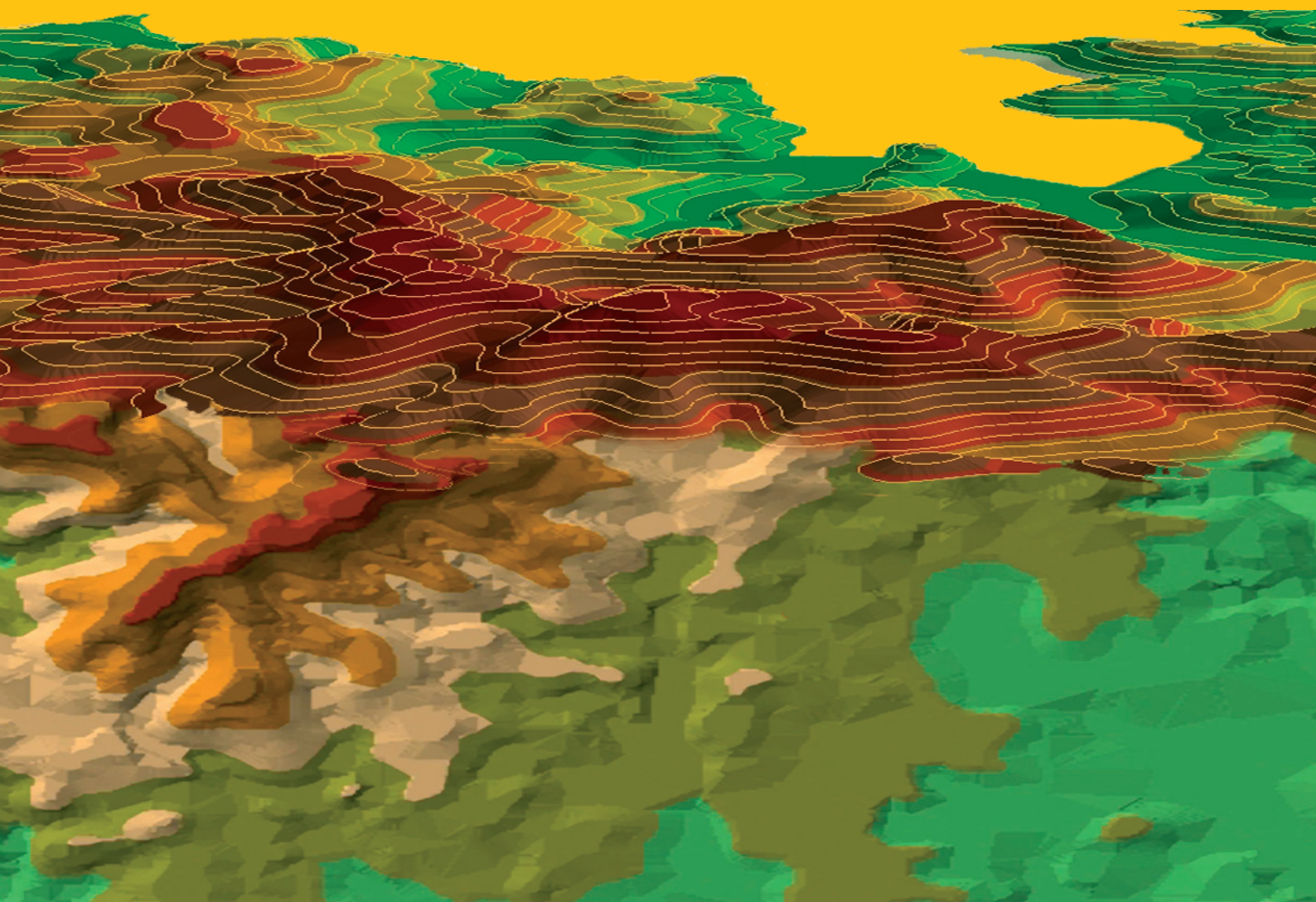


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# MORAVIAN GEOGRAPHICAL REPORTS



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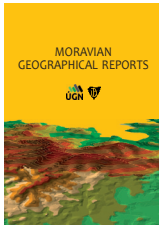
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# Consumer perception of food value: A comparative study of global supermarkets and local farmers' markets in Slovakia

František KRIŽAN<sup>a</sup> , Kristína BILKOVÁ<sup>b</sup> , Markéta NOVOTNÁ<sup>c\*</sup> ,  
 Josef KUNC<sup>c</sup> , Petra HENCELOVÁ<sup>a</sup>

## Abstract

*The paper explores how Slovak consumers perceive the value of food, sold by different retail formats (especially farmers' markets and supermarkets), in terms of the quality, price, and healthiness. The aim of this paper is to evaluate consumer perceptions regarding global and local types of retail stores where they buy food most frequently. In the study, the segmentation of consumers by generation, income, and type of residence is provided. From the methodological point of view, Mann-Whitney U and Kruskal-Wallis tests are used to test hypotheses. According to the sample of respondents (n = 1,004), large-scale stores do not offer healthier and higher-quality food. This perception, however, varies based on the income of the consumer groups. On the other hand, respondents perceive that food sold at farmers' markets is healthier and of higher quality than food in conventional stores. They do not perceive that food sold at farmers' markets is cheaper than food in conventional stores.*

**Keywords:** consumer perception, farmers' markets, retail choice, supermarkets, Slovakia

**Article history:** Received 21 July 2023, Accepted 6 December 2023, Published 30 December 2023

## 1. Introduction

Consumer behaviour changes over time and space. The economic and political conditions of retail development, as well as the current processes of retail globalisation, influence consumer perceptions (Yiridoe et al., 2005; Trembošová et al., 2021; Križan et al., 2022). Almost 35 years have now passed since the start of the economic transformation of Central European countries from centrally controlled to market economies, and this has also been manifested in changes in retail (Garb, 2007; Križan et al., 2016; Biesok & Wyród-Wróbel, 2018; Kunc & Križan, 2018; Sikos, 2019; Kunc et al., 2022; Trembošová et al., 2022). The transformation of retail had certain specifics in various countries, but their general manifestation had the nature of a change in the spatial organisation of retail and especially the emergence and dynamic development of new shopping formats, such as supermarkets, hypermarkets, and shopping centres. There continues to be a trend towards large-scale stores developing.

At the same time, however, consumers are gradually reorienting themselves on value and quality, and more recently the term sustainable consumption, linked with environmental protection, has begun to be discussed more. Its foundation rests on the use of resources in accordance with sustainable development (Geels et al., 2015). The focus on sustainable consumption patterns further

extends to tackling food-related challenges, including efforts to reduce food waste and promote universal access to information for fostering sustainable lifestyles (Gasper et al., 2019).

Alternative consumption, associated with sustainable development, leads to the development of new forms of retail sales and alternative food networks (Goodman et al., 2012). Notably, consumers have transitioned from global conventional retail chains to alternative food networks during certain periods (Spilková, 2018). In exploring consumer behaviour, studying the drivers behind purchases, as well as understanding motivations for choosing alternative channels like local businesses, presents valuable research directions (Lemaire & Limbourg, 2019).

This paper highlights a shift in consumer behaviour towards quality and sustainability, with a growing interest in sustainable consumption and alternative food networks. Additionally, it notes a shift in consumer behaviour towards quality and sustainability, with a growing interest in sustainable consumption and alternative food networks. The aim of this paper is to evaluate consumer perceptions regarding global and local types of retail stores where they buy food most frequently. We will consider conventional large-scale stores, such as supermarkets and hypermarkets, as the global type of retail, and farmers' markets,

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as a representative of alternative food networks, as the local type of retail and will work with selected demographic, socioeconomic, and spatial indicators.

A potential research gap lies in a more profound insight into the factors that shape the embrace of sustainable consumption practices in CEE countries that have undergone economic transformation over more than three decades. This may involve investigating the specific drivers and barriers that impact consumers' choices towards sustainability in the context of food and retail. The research also explores the reasons behind consumer shifts from global conventional retail chains to alternative food networks, examining the implications for both consumers and the retail sector.

An understanding of the factors influencing these shifts could contribute to a more comprehensive analysis of the transformation of the retail environment in post-socialist Central European countries, which are already reaching the level of the developed Europe in many aspects of retailing. It also explores perceptions related to the quality, cost, and healthiness of food offered in both global and local retail settings. Perceptions play a pivotal role in shaping preferences, as the subjective perception of retail significantly influences the intention to make a purchase (Niosi, 2021).

## 2. Theoretical background

The discussion of the relationship between supermarkets and alternative food networks is relevant from the viewpoint of consumer research (Yuan et al., 2021). A research gap still seems to exist in the academic literature on the opinions of consumers regarding food sold in global and local stores. The entry of multinational retail chains into the market in many CEE countries has changed the localities of purchase. The retail landscape has undergone dynamic shifts over the years, marked by the evolution of various formats (Gauri et al., 2021). Consumers have adapted relatively quickly to the new shopping formats and large-scale stores, and global retail outlets have become the preferred shopping formats (Spilková, 2008, 2012; Kunc et al., 2022).

The advent of each new format puts pressure on the older ones to evolve. In response to competitive pressures, older formats are now adopting features from newer ones while rediscovering their original strengths. In this retail evolution, there has been a further transition from larger stores to smaller, more convenient formats, demonstrating a continual adaptation to consumer preferences (Gauri et al., 2021). Therefore, both smaller and larger stores place emphasis on the provision of organic and local products, and hybrid sales concepts, such as omnichannel strategies, to facilitate convenient and rapid shopping experiences (Lichter & Malý, 2023).

This research demonstrates that there are significant differences between the customers of diverse retail formats. The study of Spilková (2018) shows that, although the demographic and socioeconomic characteristics of shoppers are still important features of their segmentation, their shopping place or alternative possibilities to acquire food are also among the most important distinguishing factors characterising shoppers. The relationship between preference for different outlets and consumer segmentation is not clearly explained (Pearson et al., 2011; Nilson et al., 2015; Dabija et al., 2018; Najdený et al., 2022; Salvietti et al., 2023). Based on this, the following hypothesis was formulated:

- H1: There is no statistically significant relationship between the type of store of most frequent purchases and selected demographic, socioeconomic, and spatial indicators.

According to some authors, food sold in supermarkets and hypermarkets is often perceived as inferior (Ozimek & Żakowska-Biemans, 2011). Other authors consider supermarkets as stores that offer safe foods (Maitinyazi & Canavari, 2021). On the other

hand, the production of local farmers at farmers' markets is a qualifier of food safety, but it is based on blind trust (Wertheim-Heck & Spaargaren, 2016). Moreover, consumers may prefer global retailers over small independent local retailers, who may be suspected of engaging in fraudulent practices (Xia & Zeng, 2006). Supermarkets, however, also provide more information on the origin of their food, hygiene and sanitation, and try to provide the best possible guarantee of food safety (Wang et al., 2009).

Globally, large-scale stores offer convenient one-store shopping, meaning shopping for a wide range of food under 'one roof', Hübner et al. (2016) state that consumers shopping in hypermarkets have higher expectations of services provided or reliable information regarding food and prices, and the results of Lim et al. (2022) pointed out that trust in food has a major impact on the satisfaction of consumers shopping in hypermarkets and shopping centres. The results of a study by Kimenju et al. (2015) indicate that shopping in supermarkets contributes to a higher likelihood of overweight or obesity in adults, with most consumers stating low food prices as the most important reason for shopping. According to these studies, the following hypotheses have been formulated:

- H2a: There is no statistically significant relationship between the perception that large-scale grocery stores offer healthier food than small-scale stores and the selected demographic, socioeconomic, and spatial indicators;
- H2b: There is no statistically significant relationship between the statement that large-scale grocery stores offer less expensive food than small-scale stores and the selected demographic, socioeconomic, and spatial indicators; and
- H2c: There is no statistically significant relationship between the statement that large-scale grocery stores offer higher quality food than small-scale stores and the selected demographic, socioeconomic, and spatial indicators.

Farmers' markets can be characterised as consumption sites that provide fresh and local food, often through direct interaction between the consumer and the producer (Benedek et al., 2018; Fendrychová & Jehlička, 2018). Increased demand for quality food can be considered an important factor in the development of alternative food networks, which highlights the recognition and supports the importance of small producers in the food system (Guthrie et al., 2006; Goodman et al., 2012). This demand is driven by the overarching challenge of sustainability and the necessity to ensure the production of high-quality, affordable, and healthy foods. In response, alternative food production and distribution schemes have emerged, utilizing technological or organisational innovations to enhance food production without compromising environmental sustainability (Lioutasa & Charatsarib, 2020).

The cost and availability of fruits and vegetables at farmers' markets are entirely dependent on the farmers servicing the market (Abley et al., 2020). The research of Valpiani et al. (2016) suggests that in many cases the fruit in farmers' markets has a similar price as that in supermarkets, and fruits sold through farmyard sales have lower prices than at supermarkets. In contrast, Thomson et al. (2021) found, that farmers' markets (compared to grocery stores) had less variety and higher prices, but locally sourced produce was more prevalent, which means an increasingly positively perceived support of local communities and small farmers, the local economy, but also the reduction of global waste and the use of local resources. According to Reicks et al. (1994), the higher food price is commonly stated as a barrier to increasing the consumption of fruits and vegetables. A study by Wunderlich et al. (2008) points out that seasonal foods (sold at farmers' markets) bring more nutritional benefits and nutrients than foods sold in supermarkets. Furthermore, farmers' markets have the potential to be a place that will make food available in low-income areas, so-called food deserts (Larson et al., 2009; McCormack, 2010).

Even from the brief overview given, it is evident there is an ambiguity in the scientific community. In this paper, it is not a question of comparing the physical prices of products; they change significantly due to inflation caused by the European (global) crisis. It is not a question of comparing the nutritional values of foods based on chemical and biological tests. The consumer must buy food regardless of whether it costs  $x$  EUR or  $x + 1$  EUR or whether chemical analyses are more or less favourable. There is a research gap in understanding consumers' perceptions of purchased food based on their own experience and de facto reasons for choosing a place to buy it.

Based on the arguments listed above, the following hypotheses have been formulated:

- H3a: There is no statistically significant relationship between the statement that food sold at farmers' markets is healthier than food in conventional stores and the selected demographic, socioeconomic, and spatial indicators.
- H3b: There is no statistically significant relationship between the statement that food sold at farmers' markets is less expensive than food in conventional stores and the selected demographic, socioeconomic, and spatial indicators.
- H3c: There is no statistically significant relationship between the statement that food sold at farmers' markets is of higher quality than food sold in conventional stores and the selected demographic, socioeconomic, and spatial indicators.

### 3. Data and methods

The research was conducted in November 2020 in the form of a questionnaire survey. The sample consisted of 1,004 respondents who represent the population of the Slovak Republic over the age of 18 in terms of gender, age, education, nationality, size categories of municipalities, and regional division. The spatial distribution of municipalities with respondents participating in the survey is visualised in Figure 1. The responses of consumers were recorded through the FOCUS research agency (Hencelová et al., 2022).

Women dominated the sample of respondents and the average age of the respondents was 47.3 years. The oldest consumer generation of respondents ('Pre-Boomers') represented 2.4% of the total, and nearly one-third of respondents (32.9%) can be included in the 'Baby Boomer' generation. A significant share of respondents belong to Generation X (22.5%) and Y (34.1%), and less than one-tenth (8.2%) of the respondents are from Generation Z. More than half of the respondents have a net monthly income of up to EUR 700, and 44.1% of respondents come from the countryside (Tab. 1). A total of 15.4% of respondents live in municipalities with under 1,000 inhabitants, 45.6% in municipalities with up to 5,000 inhabitants and almost 90% (87.5%) of respondents live in municipalities with up to 100,000 inhabitants. Since this was a representative study, the term respondent is identical in the paper with the term consumer.

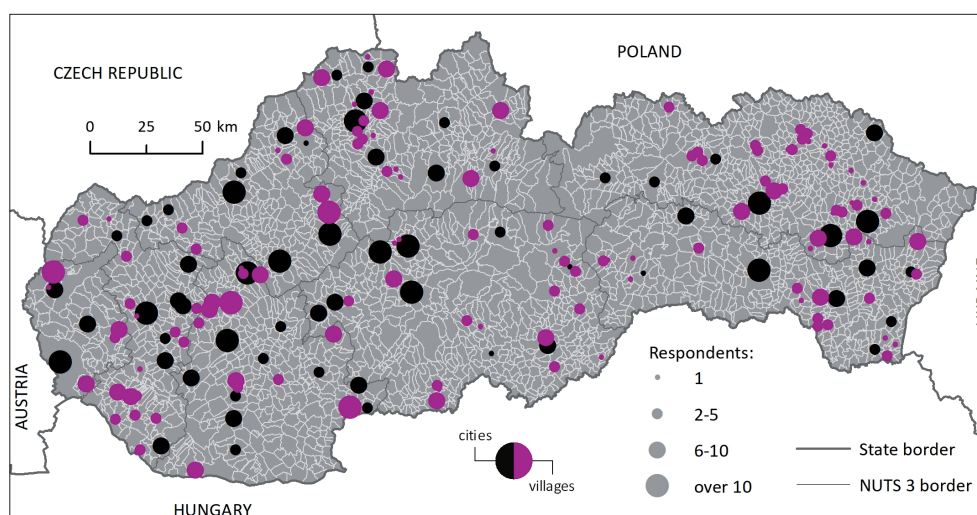


Fig. 1: Spatial distribution of respondents participating on the survey  
Source: authors' elaboration

Indicators	Share (%)	Indicators	Share (%)
<i>Gender</i>		<i>Status</i>	
Males	48.4	Single	25.4
Females	51.4	Married	62.1
		Divorced	6.1
<i>Education</i>		Widow/widower	6.4
Primary	12.5	<i>Residence</i>	
High school without graduation	27.0	Urban	55.9
High school with graduation	37.4	Rural	44.1
University	23.1	<i>Size category of residence</i>	
<i>Net monthly income</i>		Less than 1,000	15.4
Less than 300 €	8.0	1,000–1,999	14.5
301–500 €	21.2	2,000–4,999	15.7
501–700 €	25.4	5,000–19,999	16.3
701–900 €	17.7	20,000–49,999	16.3
More than 900 €	22.7	50,000–99,999	9.3
NA	5.0	100,000 and more	12.5

Tab. 1. Basic characteristics of the respondents ( $n = 1,004$ )  
Source: authors' calculations based on data from the FOCUS research agency

The age of the respondents and their inclusion among the various generations of consumers was the demographic indicator analysed. The respondents' declared net monthly personal income was the socioeconomic indicator. The place of the respondents' residence (urban vs. rural) and the size category of the municipality they lived in based on the number of inhabitants was the spatial indicator. The Mann-Whitney U test was used as the test statistic when there were two variables and the Kruskal-Wallis test was for three or more ordinal variables in the SPSS software (Gaur and Gaur, 2006).

## 4. Results

### 4.1 In what type of stores do consumers most often buy food?

In many post-socialist Central European countries, global large-scale hypermarkets and supermarkets are the most popular retail outlets (Kunc & Križan, 2018; Spilková, 2012; 2018; Machek, 2012; see Fig. 2). It generally applies that nearly half of consumers in Slovakia (41.6%) shop in supermarkets, and at the same time it needs to be noted that nearly a quarter of consumers shop in hypermarkets. Thus, two-thirds of consumers in Slovakia shop in large-scale stores, which indicates the leaning of Slovak consumers towards the consumer society (Búzik & Zeman, 2020), towards global retail. Smaller self-service stores appear to be the second most common place of shopping for Slovak consumers (25.2%), and only 0.5% of consumers in Slovakia used the Internet (online shopping) as their most frequent place of grocery shopping. Local markets (farmers' markets) show similarly low values. These are answers, however, to the question of the most frequent place of purchase, and it can be assumed that consumers often select alternative food chains, but that they are the place of most frequent purchases only in exceptional cases.

The results of testing hypothesis H1 indicate that there is a statistically significant relationship ( $p < 0.000$ ) between the type of store of the most frequent purchases and the generation of consumers. In comparison with the entire sample of respondents, Generation Z shops particularly in hypermarkets over expected values, while Generations X and Y shop especially in supermarkets, and the generation of 'Baby Boomers' and 'Pre-Boomers' in small stores.

The results of testing hypothesis H1 show that there is a statistically significant relationship ( $p < 0.000$ ) between the type of store of the most frequent shopping and the net monthly personal income of consumers. Although large-scale retail stores are generally the most popular, low-income groups of consumers buy food or other common consumer goods in small stores in excess (compared with the expected values). These in particular are consumers with a net monthly personal income of up to EUR 500, who, compared with the entire sample of respondents, buy excessively in smaller self-service stores and smaller over-the-counter stores. Consumers with a higher net monthly personal income over EUR 500 shop in excess particularly in supermarkets and less prefer small retail stores for their most common grocery shopping.

