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Flood frequency analysis of the Rasina River in Serbia

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ABSTRACT In this paper we performed flood frequency analysis by using L-moments and annual maximum series data from two hydrological stations on the Rasina River (Brus and Bivolje), for the 1961–2020 period. Homogeneity testing confirmed that the basin can be considered hydrologically homogeneous ($V_i = 0.38 < 1$). Five probability distributions – Normal, Log-Normal, Gumbel, Pearson Type III, and Log-Pearson Type III – were tested to identify the best-fit model. An L-moment ratio diagram and *Z*-statistics indicate that all distributions satisfy the test criteria, with Log-Pearson Type III showing the best overall fit for the region ($Z = 0.09$). Goodness-of-fit tests (Kolmogorov-Smirnov, Cramér-von Mises, and χ^2) confirmed Log-Pearson Type III as the best fit at the Brus station and Pearson Type III at the Bivolje station. Theoretical flood quantiles were calculated for various return periods (T-year floods). Mann–Kendall trend analysis indicated a significant decreasing discharge trend at Bivolje (–1.28 m³/s per year).

KEY WORDS flood frequency analysis – L-moments – Rasina River

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Introduction

Floods are among the most frequent and destructive natural disasters worldwide, both in terms of recurrence and the magnitude of their socio-economic and environmental impacts. They pose significant threats to human life, infrastructure, ecosystems, and economic development (Jonkman, Curran, Bouwer 2024; Ionita, Nagavciuc 2021). According to the United Nations Office for Disaster Risk Reduction (UNDRR 2025), floods account for approximately 35–40% of all natural hazard-related events globally.

In the European Economic Area, weather-related disasters have caused estimated economic losses of €487 billion between 1980 and 2020 (Snizhko et al. 2023). Future climate scenarios suggest an increase in the frequency and intensity of extreme precipitation events, further exacerbating flood risks (Alfieri et al. 2017).

Although extensive research has addressed the spatial and temporal variability of hydrological extremes, no uniform global trends have been established (Varlas et al. 2023; Kovačević-Majkić, Urošev 2014). In Europe, several studies have explored flood seasonality, frequency, and long-term trends (Lehmkuhl et al. 2022; Bloschl et al. 2019; Tramblay et al. 2019; Alfieri et al. 2016; Arnell, Gosling 2014). In northwestern Europe, rising flood frequency is mainly attributed to increased heavy precipitation. In contrast, southern Europe has experienced a decline in flood hazard due to reduced precipitation and drier soils, while eastern Europe has seen similar trends due to less intense snowmelt (Bertola et al. 2020). Regional variation is also reflected in flood timing: in eastern Europe floods are more typical in late March, while in mountainous regions maximum flows often occur in early summer (Hall, Bloschl 2018; Parajka et al. 2010). In the Mediterranean, annual streamflow volumes have consistently remained below the 1950–2013 average since the early 1980s (Masseroni et al. 2021).

In Serbia, floods are the most frequent natural hazard, accounting for 53% of disaster events (Milanović-Pešić 2020). Approximately 18% of the national territory is classified as flood-prone area (Gavrilović, Milanović-Pešić, Urošev 2012). The most vulnerable areas include Vojvodina and the Posavina and Pomoravlje regions, particularly along the Sava and Velika Morava Rivers (Gavrilović, Dukić 2002). Flood events in Serbia are commonly caused by moist Atlantic air masses or rapid snowmelt from the Dinaric Alps, with peak flows occurring in late spring and early summer (Leščešen et al. 2022).

One of the most pressing challenges in hydrology is the reliable estimation of extreme flood events (Leščešen, Dolinaj 2019). Flood Frequency Analysis (FFA) is widely used to estimate discharges associated with specific return periods, applying statistical distributions to observed data (Hu et al. 2023). Over the past several decades, many studies have been conducted on FFA across various regions and hydrological contexts (Shah, Pan Das 2024; Fischer, Schumann 2021; Morlot,

Brilly, Šraj 2019; Engeland et al. 2018; Dubey 2014; Noto, La Loggia 2009). The main goal of this research is to provide practical tools for flood estimation to inform flood engineering designs, as well as to provide a better understanding of flood characteristics.

Numerous researchers have examined the issue of flooding on rivers in Serbia through the application of FFA (Gnjato et al. 2025; Leščešen et al. 2022; Leščešen, Dolinaj 2019), as well as through analyses of high-flow conditions and major historical flood events (Gavrilović, Milanović-Pešić, Urošev 2012; Gavrilović 1981). Research has also focused on flood risk assessment and hydrological changes, with an emphasis on statistically significant long-term trends and seasonal variability in water resources (Stričević, Martić-Bursać, Gocić 2024; Leščešen et al. 2022; Stojković et al. 2017; Martić-Bursać et al. 2016; Kovačević-Majkić, Urošev 2014).

