIRE compliant). Note, however, that this research was aimed at all geographical data within public administration and not only at public administration bodies managing geographical information under INSPIRE. On the other hand, according to the free text answers obtained and verification at the INSPIRE national geoportal, such metadata have little or no information on data quality. Since 2019, all the geographic data and services published under the INSPIRE directive have been described by 100% with metadata (INSPIRE Knowledge Base 2021). Further information on the discoverability of geographical data and services may be found at Řezník et al. (2016).

The second question dealt with opening of geographical data. As depicted in Figure 1, in Czechia, 89% of geographical information (re)produced at the public administration level is available on the Web. As in many other countries, the phenomenon of the 'shapefile' was the dominant vehicle for encoding. Modern methods of interoperable encoding, like GML (Geography Markup Language) and/or (Geo)JSON (JavaScript Object Notation), were used in 11% of all publications. Nevertheless, semantic approaches like that described by Berners-Lee (2006), e.g. linked RDF (Resource Description Framework), were not used in 2016 among the surveyed bodies of public administration as they remained activities for research and pilot applications; that is, they were not massively used. More up-to-date numbers since 2016 are not available as they are not a part of INSPIRE monitoring & reporting or any other similar activity.

Figure 2 offers an alternative perspective on geographical data flows, which is also comparable to results on the European level (Craglia et al. 2012; Cetl et al. 2017). We can clearly see that the INSPIRE Annex I spatial data themes (Coordinate reference systems, Geographical grid systems, Geographical names, Administrative units, Addresses, Cadastral
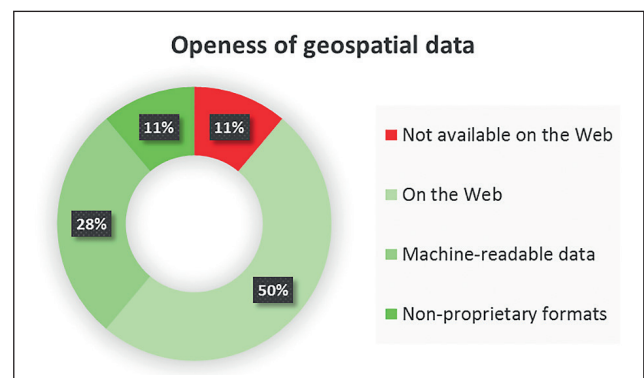

Fig. 1 Openness of geographical data within Czech public administration according to the five star rating of Linked Open Data.
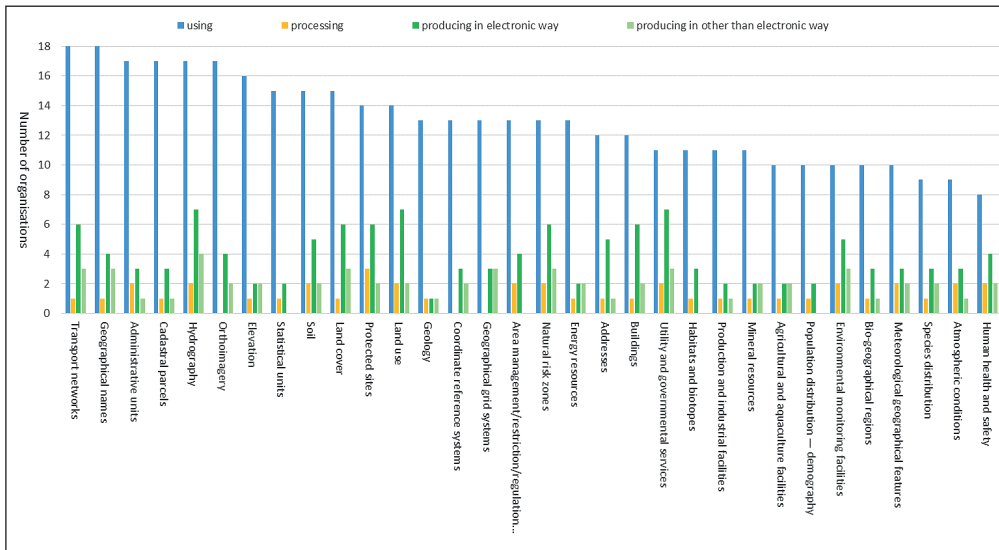
Fig. 2 Number of organisations of Czech public administration using, producing or reproducing different INSPIRE themes.

parcels, Transport networks, Hydrography and Protected Sites) were the most commonly used, as they represent reference data. Surprisingly, reference data for identical themes were typically duplicated among several organisations. It was also discovered that the duplication of data and services within one ministry has been eliminated with the adoption of INSPIRE while cross-ministerial duplication has remained. In contrast, thematic data (from INSPIRE Annex III) were the most commonly used forms for reproduction. In other words, added value in the sphere of reproduction was higher for thematic spatial data than for reference data.

Answers to financial questions provided the following findings. 66% of respondents did not have a key for splitting finances between 2011 and 2016 within their organisation, e.g. to department level. As a result, ad hoc financing took place. Data were then updated according to available finances, without reference to their life cycle (when following the definition of the life cycle as declared in Stages of the Geospatial Data Lifecycle (FGDC 2010). The same number of respondents (67%) answered that they did not have a list of priorities when investing into geographical data and services. A subsequent question was related to the existence of a life cycle for geographical information. 72% of respondents had not developed a life cycle information plan. As a consequence, finances were typically invested during the second half of a year into the most visible showcase, i.e. a geoportal. The opposite situation, homogeneous financial planning, existed in civil and military national mapping organisations, some regional governments, the Czech Geological Survey, and the Nature Conservation Agency of the Czech Republic (33% of respondents).

Figure 3 depicts the percentages of bodies that offer the respective proportions of their geographical data and services free of charge. Almost one half of the organisations surveyed offered all their geographical data and services free of charge. This situation applied mostly to small and medium geographical data producers, where (according to their statements) administrative costs related to the collection of fees would be higher than the expected income. Almost two thirds of respondents answered that their geographical data and services could be ordered via an e-shop.

Further information to Figure 3 is the following. Three research organisations kept between 2011 and 2015 some of their geographical datasets private; i.e. they did not disseminate any information, even on a paid basis. As understood from free text comments and mutual clarifications, their geographical datasets were so attractive that the desire to have access to them might be a reason for joining newly emerging (research) project consortia.

Figure 4 offers a unified view of the splitting of finances in the geographical domain within the public administration of one country. In total, this referred to a budget of approximately € 239 Mil. per year for 19 bodies of public administration that
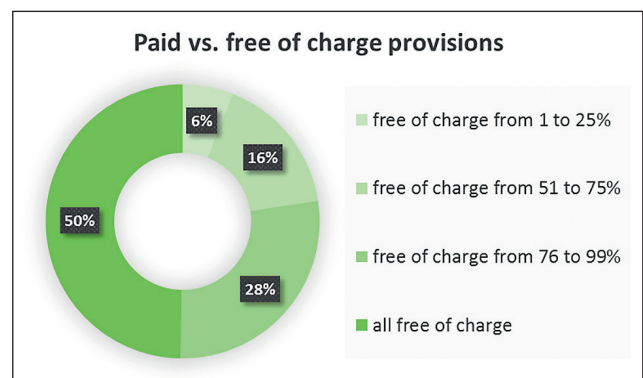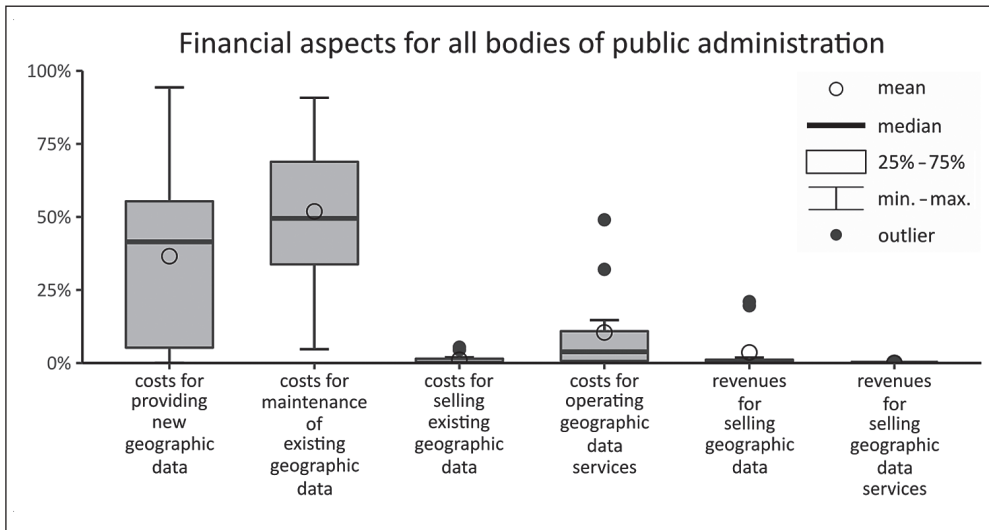

Fig. 3 Responses to the question of what proportion of geographical data and services are provided free of charge by the organisation.

Fig. 4 Descriptive statistics of financial aspects expressed as a ratio of direct costs or revenues and the total organisation's budget in a form of a box-plot; data from the whole of public administration.

are, at the same time, key producers of geographical information.

It is evident from Figure 4 that average costs between 2011 and 2015 varied to a huge extent, especially when talking about the costs of providing new geographical data and the costs of maintaining geographical data. The cost of providing new geographical data varied between 0 and 94% of the total budget allocated to geographical information.

When following Figure 4, directly received revenues account, on average, for only 4% of the overall investment into geographical information. Such a number comprises all the costs concerning provision/maintenance/selling of geographic data and operating geographic data services on the one hand and revenues for selling geographic data and services on the other hand.

Only one correlation was found between bodies of public administration when talking about costs and revenues for geographical information, see Figure 5. Czech civil and military national mapping organisations evince similarities in budget spending despite having different structures, end user groups, and total budgets (€ 36 Mil. per year vs. € 2.6 Mil. per year). Figure 5 shows that civil and military national mapping organisations typically spent their yearly budgets as follows:

– 5% on providing new geographical data,
– 90% on the maintenance of existing geographical data,
– 2.5% on the sale of existing geographical data (e-shop developments, administrators, lawyers, key accountants etc.),
– 2.5% on operating spatial data services.
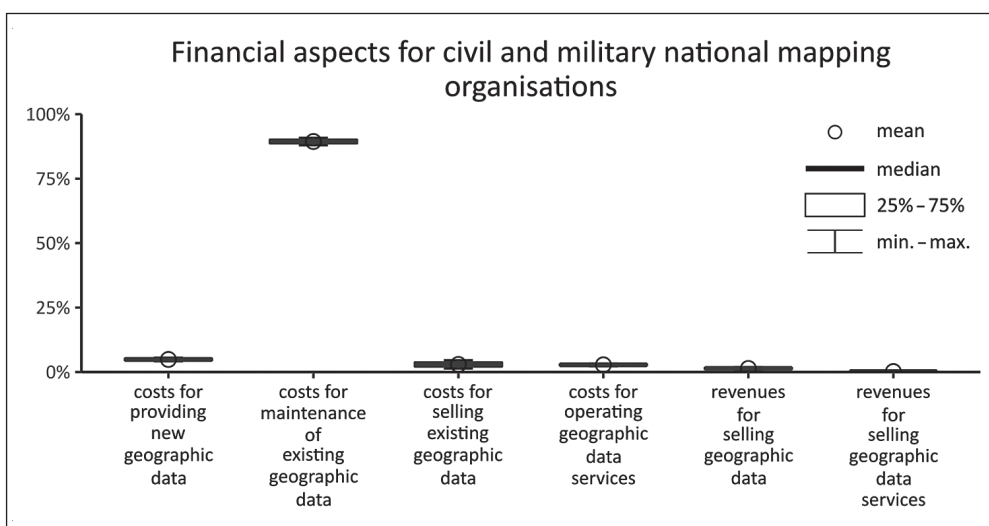
Fig. 5 Descriptive statistics of financial aspects expressed as a ratio of direct costs or revenues and the total organisatin's budget in a form of a box-plot; data from Czech civil and military national mapping organisations.

However, for the whole of public administration in general, revenues for selling geographical data reached 2% and revenues for selling geographical data services reached 0.5% of the total budget. It may be concluded that geographical data services did not have direct profitability according the conducted survey, since revenues for selling geographical services only cover 15% of the costs of operating such geographical services. However, the majority of the offered geographical services were (and as far as authors are aware still are) provided free of charge to public administration bodies and/or citizens. Such 'zero payments', so-called 'virtual payments', are not included in Figure 4 and Figure 5. For instance, 'zero payments' only from the Czech public administration to the Czech civil national mapping organisation (the Czech Office for Surveying, Mapping and Cadastre) reached 24% of their total annual budget.

Even when we filtered out civil and military national mapping organisations, the picture is still the same, as may be seen when comparing Figure 4 and Figure 6. There was no correlation between bodies of public administration from the budget analysis point of view, no matter what their level (national, regional, local), size (overall budget, number of employees) or type (administrative bodies, research institutes). It may therefore be concluded that such a situation was, among others, also a consequence of the absence of mid- and long- term planning. As mentioned above, the absence of a life cycle plan was reported by three-quarters of respondents. Finances were allocated ad hoc without appropriate planning. As a result, one body of public administration might spend 94% of its yearly budget on providing new geographical data while another might spend 65% of its yearly budget on the maintenance of existing geographical data.

Direct revenues for selling geographical data and services reached up to 10% of the costs of their provision, operation and maintenance. The costs of selling existing geographical data, among others lawyer and key accountant services, were, on average, equal to 150% of the revenues received from sales of geographical data. However, geographical data of public administration were commonly shared and/or traded for other commodities, as in the case of the mapping department of the Czech Armed Forces. Note that data for indirect revenues were available only for civil and national mapping organisations. Another added value of geographical information lies in the area of decision making. Geographical information is one of the most commonly used references on which a decision is made.Such indirect profitability cannot be explicitly evaluated through economic figures.

Another question posed to bodies of Czech public administration was dedicated to their opinion on Public-Private-Partnership (PPP). As depicted in Figure 7, 42% of respondents supported the idea of PPP in order to decrease the financial burden related to geographical information, while the same number were against. The remaining 16% failed to provide an answer to the question. When going into depth, PPP sceptics believed that the existing financial model for geographical information in public administration was a simple and stable one, despite its mid- and long-term rigidity and disunity. Such negatives were mentioned especially when talking about huge investments.

4.3 User point of view

The beginning of the second questionnaire was devoted to the usage of open geographical data and/or services from public administration. It was found that 79% of respondents use open geographical data and/or services offered by Czech public administration. Out of that 79%, the following proportions of
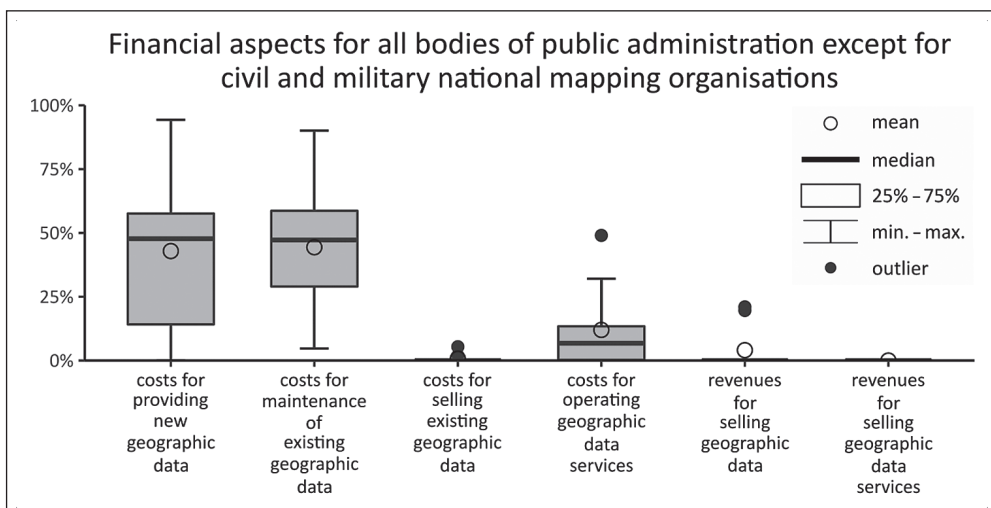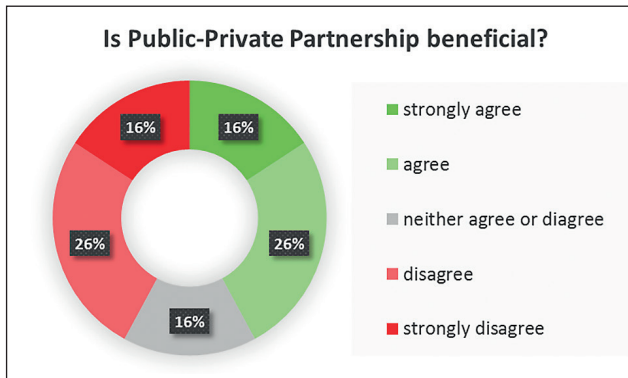

Fig. 6 Descriptive statistics of financial aspects expressed as a ratio of direct costs or revenues and the total organisation's budget in a form of a box-plot; data from the whole of public administration except for Czech civil and military national mapping organisations.

Fig. 7 Responses to the question of whether organisations are convinced that it would be beneficial for them to cooperate through a Public-Private Partnership (PPP) in order to publish their geographical data and/or services.

respondents used geographical data/services from the respective institutions and databases:

– 80% used the national Registry of territorial identification, addresses and real estate (in Czech Registr územní identifikace, adres a nemovitostí, abbreviated as RÚIAN),
– 60% used the Cadastre of Real Estate,
– 50% used orthoimagery of the Czech national mapping organisation,
– 30% used the national hydrographic database DIBAVOD (Digital Database of Water Management Data, in Czech DIgitální BÁze VOdohospodářských Dat),
– 25% used the Farmer's portal of the Czech Ministry of Agriculture,
– 25% used the data/services provided by Prague Institute of Planning and Development.

The majority of the most commonly used geographical data and services were open ones. It is clear from the answers that open geographical data and services were used:

– for internal purposes in 84% of cases,
– in 68% of cases involving contracts for the public sector,
– in 52% of cases involving contracts for the private sector.

While open geographical data and/or services were used by 79% of responders, paid geographical data and/or services were used by 65% of respondents. Indeed, when the detailed answers were analysed, we saw that paid geographical data and/or services were used:

– for internal purposes in 71% of cases,
– in 65% of cases involving contracts for the public sector,
– in 35% of cases involving contracts for the private sector.

In other words, geographical data and/or services of public administration were available for contracts with the public sector no matter whether they were used on a paid basis or free-of-charge. A very

common mechanism in such types of contracts was that a commercial company asks via one body of public administration for geographical data/services provided by another body of public administration. The obtained geographical data/services were then available free of charge to the commercial company as a subcontractor of the body of public administration providing the data. That is, the fees are not counted.

The biggest difference existed in contracts for the private sector. In such cases, the majority of users (54%) used open geographical data/services rather than products offered by public administration on a paid basis. Compared to 35% of users buying geographical data/services from public administration bodies, only 11% of users bought geographical data/services from a commercial company.

OpenStreetMap was the most important example when talking about the open substitution of paid geographical data/services of public administration. OpenStreetMap was used in 90% of all cases in which open geographical data/services were used instead of those offered by public administration on a paid basis. Czech users would prefer to use the Fundamental Base of Geographic Data of the Czech Republic (abbreviated in Czech as ZABAGED); the key topographic map in scale 1 : 10,000. However, they were discouraged by its price of about € 13,800 for planimetric components and € 3,900 for altimetry for the area of the Czechia, i.e. 78,870 km^2. In total, 91% of respondents would rather use the national geographical data/services of public administration if they were free of charge. The most requested were the following geographical data/services:

– The Fundamental Base of Geographic Data of the Czech Republic (ZABAGED) – 70% of respondents;
– National products of laser scanning, the Digital Terrain Model of the Czech Republic in its fourth (DMR 4G) and fifth (DMR 5G) generations, and the Digital Surface Model of the Czech Republic in its first generation (DMP 1G) – 25% of responders;
– The national military reference dataset (abbreviated in Czech as DMÚ 25), the national dataset on road and railway networks and archived aerial images, as well as cadastral maps – 10% of responders.

The described situation started to change in the period between 2016 and 2020. The base map of the Czech Republic, abbreviated 'Data50', is published as open data since April 2019. The base map of the Czech Republic corresponding to the scale 1 : 200,000 ('Data200') was opened that time as well. The Czech Statistical Office and the Czech Hydrometeorological Institute have also opened their geographical data between 2016 and 2020. Note cadastral data remain opened since 2012, cadastral maps since 2014.

Figure 8 presents an overview of the five biggest barriers to the (re)use of geographical information as identified in the results of the questionnaire for users of geographical information. As expected, fees were the biggest barrier as recognized by almost half

of the respondents. The second biggest barrier was that metadata were weak. The quality of metadata, services and data itself has improved due to the coordinated approach taken between 2016 and 2020 as stated by INSPIRE Knowledge Base (2021). As noted with respect to the data (re)producer's point of view above, it remains a question how a user should evaluate the applicability of the discovered data when (s) he has (almost) no information on data quality. The third most important barrier lied in the area of communication between the (re)producer and user. The fact that methods of giving feedback were overcomplicated was highlighted, especially when comparing attempts to provide feedback on public and commercial geographical products; providing feedback on the latter was reported to be much easier.

The existence of license agreements and the fact that standardization efforts were not followed correctly were commonly mentioned as barriers within the geographical community. Surprisingly, the pan-European proposal of instituting unified INSPIRE licences had not helped the situation until 2015. In 2019, efforts have been made within the Coordination Committee to harmonise data in the INSPIRE infrastructure and use Creative Commons licence (CC 4.0). But there are still others whose legislative burdens prevent them from making data available under the CC 4.0 as stated by INSPIRE Knowledge Base (2021).

On the positive side, only less than half of users recognised barriers when using geographical information provided by public administration.

5. Discussion

Discussion is firstly structured with respect to the research questions of this paper and secondly with a broad discussion with primary focus on research presented within the years 2016 and 2021.

5.1 RQ1: "What (economic) decision(s) influenced the process of creating, maintaining and providing geographic data?"

Creation, maintenance and provision of geographic data seem to be the most influenced by ad hoc allocation of finances. Finances pertaining to geographic information were in the Czechia allocated ad hoc between the years 2011 and 2015, typically within the second half of the given year and used primarily to increase the quality of presentation to a wide audience. As such, finances were rather allocated primarily to extensions, modifications and updates of geoportal instead of investments to the quality of geographic data. Such a situation starkly contrasts with a plan-based approach in the United States of America, United Kingdom and Australia (ANZLIC 2010a, 2010b; DEWBERRY 2011; OXERA 1999).
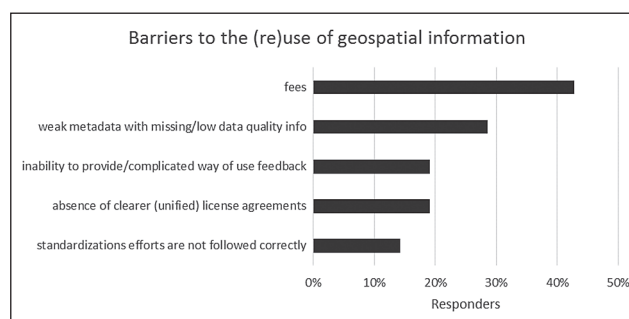

Fig. 8 Barriers to the (re)use of geographical information from public administration from the user's point of view.

It seems that the described trend was changed between 2016 and 2020 mainly due to the following aspects: (1) data of public administration became more commonly opened which appeals to their quality, (2) geoportals evolved to a complex optimised tools. The newly prepared Czech Strategy of Geographical Information Infrastructure (GeoInfoStrategy) after 2021 stresses the quality of geographic data even more than the preceding GeoInfoStrategy for years 2014–2020.

5.2 RQ2: "What geographic data, with respect to their license, do their main consumers prefer and really use?"

The results of the conducted study proved that the most commonly used geographic data were identical to the reference data as defined in Annexes I and II of the (European) INSPIRE directive (Directive 2007/2/ES). Namely in the order according to their use, transport networks, geographical names, administrative units, cadastral parcels, hydrography, orthoimagery, elevations, statistical units, soil, land cover, protected sites and land use belonged to the most commonly used spatial data themes throughout the Czech SDI (Spatial Data Infrastructure). This list of themes seem to remain stable as it was also confirmed by the INSPIRE monitoring and reporting data within the period from 2016 to 2020.

It was also confirmed in the conducted study that fees were the biggest barrier for the Czech users. Users preferred geographic data, services and maps provided by the Czech public administration; however were discouraged by their price and license restrictions that allow use only within the given time extent (typically up to five years). Such a situation changed within the period from 2016 to 2020. Several geographic data produced by public administration were opened within the last five years. More detailed examples are provided in section 4.4. Creative Commons licence (CC 4.0) became the most common used license throughout the geographic data published under the INSPIRE directive (INSPIRE Knowledge Base 2021).

5.3 RQ3: "What was the size of the market with geographic information created within the public administration, i.e. the available budget?"

Size of the market with geographic information within public administration is with its size of € 239 Mil. in average between 2011 and 2015 per 10 million inhabitants country comparable to other developed countries (ANZLIC 2010a). The annual support varied in the given period from € 210 to € 270 Mil. The five years time extent window showed a positive trend in finances allocation. The available budget increased for more than 25% within five years which was more than inflation that was 7.3% in the given five years period; 1.5% yearly average respectively (CZSO 2021).

The outcomes of the conducted study in 2016 remain also in the year 2021 the only empirical economic data on geographical information within the public administration of the Czechia. The Ministry of Interior uses the results of our study as a basis for economic considerations concerning the upcoming Czech (national) Strategy of Geographical Information Infrastructure from the year 2021 to 2027 (Kubátová 2017).

Companies from the private sector did not provide any economic inputs, as *a priori* expected. The full size of the Czech market with geographic information remains hidden.

5.4 General discussion

Purely economic considerations lead to a very different perspective compared to that of a scientist or a researcher. Since bodies of public administration are non-profit in the narrow sense of the word, revenues lost by the "opening" of data are considerably less important than the costs of investing in new hardware and software in order to service a significantly greater number of users. Paradoxically, geographical data/services are in some cases provided on a paid basis as a kind of a budget saving measure. Some believe that engaging in Public-Private Partnerships may present a way of reducing costs when data are published in an open form. However, the benefits of PPP remain questionable since respondents are divided into two polar opposite groups, i.e. strong supporters and strong opponents.

The lack of a life cycle definition seems to be the most important barrier to a more efficient geographical information financing. A plan-based approach like in the United States of America (DEWBERRY 2011), United Kingdom (OXERA 1999) and Australia (ANZLIC 2010a, 2010b), would be more suitable for the (Czech) public administration. Such a plan should be based on an analysis of the requirements with respect to inventorying or evaluating existing geographical information, obtaining new geographical information and accessing, maintaining/archiving and using/evaluating such information. The authors

of this paper proposed a methodology for developing a life cycle for geographical information which has been certified by the Czech Ministry of the Interior (as a complementary achievement to the conducted survey). At the same time, advice on establishing a cross-ministerial 'Fund for Key Geographical Information' was given in the form of a recommending report. Finances from the national budget and other resources such as EU project grants should then be assigned to a body of public administration according to the life cycle plan. Such an approach should help in reducing the cross-ministerial duplication of data and services, since intra-ministerial duplication has been eliminated by pan-European harmonisation achieved under the INSPIRE Directive (Directive 2007/2/ES).

The results of the conducted survey were classified between 2016 and 2020. The state-of-the-art analysis was performed in both time frames, in 2016 when the project finished, as well as in 2021 when this paper was revised. No surveys focused on economic aspects of geographic information have been conducted in Czechia since 2016. Relevant studies throughout the world with focus on economic values of geographical information paradoxically seem the same since no new major achievements have appeared since 2016 (Johnson et al. 2017; Pashova and Bandrova 2017; Coumans 2018; Lü et al. 2019; Craglia and Pogorzelska 2020).

6. Conclusions

Geographical information from public administration has an irreplaceable role in all kinds of human activities. On the contrary, it was shown that geographical information within Czech public administration did not boast direct profitability between the years 2011 and 2015. In other words, directly received revenues account, on average, for only 4% of the overall investment into geographical information. In the case of the Czech national mapping organisation, maximum direct revenues reached 21% of the total budget. The above mentioned numbers, however, provided only a black and white picture. If we want to see a more accurate representation between 2011 and 2015, we need to include also geographical information that was sold at zero price. A typical example is geographical information that was given to another body of public administration free of charge. If we include such 'virtual payments' for the Czech national mapping organisation, we conclude that for each euro invested into geographical information, € 0.45 are recouped. A further benefit arises with respect to activities undertaken on the basis of correct geographical information. That is, costs arising from mistakes are eliminated or reduced.

Empirical economic numbers have not been provided within Czechia and beyond since the conducted

experiment in 2016. Nevertheless, we see indirect economic impacts between 2016 and 2021. Opening the geographic information and unifying geographic data to Creative Commons licence (CC 4.0) seem the most important drivers for both, (re-)producers and users. Four geographic datasets in a scale up to 1 : 50,000 of the civil national mapping organisation were opened between September 2016 and February 2021.

The arguments presented in this paper are intended to assist all stakeholders contributing to geographical information. Note that even though the authors have attempted to provide as detailed economic survey as possible, the transferability of results from one country to another and/or upscaling from the Czechia to continental level is hardly feasible due to the variety of financial mechanisms used in different countries and at different levels. The obtained results are being used as inputs to the upcoming Czech (national) Strategy of Geographical Information Infrastructure from the year 2021 to 2027 as a more up-to-date study has not been performed so far.

Acknowledgements

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Development and state of the art of landscape science in Bulgaria

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ABSTRACT

The establishment of International Association for Landscape Ecology (IALE), European Association for Landscape Ecology (IALE-Europe) and European Landscape Convention (2000) contribute and support the exchange of different concepts and methods in the field of landscape science, and also scientific cooperation between European countries. However, the specifics of landscape science in Bulgaria are little known outside the country. This article deals with the development and status of landscape science in Bulgaria. It describes its main stages in the historical development, its main characteristics and makes some general conclusions and critical notes about the future development of landscape science in Bulgaria.

1. Introduction

The landscape science in Bulgaria has long tradition but it is poorly known outside the country due to the fact that most of the publications are in Bulgarian language. So it is not surprise that although in Bulgaria exist two landscape classifications and maps on national level and many for the part of the country none of them is included in the systematic studies (Simensen et al. 2018). Several documents (European Landscape Convention from 2000) and scientific studies (Shaw and Oldfield 2007; Simensen et al. 2018) encourage international scientific exchange of different theoretical concepts and methodological approaches in the field of landscape science because of the very complicated nature of landscape, and multiple meanings of the landscape developed in different scientific, and cultural contexts (Antrop and Van Eetvelde 2017; Miklos et al. 2019). This results in the observations that only a significant variety of methods are possible to cover the many different aspects of landscape and the many different planning and management scopes. To support this scientific challenge several international cooperation activities exists. The most important of them are the International Association for Landscape Ecology (IALE), founded in 1982 in Piestany (Slovak Republic – former Czechoslovakia), and the European Association for Landscape Ecology (IALE-Europe), founded in 2009 in Salzburg (Austria).