In the case of consumer segmentation according to the place of residence, a statistically significant relationship was confirmed ( $p = 0.002$ ) between the type of retail store for the most frequent purchases and respondents from urban or rural areas. While urban consumers in comparison with the whole sample buy predominately in supermarkets over the expected values, the values for rural consumers are, in contrast, genuinely lower than expected. At the same time, the opposite trend was noted with the preferred most frequent shopping in smaller self-service stores. Smaller expected and larger real values are typical for rural consumers, while the opposite trend is true for urban consumers. The size category of residence, determined by its population, is associated with the type of retail they choose for their most frequent purchases ( $p < 0.000$ ). Although preferences for large-scale stores for the most frequent purchases prevail in all the size categories of municipalities, in municipalities with fewer than 5,000 inhabitants, small stores do retain an important position. The most frequent shopping in hypermarkets or supermarkets in the case of consumers from such municipalities does not reach the expected value when compared with the entire sample of respondents; it represents a lower portion of shoppers.

### 4.2 Consumers' perceptions of food offered by global large-scale supermarkets and hypermarkets

In general, nearly two-thirds of consumers in Slovakia (62.7%) definitely or rather disagree with the statement that large-scale supermarkets and hypermarkets offer healthier foods (Fig. 3). Further, 8 out of 10 consumers in Slovakia view supermarkets and hypermarkets as stores that offer less expensive food (rather or definitely agree with this statement). According to the majority of Slovak consumers (73.7% of consumers), however, these stores do not offer higher quality food; in the case of consumers from the younger generations (X, Y, and Z) this fact is, after all, perceived more positively. The analysis indicates that there is a statistically significant relationship between the perception of large-scale grocery stores that offer healthier, less expensive, and higher-quality food with respect to the generation of consumers (Tab. 2).

A statistically significant relationship was also shown in the case of net monthly personal income of consumers and perception of healthier ( $p = 0.002$ ) and higher quality food ( $p = 0.002$ ). Regarding the perception that large-scale grocery stores offer less expensive food, no statistically significant relationship was shown ( $p = 0.425$ ). A higher share of respondents who definitely or rather agree with the statement that supermarkets and hypermarkets offer healthier food appeared among consumers with a higher net monthly personal income. In the case of respondents with an income above EUR 900, more than 40% agree (definitely or rather) with the perception of higher quality food, and 44% agree with the perception of healthier food offered in large-scale stores. Consumers with a net monthly personal income of EUR 500 or lower have the opposite perception. A similar statement applies regarding the perception of supermarkets and hypermarkets as stores that offer

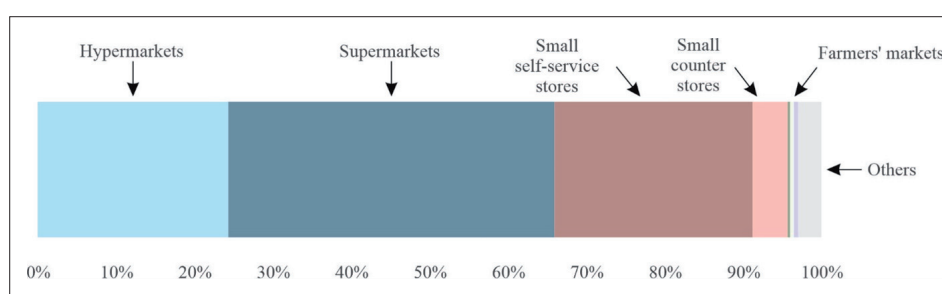


Fig. 2: Retail for the most frequent purchase of food by Slovak consumers  
Source: authors' processing based on data from the FOCUS research agency

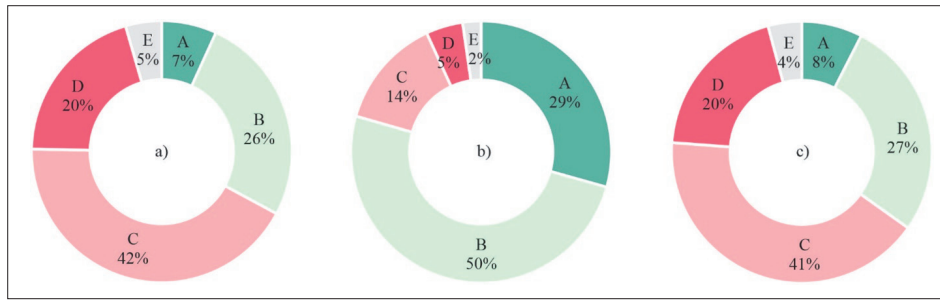


Fig. 3: Perception of Slovak consumers regarding large supermarkets and hypermarkets

Source: authors' processing based on data from the FOCUS research agency

Explanatory notes: a) Large-scale grocery stores offer healthier food than smaller stores; b) Large-scale grocery stores offer less expensive food than smaller grocery stores; c) Large-scale grocery stores offer higher quality food than smaller grocery stores;

A: definitely agree; B: rather agree; C: rather disagree; D: definitely disagree; E: I don't know

Indicators	H2a	H2b	H2c
	p-value		
Generation	<b>0.000</b>	<b>0.020</b>	<b>0.003</b>
Net monthly personal income	<b>0.002</b>	0.425	<b>0.002</b>
Residence	<b>0.038</b>	0.319	0.070
Size category of residence	<b>0.000</b>	0.066	<b>0.002</b>
Level of significance $\alpha = 0.05$			

Tab. 2: Relationships between H2 (perception of large-scale grocery stores) and demographic, socioeconomic, and spatial indicators  
Source: authors' calculations based on survey data

Indicators	H3a	H3b	H3c
	p-value		
Generation	0.235	0.507	0.674
Net monthly personal income	0.361	0.852	0.139
Residence	0.802	<b>0.000</b>	0.466
Size category of residence	0.270	<b>0.000</b>	0.224
Level of significance $\alpha = 0.05$			

Tab. 3: Relationships between H3 (perception of farmers' markets) and demographic, socioeconomic, and spatial indicators  
Source: authors' calculations based on survey data

higher-quality food. Income plays an important role not only in grocery store choice (Hiller et al., 2011; MacNell, 2018) but also in perceptions of other food attributes.

Urban consumers have a similar perception of food on offer at supermarkets and hypermarkets as rural consumers. A relationship was confirmed in the case of the perception of the offer of healthier foods. Compared with the whole sample of respondents, urban consumers definitely disagree with the statement that large-scale grocery stores offer healthier food. With the segmentation of consumers based on the size of their municipality of residence, it can be said that those from less populated localities view the offer of healthy food in large-scale stores less negatively (definitely or rather agree) than those in more populated localities. Similarly, up to half of consumers in municipalities with fewer than 1,000 inhabitants agree with the statement that supermarkets and hypermarkets offer higher quality food. The opposite perception occurs in the case of consumers from municipalities with a larger population. This may be related to the lack of food stores and food variability in less populated municipalities (Bilková et al., 2018).

#### 4.3 Consumer perceptions of food offered on local alternative food networks

Nearly 90% of consumers in Slovakia perceive food sold at farmers' markets as being healthier than those sold in conventional stores (34.7% definitely agree, 55.2% rather agree). At the same time, it can be said that consumers do not view the food sold at farmers' markets as less expensive compared with those in conventional stores (see Fig. 4). A total of 45.5% of Slovak consumers rather disagree with the statement that food sold at farmers' markets are less expensive than food in conventional stores, and 20.3% definitely disagree. The opposite perception was recorded in the case of the quality of food offered at farmers' markets, as up to 89% of consumers expressed agreement that food sold at farmers' markets is of higher quality than those sold in conventional stores. No statistically significant relationship was observed between such perceptions and consumers' net monthly personal income (Tab. 3).

With indicators linked to consumers' place of residence, a statistically significant relationship was recorded only in the case of the perception of the statement on less expensive food. More than half of consumers from municipalities with up to 1,000 inhabitants predominately agree (definitely or rather) with this statement and consider food at farmers' markets to be less expensive. Similarly, more than 42% of rural consumers perceive food at farmers' markets as less expensive than those in conventional stores. Urban consumers have the opposite perception (Tab. 3). Farmers' markets in rural areas have a long tradition of selling local products at lower prices because many consumers source their seasonal food themselves. In contrast, urban farmers' markets are considered a new phenomenon in Slovakia and have become a trendy shopping venue associated with sustainable consumption and higher prices (Križan et al., 2022).

### 5. Discussion

Retail is changing in both time and space, and consumer shopping behaviour is changing with it. In post-socialist Central European countries, global large-scale supermarkets and hypermarkets have become the most frequently visited stores for the purchase of food (Kok, 2007; Ozimek & Żakowska-Biemans, 2011; Machek, 2012; Rudawska & Bilinska-Reformat, 2018; Fehér et al., 2021). These findings were also confirmed in the case of Slovak consumers, two-thirds of whom shop most often in global retail stores. Although local farmers' markets are gaining in popularity in post-socialist countries (Qendro, 2015; Syrovátková et al., 2015; Balogh et al., 2016; Spilková, 2018; Blumberg & Mincyte, 2019), only a negligible share of consumers use them as the most common place to buy food. On the other hand, it is necessary to consider the seasonality of farmers' markets, because of their shorter season which operates mainly from late spring to early autumn (Dimitri et al., 2015). This might be one of the main reasons for the reduced participation at farmers' markets and the lower availability and variety of local foods (Schmidt et al., 2011; Tchoukaleyska, 2013). The results from Slovakia indicate that there is a statistically





Fig. 4: Perception of Slovak consumers regarding farmers' markets

Source: authors' processing based on data from the FOCUS research agency

Explanatory notes: a) Food sold at farmers' markets is healthier than food sold in conventional stores; b) Food sold at farmers' markets is less expensive than food sold in conventional stores; c) Food sold at farmers' markets is of higher quality than food sold in conventional stores; A: definitely agree; B: rather agree; C: rather disagree; D: definitely disagree; E: I don't know

significant relationship between the type of store of the most frequent purchases and the generation of consumers. Compared with the entire sample of respondents, Generation Z shops above the expected values in hypermarkets, Generations X and Y mainly in supermarkets, and the 'Baby Boomers' and 'Pre-Boomers' in smaller stores (cf. Klapilová Krbová, 2016; Koksál, 2019).

As many as 8 out of 10 consumers in Slovakia perceive global supermarkets and hypermarkets as stores offering less expensive food, though not higher quality food. On the contrary, a large majority (almost 90%) of consumers agreed that food sold at farmers' markets is better quality than food sold in regular stores. Statistically significant relationships were confirmed only between the given statement in the case of the net monthly personal income of consumers and the perception of healthier and higher quality food. The greater popularity of smaller, specialised shops, farmers' markets, etc. with often fresher and healthier, but also more expensive food has been demonstrated in earlier studies in Central Europe (Kunc et al., 2012a; Križan et al., 2015). On the other hand, the advantages associated with higher quality but also higher price were more likely to be sought by higher income groups (Kunc et al., 2012b). Thus, it is possible that even average affluent Slovak consumers are turning their habits towards more sustainable consumption.

Differences in perceptions of the food offered in large-scale stores between urban and rural consumers were not confirmed either. It can be stated, however, that consumers from less populated municipalities perceive the offer of healthy and higher quality food in large-scale stores less negatively than consumers in more populated municipalities. From our own experience, previous research, and expert studies (Kunc et al., 2012c; Maryáš et al., 2014; GfK, 2017), this finding can be explained by the relatively long-standing habit of (not only) Slovak consumers prefer shopping in super/hypermarkets, which is also associated with a slightly 'blind' trust in packaged and often foreign food. Even this shopping behaviour may soon start to turn in favour of smaller stores and farmers' markets, however.

Nearly 90% of consumers in Slovakia perceive food sold at local farmers' markets as healthier compared to those in conventional stores. Consumers believe that the food they buy mostly comes from farmers' markets and their own production has characteristics linked with organic food (Petrescu et al., 2017). The perception of Slovak consumers on the quality of food sold at farmers' markets is similar to that of other countries (Spilková et al., 2015; Wolf et al., 2005), which points to a similar conception of alternative foods in different regions of the world. Consumers perceive food at farmers' markets as being fresher, healthier, and of higher quality than food from supermarkets. The quality, freshness, and ripeness of produce are the most important factors for shopping food at farmers' markets (Trobe, 2001) since food sold at farmers' markets is of higher quality compared to those

available elsewhere (Smithers et al., 2008). The generally accepted thesis that, in comparison with the younger generations, older people are aware that industrially produced and processed foods from conventional retail chains do not taste the same as the food they ate as children (Syróvátková, 2016) was not confirmed in the case of Slovak consumers. In Slovakia, the relationship between generations of consumers and their perceptions of food sold at farmers' markets was not confirmed. This may indicate a trend that alternative food networks in Slovakia are generally perceived as places that offer healthier and higher quality food, regardless of the age of consumers.

According to a study by Lyon (2009), consumers at farmers' markets in Scotland are looking for high-quality food and direct contact with local producers. A study in the Czech Republic shows that farmers' markets are not socially exclusive, since pensioners, a social group traditionally with a lower income, represent a significant proportion of all customers (Syróvátková et al., 2015). The economic situation of the household is an important factor in shopping at farmers' markets, but other factors likely need to be taken into consideration (Spilková et al., 2013). From a study on Slovak consumers, the conclusion has been reached that the difference between consumer income is not a significant factor in the segmentation of consumers in terms of their perception of farmers' markets and the food they offer.

Slovak consumers do not agree with the statement that food sold at farmers' markets are less expensive than those sold in conventional stores. Similar results can be seen in other countries, and food prices at farmers' markets are a barrier to consumer purchases (Žakovská-Biemans, 2011). Consumers, however, do perceive food in farmers' markets as having higher value at a more reasonable (lower) price than in supermarkets (Wolf et al., 2005), though a higher price may lead to hesitation in purchasing such food (Žakovská-Biemans, 2011). Gil et al. (2000) call for lowering the existing price gap between conventional and organic food so that consumption at alternative food networks can be increased. On the other hand, consumers are willing to pay a higher amount (surcharge) for food at farmers' markets (Yiridoe et al., 2005), especially with a clear local (regional) origin (Lang et al., 2014). In Slovakia, differences between the perception of the price of food from farmers' markets and place residence were identified. Urban and rural consumers perceive the price of food differently. Rural consumers consider food sold at farmers' markets to be less expensive (compared with conventional stores) than urban consumers. While farmers' markets in the Slovak countryside are considered to be something obvious with a long tradition, in cities they are transformed into modern and trendy places of consumption. Urban consumers in this way express a kind of attitude, particularly towards globalisation or consumerism, and positive attitudes towards a more ethical and greener lifestyle (Spilková et al., 2013). This, too, may be one of the reasons why

food sold at urban farmers' markets is more expensive than those in conventional stores, which consumers have confirmed with their own attitudes. These results also indicate that for a more detailed understanding of consumer behaviour, it is necessary that research focus not only on traditional demographic or socioeconomic indicators but also on spatial indicators, such as place of residence (Weatherell et al., 2003).

Although the results of the questionnaire from one small European country will not address the established research gap, they do offer an additional piece of the puzzle for understanding the dichotomy of consumers between the choice of global and local food retailers. The results have implications for the grocery sector, in the sense of emphasising aspects associated with the quality, price, and health aspects of foods that influence consumers' food choices. This study examines the profile and perceptions of shoppers in global and local types of grocery stores, which can provide additional information regarding consumer behaviour and preferences in understanding the retail environment.

## 6. Conclusions

Large-scale food retail outlets of a global nature, such as supermarkets and hypermarkets, have gained popularity among consumers in Central Europe. This research demonstrates generational differences among consumers in their preferences for the most common shopping formats (H1). Although not universally applicable due to senior citizens favouring super/hypermarkets during discount promotions, older generations generally prefer smaller stores. This preference is influenced by factors such as the spatial distribution of the population and the availability of stores. Particularly in rural areas, an older generation and smaller stores prevail, whereas in urban areas, larger retail outlets are favoured by the younger generation. These findings highlight the discernible differences in preferences between rural and urban areas, emphasising the spatial dimension in understanding consumer shopping behaviour. Furthermore, this research reveals a statistically significant relationship between the type of preferred shopping formats and the consumer's net monthly income. These findings offer crucial insights for marketing strategies.

Contrary to studies addressing food security and food deserts, the survey in Slovakia contradicts the notion that global food retailers offer healthier and higher-quality food items. Varying perceptions of the healthiness of food sold in supermarkets were identified among different age groups, income categories, residential areas, and municipality sizes (H2a). While the majority of consumers prefer supermarkets, possibly due to their perceived affordability, distinctions in attitudes were observed among different generations of consumers (H2b). Negative emotions towards supermarkets as outlets offering higher-quality food items (H2c) may be associated with widely publicised scandals and sanctions for non-compliance with hygiene regulations. Consumers seem less aware of the quality, however, associated with product diversity (BIO, lactose-free, gluten-free, vegan, etc.) and the range of choices, from lower to higher-quality items, available in global retailers.

The trust established between consumers and local farmers is evident in the conclusion that the vast majority (up to 9 out of 10) of Slovak consumers consider food from farmers' markets to be healthier compared to regular stores. This sentiment is consistent across all analysed consumer segments. People often trust food from farmers' markets more due to direct contact with producers, increasing transparency in production, and the perception that these markets offer local, seasonal, and less 'industrially processed' foods, all associated with higher quality and health benefits (H3a). On the other hand, most consumers perceive food at farmers' markets to be more expensive. Opinions on this matter vary based

on location, with a statistically significant relationship observed between consumers from urban and rural areas. Consumers from urban areas view farmers' markets as trendy with added value and, consequently, higher food prices. Conversely, consumers from rural areas in Slovakia maintain the tradition of affordable local food purchases. These perceptions regarding the quality of food sold at local farmers' markets hold true across all analysed consumer segments (H3c).

It is important to note that Slovakia has not yet implemented a 'farmers' market code', which may lead to different consumer attitudes towards farmers' markets. While global retailers exhibit a degree of uniformity and networking, local farmers' markets are characterised by heterogeneity and individualism. These findings open avenues for future research in the geographic study of retail and consumption trends.

The primary contribution of this research is the revelation that consumers in Slovakia perceive global retailers (supermarkets) as offering lower-quality food. This perception is consistent among urban and rural consumers, indicating that location does not significantly affect the perception of food quality in supermarkets. Specifically, the findings demonstrate that consumers consider food sold at farmers' markets to be of higher quality and healthier compared to food in global retail outlets. This perception is consistent across all age groups of consumers. At the same time, differences in income do not significantly affect consumer perception of the products offered by farmers' markets.

Furthermore, the research provides insights from a post-socialist country, where consumer behaviour exhibits specific characteristics due to the past political and economic insularity that has also impacted the retail sector. This is an important contribution that allows us to understand the dynamics of changing shopping behaviours and adaptation to globalization trends and patterns from other developed countries. Over the past three decades, Slovak consumers have adopted shopping behaviour patterns that have been in place elsewhere for a longer time. The results also expand the theoretical understanding of how consumer decision-making varies depending on socio-demographic characteristics and perceptions of different consumer groups.

Understanding consumers as individuals within specific segments, categorised by their place of residence or the size of their communities, is crucial for grasping their food retail preferences and making informed predictions. The study underscores the importance of location-specific factors in shaping consumer perceptions, urging retailers to consider these factors in pricing, promotion, and product strategies. With data collected during the COVID-19 pandemic, the research highlights the need for businesses to adapt operations, strengthening online shopping, and ensuring health and safety measures.

This adaptive approach enables managers to continually gather consumer insights. By incorporating these insights, producers and farmers' market managers, as well as retailers and supermarket managers, can make informed decisions in response to market dynamics, optimize product offerings, and enhance the overall shopping experience in both global and local food retail environments. This not only ensures a more efficient allocation of resources but also facilitates a more responsive and consumer-centric approach across the entire food supply chain.

The paper and its findings should be considered within the broader context of the COVID-19 pandemic situation. Given that the data collection took place during the pandemic (November 2020), it is essential to interpret the results in light of this unique situation. Future studies could be focused on other factors with an impact on the perception of consumers in Slovakia on conventional or alternative food networks. These studies could also take into account the consequences of other ongoing crises

such as the energy and geopolitical crises in Central Europe on changing preferences observed in global supermarkets and local farmers' markets.

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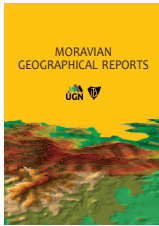
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# The divided town of Český Těšín/Cieszyn as the most integrated part of the Czech-Polish borderland: A life in the cross-border educational togetherness or side by side?