Accurate flow forecasting is crucial for water resource management, infrastructure planning, and operational decision-making (Samantaray, Sahoo 2020). Flood frequency analysis (FFA) provides essential estimates of flood magnitude and frequency for risk assessment and engineering design (Shah, Pan Das 2024; Ahmad et al. 2016), relying on long-term, high-quality peak discharge data (Hu et al. 2023). Commonly used statistical distributions in FFA include Normal (N), Log-Normal (LN), Gumbel (GUM), Generalized Extreme Value (GEV), Pearson Type III (PIII) and Log-Pearson Type III (LPIII) distributions. Different countries have adopted specific distributions for national applications – for example, the GEV in Europe (Kousar et al. 2020), LPIII in the United States (England et al. 2019), GEV and PIII in Australia (Rahman et al. 2013).

Although FFA has been widely applied in Serbia and Europe, most studies focus on major rivers or regional-scale assessments, while small catchments like the Rasina River Basin remain less investigated (Stričević, Martić-Bursać, Gocić 2024; Leščešen et al. 2022). Flood trends and methodological results vary due to differences in hydrological regimes and data availability (Bertola et al. 2020; Alfieri et al. 2016). The L-moments method was selected for its robustness with limited sample sizes and reliability in characterizing extreme events (Dubey 2014; Hosking, Wallis 1997), allowing this study to provide dependable estimates of extreme discharges in small Serbian catchments. This study focuses on the Rasina River basin in central Serbia, analyzing discharge data from two hydrological stations – Brus and Bivolje – for the period 1961–2020. The Brus station represents a near-natural streamflow regime, while Bivolje is influenced by the Ćelije Reservoir, located in the Zlatar Gorge. As extreme floods in the Rasina River are expected to become more frequent due to climate change, a reliable FFA is essential for engineering applications. Therefore, this study focuses on the estimation of extreme river discharges.

The main objectives of the study are to: assess the hydrological homogeneity of the Rasina River Basin; estimate regionalized flood parameters using the

L-moments method; identify the best-fitting probability distribution for modeling flood magnitudes; detect trends in annual maximum discharges using the Mann–Kendall (MK) test.

The broader aim of this research is to emphasize the need for comprehensive flood analyses in small catchments across Serbia in order to enhance flood prediction capabilities and support the implementation of effective mitigation strategies.

Study area

The basin of the Rasina River is situated in the south part of the middle Serbia connecting the Dinaric and Serbian – Macedonian masses (Fig. 1). The Rasina is formed on the east and south-east slopes of the mountains of Goč, Željin and Crni Vrh, where its constituents, the Vranjuša and the Burmanska River originate. These streams merge near Rogavčina, forming the Rasina River, which flows into the Zapadna Morava River after 92.3 km, approximately 5 km downstream from Kruševac, at an altitude of 134 m a.s.l. (Dimitrijević 2010). The basin covers an area of 979.6 km², representing 6.18% of the Zapadna Morava basin (Stričević 2015).

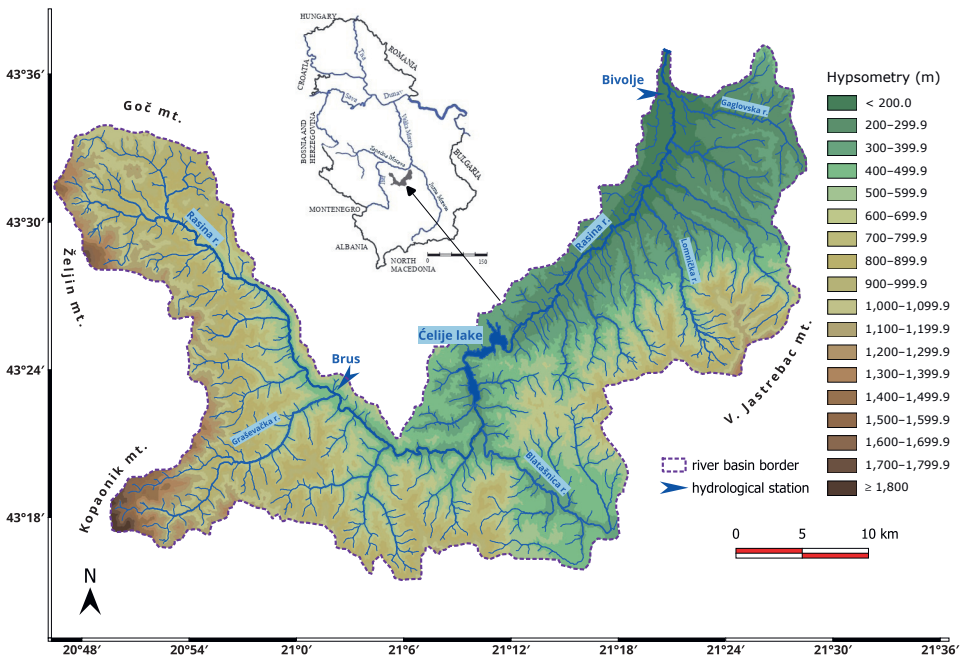


Fig. 1 – Geographical position of the research area and hydrological stations Brus and Bivolje in the Rasina River basin. Source: QGIS software with 30 m SRTM DEM (USGS EarthExplorer).