The aims of this article are: 1) to trace the development of landscape science in Bulgaria, its roots and historical traditions; 2) to describe the main landscape directions and branches that are developed in Bulgaria; 3) to make some conclusions about the state of the art of landscape science in Bulgaria; 4) to point some of the main new challenges in the future development of landscape science in Bulgaria.

Here we will present an author's overview of the main landscape directions, its current state and general features, as well as some of the most notable and representative publications for each branch. More complete list of the landscape publications in Bulgaria is included in the monograph "Landscape Geography of Bulgaria" (Velchev et al. 2011), and also in the article of G. Zhelezov and S. Nedkov (2019). Briefly here we want not only to present some critical introduction in to the landscape science in Bulgaria for a broader audience, but also to stimulate a further discussion about its future development and scientific problems.

2. Main periods in the development of landscape science in Bulgaria

Following the periodization of A. Velchev et al. (2011) there are three main periods in the development of landscape science in Bulgaria: 1) Prior to World War II. 2) Between 1970s years and the end of 1980s years.

3) After the beginning of 1990s years. The last period we will divide in to two sub periods: 3a) Between 1990s years and the beginning of the new millennium 2000. 3b) After the beginning of the 2000s.

During the first period to the landscapes in Bulgaria pay attention foreign scholars like T. Fisher, O. Maull and A. Burchard. First Bulgarian scholars who mention the term landscape in scientific works were Zheko Radev and Dimitar Yaranov. First publication dedicated to landscapes of Bulgaria was published by Ivan Batakliev with the title "Landscape division of Bulgaria" (Batakliev 1934) (Fig. 1). Later Ignat Penkov published the essay "Cultural landscape" (Penkov 1943). At that time the landscape publications in Bulgaria were influenced mostly by the German-speaking geographical science and the most notable scholars like S. Passage, A. Hettner, O. Maull, and H. Hassinger.

After the WWII the development of landscape science in Bulgaria was suspended. Professors D. Yaranov and I. Batakliev were released from Sofia University for political reasons. The other authors abandon the use of the term landscape and research on landscape topics.

The second period began in the early 1970s, when I. Ivanov, D. Dimitrov and P. Penchev published an article discussing the state of the art of physical geography in Bulgaria (Ivanov et al. 1970). In this publication they pay attention to the need to study natural complexes (systems): the landscapes. A little later was established the Department of Landscape Science at the Faculty of Geology and Geography of Sofia University, and the Section of Landscape Science at the Geographical Institute of the Bulgarian Academy of Sciences. A few years later, a number of authors began publishing researches on landscape topics. Among the first of them were P. Petrov, M. Georgiev, K. Mishev, and A. Velchev. Later, others were included, and the
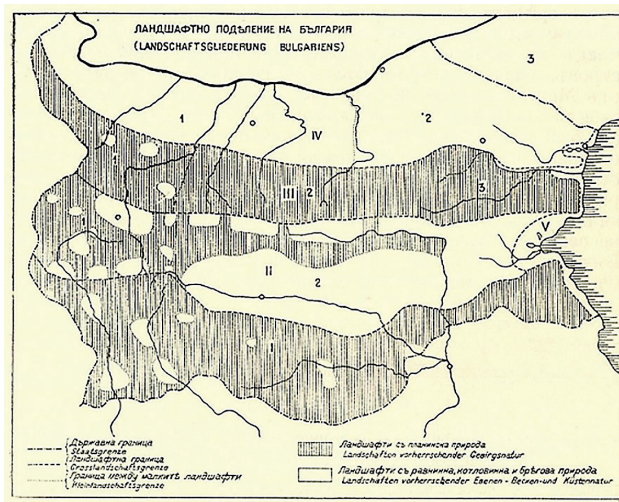

Fig. 1 Sketch map of landscape divisions of Bulgaria by Ivan Batakliev: area with hachures shows landscapes with mountain nature; area without hachures shows landscapes with plain, lowland and valley nature (Zhelezov 2020).

number and thematic scope of publications increased significantly. At that time, Bulgarian landscape science was oriented and adopted the theoretical and methodological concepts of the landscape science developed in the former Soviet republics and especially in Russia. To a lesser extent was the influence of landscape concepts from other former socialist states such as the former East Germany, Poland and the former Czechoslovakia. This influence increased at the 1980s, especially after the establishment of IALE in 1982 (in former Czechoslovakia).

The third period in the development of landscape science in Bulgaria started after 1990. During this period Bulgarian science opens to the theoretical and methodological concepts of landscape ecology developed in countries such as the former West Germany, USA, France and others. During the first sub period in the Bulgarian landscape science the theoretical concepts of landscape ecology began to spread and to be better known. During the second sub period (after the start of the European Landscape Convention in 2000 and its ratification by countries) not only theoretical but also methodological concepts from landscape ecology began to penetrate in the Bulgarian landscape studies. Also during this sub period the number of landscape publications published in international scientific journals by Bulgarian authors or with Bulgarian participation significantly increase.

3. Basic theoretical concepts of landscape science in Bulgaria

In the theoretical concepts of the Bulgarian landscape science the strongest is the imprint of the Russian landscape science (the Russian "landshaftovedenie"). It is based on the main contributions of Vasily Dokuchaev, who besides being known as the founder of modern soil science (Bockheim et al. 2005; Brevik and Hartemink 2010; Blinnikov 2011; Johnson and Schaetzl 2015; Rodrigo-Comino et al. 2017) has a contribution even to the environmental history of the steppes (Moon 2005). In the landscape science he is author of the essay "Toward the Study of the Zones of Nature" from 1899 in which he grounded the doctrine of the horizontal and altitudinal natural zones. Later in 1913, Lev Berg introduced the term landscape (from German "landschaft"), called Dokuchaev's natural zones landscape zones, and linked the science of landscape inseparably to the tradition of geography (Shaw and Oldfield 2007; Oldfield and Shaw 2016). In the essay "Toward the Study of the Zones of Nature", Dokuchaev wrote that in the past scholars studied "individual bodies – minerals, rocks, plants and animals – and phenomena, individual elements – fire (volcanism), water, earth, air, in which science has achieved amazing results, but not their relations, not this genetic, age-old and always

regular connection that exists between forces, bodies and phenomena, between nonliving and living nature, between the plant, animal and mineral kingdoms on the one hand and man, with his way of life and even spiritual world – on the other" (Dokuchaev 1949). With this Dokuchaev continued those searches that Humboldt began (although Dokuchaev does not mention Humboldt explicitly) – the study of the relationship between living and nonliving nature (Wulf 2015; Antrop and Van Eetvelde 2017). Although Humboldt mention the landscape in his works primarily from a physiognomic and aesthetic point of view, he paves the way for future research into these complex relationships with the discovery of plant-climatic horizontal and altitudinal zonation (Humboldt and Bonpland 2009; Egerton 2009; Buttimer 2012; Debarbieux 2012; Arraes 2018). In German geography, the Humboldt's perspective was developed in the concept of landscape first by O. Schlüter and S. Passarge (Martin 2005).

In the conceptions of the landscape adopted by different authors, certain similarities and general positions can be established, as well as some differences, which we will try to summarize below. Among the characteristics of the landscape that are recognized by most authors we can outline the following: 1) the landscape is a complex system and like any system is made up of interacting and interdependent components; 2) the landscape has spatial integrity so it is a natural-territorial complex, limited in space and including all natural components of a given area ("spatial whole"); 3) the landscape does not have a specific biotic or abiotic center (unlike the ecosystem, which is biocentric) (Fig. 2); 4) the landscape is an open system that constantly interacts with the surrounding space – terrestrial and cosmic, as well as with society (human activity); 5) the landscape is a dynamic ("multidimensional") functional system, which is characterized by certain changes over time.

These characteristics constitute the basic theoretical core of the term landscape. At the same time, several directions are formed related to the differences in
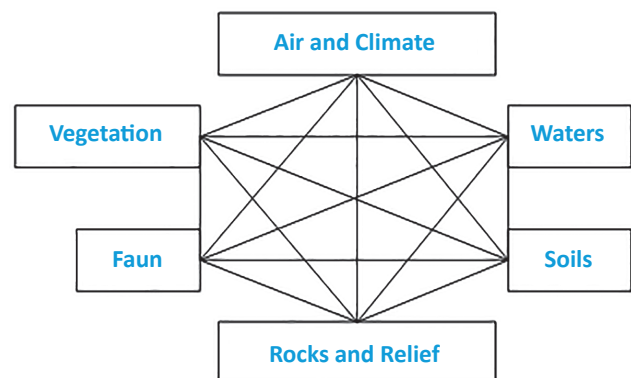

Fig. 2 Natural landscape as geosystem and "spatial whole" – landscape components and their interconnections.
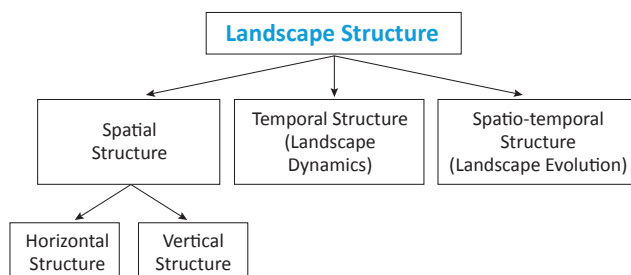
Fig. 3 Chart illustrating the different types of landscape structure.

the interpretation of the different groups of authors, in which the landscape can be understood differently: 1) as a geographical individual, a regional concept, which is one of the hierarchical levels in the physical-geographical differentiation; 2) as a typological concept of different rank, a result of a summary of certain characteristics of the territory, giving it relative homogeneity; 3) as a general concept, synonymous with a natural-territorial complex, both typological and regional.

In the Bulgarian landscape science the views about the landscape as a general concept or as a typological concept prevail (unlike in the Russia where the regional concept is the most widespread).

Apart from the term landscape, other concepts related to the subject of landscape research are also important to be described. One of them is the concept of the landscape structure (Fig. 3). In a narrower sense, the Latin term structure means a pattern, an arrangement of the parts that make up a particular object. In this narrow sense, it usually refers only to the spatial structure of landscapes, which in turn is horizontal and vertical.

In a broader sense, the general definition of structure is the spatio-temporal organization of the geosystems (Velchev et al. 2011). This, in turn, requires that not only the spatial but also the temporal aspect should be taken into account in the aspects of the structure. So some scholars distinguish also temporal structure and spatio-temporal structure both related with the landscape changes.

Many scholars accept the concept that landscape changes are divided into: evolution (or development) – qualitative, irreversible changes of the system; dynamics – mainly quantitative, conditionally reversible changes (for instance diurnal or seasonal changes) (Penin 2007).

4. Main directions of landscape science in Bulgaria

The landscape science in Bulgaria covers various directions and branches. Only the main of them will be described here. Some publications discuss theoretical questions and landscape concepts. A lot of them are

concern with regional research and landscape mapping of specific parts of the country. Another main direction is landscape classification and also regionalization of the county based on landscape map. One direction witch is very extensive in its development is landscape geochemistry. Among with it a specific branch is landscape geophysics. We will discuss them in more detail below. Another very important branch in landscape researches is human impact on landscapes: landscape anthropogenisation (the study of different aspects of landscape transformation by human activity) and landscape deanthropogenisation (self-restoration of landscapes after reducing or terminating human activity). Several studies are concern with applied landscape science – landscape evaluation for specific purposes (agriculture, forestry, recreation etc.). Some new directions are landscape ecology and landscape planning, and also ecosystem services. Most of these directions are reflected in the university programs at master's levels (Penin and Konteva 2013).

Some of the most important publications in Bulgaria include: university textbooks (Petrov 1990; Penin 1997; Petrov 2011; Borisova 2013); monographs (Yakushko et al. 1983; Velchev and Petrov 1993; Velchev et al. 2011; Todorov and Velchev 2014; Cholakova 2018; Nam 2021); dictionaries (Penin 2007).

5. Landscape classification and mapping – the study of the horizontal landscape structure

The landscape maps are common basis for characterisation of the horizontal landscape structure. The map's cartographic legend reflects the landscape classification. There are a wide variety of landscape classification schemes. At this stage, two classification systems have been developed and applied for
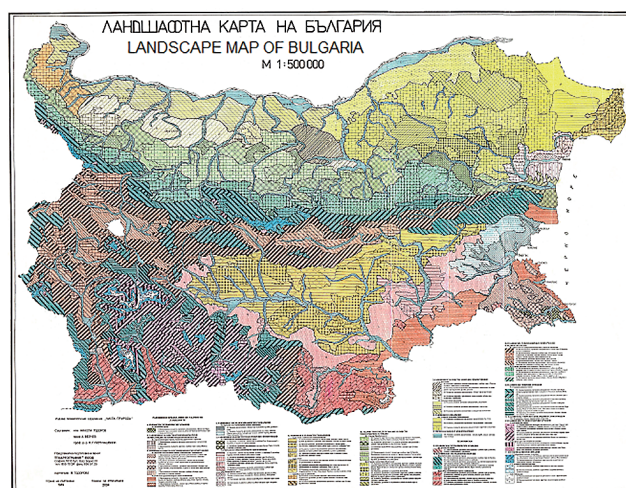

Fig. 4 The second landscape map of Bulgaria by A. Velchev et al., form 1992, at scale 1 : 500,000 (Prodanova and Petrova 2020).
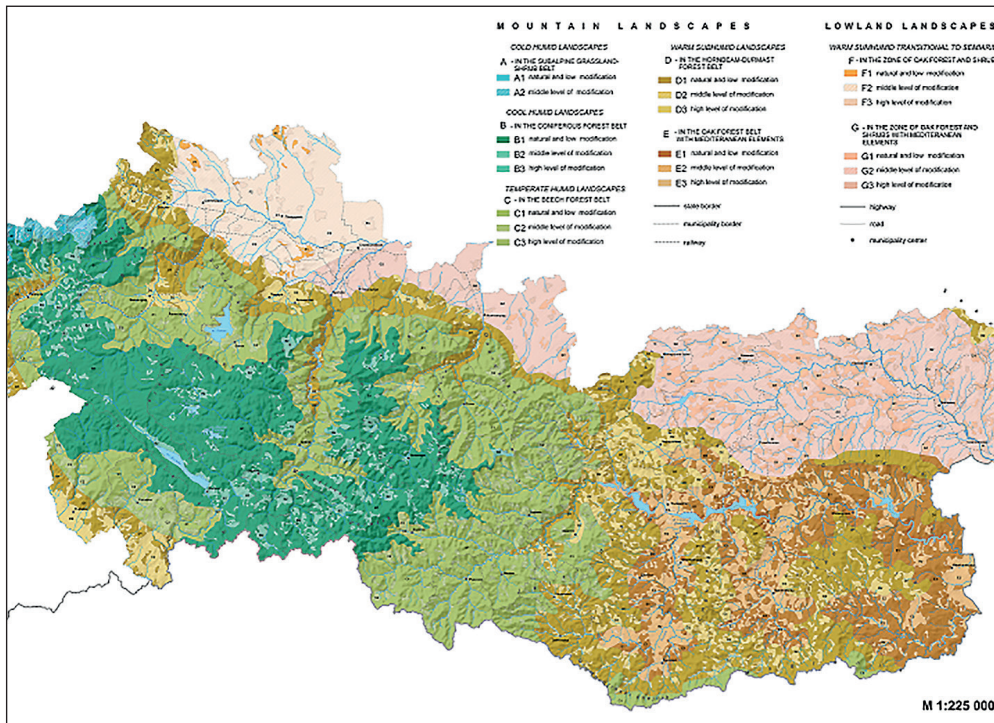
Fig. 5 Landscape map of Rhodopes at scale 1 : 225,000 (Gikov and Nedkov 2008).

the whole territory of Bulgaria. The first follows the classification scheme of N. Gvozdetsky and was used to compile a landscape map of Bulgaria at a scale of 1 : 400,000 (Petrov 1979). The second follows the classification scheme of N. Beruchashvili and was used to compile a landscape map of Bulgaria at a scale of 1 : 500,000 (Velchev et al. 1992) (Fig. 4). Along with them, a number of variants and modifications of the above two classifications and even completely new classifications have been proposed, which have been applied only to certain parts of the country (Velchev et al. 2011; Petrov 2011).

The two landscape maps of Bulgaria represent only the natural (potential) landscapes not taking in to account the landscape anthropogenic modifications. There is currently no landscape map at national level representing cultural landscapes or so called contemporary landscapes. Such maps exist only for the parts of the country. A good example for modern landscape mapping of contemporary landscapes with implementation of GIS is the "Atlas of Contemporary Landscapes of Rhodopes" (Gikov and Nedkov 2008) (Fig. 5).

The first landscape web-map was compiled for Vitosha Mountain (Tzvetkov 2017; see internet sources) and it includes two maps: of potential landscapes (Fig. 6) and of landscape anthropogenic modifications (Fig. 7).
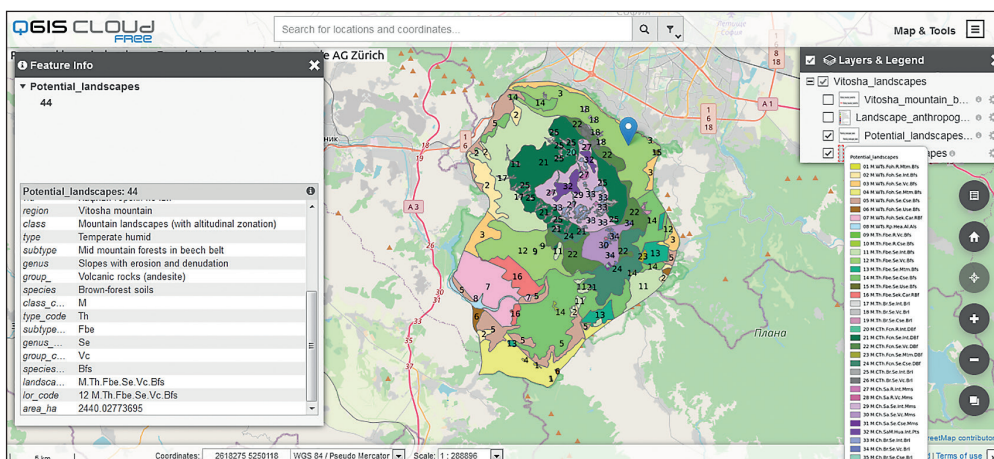

Fig. 6 Web-map of potential landscapes of Vitosha Mountain with feature info window.
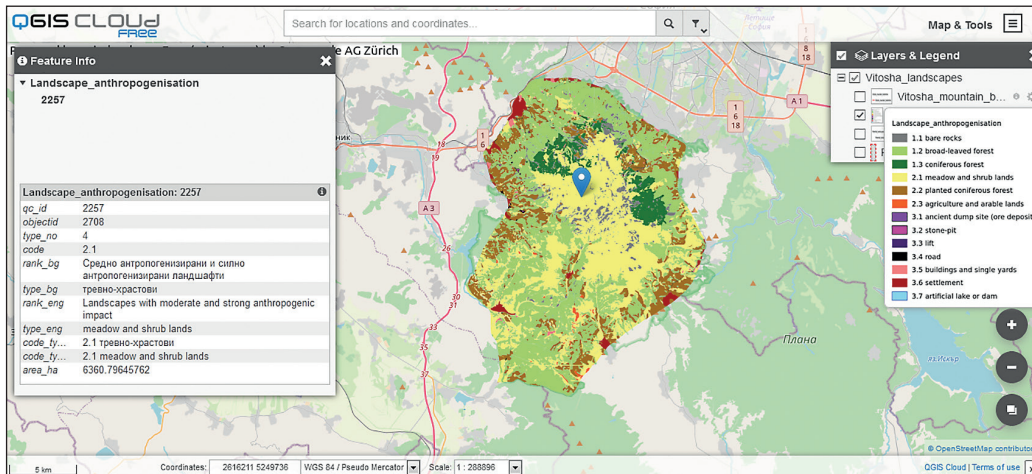
Fig. 7 Web-map of landscape anthropogenisation of Vitosha Mountain with feature info window showing the attributes of the selected feature.

6. Landscape geophysics – the study of the vertical landscape structure and landscape dynamics

The landscape geophysics is related to the study of the physical properties of geosystems – the processes of exchange of matter, energy and information, both within the geosystems themselves and between geosystems. In Bulgaria landscape geophysics follows a specific school developed by the Georgian geographer N. Beruchashvili (Gachechiladze et al. 2017). He developed his own theoretical concepts and methodological approaches to study the vertical landscape structure and landscape dynamics (Beruchashvili 1986, 1990). These methods can be applied on field,

semi-stationary and stationary researches. Generally in this approach he distinguishes so called geomasses – elementary structural and functional parts of the landscape. They are qualitatively heterogeneous bodies characterized by a certain mass, specific functional purpose, rate of change in time and speed of movement in space. He defines the following seven classes of geomasses: aeromasses, phytomasses, zoomasses, mortmasses (mass of dead organic matter), lithomasses, pedomasses and hydromasses. Each class is subdivided in to diffident types and subtypes and all of them have short indexes (abbreviations). Geomasses differs from landscape components (see Fig. 2) with greater material homogeneity. The component is practically a complex formation and different geomasses are present in it, but one of them
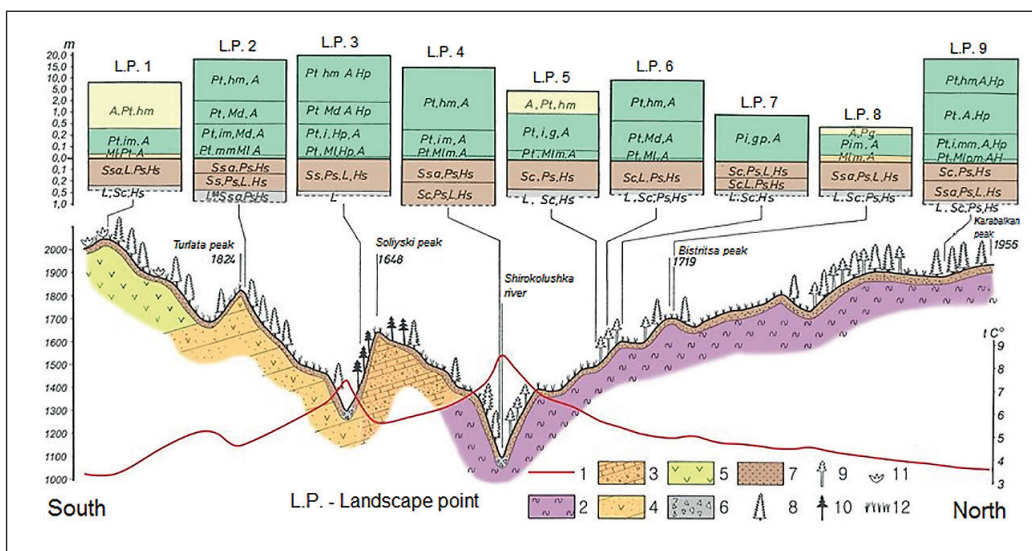

Fig. 8 Landscape profile in Rhodopes with nine landscape points and their landscape geophysical characteristic showing vertical structure described as geohorizons. Legend: 1) Mean annual temperature; 2) Metamorphic rocks; 3) Paleogene sedimentary rocks; 4) Paleogene sedimentary and volcanic rocks; 5) Paleogene volcanic rocks; 6) Alluvial deposit; 7) Brown forest soils; 8) Picea abies; 9) Pinus sylvestris; 10) Pinus nigra; 11) Juniperus sp.; 12) Herbaceous vegetation (Nikolova et al. 1997).

always prevails and is the basis for its substrate. Also he proposes that the vertical structure of the elementary landscapes may be presented as different geohorizons, which are homogeneous combinations (layers) of a certain set of geomasses, characterized by a series of specific landscape-geophysical features. The main characteristics of geohorizons are: thickness; complexity (number of geohorizons); intensity (number of geohorizons per 1 m of the vertical profile) and composition (the set of specific geohorizons for a given landscape). For instance a part of this research approach and its visualization is shown on Fig. 8.

These methods for field and stationary researches are applied mostly in Southwestern Bulgaria (Todorov, Velchev 2014). Here is situated also the only one landscape stationary in Bulgaria (scientific base of Sofia University "St. K. Ohridski") near the city of Zemen, Pernik district (Velchev and Petrov 1993).

7. Landscape geochemistry – the study of the chemical elements in landscapes

The behavior of atoms in natural processes is a research subject of many sciences, which leads to the emergence of a number of interdisciplinary scientific fields. At the boundary between geography and chemistry is the landscape geochemistry, studying the history and behavior of atoms in landscapes. Among its important goals are to reveal the patterns in the migration, concentration and differentiation of chemical elements and compounds in the landscapes (Perel'man and Kasimov 1999). The founders of this branch are B. Polinov, M. Glazovskaya, A. Perel'man and also V. Vernadsky, and A. Fersman. They developed the theoretical and methodological basis of the landscape geochemistry both for scientific and for practical proposes. The former include many different tasks from discovering of ore deposits to environmental pollution assessment (Perelman and Kasimov 1999; Kasimov 2013).

The concepts of landscape geochemistry are known in different countries from Poland (Ostaszewska 2010) to Canada (Fortescue 1992) and China (Yu et al. 2019). Several scholars have pointed out that landscape geochemistry has more in common with the better known to the international scientific community environmental geochemistry (Fortescue 1992; Yu et al. 2019).

In Bulgaria it is widely used for environmental assessment of some trace elements (e.g. Cu, Zn, Pb, Cd, As, Co, Cr, Ni, Mn etc.) and its pollution. For several decades of researches all over the country the data accumulation allows estimating the geogenic (for background regions) and technogenic (for polluted regions) concentrations of some trace elements in soils and bottom sediments of the country (Penin 2003) as it is shown on Fig. 9 and Fig. 10.

7. Ecosystem services – the evaluation and mapping of landscape and ecosystem services

The study of ecosystem services is a brand new direction in landscape ecology. It spread fast thought the scientific community and penetrates in Bulgaria where several scholars were involved in to it (Zhelezov and Nedkov 2019). This lead to a new international scientific collaborations and a series of publications, most notable of which are connected with regional studies and ecosystem valuation (Nedkov 2011; Nedkov and Burkhard 2012) as well as novel methods for mapping ecosystem services (Burkhard et al. 2012). The research and assessment of the ecosystem services are mainly concerned in the mountain areas of the country, although several researches are accomplished in municipalities with more diverse landscapes (Nedkov et al. 2018a), in urban landscapes (Nedkov et al. 2018b), and for natural heritage on national level (Ihtimanski et al. 2020). Some of these studies are included in comparative analysis of case studies in EU and allow involving Bulgaria in intensive international exchange of theory, methods and policy in the field of ecosystem services (Geneletti et al. 2020).
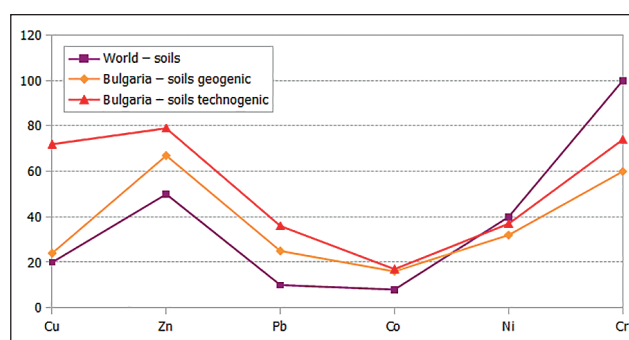

Fig. 9 Diagram shows some trace element concentrations (in ppm) in world soils (Kirkham 2008), Bulgaria – soils geogenic regions (Penin 2003), Bulgaria – soils technogenic regions (Penin 2003).
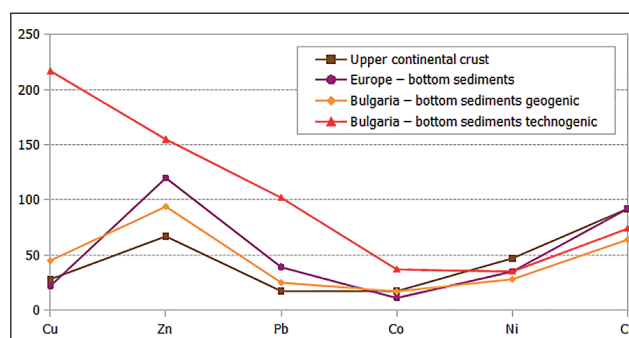

Fig. 10 Diagram shows some trace element concentrations (in ppm) in upper continental crust (Rudnick and Gao 2014), Europe – bottom sediments (Salminen 2005), Bulgaria – bottom sediments geogenic regions (Penin 2003), Bulgaria – bottom sediments technogenic regions (Penin 2003).

8. Conclusions

Several important conclusions are possible to express about the development and state of the art of landscape science in Bulgaria. Here we will try to outline the pros and cons as well as not only past and current features but also the future trends.

The development of landscape science in Bulgaria has long traditions but its development was not continuous through the years. From 1945 to 1970 there is a hiatus in this development due to the political reasons. Also during some periods (e.g. between 1945 and 1990) its development was strongly dependent by the political development of the country and this political context has its imprint to the whole scientific development. This is common for every former socialist's country but even in this every country has its own specifics and among with the political context also cultural and personal factors shape the development of landscape science in Bulgaria.

The landscape science in Bulgaria store some theoretical and methodological concepts influenced by Russian landscape science which imprint a specific scientific content. This content differ form some widely (if not globally) adopted concepts of the landscape ecology. This in turn is an obstacle for international collaborations. In an attempt to overcome this it is crucial to reevaluate these concepts and to preserve best of these traditions keeping some of the most valuable concepts. (The hastily tendency to abandon most if not all of them may lead to the paradox that in time they will have to be rediscovered.) But that is not enough. These concepts should be developing further and at least but not last they should be spread to the international scientific exchange. Here we propose that the concept of landscape as geosystem, spatial integrity of landscape, the "multidimensional" view of landscape (the concepts of landscape structure), and the landscape typology are core scientific approaches.

During the last decades in Bulgarian landscape science penetrate some theoretical and methodological concepts form the landscape ecology. However these concepts are still relatively little known and even less applied in specific studies in Bulgaria. This is valid especially for statistical landscape analysis methods.

One significant disadvantage of the current state of the landscape science is that Bulgaria still don't has a digital landscape map which presents the contemporary landscapes ("cultural landscapes") and its anthropogenic modifications created by the modern GIS. This is a key factor for slowing the development of landscape science in Bulgaria and also for impedes the application of landscape theory in practice and in landscape planning.

One specific advantage is the strong developing of the landscape geochemistry but is should be more linked to the practice of governmental institutions in environmental protection and public health management. During the last years there is a trend to abandon the landscape geophysics. Some scholars shift their scientific interests to new branches like remote sensing and ecosystem services. This trend is a result of the implementation of new methods and the tendency to expansion of the remote sensing and GIS and reduction of the "old fashion" field methods.

Here we argue and call that the further development of landscape science in Bulgaria should preserve the main branches described above, and continue to enrich with new ones. This enrichment should be done in more intensive participation of Bulgarian scientist in to international activities connected with the International Association for Landscape Ecology (IALE), European Association for Landscape Ecology (IALE-Europe), and also other international scientific and research networks (like Landscape Europe, Landscape Tomorrow, UNISCAPE, CIVILSCAPE etc.).