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## Abstract

*The (non)contribution of schools towards cross-border integration in the divided town of Těšín/Cieszyn, located on the Czech-Polish border, is analysed in this article. The pandemic-related border closures revealed a substantial level of togetherness in this town, manifested by various social activities. Moreover, a part of these (during the pandemic restricted) cross-border social practices were those in education. We applied a mix of quantitative and qualitative methods to diagnose the directions of cross-border educational flows, the approach of schools towards the identified joint cross-border social practices, and the possible level of togetherness. As a result, one-sidedness (Polish pupils attending schools in the Czech Republic) of cross-border flows was identified – which also follows the direction of a cross-border workforce. Except for the schools with Polish as the instruction language, located in the Czech part of the town, primarily serving Polish speakers living in the Czech Republic, we can mention hardly any mutually shared feeling of togetherness and an actual place-based approach towards educational governance in this divided town. We observe some ties in education between the autochthonous Polish minority in the Czech Republic and the Poles in Poland, without the involvement of pupils or teachers of Czech ethnicity, who do not reflect opportunities behind the border.*

**Keywords:** cross-border integration; schools; Těšín/Cieszyn; barriers; functional integration; Poland; Czech Republic

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## 1. Introduction

Around one-third of the EU citizens live in border areas. Borderlands are affected by plentiful negative phenomena linked to the border's barrier function (Scott, 2019). Cross-border cooperation (CBC) has therefore become a tool that strives to assist in removing those barriers and contributes to the quality of borderlands as living spaces (Dokoupil, 1999; Brunnet-Jailly, 2005; Klatt, 2019). CBC, implemented by public actors at sub-national levels, became one of the critical forms of micro-foreign policy/paradiplomacy (Duchacek, 1988), deliberately differentiated from other forms of cooperation that had been intensified at the nation-state level.

CBC has been the playground of actors representing local and regional administration bodies, which constructed the first CBC entities with various legal and administrative forms. Most of them named themselves "Euroregion", and this term became one of the most frequent keywords in border studies (Dura et al., 2019).

Nevertheless, local and regional actors' "monopolist" position in CBC has been eroded by other actors, who also decided to join their forces across national borders. In the areas of advanced cross-border integration (CBI), a cross-border multidimensional convergence process, mainly in the Upper Rhine Valley (French-German-Swiss border) and the Greater Region (French-German-Belgian-Luxembourg border), the cross-border associations gathering other actors started to appear in the 1970s (Decoville et al., 2013). The introduction of the INTERREG program was a significant incentive to engage in CBC for many non-profit actors, including schools.

In 1989, the wave of democratic revolutions brought along changes in the political organisation of Central and Eastern European states. They declared ambitions to return to Europe, which materialised in their EU accession after 2004. Public actors from this part of Europe, including schools, started to be involved in CBC too, which was eased by an extension of the Schengen zone in December 2007, when the post-communist EU members (except

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for Romania and Bulgaria) were involved in the Schengen space. Euroregions, EGTCs, divided towns, and other CBC actors started contributing to the higher level of CBI with massive INTERREG funding.

Given the long history of mutual CBC, advanced CBI can be observed in the “EU core”. Durand and Decoville (2020) studied CBI in the EU and observed six principal macroregional patterns. The highest one was found in so-called Rhineland countries, where a high level of cross-border flows in both directions was observed. The CBI in the new “EU” is, according to Durand and Decoville (2020), dependent on the INTERREG program, cross-border flows are not symmetrical, and the feeling of togetherness is weaker.

The COVID-19 pandemic, however, which led to restricted cross-border flows and protests of the inhabitants of border regions against these restrictions, highlighted that CBI seems to be relatively high also in the (generally considered to be the less integrated ones) Central and Eastern European borderlands – the German-Polish (Jańczak, 2020; Opiłowska, 2020) or Czech-Polish border can be mentioned here (Opiola & Böhm, 2021). This relatively new finding asks for further scholarship.

The divided town of Cieszyn/Český Těšín, situated on the east of the mutual Polish-Czech border, is considered to be the most integrated part of the entire border (cf. Pászto et al., 2019; Böhm, 2022). The pandemic-related restrictions revealed that many inhabitants of both parts of the divided town tend to understand it as a single living space, where the daily social practices ignore the border (Kasperek & Olszewski, 2020; Böhm, 2022; Kajta & Opiłowska, 2022). The survey conducted by the Euroregion (Olszewski, 2021) also pointed out that these border closures restricted their (or their children's) access to education on the other side of the border. This fact advised us that a cross-border dimension of education deserves further attention in this divided town.

It was an exciting finding, given that CBI in education in the EU is far behind the level of integration in other areas of human activities. The European Commission (2021) reflects on progress made in the last few years and assesses the challenges in these border regions. Numerous examples of good practice are recounted, presenting specific cases and evidence of tangible achievements across various policy areas. The report however ultimately finds that increased CBC is necessary to make these regions more resilient and help them harness their potential. The report explicitly states (p. 9):

“The present promoting training and job-seeking across the border is rarely done systematically, which makes it hard to maximise the potential of demand and supply available across the broader cross-border region.”

Hence, the aims of this paper, focusing on the divided Český Těšín/Cieszyn, are fourfold:

1. To analyse whether there are significant cross-border flows of pupils in the divided town, and (if yes) what is their direction;
2. If there are these cross-border flows, we will try to identify the reaction of local schools and other relevant actors in the field of education: how are these cross-border flows reflected, whether and how the schools prepare their pupils for future (professional) life on both sides of the border in the divided town;
3. We want to explore to what extent the schools and other education actors cooperate; and
4. Lastly, we plan to identify whether there are cross-border social practices among upper secondary school students from both parts of the divided town.

We hypothesise that there is a limited volume of cross-border flows of pupils in the studied divided town. Hypotheses are based on the literature and our long-term experience from Těšín/Cieszyn

Silesia. We expect that some pupils from the Polish part of the divided town attend the schools for the Polish minority in the Czech part (Gajdzica & Kubiczek, 2012; Böhm, 2017). Furthermore, given the high number of Poles working in the Czech part of the region (Kasperek & Olszewski, 2020), we expect that a certain level of cross-borderness could be partly observed in vocational schools on the Polish side of the border. Given the presence of schools with Polish as an instruction language in the Czech part of the studied territory, serving the Polish-speaking minority living there, we expect that these schools will be the drivers of CBC in the field of education.

The article is organised as follows: the next section provides an overview of the leading research directions in border studies, with attention dedicated to divided cities' scholarship and scholarship on CBI in education. The third section outlines the methodology and the primary materials analysed in the article. The fourth section presents and discusses the research findings, based on the work with the statistics, analysis of implemented CBC projects in the field of education in the 2014–2020 programming period, conducted survey, mental mapping and focus group meeting. The final section draws conclusions, highlights the principal elements of CBI in education in the studied territory, and identifies further possible research directions.

## 2. Theoretical background

### 2.1 Research directions in border studies

Freedom of movement of EU citizens across borders in Europe is a cornerstone of the EU and has become an object of continuous scholarly attention. Free border crossing and the developed CBC became one of the principal EU narratives (Scott, 2016). Multi-level governance, EU regional cohesion policies, the Europe of Regions discourse, and an increase in paradiplomatic activities of sub-national state authorities supported a consensus on rescaling Europe with an increasing influence of regional and local actors from a cross-border perspective (Hooghe & Marks, 1993; Keating, 1998; Scott, 1999; Warleigh-Lack et al., 2011; Klatt, 2019). The CBC belongs, next to the Erasmus, to the most tangible successes of the European integration process, which is based on mutual interdependence (Scott, 2016).

In the last 20 years, the number of CBC structures has exploded in Europe (Zumbusch & Scherer, 2019). Researching CBC presents a cornerstone of border studies as a specific sub-discipline, which is based on studying the interplay of:

1. Market forces and trade flows;
2. Policy activities of multiple levels of governments on adjacent borders;
3. The particular political clout of borderland communities; and
4. Their specific culture (Brunnet-Jailly, 2005).

Böhm (2023) argues that CBC has five principal roles:

1. Multi-level governance role;
2. Regional development tool;
3. Paradiplomacy;
4. Reconciliation; and
5. Europe-building role.

While (at least in the EU) research on debordering has dominated border studies in the EU until recently, the rebordering tendencies have been researched there for at least two decades, too.

Manifold barriers have complicated CBI, however. They range from legal and administrative barriers to cultural and mental ones (Klatt, 2019). A combination of those factors has contributed to the long-lasting tendency to overlook the possibilities which might be offered in neighbouring regions behind the national borders

(van Houtum, 1999; Van Houtum & Van der Velde, 2004; Van der Velde & Naerssen, 2011). In the post-communist EU, it is believed that the level of CBI and cross/border trust is generally weaker than in the “old EU” (Durand & Decoville, 2020).

Moreover, border crossing and CBC significantly differ in various parts of Europe. So far, only (!) Eurobarometer poll (2015) explicitly addressing border regions revealed very different levels of cross-border practices and mutual social trust among border region residents in the EU, which is much higher in the EU core than between new member states, except the Czech-Slovak border (Eurobarometer, 2015). A difference between CBI in various parts of European patterns was primarily caused by a longer tradition of CBC in the “EU core”. With a certain level of simplification, we can still observe differences in the cross-border social practices in the “old-old EU, old-new EU, and new-new EU” borderlands.

The Czech-Polish border is almost 800 kilometers long, and CBC there has become an object of scholarship. Lewkowicz (2019) sees the Polish-Czech border as one of the better-integrated ones, using the comparative perspective of all Polish borders. Dozblasz (2015), Böhm and Šmída (2019) and Vaishar et al. (2013) underlined the importance of cross-border tourism for joint CBC initiatives. The social and cultural dimensions of the Polish-Czech borderland were studied in the work of Śliz and Szczepański (2016), Dębicki (2010), Dozblasz (2013; 2016), Czepil and Opiola (2013).

Těšín/Cieszyn Silesia, with its Polish minority living on the Czech side, is, according to many scholars, the most integrated part of the borderland with a high volume of multiple cross-border flows (Pászto et al., 2019; Opiola & Böhm, 2022), where the CBC contributed to the mutual post-conflict reconciliation (Böhm, 2023). Wróblewski and Kasperek (2019) analysed cross-border cultural cooperation, and also observed its highest intensity in Těšín/Cieszyn Silesia.

Divided towns have become one of the symbols of European integration, as the borders have gradually been losing their separation function, and these “bridge towns” started to head toward gradually higher togetherness (Joenniemi & Sergunin, 2011). They became a model of post-conflict reconciliation in many European border regions (*cf.* Böhm, 2023).

There is no single agreement on the level of CBI in divided towns. Dębicki and Tamáska (2014) claimed that interactions are mainly reduced to nonpersonal actions. They argue that divided twin towns are far from integrated and “reunited” urban structures. On the other hand, Joenniemi and Sergunin (2011, p. 128) have argued that:

“...the twin city concept has enabled several cities to use their location to opt for new forms of being and acting. The providing of a new and broader twist to the concept of the twin city and reproducing it in a trans-border context constitutes one specific aspect of an increasingly integrated political landscape.”

Kaisto (2017, p. 464) argues that

“individuals are likely to identify with the twin city if their spatial perceptions of and lived experiences in the twin city correspond with the associations they have of the concept.”

She recommends paying more attention to how local citizens understand twin cities as concepts and spaces for everyday life.

The COVID-19 pandemic has caused the comeback of physical borders in the Schengen space. The border scholars focused on the effect of this “covidfencing” (Medeiros et al., 2021) in various parts of Europe. They agreed that the pandemic challenged the fundamental freedoms of the EU in a very complex way (Hennig, 2020; Jańczak, 2020; Unfried, 2020; Medeiros et al., 2021). The pandemic showed how resilient and meaningful national borders remain (Castan Pinos & Radil, 2020).

The reintroduction of physical borders has also demonstrated the high level of CBI in certain border regions, however, especially in divided towns (Jańczak, 2020; Opiłowska, 2021; Böhm, 2022, 2023; Opiola & Böhm, 2022; Kajta et al., 2023). Hennig (2020) highlighted the significance of civil society actors in times of crisis, who could lobby for a less restrictive border management response and help to hold bilateral relations together. Böhm (2023) even advised understanding covidfencing as a possible new “fuel” for CBC actors.

## 2.2 Cross-border integration in the field of education

Whereas the (general) CBI has become a repeated object of scientific attention, as shortly sketched in the upper paragraphs, the research of CBC in the field of education in the EU has been much more modest. We identified several articles analysing the contribution of schools toward CBI, however. Still, their results were very similar: the existing school curricula primarily cover historical and cultural issues that enforce the “national” interpretation of history and a homogenous national culture (Pasięka, 2015). McCall (2012) underlines the roles of schools in post-conflict reconciliation, using the example of Irish “post-troubles” reconciliation.

Universities and tertiary education providers are the most active ones in implementing CBC in the field of education, both in the EU – where even the cross-border association of universities – the University of the Greater Region and the Association of the Upper Rhine Valley Universities (Böhm et al., 2021), as well as outside of it (e.g. Ermakova and Nikulina, 2019). The symbolic importance of French-German cooperation overshadows other bilateral borders in Europe. This symbolical importance is underlined by the existence of the French-German University, a financial tool supporting the collaboration of tertiary education providers in both countries.

The lack of research on CBC of elementary schools, however, does not mean the absence of such cooperation. There are even more or less formalised cross-border associations of schools: Standing Conference on Teacher Education, North and South (SCoTENS) gathering 34 colleges of education, university education departments, teaching councils, curriculum councils, education trade unions and education centres on the island of Ireland with a responsibility for and interest in teacher education; the Swiss-French-German association TRISCHOLA attempted to promote bilingualism in the Upper Rhine Valley; the trilateral Schkola Association operates in the German-Czech-Polish Euroregion Neisse-Nisa-Nysa, intending to develop togetherness further (SCHKOLA, 2023) in this tripartite region.

We identified certain pieces of research which at least partially touched on the issue of CBC in the field of education in the Czech-Polish borderland. In works focused on the more “western” part of the Czech-Polish borderline, the lower level of cross-border trust results also in inadequate mental preparedness of students to study in the country of the neighbour, as evidenced by a survey with the target group of high school students (Böhm et al., 2019). Böhm (2017) analysed the use of microprojects in the field of education in all Czech-Polish Euroregions. Despite the high level of CBI in the Těšín/Cieszyn Silesia Euroregion, the number of educational projects was low. The CBC of schools is surprisingly more intense in different border transects, mainly in the Euroregions Silesia and Neisse-Nisa-Nysa. Szafrńska (2017) indicated that the prevailing pattern of most of the teachers from the Euroregion Těšín/Cieszyn Silesia, named after the divided Cieszyn/Český Těšín, is non-cooperation across the border. We also found other works focusing on stereotypes and prejudices *vis-à-vis* neighbour in the schools (Ogrodzka-Mazur, 2004), the perception of Czechs by Polish teachers in the divided town (Szafrńska, 2018), or roles of the Polish minority living in the Czech Republic, involving schools with Polish as an instruction language (Gajdzica & Kubiczek, 2012; Böhm, 2017).



Research on textbooks, especially potentially conflicting interpretations of often disputed joint history, could also shed light on the studied matter. When the mutual pictures of neighbours in Polish and Czech textbooks were analysed, however, in the eponymous book in major detail (cf. Gracová et al., 2014), no room was dedicated to the possible contributions of schools towards the creation a joint “living and working space”, except for accent on intercultural understanding.

Since there was a lack of scientific focus on the roles of schools in preparing students for cross-border opportunities in the labour market, we were advised to explore the connections between educational governance and local territorial strategies. One perspective emphasises coordinating educational institutions within a specific area, forming what is known as local educational landscapes. The other viewpoint, rooted in a place-based approach, regards educational institutions as integral to a location's identity and cultural heritage. Researchers studying territorial education governance tend to adopt this place-based approach, giving significant consideration to the interactions between educational institutions, actors, and the unique territory in which they are situated (Jahnke, 2019). Despite this place-based approach being primarily tested to explore the ideal governance of schooling in rural areas, it could be applied when looking at the eventual educational administration of cross-border regions.

### 3. Methodology

#### 3.1 Regional context – divided town of Český Těšín/Cieszyn

The studied towns Cieszyn and Český Těšín were created in 1920 after an armed conflict between newly forming Czechoslovakia and Poland over the Těšín/Cieszyn Silesia with significant Polish presence and the Spa Conference of ambassadors of world powers. The originally integral city Těšín/Cieszyn/Teschén split into two parts, and the Olza River became a national border. Then, the town experienced several rebordering and debordering periods in the last 100 years of turbulent history (Boháč, 2017). One hundred years later, approximately one-fifth of the entire population living in the Czech part of the territory still uses Polish as its mother tongue, and 3,297 of the total 23,436 Český Těšín inhabitants declare Polish ethnicity (CZSO, 2023). Poles in Těšín/Cieszyn Silesia have run their schools with Polish as the instruction language under the auspices of Czechoslovakia/Czech Republic since 1920. No Czech minority is present among 34,297 inhabitants of Cieszyn, according to official statistics (Statistics Poland, 2023). Figure 1 depicts the current map of Cieszyn and Český Těšín and the surrounding region.

Cross-border contacts were maintained in the region after its division. After the wave of democratic revolutions, the two towns started to cooperate more closely. In 1993, regional cooperation between both Cieszyn and Český Těšín was formalised through their mutual agreement. Their successful collaboration contributed to establishing the Těšín/Cieszyn Silesia Euroregion in 1998. Cooperation in the divided town is vital for the operations of the Euroregion (Böhm, 2021).

After the EU enlargement, the EU funds provided a financial incentive for joint development. In 2007, the Schengen area enlargement helped to strengthen cross-border ties in the divided town further. Cross-border commuting started to occur more frequently because the Poles began to take advantage of the higher earnings and available job vacancies on the Czech side of the border (Opiola & Böhm, 2022). The everyday cross-borderness was significantly damaged when free border crossing was restricted due to the COVID-19 pandemic. Yet, the massive protests against the border closures showed that the locals considered crossing the border and having activities on both sides normal and desirable. The research revealed that the actual level of CBI, mainly in the cross-

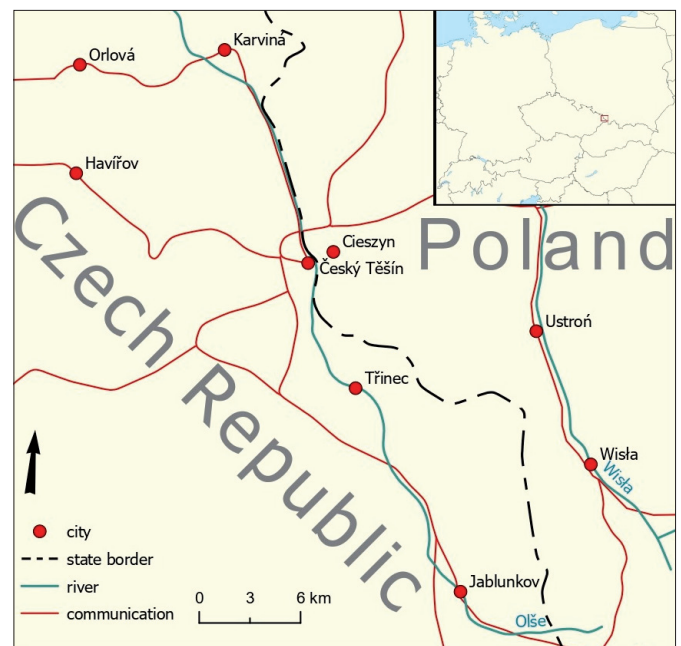


Fig. 1: Location of Český Těšín/Cieszyn at the Czech-Polish border  
Source: authors' elaboration

border labour market, is higher than it was generally considered (Böhm, 2021; Kajta & Opiłowska, 2021; Olszewski, 2021). The papers mentioned above also pointed at a different form of observed cross-border flows/practices: generally speaking, Czechs come to Poland to benefit from the lower prices of goods and services, whereas the Poles cross the border for work and study purposes.

#### 3.2 Methods and data

The research was based on a methodological mix. After the literature review phase, we tried to identify the number of elementary school pupils from one side of the border attending the school on the other side. By doing that, we identified a significant lack of reliable and mainly comparable cross-border statistical data because the Polish authorities responsible for the administration of the school network do not distinguish the nationality of their pupils, while the Czech do. This difference made the acquisition of relevant data rather lengthy (we had to telephone all schools to identify the numbers of Czech/Polish pupils on the other side of the border).

The INTERREG program has helped to initiate thousands of cross-border partnerships. Durand and Decoville (2020) state that its use is a dominant feature for CBC in the “new” Europe. Hence, we analysed the use of the INTERREG program for the partnership of schools and educational institutions in the studied divided town. Special attention was dedicated to using the Small Project Funds, an instrument designed specifically to support “soft” non-investment people-to-people projects.

Initially, we planned to analyse the curricular documents' content (cf. Neuendorf, 2017) of all elementary schools in the divided town, focusing on cross-borderness and perception of the neighbouring country. It turned out, however, that both education systems differ, as every single Czech school must have its curricular document (*Školní vzdělávací program, ŠVP*) following the content of the national curricular document (*Rámcový vzdělávací program, RVP*), whereas the Polish national curriculum (*Podstawa programowa*) has to be followed by each school in Poland directly – without a need to elaborate its school curriculum, as is the case in the Czech Republic. Hence, we decided to analyse the curricula of schools on the Czech side of the divided town, and the analogical findings regarding schools on the Polish side were obtained in a phase during the focus group meeting.

In the later phase, we designed a questionnaire for the teachers of elementary and high schools from both sides of the divided town (and their immediately neighbouring municipalities). We decided to use the computer-assisted web interview (CAWI), which is part of a methodology based on a questionnaire provided to respondents with a link. Despite initial problems, we gathered 99 responses from the Polish and 55 from the Czech side of the border, which is ca 25% of elementary and high school teachers from both parts of the divided town. We consider this sample to be sufficient for the needs of our research. We believe that the opinions of “non-answering” 75% would not differ substantially.

We also tried to capture whether students of high schools from both parts of the divided town have at least a portion of their social practices on the other side of the border. We did this by means of simplified mental maps (Gould & White, 1968): we prepared a simplified bilingual (Czech and Polish) version of a map of the neighbourhood of the divided town with a set of questions which tried to address various social practices of high school students. We attempted to work with a comparable sample of students. Hence, we attended three comparable schools: one in the Polish part of the divided town (26 students) and two schools in the Czech part: one for the Polish minority in its Czech part, where Polish is the instruction language (24 students), and one with the Czech language of instruction (17 students). In all these schools, we worked with comparable sizes of students. High school students were chosen for this task instead of lower-level pupils because they behave more independently and have more exact ideas about their future.

To obtain as complex picture as possible, we organised a focus group meeting (composed of teachers from elementary and high schools from both sides of the divided town) to verify and complement the validity of the data obtained in the previous research steps. The focus group meeting was attended by 22 teachers and lasted one and a half days.

We organised our work in two phases: during 2022, after the literature review, we worked with the statistics and analysed cross-border projects. We also organised our quantitative survey. In February 2023, we organised a focus group, which led us to the decision to look for further border-crossing patterns, which was done in May and June 2023 in three high schools of the divided town.

#### 4. Results

According to the official statistics (CZSO, 2023; Statistics Poland, 2023), there are six elementary schools in Český Těšín (two of them with the Polish language of instruction in the Czech part) and 10 in Cieszyn. The cross-border flows of pupils are clearly demonstrated in Table 1. It depicts the flow of children between both parts of the divided town. It informs us of several phenomena: there is a clear one-sided residential/study flow in the studied divided town, as the Poles send their children to the schools on the other side of the border – at least 44 children living on the Polish part of the town attend the elementary school in Český Těšín – whereas only one child from the Czech side of the border attends elementary school in (Polish) Cieszyn. During the focus group, participants explained the motivation of such parents:

"In the Czech part of the town in the school with Polish as an instruction language, Polish children benefit from the better quality of education, from the smaller study groups and, moreover,

they learn the Czech language as a bonus, which can help them with later employment in the Czech Republic significantly."

The focus group participants also pointed out that Polish parents generally appreciate the “community approach” in the schools with Polish as an instruction language in the Czech part of the town. This “community approach” is given by the fact that these minority schools are relatively coherent. Moreover, they offer a wide range of extracurricular activities, which last until 5 PM. Moreover, the Polish parents also appreciate the absence of religion in schools in the Czech part of the border.

In the 2020–2021 school year, there were 1,534 pupils according to the last accurate statistics (Statistics Poland, 2023). Given that there were some 1,600 pupils aged 7–15 living in Cieszyn, 44 of them attending the school on the other side of the border still constitute merely 2.75% of the total number. In addition to the pupils, there are also one-way cross-border flows of teachers from the Polish part of the town in the schools with Polish as the instruction language in the Czech part of the town (up to 10 in total, which is ca 4% of all teachers teaching in schools in Český Těšín). These flows are caused primarily by higher salaries in the Czech Republic, but teachers also appreciate better school equipment and organisation of study there.

Additionally, Table 1 demonstrates that some Polish families permanently live on the Czech side of the border. According to the opinions of participants of the focus group, this phenomenon is caused by the better “value for money” of apartments in the Czech part of the divided town.

As mentioned earlier, the introduction of the INTERREG program caused a significant increase in cross-border entities, initiatives and projects. Durand and Decoville (2020) stressed that this CBC incentive is significant in post-communist Europe. Hence, we attempted to analyse whether (and if yes, how big part) INTERREG-funded projects implemented in the studied territory support the CBC in the field of education. We analysed the INTERREG-funded projects in the 2014–2020 programming period, funded in the framework of the Microprojects Scheme in the Těšín/Cieszyn Silesia Euroregion. The Czech-Polish INTERREG program, as is the case for many other INTERREG programs, supports two types of projects:

1. the “major projects” (generally over 40,000 EUR), distributed by the Joint Technical Secretariat in Olomouc; and
2. microprojects (generally up to 40,000 EUR, in the cases of the small infrastructure projects up to 60,000 EUR), distributed by six Euroregions operating in the Czech-Polish borderland – the Euroregion Těšín/Cieszyn Silesia is one of them.

A closer look at the implemented projects showed that education and cooperation of schools are underrepresented topics. In the 2014–2020 period, 226 microprojects were implemented in the Euroregion Těšín/Cieszyn Silesia: 74 of them in the priority axis “Developing the potential of natural and cultural resources”, 145 in the priority axis “Cooperation of institutions and communities” and only 7 (!) in the priority axis “Education and qualifications”. As the priority axis “Cooperation of institutions and communities” also offers a space for cooperation and networking of schools/education institutions, we analysed the list of 145 projects implemented under this priority more closely. It turned out that only 5 out of those projects targetted cooperation

Number of children living in Český Těšín which attend elementary schools in Cieszyn			Number of children living in Cieszyn which attend elementary schools in the Czech Republic
Total	of Polish citizenship	of Czech citizenship	Total
6	5	1	44

Tab. 1: Overview of the number of pupils crossing the border

Source: authors' elaboration based on the data provided by the cities of Český Těšín and Cieszyn

in the field of education. At least one of the project partners was from the other side of the divided town (and immediately adjacent Czech town Třinec).

The above-mentioned overview showed that the most active actors involved in implementing CBC in education are universities (there are two tertiary education providers in the Polish part of the divided town), NGOs, and the Pedagogical Center for Polish Minority Education in the Czech Republic, based in the Czech part of the divided town. The direct involvement of elementary schools (which are represented by municipalities and districts in Poland, as they cannot submit projects on their own, contrary to the Czech Republic) in these projects is minor – only two elementary schools from the Czech part of the divided town, which to an entire or substantial extent teach the Polish minority students living in the Czech Republic, have been involved in more than one project.

The analysis of school curricula on the Czech side of the divided town revealed a striking ignorance of the existence of its Polish side (no mention of the existence of the Polish part of Cieszyn in all researched schools with Czech as the instruction language). The only unsurprising exceptions were schools with Polish as the instruction language with pupils from the Polish part of the divided town, as shown in Table 1. When trying to obtain analogical information about the schools in Cieszyn, we must have relied on testimonies obtained during the focus group. Its Polish participants from vocational schools claimed that they repeatedly work with future employers from the Czech side of the divided town, mainly through visits of representatives of these Czech employers to their schools. Moreover, one of the vocational schools in the Polish part of the divided town concluded an agreement envisaging regular cross-border internships for their apprentices in one of the companies in the Czech Republic, Třinec Iron and Steel Works (Třinecké železářny).

During the focus group, it turned out that there is no institutionalised cooperation in education between both parts of the divided town – which has annually organised many joint sessions of municipal councils, which also implemented joint investment projects and developed many elements of common cross-border leisure-time infrastructure.

“Many years ago, there were two meetings of directors of all schools from both parts of the town, which were aimed at beginning the cooperation... As they were organised formally, it resulted in a purely formalistic exchange, which phased out shortly.”

In the Google-based survey, the teachers were asked whether living in borderlands impacts the formation of attitudes and behaviours of young people. Whereas more than 65% of Polish teachers admitted that this (borderlands) location substantially (and 33% of all respondents claim that it matters to some extent), the teachers from the Czech side answered slightly differently: 40% of them consider living in the borderlands being a critical aspect forming attitudes and behaviours of young people, the majority of respondents, over 58% believe that this impact is limited.

Another explored area focused on the possibility of working and earning on the other side of the border and offered remarkably different answers from both sides. More than half (56%) of Polish teachers say Polish youth often consider working in the Czech Republic. The Polish labour market does not seem attractive to Czech youth, as more than 70% of Czech teachers said that their students rarely choose the opportunity to work in Poland. Hence, we decided to explore this area by looking for important indications of the possible choice of work by young people on both sides of the border.

The results in Table 2 indicate fundamental differences in the perception of several indications regarding the decision to work on the other side of the border. Respondents say higher earnings in the Czech Republic and better social care are important for Polish youth. The physical proximity and accessibility of well-paid jobs are essential pull factors.

The answers of Czech teachers indicate the one-way cross-border flows in the studied region – from Poland to the Czech Republic. The only two answers admitted a possibility of working on the other side of the border: the proximity of the workplace and knowledge of the neighbour's language – given the presence of a Polish minority living in the Czech Republic.

In the final phase of our research, we distributed mental maps to three comprehensive upper secondary schools in a divided town (gymnázium/liceum) – we worked with the same comparable

Motivating factor	Polish teachers	Czech teachers
	(%)	(%)
Higher earnings	92.9	10.9
Better social protection	62.2	0.0
A calmer pace of work and life	42.2	1.8
Desire to get to know other cultures	8.2	27.3
Proximity and accessibility of workplaces	69.4	43.6
Knowledge of the language due to growing up in the border area	18.8	40.0

Tab. 2: Factors determining the decision to take up work in the neighbouring country as reported by elementary and high school teachers. Notes: Multiple choice question. Polish teachers (N = 98), Czech teachers (N = 55)

Source: authors' survey

Type of social practice (place, where a person...)	Share (%) of all respondents who spend at least a part of their social practice in a neighbouring country (CZ or PL only)		
	Cieszyn	Český Těšín (Polish minority)	Český Těšín
Does shopping	0	42	12
Spends a free-time	0	25	0
Feels well	11.1	28	0
Has friends	5.36	25	0
Makes trips	6	50	12
Wants to have a future work	0 (desire to work abroad indicated, without closer specification)	19 (all in Kraków)	0
Wants to have tertiary studies	0	48 (only 10% of respondents have PL as the only opportunity)	0

Tab. 3: Cross-border social practices of high school students from the analysed divided town

Source: authors' survey

type of schools, which prepare their students for future tertiary education. Two of these schools cater to the majority population, while the third focuses on instructing the Polish minority residing in the Czech part of the region. The sample of students included in the study was comparable in terms of size (ranging from 17 to 24 students), age (between 15 and 18), and type of schools, as all three institutions prepare students for tertiary education. Table 3 in our research findings provides information about the extent of the students' cross-border social practices within the neighboring country covered by this study.

The mapping results unequivocally demonstrate that Polish minority upper secondary school students from the Czech part of the divided town engage in a significant portion of their social practices on both sides of the border. In contrast, Czech students attending secondary schools with Czech language instruction limit their cross-border social practices, as expected, to shopping and trips. We initially anticipated that Polish students, particularly those from the Polish Cieszyn area, where many residents work in the Czech Republic, would express willingness to work there. Despite several Polish students expressing plans to seek employment abroad, however, none of them specifically mentioned the Czech Republic as a potential working destination.

## 7. Discussion and conclusions

(Difficultly compiled) statistics confirmed our hypothesis that cross-border flows of elementary school pupils exist but are asymmetric. The total number of commuting pupils corresponds to the size of two school classes. The flow from Cieszyn to Český Těšín is dominant. In contrast, the opposite flow involves only a few individuals and only one pupil of Czech citizenship who is from a mixed marriage. It should be noted that commuting pupils from the Polish part of the divided town attend schools with the Polish language of instruction in the Czech territory. This cross-border school attendance is the case of approximately 3% of all pupils aged 6/7–15 living in the Polish part of the divided town. Although this cross-border (elementary) schooling is not the mainstream pattern in education in the divided town, it cannot be entirely ignored. The parents of involved children are motivated by the perceived better quality of the schools on the other side of the border, smaller numbers of pupils in class, and the chance to master the Czech language too. Interestingly, there are also cross-border flows of Polish teachers employed in (Polish-speaking) schools in the Czech part of the divided town.

This one-sidedness (Poles attending or working in schools in the Czech Republic) of cross-border flows is also reflected in schools' approaches from both parts of the divided town towards their neighbours. Generally speaking, (Czech language) schools and teachers from the Czech part of the border do not reflect their school's unique location in the divided town and still perceive the border as a barrier. It is not the case for the schools with Polish as the instruction language, located in the Czech part of the town, as these schools were established to serve Polish speakers living in the Czech Republic (not only Český Těšín but also surrounding settlements) who self-identify as Poles with Czech passports. Moreover, these schools have pupils from Poland. Despite their curricula reflecting their "Polishness" and the region's cross-border nature, we failed to identify formally anchored measures preparing the pupils of those schools to exploit the labour market in the Polish part of the town. Schools with Polish as the instruction language in the Czech Republic cannot be considered drivers of CBC in education in the region (see next paragraph), which contradicts the second hypothesis. Given the higher salary level in the Czech Republic, it can be stated that the teachers of Polish schools showed more willingness to prepare their pupils for eventual later employment in the Czech Republic. Cooperation attempts are visible between vocational schools from Cieszyn and

Czech industrial companies. These activities are related to the greater willingness of Poles to work in blue-collar positions in the Czech Republic, which are not so popular among Czechs.

We can hardly mention any highly developed feelings of togetherness. In general (maybe for the time being only), schools are significantly less active in CBC in the Euroregion Těšín/Cieszyn Silesia than they should/could be due to the advanced CBI of the entire region. If they already started cross-border projects, they engage in "light" meeting projects. The schools have not yet entered deeper cooperation regarding adapting educational curricula/subjects, although they are located in a relatively well-integrated cross-border region with significant cross-border interactions – including those in the labour market. We also failed to identify any systemic study offer of the language of the neighbour – with the exception of schools with Polish as the instruction language in the Czech Republic.

Despite the town's image of an almost united Czech-Polish territory and the successful laboratory of European integration in Central-Eastern Europe, students and teachers rarely interact with each other. How is this discrepancy possible, given that the studied territory is perceived to be so strongly intertwined and yet we find the opposite in the reality of education? The reasons are manifold, yet the main ones can be seen in the already mentioned one-sidedness of cross-border flows. The current "pragmatic" educational flows reflect the still-existing economic disproportion between Poland and the Czech Republic and the presence of the autochthonous Polish minority on the Czech territory. Such a situation prevents deeper mutual integration (cf. Durand & Decoville, 2020). Another partial reason can be seen in the slight language barrier (especially among ethnic Czechs who fail to understand Polish and even local Silesian dialect), persisting national stereotypes (Hřebíčková & Graf, 2014) exacerbated by the Czech-Polish war Seven-Day War in 1919 (Boháč, 2017), and insufficient public transport cross-border connection between Český Těšín and Cieszyn.

Moreover, it seems that not only schools but also their founders (both municipalities run elementary schools; secondary schools are managed by (the Polish) Cieszyn district and the (Czech) Moravian-Silesian Region) ignore specificities of the divided town and prefer national matters to "place-based expected" cross-border ties in the governance of education – with one exception, the legally-binding existence of Polish minority education in the Czech Republic.

The Polish minority living in the Czech part of the divided town acts as a cooperation bridge (Klatt, 2018). Also, the mental mapping results left no doubt that upper secondary school students belonging to the Polish minority in the Czech part of the divided town actively participate in a considerable amount in their social activities on both sides of the border, confirming that minorities have the "bridge" function (Klatt, 2018).

The Pedagogical Centre for Polish Minority Education in the Czech Republic is the public institution, promoting the mutual CBC in the field of education in the divided town, by the means of organising joint training activities and projects. Except for the Centre, we failed to identify any other (public) institution actively contributing to the CBC of schools. Without the Centre – which was established by the Czech Ministry of Education, with the aim of meeting the needs of schools with Polish language instruction in the Czech Republic, as well as fostering the further development of educational professionals in these institutions – thus not for CBC primarily – the level of CBC would probably be much lower. Despite the Euroregion trying to promote it actively, education is just one of the many fields it covers – and according to the number of projects focusing on the CBC in the education field, a marginal one. Both municipal administrations seem to be relatively inefficient/passive in promoting CBC in the education field.

This text showed that CBC of schools could be a topic that deserves more attention than it has received. Existing cross-border linkages play a vital role in enhancing local resilience of cross-border links, whether it is the movement of labour across borders, which contributes to regional stability and resilience development (Koch, 2021; Laine, 2021), or the expansion of one's "cognitive space" by engaging with the other side to understand the essence of being "local" (Svensson & Balogh, 2021). To this end, further research involving stakeholders responsible for cross-border school cooperation and cross-border education governance is needed.

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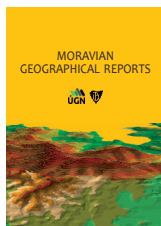
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# The Turów coal mine international dispute as a determinant of the cross-border integration of inhabitants of the Polish-Czech border

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## Abstract

The crisis around the operation of the Turów coal mine and its impact on cross-border relations in the Polish-Czech borderlands is examined in this article. The genesis of the international dispute and its course is analysed on the basis of international relations and border studies theories. Moreover, the specific cross-border relations and asymmetries in the area are studied. Then, the authors discuss the methodology and results of the research through questionnaires and formulate conclusions drawn from the research conducted by the Polish-Czech research team in 2022. The results prove that the nearly two-year Polish-Czech dispute over the Turów mine hurt the cross-border activity of the inhabitants of the Polish-Czech border. Despite alarming media news, this impact was weak and short-lived. It ultimately did not significantly impact the cross-border integration of the inhabitants or cause a deterioration of relations between the Polish and Czech sides of the Euroregion Neisse-Nisa-Nysa. The crisis was caused by the lack of adequate communication between local governments from Poland and the Czech Republic and insufficient commitment from the local and regional authorities. Another cause was the poor integration of residents in the border area, although the cross-border cooperation epitomised by the Euroregion Neisse-Nisa-Nysa is not poorly rated.

**Keywords:** Turów coal mine; international dispute; cross-border integration; Polish-Czech border; Euroregion Neisse-Nisa-Nysa

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## 1. Introduction

About one-third of Europeans reside in border regions, which are subject to several obstacles caused by the barrier function of national borders. Cross-border cooperation (CBC) is a vital tool that can help eliminate these barriers. CBC involves institutionalised cooperation between subnational public actors, with central states defining the terms and conditions for conducting CBC activities (Beck, 2019).

One such CBC entity is the German-Czech-Polish Euroregion Neisse-Nisa-Nysa (ERN), established in 1991 as the first cross-border entity involving members from the former Soviet bloc (Branda, 2009). The core area of ERN is called the Three-border Region. ERN has successfully developed and promoted cross-border partnerships and has served as a model for other such entities. The ERN has also been supported by the Little Triangle, a union of three municipalities closest to the trilateral border point (Zittau, Hrádek nad Nisou, and Bogatynia), and the European Grouping of Territorial Cooperation (EGTC) NOVUM, a Czech-Polish entity gathering five regions with CBC as its core business.

The ERN's success, however, has been tarnished by the bilateral dispute between Poland and the Czech Republic over the Polish lignite mine Turów. Severe effects of mining on the Czech territory have emerged since the 2010s. The conflict began in 2019 when the PGE (*Polska Grupa Energetyczna* = Polish

Energy Group), a Polish state-owned consortium, announced the mining expansion and its continuation until 2044. The dispute escalated in February 2021 when the Czech Republic sued Poland before the Court of Justice of the European Union (CJEU). The conflict was resolved through a bilateral agreement between the Polish and Czech governments in February 2022, with the national level taking the lead in the negotiations, leaving local and regional actors on the sidelines.

In this case, the political situation and atmosphere in Poland cannot be disregarded. The conflict over Turów was just one of many disputes between Poland and the EU bodies. It should also be underlined that the dispute cannot be reduced only to a debate at the level of the government and regional authorities. It offered several additional layers, where NGOs played their important role, as environmental organisations on both sides of the border conducted a coherent social campaign about the Turów power plant at the supranational level.