Acknowledgments

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Internet sources

Web-map of landscapes in Vitosha Mountain URL's:
Webmap: http://qgiscloud.com/jdgis/Vitosha_landscapes
WMS: http://wms.qgiscloud.com/jdgis/Vitosha_ landscapes
The classifications of the potential landscapes and landscape anthropogenisation impact in Vitosha, presented like full attributive tables of the GIS layers can be found on the following URL: https://goo.gl/EKHWxH

The effect of public space indicators on the rural district's life quality in Kuhdasht county, Iran

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ABSTRACT

This article evaluates nine rural districts in Kuhdasht county, Iran, with a population of 3535 between 2013–2016. We address the following two questions: First, what are the most important criteria and effective indicators in the rural population's quality life enhancement? Second, is there any significant relationship between the public space indicators and quality life enhancement in the case study area? Six factors, including perceptual vision, buildings skeletons, culture and communities, activities, social interaction, and the environment from local peoples' perspectives, explained 52.6 percent of the total variable variances. The Friedman test showed a significant difference among criteria of esthetics, semantic-perceptual, and activity-based functional at the alpha level of 0.01. The fitting growth regression model showed that the positive effect of the public space indicators on the rural population's vitality and dynamism quality enhancement was about 0.723, indicating a significant relationship between them. It also stated a vital role of public space indicators in the rural population's vitality and dynamism quality enhancement in the study area. The most important indicators were those of economic, social, and cultural dynamism and the body and space indicators.

1. Introduction

In recent decades, the growing concern of traditional landscapes disappearance and emergence of new ones was paramount importance, not only in developing but also in developed countries. This led to fundamental changes in cultural and traditional landscapes namely types, settlements and landscape's identity (Stockdale and Barker 2009; Meeus et al. 1990; Jung and Ryu 2015). Therefore, the traditional landscapes of the villages should be considering and protect globally in interdisciplinary and interdepartmental frames, in order to pave the way for the environment's protection, attraction and cultural identity. Today, considering the change in youths and elderlies' tastes and behaviors, equipping the rural spaces with the standard furniture adaptable to the sociocultural behavior and rural customs have become a necessary issue (Johnson and Glover 2013). Since, the rural perspective with different semantic, applied, and body dimensions is of high significance in rural space visual organization and quality, it is remarkably effective in visual and structural integrity of the buildings, streets, and places constituting the rural space and environment. Thence, these structures caused the villages to be like a living being possess quality life and dynamism providing people with attractiveness and security (Węziak-Białowolska 2016). Therefore, dynamism in villages is vitally important. The purpose of the current study is to investigate the influence of public spaces indicators on the rural population's quality life and dynamism quality enhancement in the focused zone (Beck 2009). This study fills the gap in the literature in a way that not only it studies rural furniture and landscapes but also effective factors on them and their influence on the rural population's quality life and dynamism quality enhancement. This study, aims at answering the following research questions:

1. What are the most important criterions and effective indicators in the rural population's quality life population enhancement?
2. Is there any significant relationship between the public space indicators and quality life enhancement in the focused zone of the study?

1.1 Scholars' views towards public spaces

Based on the public connotation of space, the concept of public spaces has been put forward by scholars. Chen Bo believes that public space is the place and carrier for Local people to participate in Economic, Social and cultural life, which has both geographical spatial significance and sociological sense of public spirit and belonging consciousness (Zhong 2020). Moroni and Chiodelli (2014): "Public (state owned) space is the most likely setting for polemical scenes that start conversations about the public good. Public space should not be viewed only as a site for leisure or recreation but also as a place where people can come together to meet as citizens rather than as consumers or clients."

People's public life occurs in urban-rural public spaces in a complex set of forms and functions; accordingly, these spaces must be capable to contain diverse behavior, uses and activities such as shopping, walking, conversation, using the facilities to entertain, relax or even passing the time as daily activities, and also periodic festivities and events (Jalaladdini and Oktay 2012).

These public spaces interpreters discussed how the space and environment affect people, their feeling, and behavior. The discussion of the public spaces' issues categorized into three sections: 1. Physical characteristics of the spaces; 2. Activities happening in the spaces; and 3. the definition of space. These are three sections as 'morphological dimension', 'social and functional dimension' and 'perceptual dimension' (Majedi et al. 2014). According to Carmona et al. 2010; Orum and O'Neal 2009, public space performs several functions, including: 1. Liveability relevance: For example, streets for pedestrian and vehicular movement, parks, hospitals, etc.; these public spaces relate to certain essential aspects of our being individuals with a body (and hence with the need to move through space to reach other places, to sit and rest, to breathe clean air, go jogging, receive medical assistance, etc.); 2. Sociability relevance: For example, squares, sidewalks, etc.; such spaces enable us to meet other people; 3. Political relevance: For instance, plazas, public halls, etc.; these spaces provide arenas for public debate on civic issues or in which people can demonstrate and protest.

Gehl and Gemzøe (1999) also showed how the public spaces' environment quality affect people's manner and amount of using them. Based on Gehl, public spaces' activities are recognizable in three sections namely necessary, voluntary, and social activities. When a space suffers from a low quality, the necessary activities are the only type happened in it. With the space quality enhancement, not only necessary activities, but also a plethora of voluntary and social activities will be probable to be happen and people will have more tendencies to do them (Gehl and Gemzøe 1999) (Figure 1).
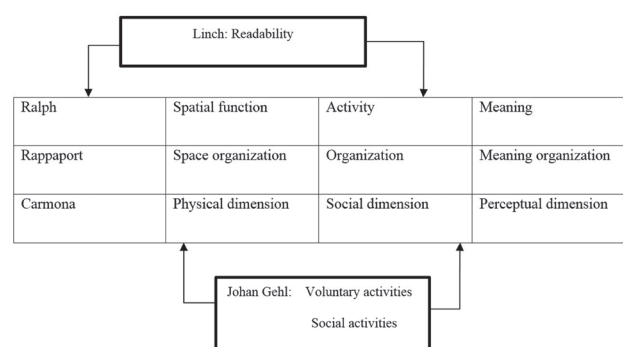

Fig. 1 Relationship between human and space (Gehl and Gemzøe 1999).

Therefore, besides having physical dimensions, public space is a systematic space and a compound essence, which are intertwine with social time and society's culture in a way that society's sociocultural, economic, and political proportionality play a crucial role in perceiving it (Jung and Ryu 2015). The information provided in Table 1 help to define the public spaces, function measurements, and to understand the public spaces' key characteristics.

Tab. 1 Important approaches in defining and analyzing public spaces.

Researcher	Definitions	Key characteristics of the approach	Key characteristics	Main functions
Carr et al. (1992)	– Space is considered as a common ground on which people connect the functional and ritual activities of a society whether in normal life or periodical festivals	– A connection for the ritual and functional activities – A common public space	– Responsible, democratic, and meaningful	Tranquility (connection and interaction)
Zukin (1195)	– Public spaces regularly choose the signs and borders of the society as the topic of discussion – Public space is a tool for peoples' social life perspective adjustment	– A key for societies' discussions – A key for the toleration of the differences for entering the social life – A key for interactional situation – A key for enhancement of the social life's perspective	– Equity participation, identification, information and connection exchange	
Landry (2000)	– Public space is a complicated, protean, and instable space – Public spaces are the reflection of the human efforts with reference to which social worlds manufactures are designed, adapted, and interpreted – Public spaces are open spaces for public discussions and displeasure statement	– A key for public discussion and their interpretation – A key for peace and philandrophy	– Cooperation, creating social networks and institutions	
Martin and Brshav (2005)	– It is a space which includes activities, events, inspirations and stimulation enhancing the public space quality – It is a space that despite the differences, it functions as a place for meetings, bazar, and traffic	– A key for the diversification of the activities – A key for cooperation and lessening the differences	– Social partnership and social network	Protection
Bentley (2011)	– Public space covers all the regions that are open to the peoples of the society originally not necessarily operationally – Public space is a space that is created and protected by governmental officials and are accessible to people	– A key for accessing to a public space – Governmental perspective for public assesses – A key for accessing to an environmental opportunity	– Social justice, democratic and meaningful	
Jacobs (1961)	– Public space (comprehensive definition) designed related to all the sections of the environment such as public and private, inner and outer, urban and rural. It Is a space where people are free like streets, squares etc. and includes mostly residential, commercial, and social-civil usage	– A key for social justice in countyand village – A key for respecting others' rights – A key for equity participation – A key for public access	– Social justice, equity participation, cooperation and strengthening people	Pleasure

Todays, the villages' important role in economic, social, and political development in regional, local, and international scales and the sequences of being underdeveloped lead to a special attention toward the rural development. So, most researchers believe that rural development's the introduction to the sociopolitical and cultural development concluding in national level developments (Hartel et al. 2014). Rural public spaces should be able to satisfy the spiritual needs and provide people with an acceptable level of quality.

The rural population public spaces' quantitative needs could be dived into three categories of protection, tranquility, and pleasure. Protection is composed of traffic, security, limitations and unfavorable atmosphere conditions. Tranquility is composed of walking, stopping, sitting, watching, speaking and listening as well as activities and plays. Pleasure, includes visual quality (nature, sunshine, wind, breeze, and plants) which are perceived through senses (Helen 2009).

Therefore, based on what mentioned above, it could be said that the visual and environmental tranquility are the crucial and important components of secured rural environment. For instance, proper color usage in designing the rural furniture is one of the proper solutions in customization of the rural appearance and plays a crucial role in perceiving the environment in a way that the colors are perceived in their best condition by people who are between 16–35 years old (Tveit 2009).The most important function of public spaces in rural tranquility enhancement can be divided into three categories of protector, tranquility and pleasure, which are shown in Figure 2 (Kavvakebi et al. 2012).
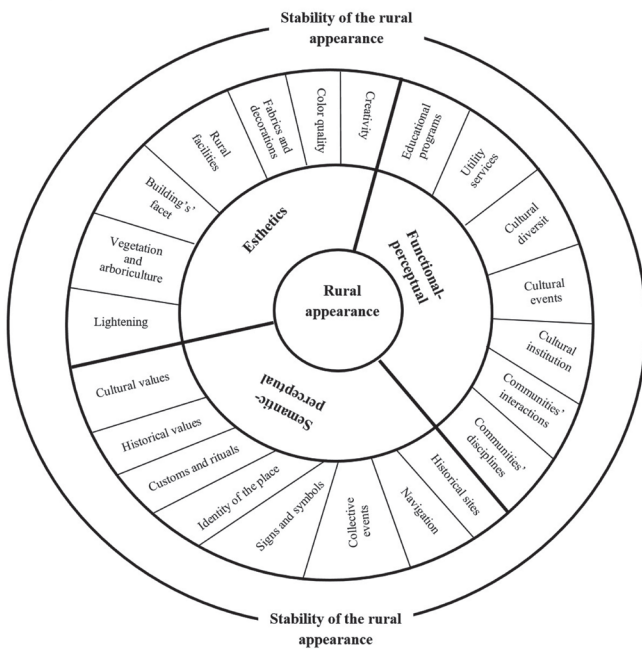
meaning quality of life, should replace "livability" when referring to the quality life. Charles Landry also analyzed the meaning of quality life in a different manner by differentiating quality life with an approach consisting of four main topical functions including economic quality life, social quality life, and cultural and environmental quality life and liveliness. Therefore, a vital space is spaces in which people spend large amount of their time not obligatory but voluntary (Tveit 2009). Table 2 shows effective factors on quality life from theoreticians' perspectives.

Continuity of the people's settlement in villages can be the source of economic and cultural civilization of a society. With keeping and protecting the rural landscapes and perspectives of villages and the esthetic quality of their spaces, not only can it be updated with the changes in technology, industrial and economic system, but also can stabilize and strengthen the rural culture and civilization and pave the way for the rural population's quality life and dynamism quality enhancement. Some researchers believe that economic factors such as low level of poverty, job possession, appropriate levels of life

Fig. 2 Public spaces functions in rural regions.
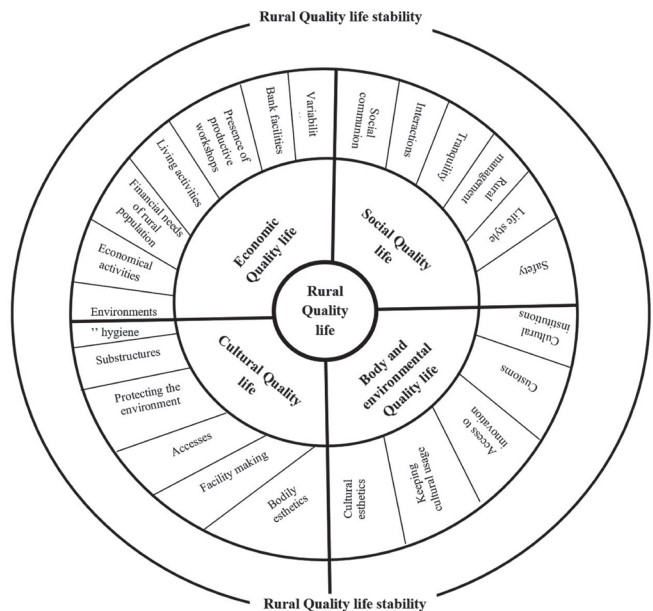
Fig. 3 Functions of public spaces in rural areas.

1.2 Rural population public spaces and Quality life

Quality life can simply be defined as "the cap county of a phenomenon for survival and growth". In micro level quality life can be defined as the variety of activities in public area and its adaptability with urban and rural spaces in a framework of similar structures of the behavioral state (Idris et al. 2016). The England's architecture and built environment committee head believes that the word "Quality life",

expenses and income, and access to appropriate credits are indicators of villages quality life. In body dimension, researchers view the quality life indicators as the presence of appropriate substructures locals' desirable access (Whisler et al. 2008), desirable dwelling, appropriate life facilities (Besser et al. 2009), and educational spaces. Figure 3 describes the criterions and indicators of villages' quality life from them the insights were gotten for designing the questionnaire and dependent variables

Tab. 2 Effective factors on the quality life from theoreticians' perspective.

| Theoreticians	Effective factors Quality life
Landry (2000)	This scholar differentiates Quality life and liveliness: – Quality life types: economic Quality life, social Quality life, cultural Quality life, environmental quality life – 9 necessary criterions for Quality life and liveliness: useful population density, access diversity, safety, identity and differentiation, creativity, connection and collaboration, organizational capacountyand competition
Martin and Brshav (2005)	This scholar believes that health control includes three main parts: – attractiveness: trade and exchange, services, residential, arts, culture, entertainment, retailing – access: deliveries and changes, public transportation, walking and cycling, options for special people with special needs, personal vehicle – tranquility: private spaces and privatizing, streets' appearance, feeling of safety in public area, identity and safety Quality making Quality life: 1. Diversity, 2. Good public spaces, 3. Purchasing and traveling, 4. Public transportation Effective functions in Quality life and diversity: 1. Decrease in city-dwelling, 2. Activeness, 3. Social change, 4. Leisure and traveling
Bentley (2011)	Quality of furniture and designing: 1. Permeance, 2. Diversity, 3. Readability, 4. Flexibility, 5. Visual adaptability, 6. Richness, 7. Privatizing ability, 8. Energy consumption productivity, 9. Cleanliness and having the lowest level of air pollution, 10. Protecting and supporting the nature and wild life (protecting ecosystems)
Jacobs (1961)	– Necessity of the combination of main usages (usage diversity) – Necessity of the short blocks (body diversity) – Necessity of the buildings with different age and situations (body diversity) – Sufficient density of population (activity diversity)
Lynch (2004)	– 1. Survival, 2. Safety, 3. Adaptability, 4. Health providing and genetically diverse creatures, 5. Present and future stability of the biological society Mostly biological and ecological criterions – Quality life analysis in a large scale

Source: Authors with available sources, 2016

2. Method and Instruments
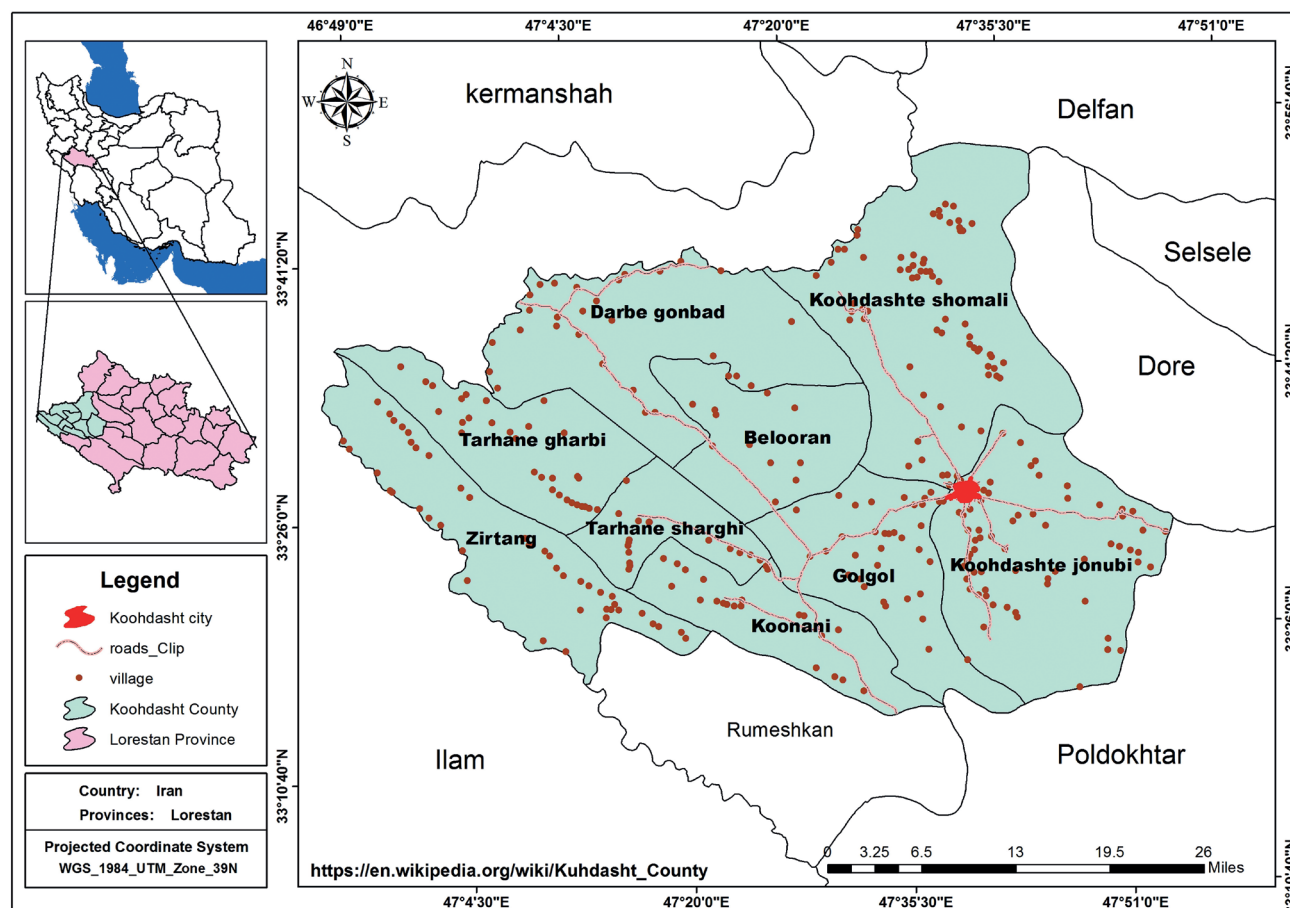
Fig 4 Location of villages in the studied rural area (https://en.wikipedia.org/wiki/Kuhdasht_County).

Kuhdasht county (33°32′N 47°36′E), one of the dependencies of Lorestan province, Iran, is connected to Kermanshah from the north, from south and southwest it is connected to Ilam province, and from east it is connected to Khorramabad County. It has the height of 1195 from the sea level. It has a moderate and semi-arid climate with the maximum and minimum temperature of 42 and –7 degrees respectively. It has the average rainfall level of 400 ml annually. Calcareous and Clay constitute the soil type of this region. The samples and signs gathered through the archeology investigations and analysis showed that the climate of the region is part of the Zagros Mountains. Because of having Glaciers, watery valleys, and moderate climate, this region was an appropriate habitat for trees and plants, wild animals, and cave dwellers. This brought about people's effort in culture creation and designing and making rocky tools for satisfying their needs (Figure 4).

Table (3) shows the internal political divisions of Iran and access to services and facilities in the city of Kuhdasht. Political divisions in Iran include (province, county, region, district, city, village) (https://www.amar.org.ir/english). Also, in Table (3), the existence of services and access to facilities in each village is specified as a percentage (https://www.amar.org.ir/english) also Figure (5), some of the public spaces that people tend to participate in the community is shown.

In the current study, to the purposes mentioned earlier, the research clarified the why and how of the questions and their dimensions. Therefore, the current study is applied in purpose and descriptive analytical in methodology. Two methods were used for data gathering namely documentary method including theoretical studies and the descriptive data for villages' spaces and field study using a five-point Likert-scale questionnaire with the options of very low, low, medium, high, and very high. To analyze the data, SPSS statistical procedures were used. The validity of the questionnaire was calculated using Cronbach's alpha and the results for public spaces' criterions (Esthetics, semantic-perceptual, functional-perceptual), rural quality life dimensions (economic, social, cultural, body, environmental) was 0.749 and 0.767 respectively. After analyzing the gap in the region, effective factors were identified. Firstly, the amount of each indicator constituting public spaces' effective factor share was calculated through the people's perspectives and using Mean as the statistical procedure. For measuring the desirable level, inferential statistics (Regression, Friedman, and Factor Analysis) was used.

The situational zone of the current study is Kouhdasht County, Iran, and it conducted between 2013–2016 in nine villages whose population is estimated

Fig. 5 Studied a sample of public spaces in villages in the county Kuhdasht. 1. Tomb of Imam Zadeh Mohammad in the villages of Darb Gonbad (https://en.wikipedia.org/wiki/Darb-e_Gonbad), 2. Local bazaars Kuhdasht Shomali Rural District (https://en.wikipedia.org/wiki/Kuhdasht-e_Shomali_Rural_District), 3. Local folk dance in the villages of Kuhdasht-e Jonubi Rural District (https://en.wikipedia.org/wiki/Kuhdasht-e_Jonubi_Rural_District), 4. Forest park in Boluran Rural District (https://en.wikipedia.org/wiki/Boluran).

Tab. 3 Services and access to facilities in the studied district.

Political divisions in Iran					Services and access to facilities							
Country	Province	County	region	Township	Educational	Cultural and sports	Religious	Political and administrative	Electricity, gas and water	Health	Business and services	Communications and transportation
Iran	Lorestan	Kuhdasht	Tarhan	Tarhan Eastern	12.31	0.00	121.15	24.18	40.00	7.69	12.18	16.35
			Tarhan	Tarhan Western	9.14	0.00	101.85	19.58	70.37	7.41	10.19	9.72
			Central	Kouhdasht Jonubi	10.18	1.36	102.95	10.91	34.55	5.45	7.88	13.18
			Central	Kouhdasht Shomali	5.21	0.00	96.96	3.66	60.77	0.90	4.17	3.69
			Central	Koulkoul	8.89	2.08	84.38	10.12	27.08	6.00	8.33	14.32
			Kounany	Ziyrtang	6.32	0.00	96.47	6.59	27.69	2.71	4.70	5.45
			Kounany	Kounany	9.09	0.00	98.86	13.64	32.73	4.55	7.95	17.05
			Darb Gounbad	Blouran	12.94	0.00	125.00	9.24	56.47	4.84	9.80	10.29
			Darb Gounbad	Darb Gounbad	8.07	2.63	104.61	18.05	34.74	4.33	10.09	13.82

Tab. 4 population and households in the sample Rural District in research.

Rural District	Population	Male	Female	The number of households	Questionnaire
Kuhdasht Shomali	5094	2580	2514	1188	22
Kuhdasht Jonubi	7807	3854	3953	1756	34
Koulkoul	16981	8633	8348	3989	74
Tarhan Western	7287	3719	3568	1519	32
Tarhan Eastern	12704	6522	6182	3033	55
Darb Gounbad	6031	3043	2988	1376	26
Kounany	7160	3573	3587	1765	31
Blouran	4650	2395	2255	1094	20
Ziyrtang	5821	2999	2822	1494	25
Total	73535	37318	36217	16026	320

Reference: census of the Iranian Statistical Center in 2016

about 73535. Cochran's sample size formula was used for sampling and 320 samples were analyzed. Simple random sampling was used for the questionnaire in nine villages. Table 4 describes the population, families, and number of samples in each village.

$$n = \frac{\frac{(1.96)^2(0.50)(0.50)}{(0.05)^2}}{1 + \frac{1}{73535}(\frac{(1.96)^2(0.50)(0.50)}{(0.05)^2} - 1)} = 32$$

N (population) = 73535
P (people with characteristic) = 50%

Q (people lack characteristic) = 50%
D (speech correctness difference probability) = 5%
T (speech correctness rate) = 50%

2.1 Regression Model

The main purpose of the regression is to find an approximate relationship between independent and dependent variable. Linear regression used when there is a linear relationship between two variables; otherwise, non-linear regression will be used. Hence, if we name the dependent variable (Y) and the

independent variable (X), the simple linear regression model of (Y) based on (X) is:

$$y = a + BX$$

In the above formula, and b are fixed numbers and coefficients of is the intercepts, which shows the amount of Y for, and b is the slope of the regression line. 1 unit increase in Y will show an increase in X. a and b parameters' values are passive and should be calculated through the information and observation of (x, y). Actually, there is no precise linear relationship between x and y variables. In other words, (x, y) cannot be placed on a straight line, but these points are deviated from the straight line.

It can be written for the deviation of the ith observation with e_i:

$$y_i = y + e_i$$

In which, y_i is the intercept of ith observation and $\widehat{y_i} = a + bx_i$ is the intercept of regression line for x_i. To put it in another words, the best fitting is reached through minimizing the sum of the error squares $\sum e_i^2$, which is calculated through this formula:

$$f(a,b) = \sum_{i-}^{n} e_{e^2} = \sum_{i=1}^{n} (y_i + y_i)^2 = \sum_{i=1}^{n} (y_i - (a + bx_i))^2$$

$$\frac{df(a,b)}{df} = \sum_{i=1}^{n} -2(y_i - (a + bx_i))$$

$$\frac{df(a,b)}{df} = \sum_{i=1}^{n} -2x_i (y_i - (a + bx_i))$$

Normal equations found through above formula:

$$\sum_{i=1}^{n} x_{iyi} = a \sum_{i=1}^{n} x_i + B \sum_{i=1}^{n} x_i \, x_{1^2}$$

a and b can be found by solving the normal equations:

$$a = \bar{y} - B\bar{x}$$

$$F_j = \sum w_{ji} x_i = w_{j1}x_1 + w_{j1}x_1 + w_{j2}x_2 + \cdots + w_{ip}x_p$$

For the meaningfulness of the regression slope the below formula is used:

$$t = \frac{b}{\sqrt{\frac{MSE}{S_{XX}}}}$$

In this formula, MSE (mean of sum of errors) and S_{XX} are calculated through using below formula:

$$S_{XX} = \sum (X_1 - X)^2$$

2.2 Friedman Test

The Friedman Test divided in a two-way table consisting of N rows and K columns. The rows include subjects or sample set of subjects and the columns include different situations. If the subjects' marks, which are a specific situation, be the focus of the study, each row signifies the mark of one subject in k situation. The database of the very test is an ordinal one. The marks will be ranked in different rows meaning that when the k situation is being observed, the marks will be arranged from 1 to k. Friedman test shows the probability that the columns of the table (sample groups) come from the same population. When the number of rows and columns are not too small, it can be shown that they have equal distribution to 'chi-square' and degrees of freedom of df = k – 1 and the calculation procedure is:

$$X_r^2 = \frac{12}{NK(K+1)} \sum R_j^2 - 3N(k-1)$$

N = number of rows
K = number of columns
R_i^2 = determining the significance of X_r^2 using

2.3 Factor Analysis

Factor analysis is a technique used to describe variability among observed correlated variables in terms of lower number of unobserved variables. Being economical is the main purpose of factor analysis by using the smallest clarifying concepts for maximum level of common variance in correlation matrix. The main hypothesis of the factor analysis is that the underlying factors of the variables can be used in clarifying sophisticated phenomena and the observed correlation between variables signifies their association in these factors. The purpose of factor analysis is identifying the unobserved variables based on a set of observed variables. Factor, is a new variable calculated through linear combination of the observed variables main marks using this formula:

$$FJ = X_i W_{ij} + x_2 w_2 + \cdots + x_p^w F_j = \sum w_{ji} x_i = w_{i1}x_1 + w_{j2}x_2 + \cdots + w_{jp}x_p$$

In this formula, w represents factor score coefficients and p is the number of variables. These factors are hypothetical and theoretical structures in themselves playing a vital role in helping to interpretation of the consistency in dataset. Therefore, factor analysis is valuable in that it provides the researcher with a useful organizational pattern that can be used for interpretation of copious behaviors with the maximum level of saving in clarifier factors.

Table 5 shows the descriptive statistics for the participants. It can be inferred from the table that considering age, participants who are between 21–30 years

old with the frequency of 178 and 54.3 percent have the highest numbers of answers. On the other hand, considering the educational level, associate degree and higher choice with the frequency of 110 and 34.4 percent have the highest number, and considering the gender, 170 participants with the level of 52.3 and considering the job, the housewife choice with the frequency of 122and level of 41.5 have the highest number of answers.

Tab. 5 Descriptive information of local people's respondents.

Local people			
Variable	Ccategory	Frequency	Percentage %
Gender	Female	150	47.7
	Male	170	52.3
Age	20–30 years	178	54.3
	31–40 years	75	25.6
	41–50 years	37	10.5
	51 years and above	30	9.6
Education	illiterate	35	8.7
	Been reading and writing	20	6.2
	Primary	25	6.6
	Guidance	38	12
	High school	92	32.1
	Graduate And higher	110	34.4
Job	Government employees	35	10.9
	Agriculture	61	18.2
	Self-employed	88	26.4
	Retired	9	1.9
	housewife	122	41.5
	Other	5	1.1

3. Analysis of Results

In the current study, for identifying and analyzing the role of public spaces effective indicators, three criterions namely esthetic, semantic-perceptual, and activity-based functional were used. Each criterion includes components and variables. Variance analysis was used for analyzing the variables and the results showed that the variables of the presence of utility services, social interactions in situations, and the presence of educational programs with the variances of 1.258, 1.240, and 1.205 have the highest rates from people's perspectives towards the issue respectively. That it can be researched (Song et al. 2016) compared. They in this research with purpose attempt to examine how privately owned public spaces through incentive zoning have played out as a means to generate public spaces New York City, And the results were Using spatial statistical analyses, we find that the inclusion of privately owned public spaces reduces overall average distance to the

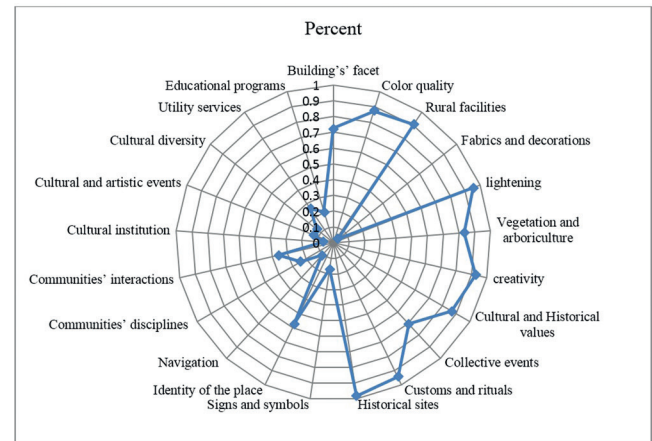nearest public space from both working and living population (Figure 6).