This article has a primary ambition to identify and quantify the impact of the dispute (and its politically tinged interpretation and media coverage) on cross-border activities, relations, and the trust of people inhabiting the area influenced by the conflict, mainly those from directly affected municipalities in the ERN. A secondary objective is to understand the dynamics of the dispute and its perception on both sides of the border. The added value

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of these goals and possible takeaway for international readership should be seen in the fact that we are analysing activities in the cross-border region, which has been heavily influenced by the presence of nationalist populism narratives, certainly at least in one of its parts.

The paper is structured as follows: after the introduction, in the theoretical part, we first define the international and cross-border dispute, and then we approach dimensions of cross-border integration (CBI), where we underline the importance of cross-border trust and civic engagement, as well as for resilient borderlands. The theoretical part also sketches the influence of nationalist populism narratives in the Polish part of the studied region. Afterward, we detail the development of the dispute and related reporting by the media. In the methodological part, we outline the methods used in our research. Then, we present and discuss findings and formulate main conclusions and a possible interpretation for readers.

## 2. Theoretical background

Our paper views cross-border conflict as contentious disagreements between countries, leading to short- or long-term disputes. This perspective is consistent with prior research conducted by Blatter (2001) and Chilla et al. (2012). The prevalence of border disputes in cross-border conflict (as noted by Popescu, 2008; Schultz, 2015; Vazquez, 2015) has sparked research into the underlying causes of these conflicts, their escalation, and the conditions under which they can be resolved (Meinhof, 2003; Kurnicki & Sternberg, 2016). These conflicts can be analysed and categorised based on different aspects such as intensity, degree of actor involvement, and damage to cross-border assets (Arieli, 2016; Berg, 2018).

A country can sue another country, but there must be common membership of both countries in the organisation that will decide the dispute (Sumner, 2004). The Turów dispute took place between the states of the EU, which has internal mechanisms for effectively enforcing compliance with the judgment. The mine is located in the ERN, where the CBC of subnational actors has been contributing to CBI since 1991. CBI is a complex process contributing to deterritorialisation, which encourages the exploration of soft rather than harder spaces by cross-border planning (Faludi, 2018), based on three dimensions:

1. The functional one is ensured by existing cross-border flows. These can be analysed using the gravitational model in geography and the concept of border effect;
2. The institutional dimension is a result of the involvement of various stakeholders in cross-border structures and projects. Cross-border structures can differ in geographical extent, cooperation intensity and type of involved subjects (Perkmann, 2003); and
3. The ideational dimension illustrates the level of mutual social trust between populations from either side of the border, which can even result in a perception of joint togetherness. This dimension is the hardest to measure.

In addition to sociological surveys, cultural-historical analysis searching for cross-border similarities can be used (Stoklosa & Besler, 2014). The intensity of cross-border contacts is crucial for building strong ideational CBI (Mirwaldt, 2010).

Our article will mainly focus on the ideational dimension, as it makes the difference between CBC groupings in the EU: the Czech-Polish border belongs to the new-new EU border region pattern with the weakest CBI. Generally, it is characterised by low mutual social trust between populations living on either side of the border, the low interpenetration of neighbouring border territories by the people, few cross-border activities, and a high dependency on INTERREG funding (Durand & Decoville, 2019).

The borderline is not a monolith however. The deepest CBI can be observed in the very east of the border, in Euroregion Śląsk Cieszyński/Těšínské Slezsko, with an autochthonous Polish minority on the territory of the Czech part of the Euroregion – acting as a cooperation bridge – and lowest barrier caused by language differences (Böhm, 2023; Pászto et al., 2019). The advanced level of togetherness was observed there in the times influenced by the Covid-19 pandemic when the locals protested against border-crossing restrictions in the divided town Cieszyn/Těšín (Kajta & Opilowska, 2021; Böhm, 2022a). Above-average CBI is also observable in the ERN, where the studied area belongs. ERN has a robust institutional dimension of CBI, resulting from the active role of the ERN involvement in CBC projects. Also, in the ERN, a certain level of cross-border togetherness was manifested by happenings along the (closed) border during the Covid-19 pandemic (Opioła & Böhm, 2022; Novotný & Böhm, 2022). The institutional strength of the ERN is not (yet) fully reflected in the integration of the population (Bohác et al., 2023).

Enhancing mutual trust across borders is a fundamental element of “social capital”, which denotes individuals’ ability to collaborate willingly. Trust arises from shared values and established routines (Anheier & Kendall, 2002). Consequently, individuals who have faith in one another are more likely to cooperate, and the beneficial outcomes of cooperation accumulate as they continue working together. Therefore, trust plays a pivotal role in selecting partners (Zach & Hill, 2017) and serves as the cornerstone for various forms of collaboration (Paldam, 2000). Strengthening cross-border trust has the potential to foster the development of cross-border identity. According to Andersen and Prokkola (2021), individuals’ self-identification is a vital asset and resource for adapting to geopolitical shifts. Cultivating positive emotions and emotional connections with cross-border regions’ “other side” appears significant (Lehtonen & de Carlo, 2019).

In building cross-border trust, the role of civil society is important, as it helps to deepen and extend direct relations between residents living on both sides of the border. The role of civil society and its challenges in the mining industry and energy transition have been extensively described in the literature (*cf.* Öge, 2017 or Aspinwall, 2021), but mainly on a “mono-national basis”. However, only recently, Zuk & Žuk (2022a) proposed to ask whether we can speak of a supranational global civil energy society inspired by the Turów conflict.

The continuous string of crises has emphasised the utmost significance of resilience in advancing border regions (European Commission, 2021; Chilla & Lambracht, 2022; Hippe et al., 2023). The notion of resilience has shifted the emphasis from reactive strategies to proactive approaches that cultivate a comprehensive capacity to rebound from adversity swiftly, effectively adapt to challenges, and endure the enduring strains imposed by crises on individuals and communities (Laine, 2021). As per Boschma (2015), resilience ought to be perceived through an evolutionary lens, considering it an ongoing process rather than a static region attribute. A resilient cross-border region can withstand disruptions in a manner that prevents a complete collapse of CBI progress. For instance, if there is a sudden increase in border control measures or a reduction in opportunities for CBC due to funding cuts, a resilient region will either adapt to the shock and maintain its current level of integration (referred to as an adaptive cross-border region), or it will transform itself by exploring alternative routes of CBC and achieve a higher level of integration (known as a transformative cross-border region) (Makkonen et al., 2019). Despite more attention given to the externally caused shock in the literature on the resilience of cross-border regions, Laine (2021) underlines the need to focus on the internally “slowly-boiled” crisis. The Turów-related dispute can serve as an example of this.



The entire turmoil around Turów did not happen in a political vacuum. The PiS (*Prawo i Sprawiedliwość* = Law and Justice) party, governing in Poland since 2015, is labelled as a right or nationalist populist one (cf. Przybylski, 2018; Varga & Buzogány, 2021). National populism is an ideology that prioritises the nation's culture and interests and promises to give voice to people who feel that they have been neglected, even held in contempt, by distant elites (Martinelli, 2018; Mazzoleni, 2023). For national or right-wing populists, the common enemy is the EU and its bodies, being the example of a remote, bureaucratic elite acting against the interests of the citizens (Mazzoleni, 2023).

The national-populist opposition against supranational powers and the appeal to restore people's sovereignty is strongly connected with a dialectic between territorial de-bordering and re-bordering (Popescu, 2012; Mazzoleni, 2023). Obviously, territorial sovereignty places borders at its core, making anything connected to a state's border or its traversal susceptible to potential politicisation (Scott, 2020).

### 3. The course of the Czech-Polish dispute over the Turów coal mine

Turów coal mine is located in the Bogatynia commune in Poland (see Fig. 1). The pit of the surface mine is currently less than 1 km from the Czech Republic and 200 metres from Germany. The scope of activities of the mine mainly includes mining and enrichment of lignite (KWB Turów, 2023). It is a property of PGE, owned by the Polish state, and due to its crucial role in the country's energy security, it provides around 7% of electricity consumed in Poland. The closure of the mine would result in the almost simultaneous shutdown of the power plant located in the immediate vicinity of the mine, meaning the loss of jobs for over 3,500 employees of the energy complex in Turów and nearly 1,800 people who work in companies cooperating with the PGE. The Turów energy complex is estimated to ensure a stable living for approximately 60–80 thousand people (Centrum Informacji o Rynku Energii, 2021). Moreover, the complex makes Bogatynia one of the wealthiest communes in Poland, although it is not visible at first sight to its visitors. Some parts of the commune and roads seem neglected. The dependence of southwestern Poland on the Turów complex is also evident from socio-economic data showing the smaller number of economic subjects in the surrounding area, which indicates the dominance of the complex as a leading employer (Statistics Poland, 2023). No such significant employer exists in the adjacent Czech borderland, where the economy is more diversified. Other cross-border asymmetries are observed in transport and environmental matters (Boháč et al., 2023). The number of votes

for the PiS party, which is pro-mining, in Bogatynia is traditionally above standard in the context of Western Poland (Państwowa Komisja Wyborcza, 2019).

In March 2020, the Polish Minister of Climate and Environment granted the Turów Mine a concession for extracting lignite in Turów until 2026. This decision was the spark that ignited a dispute that dominated the media space not only in Poland and the Czech Republic but also in the EU, promoting a climate justice agenda. The Czech Republic claimed that Poland violated European Union law by deciding to extend the Turów Mine license. Therefore, in September 2020, it brought a complaint to the CJEU. A complaint was supported by the petition of Czech citizens living near the mine, which the European Parliament and European Commission justified. In the opinion of the Czech Government, the main reason for the action was the negative impact of the mine on the border regions where the groundwater level had decreased, accompanied by problems with excessive noise and air pollution and the long-term discontent of local people and environmental activists. According to research conducted by Czech experts, approximately 30,000 people residing in the Czech part of the border region face a shortage of potable water (Datel & Hrabánková, 2020). In addition, according to the Czech side, Poland could not provide complete information concerning the procedure for issuing a mining permit until 2026. It violated the principle of sincere cooperation resulting from the EU Treaty. Thus, the government of the Czech Republic demanded that mining in Turów should be suspended until the CJEU reached a decision.

In April 2021, Poland demanded the CJEU to reject the Czech Republic's request to suspend production. The Polish side argued that the interim measure requested by the Czech Republic was disproportionate and did not ensure a proper balance of interests, "and its application would expose Poland and its citizens to considerable and irreparable damage" (Teraz Środowisko, 2021).

In May 2021, the CJEU acceded to the request of the Czech Republic and ordered Poland to immediately suspend production at the Turów Mine until the dispute was resolved. Considering the CJEU's decision unfair and impossible to implement, the Polish side refused to stop production in the mine. Consequently, there was a further escalation of the dispute, and the CJEU imposed a fine on Poland of 2.3 million PLN (500 000 EUR) per day starting September 20, 2021. Poland refused to pay the fine, so the EU has written off the final amount incurred by illegal mining between September 20, 2021, and February 4, 2022, from European project money for Poland.

On February 4, 2022, the governments of the Czech Republic and Poland, after several months of talks and negotiations, informed the CJEU of the conclusion of a settlement regarding the Turów Mine. In accordance with the regulations, the President of the CJEU decided to remove the case from the register, thus ending the nearly two-year-long dispute over the mine. The agreement between the governments of both countries assumed the payment by Poland of 35 million EUR in compensation and an additional 10 million EUR from the PGE to the (Czech) Liberec region. Out of the 35 million EUR paid by Poland, the government of the Czech Republic transferred 35 million to a transparent account of the Liberec region, and 10 million remained at the ministry's discretion (Žuk & Žuk, 2022b). The willingness of the Czech government led by Petr Fiala was partly explained by the adherence of his political party to the same fraction in the European parliament as the Polish ruling party. The political opposition and environmental activists criticised the agreement in the Czech Republic. The environmental activists criticised the low transparency accompanying the deal. They claimed that the agreement would not help the Czech part of the territory, and the political opposition declared that the amount paid by Poland should have been higher.



Fig. 1. The location of the Turów coal mine  
Source: authors' elaboration

In the contract, the Polish side undertook, among others, to complete the construction of an underground wall to prevent groundwater runoff from the territory of the Czech Republic, as well as to build a protective wall and other measures to improve air quality in the ERN. Until mining is completed, the contract also provides for monitoring noise levels, air quality, landslides and groundwater levels. Part of the funds received from Poland was to finance monitoring stations measuring various physical and chemical properties and analysing incoming data. The 10 million EUR provided by PGE was to be used to support the financing of local and regional environmental projects under the auspices of the ERN. As a result of the agreement, mining in the Turów Mine will be possible until 2044.

The media intensely publicised the dispute. At first, the Polish press did not pay much attention to the matter, but after the Czech Republic filed a lawsuit with the European Court of Justice, they started covering it four times more than the Czech media. The analysis of the Institute of Media Monitoring (IMM) from Poland showed that the Turów crisis in the period from September 2020 to September 2021 was addressed by journalists representing all types of media in Poland and the Czech Republic nearly 120,000 times (including in social media), in which there were over 75,000 mentions, statements and comments from politicians, experts, citizens or environmental organisations. According to the IMM estimates, every Polish citizen over 15 could see information about the Turów Mine on television, radio, press, and internet portals as many as 72 times and in social media at least once. In the Czech Republic, however, these numbers are 58 times lower in traditional media and six times lower on social media channels (IMM, 2021). It appears that they were reporting on two different Turóws, however: the Polish media focused on the site's significance as the largest employer and a critical energy source for Poland. While they acknowledged the negative impact on groundwater levels, they emphasised that constructing an underground filter wall would resolve this issue. In contrast, the Czech media accentuated the environmental impact, specifically the loss of groundwater and increased noise and dust. Similar findings were revealed by the Czech company Newton Media (2021), which analysed Czech, Polish, and German online media coverage of the dispute from June 2019 to April 2021.

The dispute also had a different civic society engagement layer: NGOs from the Czech Republic, Poland, and Germany collaborated on a joint social campaign against the mine. It took place at the supranational level and involved various activities, such as petitions, demonstrations, media campaigns, legal actions, and lobbying at the European institutions. One of its goals was to support the lawsuit against Poland at the CJEU for extending the mining in Turów without proper environmental impact assessment and public consultation. The Court issued an interim measure that ordered Poland to stop mining until the dispute is resolved.

Another campaign goal was to highlight the absurdity of extending the mining in Turów until 2044, when the EU aims to be carbon-neutral by 2050. The campaign also emphasised the negative impacts of Turów on the water, air and soil quality in the surrounding areas. Greenpeace, Frank Bold, and Stop Turów on the supranational level or Neighbourhood Association Uhelná (*Sousedský spolek Uhelná*) and Together for Water (*Společně pro vodu*) on the local level, supported the Czech struggle. The Solidarity (*Solidarność*) movement, including trade unionists from the Turów energy complex, was a significant pro-mining NGO on the Polish side (Boháč et al., 2023).

#### 4. Basic research assumptions and methodology

Our study primarily delved into the functional and ideational aspects of CBI. The impact of the Turów crisis on CBI's institutional dimension was not within the scope of this paper, as

it had been analysed by Kurowska-Pyss et al. (2022). In terms of operationalising CBI for our research, we grounded the ideational dimension by measuring spatial cross-border interactions, ideally through direct inquiries about relationships with individuals from neighbouring nations. To achieve this, we conducted a survey to track the percentage of individuals who frequently visit friends or family across the border. Additionally, our conclusions were informed by a broader understanding of cultural-historical factors in the studied region, such as the history of population exchange, border permeability, and linguistic similarities. When examining the functional dimension of CBI, our focus was primarily on the overall cross-border movement of people. The frequency of border crossings, as indicated by the survey, served as an indicator of the functional dimension for various reasons mentioned in the study. Also, the data on traffic intensity can be telling. Nevertheless, official public institutions focused on transport do not measure traffic intensity on the borders. That is why we present the data from Drápela and Bašta (2018) in the conclusions.

We acknowledge the limited validity of the data obtained from our central survey. Unfortunately, there is no centralised data available for cross-border commuting and other aspects of CBI. To compensate for this gap, we present the cultural-historical and transport findings, along with previous research results from Kurowska-Pysz et al. (2022) and Siatkowski et al. (2022), conducted within our project team (refer to the Acknowledgment section) as additional resources. Our research involved 15 anonymised, in-depth, semi-structured interviews with representatives from Czech offices, institutions, organisations, and local businesses, as well as 15 interviews with their Polish counterparts and beneficiaries engaged in CBC projects in the ERN. In total, 35 questionnaires were administered to individuals in both the Czech and Polish groups. The sampling for this research was purposeful.

It was assumed that the dispute over the Turów mine (at the central level – between the governments of Poland and the Czech Republic) had a significant, negative impact on the CBI of the inhabitants of Poland and the Czech Republic at the local level. Several heated protests of Czech environmental activists or trade unionists from the Turów Mine on the Czech-Polish border between Hrádek nad Nisou and Bogatynia supported this assumption. One of the medialised climaxes of the tension was when Alaska pub in Bogatynia put up a sign "We do not serve Czechs". Therefore, the unsurprising hypothesis was adopted that the escalation of the dispute between the Polish and Czech governments over Turów negatively impacted the CBI of the inhabitants of the ERN.

To test the research hypothesis, latent variables were placed in the structural equation model (SEM). SEM analysis was performed based on the factor model estimated by the principal components method in correspondence with the results obtained, which did not assume the elimination of any variable. The structural equation model is depicted in Figure 2.

To verify the hypothesis, a quantitative survey with local inhabitants was conducted involving a group of 330 people – residents of the Polish and Czech sides of the ERN, in 2022. 500,555 people inhabit the Polish side of the ERN, while the Czech side is inhabited by about 425,000 (CZSO, 2021b). The proper sample size (representative of the entire population of the ERN) was calculated based on the sample selection calculator, assuming a maximum error of 5% and a confidence level of 95%. Due to the lack of a suitable sample size, the deliberate selection of units for the sample was justified (the sample included people living in both the Polish and Czech sides of the ERN, in particular, people familiar with the problem of the dispute over the Turów Mine). Many efforts were made to ensure that the research sample, in terms of such characteristics as gender, age and education, was the best possible representation of the entire population affected

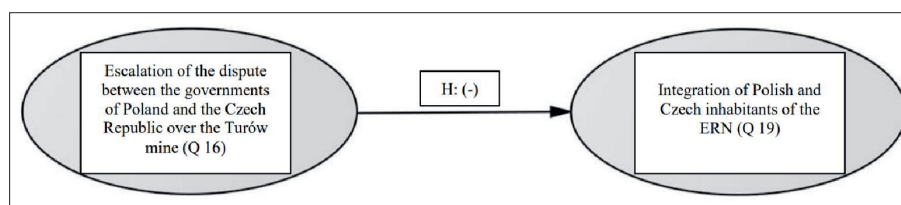


Fig. 2: Hypothetical-deductive model

Source: authors' conceptualisation

by the Turów problem. The main survey was carried out in the Bogatynia commune (21,891 inhabitants) (Statistics Poland, 2023), and on the Czech side, it covered the inhabitants of the following municipalities adjacent to Bogatynia and experiencing the adverse effects of mining: Hrádek nad Nisou (7,704 inhabitants), Chrastava (6,260), Heřmanice (260), Kunratice (354), and Višňová (1,353) (CZSO, 2021a). Considering only the affected area, the sample is even more representative.

The data were collected using a standardised paper questionnaire in the first half of 2022 after reaching the Czech-Polish agreement. 400 respondents took part in the survey. Following verification, incomplete and erroneous questionnaires were rejected. Ultimately, this resulted in 330 correctly completed questionnaires (194 questionnaires were filled in by the respondents on the Polish side, 136 by the respondents on the Czech side). Women constituted 58.18% of the sample, and men 41.82%. The most numerous groups of respondents were people aged 45–54 (27.69%) and 55–64 (18.46%). The majority of the respondents were respondents with secondary education (54.29%), and 22.09% were people with vocational education (see Tab. 1).

Characteristics		Share (%)
Gender	Females	58.2
	Males	41.8
Age (years)	18–24	13.9
	25–34	10.4
	35–44	16.6
	45–54	27.7
	55–64	18.5
	65 or more	12.9
Education	Primary	3.7
	Trade school	22.1
	Secondary	54.3
	Higher	19.9

Tab. 1: Personal data of the respondents

Source: authors' survey

Component	Please indicate to what extent you agree with the following statements.
Q_16.1	The dispute over the Turów Mine weakened the ties between Poles and Czechs
Q_16.2	The dispute over the Turów Mine made me stop seeing the area on the other side of the border (Poland/Czech Republic) as a place I would like to visit
Q_16.3	The dispute over the Turów Mine caused me to stop being interested in the problems of my neighbours (Poles/Czechs) living on the other side of the border
Q_16.4	The dispute over the Turów Mine caused me to lose faith in the sense of further development of Czech-Polish relations
Q_16.5	The dispute over the Turów Mine made me realize how much divides Poles and Czechs

Tab. 2: Components for measuring the impact of the dispute between the Polish and Czech governments on the perception of Czechs by Poles and Poles by Czechs. Source: authors' research

Component	What, in your opinion, is the impact of the dispute over the Turów Mine on local cross-border activity in the areas listed below
Q_19.1	Poles working in the Czech Republic
Q_19.2	Czechs shopping in Poland
Q_19.3	Poles travelling to the Czech Republic for tourism
Q_19.4	Czechs travelling to Poland for tourism
Q_19.5	Business contacts between Poles and Czechs
Q_19.6	Czech-Polish social contacts (e.g. between local governments, firefighters, sports clubs, social clubs)

Tab. 3: Components for measuring the cross-border integration of border residents in the ERN

Source: authors' research

In order to discern the impact of the dispute between the Polish and Czech governments on the perception of Czechs by Poles and Poles by Czechs, respondents were asked to respond to 5 statements on a 5-point Likert scale, ranging from "I strongly disagree" to "I strongly agree" (Tab. 2). The statements used to measure the impact of the dispute between the Polish and Czech governments on the general perception of Czechs by Poles and Poles by Czechs (5 statements in total) were developed based on individual in-depth interviews with experts professionally dealing with the issues of Czech-Polish relations. To capture the degree of integration of the Polish and Czech inhabitants of the ERN, the respondents were asked to respond to an additional 6 statements, also using the Likert scale (Tab. 3). The analyses used a combination of exploratory and confirmatory statistics. We detail our approach in the Appendix.

## 5. Results

The central hypothesis (H) assumes that the escalation of the dispute between the Polish and Czech governments over the Turów Mine harms the CBI of the inhabitants of the ERN. As a result, along with the increasingly negative perception of Czechs by Poles and Poles by Czechs (caused by the dispute between the governments of Poland and the Czech Republic), the tendency of borderland residents to participate in local cross-border activities indeed decreased. The parameters of the estimated model are presented in Table 9 in the Appendix.

The values of all measurements of the goodness of fit prove that the theoretical model was well-adjusted to the empirical data. Finally, the model correctly implies the actual structure of the variance-covariance matrix between the analysed components of the construct. The path model with the estimated coefficient (standardised coefficient) is depicted in Figure 3.

It can, therefore, be said that, in the opinion of Poles and Czechs, as the respondents' degree of agreement as to the negative impact of the dispute over the Turów Mine on the relationship

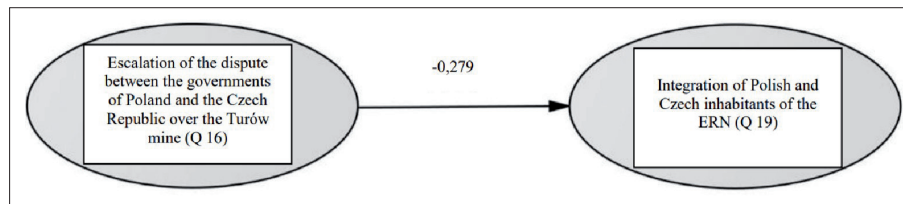


Fig. 3: Model with estimated coefficients – Poland and the Czech Republic  
Source: authors' research

between Poles and Czechs increased, the more negatively they assessed the local cross-border activity in the areas mentioned in the study, thus confirming the adopted research hypothesis. The perception of Poles by Czechs and Czechs by Poles as a result of the intergovernmental dispute between Poland and the Czech Republic about the Turów Mine deteriorated, which harmed the already relatively weak CBI of the inhabitants of the ERN. The estimated parameters of the research model prove that the effect is weak (the standardised regression coefficient is  $-0.279$ ) but statistically significant.

The frequency of crossing the Czech-Polish border by the surveyed inhabitants of the ERN with an indication of the purpose of crossing the border is presented in Table 4.

The most common reason for Czech respondents crossing the border is shopping – nearly 28% of respondents used this very often and often option, followed by travel (transit). Lower prices of food and petrol cause the popularity of the Polish borderland for shopping among Czechs. Polish respondents most often cross the border in connection with foreign travel (transit) and for tourist reasons (sport/tourism). Tourist and sport reasons are connected to the lack of tourist attractions and advanced sports facilities in Bogatynia.

Cross-border flows within the functional dimension of CBI in the Three-border Region are very pragmatic and basic. Crossing the border because of work, business, healthcare, and education is very rare. Crossing the border because of family or friends, which can strengthen the ideational dimension of CBI, is rare.

Additional research showed interesting data. Polish representatives, during interviews, denied any detrimental impact, a sentiment echoed by most Czech counterparts. Their

perspectives diverged significantly, however, regarding the roots of the conflict. Polish representatives attributed it to external factors, alleging it was artificially created by the Czech central authority, influenced by the 2021 parliamentary elections and the efforts of the Andrej Babiš government to sway the Czech electorate, exacerbated by media coverage. In their view, Polish environmental negligence played a secondary role. On the other hand, Czech representatives believed the conflict stemmed from Polish non-communication, obstructionist behaviour, and the absence of constructive proposals across various hierarchical levels, as Siatkowski et al. (2022) documented.

According to the observations from individuals within the CBC entities in the ERN, the negative impact of the Turów dispute on CBC and CBI was limited, with slightly more significant repercussions felt on the Polish side (see Tab. 5). No noticeable adverse effects on their project teams' and partnerships' interpersonal relationships were revealed. According to the CBC project beneficiaries, the most significant (rather negative) impact was obvious in general neighbour relations between Czech and Poles in the studied region.

## 6. Discussion and conclusions

The Turów-related conflict was not the first Czech-Polish intergovernmental conflict. Importantly, not all disputes were a disintegrating factor on the Czech-Polish border. An example of this kind of dispute may be the 1988 conflict over the construction of a coking plant in Stonava (a municipality in the Śląsk Cieszyński/Těšínské Slezsko Euroregion, close to the Polish border). The chain of events triggered by the decisions on this investment, both at a central and local level, including mass protests, was something

Reason for crossing the border	Very often (%)		Often (%)		Rarely (%)		Very rarely (%)		No crossing (%)	
	PL	CZ	PL	CZ	PL	CZ	PL	CZ	PL	CZ
Family/Friends	3.8	0	10.9	7.6	11.4	7.6	7.6	5.9	66.3	78.8
Work	7.1	0	1.1	3.5	1.1	9.7	1.6	3.5	89.1	83.3
Business	1.1	0.9	1.1	5.3	2.2	0.9	6.0	7.1	89.6	85.8
Shopping	1.1	3.3	6.5	24.6	16.3	28.7	26.6	27.1	49.5	16.4
Learning (education offer)	0	0	2.2	1.7	2.7	5.2	1.6	12.9	93.5	80.2
Healthcare (medical services)	0	0	1.1	0	3.8	0.9	8.2	6.3	86.9	92.9
Culture/Entertainment	3.3	0.9	8.7	1.8	11.9	9.0	25.0	27.0	51.1	61.3
Sport/Tourism	8.6	0	15.1	7.0	20.5	21.9	26.0	31.6	29.7	39.5
Journey (transit)	10.6	8.6	14.3	8.6	26.5	19.8	22.8	26.7	25.9	36.2

Tab. 4: Main reasons for crossing the Czech-Polish border by the surveyed inhabitants of the ERN. Source: authors' research

Reason for crossing the border	Very negative (%)		Rather negative (%)		Neither (%)		Rather positive (%)		Very positive (%)	
	PL	CZ	PL	CZ	PL	CZ	PL	CZ	PL	CZ
Good neighbour relations between Poles and Czechs on the border	5.7	13.5	40.0	30.0	51.4	56.8	2.9	0	0	0
People-to-people contacts in Czech-Polish teams that jointly implement cross-border projects	0	2.7	11.4	18.9	82.9	75.7	2.9	2.7	2.9	0
Communication between Polish and Czech partners in cross-border projects	0	0	17.1	10.8	77.1	86.5	5.7	2.7	0	0

Tab. 5: Comparison of assessments regarding the impact of the Turów dispute on the aspects of Czech-Polish cross-border cooperation and integration. Source: Kurowska-Pysz et al., 2022 (modified by the authors)

new for the Czech-Polish border. As a result, the decision to build was suspended (Wróblewski, 2020). In 2003, the construction of a coal-fired heating plant in Stonava, Czech Republic, began again. The decision to commence the investment was carried out in secrecy. The information finally appeared in the Polish press, however, which caused concern among local communities on the Polish and Czech sides of the border. Protests were organised, there were diplomatic interventions, and alarmist petitions were sent. Polish expert opinions warned that contamination standards might be exceeded periodically in the Moravian Gate, the Beskydy Mountains, and Upper Silesia. Czech ecologists also became active as it turned out that 90% of pollutants from Stonava would settle within 3.5 km of the heating plant (mainly in the territory of the Czech Republic). The disputes over Stonava, however, were significant not only because of the ecological emotions that often accompany investments in the energy sector. Their rank and importance resulted from the fact that, for the first time in the history of Czech-Polish contacts, these disputes broke the mutual isolation of local border communities. An utterly unique structure of the actors in this conflict was formed, as the regional civic circles from the Czech Republic and Poland stood against political authority. Thus, Czech-Polish intergovernmental disputes over Stonava had a character that integrated the local community on the border.

The research conducted in the ERN area shows that the Turów crisis was different, however. It was confirmed that the emotions felt during this intergovernmental dispute did not significantly translate into integrating local communities on both sides of the border. The crisis was more similar to the Temelín crisis between the Czech Republic and Austria (Fawn, 2006) by dividing local communities on both sides of the border and involvement of the EU. The analyses and calculations carried out within our research indicate that the impact on integration was negative. The negative effect on the CBI of local communities was relatively weak, however, and incidents mentioned among basic research assumptions were sporadic.

Additional research showed that Czech and Polish representatives did not notice any changes in Czech-Polish relations during the Turów dispute. Still, they had different opinions about the causes of the Turów dispute. Contrasting viewpoints reduced the possibility of reaching an agreement at the regional level. CBC project beneficiaries, unlike representatives, pointed out the slight deterioration of Czech-Polish relations during the crisis and no major problems within their practical CBC. These diverse findings (Kurowska-Pysz et al., 2022; Siatkowski et al., 2022), obtained through different research methods, paint a multifaceted picture of the Turów crisis's influence on CBI.

The negative effect could have been stronger if the research had been conducted earlier when the dispute peaked. The Czech-Polish agreement on Turów was acceptable to the Polish side, so the Polish population could consider it a victory. That is probably why relations with Czechs were no longer so tense. The effect of cross-border disputes on CBI is not much studied in the scientific literature. Mirwaldt (2010) applied the contact theory to border studies and found the connection between intensive cross-border contacts and positive cross-border citizen relations. We also found a correlation between the intensity of cross-border contacts and cross-border citizen relations, which can be perceived as an ideational dimension of CBI.

The course of the dispute showed the brutal political realism of the Polish government and regional government, preferring energy and job security, which disregarded environmental protection and peaceful neighbour relations. The Polish approach coincides with its illiberal policies of the last years, conflicting with the EU's social, economic and political ethos (Szent-Ivanyi & Kugiel, 2020). Polish Turoszów Basin residents adopted the attitude of energy

nationalism and seemed reluctant to accept any changes in the region (Žuk, 2023). The more considerable involvement of Poles in the dispute was also reflected in the higher participation of Polish respondents in social action/demonstrations connected with the conflict, as almost a quarter of Polish respondents (24%) took part in them. In contrast, the participation on the Czech side was four times lower. In the end, participants declared a certain level of tiredness, claiming that the conflict could have been resolved much earlier without the intervention of the CJEU.

Initiatives led by the ERN to mitigate the effects of the dispute were relatively little known by the inhabitants on either side of the border. Almost half of the respondents from the Czech side and 70.4% of Polish residents heard about local social consultations regarding resolving the dispute over the Turów Mine. Still, their participation in social talks was minimal. They had little knowledge about the organisers and did not know the local actions that were designed to alleviate the dispute. Therefore, it can be concluded that despite many cross-border projects, often implemented by Polish and Czech public institutions (including local governments) or third-sector organisations, ideational integration and mutual trust should be more advanced in this particular border area, which, despite the institutional strength of the ERN (especially the Czech part), belongs to the new-new EU border region pattern (Böhm et al., 2023).

There was no sincere dialogue between the main actors in the dispute at the local or regional levels. The attitude of the ERN, an entity run by three national secretariats, cannot be described as mutual communication. Whereas the Czech secretariat at least tried to engage in discussions, the Polish one instead pretended that no dispute existed. Hence, we believe that both "covidfencing" (Medeiros et al., 2021) and the Turów dispute have effectively highlighted the limitations of the current ERN based on the collaboration of three distinct legal entities. It would be a logical step to establish an EGTC, which would undoubtedly compel CBC actors to work together in a more coordinated fashion.

Current social weak ties visible from the table depicting the ideational level are the product of many factors. We should mention the existence of a border that was little permeable in the past (especially during the Socialist era), the absence of historical ties with an influx of people unrelated to the region (the Polish part was inhabited by a new population after World War 2 and in the Czech part, approximately 90% of people were newcomers) poor knowledge of the neighbours' language (despite the languages belong to one Western Slavic language branch) (Böhm, 2022b), the entrenchment of national stereotypes and historical traumas (Hřebíčková & Graf, 2014), and preference of national matters over cross-border ties (Boháč et al., 2023). Despite the implementation of many cross-border projects between the inhabitants of both countries, a clear division between the Polish and Czech communities is still visible, which prevents narrowing the mutual cognitive distance between both communities (van Houtum, 2000). The "us and them" effect – identified in all research phases – indeed fed the mutual mental distance and reduced cross-border trust between people. It also contributed to extending the "indifference bandwidth" (Spierings & van der Velde, 2013). The only examples of initiatives held as a reaction to the dispute, which tried to expand its own "cognitive space" by involving the other side in the "joint local" (Svensson & Balogh, 2021), were those organised by environmental NGOs. These NGOs are, however, with one example, based outside of the ERN.

Data from the studied area are available in the article measuring border effect in the Three-border Region (Drápela & Bašta, 2018). Border effect documents the functional dimension of CBI. These data are old, and the situation has slightly changed due to increased Czech demand for food and gasoline from Poland, but they can serve as an illustration. They show a significant border

effect between the Czech Republic and Poland in the studied region (specifically on the roads between Frýdlant and Bogatynia or Habartice and Zawidów in comparison to the roads connecting the Czech Republic and Germany), which is caused by the above-mentioned weak social ties and poor transport infrastructure (especially on the Polish side of the border).

CBI is a multi-stage and extended process. It must reach a stage, however, where a sincere dialogue and mutual, constant contact between Poles and Czechs will make the community living in the cross-border area more coherent and harmoniously functional. Thanks to this, in the future, disputes will be able to be resolved much faster at local or regional levels and not at the central level or on the EU forum. The emergence of new and difficult-to-solve situations may result in temporary local conflicts that disrupt the current integration shape. In such cases, however, it is to be hoped that as a result of the long-standing contact and cooperation of the inhabitants of the cross-border area and their mutual consolidation that has occurred due to conflict situations, everyone will strive to solve them quickly. The research shows that such a situation did not happen in the ERN, however. Therefore, the CJEU was involved in resolving the dispute. Only then, despite many adversities, differences of opinion, divergent interests or ignoring the other party's arguments, the controversy over the Turów Mine was terminated.

Notably, the Turów dispute suggests that border regions can be viewed as spatial circumstances that can be leveraged for populist mobilisation within multifaceted governance contexts (cf. Mazzoleni, 2023). This card has been played by the Polish PiS party also a long time after the conclusion of the bilateral agreement, as it started its election campaign with a rally in Bogatynia in May 2023, applying clear “defending our interests” rhetoric. The research outcomes also advise that populist-nationalistic narratives influence cross-border social practices, at least to some extent, and are a challenge for resilient CBI.

We believe that our results may constitute a starting point for further research on stimulants and de-stimulants in the process of CBI of the inhabitants of the Czech-Polish border. The challenges arising from the dispute can catalyse personal and societal development, presenting an opportunity for transformation. By embracing these adversities, individuals and communities can develop resilience, allowing them to adapt and flourish amidst persistent change and uncertainty (Shaw, 2012). It is also worth asking whether this conflict can facilitate the construction of a supranational civil energy society.

Poland is a prominent lignite producer in Europe, contributing 46 million tonnes annually, constituting 20% of the EU's total production. The country's energy infrastructure heavily relies on lignite. The Czech Republic, a significant lignite extractor with an annual output of 29 million tonnes, maintains a more considerable energy diversity (data for 2020 – Eurostat, 2021). The lignite mines in the Czech Republic are not located in the immediate vicinity of borders, so they do not cause cross-border tensions and their adverse effects are felt by Czech citizens. Both countries have ambitious official plans to transform their energy sector within the adaptation to the EU regulatory requirements related to the 2030 climate and energy targets, the European Green Deal and the pursuit of climate neutrality tied to the Paris Agreement. The transition in Poland and the Czech Republic, however, would be complicated if we consider their current state compared to the EU average energy situation (e.g. types of energy sources, the share of renewable energy, the share of emissions coming out of the energy sector).

Therefore, our research also indicates other than cross-border consequences: the conflict around Turów may be a symbol of both tensions and challenges related to energy policy that will occur in the coming years with limiting the import of fossil fuels

from Russia or other controversial countries and general energy transition in the EU. In this sense, this dispute has also revealed the semi-peripheral and possibly backward nature of the energy model existing in post-communist EU member states, mainly those from the Visegrad Group (Žuk et al., 2023).

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## Appendices

First, an analysis of the reliability of the component used to measure the perception of Czechs by Poles and Poles by Czechs in connection with the dispute was carried out. It was done using SPSS software and the "Reliability analysis" module. As the analytical model, Cronbach's alpha internal consistency model was selected based on the average correlation between the scale items (Timm, 2002) – in the case analysed, this was 0.854. The result is satisfactory, and further analysis did not show that removing any item would significantly increase Cronbach's alpha value. The next stage was exploratory factor analysis performed using the principal components method and Promax orthogonal rotation using SPSS software (Konarski, 2015). The Kaiser-Meyer-Olkin (KMO) sample adequacy coefficient was 0.825. A KMO coefficient of 0.825 indicates that there are grounds for factor analysis. Similarly, in the case of the Bartlett sphericity test – the hypothesis of the individuality of the correlation matrix between the statements can be rejected. Assuming that the 5 statements analysed constitute a single factor, it was observed that this explains 64.151% of the variability of the input data set. Thus, reducing the 5-dimensional set to a single, hidden factor results in the loss of 35.849% of the information. Assuming that the variables for which factor loadings exceed 0.5 (in terms of a module) should be selected, the final matrix of factor loadings is presented in Appendix 1.

Component matrix	
Component	Component 1
Q_16.2	0.879
Q_16.3	0.841
Q_16.5	0.824
Q_16.4	0.822
Q_16.1	0.610

Factor extraction method – principal components.  
a. 1 – number of extracted components.

Appendix 1: Matrix of factor loadings  
Source: authors' research

The information in Appendix 1 shows that all the variables have high positive value factor loadings on the factor analysed, which is the desired result. Then, the reliability of the components used to measure the degree of CBI of Polish and Czech inhabitants of the ERN was analysed. The software used, and all assumptions are the same as in the case of the previously discussed component used to measure the perception of Czechs by Poles and Poles by Czechs in connection with the dispute. The system used to measure the CBI of the inhabitants of the ERN consisted of six test items. For such a set of questions, Cronbach's alpha coefficient is 0.916. The result is satisfactory, and further analysis demonstrated that removing any item would not increase Cronbach's alpha value. Reliability analysis showed that all items in the summary scale strongly correlate with it (above the level of 0.6). It follows that in further research, all analysed statements should be used. In the next step, factor analysis was performed. The sample quality is as follows for the six statements making up question 19 (Appendix 2).

Kaiser-Mayer-Olkin and Bartlett tests		
KMO measure of sampling adequacy		0.897
Bartlett's sphericity test	Approximate chi-square	1061.604
	Degree of freedom	15
	Relevance	< 0.001

Appendix 2: KMO test and Bartlett sphericity test  
Source: authors' research

The KMO coefficient of 0.897 indicates that there are grounds for factor analysis. Similarly, in the case of the Bartlett sphericity test – the hypothesis of the individuality of the correlation matrix between the statements can be rejected. The obtained results indicated that they fit with the data – none of the scale items were eliminated from the analysis. Considering the degree of explanation of the variability of the input set of variables, it was possible to detect one factor explaining 70.81% of the information for the full set of 6 observable variables. Thus, reducing the 6-dimensional set to a single, hidden factor results in the loss of 29.19% of the information.



Assuming that the variables for which factor loadings exceed the level of 0.5 (in terms of a module) are selected, the final matrix of factor loadings is shown in Appendix 3. The data shows that all the variables have high positive value factor loadings on the factor analysed, which is the desired result.