Fig. 6 The effects of the components of public spaces on the development of the quality of viability and dynamics of villagers.

Figure 7 shows the variables and rural public spaces indicators Mean in the current study in a way that the esthetic indicator, semantic-perceptual indicator, and functional-perceptual indicator have the Mean of 4.03, 3.61, and 3.99 respectively. Hence, in esthetic indicator, building façade variable (M = 4.30), in functional-perceptual indicator, the utility service variable (M = 4.25), and in semantic-perceptual indicator, the historic sites variable (M = 3.89) has the highest percentages of Mean.

Inferential statistics was used for analyzing the descriptive statistic of the participants, which
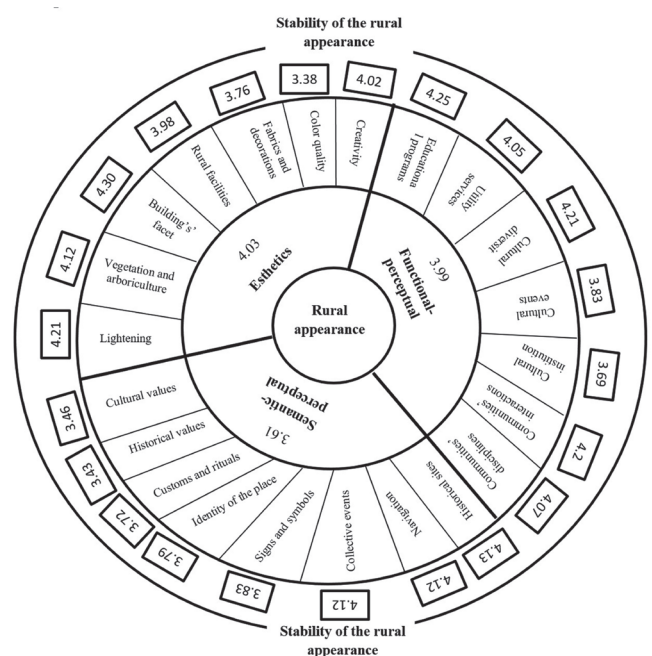

Fig. 7 Average indices and variables a rural landscape used by local people's views.

referred to in research method section, and answering the research questions. Table 6 shows that ranked Friedman test was used for analyzing the significant difference among these branches. Based on this test, there is a significant difference among esthetic, semantic-perceptual, and activity-based -functional criterions at alpha level of 0.01. ordinal mean analysis of the data resulted from the quantitative analysis of the available capacities in enhancing the rural regions quality life and dynamism quality signifies the crucial role played by public spaces effective factors in quality life enhancement to a higher level above medium one. Therefore, regarding the results of the Friedman test it can be inferred that the reasons for the vital role of the public spaces effective factors in rural regions quality life and dynamism quality from local people's perspectives.

1) The esthetic variable group stands first in the focused villages of the study with the mean rate of 2.89 from local people's perspectives which was higher than desirable rate, because of the building facets (material, color, window form), color quality, rural facilities (bus station, bench, dustbin), walls fabrics and decoration, lightening, vegetation and environment attractiveness, and creativity. This study can be compared with (Kline 2006) study believing that social and economic changes of the rural outdoor spaces together with population growth, income increase, and interest and enthusiasm increase pave the way for supporting the protection of the outdoor spaces and unprotected lands.

2) Semantic-perceptual variables group stands second in the triple factors with the mean of 1.80 because of the historical and cultural values, individual and collective events, customs and traditions, historical sites, signs and symbols, places' identity, and navigation sense. Our information base did not provide us with any report for drawing a comparison.

3) Activity-based –functional variables group have the lowest ordinal mean from the local people's perspectives because of the social and natural supervision on the space, social interactions, presence of cultural institutions, artistic and cultural events, presence of utility services and educational programs. The results can be compared with (Jalaladdini and Oktay, 2012) study in Cyprus believing that the public spaces functions in social, walking, and tourism value aspect play a vital role in pleasure and dynamism.

Factor analysis was used for analyzing the accuracy of the study and reducing the number of variables into smaller and crucial ones in determination of each public space criterion's share in rural regions as well as identifying the most important factors in increasing the quality life. 20 factors were extracted by comprehensive analysis of the theoretical studies and fieldwork in the focused zone of the study. KMO indicator and Bartlett's test were also used for analyzing the internal consistency and suitability of the data

for factor analysis. The result of the Bartlett's test was significant in 99% confidence interval and suitable KMO index (Table 7) signifies the internal consistency and suitability of the data for factor analysis.

Tab. 6 Significance of the mean difference of sample criteria based on Friedman test statistic.

Local people's views			
Criteria	Number	Mean Numerical	Average Ranking Friedman's
Esthetics	320	14.4	2.89
Semantic-perceptual	320	3.69	1.80
Functional-perceptual	320	3.58	.89
Chi-Square	18.86		
df	2		
Asymp. Sig.	0.000		

Tab. 7 Bartlett test at a meaningful level.

Total analyzed	Opinions	Kaiser–Meyer–Olkin Measure of Sampling Adequacy.	Bartlett's Test	Sig.
Total indices of public spaces in improving the quality of viability and dynamism of villagers	Local people	.850	913.34	0.000

Tab. 8 Extracted factors with special value, percentage of variance and cumulative percentage of variance.

People's View				
		Rotation Sums of Squared Loadings		
Row	Factor	Total	% of Variance	% of Cumulative
1	factor one	2.28	11.30	11.30
2	factor two	2.06	10.28	21.58
3	factor three	1.93	9.73	31.32
4	factor four	1.53	7.70	39.03
5	factor five	1.47	7.33	46.37
6	factor six	1.31	6.59	52.96

Considering the effective factors, 6 factors were extracted with Eigenvalues exceeding 1 for the rural public spaces. Table 8 describes the number of extracted factors with their Eigenvalues, their variance percentages, and cumulative frequency of variance percentages. Eigenvalue shows each factor's share from the total variances and the bigger the Eigenvalue the more important and effective is the factor. The first factor has the highest and the last factor has the

lowest role in explaining the variables and the sex factors explained 52.640% of the total variances.

3.1 Factor one: perceptual vision

Based on Table 9, historical sites, sign and symbols, navigation senses, color quality, rural environments attractiveness variables stand for the first factor. Factor loadings show that these variables have high positive correlation with the first factor. The eigenvalue of this factor is 2.28 exceeding other factors and explains 11.301 percent of the total variance. So, it can be inferred that there is a high correlation between the variables underlying the perceptual vision variable and they have a conspicuous effect on the rural population's quality life. The even findings can be with results (Nasution et al. 2014), In medan, Indonesia compare and concluded the research found that the public open space in medan county is a livable place when it has a high level of usage. The livable public open space relates to quality of life via the satisfaction with health, recreation and urban environment.

Tab. 9 Variables of each factor and factor loadings resulted from rotated matrix.

Factors	Variables	Factor loadings
Perceptual vision	Historical memos and sites	0.768
	Signs and symbols	0.542
	Navigation sense	0.658
	Color quality	0.568
	Environmental attractiveness	0.615
Main body of the buildings	Building facets (materials, colors, windows form)	0.501
	Walls' fabrics and decorations	0.647
	Passages lightening	0.651
	Accessibility of the passages	0.575
Culture and communities	Cultural and artistic events	0.506
	Presence of cultural institutions	0.563
	Cultural and historical values	0.737
	Customs and rituals	0.580
Activities	Presence of educational program	0.699
	Peoples' creativity in activities	0.625
	Presence of utility services	0.553
Environmental	Vegetation and arboriculture	0.621
	Climate elements	0.586
Social interaction	Collective and individual events	0.774
	Social and natural supervision of the space	0.648
	Social interactions in places	0.568

3.2 Factor two: buildings' skeleton

The variables underlying this factor are building facets (materials, color, window forms), walls' fabrics

and decoration, passages lightening and associability. The factor loading of these variables is between 0.501 and 0.651 and all of them are positively correlated with the second factor. Considering the importance of the constituting variables with eigenvalue of 2.06, they explain 10.286 percent of the total variance. in the same Relation (Kurz 2014), In his research in bane to this conclusion Receipt the analyses show that public spaces could play an important role in creating, respectively reshaping towns and villages and improve the quality of the site.

3.3 Factor three: culture and communities

This factor includes variables such as cultural and artistic events, presence of cultural institutions, historical and cultural values, rituals, and customs. This factor's eigenvalue in 1.93 and it explains 9.739 percent of the total variance. There is also a high correlation among all the variables. The findings can be with results (Kaźmierczak 2013; Francis et al. 2012) compared and they believe public spaces also provide opportunities for social interactions that contribute to creating sense of community and neighborhood social ties.

3.4 Factor four: activities

Variables such as the presence of educational programs, people's creativity in activities, and activity in utility services constitute the fourth factor with eigenvalue of 1.53 explaining 7.707 percent of total variances. It can be inferred from these variables that activities play a crucial role in rural population's quality life enhancement. The variables of this factor are correlated with each other with factor loadings between 0.533 and 0.699 research (Yoon and Srinivasan 2015), at of the Pearl River Delta in China cited and concluded the public spaces in towns, public facilities to increase the quality of life provided and paves the way for increased recreational facilities, Availability of public spaces for activities created and where people are satisfied.

3.5 Factor five and six: social interaction and environment

Factors five and sic with two and three variables and eigenvalues of 1.47 and 1.31 explained 7.338 and 6.591 percent of the total variances respectively. Factor five variables are vegetation and arboriculture, and local spaces and factor six variables are individual and collective events, natural and social supervision considering all the social interactions for this factor. In this area can be researched (Ismail and Said 2015), in Malaysian cities there have been mentioned and concluded this paper argues that community participation in the design and planning of urban public spaces can draw residents to establish

a sense of attachment that may lead to community maintaining the spaces. Also (Friedmann 2007), in his research with title "Reflections on Place and Place-making in the Cities of China" with purpose this article is about the small spaces of the county we call 'places'. Places are shaped by being lived in; they are spaces of encounter where the little histories of the county are played on. Concluded, place-making in today's China is a contested process. The county is filling up with immense, architect-designed, non-place spaces, from airports and subways to luxury hotels, office towers and suburban malls.

General Linear Model has been used for investigating the public spaces effective factor roles and consequences on quality life and dynamism quality. Therefore, for the investigation of local people's perspective: esthetic, functional perceptual, and activity-based – functional variables are used as independent variables and from quality life criterions: economic, social, cultural, and environmental variables are used as dependent ones in general linear model.[1] Fitting growth regression model signified the positive effects of public spaces effective factors in rural population's quality life and dynamism quality enhancement at the level of 0.723 (Table 10).

Tab. 10 Analysis of variance of factors affecting the quality life of villagers on the role of effective factors in public spaces.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.723	0.523	0.515	0.322

In the current study, the effective indicators and factors roles in the focuses villages' dynamism quality were specified by general linear model synchronously. The results showed that all the fourfold indicators which are economic, social, cultural, body and environmental are significant (Table 11).

Tab. 11 Analysis of variance based on the existence of a linear relationship between the degree of satisfaction of the people and the effective factors of the general spatial criteria.

| Components	Sum of squares	df	Mean Square	F	Sig.
Regression	14.94	4	3.373		
Residual	13.65	316		69.26	0.000
Total	28.59	320	0.054		

---

1   Regression $y = a + bx$ was used for the analysis of the public space's effective indicators roles in rural population's quality life and dynamism which shows a significant level for the used indicators.

Table 12 indicates that by analyzing ß values it can be inferred that from among the fourfold indicators, body and environmental indicators (0.424) are the most effective and cultural indicators (0.028) are the least effective ones in quality life in the focused villages of the study.

Tab. 12 The coefficients of the intensity of relations between variables of public spaces on the Quality life of villagers.

Name variable	Coefficients				
	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
(Constant)	1.66	0.14	–	11.550	0.000
Cultural	0.019	0.033	0.028	0.575	0.066
social	0.235	0.034	0.363	6.902	0.000
Economic	0.063	0.035	0.102	1.789	0.006
Environmental and physical	0.245	0.032	0.424	8.277	0.000

Figure 8 shows variable means and quality life indicators in the focused zone of the study in which local people's expectations are investigated in relation to the quality life level. From among the considered indicators, economic quality life indicator, social quality life indicator, cultural quality life indicator, and body and environmental indicator have the means of 3.67, 3.72, 3.60 and 3.91 respectively. This suggests that attention towards the quality life in the focused villages is of paramount importance and local managers and authorities should pave the way for the
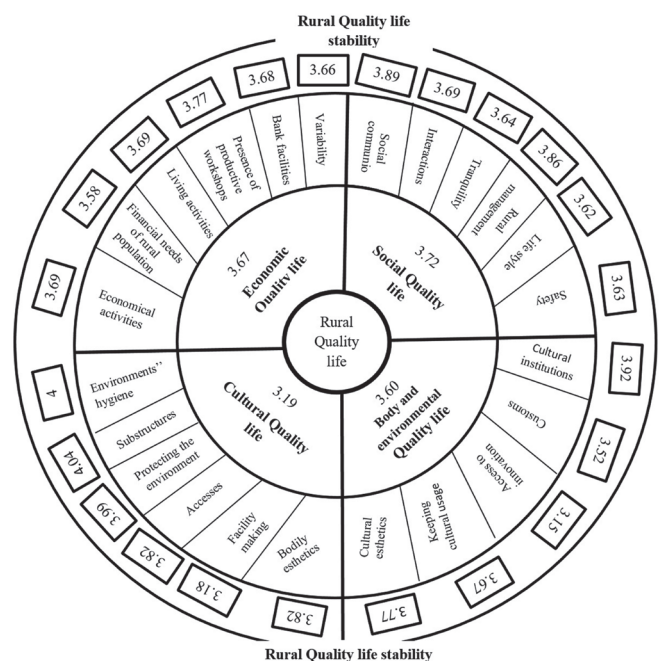
Fig. 8 Average indices and quality of life used by local people's views

enhancement of public spaces in urban and rural regions. In the same line, (Bolívar et al. 2010), study can be referred to which believes that body safety and interaction between body and space should be taken into account in public spaces designing (Figure 8).

4. Discussion

In rural planning today, the attention of public spaces such as streets, squares and communication nodes have a valuable place in the quality of life of local people, this is due to the effects of these spaces on the cultural and social aspects of the villagers. Due to their special nature and function, rural public spaces play an effective role in the spatial and physical structure of villagers and the semantic and mental reproduction of local people. So, the social value of rural public spaces makes them significant within the rural, since they are involved with people needs, from the very basic to the complex. As such, public spaces affect local people's quality of life. They have to afford local people various activities; otherwise, parts of the society will be pushed out of the public realm which results in serious limitations for the daily lives of local people. In addition, The Attention to the function of public spaces should be considered as one of the guidance in the implementation of rural local plan. The content of the plan is very important as an evidence of the community representation to fulfil their right in the local plan.

Attention to social value (quality life) has been increased in the recent rural planning theories owing to the negative effects of the visual-artistic trends in the rural design and due to focus on the requirements of Machine life rather than pedestrian needs. In this context, reviewing various approaches and aspects in rural public space was found important to reveal the interrelationship between the physical environment and the social environment. The key issues concerning quality life in a place are the presence of people at different times and the compatibility of public spaces diverse activities. quality life relates to various dimensions of a public space including both physical and social aspects. In rural planning, no attention is paid to public spaces, have the potential to be transformed into vibrant and quality life public spaces by hosting various activities and events. The analysis of the public spaces in Kuhdasht County and the most quality life and dynamism quality.

Spaces in these counties, shows how they work socially. In county, the presence of people is evident at different times. However, the determinants of quality life in applied spaces such as natural landscapes, mosques, markets, rural public squares are different. County views and historical and cultural fields is vital owing to the presence of the visitors and tourists are the main users that make the area vibrant. It can be concluded that not all public spaces have same

reasons or work in a similar way. Hence, a place could be considered quality life with different basis which eventuate to different feelings in the space. Whether two spaces have similar or different basis and reasons for dynamism quality, it is obvious that quality life spaces are healthier and safer where people could interact more and tend to stay longer since they enjoy their time in public. This presence also attracts other people's attention, and it makes a cycle. If a place is attractive, the people would come and if people are present, the place would become even more attractive. However, it should be ensured that the presence of people is not possible through the commercialized functions only, but supported by pleasant pedestrian corners/facilities enabling them to sit and spend the time without necessarily eating or drinking. Therefore, in order to answer the first question, the findings showed that the perceptual image factor with a value of variance (11.301) percent, the body factor of buildings with 10.286 percent variance, culture and communities' factor with a value of 9.739 percent Variance, activity factor with 7.707% variance and environmental factor and social interactions each explained 7.338 and 6.591% of total variance. This shows that the first factor had the most and the sixth factor had the least effects. Also, in order to answer the second question, the findings of multivariate regression have shown that its fit is 0.723, which shows the positive effects of the components of public spaces in improving the quality of life of villagers. Expressive values showed that environmental and physical indicators had the most and cultural indicators had the least effects.

5. Conclusion

The results of the study showed that from among the considered criterions, esthetic, semantic-perceptual, and activity-based –functional with the rates of 2.52, 1.79 and 0.69 have the highest rank and effect on the life quality indicator. On the other hand, the results of the factor analysis showed that the first factor, visual perception, has the highest and the sixth factor, social interaction, has the lowest part in explaining the total variables and from local people's perspectives the 6 factors collectively explained 52.640 percent of the total variables. The fitting growth regression model indicated the positive significant effect of public spaces effective factors on rural population's quality life and dynamism quality enhancement was 0.723, which shows a significant relationship between public spaces indicators roles in rural population's quality life and dynamism quality enhancement in the focused zone of the study.

Now, according to we must underline and hear the borderless voices (the Local people). Then, we need a written proof upon the space for legality rural plan for the local community to resolve the issues. When the physical aspects of space can accommodate the

space needs of the Forgotten, accommodative public space in Local people quality life will be created. Thus, as society will be educated to learn and share, to respect the rights of other users in the rural, and consequently the physical quality of the visual rural will be better because there are no annexation of space and overlapping activities. So, we can create the public space for Local People in line with the quality-of-life use.

Acknowledgements

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Global horizontal irradiation: spatio-temporal variability on a regional scale in the south of the Pampeana region (Argentina)

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ABSTRACT

The objective of this work is to analyze the spatio-temporal distribution of Global Horizontal Irradiation (GHI) on a regional scale and its relationship with frequent synoptic situations in the south of the Pampeana region (Argentina). It was verified that the latitudinal pattern of distribution of the GHI is modified in the region by cloud cover, which is in turn determined by the seasonal dynamics of action centers and the passage of fronts in summer and winter. The South America Monsoon System (SAMS) defines differential situations of cloudiness and rainfall in the region, which affect GHI. GHI increased successively between the decades 1981–2010, a factor associated with the variability of rainfall that characterizes the region.

1. Introduction

Solar radiation is the main source of energy for all climatic processes and the determining factor of the intensity and distribution gradients of different climate elements (such as temperature, humidity and atmospheric pressure, among others). Thus, radiation is the ultimate cause of climate differences and affects all climate-related phenomena (Patton, Alexander, and Kramer 1978).

Solar radiation reaching the earth surface depends on solar height, day length, atmospheric conditions and terrain topography. While site conditions (latitude and topography) determine the intensity and duration of insolation, the earth's atmosphere filters incident radiation by absorption, diffusion and reflection processes (Abal 2012; Patton, Alexander, and Kramer 1978; Oke et al. 2017; Sengupta et al. 2017). About the theoretical concepts regarding solar radiation, this paper uses the following terms: direct radiation, diffusse radiation and Global Horizontal Irradiation (GHI). Direct radiation is that which is received directly from the Sun without suffering any atmospheric dispersion. Diffuse radiation is the one the surface receives after being deflected by discrete particles present in the atmosphere. GHI is the geometric sum of direct and diffuse radiation received on a surface (Hermosillo Villalobos, Gudiño Ayala, and Mendoza Ramírez 1995; Habte et al. 2017).

Solar radiation has become an object of growing scientific interest due to its potential for sustainable energy optimization. Photovoltaic electricity production is one of the most recent renewable energy sources with the widest field of application. However, the use of the solar resource depends on the knowledge of the intensity and distribution of solar radiation received in a given space, as well as its temporal variation (Sengupta et al. 2017; Vera Mella and Baldasano Recio 2005). Regardless of site conditions the dynamics of atmospheric action centers and cloud type and cover associated are the main causes of the spatio-temporal variability of solar radiation (Weber 1994; Matuszko 2012; Fernández, Gentili, and Campo 2018). Consequently, the interaction of solar radiation and its components with action centers dynamics has been increasingly studied by numerous researchers around the world (Jerez and Trigo 2013; Pozo-Vázquez et al. 2004; Tomson and Hansen 2010; Urban, Migała, and Pawliczek 2017; Fernández, Gentili, and Campo 2018). The study of the spatio-temporal variability of the solar resource and its representation by way of theme maps constitutes a basic management tool useful when evaluating and executing measures aimed at sustainable energy development (Gueymard and Wilcox 2011; Habte et al. 2017). Numerous investigations are focused on the study of solar radiation components and their spatio-temporal variability, mainly regarding its use as an energy resource (De Miguel et al. 1994; Gallegos and Righini 2002; Gómez-Tagle Chávez and Chávez Huerta 2004; Lohmann et al. 2006; Raichijk et al. 2006a; Raichijk et al. 2006b; Grossi Gallegos and Spreafichi 2007; Lave and Kleissl 2010; Grossi Gallegos et al. 2010; Gueymard and Wilcox 2011; Davy and Troccoli 2012; Sanchez-Lorenzo et al. 2012; Righini and Aristegui 2013; Gueymard 2012; Raichijk 2012; Raichijk 2013; Gil et al. 2015).

One of the greatest challenges in the study of radiation in terms of resources relates to the high cost of measurement instruments and consequent unavailability of continuous records in space and time in the long term. This challenge involves Argentina and numerous regions in other developing countries, where the availability of solar radiation records is often limited (Raichijk, Grossi Gallegos, and Righini 2006; Ramirez Camargo et al. 2015). In this situation, it is necessary to look for alternative data sources in order to assess the variability of the solar resource in different territories. Historically, the data on sunshine hours have been used to estimate GHI (Löf, Duffie, and Smith 1966; Hay 1979; Benson et al. 1984; Román, Bilbao, and de Miguel 2014; Assi and Jama 2010; Sengupta et al. 2017; Argungu, Dabai, and Scholar 2017). The use of numerical models for GHI studies emerges as an alternative, reanalysis being one of the most used (Schroeder et al. 2009; Linares-Rodríguez et al. 2011; Lohmann et al. 2006; Ramirez Camargo et al. 2015). In this context, our objective in this study has been to analyze the spatio-temporal distribution of GHI at a regional level and its relation with frequent synoptic situations in the south of the Pampeana region (Argentina). From the environmental climate and given the growing energy requirements of urban centers, it is necessary to assess the renewable energy potential as a possibility of energy matrix diversification at a regional and local level.

2. Materials and methods

2.1 Study area

The study area includes the southern sector of the Argentine Pampeana region. It covers the south of Buenos Aires province, the east of La Pampa province and a sector of the northwest of Río Negro province (Fig. 1)

The climate in the south of the Pampeana region is temperate. Within this temperate climate a difference can be established between the temperate transition to arid climate in the South and the temperate oceanic climate in the eastern sector near the sea (García 2013). Regional atmospheric circulation is controlled by large-scale systems influencing southern South America; namely the semi-permanent anticyclones from the Atlantic (South Atlantic High, SAH) and Pacific (South Pacific High, SPH) oceans (Chiozza and Figueras 1982; Grimm, Barros, and Doyle 2000) (Fig. 2). Furthermore, the studied sector is located
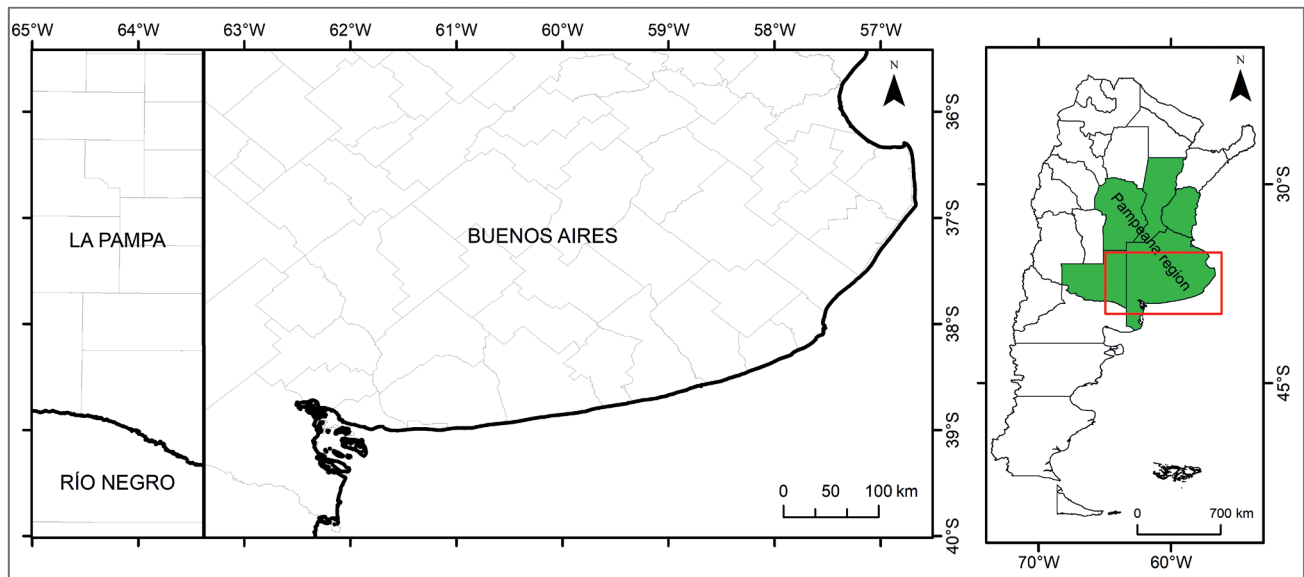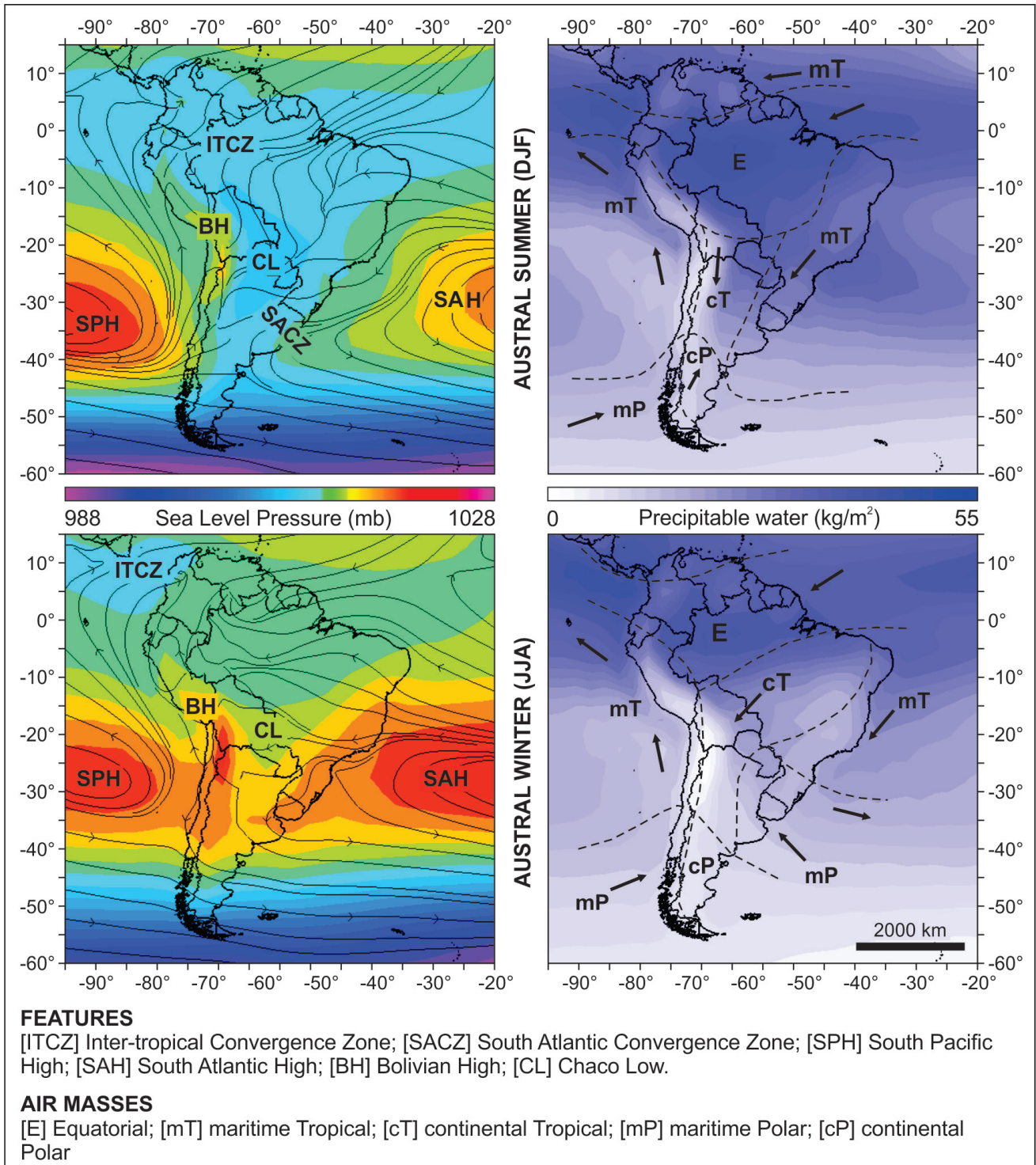
Fig. 1 Study area.

in one of the areas with the highest frequency of passage of migratory anticyclonic systems (García 2013; Celemín 1984). These systems enter the territory in a west-east direction and are characterized by causing various weather conditions associated with their passage (Celemín 1984; Alessandro 1998). In winter, the influence of cold and humid air arising from cellular detachments of the High Pressures of the South Pacific Ocean stands out (García 2013; Sinclair 1996; Mendes 2006; Ambrizzi and Pezza 1999; Bruniard 1981; Pezza and Ambrizzi 2003; Celemín 1984; Alessandro 1998). In summer and within the continent, the continental Tropical air masses (cT) inhibit precipitation, generating droughts and loss of energy due to night cooling. In the coastal areas of the Pampeana region, maritime Tropical air masses (mT) dominate. These emerge from the western edge of the South Atlantic Anticyclone, its entry to the continent favors the development of cloudiness and precipitation and the summer storms that occur in the region (Fig. 2) (Scian 2010; Celemín 1984; Bejarán and Camilloni 2003). The regional thermal spatial distribution has a rather homogeneous character and is mainly determined by geographical factors on a regional scale, such as altitude, proximity to the sea or advective movements. The continental influence defines the values of annual thermal amplitude and the occurrence of frosts (Campo de Ferreras, Capelli de Steffens, and Diez 2004).

In the southern Pampeana region, rainfall has a marked spatio-temporal variability. Precipitated amounts decrease from northeast to southwest, with differences that exceed 400 mm (Gabella, Zapperi Paula, and Campo Alicia 2010; García 2013). Likewise, the presence of a rainy season extending from October to March and a relatively dry season from May to September can be observed (Casado and Campo 2019; Gabella, Zapperi Paula, and Campo Alicia

2010). Although previous studies found maximum peaks in spring and autumn (Capelli de Steffens, Piccolo, and Campo de Ferreras 2005; Campo de Ferreras, Capelli de Steffens, and Diez 2004), recent studies in the region (Gabella, Zapperi Paula, and Campo Alicia 2010) and at a local level (Gentili and Gil 2013) identify summer as the rainiest season. This coincides with the increase in summer precipitation registered in large sectors of the American continent since 1970 (Casado and Campo 2019; Liebmann et al. 2004). Summer rainfall is mainly caused by convective activity and the development of frontal systems, while in the dry season precipitation is linked to frontal systems (cold and warm), frontal waves and cyclogenesis processes (P. Zapperi et al. 2007; P. A. Zapperi et al. 2006). About the precipitation types, Sarochar et al. (2005) found that between January 1995 and December 2001, convection produced about 75% of the precipitation, the remaining 25% due to stratiform cloudiness. Precipitation of stratiform origin only showed greater weight in April and October. Convective precipitation is associated with cumuliform cloudiness (cummulus congestus and cumulonimbus). This result is consistent with more recent investigations (Sarochar 2018). Regarding cloudiness in the study area, Fernández et al. (2018) analyzed its spatial distribution in the period 2001–2015. The authors found higher percentages (31.6–38%), of overcast skies in the northeast of the study area. The highest clear skies percentages were found in the west of the study area and they decreased in a west-east direction. This is in good agreement with the decrease in precipitations amounts stated earlier. At interannual scale, rainfall in the region has great variability which allows differentiating between dry and wet periods (Bohn, Piccolo, and Perillo 2011; Campo, Ramos, and Zapperi 2008; Scian 2010; Campo de Ferreras, Capelli

FEATURES
[ITCZ] Inter-tropical Convergence Zone; [SACZ] South Atlantic Convergence Zone; [SPH] South Pacific High; [SAH] South Atlantic High; [BH] Bolivian High; [CL] Chaco Low.

AIR MASSES
[E] Equatorial; [mT] maritime Tropical; [cT] continental Tropical; [mP] maritime Polar; [cP] continental Polar

Fig. 2 Seasonal patterns of atmospheric circulation and precipitable water over South America and adjacent oceans.

Source: Sea level pressure, surface wind streamlines, and precipitable water maps were derived from long-term (1981-2010) monthly means of the NCEP/NCAR Reanalysis. Fronts and air masses were based on Campo et al. (2004). Modified from Casado (2013).

de Steffens, and Diez 2004; Ferrelli et al. 2012; Gentili 2012; P. A. Zapperi 2012). This phenomenon can be related to the El Niño Southern Oscillation (ENSO, for its acronym in English) (Ferrelli 2016; Grimm, Barros, and Doyle 2000; Grimm 2011), although a great complexity of atmospheric processes is also involved, such as sea surface temperature anomalies in the South Atlantic Ocean or variations in the convective activity

of the South Atlantic Convergence Zone (Doyle and Barros 2002; Barros et al. 2000; Casado and Campo 2019).

2.2 Data collection and analysis

This work uses Global Horizontal Irradiation (GHI, MJ m^2 d^{-1}) gridded data extracted from the Climate

Forecast System Reanalysis (CFSR) of the National Center for Environmental Prediction (NCEP) (Saha et al. 2010). The selected area has 365,500 km² and includes 369 points evenly distributed every 0.25° lat/long. Average annual radiation values were calculated for the 1981–2010 period, decadal means (1981–1990; 1991–2000; 2001–2010) and seasonal means (DJF; JJA) for each decade as well as for the entire period. This provided 12 data series for each of the points extracted. The data matrix (369 × 12) was incorporated into a Geographic Information System (ArcGIS, ESRI®) to obtain spatial distribution maps of each of the data series. The Kriging interpolation method and a 2 km mesh were used.

On the other hand, the NCEP/ NCAR Reanalysis products derived from the Physical Sciences Laboratory (NOAA) were used to compare the spatio-temporal variation of the GHI with the dynamics of action centers in the area and period considered. Within the range of available data, surface variables (.995 sigma level) were selected. These include monthly means and long term means of sea level pressure (hPa), uwind (m s^{-1}), and vwind (m s^{-1}) for the period 1981–2010. The visualization, treatment and statistical analysis of the pressure and wind series were carried out in the Integrated Data Viewer program (IDV, Unidata).

3. Results and discussion

The mean annual distribution of atmospheric pressure values at sea level and surface winds in Argentina (Fig. 3A) and in the south of the Pampeana region (Fig. 3B) were analyzed. Figure 3A shows the presence of the Chaco Low (CL), SPH and SAH, whose pressures exceed 1020 hPa (Scian 2010). SAH is responsible for the downward pressure gradient in an east-west direction, originating the east and northeast component winds of the study area (Fig. 3B) and air masses loaded with humidity. Consequently, temperate climates with oceanic influence typical of the south pampeana region have a higher frequency of rainfall, low potential evapotranspiration and conditions leading to fog formation. In the coastal areas of the Pampeana region dominate maritime Tropical air masses (mT) which emerge from the western edge of the South Atlantic Anticyclone, whose entry to the continent favors the development of cloudiness and precipitation and the summer storms that occur in the region (Capelli de Steffens, Piccolo, and Campo de Ferreras 2005; Scian 2010; Celemín 1984; García 2013). As air masses advance over the continent, weather conditions are characterized by scarce rainfall, lower relative humidity values and cloudiness (Capitanelli 2008).

The annual distribution of GHI in the study area (Fig. 4) corresponds to the synoptic characteristics of the analyzed sector. The variable was observed to have an increasing gradient in an east-west direction, which coincides with the increase of the continental influence. Annual average values between 19.5 and 16.5 MJ m² of GHI were estimated for the period 1981–2010. Coastal zones in the eastern Buenos Aires province sector have lower GHI values than the rest of the study area. The southern sector of Buenos Aires province, despite its coastal location, has radiative conditions similar to the surrounding continental areas.
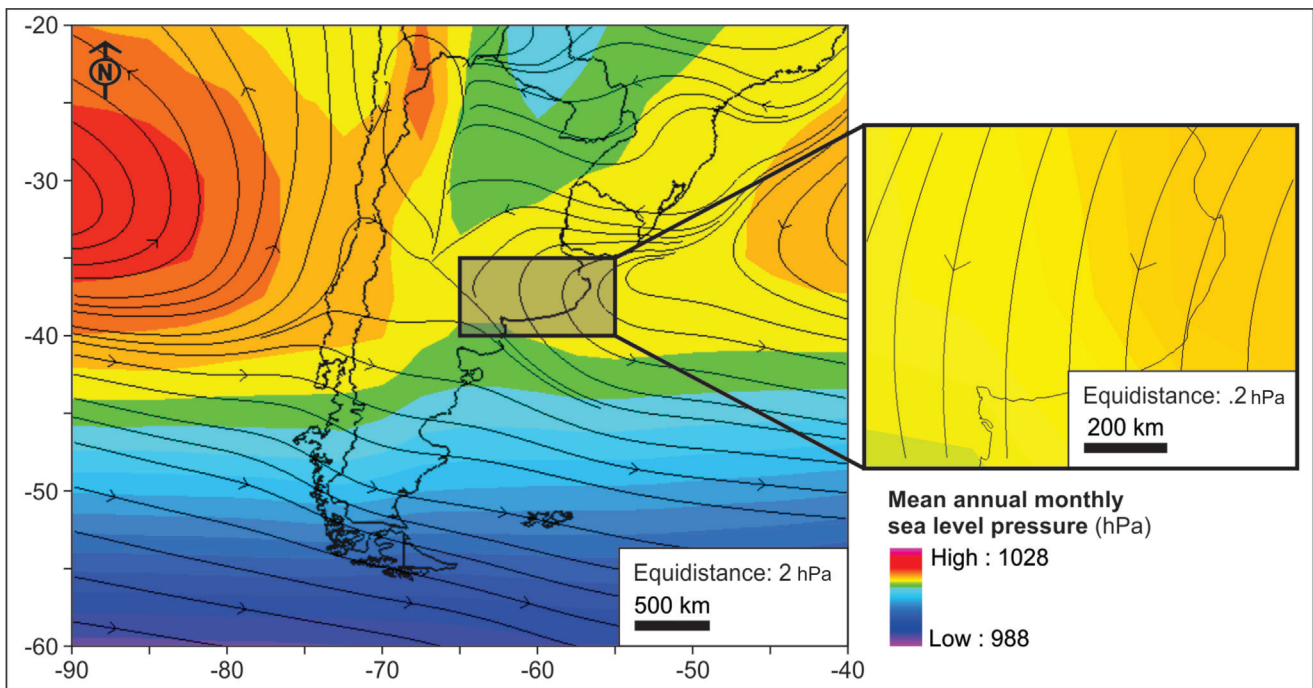

Fig. 3 Mean annual sea level pressure (hPa) and surface wind streamlines (m s^{-1}) for the period 1981–2010.
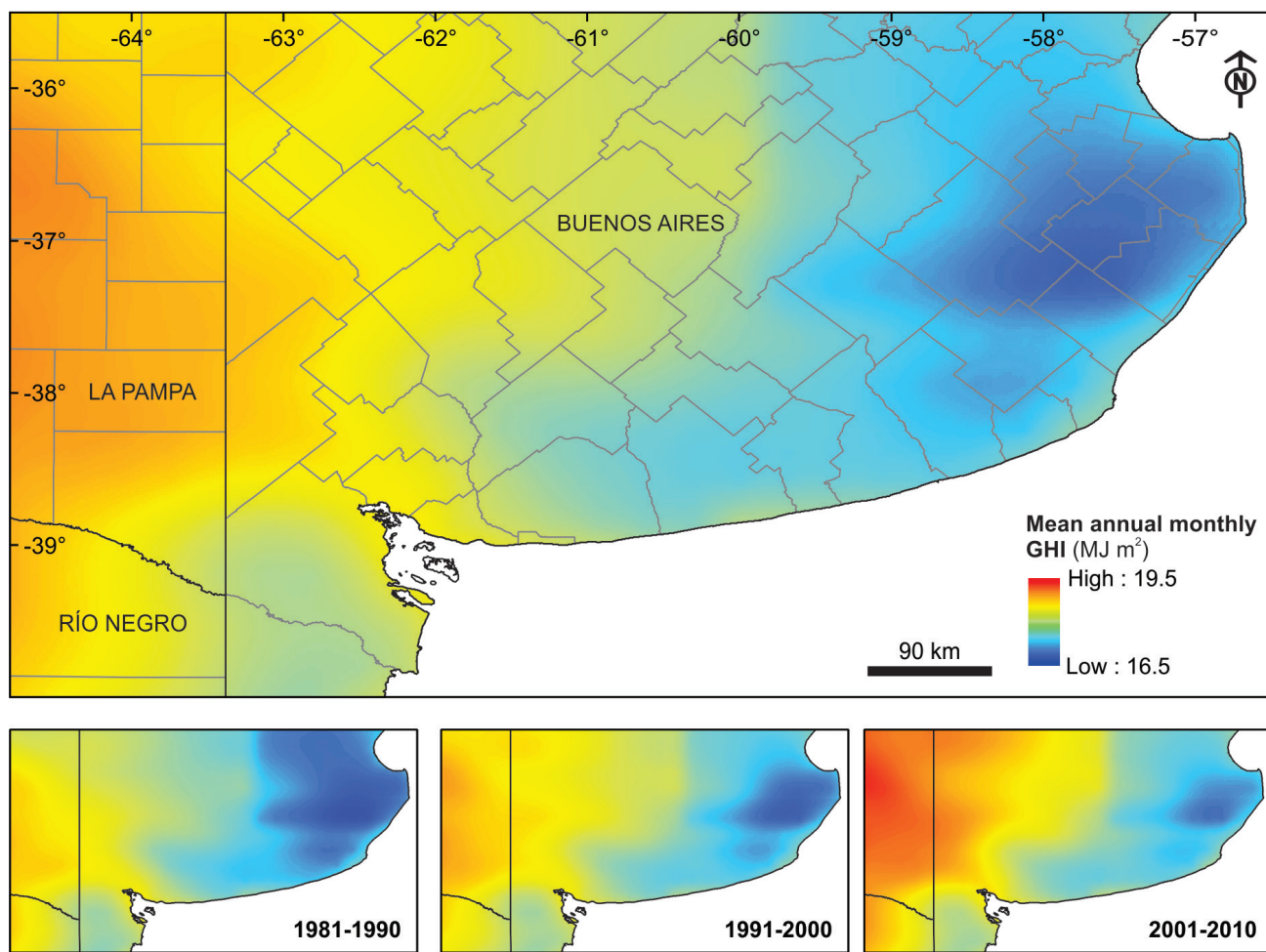
Fig. 4 Distribution of the mean annual Global Horizontal Irradiation (GHI) in the south of the Pampeana region (1981–2010).
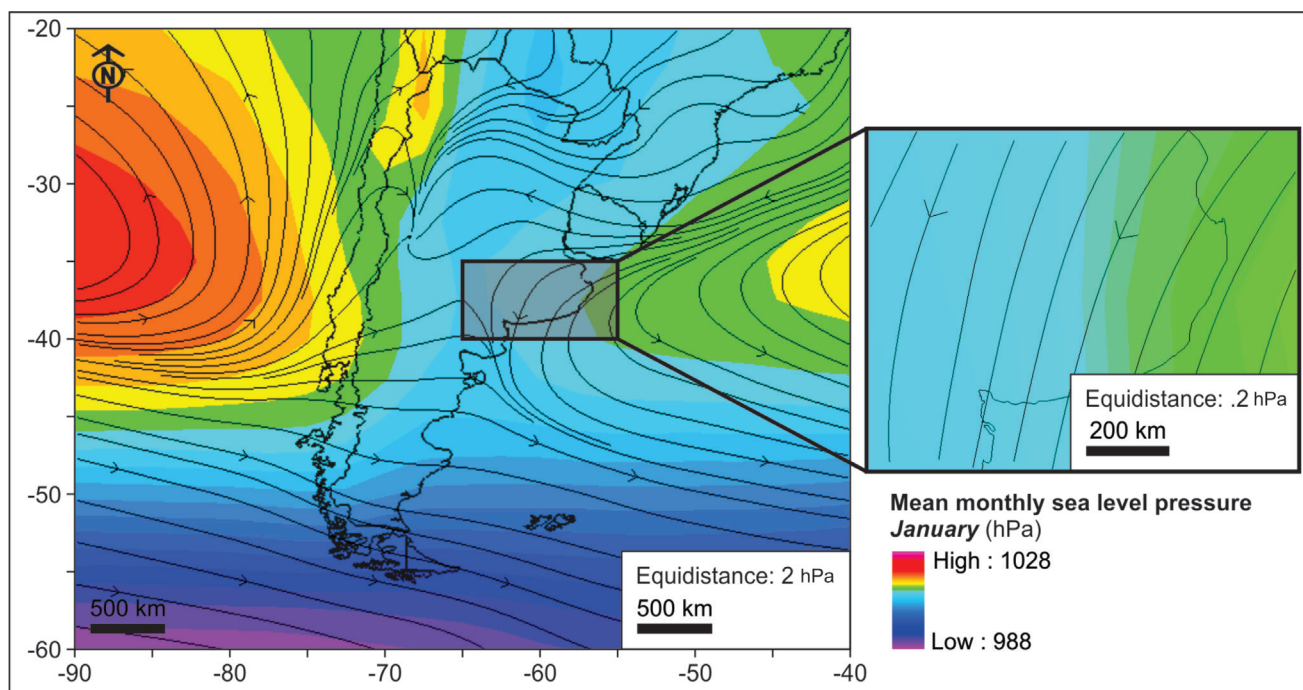

Fig. 5 Mean monthly sea level pressure (hPa) and surface wind streamlines (m s⁻¹) during austral summer for the period 1981–2010.

The regional atmospheric circulation that defines the greater frequency of winds from the North, Northwest and West and the influence of continental Tropical air masses (cT) inhibit the formation of clouds and precipitation, which explains the greater availability of GHI in the sector (Capelli de Steffens, Piccolo, and Campo de Ferreras 2005). Regarding interdecadal analysis, the distribution of the variable can be linked to the variability of rainfall that characterizes the region. Although GHI is directly influenced by cloud cover and the presence of clouds does not necessarily imply the occurrence of precipitation, they are considered to be weather elements with closely linked dynamics. Droughts in Argentina are directly associated with persistent anticyclonic conditions and a change in cloud cover of an area may be indicative of the beginning of this type of event (Piccolo, Capelli de Steffens, and Campo de Ferreras 2002). It can be observed that in the decade 1991–2000, all sectors located north of the area registered higher GHI values compared to 1981–1990. Furthermore, maps show that GHI increased successively in the region between the decades 1991–2000 and 2001–2010. The area with higher GHI values expanded towards the northeast and the areas with lower GHI were reduced in the eastern sector. In the decade 2001–2010, the western sector of the study area shows the highest GHI value estimated. These findings are in agreement with the trends found in rainfall volumes on a regional scale. Campo et al. (2008) registered the existence of two humid periods between 1976 and 1988 and between 1992 and 1997, associated with El Niño events of the El Niño-Southern Oscillation (ENSO) phenomenon. On the other hand, the period 2004–2009 is defined as one of the most important droughts since 1950 (Bohn, Piccolo, and Perillo 2011; Ferrelli 2010; Scarpati and Capriolo 2013). By 2005, the drought had already affected 46% of Buenos Aires province and in 2008 the national government declared the area Agricultural Disaster. The most affected areas were concentrated in the south of the province, including Bahía Blanca (Andrade, Laporta, and Iezzi 2009; Scarpati and Capriolo 2013).

The summer situation (Fig. 5) is generally defined by the presence of a low thermal pressure system in northern Argentina (CL), as well as low pressure centers (corresponding to the subpolar low pressure belt) south of Patagonia and the semi-permanent anticyclones of the Pacific and Atlantic oceans (Fig. 5A), which have a more northern position approximately 5° latitude closer to the Equator in winter) – due to the displacement of the climate system as a whole towards the south during summer (Garreaud and Aceituno 2007; Scian 2010; Minetti 2007; Hoffmann 1992; Inzunza 2012). The summer atmospheric dynamics in the study area is partly defined by the occurrence of the South America Monsoon System (SAMS), an atmospheric phenomenon related to annual rainfall variability (Vera et al. 2006; Marengo et al. 2012;

Mendonça 2017; Zhou and Lau 1998; Romero Aravena et al. 2011; González and Barros 2001). The SAMS comprises a complex spatial structure fundamentally composed of the Intertropical Convergence Zone (ITCZ), the Bolivian High (BH) and the Chaco Low (CL) (Romero Aravena et al. 2011; Franco et al. 2017). In the Amazon, strong summer convective heating results in the generation of BH, associated with the CL centered over northern Argentina, which also intensifies during summer. The increase in continental convection is related to ITCZ migration (from 14° N in August-September to 5° S March–April) and the predominance of east-northeast winds (Romero Aravena et al. 2011). Thus, during summer the east-northeast circulation brings tropical air masses from Brazil to central Argentina; the main cause of rainfall in the study area (González and Barros 2001; Celemín 1984; Doyle and Barros 2002). Figure 5 shows that, while the N zone of the study area is fundamentally influenced by E-NE component winds (carriers of humidity and precipitation), the SW zone has a greater influence from the W winds that, due to their continental route are carriers of dry air masses. This atmospheric dynamic defines differential situations of cloudiness and precipitation in the study area. On the other hand, SAH is located on the coasts of Brazil and Uruguay and extends a high pressure zone to the east of Buenos Aires province (Fig. 5). As a consequence, Atlantic air masses, which have a more southern influence, penetrate the continent loaded with humidity contributing to the increase in cloud cover and the consequent decrease in GHI in the eastern sector of the study area. As they move across the continent air masses lose moisture and cloud cover decreases. According to the most frequent summer synoptic situations stated by Celemín (1984), the advance of cold fronts from Patagonia to the northeast may allow the formation of lines of instability in several sectors of Buenos Aires, which define bad weather conditions, cloudiness and rainfall in the region (P. Zapperi et al. 2007; Casado and Campo 2019; Gabella, Zapperi Paula, and Campo Alicia 2010; Celemín 1984; Rubí Bianchi and Cravero 2010).

The average summer regional distribution of GHI (Fig. 6) ranges between 25 and 29 MJ m^2. Interdecadal analysis shows GHI values increased throughout the analyzed area between 1981 and 2010. GHI distribution in the region coincides with periods of water excesses that characterized Argentina until 2003, subsequently followed by a drier period. The southeast zone of the study area has lower GHI values than the central zone. A descending gradient is observed in a west-east direction in the northern sector of the study area. On the other hand, the continental zone has lower GHI values than the coastal zone in the south of the study area. As with annual distribution, the relationship between GHI distribution and the continentality of the analyzed area is evident. On the other hand, common synoptic situations in the warm
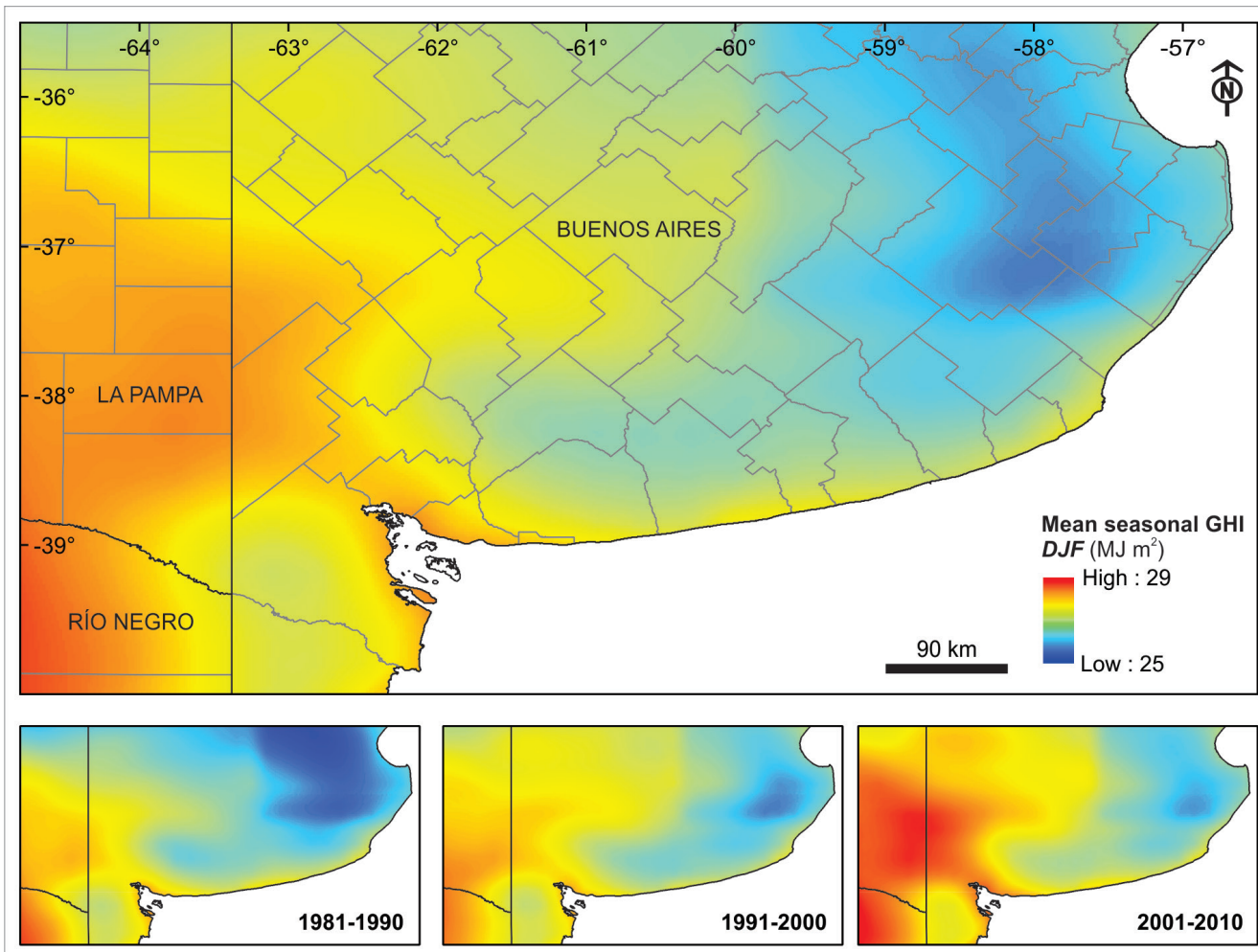
Fig. 6 Distribution of the seasonal mean Global Horizontal Irradiation (GHI) (DJF) in the south of the Pampeana region (1981–2010).
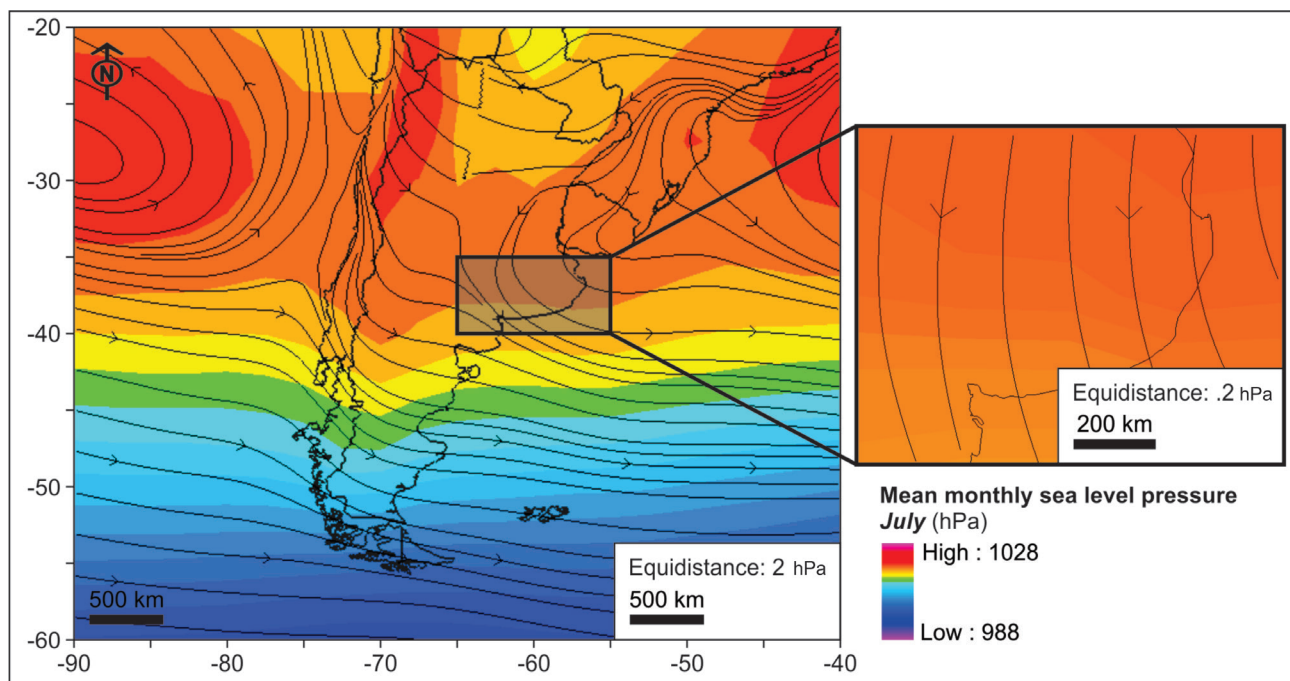

Fig. 7 Mean monthly sea level pressure (hPa) and surface wind streamlines (m s^{-1}) during austral winter for the period 1981–2010.

season are directly related to rainfall occurrence and cloud cover in the study area, so GHI distribution can be explained by analyzing the typical summer synoptic conditions of the region.

The winter distribution (1981–2010) of atmospheric pressure values at sea level and associated winds in Argentina (Fig. 7A) and in the south of the Pampeana region (Fig. 7B) were analyzed. SPH and SAH can be seen to migrate north as a consequence of the displacement of the warming zone. The influence of air masses loaded with humidity from SAH is reduced in the NE zone of the study area, so a downward pressure gradient is observed in the NE-SW direction, with the presence of high pressures in the center of the country. CL is weakened during winter months, so the influence of westerly winds is greater in the study area, unlike the summer period. As stated by Celemín (1984), during winter the passage of cold fronts is related with the presence of middle clouds, generally Altocumulus (AC), Altostratus (AS) and when rainfall starts, Nimbostratus (NS). The anticyclonic presence in the center of the country after the passage of the cold front defines clear skies in the northwestern sector of the south Buenos Aires province.

The occurrence of Sudestadas can be associated with GHI distribution in the study area. The Sudestada is a weather condition characterized by the occurrence of strong and persistent winds from the southeast sector, usually accompanied by rains affecting the coasts of the Buenos Aires province (Celemín 1984; Escobar, Vargas, and Bischoff 2004; Pizarro et al. 2007; Ferreras, Moresino, and Huamantinco 2004; Ramos and Campo 2008; Servicio Meteorológico

Nacional 2010). The Sudestada commonly extends from 1 to 3 days and begins with a cold front passage that crosses Patagonia and Buenos Aires province and by the action of a high pressure system located over Patagonia or southern Buenos Aires. This center is a cell detachment of the semi-permanent South Pacific anticyclone. From this action center, other smaller anticyclones called migratory are periodically detached and enter Argentine territory moving towards the east to later join the South Atlantic Anticyclone (Alessandro 1998; Aguirre et al. 2021). Each of the positions of the migratory anticyclones will define particular weather conditions and wind directions (Celemín 1984). When the cold front stops in the north Argentine territory and becomes stationary, a low pressure center (frontal wave) can form in the north of Uruguay, which will attract winds emitted by the migratory anticyclone located in north Patagonia. As a consequence, the province of Buenos Aires will receive winds from the east-southeast with speeds of 20 to 30 knots and with gusts of 40 to 50 knots, with the possibility of rain, drizzle and sometimes thunderstorms in the coastal areas. In this way, the occurrence of the Sudestada will define clear sky situations for continental zones of the study area, while in coastal zones clouds and rainfall will occur. This analysis coincides with findings by other authors (Casado and Picone 2018; Penalba and Vargas 2004), who argue that the west Buenos Aires province exhibits a more marked dry season, which can be interrupted by the action of frontal systems (P. A. Zapperi et al. 2006). Celemín (1984) developed a model for anticyclone tracks in Argentina based on a historical compilation of record anticyclones (Fig. 8). Recent investigations
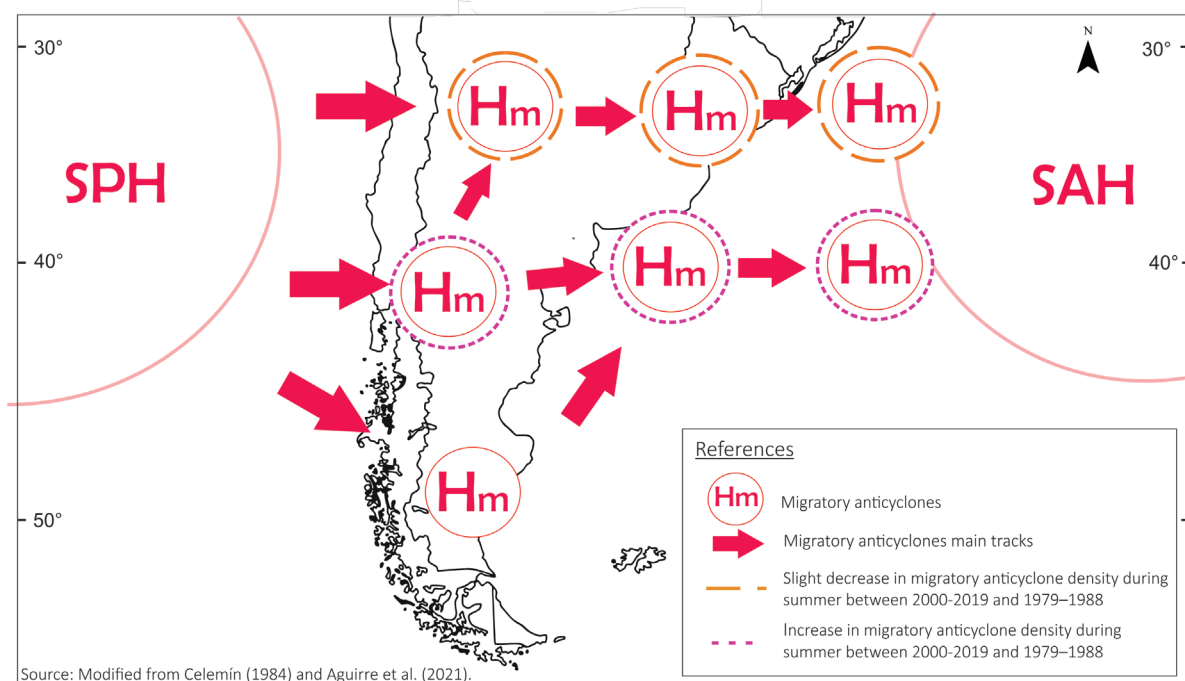

Source: Modified from Celemín (1984) and Aguirre et al. (2021).