Component matrix	
Component	Component 1
Q_19.3	0.897
Q_19.4	0.893
Q_19.2	0.829
Q_19.5	0.820
Q_19.1	0.814
Q_19.6	0.789

Factor extraction method – principal components.  
a. 1 – number of extracted components.

Appendix 3: Matrix of factor loadings  
Source: authors' research

The information in Appendix 4 shows that the opinion of the dispute (question 16) harmed the CBI of the inhabitants of the ERN. The relationship is statistically significant and weak (at the level of -0.279). Appendix 5 presents the measures of the goodness of fit of the model fit. The values of all measurements of the goodness of fit prove that the theoretical model was well-adjusted to the empirical data. Finally, the model correctly implies the actual structure of the variance-covariance matrix between the analysed components of the construct. The path model with the estimated coefficient (standardized coefficient) is depicted in Figure 3.

Component	Model coefficient	Standardized coefficient	Standard error	t statistics	p-value	R-square
Local cross-border activity (Q_19) <-- Opinion on the dispute (Q_16)	-0.232	-0.279	0.057	-4.062	< 0.001*	0.078

Appendix 4: Model coefficients

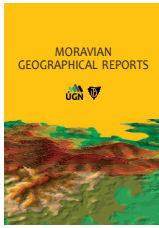
\* Statistical significance at the level of 0.05

Source: authors' research

The goodness of fit measure	Value	Status
CMIN/degree of freedom	1.237	acceptable
RMR	0.034	acceptable
GFI	0.982	acceptable
AGFI	0.957	acceptable
CFI	0.998	acceptable
RMSEA	0.011	acceptable
PCLOSE	0.976	acceptable

Appendix 5: Model goodness of fit measurements

Source: authors' research



# Assessing and forecasting the influence of environmental controls on windstorm disturbances in the Central Low Tatras, through regression models

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## Abstract

Nowadays, the large-scale disturbance and subsequent temporary deforestation of mountain forests are widely discussed phenomena. In this study, we built both a logistic regression model (LRM) and a generalised additive model (GAM), in order to understand the drivers of deforestation after the Elisabeth windstorm (2004) in the Central Low Tatras, Slovakia. A set of topographic and biotic characteristics was selected as explanatory variables, while the presence of deforestation was a response variable. The results show that the most prone to windstorm-driven damage are forests growing at a high elevation, in the ridge's surroundings, and on gentle slopes exposed to the wind during the disturbance. Moreover, the stands with a high proportion of Norway spruce and with medium-diameter trees, which are under forest management, were identified as more vulnerable. Additionally, both models were used to identify those stands, which would be most susceptible to damage by future windstorms. According to its explanatory power and building efficiency, we propose using of LRM rather than GAM in similar large-scale studies. The addressed methods can be used in local forest management, as scientifically based decision-making appears to be crucial for maintaining mountain forests resistant to gusty winds, as well as other disturbing agents.

**Keywords:** driving factors; forest management; mountain spruce forests; wind disturbance; regression models, Slovakia

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## 1. Introduction

In this study, we focused on forests of the central part of the Low Tatras in Slovakia, which were disturbed due to the windstorm Elisabeth in 2004. Besides the well-described role of ecological drivers on windstorm-driven deforestation in the near High Tatras, no similar research has been conducted in the Low Tatras. We used both logistic regression and generalised additive models to evaluate the impact of topographic and biotic factors in this area. Based on related research, the expected impact of topographic and biotic factors has been defined and summarised in the following hypothesis:

- Trees on steep, convex slopes exposed to the prevailing wind direction during the disturbance in the vicinity of ridges are the most prone to windstorm-related damage;
- Forest stands with homogenous species and age structure, with a high abundance of *Picea abies* and with higher trees of medium diameter are most prone to wind disturbances.

Apart from testing these hypotheses, we aim to:

- Compare the performance of the LRM and the GAM using the receiver operating characteristics curve (ROC) and area under

curve (AUC), as well as assess their suitability to evaluate and predict windstorm-driven damage;

- Apply the final LRM and GAM that were trained on 2004 data to the current, up-to-date datasets, and thus, calculate an actual damage probability map.

## 2. Theoretical background

Temporary deforestation caused by extreme wind has always been an integral part of the forest disturbance regime and its circular restoration (Jakuš et al., 2015; Mezei et al., 2017a; White & Pickett, 1985). Despite windstorms not being a recent phenomenon, storm damage increased in Europe during the 20<sup>th</sup> century, mostly due to changes in forest management (Schelhaas et al., 2003). Moreover, wind events may reoccur more frequently in the current century due to climate change, which has the potential to invalidate historical baselines by altering the key drivers of disturbance regimes (Fleischer et al., 2017; Mezei et al., 2017b; Romagnoli et al., 2023). Besides other effects, wind damage to forests leads to carbon losses in the landscape (Seidl et al., 2014) and sometimes increases the risk of bark beetle outbreaks,

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particularly in dominant Norway spruce (*Picea abies* L. Karst) stands (Nikolov et al., 2014). At the same time, windstorms are the most serious, long-term, harmful agents in the forests, followed by bark beetles, whose increased population is also closely related to the consequences of wind disasters (Konôpka et al., 2016).

Evaluation of various environmental controls on the presence of temporary windstorm-driven deforestation is a frequently used and well-applicable approach to study the impact of windstorms on land cover changes in mountain areas. In addition to the models based on machine learning algorithms (Dobor et al., 2020; Schindler et al., 2016), a variety of regression models represent the most preferred methods of understanding the aforementioned impact. Among others, generalised linear models (GLM) (Hanewinkel et al., 2014; Kramer et al., 2001) and generalised additive models (GAM) (Falán et al., 2009, 2020; Schmidt et al., 2010; Suvanto et al., 2019) pose the most effective and frequently used way to uncover relationships between windstorm-driven deforestation and its environmental drivers.

GLMs can simulate linear relationships between the response variable and explanatory variables. In the logistic regression models (LRM), the response variable is binary (Klaus et al., 2011). These models are easy to build and interpret (Suvanto et al., 2019). On the other hand, they cannot capture non-linear relationships. In order to understand non-linear patterns, the use of GAMs is recommended. GAMs estimate relationships between the dependent variable and predictors using a number of smoothing functions (Wood, 2017). However, GAMs are also highly prone to overfitting (Wood, 2008).

Regression models of forest damage are mainly stochastic, meaning their validity is regionally limited (Lanquaye-Opoku & Mitchell, 2005). This limitation is usually a consequence of the usage of low-coverage datasets and the area's microclimatic and topographic disparities.

The response variable entering the aforementioned models is connected to the extent of forest disturbance. Usually, this is described either spatially, as the presence/intensity of temporary deforestation in a coherent area (Kenderes et al., 2007; Krejci et al., 2018), or structurally, as tree mortality on selected field plots (Falán et al., 2020; Seidl & Blennow, 2012). Elevation, slope, aspect, profile, planar curvature, slope position, and landforms have been assessed as the most relevant topographic explanatory

variables in previous studies (Čada et al., 2016; Dobbertin, 2002; Kramer et al., 2001; Krejci et al., 2018; Mayer et al., 2005).

When taking into consideration biotic explanatory variables, the impact of these factors was often evaluated as follows: species structure of the stand (including the proportion of the coniferous species, mainly *Picea abies*), stand age, diameter at breast height (DBH), stand height, stand density, and the vicinity of the unforested (deforested) area (Jalkanen & Mattila, 2000; Klaus et al., 2011; Lohmander & Helles, 1987; Mikita et al., 2012; Očtyra, 2020). Apart from topographic and biotic factors, soil (Falán et al., 2020; Mayer et al., 2005) and anthropogenetic factors (Hanewinkel et al., 2014; Klaus et al., 2011; Klopčic et al., 2009) were investigated as well.

### 3. Data and methods

#### 3.1 Study area

The Low Tatras is an extensive, west-east elongated mountain range situated in Central Slovakia. A major part of the mountain range is protected by the Low Tatras National Park.

The reference study area consists of two plots located south of the Low Tatras central ridge, namely Beňuška (plot A) and Babiná (plot B) (Fig. 1). Considering the specific behaviour of the wind masses in the rugged topography of this mountain range, only the most deforested southern part was selected for this study, specifically two south-directed side ridges and their surroundings. The choice of the plots was based on representativeness assessment, in the sense of spatial patterns of deforested areas, the presence of most typical landforms and the stand structure across the central part of Low Tatras. The size of each plot is approximately 2 × 4 km. There is a west-east distance of 6 km between the plots.

According to the Global Forest Watch data (Hansen et al., 2013), the tree cover of the reference study area was 79% in 2010. Predominant species in both bush and tree layers are *Picea abies*, *Fagus sylvatica*, *Acer pseudoplatanus*, *Abies alba*, *Sorbus aucuparia*, and *Pinus mugo*.

At some locations, species structure follows natural vertical zonation. Most of the landscape, however, was modified by intense logging and subsequent artificial forest restoration, which resulted in a high abundance of *Picea abies* monocultures.

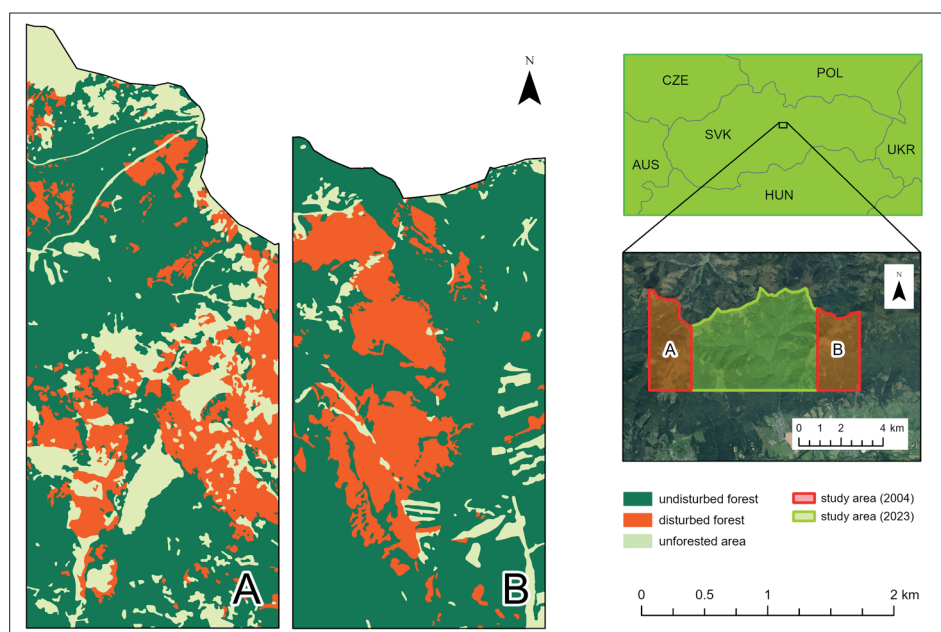


Fig. 1: Presence of deforestation after the Elisabeth windstorm (2004) in the study areas and its locations

Source: Orthophotomosaics of the Slovak republic (2021), provided by the Geodetic and Cartographic Institute Bratislava and the National Forestry Centre

On November 19<sup>th</sup>, 2004, the study area was hit by the Elisabeth windstorm. Wind from the northwest reached a speed of 230 kph (Faltan et al., 2021). Between the years 2004 and 2005, 153 hectares of forests were damaged in the study area (2004) based on the Global Forest Watch. Subsequently, dynamic deforestation continued, as a bark beetle outbreak and related logging occurred.

### 3.2 Data

Variables that reflect both forest damage and could influence the local wind impact by topographic or biotic conditions, were used in the analysis. All of these variables were obtained or derived from a digital elevation model and forestry databases.

The response variable (marked as “DIST04”) was set as binary, thereby distinguishing between “disturbed forest” and “undisturbed forest” (Fig. 1). All the extensive areas of wind stem breakages and trees uprootings, as well as stands with the apparent decrease of tree cover due to windstorm were classified as “disturbed forest”. Creating more categories based solely on aerial photography would have introduced more error (Kenderes et al., 2007). Unforested areas (e.g. meadows, rocks, roads with paved surfaces, etc.) were excluded from further analyses.

The impact of a single natural disturbance, the Elisabeth windstorm (2004), was thus inspected. The presence of temporary deforestation was identified manually, using ArcGIS PRO 3.0. Land cover change detection was based on comparing aerial photography from the years 2002 (pre-disturbance state) and 2006 (post-disturbance state), provided by Eurosense Ltd. The size of the smallest identified area (0.1 ha), the minimum size of change polygons (0.02 ha), as well as the classification of forested areas were set based on the modification of the CORINE Land Cover method for detailed identification of spatial landscape structure by Ořahel et al. (2017).

A set of explanatory variables entering models is introduced in Table 1. Topographic variables were obtained from the digital elevation model “DMR 3.5”. This 10 m resolution open-source DEM completed in 2015, is provided by The Geodesy, Cartography and Cadastre Authority of the Slovak Republic. According to our previous experiment (Šagát & Rusinko, 2022), topographic variables calculated from the more detailed “DMR 5.0” showed lower explanatory power than variables obtained from the “DMR 3.5”.

All the rasters of selected topographic variables were computed in ArcGIS PRO 3.0. ASP takes 8 values, indicating the main directions the slopes face. *NWDIR* was defined as the difference between the actual slope aspect and a 135° direction, and so

it ranges from 0 to 180° (Faltan et al., 2020). Regarding *TPI* (Weis, 2001), original DEM cell values were recalculated as the mean of 500 × 500 neighbour cells. Consequently, *TPI* raster values were obtained as the difference between recalculated and original DEM. Additionally, values were rescaled to 0–100 range, where 0 corresponds to the valley bottom and 100 to the ridge. *TWI* (Kopecký & Čížková, 2010) was calculated using tangent slope and flow accumulation rasters.

Stand variables data were obtained from layers of basic forest management units and the related plans of forest management (PSL), which had been provided by the National Forest Centre. Plans with validity starting from the years 1999 and 2004 were used, to capture the state of vegetation before wind disturbance. Stands with a maximum age lower than 10 years and a height lower than 2 meters were excluded from further analyses. *EUAG* considers two values: even-aged forest (0) and uneven-aged forest (1). Also, *FMR* is binary – “forest under conservation” (0) and “forest under active management” (1). *DBH* was calculated as the weighted average value, taking into consideration the actual tree species proportions. In the case of overlapping descriptions for a single forest unit (frequent occurrence in forests with multiple age categories), *DENS* was used as the weighting parameter in the calculation of other variables.

In ArcGIS PRO 3.0, values of the aforementioned variables were extracted to the grid point layer with a fixed distance of 10 m. Consequently, a randomised selection of observations was performed. Fifteen thousand points were selected for each *DIST04* response state, with a minimum mutual distance set to 20 m. The resulting attribute table was used for further statistical analysis.

### 3.3 Logistic regression model

All observations were divided between training and testing in RStudio 2022.02.0, maintaining the ratio of 80 : 20. A generalised linear model was fitted using the *glm* function in the *stats* package. The family was defined as binomial, and function was set to logit link. All continuous predictors were subjected to a logarithm and square root transformation tests to account for non-linear relationships. Those that showed a lower AIC than models with untransformed variables were included in the final model.

Moreover, we inspected the presence of potential multicollinearity between the predictors (Dormann et al., 2013; Zuur et al., 2010). The *vif* function from the *car* package was used to compute the generalised variance inflation factors (GVIF) (Fox & Monette, 1992). *NWDIR*, *DECX* and *AGE* exceeded the threshold of 4, and were thus removed from the model. Also, these variables

Category	Model variable	Abbrev.	Type	Unit	
Topographic	Elevation	<i>ELEV</i>	continuous	m a.s.l.	
	Slope	<i>SLOPE</i>	continuous	°	
	Aspect	<i>ASP</i>	categorical	-	
	Exposure to NW winds	<i>NWDIR</i>	continuous	°	
	Planar curvature	<i>PLAN</i>	continuous	10 <sup>-2</sup> z unit	
	Profile curvature	<i>PROF</i>	continuous	10 <sup>-2</sup> z unit	
	Topographic Position Index	<i>TPI</i>	continuous	-	
	Topographic wetness index	<i>TWI</i>	continuous	-	
	Biotic	Number of tree species in the stand	<i>SPC</i>	continuous	-
		Even / uneven-aged stand	<i>EUAG</i>	categorical	-
The proportion of <i>Picea abies</i> in the stand		<i>PICEA</i>	continuous	%	
The proportion of deciduous tree species in the stand		<i>DECX</i>	continuous	%	
Maximum age of the stand		<i>AGE</i>	continuous	years	
Maximum height of the stand		<i>HGHT</i>	continuous	m	
The average diameter of the trees in the stand		<i>DBH</i>	continuous	cm	
Average tree density		<i>DENS</i>	continuous	-	
Forest management regime		<i>FMR</i>	categorical	-	

Tab. 1: Explanatory variables entering the generalised additive model  
Source: authors' conceptualisation

weren't used to fit a generalised additive model (see section 2.4). *HGHT* and *DBH* slightly surpassed the threshold, but were kept in the model, considering their importance and mutual relationship causing the multicollinearity. Insignificantly performing variables ( $p < 0.05$ ) were excluded from the final model as well.

As a consequence, the *predict* function from the *car* package was used to estimate values of a testing data frame using the fitted LRM. The prediction type was set to response. Finally, we computed the receiver operating characteristic curve (ROC) and the area under curve (AUC) to assess the model classification ability (Fawcett, 2006). The *roc* function in the *pROC* package was used. Additionally, the *varImp* function from the *caret* package was applied to assess the relative importance of the model variables.

### 3.4 Generalised additive model

Generalised additive model was built in order to inspect non-linear relationships between the response variable and the predictors. In a GAM, the aforementioned relationship is approximated by the means of non-linear smoothing functions (Pedersen et al., 2019).

The GAM was computed using the *mgcv* package and *gam* function. The method of restricted maximum likelihood (*REML*) was applied. The family object was defined as binomial. The number of basic functions computed for the specified basis type ( $k$  value) was selected separately for each variable, taking into consideration the representativeness of the underlying relationship, as well as the computational efficiency (Wood, 2017). The selected value was lower than  $k = 15$ , and lower than EDFs in all the cases.

Model validation was performed similarly, as described in section 2.3. However, the *predict.gam* function in the *mgcv* package was used to predict the *DIST04* values of the testing data frame.

### 3.5 Probability map of a windstorm-driven damage

For the computation of an up-to-date damage probability map (Pawlik et al., 2022; Suvanto et al., 2019), a larger study area was delimited (Fig. 1). The set of used explanatory variables was introduced in section 2.2. Areas not covered by the layer of basic forest management units were defined as unforested and ignored in further analysis. The plans of forest management with validity beginning in the years 2014 and 2019 were utilised to obtain up-to-date stand variables data. Observations with *AGE* < 10 and *HGHT* < 2 were excluded. Again, *DENS* was used as the weighting factor in the re-calculation of explanatory variables, when several descriptions for the same forest unit overlapped. The grid point layer was used to extract the values of the aforementioned variables with a fixed distance of 10 m between the observations.

Damage probability was estimated separately using the LRM and the GAM. For the LRM, the *predict* function in the *car* package was used, while in the case of the GAM, the *predict.gam* function in the *mgcv* package was applied. In both cases, predictions were set to the scale of response (0–1).

As a consequence, predicted response states were assigned to each grid point in ArcGIS PRO 3.0. From these, two rasters were computed, where every 10 m cell corresponds to a certain response state. Finally, cell values of damage probability were reclassified into 10 intervals based on percentiles, so that each category had an even number of observations.

## 4. Results

### 4.1 Drivers of a windstorm-related damage

Similar trends regarding the relationship between the environmental factors and the presence of windstorm-driven temporary deforestation were demonstrated by both the generalised

additive model and the logistic regression. In the LRM, elevation, aspect, forest management category, tree diameter, and the proportion of Norway spruce were the most important variables. In contrast, the significance of the tree height, forest density, age diversity and the number of tree species was marginal.

Our models show that the probability of the disturbance increases with the elevation. According to the GAM, forests growing between 1,200 and 1,400 metres above sea level are the most susceptible. Gentle slopes are more prone to damage compared to the steeper ones. In the case of planar curvature, convex slopes appear to be more endangered. The profile curvature was insignificant in both models. Slopes that are immediately exposed to the wind during the disturbance are the most vulnerable. In our instance, a northwest wind harmed the forests growing on the north, northwest, and northeast exposed slopes. The impact of TPI shows that the damage probability rises with the distance from the valley bottom, with the exception of the immediate surroundings of the ridge. The higher vulnerability of the forest appears to be connected to dry soils (represented by lower TWI).