Fig. 8 Stationary and migratory anticyclones scheme in the southern area of South America.

(Aguirre et al. 2019; 2021) analyzed the average density of anticyclones in the Southern Hemisphere. Aguirre et al. (2021) documented the difference between the density of the 2000–2019 decade and the first decade of the data (1979–1988). The authors found that during summer an increase in migratory anticyclone density was noticeable around 40° S, while a slight decrease was observed between 27° S and 38° S. Nevertheless, minor changes in density of migratory anticyclones were found during winter. It can be inferred that around 40° S, during the advance of migratory anticyclones between the firsts two positions of the main track situated around 40° S (Fig. 8), eastern flanks of the action centers that coincide with the coastal zones are those that present the maximum percentage of sky covered, with between 6 and 8 oktas of medium clouds and 2 and 4 oktas of low clouds (Celemín 1984).

GHI spatial distribution in the south of Buenos Aires during the winter season (Fig. 9) shows an increasing gradient in a southeast-northwest direction, with values that range between 8 and 11 MJ m². The lower spatial variability with respect to the summer situation is in agreement with reports by other researchers, a factor related to solar flux reduction and

greater occurrence of totally cloudy skies (Grossi Gallegos 1997; Hay 1984). The distribution is observed to have a pattern mainly influenced by the occurrence of frequent synoptic situations in the mentioned season, which define winter cloudiness patterns. These are fundamentally two: the advance of cold fronts on Argentine territory and the Sudestada situation (Celemín 1984). GHI spatial distribution during the winter season presents an ascending gradient in a southeast-northwest direction, approximately perpendicular to the direction of advance of fronts (and associated cloud cover) which continuously cross the country (Rubí Bianchi and Cravero 2010).

4. Conclusions

GHI spatio-temporal distribution in the south of the Pampeana region was analyzed. The analysis was approached at a regional scale, identifying its variability based on the synoptic conditions and associated cloud cover. Regionally, it was verified the latitudinal pattern of GHI distribution is modified by cloud cover, determined by seasonal dynamics of the action centers and the passage of fronts, which continuously
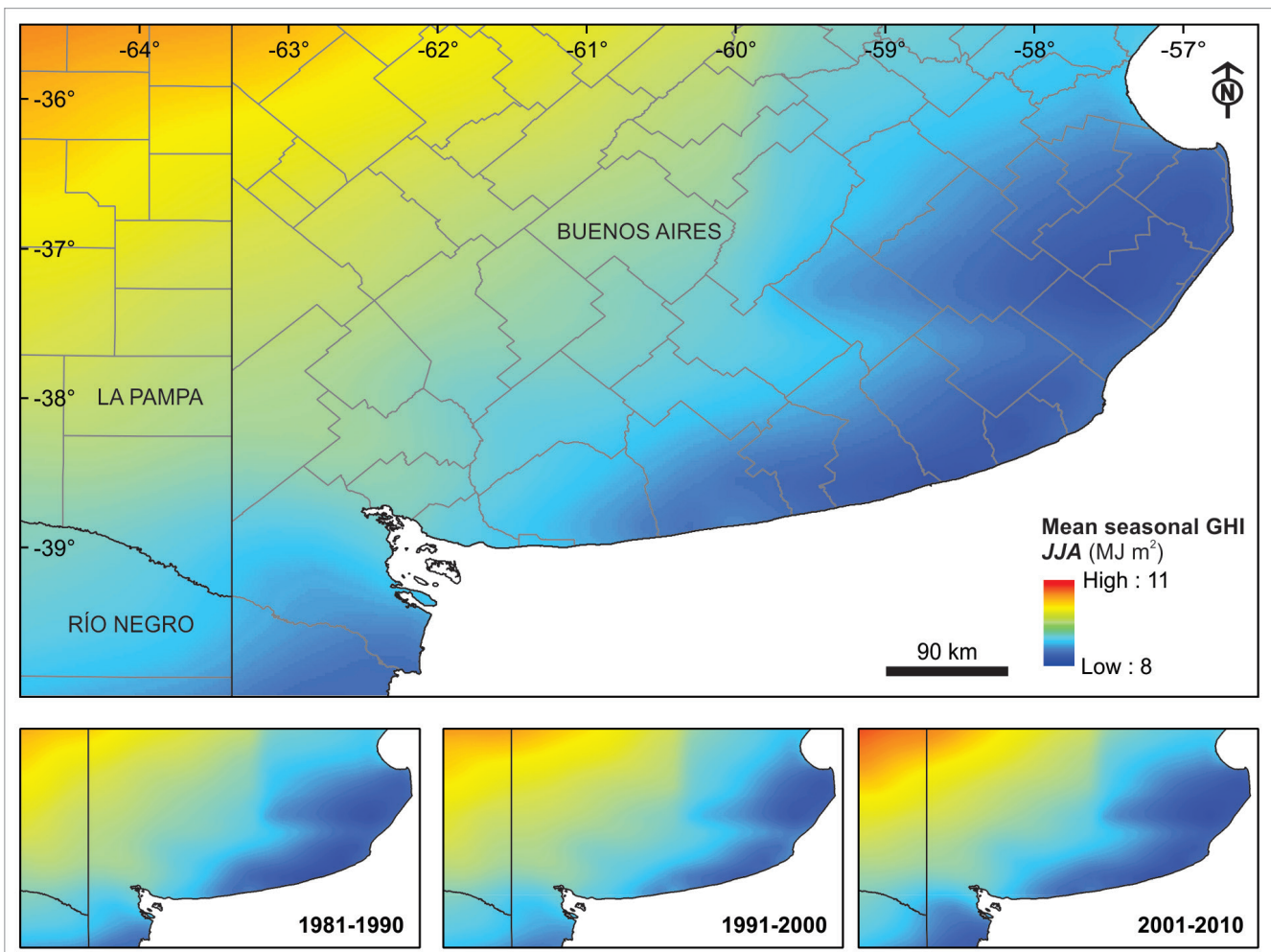

Fig. 9 Distribution of seasonal mean Global Horizontal Irradiation (GHI) (JJA) in the south of the Pampeana region (1981–2010).

cross the Argentine territory. Among climatic features involved, the SAMS defines differential situations of cloudiness and rainfall in the region, which affect GHI. Furthermore, the interdecadal spatio-temporal variability of GHI was studied; a successive increase was observed in the region between 1981–2010. The distribution of the variable can be linked to the cloudiness and rainfall variability that characterizes the region.

During the summer, Atlantic air masses, with a more southerly influence, penetrate the continent loaded with humidity, contributing (with the associated cloudiness) to the decrease in GHI in the eastern sector of the area. As they move across the continent, air masses lose moisture and cloud cover decreases, which explains GHI increase in central areas of the zone studied. On the other hand, due to the dynamics of SAMS, the N zone of the study area is fundamentally influenced by E-NE winds (carriers of humidity and precipitation), while the SW has greater influence of W winds that carry dry air masses. During winter, GHI spatial distribution presents an ascending gradient in a southeast-northwest direction, approximately perpendicular to the direction of fronts advance and to the isobaric arrangement manifested in the final phases of the most frequent winter synoptic situations. The presence of the low pressure system in the Atlantic Ocean defines descending cloud patterns in the southeast-northwest direction. The anticyclonic presence in the center of the country after the passage of cold fronts defines clear skies for the southwestern sector of the study area and, therefore, higher GHI values in these sectors. Furthermore, the Sudestada and migratory action centers associated with its formation can also be associated with GHI winter distribution in the study area.

Knowing the characteristics of insolation and the factors affecting its spatio-temporal variability in the regional context constitutes a fundamental input to promote sustainable development measures. With more than 90% of the population located in urban settlements, photovoltaic electricity production in the Pampeana region is an important measure in terms of energy diversification. The present work is the first phase in the analysis of solar climate in order to determine the potentiality of this resource.

Acknowledgements

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The influence of mayors as candidates in the 2017 parliamentary elections on voter decision-making in Czechia

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ABSTRACT

Local activities of electoral candidates represent one of the key factors influencing voting behaviour. Many studies have shown an elevated electoral support for candidates in the municipality of their residence and the surrounding region. By using the example of mayors who candidated in the 2017 Czech parliamentary elections, this article proves that this voting behaviour is manifested not only through the territorial concentration of preferential votes, but also through higher local electoral support of political parties represented by these candidates. This so-called friends and neighbours effect is stronger in smaller, less populous municipalities. Its spatial extent is not necessarily limited to the respective municipality, but if a well-known and popular mayor appears at the top of the regional candidate list, it can affect voters living many kilometers away, especially in non-metropolitan areas.

1. Introduction

In recent years, (not only) the Czech political scene has undergone significant changes. This is especially the rise of populism and the political parties that operate on its principles (Mudde and Kaltwasser 2018), dividing society through controversial topics such as the perception of international migration or the attitudes towards the European Union (Inglehart and Norris 2016). The traditional division of Czech political parties on the right-wing and left-wing has gradually turned into a duel between populism on the one hand and entities holding the principles of liberal democracy on the other, which has substantially redrawn the current Czech electoral maps and disrupted the long-term continuity of electoral patterns. What remains, however, is certainly a large number of voters, for whose decision on which political party to support in the elections, specific candidates – popular national and also local personalities of the political party – are more important than its ideology (Mikešová 2019).

The main goal of the conducted research is to empirically contribute to the understanding of spatial patterns of electoral support of political parties in Czechia, specifically on the example of the Czech parliamentary elections 2017. The study focuses predominantly on the impact of spatial context on voter decision-making, namely on the friends and neighbours effect, which is a term for the influence of geographical distance between voter and candidate (Arzheimer and Evans 2012). We can often observe that candidates receive higher electoral support in their municipality of residence and the surrounding area (Gimpel et al. 2008; Malcová 2012; Roy and Alcantara 2015). Not all candidates have this ability, but especially those who are familiar to local citizens and strongly connected with a specific municipality or locality, such as mayors, can mobilize their "home" voters. Alongside doctors or teachers, mayors are those whom citizens trust very much (Sedláčková 2012), which is important for deciding on the support of a particular candidate (and indirectly the party he or she is running for) in elections.

In the Czech parliamentary elections 2017, mayors were one of the most frequently represented professions on candidate lists (Dýnková 2017). This contribution analyses not only their spatial distribution, but mainly their potential to modify the voting behaviour of the inhabitants of the respective municipalities. In some cases, the influence of their candidacy may be noticeable in larger areas (Bernard, Kostelecký, and Šimon 2014; Panagopoulos and Bailey 2020). In this study, it is monitored using spatial statistical tools of geoinformation systems on the example of STAN candidates, a political movement whose full name is Mayors and Independents and which is primarily based on the personalities that people know from communal politics. This is the main reason why STAN was chosen as the primary object of the study.

2. Theoretical background

The support of political parties in Czechia and also in other countries is certainly not spatially homogeneous, as evidenced by territorial differences in election results. These differentiations can be explained by two approaches in the field of electoral geography. The first is a *compositional approach* for which individual characteristics of voters, such as gender, age, education, religion, standard of living or type of employment, are key factors in the question of the formation of different political orientations (Kitschelt 1994). The second is a *contextual approach* that emphasizes the influence of the local environment, where we live and which contributes to the formation of our values and opinions, including voting behaviour (Cox 1969; Kostelecký and Čermák 2004). The application of these two approaches is not exclusive; on the contrary, it is always ideal to combine both (Bernard and Kostelecký 2014; Weng 2015).

Most electoral-geographical studies are based on the search for a relationship between the composition of the population of territorial-administrative units and the electoral support of specific political parties. Differences in the socio-demographic and socio-economic structure between the analysed geographical units significantly determine local and regional differences in election results (Kowalski 1999; Kostelecký 2009; Harbers 2017; Lepič 2017). This idea is based on the *cleavage theory* (Lipset and Rokkan 1967). The premise of this theory is the fact that people belonging to the same social group show identical or at least similar voting behaviour and that they are spatially concentrated in certain areas – for example historically in Western Europe there were conservative-minded villagers working mainly in agriculture and, on the other hand, much more liberal-oriented inhabitants of port cities. However, Hloušek (2002) shows in his study that the adoption of Lipset's and Rokkan's cleavage theory does not lead to a deeper understanding of the development of national party systems during the 1990s in Central and Eastern Europe, including Czechia. According to Hloušek (2002), it is necessary to work with a different matrix of variables in the analysis of regional differences in election results than those applied by older research from the Western European electoral environment.

2.1 Spatial context of electoral behaviour

Only a minority of research in the field of electoral geography pays dominant attention to the influences of the spatial context (Weng 2015). Contextual factors influencing electoral behaviour can have an impact at different subnational levels, with different strength, and also in very diverse forms (Taylor and Johnston 1979). Agnew (1996) points out that the context is always multi-scale, from household and close neighbourhood to the context of the local and regional environment, as well as spatio-temporal, because it

changes significantly over time. Specific historical events also influence voting behaviour in a certain locality and their impact can be sometimes seen even for several generations – for example, in Czechia, demographic development in the Sudetenland after the Second World War associated with disruption of local communities and settlement continuity, which results in an overall lower level of civil society, including civic engagement, and consequently regularly lower voter turnout (Šimon 2015).

One of the most frequently discussed contextual factors of electoral behaviour is the *neighbourhood effect*: The influence of personal interactions between people, as the voter decision-making is highly conditioned by opinions of people around them (Pattie and Johnston 2000). The neighbourhood effect is best described by the phrase "people who talk together, vote together" (Miller 1977: 65). People partly take opinions, including who to support in the elections, from their relatives and close friends and are influenced by information circulating in their social networks. Traditionally, this term was used mainly for the influence of family, friends or colleagues at work, but in today's modern age, these social networks can also be understood as internet communities and "personal" interactions between people in the virtual world.

A large questionnaire survey on the parliamentary elections in Great Britain found that people are more likely to change their vote in a certain direction if those with whom they most discuss political issues also support it (Pattie and Johnston 2000). Within the contextual approach of electoral geography, the neighborhood effect can be understand as strengthening the importance of individual socio-demographic and socio-economic characteristics of voters in case of their agreement with people around them, or weakening of their importance in a situation where the voter is mainly in contact with people from different social groups and with different political opinions (Butler and Stokes 1969; Stephens 1981; MacAllister et al. 2001).

Other factors of the spatial context that significantly modify electoral behaviour in specific localities are the effects of the spatial organization of political parties (Shin 2001). This is particularly the importance of locally targeted election campaigns – *campaign effect*, but also the territorial distribution of strong candidates who have the potential to gain above-average electoral support in their hometowns and regions not only for themselves but also for the political party they represent. For the second described phenomenon, some authors use the term *friends and neighbours effect* (Tatalovich 1975; Johnston et al. 2016; Panagopoulos and Bailey 2020), while others prefer the term *candidate effect* (Roy and Alcantara 2015).

In fact, both effects connected with the parties' regional activities are very often interrelated (Pickery 2002). If the political party has strong personalities at the top of candidate list in a certain locality, it allows it to intensify the election campaign here, which further attracts new voters. Empirical research on the campaign effect (Denver and Hands 1993; Johnston and Pattie 1997) show not only a significantly higher electoral support of a political party in localities where it spents more finances during the election campaign, but also an apparent mobilization of voters, which is reflected in higher overall voter turnout in these areas. According to these studies, the campaign effect is not primarily about the conversion of voters of other parties and movements, but rather about the mobilization of politically ambivalent citizens who would probably not even go to the polls without the influence of the election campaign.

The potential of voter mobilization is also shown by the friends and neighbours effect (Rice and Macht 1987; Baumann et al. 2021). The causes of this effect are not only the possible personal relations between the candidate and voters from the same municipality or locality, but also the so-called "shared geography" and local patriotism play a key role, attracting citizens to ballot boxes to support their local candidate (Panagopoulos, Leighley, and Hamel 2017). The primary reason for the existence of the friends and neighbours effect can be conceptualized as a relationship between trust and distance. People have more trust in someone, who is close to them, not only in friendly and emotional way, but also geographically (Gimpel et al. 2008). With increasing distance between people, trust decreases, as does the electoral support of the candidate (Górecki and Marsh 2012; Malcová 2012).

In the Czech parliamentary elections, the friends and neighbours effect has two main impacts. It manifests itself in the spatial concentration of preferential votes of individual candidates near their place of residence (Voda and Pink 2009), but secondarily also in the higher electoral support of political parties in localities where some of their strong leading candidates stand (Bernard, Kostelecký, and Šimon 2014). The analytical focus of this article is on the relevance of the friends and neighbours effect in relation to the choice of the supported political party, not to the preferential voting for individual candidates.

When monitoring the influence of the effect on the spatial patterns of preferential voting, we must keep in mind that the position on the candidate list plays a big role. In the Czech electoral environment, candidates at the top of the candidate lists have a noticeable advantage, a greater chance of being elected, which is associated with a larger share of preferential votes received. The whole concept (relationship between preferential voting and candidates' places of residence) is therefore better observable, for example, in Finland (Put, Schoultz, and Isotalo 2020), where candidates are listed in alphabetical order.

Recent studies of the influence of local candidates on the choice of supported political party show that the effect is stronger within the majority, especially FPTP (first past the post), electoral systems (Kal

Munis 2021; Put 2021) and that the degree of regional identity of the local population is very important. The friends and neighbours effect can be a reflection of the local identity of voters, their sense of belonging to their municipality or region, for which they prefer candidates from their immediate surroundings (Schulte-Cloos and Bauer 2021).

New research tends to be linked to practice and can serve to optimize the process of drawing up candidate lists and as a basis for the nomination strategies of individual political parties and movements (Put, Schoultz, and Isotalo 2020). The use of similar research by political parties is supported by growing tendencies to personalise politics. In connection with this fact, an increasing share of voters focuses more on the selection of candidates than on the parties and tends to favor those who act more credibly for them. It can be sympathy for the party's election leader or the support of particular locally connected candidates from the same municipality or nearby town, such as mayors, whose influence on voter decision-making is the core theme of this paper.

No similarly focused academic work has been published in Czechia so far. Nevertheless, Mikešová (2019) mentioned the importance of mayors as candidates in the Czech parliamentary elections, when she analysed electoral behaviour in different regions of the country through in-depth interviews. Some respondents stated that the high quality management of their municipality by a certain political party could be the reason to support the same party also at a higher political level. Studies directly aimed at the advantage of being a mayor when running for national parliament can be found in foreign literature (Blais et al. 2003; Put and Maddens 2015). However, these authors used very different approaches to measure the relevance and strength of the friends and neighbours effect, so the findings are not comparable with the results of my research.

3. Methodology and data

In the Czech parliamentary elections 2017, more than five million valid votes were cast with a turnout of 60.8%. The dominant winner of the elections in all regions of Czechia was the political movement ANO 2011 (ANO) with an overall electoral support of 29.6%. In order to win seats in the Chamber of Deputies, it is necessary to exceed the 5% electoral gain limit, which was achieved also by eight other political parties: Civic Democratic Party (ODS), Czech Pirate Party (Piráti), Freedom and Direct Democracy (SPD), Communist Party of Bohemia and Moravia (KSČM), Czech Social Democratic Party (ČSSD), Christian and Democratic Union – Czechoslovak People's Party (KDU-ČSL), TOP 09, Mayors and Independents (STAN).

In the first step of the analysis, this paper observes the dependence of electoral support of all nine successful political parties (and movements) on the territorially heterogeneous structure of the population at the level of municipalities. The nine separate multiple linear regression models always included one dependent variable, which was the electoral support of the analysed political party, and six independent variables (predictors), representing both socio-demographic (age, education, religion) and socio-economic (type of employment, standard of living) characteristics of the population. Six indicators were used as predictors (all as relative values in respective municipality): citizens over the age of 65, people with university degree, Catholics, the unemployed, private entrepreneurs and people facing distraint (whose property was confiscated due to unpaid debts). The gender factor also has a significant influence on voting behaviour in Czechia (Řeháková 1999), but this variable (proportion of men and women) shows very little variability in space, so it makes no sense to include it in regression models. Its influence would have to be observed at the individual level, not on aggregated data.

One of the outputs of the multiple linear regression are residuals, which for each political party show the differences between its actual electoral support in the Czech parliamentary elections 2017 and the electoral support predicted on the basis of the social composition of the population in each municipality. When the residual value is positive, it means that the political party had higher electoral support in the municipality than we would expect according to the regression model. In this respect, the studied friends and neighbours effect or other contextual factors can often play an important role in explaining these deviations.

The analysis of residuals was used for two main purposes: 1) to measure the strength of the friends and neighbours effect in the municipalities whose mayor figured on the candidate list of any of the nine analysed political parties; 2) to observe the spatial extent of the local influence of the mayors on candidate lists on the example of the political movement STAN. The first of these two points of the analysis was supplemented by the search for correlation between the strength of the friends and neighbours effect and the population of the municipality to which this effect relates. Information about the place of residence and occupation of all candidates is available on the website of Czech Statistical Office (2017). The analyses included candidates who have stated "mayor" as their occupation on the list of candidates.

Municipalities with mayors on candidate lists were divided into seven categories according to their number of inhabitants. Mean, α-trimmed mean (α = 5%) and median of the residual values of the electoral support of the political parties represented by the candidates (analysed mayors) were calculated. The less frequently used term α-trimmed mean is a mathematical quantity, in the calculation of which α of the smallest and largest values

are separated from the original dataset and the arithmetic mean is calculated from the remaining $(100 – 2\alpha)\%$ values (Hendl 2006).

The method of local hot spot analysis was applied to study the spatial extent of the friends and neighbours effect. This tool makes it possible to identify spatial clusters of territorial units that have significantly above-average or below-average values of the observed phenomenon. In our case, these were clusters of municipalities with significantly positive or negative residuals as differences between actual and expected electoral support. A constant limit distance model set at 10 km was used to calculate the spatial weights. This distance is used in analyses for Czech municipalities mainly because each municipality should have at least one neighbouring unit in the analysis (the largest distance of a municipality from its nearest neighbouring municipality in Czechia is 9.4 km).

Clusters of positive residuals are relevant in determining the influence of the friends and neighbours effect. Although there may be a negative friends and neighbours effect as well, its strength and spatial extent is usually not large enough to manifest itself as a cluster of negative residuals, which therefore have different causes. Local hot spot analysis was previously used by Bernard, Kostelecký and Šimon (2014) to capture various types of spatial contextual influences on voter decision-making in Czech parliamentary elections. According to them, research at the lowest possible scale level makes it possible to reveal even quite small site-specific deviations of electoral behaviour. It is the reason why municipalities were chosen as the basic spatial units of all analyses also in my study.

The study works with open data of the results of the Czech parliamentary elections 2017, which are administered by the Czech Statistical Office (2017). However, these are not election data for municipalities, but for individual polling stations, therefore their aggregation to the level of municipalities was necessary. At the level of polling stations, there are no available data about the composition of their population. These are accessible in a very detailed form for all Czech municipalities (a total of 6,258 municipalities) thanks to the regular population census, which last took place in 2011 (Czech Statistical Office 2011).

It would be more appropriate if we had similar data for the year when the analysed elections took place, as the composition of the population of some municipalities could partially change between 2011 and 2017, which would affect the relevance of the research results. However, six years is not that long time in terms of socio-demographic changes and also dynamic population changes occur only in some specific localities, for example in suburban areas in the hinterland of cities such as Prague or Brno (Novák and Netrdová 2011). The additional source was the database about people, whose property was confiscated due to unpaid debts, and their share in individual municipalities in the Czechia, provided by the Institute of Sociology of the Czech Academy of Sciences (Hábl 2017).

A methodological problem that has accompanied geographical research conducted in the Czech electoral environment for many years is the fact that Czech citizens are not obliged to vote in their municipality of residence, but can apply for a so-called voting card that entitles them to vote in any polling station across the country. This alternative is used by a large number of voters in Czechia, but the number of used voting cards is not ascertainable. The high proportion of such voters causes deviations from spatial patterns of voting behaviour, especially in tourist attractive localities such as Krkonoše (Giant Mountains) or Šumava (Bohemian Forest), where many tourists, for example from Prague and its surroundings or other bigger cities, cast their votes (Bernard, Kostelecký, and Šimon 2014).

4. Research results and discussion

In the Czech parliamentary elections 2017, we could observe significant spatial differences in election results. In some localities, populist parties, which in Czechia include SPD movement, but also ANO or KSČM (Bendl, Bořil, and Suchánek 2020), had very above-average support, while in other localities most voters preferred liberal-oriented political parties. Using multiple linear regression analysis, it was possible to determine the dependence of electoral support of all nine successful political parties on the structure of the population of Czech municipalities (Tab. 1), which partly explains the territorial differentiation of election results and spatial patterns of electoral behaviour in Czechia.

The winning political movement ANO received above-average electoral support in areas with a smaller share of private entrepreneurs and university-educated people and also in places with a higher unemployment rate. A similar association was manifested in the electoral support of KSČM and SPD. Both of them received above-average electoral gains also in localities with a higher proportion of people facing distraint, who vote more often for these anti-system political parties.

The only major difference in the dependencies of the electoral support of the two discussed parties is the influence of the share of seniors (aged over 65) on their election result in the respective municipality. While the Communists benefit from a higher proportion of seniors, as do other from traditional left-wing political parties – ČSSD, the new (founded in 2015) far-right political movement SPD led by Tomio Okamura had significantly lower electoral support in municipalities with a higher share of elderly citizens.

Tab. 1 Dependence of electoral support of political parties in the Czech parliamentary elections 2017 on the structure of population at the level of municipalities (standardized beta coefficients of multiple linear regression models).

Independent variables – Share in the population	Dependent variables – Electoral support of particular political parties								
	ANO	ODS	Piráti	SPD	KSČM	ČSSD	KDU-ČSL	TOP 09	STAN
University graduates	−.201	.318	.204	−.141	−.243	−.091	.032	.376	
Catholics	−.240	−.185	−.190		−.117	.105	.793	−.142	−.176
Unemployed	.041	−.173	−.154	.163	.188		.024	−.092	−.075
Aged over 65			−.028	−.102	.110	.137	−.036		
Private entrepreneurs	−.193	.251	.144	−.026	−.144	−.090	−.028	.185	.096
Facing distraint			−.057	.068	.034		−.037		−.055
R square	*.156*	*.289*	*.166*	*.091*	*.193*	*.060*	*.641*	*.248*	*.047*

Sources: Czech Statistical Office (2011; 2017), Hábl (2017); author's calculations.

Note: Only statistically significant values are shown in the table (p < 0.05).

The electoral preferences of KDU-ČSL in individual municipalities are very strongly correlated with the share of Catholics. This dependence is confirmed by many other studies of electoral behaviour patterns in Czechia, such as Voda (2010), who determined using the binary logistic regression method that the probability of voting KDU-ČSL is 26 times higher for a person who goes to church at least once a month in comparison with those who do not. Other determinants of the electoral support of this political party are also statistically significant at the level of municipalities, but all of them are very weak with the standardized beta coefficients lower than ±0.04 (Tab. 1).

An interesting finding is the similarity of the results of multiple linear regression models for four different political parties: ODS, Piráti, TOP 09 and STAN. All of them could be classified as liberal-oriented entities, and at the same time they all ended up in opposition after the Czech parliamentary elections 2017. Electoral support of these four political parties is above-average in municipalities with a higher share of private entrepreneurs, lower unemployment rate, a lower share of Catholics and, with the exception of STAN, also in municipalities with a higher share of university-educated people. This is an indicator for which we record a strong positive correlation dominantly with the electoral preferences of TOP 09 and ODS.

In Tab. 1, the last row shows the coefficients of determination (R square) for all nine regression models. This value denotes to what extent the spatial differentiation of electoral support of a particular political party can be explained on the basis of the heterogeneous structure of the population of Czech municipalities. Most, specifically 64.1% of the variability was explained in the electoral support of KDU-ČSL, primarily due to the religion factor and the higher electoral gains of the party in Catholic areas. On the contrary, the electoral support of STAN is the least determined by the composition of population. The regression model for this party explained
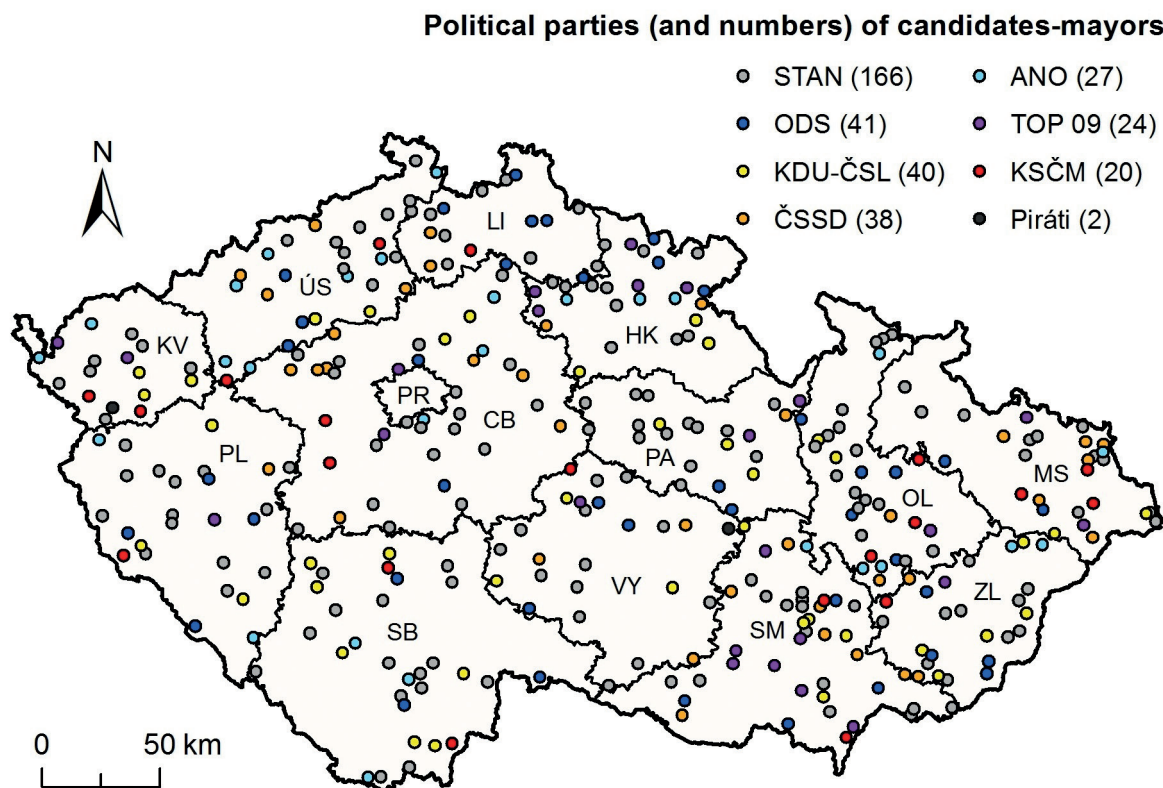
only 4.7% of the variability of its electoral gains at the level of municipalities. This indicates the need to look for other, especially various contextual, factors, such as the friends and neighbours effect, that would better explain the spatial patterns of electoral preferences.

4.1 Mayors on candidate lists

The friends and neighbours effect should, by its very nature, be most evident on the instance of strong and well-known, but at the same time strongly locally connected personalities. As more than 7,500 candidates took part in the studied parliamentary elections (Czech Statistical Office 2017), it would be very difficult to analyse the electoral support in their home municipalities for all of them. Therefore, only one specific group of candidates was selected – the mayors of Czech municipalities, for whom existence of the effect could be reasonably expected. Mayors are usually candidates that local citizens know and trust, which is an important prerequisite for why, thanks to their candidacy, voters in the respective municipalities could also support the political parties and movements represented by them.

A total of 358 mayors were present on the candidate lists of the nine analysed political parties in the Czech parliamentary elections 2017. The largest share from this number belongs to the STAN candidates, among which there were 166 mayors of Czech towns and municipalities. In terms of representation of other political parties, 41 mayors sought parliamentary seats as ODS candidates, KDU-ČSL had 40, ČSSD 38, ANO 27, TOP 09 24, KSČM 20, Piráti only two and SPD none of mayors on its candidate lists. These values could partly reflect the strength of political parties in Czech local politics and also the "bottom up tendencies" of their candidates. While an ascending political career paths are typical for STAN candidates, SPD is much more nationwide without emphasis on the local level.

The attached Fig. 1 shows the map of municipalities whose mayors appeared on the candidate lists in the

Political parties (and numbers) of candidates-mayors

- STAN (166)
- ANO (27)
- ODS (41)
- TOP 09 (24)
- KDU-ČSL (40)
- KSČM (20)
- ČSSD (38)
- Piráti (2)

Fig. 1 Geographical distribution of mayors participating in the Czech parliamentary elections 2017.

Sources: Arcdata Praha (2016), Czech Statistical Office (2017); composed by author.

Notes: List of regions (abbreviations): Central Bohemian Region (CB), Hradec Králové Region (HK), Karlovy Vary Region (KV), Liberec Region (LI), Moravian-Silesian Region (MS), Olomouc Region (OL), Pardubice Region (PA), Plzeň Region (PL), Prague (PR), South Bohemian Region (SB), South Moravian Region (SM), Ústí nad Labem Region (ÚS), Vysočina Region (VY), Zlín Region (ZL). The map only includes data on mayors on the candidate lists of political parties that have exceeded the 5% quorum.

analysed elections. Their spatial distribution was relatively even, yet the map shows regions in which their significantly higher concentration is evident compared to other areas, such as the region of Central Moravia. At the same time, individual parties and movements had their candidate mayors very spatially dispersed as well, and no significant clustering of mayors of any of the political entities into a specific locality could be observed. An example of a party whose candidates from among the mayors of Czech municipalities show a certain degree of spatial clustering would be TOP 09, where 12 out of 24 mayors on the party's candidate lists were registered in just two regions: South Moravian Region and Hradec Králové Region, where the political party was generally relatively stronger in comparison with the rest of the country, except Prague.

Mayors from variously large municipalities appeared on the candidate lists (Tab. 2). Both very small municipalities and big towns, including the regional capitals, were represented. However, mayors from smaller municipalities in most cases only supplemented the regional candidate lists and were placed on the bottom of the lists, without a reasonable chance of success. Martin Kupka from Líbeznice (2,207 inhabitants in 2011) was the only mayor of a small municipality who managed to obtain the mandate in the Chamber of Deputies from almost the last place (position 31 out

of a total of 34 candidates) on the candidate list thanks to a large number of preferential votes. The explanation of his success may be that he also works as a councillor of the Central Bohemian Region and since 2014 also as a vice-chairman of ODS, so his local competence is therefore wider and his name and face are not known only to the citizens of his municipality, but to the inhabitants of the whole region.

Tab. 2 Mayors on candidate lists according to the population size of the municipality.

Population of the municipality	Number of mayors on candidate lists	Number of successful candidates out of these mayors
Under 500	35	0
501 – 1 000	63	0
1 001 – 1 500	47	0
1 501 – 2 500	64	2
2 501 – 5 000	53	0
5 001 – 10 000	45	1
Over 10 000	51	9
Total	*358*	*12*

Source: Czech Statistical Office (2017); author's calculations.

Notes: Values in the table include nine successful political parties in the analysed elections. A successful candidate is the one who earned a seat in the Chamber of Deputies.

A total of 12 mayors won a seat in the Chamber of Deputies. Half of them headed the regional candidate list of their political party, and at the time of the elections in October 2017 they were top representatives of towns with more than 10,000 inhabitants (namely Jablonec nad Nisou, Kolín, Mariánské Lázně, Náchod, Trutnov and Uherské Hradiště). From the sixth place on the ODS candidate list in the Pardubice Region, the very popular and long-time mayor of Polička (population of approximately 8,800 inhabitants) Jaroslav Martinů managed to succeed. He received more than half of the preferential votes, thanks to which he became a deputy, in Polička and the nearby hinterland. This indicates a significant spatial concentration of preferential votes, which is one of the direct manifestations of the friends and neighbours effect in the Czech parliamentary elections (Voda and Pink 2009).

4.2 Measuring friends and neighbours effect at the level of municipalities

A secondary manifestation of the friends and neighbours effect in parliamentary elections in Czechia may be significantly higher electoral support of political parties in municipalities and localities where some of their candidates live. As part of the analysis of the influence of mayors on the electoral behaviour of the inhabitants of the respective municipalities, residuals from regression models were used to measure the strength of the effect, which show deviations in the electoral gain of each of the nine successful political parties in individual municipalities in Czechia. In other words, this method can be used to monitor where do the parties have higher and where, on the contrary, lower electoral support, after removing the influence of spatially differentiated socio-demographic and socio-economic structure of the population.

In most municipalities, specifically in 341 out of 358 municipalities with a mayor as a candidate in the parliamentary elections, which means 95.3% of all cases, the calculated residuals acquired positive values (see Fig. 2). This statistically proves that it is not only a random deviation, but a systematic influence of the candidacy of the local mayors on the election results in the respective municipalities. The average value of regression residuals was 6.7%. This result can be interpreted as that if a mayor ran in the Czech parliamentary elections 2017, the electoral gain of the political party he represented was in his municipality on average 6.7 percentage points higher than we would expect based on the municipality's population characteristics.

Residual value of electoral support

- 10.1% – 66.5%
- 5.1% – 10.0%
- 1.6% – 5.0%
- -1.5% – 1.5%
- -3.3% – -1.6%
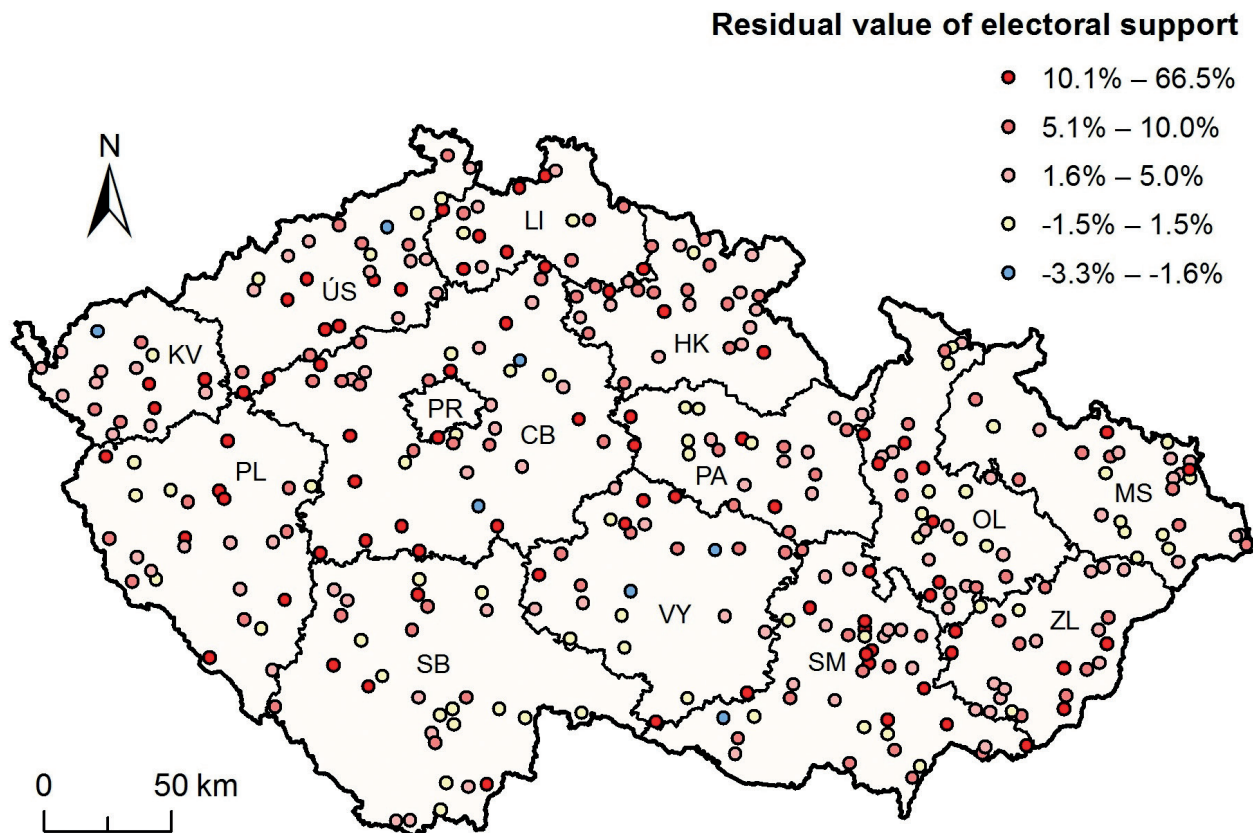
Fig. 2 Differences between actual and expected electoral support of political parties in the municipalities where their candidates-mayors live.

Sources: Arcdata Praha (2016), Czech Statistical Office (2011; 2017), Hábl (2017); composed by author (including own calculations).

Note: The same abbreviations of regions are used in the map as in Fig. 1. The map only includes data on mayors on the candidate lists of political parties that have exceeded the 5% quorum.

However, the arithmetic mean can be greatly affected by extreme values, so it would be more appropriate to work with, for example, the median or α-trimmed mean. The median electoral support residual is 4.8%, almost two percentage points lower than the mean, and the α-trimmed mean is 6.0%. As it turns out, the mean is increased by extreme observations, so it is influenced mainly by extremely high residual values. The highest residual of electoral support was recorded in the Central Bohemian village of Těchařovice, whose mayor Vanda Bělinová appeared on the ČSSD candidate list and the party won 73.9% of valid votes in this village (residual +66.5%). In absolute numbers, however, it was only 17 votes out of a total of 23, and this extreme local support had virtually no impact on the party's result in the wider region.

As we can see from Fig. 2, there are no significant spatial patterns and differences among the Czech regions in relation to the strength of the friends and neighbours effect analysed on the example of mayors as candidates in the parliamentary elections. Municipalities with a residual value higher than 10%, of which there are a total of 78, are spread throughout the whole country. There are most such municipalities in the Central Bohemian Region – a total of 13, on the other hand the least in the Moravian-Silesian Region – only two. Similarly, municipalities with more noticeably negative residuals (below −1.5%) are not located in one specific region, but can be found in different parts of Czechia.

It is also interesting to look at the municipalities in which the residual of the electoral support of the relevant political party was negative. In addition to large cities, relatively small villages can be found among 17 of them as well. An example is the Staré Město pod Landštejnem, where ODS had a lower electoral preferences than predicted by the theoretical regression model, even though the mayor of the village, Alena Šindlerová, was present on the candidate list. In a village with about 500 inhabitants we would definitely not expect something similar, but it turns out that the sole presence of the candidate on the list is not sufficient if it is not connected with his quality or popularity among local residents, as evidenced by the significant decline of ODS support in this village between municipal elections in 2014 and 2018.

The magnitude of the candidate mayor's influence on the election result of the relevant party in the respective municipality shows considerable variability across the 358 analysed candidates. Foreign studies (Tatalovich 1975; Lewis-Beck and Rice 1983; Gimpel et al. 2008), as well as Czech ones (Malcová 2012), agree that the most important determinant of the strength of the friends and neighbours effect is the population size of the municipality or region to which the effect relates. This relationship was also demonstrated on the example of mayors as candidates in the Czech parliamentary elections 2017. The highest average strength of the friends and neighbours effect is clearly evident in the smallest municipalities. With the growing number of inhabitants in the municipality, the strength of the effect gradually decreases (Fig. 3).

The increase in electoral support of the relevant political party or movement thanks to the local mayor on the candidate list reaches in municipalities with less than 500 inhabitants on average 16 percentage points. The values of regression residuals are also above-average in next two size categories, including municipalities with the population between 500 and 1,500 inhabitants. In towns, on the other hand,
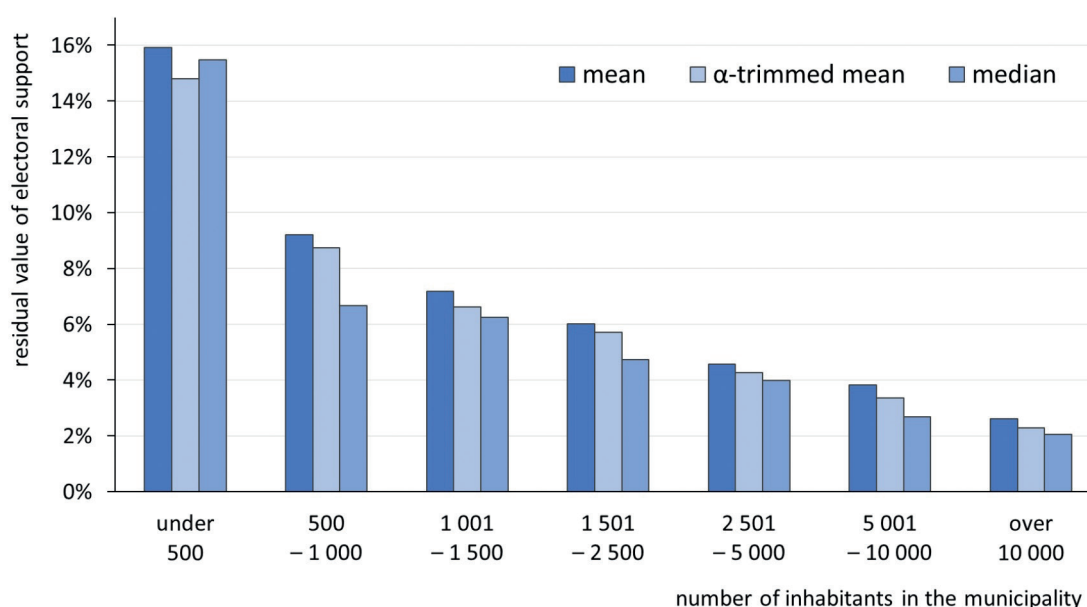

Fig. 3 Increased local electoral support of a political party thanks to the mayor on the candidate list, depending on the population size of the municipality.

Sources: Czech Statistical Office (2011; 2017), Hábl (2017); composed by author (including own calculations).

the influence of the friends and neighbours effect on the election results is much more marginal in relative terms, which, however, is not true when converted to the absolute number of voters. Moreover, even in some (bigger) towns, the strength of the effect reaches considerably high values, suggesting the quality and popularity of the local mayors. An example is the candidacy of Vít Rakušan, the mayor of Kolín (residual +20.8%), the already mentioned mayor of Polička, Jaroslav Martinů (+12.5%) or Petr Třešňák from Mariánské Lázně (+7.9%).

There are many reasons why the candidacy of strong local personalities, such as mayors, has a greater impact on changes in electoral preferences in small municipalities. In the very smallest municipalities, even personal acquaintance and relations between the mayor and the citizens can be expected. Citizens of a small municipality identify more with their mayor as a candidate for the Chamber of Deputies and appreciate the opportunity to support someone they know very well in the elections.

With the growing size of the municipality, the intensity of social ties and social cohesion among its citizens decreases. An important explanatory factor is also the growing number of competing candidates from the same municipality on candidate lists of various political parties, as a result of which the so-called personal votes associated with the presence of a local candidate, whom voters would consider their "neighbour", are divided between more parties.

Differences in the strength of the friends and neighbours effect can be observed also between groups of candidates-mayors representing different political parties. The average residual value of electoral support (α-trimmed mean) was the highest in municipalities with mayors on the candidate lists of KSČM (8.6%). Compared to other political parties or movements, this value was more than two percentage points higher, which can be explained by the smallest average population size of respective municipalities (approximately 1,400 inhabitants), whose mayors were candidates for this party.

4.3 Spatial extent of the effect on the example of STAN candidates

The friends and neighbours effect does not influence voter decision-making only in specific municipalities, as presented in previous chapter, but also at higher geographical scale levels. Therefore, the impact of the effect of mayors on candidate lists was analysed through a local hot spot analysis, which allows to monitor larger areas under their influence. The spatial patterns of electoral support of STAN were examined. This political movement is dominantly based on well-known personalities from the local politics of Czech towns and municipalities. At the same time, the territorial differentiation of STAN's electoral preferences can hardly be explained through the spatially heterogeneous composition of the population at the municipal level (Tab. 1). These are the reasons why we can assume that the differences in the party's electoral gains between different localities are particularly influenced by contextual factors, such as the friends and neighbours effect.

The political party recorded the highest support in the Czech parliamentary elections 2017 in the Liberec Region (Czech Statistical Office 2017). The main reason was the performance of a strong regional political subject Mayors for the Liberec Region (SLK), which has already won the regional elections there three times in a row. A large part of the candidates elected as the regional representatives were also on the STAN candidate list in the parliamentary elections, including Martin Půta, the regional council president of the Liberec Region. This resulted in significantly higher STAN electoral support in the entire region than expected by the regression model (Fig. 4).

Another very large cluster of municipalities with higher than expected STAN electoral support was located in the Central Bohemian Region, specifically in its eastern part. This local hot spot can be partly explained by the friends and neighbours effect associated with the mayor of Kolín, Vít Rakušan. The spatial cluster of positive residuals covered in all directions the area to an air distance of approximately 25 km from Kolín, which may show the distance to which voters still considered this candidate, STAN leader in the Central Bohemian Region, as their "neighbour" and thus influenced their voting behaviour.

In the Central Bohemian Region we can observe also several smaller areas under the influence of the effect. These are, for example, the immediate vicinity of municipalities such as Petrovice, Hvožďany or Kroučová, whose mayors also ran in the 2017 parliamentary elections for STAN and received higher electoral preferences in their home locations not only for themselves but for the political party they represented as well. Although these three municipalities are located in different parts of the region, in terms of their location we could include all of them in the so-called inner periphery of Czechia, situated at the regional borders between administrative units within the country (Musil and Müller 2008). One of the causes of a stronger manifestation of the friends and neighbours effect in such localities may be the fact that candidates from the peripheral areas of the state usually have an easier position in terms of less potential local rivalry (Gimpel et al. 2008).

The opposite situation was recorded on the example of Věra Kovářová, the former mayor of Chýně, west of Prague. Despite the fact that she is a regional representative and a deputy who ran from second place on the STAN candidate list, her candidacy did not transform into above-average electoral support of the party anywhere else than in the respective municipality. This contrast was also evident in other candidates from different localities of the Central Bohemian Region and shows differences in the strength of the
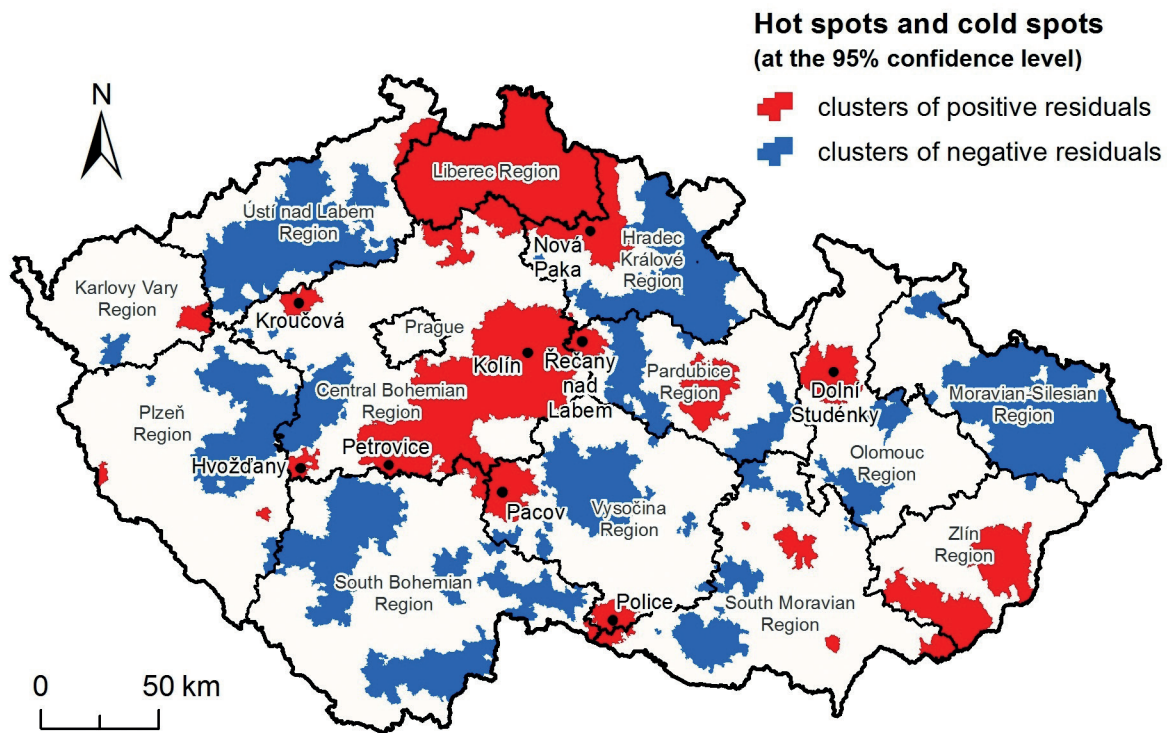
Fig. 4 Spatial clusters of positive and negative residuals of STAN electoral support.

Sources: Arcdata Praha (2016), Czech Statistical Office (2011; 2017), Hábl (2017); composed by author (including own calculations).

friends and neighbours effect and its spatial extent between candidates from the metropolitan area and the peripheral countryside.

Also in other regions, clusters of positive residuals connected with the friends and neighbours effect, specifically with the influence of the mayors on the STAN candidate lists, are more often found in peripheral, or at least in non-metropolitan areas (Fig. 4). Most of them are candidates from the forefront of candidate lists in the respective regions. In the Hradec Králové Region, the STAN electoral support hot spot is located in the north-western part of the region, especially in the area around the town of Nová Paka, whose mayor Josef Cogan ran from the first place on the regional candidate list.

The same situation is observable in the Pardubice region, where STAN had significantly higher than the regression model expected (based on the population structure) electoral support in the western part of the region, around Řečany nad Labem. The mayor of this municipality Michaela Matoušková was also one of the regional leaders of STAN in the Czech parliamentary elections 2017. Two mayors in the leading positions of the candidate list in the Vysočina Region – namely Lukáš Vlček from Pacov and Karel Janoušek from Police – also contributed to the statistically significant increase in the party's electoral support in the localities of their residence.

A similar example of the friends and neighbours effect is the candidacy of Radim Sršeň, mayor of Dolní Studénky and the regional leader of STAN in the

Olomouc Region. The spatial cluster of municipalities with positive residuals surrounds Dolní Studénky approximately to a distance of 15 km from the municipality, which is located in its center. The majority of preferential votes cast for Radim Sršeň are also concentrated in this micro-region.

To more accurately determine the impact of the friends and neighbours effect, more than one parliamentary elections should be analysed, using a longitudinal approach to monitor changes in spatial patterns of political party electoral support. This would better show whether in some of the localities associated with the influence of the studied effect, the party's support was not significantly higher already before 2017, when the local personality did not run in the elections. However, STAN is a relatively new political movement, competed in 2017 as an independent political party for the first time, so this longitudinal view is not applicable. Fig. 4 also depicts as clusters of positive residuals some localities which cannot be unambiguously connected with the friends and neighbours effect. The reason for higher electoral support is not always clear and detectable using the presented methodology, for example in the area in the middle of the Pardubice Region.

5. Conclusions

Territorial differences in the results of the Czech parliamentary elections 2017 at the level of municipalities

can be partially explained by heterogeneous population structure (different share of university-educated people, private entrepreneurs, Catholics, senior citizens, unemployed or people with debts, facing distraint), but the majority of spatial variability of electoral support of individual political parties remains unexplained using this compositional approach. The only exception in the Czech parliamentary elections is the political party KDU-ČSL, whose electoral preferences are strongly dependent on the degree of religiosity. This strong dependence is also documented by other geographical studies of the Czech parliamentary elections (Kouba 2007; Kostelecký 2009; Voda 2010).

The article shows that the voter is not only an isolated individual, but part of a system in which his voting decisions are influenced by the spatial context of the locality where he lives. In this respect, the connection of specific individuals on candidate lists with certain localities is very important. It has been shown on the example of mayors that candidates receive significantly above-average electoral support not only for themselves through preferential voting, but also for the political party they represent, through higher percentage of electoral votes, in their municipality of residence. Therefore, this contribution represents an empirical evidence of the validity of the theoretical concept of the friends and neighbours effect in Czechia.

The mayor's candidacy for the Chamber of Deputies has a greater impact on voting behaviour in smaller municipalities, which corresponds to theoretical assumptions and empirical results of older research (Gimpel et al. 2008; Malcová 2012). In bigger towns, the relationship between the mayor and the citizens is usually not so close. At the same time, the importance of friends and neighbours effect is diminished due to larger number of candidates from the same town on the candidate lists of different political parties which results in more competition among local candidates. The key factor is not only the size of the municipality, but also the popularity of the mayor and the perception of his involvement in solving local problems and the organization of community life. The effect is most intense in the municipalities of candidates´ residency, but it can also be seen in the adjacent municipalities or even in the wider micro-region.

The spatial patterns of STAN electoral support highlighted a stronger friends and neighbours effect for candidates from non-metropolitan areas, specifically from the inner peripheries near the administrative borders between Czech regions. This finding agrees with the conclusions of the work of Blais et al. (2003) from Canada, where the candidacy of a strong local personality also has a greater influence on voting behaviour in rural areas. As expected, the effect was most noticeable for regional leaders of the party, generally for mayors from the forefront of candidate lists, who are usually also more promoted in election campaigns.

The results, which show a significant influence of local candidates on voter decision-making in the Czech electoral environment, are also applicable in practice. The potential of the friends and neighbours effect could be used by political parties in the process of drawing up candidate lists or in the implementation of locally targeted election campaigns. A concrete example from Czechia is the election strategy of the regional political movement Jihočeši 2012, the main motto of which is the slogan "We are your neighbours".

It is very difficult to estimate in which direction the factors influencing voting behaviour will develop in the future. There is certainly no evidence that the friends and neighbours effect should lose its significance. On the contrary, recent studies of the Czech electoral environment (Malcová 2012; Mikešová 2019) mention its growing relevance, related to tendencies to personalise politics and promote strong candidates, including local ones, in election campaigns. The question of who is running for a particular political party is increasingly important for voter decision-making, compared to the declining interest in election programs (Linek and Voženílková 2017).

Acknowledgements

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Themes, approaches, and methods in the geographical analysis of Czech and Slovak parliamentary elections: a systematic review

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ABSTRACT

This article reviews the field of electoral geography in Czechia and Slovakia. It systematically analyses selected publications to identify the most and least frequently researched topics, theories, and methods. Most of the analyzed studies strived to determine the factors underlying the uneven geographical distribution of election results. Issues of turnout and geographical representation were the least common. The cleavage theory was the most frequently applied theoretical approach, although most studies did not apply any theory. Only one study used the qualitative methodology, whereas the rest relied on quantitative methods. Most often, analyses were performed at the scale of districts and municipalities. The article identifies possible directions for future research in the electoral geography of Czechia and Slovakia.

1. Introduction

By 2020, 30 years had passed since the first free parliamentary elections in post-socialist Czechoslovakia following the end of the undemocratic regime. A year after that event, the first publication was published on the geographical aspects of those election results (Blažek and Kostelecký 1991). This work was soon followed by other geographical papers. Since the initial description of the geographical distribution of political party support, electoral geography has gradually begun to address other issues related to elections and geography. How is turnout changing in different regions? Is there a difference in the voting behavior of rural and urban areas? What factors influence the distribution of electoral support? The publications were also expanded by various methods through which the authors tried to obtain answers to these questions. After 30 years of developing electoral geography in Czechia and Slovakia, it is therefore time to ask what is known about the geographical distribution of electoral results in these countries, and what, on the contrary, remains hidden.

Several studies have dealt with the state of electoral geography in these two countries (Madleňák 2010; Plešivčák 2014b; Plešivčák et al. 2016). The disadvantage of these studies is however their focus on the development of electoral geography in terms of global trends, where the specific environment of Czechia and Slovakia is considered to a lesser extent only (Madleňák 2010; Plešivčák et al. 2016), or research is concerned with only one selected aspect of electoral geography in the study area (Plešivčák 2014b).

Therefore, the aim of this paper is to systematically search and analyze publications that deal with the issue of electoral geography in both countries and to determine which areas of research are well studied and, conversely, which topics of electoral geography deserve more attention in the future. Specifically, the work will try to answer several questions:

– What topics are covered in the electoral geography publications?
– Upon which theories are the authors' analyses based?
– What methods were used to do this?
– What geographical scale level was used in the research?

The second section will deal with the analysis of the state of knowledge in electoral geography as well as the use of a systematic scientific literature review. The section that follows will then describe the procedure of selecting relevant publications and the method of data extraction and synthesis. The results of the analysis will then be presented in the fourth section. The final part will discuss the results and summarize new findings.

2. Systematic review as a method of studying the state of electoral geography

Most studies concerning electoral geography are based on previous findings. However, some studies focus purely on determining the state of knowledge. They usually work on a certain area and period in which they show the progress of electoral geography. These studies use various maps and statistical outputs (e.g., Clem 2006; Zarycki 2015; van Hamme et al. 2018). Other works compare the development of electoral geography in different areas and point out similarities and differences (e.g., Johnston 2005). One way to capture the state of knowledge is to analyze the available literature; this reveals not only well-known topics but also topics that deserve more attention (e.g., Weaver 2014). Two possible methods of literature analysis are the bibliometric analysis (Leib and Quinton 2011; Jokić et al. 2019) and the systematic review.