As for the stand variables, the probability of disturbance increases with the proportion of Norway spruce. Trees of a medium diameter (40 cm) and a height of 25 m are the most prone to damage. Forests of the opened canopy are more vulnerable. Moreover, susceptibility decreases with the number of tree species in the stand. Uneven-aged forests appear to be more susceptible. In addition, higher windstorm-driven damage is expected in forests under active forestry management, when compared to the protected ones.

Effect plots of selected predictors are shown in Figure 2 and Figure 3.

### 4.2 Model comparison and application

The logistic regression model showed  $AUC = 0.80$  on both training and testing data frame. The generalised additive model reached the  $AUC = 0.85$  on training data and  $AUC = 0.84$  on testing data. As a rule of thumb, these values are generally regarded as acceptable. Also, the GAM scored  $R^2 = 0.38$ . Windstorm-driven damage probability maps (Fig. 4) show how input variables synergically affect the risk of a future damage.

## 5. Discussion

### 5.1 Comparison of the logistic regression model and the generalised additive model

According to the values of AUC on both training and testing datasets, the GAM did not perform markedly better compared to the LRM. Nevertheless, it was helpful in understanding the non-linear relationships between the presence of disturbance and some predictors, especially elevation, TPI, and the DBH. Falfan et al. (2020) states the advantages of GAM in interpreting the influence of soil factors on wind disturbances, which were not the focus of our study. Based on the correct classification score, the efficiency of using the GAM remains questionable. It is more time-consuming to construct and more complicated to interpret than the LRM (Suvanto et al., 2019). Moreover, reliability of its results can be easily compromised by overfitting and by the usage of an inadequate number of basic functions computed for the specified basis type (Wood, 2017).

### 5.2 The impact of abiotic drivers on windstorm-driven deforestation

In this case study, both the GAM and LRM showed a positive dependence between values of elevation and damage probability. The same relationship was described by Klaus et al. (2011) and Mikita et al. (2012). Contradictory results were published, e.g. by

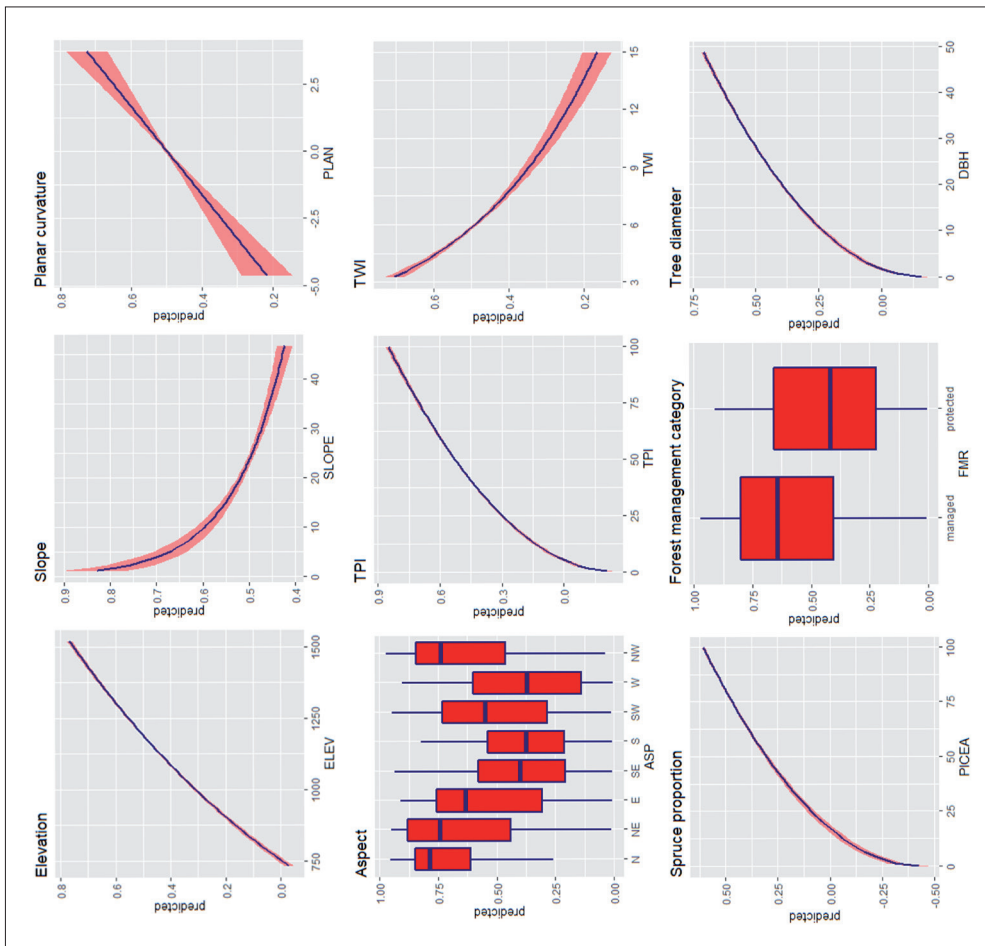


Fig. 2: Logistic regression partial effect plots of the explanatory variables. X axis describes data distribution. Y describes damage probability estimated by the fitted LRM on the test data frame. 95% confidence interval used (red). Only the most important predictors are displayed based on varImp values. TPI- Topographic Position Index; TWI- Topography Wetness Index. Source: authors' calculations

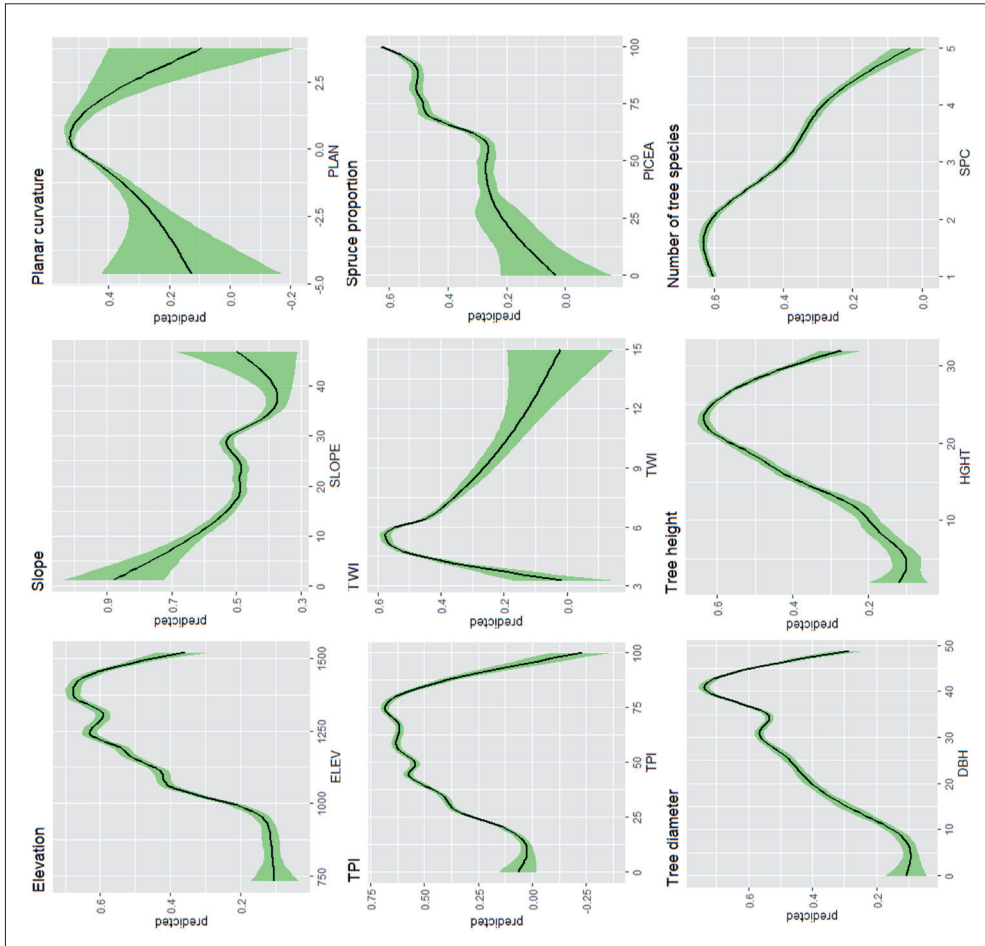


Fig. 3: Generalised additive model partial effect plots of the explanatory variables. X axis describes data distribution. Y describes damage probability estimated by the fitted GAM on the test data frame. 95% confidence interval used (green). All model variables are displayed, except for factor and tree density. TPI- Topographic Position Index; TWI- Topography Wetness Index. Source: authors' calculations

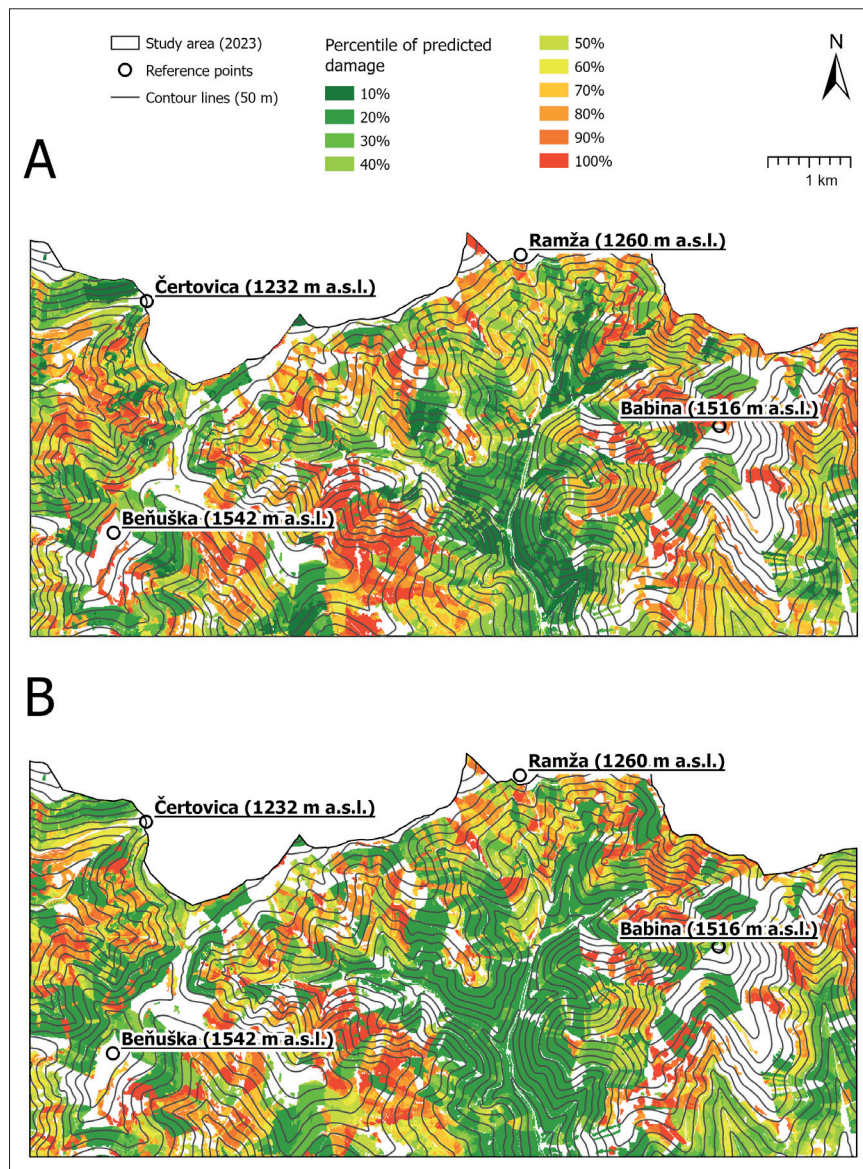


Fig. 4: Windstorm-driven damage probability maps based on the logistic regression model (A) and the generalised additive model (B)  
Source: authors' calculations and elaboration

Minár et al. (2009), while others found this variable insignificant (Dobbertin, 2002; Schmoeckel & Kottmeier, 2008). It must be pointed out that elevation is a proxy variable, reflecting another abiotic control, for instance, higher wind speed (Svoboda et al., 2012). The character of the windstorm, however, as well as the topographic disposition of the study area, must be taken into consideration when interpreting the impact of elevation on deforestation. For example, in the High Tatras, windstorm Elisabeth affected mostly the colluvial slopes with lower elevation, where it took a form of bora — a warm mass of air falling from the High Tatra peaks directly to the basin with embracing speed (Falfán et al., 2009).

According to our models, gentle slopes are more prone to windstorm-driven damage compared to steep ones. Mayer et al. (2005) explain this as a consequence of more intense water logging compared to the steep slopes with a higher runoff, and thus worse soil conditions to fix a root system.

In our case, gentle angles were connected prominently to the ridge's surroundings and initial slopes. Therefore, this relationship can be explained by the aforementioned higher wind speed near the ridges rather than more intense water logging. Different outcomes were reported by Dobbertin (2002) and Ochtyra (2020),

who consider moderate slopes to be the most prone to damage. Larger study areas were inspected, however. Moreover, we tested a tangent slope angle as an alternative variable, but it did not perform significantly, meaning the slope does not affect the presence of deforestation via gravity forces (Falfán et al., 2020).

Considering slope position, some authors (Čada et al., 2016; Klopčič et al., 2009; Schütz et al., 2006) agree that the risk of deforestation increases from the valley bottom to the ridges. Our findings mostly support this premise. As uncovered by GAM, however, the probability of the disturbance rapidly decreases in the ridge's surroundings. This can be explained by the high abundance of unforested areas in the close ridge's surroundings. According to Stathers et al. (1994), this relationship is more complex and depends on the prevailing wind direction. Kramer et al. (2001) point out that valley bottoms can be endangered as well due to the so-called "valley effect", which includes channelling and bending of the wind.

Slope curvature is a rarely studied explanatory variable (Falfán et al., 2020). In our study, convex slopes were more susceptible to damage compared to concave ones, especially in terms of planar curvature, which correlates to the findings of Hanewinkel et al. (2014). Profile curvature did not perform significantly.

Our models indicated that the most vulnerable to the windstorm-driven deforestation in the study area are the north, northeast, and northwest facing slopes, which were directly exposed to the northwest wind during the disturbance. Similar results were published by Dobbertin (2002). The “Lee slope effect” described by Everham and Brokaw (1996) and Foster and Boose (1992) was not observed. Aspect entered the models as a factor variable. We also tested two numeric modifications: extra variable *NWDIR*, which reflects slope exposition to the prevailing wind direction, and alternative calculation of ASP as northness and eastness (Roberts, 1986). While the former was removed from the model due to multicollinearity, the latter was insignificant in both models.

*TWI* is another marginally-used variable (Pawlik et al., 2022). In the study area, wet positions are not sufficiently represented due to the rugged relief with the steep slopes. As the GAM shows, very dry positions tend to be less susceptible to windstorm damage when compared to moderately dry ones.

As for abiotic variables, some authors tend to use edaphic variables in their models as well (Mayer et al., 2005; Panferov et al., 2009; Ruel, 2000). In our study area, soil characteristics were mapped only on medium and small scales. Therefore, they could not be implemented in our model, especially when considering the size of the study area.

### 5.3 The impact of biotic drivers on windstorm-driven deforestation

The higher number of tree species in the stand positively affected forest resistibility to damage. This has a close connection to another observed relationship – a rising risk of damage with a rising proportion of *Picea abies*. As mentioned previously in section 2.1, the natural species composition of the Low Tatras forests has been modified by the planting of spruce monocultures. There is a general consensus on that when it comes to windstorm-driven damage; coniferous stands are more endangered than deciduous ones (Albrecht et al., 2012; Lohmander & Helles, 1987; Ruel, 1995; Usbeck et al., 2010). In comparison with the deciduous tree species, spruce has both a superficial rooting prone to rotting, as well as a disproportional ratio between the tree height and the DBH (Klaus et al., 2011). Also, heterogenous stands positively affect soil productivity, as the humification and mineralisation of organic remains originating from different tree species maintain different speeds. Moreover, outside the growing season, evergreen species have a higher wind load, in contrast to leafless deciduous trees (Dobbertin, 2002). According to Krejci et al. (2018) and Valinger and Fridman (2011), even 25–30% of deciduous species in the stand can reduce the risk of damage by 50%. Despite these facts, semi-extensive planting of Norway spruce is an ongoing process in Slovakia due to economic interests (fast growing, high heat value, variety of applications).

Klopčič et al. (2009) point out that even-aged forests were more prone to windstorm-driven damage than heterogenous ones. Despite our findings being different, this can be explained by the forestry datasets used, where both shrubs and mature forests were frequently included in a single stand unit. Such heterogenous vertical structure can signify affect both opened canopy and the high abundance of forest edges, which enhance stand susceptibility (Mikita et al., 2012). The variable *AGE* has to be removed from our models due to multicollinearity, but the results of Jalkanen and Mattila (2000) and Ochtyra (2020) indicate that higher stand age increases the risk of deforestation. This can be reasoned by higher susceptibility to parasite attacks and diseases in the case of old trees, as well as longer development of tree height compared to the development of root depth (Lohmander & Helles, 1987).

When considering forest density, stands with an opened canopy tend to be more susceptible according to our models. The influence of this variable was marginal, however, which is in line with the

findings of Hanewinkel et al. (2014) and Mikita et al. (2012). Kenderes et al. (2007) point out that the stands with a closed canopy can also be endangered due to thinning. Insufficient light conditions result in a competitive behaviour of individual trees, which relates to the high stems with low DBH. This phenomenon is more prevalent in monocultures.

As presented by Everham and Brokaw (1996), Klopčič et al. (2009), and Peterson and Pickett (1991), trees of medium diameter (approximately 30–50 cm) are the most prone to windstorm-driven damage. This can be explained by both the shelter of the smallest trees and the resilience of the largest ones. The described dependence is in line with the relationship uncovered by our GAM.

DBH has a close bond to another frequently studied variable – tree height. Some authors (Schütz et al., 2006; Valinger & Fridman, 2011) use a ratio between the DBH and the tree height as a single predictor. As shown in Figure 3, these two variables are characterised by similar patterns of its influence on the damage severity, with medium-high trees (20–30 m) being the most susceptible. The importance of the DBH was more prominent compared to the tree height in the LRM, however. Nevertheless, this relationship is strongly influenced by other stand variables, e.g. forest density, which can determine the aforementioned thinning (Lohmander & Helles, 1987).

### 5.4 Forest management implications

Forest management interventions essentially modify the vertical and horizontal structure of the forest, as well as its species composition. Through these predictors, the susceptibility of forests to natural disturbances is determined. According to the LRM, protected forests and special-objective forests are more resilient to damage, when compared to those under active management, although the difference in damage probability is not substantial.

As implied in section 4.2, maintaining diverse forests in the sense of species composition and age structure is essential for its future stability and resilience against natural disturbances. In the natural reservations and the cores of protected areas, a non-intervention approach is recommended, as the natural forest development, which includes both disturbances and the stand restoration, is sufficient for creating a heterogenous structure (Nováková & Edwards-Jonášová, 2015).

Besides the protected areas, a non-intervention scheme is not suitable, as the windbreaks and windthrows quickly turn into hotspots of subcortical insect infestations (Sproull et al., 2015). Therefore, the application of small-scale, irregular shelterwood and single-tree selection systems is suggested to increase the heterogeneity of the stand artificially (Klopčič et al., 2009). It must be noted that the high proportion of medium-scale cuts increases the density of susceptible forest edges (Lohmander & Helles, 1987).

According to Griess et al. (2012), intentional mixing of tree species in a single stand enhances its resilience to the natural disturbances. Additionally, it is crucial to reduce the proportion of Norway spruce in the areas outside its natural distribution, as the species vitality and defence mechanisms are failing under ongoing climate change (Dobor et al., 2020; Šagát et al., 2021).

## 6. Conclusion

In this case study, we constructed both a logistic regression model and a generalised additive model to better understand the factors that contributed to deforestation in the Central Low Tatras of Slovakia following the Elisabeth windstorm in 2004.

Both hypotheses, describing the expected influence of the selected topographic and biotic variables on the presence of deforestation, were verified. When considering topography, the



most prone to windstorm-driven damage are forests on steep convex slopes exposed to the disturbance's dominant wind direction, especially in the vicinity of ridges. Regarding the stand characteristics, medium tree diameter and the high proportion of Norway spruce are the leading determinants of deforestation. While tree height and species structure displayed the expected effects, their importance was unsubstantial and stand age did not perform significantly.

As indicated by AUC values, the generalised additive model did not significantly outperform the logistic regression model, which is also more efficient to build and easier to interpret. Additionally, windstorm damage probability maps were computed, enabling the identification of the most endangered stands across the study area and the adjustment of management interventions to lower the risk of future extensive disturbances.

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