The systematic review is the application of scientific strategies that limit bias through systematic assembly, critical appraisal, and synthesis of all relevant studies on a specific topic (Cook et al. 1995). While it is commonly used in medical studies (e.g., Cook et al. 1995; Wright et al. 2007), systematic reviews have emerged in several other scientific fields (e.g., Lösel et al. 2018; Novotný et al. 2018).

Only a handful of systematic reviews have been created on the topic of electoral geography, and the topic has usually been connected with other topics such as political brands (Nielsen 2017), disability (Virendrakumar et al. 2018), or education (Manning and Edwards 2014). A systematic review therefore is necessary in order to discover and make systematic the knowledge about the geography of electoral results in Czechia and Slovakia since 1989.

Before proceeding with the review, let us first explore the state of knowledge in world electoral geography. For Reynolds (1990), research in electoral geography has tended to focus on one of three issues: The first is the geography of voting, where the objective is to explain the spatial pattern of voting in terms of some other mappable characteristics. Second is the geographical influences on voting, where the object is to explain voting based on spatial contexts. Third is the geography of representation, which explores the means through which votes are converted into seats (Reynolds 1990).

Madleňák (2010) identified six current research trends in electoral geography: (1) the contextual approach, where the study of the neighborhood effect plays a significant role; (2) the identification of factors which determine elections; (3) the difference between urban and rural voters; (4) the spatial context of election campaigns; (5) the spatial aspects of political participation and representation; and (6) the spatial organization of elections.

Leib and Quinton (2011) analyzed 224 articles from 1990 to 2007 and grouped electoral geography studies into four broad categories. The largest category is called "vote studies," which examine the spatial distribution of compositional factors or place-based contextual factors. This category covers a large variety of topics like the difference between city and suburban voters, turnout distribution, and others. The second category is "electoral system research," which approached the issue of voting systems from several directions. The third concerns discussions and examinations of the (re)districting process, while the last grouping attempts to find methods of bring electoral studies into the classroom. The authors also claimed that almost all electoral geography studies are situated within the spatial-analytic tradition; however, in recent years, studies from post-structuralist viewpoints have grown in popularity.

3. Methods

In the selection of suitable publications, only publications which dealt with parliamentary elections and the analysis of the intrastate geographical distribution of these election results were included. No restrictions were placed on the research design or methods used, and both quantitative and qualitative works were selected. However, publications lacking a geographical aspect were excluded. The focus on parliamentary elections was chosen for several reasons. In both countries surveyed, parliamentary elections are the most important of the elections thanks to the large amount of interest they attract (Kostelecký et al. 2015) – hence why most professional publications deal with them. Other options were not included due to the scope of this work.

The publications were first found in the Web of Science (WoS) and Scopus databases in November and December 2020 via searches for the terms "parliamentary election," "Slovakia," "Slovak Republic," "Czechia," "Czech Republic," and "Czechoslovakia" within the article, book, or book chapter categories. Other relevant articles, books, or book chapters were identified by screening references in relevant studies found in the database searches. Studies in English, Czech, and Slovak published between 1990 and 2020 were chosen.

During the database search, duplicate records and studies unrelated to the topic were discarded based on the title or abstract. Reference screening was then performed on the remaining studies so as to identify the largest possible list of relevant publications not included in the databases. Subsequently, articles were read in full; publications without a sufficient geographical aspect – they focused on elections only at the state level – or works with content similar to or duplicated in other studies (and thus not providing new, added information) were excluded.

During the data extraction phase, information on the topic of study, theoretical concepts, analytical methods, and geographical scale of analysis was gathered from the articles.

After the extraction of this information from the studies, the articles were grouped based on information similarity. Individual groups are discussed in more detail in the following section.

4. Results

4.1 Final sample of studies

Initial searches on Web of Science and Scopus yielded 332 unique studies, of which 305 were excluded by eliminating duplicates and screening titles and abstracts. An additional 78 potentially relevant studies were identified using the snowballing technique. This strategy yielded 105 studies, which were analyzed in full. Three of these were excluded due to insufficient geographical aspects. In the next step, three additional studies were excluded as their content was duplicated in other studies. The final sample for data extraction therefore consisted of 99 unique studies. Only nine of them were published in foreign publications, with the remainder being published in Czech (37) or Slovak (53) journals or books. Table 1 shows the characteristics of these studies in more detail.

Tab. 1 Categorization of studies by publication year and type.

	WoS journal	Scopus journal	Other journal	Book	Book chapter	Total
1991–2000	1	5	6	1	1	14
2001–2010	2	0	12	2	2	18
2011–2020	17	12	18	9	11	67
Total	20	17	36	12	14	99

These studies were divided into 9 categories based on the topic of study, 7 categories based on theoretical concepts, 17 categories based on analytical methods, and 7 categories according to the geographical scale of analysis. An overview of the extracted information from each study is shown in appendix 1.

4.2 Topics of study

The studies have been divided into nine thematic groups and are presented below followed by a description and starting with the most numerous, which includes 19 studies dealing with factors that influence geographical differences in electoral results. These studies are distinguished by theories and methods used to identify key factors influencing election results. Some studies do not work with any theories (Krivý et al. 1996; Kostelecký 2001; 2009; Spurná 2008; Plešivčák 2011b;

Gurňák and Mikuš 2012; Nestorová-Dická and Molnár 2013; Bahna and Zagrapan 2017), whereas the most common theory used is cleavage theory (Kostelecký 1994; Plešivčák 2014b; Baboš and Malová 2015; Voda 2015; Voda and Pink 2015) and the effect of contextual factors on election results (Kouba 2007; Bernard et al. 2014; Maškarinec 2014; Mikešová 2019). One study works with grievance theory (Maškarinec and Bláha 2014), and another uses the concept of phantom borders (Šimon 2015).

A frequent geographical study of parliamentary elections in Czechia and Slovakia is a review of specific election results. Authors of these studies often publish follow-up studies (e.g., Krivý 1999; 2003; 2006; 2011; 2012; Krivý and Majo 2018). This type of study was popular among geographers, especially in the early 1990s due to the unavailability of data concerning several elections (Blažek and Kostelecký 1991; Mariot 1991; 1994; 1996). Later, this type of study was used by early sociologists and political scientists (Navrátil 2010; Pink 2011). They are also frequent in books focusing on the political and sociological aspects of elections. In these books, the geographical aspects of the elections form one of several chapters (Krivý 2012; Pink and Voda 2014; Rybář et al. 2017; Krivý and Majo 2018; Voda 2019).

Six studies can be described as analyzing multiple elections. These studies examine changes in the geographical distribution of voting support over time. This type of research is more often published in a separate book (Madleňák 2012; Pink et al. 2012) or a chapter within a book (Jehlička et al. 1993; Gyárfášová and Krivý 2012; Mikuš 2014). Only one study in this category was published in a journal (Madleňák 2006), and the specificity of this publication is its focus on one specific area (Orava region).

Ten studies focus on a particular political party or political family. The main topic of these studies is detailed analysis of the geographical distribution of support for a particular party/family. Authors usually examine traditionally established political parties, such as the communist parties (Kyloušek and Pink 2007), social democratic parties (Kyloušek and Pink 2009), Hungarian parties (Mariot 2003a; Szabó and Tátrai 2016) or the Movement for a Democratic Slovakia (Mariot 2003b). However, there are also studies that focus on new political actors, such as Slovakia's Party of Civic Understanding and Alliance of the New Citizen (Mariot 2004) or the Czech Pirate Party (Maškarinec 2020b). In the last decade, they have come to the forefront of work addressing the issue of populist or radical right-wing parties (Mikuš and Gurňák 2012; 2016; 2019).

Another group of studies focuses on showing the distribution of electoral support for political parties in elections. Until 2015, studies that used a simple map display (Plešivčák 2011a) or Jehlička and Sýkora's (1991) method of identifying electoral support areas dominated (Baráth et al. 1995; Szöllös 2000;

2006; Kostelecký et al. 2015). Since 2015, thanks to Maškarinec (2015; 2017a; 2017b; 2019; 2020a; 2020b), the spatial autocorrelation method has come to the fore, specifically, the analysis of the local indicator of spatial autocorrelation (LISA).

A popular topic of electoral geography is the comparison of voting behavior in urban and rural regions or in border and peripheral areas. Kostelecký and Krivý (2015) examined urban-rural differences in election results in Czechia and Slovakia, while Plešivčák, with a focus on Slovakia, examined the differences between urban municipalities and the countryside (2012a, 2012b, 2012c 2013b, 2014a). Mariot (1999) addressed the issue of voting behavior in cities, Mikuš and Malíková (2015) analyzed voting behavior in marginal rural areas in eastern Slovakia, and Daněk (2000) addressed the issue of peripheral border areas.

In recent years, electoral geographers have also focused on the spatial aspects of voting behavior within the largest cities. For example, Plešivčák (2013a) and Bahna and Majo (2012) analyzed the geography of election results in Bratislava, Kerekeš (2018) analyzed election results in Košice, and Bahna, Kerekeš, and Majo (2018) compared the voting behavior of Bratislava and Košice. Kerekeš (2020) further analyzed election results within Prague's districts. Attention has also been paid to the issue of suburban residential voting behavior. Kostelecký (2005) examined spatial patterns of voting behavior in the metropolitan areas of Prague, Brno, Ostrava, and Pilsen, while Šuška et al. (2018) analyzed the suburban area of Bratislava.

Eleven studies also deal with the issue of electoral geography in the pre-1989 period. They usually work with election results from interwar Czechoslovakia or with the 1946 elections. An exception is a paper by Fňukal (2008), who examined the 1907 elections to the Austro-Hungarian Imperial Council. The first studies to employ election results from the First Czechoslovak Republic used them in comparison with the results of several political parties (Maškarinec 2011; Kostelecký et al. 2014) or single parties, such as the Communist Party of Bohemia and Moravia (Daněk 1993; Balík 2006) or the Christian and Democratic Union – Czechoslovak People's Party (Voda 2011) in elections after 1989. Later, studies began to solely focus on the geographical aspects of elections from the interwar Czechoslovakia period (Král 2016; Przybyla 2019), with several works analyzing the 1929 election results for their relative proximity in time to the 1930 population census (Šerý and Urbančíkova 2011; Bahna a Krivý 2016; Madleňák and Balažovič 2018).

Only five geographical studies dealt exclusively with the issue of turnout, and all of them have come out in the last 10 years (Mikuš and Gurňák 2014; Nový 2014; Kevický 2020a; 2020b; Kevický and Daněk 2020). These studies seek to map the uneven distribution of turnout, some of which also try to identify several factors influencing voter turnout "maps" in

Czechia and Slovakia (Kevický 2020b; Kevický and Daněk 2020).

Among the less common topics is the issue of territorial representation. Four of the five studies dealing with this topic concern Slovakia (Brunn and Vlčková 1994; Charvát 2016; Madleňák 2017; 2019), with the remaining study dealing with the Czech territory (Mikešová and Kostelecký 2016). These studies mostly point out that central areas of both Czechia and Slovakia are significantly overrepresented among the deputies, whereas some peripheral areas have no representatives in parliament.
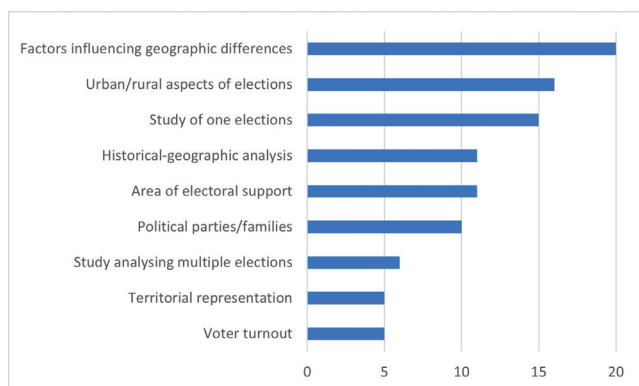

Fig. 1 Division of studies by topic (%).

4.3 Theoretical background of study

As many as 69 studies use no explicit theory and are descriptive only. Among the studies based on theory, cleavage theory is most often applied. Fourteen studies work with this theory, mostly focusing on determining the factors influencing geographical differences in election results (Kostelecký 1994; Plešivčák 2014b; Voda 2015; Voda and Pink 2015; Lysek et al. 2020), on the differences between urban and rural voting (Plešivčák 2013a; 2014a; Kerekeš 2018), and on the examination electoral support for specific political parties/families (Szabó and Tátrai 2016; Mikuš and Gurňák 2019). Cleavage theory was also used by two studies analyzing multiple elections (Madleňák 2012; Pink et al. 2012), and one study focused on a historical-geographic analysis (Madleňák and Balažovič 2018).

Another large group of studies discussed the issue of contextual effects. This theoretical concept is used in studies that focus on determining geographical factors influencing electoral support, such as the effect of friends and neighbors, issue voting, or the neighborhood effect (Kouba 2007; Bernard et al. 2014; Maškarinec 2014; 2015; 2017a; 2017b; 2019; 2020a; 2020b; Mikešová 2019).

Of the studies focused on the issue of turnout, only three make use of theory, for instance, societal modernization theory, mobilization theory, or habitual voting theory (Kevický 2020a; 2020b; Kevický and

Daněk 2020). The remaining studies work with grievance theory (Maškarinec and Bláha 2014), the conceptual sociological structure of city (Kerekeš 2020), and the theory of phantom borders (Šimon 2015).
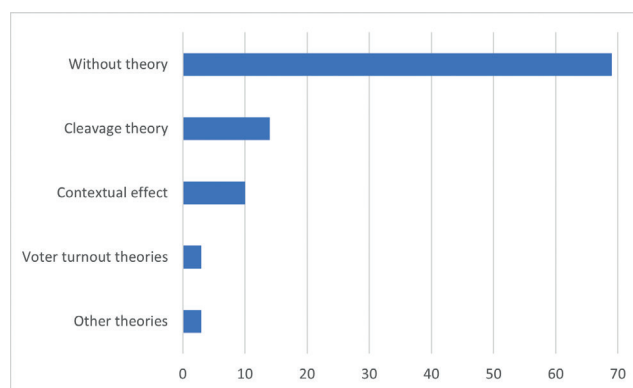

Fig. 2 Division of studies by theoretical background (%).

4.4 Methods

The methods in the analyzed studies can be divided into two groups. The first uses methods that display election results through maps. This method was employed in 61 studies, out of which 23 used straightforward map visualizations displaying election results using a simple cartogram (e.g., above-average/below-average election support). The delimitation of electoral support areas, proposed by Jehlička and Sýkora (1991), is also used often – 28 studies. This method displays election results and allows for the analysis of their spatial stability. LISA analysis is the least common method of displaying election results and was mainly used by Maškarinec (2014; 2015; 2017a; 2017b; 2019; 2020a, 2020b) but also Kouba (2007) and Kevický (2020b).

The second group employed methods of analyzing election results. Eighteen studies use simple descriptive analysis, in which, for example, regions with the greatest support for political parties are identified or the results of elections are described. This type of method is used mainly by studies focused on one election (e.g., Krivý 1999; 2012) and those focused on the characterization of differences in electoral support between urban and rural areas (e.g., Plešivčák 2012a; 2012b).

Seventeen studies use correlation analysis to identify factors influencing electoral support, and 22 use regression analysis to determine factors influencing the geographical distribution of voting support. Most authors used linear regression analysis. Spurná (2008), Maškarinec (2014; 2020b), and Lysek et al. (2020) work with geographically weighted regression or spatial regression, and Bernard et al. (2014) uses ecological regression.

Studies of territorial representation usually use different methods for the study of proportionality.

These include the calculation of the least squares index (Charvát 2016) or the index of regional political representation (Madleňák 2017; 2019). Three studies (Blažek and Kostelecký 1991; Gyárfášová and Krivý 2012; Madleňák and Balažovič 2018) use cluster analysis, while Netorová-Dická and Molnár (2013) work with factor analysis.

Less often used methods include ecological inference methods (Bahna and Krivý 2016; Bahna et al. 2018; Lysek et al. 2020), spatial econometrics (Plešivčák 2014b), component analysis (Kerekeš 2020), and regional typization (Plešivčák 2013b). Plešivčák (2014a) conducted a study review dealing with elections in urban and rural regions. The only study out of 99 that was not quantitatively focused, using qualitative data analysis instead, is the study by Mikešová (2019). Mikešová (2019) analyzed nine focus group discussions and 44 in-depth interviews across 10 Czech localities.
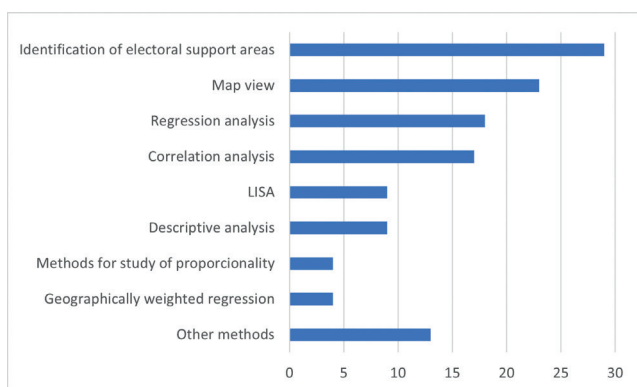

Fig. 3 Division of studies by methods (%).

4.5 Geographical scale of study

Both Czechia and Slovakia use a three-tier territorial-administrative system: regions, districts, and municipalities. Most often, analyses were performed at the district level (51 studies). The second most frequent territorial unit studied are municipalities, with which 39 studies work. Two studies work with regions (Mikuš and Gurňák 2012; Charvát 2016).

Studies examining election results in specific cities used data at the borough level (Plešivčák 2013a; Kerekeš 2018) or the level of electoral districts (Bahna and Majo 2012; Bahna et al. 2018; Kerekeš 2020). The study by Fňukal (2008) also works with electoral district territorial units.

Eight studies work with a territorial unit of functional urban regions (Plešivčák 2011a; 2011b; 2012a; 2012b; 2012c; 2013b; 2014b). Some studies analyze the election results from 1918 to 1938 using historical juridical districts as a territorial unit (Daněk 1993; Kostelecký et al. 2014; Král 2016). Jehlička and Sýkora (1991) and Šimon (2015) also work with juridical districts.
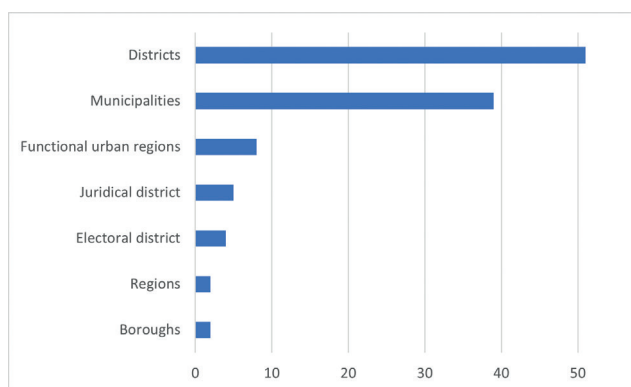

Fig. 4 Division of studies by geographical scale (%).

5. Discussion and conclusion

This systematic review of literature on electoral geography in Czechia and Slovakia has shown several significant trends. Most studies focus on identifying factors that influence election results. The second most common topic is the study of specific elections. This theme was dominate among geographers in the 1990s but, later, appears mainly within chapters of books analyzing not only the geographical aspects of elections but also the political, sociological, economic, or psychological. Other more frequent topics are the analysis of the urban and rural environment influences on voting behavior or studies showing the long-term stability of electoral support for political parties. Given the democratic history of interwar Czechoslovakia and the availability of data, studies also analyze the historical results of the elections. Several studies deal with the electoral support of political parties and political families. However, established political parties are analyzed in most cases, and authors have only begun to address new political families, such as the populist radical right, in recent years. Little attention is paid to the topics of turnout and geographical representation.

Many studies are not based on any theoretical basis, the most used of which was cleavage theory. From the point of view of methods, quantitative methods dominate. The identification of electoral support areas is used to display election results on a map. In the last decade, some authors have also used LISA analysis to show the distribution of results. Regression and correlation analysis are used to determine the factors influencing election results. Analysis based on districts and municipalities as spatial units of analysis was most often used, but some studies also used historical territorial units or functional urban regions.

In comparison to global trends, a positive feature in the state of electoral geography study within Czechia and Slovakia is that the number of studies have increased and they are increasingly being published in journals with impact factor and Scopus indexed

journals, whereas the number of electoral geography studies have been decreasing globally in recent years (Leib and Quinton 2011). The systematic review showed that all three of Reynolds's (1990) issues are represented. Most studies belong to the geography of voting. Geographical influences on voting and the geography of representation are less represented in Czech and Slovak studies but the number has been rising in recent years. Czech and Slovak electoral geography has also considered some global research trends, which were identified by Madleňák (2010). No study reflected the spatial context of election campaigns or the spatial organization of elections. According to Leib and Quinton's (2011) classification, all the analyzed studies belong among "vote studies" and are situated within the spatial-analytic tradition. Studies about the (re)districting process and electoral system research studies are missing in both countries. Czech and Slovak electoral geography should develop studies from post-structuralist viewpoints to be published.

This systematic review contributes to a deeper understanding of electoral geography in Czechia and Slovakia. The findings may help researchers identify less used themes, theories, and methods of electoral geography. The study also presents an approach to operationalize, analyze, and synthesize literature which may analogously be applied elsewhere.

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Appendix 1

List of analyzed studies detailing topic, theoretical frame, method, and geographical scale.

References	Study theme	Theoretical background	Methods	Scale of study
Baboš and Malová (2015)	factors influencing geographic differences in electoral results	cleavage theory	regression analysis	districts
Bahna et al. (2018)	urban/rural aspects of elections	without theory	identification of electoral support areas, ecological inference	electoral districts
Bahna and Krivý (2016)	historical-geographic analysis	without theory	ecological inference	districts
Bahna and Majo (2012)	urban/rural aspects of elections	without theory	map view	electoral districts
Bahna and Zagrapan (2017)	factors influencing geographic differences in electoral results	without theory	regression analysis	municipalities
Balík (2006)	historical-geographic analysis	without theory	identification of electoral support areas	municipalities
Baráth et al. (1995)	area of electoral support	without theory	identification of electoral support areas	districts
Bernard et al. (2014)	factors influencing geographic differences in electoral results	contextual effect	ecological regression	municipalities
Blažek and Kostelecký (1991)	study of one election	without theory	cluster analysis, regression analysis	districts
Brunn and Vlčková (1994)	territorial representation	without theory	descriptive analysis	districts
Daněk (1993)	historical-geographic analysis	without theory	regression analysis	juridical districts
Daněk (2000)	urban/rural aspects of elections	without theory	map view, descriptive analysis	districts
Fňukal (2008)	historical-geographic analysis	without theory	methods for study of proportionality	electoral districts
Gurňák and Mikuš (2012)	factors influencing geographic differences in electoral results	without theory	correlation analysis	municipalities
Gyárfášová and Krivý (2012)	study analyzing multiple elections	without theory	cluster analysis, identification of electoral support areas	districts, municipalities
Charvát (2016)	territorial representation	without theory	methods for study of proportionality	regions
Jehlička and Sýkora (1991)	area of electoral support	without theory	identification of electoral support areas	juridical districts
Jehlička et al. (1993)	study analyzing multiple elections	without theory	identification of electoral support areas	districts
Kerekeš (2018)	urban/rural aspects of elections	cleavage theory	regression analysis, identification of electoral support areas	boroughs
Kerekeš (2020)	urban/rural aspects of elections	conceptual sociological structure of city	component analysis	electoral districts
Kevický (2020a)	voter turnout	voter turnout theories	identification of electoral support areas	districts
Kevický (2020b)	voter turnout	voter turnout theories	LISA, regression analysis	municipalities
Kevický and Daněk (2020)	voter turnout	voter turnout theories	regression analysis	municipalities
Kostelecký (1994)	factors influencing geographic differences in electoral results	cleavage theory	regression analysis	districts
Kostelecký (2001)	factors influencing geographic differences in electoral results	without theory	regression analysis	districts
Kostelecký (2005)	urban/rural aspects of elections	without theory	regression analysis, correlation analysis	municipalities
Kostelecký (2009)	factors influencing geographic differences in electoral results	without theory	regression analysis	districts
Kostelecký and Krivý (2015)	urban/rural aspects of elections	without theory	descriptive analysis	municipalities

References	Study theme	Theoretical background	Methods	Scale of study
Kostelecký et al. (2014)	historical-geographic analysis	without theory	identification of electoral support areas	juridical districts
Kostelecký et al. (2015)	area of electoral support	without theory	identification of electoral support areas	districts
Kouba (2007)	factors influencing geographic differences in electoral results	contextual effect	LISA, regression analysis	districts
Král (2016)	historical-geographic analysis	without theory	correlation analysis, identification of electoral support areas	juridical districts
Krivý (1999)	study of one election	without theory	map view, descriptive analysis	districts, municipalities
Krivý (2003)	study of one election	without theory	descriptive analysis, identification of electoral support areas	districts
Krivý (2006)	study of one election	without theory	descriptive analysis, identification of electoral support areas	districts
Krivý (2011)	study of one election	without theory	descriptive analysis, identification of electoral support areas	districts, municipalities
Krivý (2012)	study of one election	without theory	descriptive analysis, identification of electoral support areas	districts, municipalities
Krivý et al (1996)	factors influencing geographic differences in electoral results	without theory	correlation analysis, identification of electoral support areas	districts
Krivý and Majo (2018)	study of one election	without theory	descriptive analysis, identification of electoral support areas	districts, municipalities
Kyloušek and Pink (2007)	political parties/families	without theory	correlation analysis, identification of electoral support areas	districts
Kyloušek and Pink (2009)	political parties/families	without theory	correlation analysis, identification of electoral support areas	districts
Lysek et al. (2020)	factors influencing geographic differences in electoral results	cleavage theory	regression analysis, geographically weighted regression, ecological inference	municipalities
Madleňák (2006)	study analyzing multiple elections	without theory	map view	municipalities
Madleňák (2012)	study analyzing multiple elections	cleavage theory	correlation analysis, identification of electoral support areas	districts
Madleňák (2017)	territorial representation	without theory	methods for study of proportionality	districts
Madleňák (2019)	territorial representation	without theory	methods for study of proportionality	districts
Madleňák and Balažovič (2018)	historical-geographic analysis	cleavage theory	cluster analysis	municipalities
Mariot (1991)	study of one election	without theory	map view	municipalities
Mariot (1994)	study of one election	without theory	descriptive analysis	districts
Mariot (1996)	study of one election	without theory	map view	districts
Mariot (1999)	urban/rural aspects of elections	without theory	map view, descriptive analysis	municipalities
Mariot (2003a)	political parties/families	without theory	correlation analysis	districts, municipalities
Mariot (2003b)	political parties/families	without theory	map view	municipalities
Mariot (2004)	political parties/families	without theory	map view, descriptive analysis	municipalities
Maškarinec (2011)	historical-geographic analysis	without theory	identification of electoral support areas	municipalities

References	Study theme	Theoretical background	Methods	Scale of study
Maškarinec (2014)	factors influencing geographic differences in electoral results	contextual effect	LISA, geographically weighted regression	municipalities
Maškarinec (2015)	area of electoral support	contextual effect	LISA	districts
Maškarinec (2017a)	area of electoral support	contextual effect	LISA	districts
Maškarinec (2017b)	area of electoral support	contextual effect	LISA	districts
Maškarinec (2019)	area of electoral support	contextual effect	LISA	districts
Maškarinec (2020a)	area of electoral support	contextual effect	LISA	municipalities
Maškarinec (2020b)	political parties/families	contextual effect	LISA, geographically weighted regression	municipalities
Maškarinec and Bláha (2014)	factors influencing geographic differences in electoral results	grievance theory	regression analysis	districts
Mikešová (2019)	factors influencing geographic differences in electoral results	contextual effect	qualitative data analysis	municipalities
Mikešová and Kostelecký (2016)	territorial representation	without theory	map view, methods for study of proportionality	districts
Mikuš (2014)	study analyzing multiple elections	without theory	map view, correlation analysis	districts, municipalities
Mikuš and Gurňák (2012)	political parties/families	without theory	descriptive analysis	regions, municipalities
Mikuš and Gurňák (2014)	voter turnout	without theory	map view	municipalities
Mikuš and Gurňák (2016)	political parties/families	without theory	map view, correlation analysis	districts
Mikuš and Gurňák (2019)	political parties/families	cleavage theory	regression analysis	districts, municipalities
Mikuš and Máliková (2015)	urban/rural aspects of elections	without theory	map view, descriptive analysis	municipalities
Navrátil (2010)	study of one election	without theory	correlation analysis, identification of electoral support areas	districts
Nestorová-Dická and Molnár (2013)	factors influencing geographic differences in electoral results	without theory	factor analysis	districts
Nový (2014)	voter turnout	without theory	map view, correlation analysis	districts, municipalities
Pink (2011)	study of one election	without theory	identification of electoral support areas	districts
Pink et al. (2012)	study analyzing multiple elections	cleavage theory	regression analysis, identification of electoral support areas	districts
Pink and Voda (2014)	study of one election	without theory	identification of electoral support areas	districts
Plešivčák (2011a)	area of electoral support	without theory	map view	functional urban regions
Plešivčák (2011b)	factors influencing geographic differences in electoral results	without theory	correlation analysis	functional urban regions
Plešivčák (2012a)	urban/rural aspects of elections	without theory	map view, descriptive analysis	functional urban regions
Plešivčák (2012b)	urban/rural aspects of elections	without theory	map view, descriptive analysis	functional urban regions
Plešivčák (2012c)	urban/rural aspects of elections	without theory	map view, descriptive analysis	functional urban regions
Plešivčák (2013a)	urban/rural aspects of elections	cleavage theory	map view, descriptive analysis	boroughs
Plešivčák (2013b)	urban/rural aspects of elections	without theory	regional typization	functional urban regions
Plešivčák (2014a)	urban/rural aspects of elections	cleavage theory	review	municipalities
Plešivčák (2014b)	factors influencing geographic differences in electoral results	cleavage theory	spatial econometrics	functional urban regions
Przybyla (2019)	historical-geographic analysis	without theory	correlation analysis	districts
Rybář et al. (2017)	study of one election	without theory	correlation analysis	districts

References	Study theme	Theoretical background	Methods	Scale of study
Spurná (2008)	factors influencing geographic differences in electoral results	without theory	geographically weighted regression	municipalities
Szabó and Tátrai (2016)	political parties/families	cleavage theory	map view	municipalities
Szöllös (2000)	area of electoral support	without theory	identification of electoral support areas	districts
Szöllös (2006)	area of electoral support	without theory	identification of electoral support areas	districts
Šerý and Urbančíková (2011)	historical-geographic analysis	without theory	correlation analysis, identification of electoral support areas	municipalities
Šimon (2015)	factors influencing geographic differences in electoral results	theory of phantom borders	map view	juridical districts
Šuška et al. (2018)	urban/rural aspects of elections	without theory	map view	municipalities
Voda (2011)	historical-geographic analysis	without theory	identification of electoral support areas	districts
Voda (2015)	factors influencing geographic differences in electoral results	cleavage theory	regression analysis	districts, municipalities
Voda (2019)	study of one election	without theory	correlation analysis	districts
Voda and Pink (2015)	factors influencing geographic differences in electoral results	cleavage theory	regression analysis	municipalities