The river network comprises 955 watercourses, with a drainage density of 1.383 km/km². The largest tributaries are the Grošnička River and Blatašnica on the right side and the Zagrža on the left. Average discharge of the Rasina River in the period from 1961 to 2020 was 7.37 m³/s, which gave the specific runoff of 7.52 l/s/km².

The elevation ranges from 134 m to 1,934 m a.s.l., with a mean altitude of 590.9 m. About 45.3% of the basin area lies below 500 m, 41.2% between 500 and 1,000 m, and 13.5% above 1,000 m a.s.l. (Dimitrijević 2010). The largest part of the Rasina River basin is situated in the zone of temperate continental climate with continental pluviometric regime, while mountainous climate is represented on the mountain edge of the basin. In the north, the basin is widely open towards Župa and the valley of the Zapadna Morava, from where continental air masses penetrate unhindered. The average annual air temperature in the basin is 8.9 °C and mean annual precipitation amounts to 794 mm. Approximately 30% of precipitation contributes to runoff (runoff coefficient 0.30), with the highest values recorded in spring (0.48) and the lowest in summer (0.15). According to the Corine Land Cover database (2012) agricultural areas cover 32% of the basin, mainly at lower altitudes near river valleys and settlements, while forests and semi-natural areas occupy 58%. According to the 2021 census (Statistical Office of the Republic of Serbia – SORS 2021), this territory has a total population of 154,659, distributed across two urban and 211 rural settlements.

In 1972, Lake Ćelije was created by damming the Rasina River in the Zlatar Gorge, approximately 33 km upstream from its confluence with the Zapadna Morava River. The reservoir serves multiple purposes, including flood control and flow regulation, significantly reducing flood intensity and frequency in the downstream river section (Vujović 1995).

Data and methods

Flood frequency analysis (FFA) of the Rasina River basin was conducted by using annual maximum series (AMS) data, which consist of the largest discharge event recorded each year. The AMS method is widely used in hydrological practice due to its simplicity and the relatively low data requirements for estimating statistical distributions (Anghel, Ilinca 2023; Ilinca, Anghel 2022; Leščešen et al. 2022; Anwat et al. 2021; Bezak, Brilly, Šraj 2016; Urošev et al. 2016). In this study, a 60-year dataset (1961–2020) of AMS discharge values from two gauging stations (Brus and Bivolje) on the Rasina River, was analyzed. The data were obtained from the Republic Hydrometeorological Service of Serbia (RHMSS). The locations of the stations are shown in Figure 1, and their main geographical parameters are summarized in Table 1. The research area was visualized using QGIS 3.40 and SAGA GIS

with a 30 m SRTM DEM (USGS EarthExplorer) and the station locations were obtained from RHMSS.

FFA enables the estimation of future flood magnitudes and return periods, particularly useful in regions with similar climatic and hydrological conditions. Numerous studies have been focused on identifying suitable probability distribution functions for modeling annual maximum flood events (Sahu, Kant Verma, Ahmad 2022; Radevski, Gorin 2017; Vasilevski, Radevski 2014). While there is no strict rule for selecting a specific distribution for short-term AMS data, this study evaluated five commonly used distributions: Normal (N), Log-Normal (LN), Gumbel (GUM), Pearson Type III (PIII), and Log-Pearson Type III (LPIII). These distributions were applied to model flood magnitudes at the two gauging stations. The probability density functions (PDF) and quantile functions y(*F*) for each distribution are presented in Table 2 (Gnjato et al. 2025; Anghel, Ilinca 2023; Deraman, Abd Mutalib, Mukhtar 2017).

Goodness-of-fit was evaluated using statistical tests: Chi-square (χ^2), Cramér–von Mises (CvM), and Kolmogorov–Smirnov (K–S), as well as graphical assessments. The fitted distributions were used to estimate discharge values for various return periods (5, 10, 15, 50 years, etc; Fischer, Schumann 2021; Acharya, Joshi 2020; Deraman, Abd Mutalib, Mukhtar 2017; Smith, Sampson, Bates 2015). The corresponding cumulative distribution functions (CDFs) are also presented to illustrate the flood probabilities associated with different magnitudes.

The first step in FFA is to determine the level of regional homogeneity (Gnjato et al. 2025; Leščešen et al. 2022; Leščešen, Dolinaj 2019). To identify the homogeneity of the study area, a homogeneity test was first applied to stations data in the Rasina River basin. For quantitative evaluation, Hosking, Wallis (1993) proposed a homogeneity test statistic and a goodness-of-fit statistic for determining the regional distribution. The homogeneity test checks whether the selected group of stations can be considered a random realization of the same dimensionless distribution in terms of L-Cv (V_1), L-Cv and L-Cs (V_2) and L-Cs and L-Ck (V_3). V_1 represents the Euclidean distance between the L-Cv values for each station individually and the regional mean L-Cv, while V_2 and V_3 represent the distances in L-Cs–L-Cv and L-Ck–L-Cs, respectively. For the sample and simulated regions, V_i is calculated as:

$$V_1 = \left\{\sum_{i=1}^{n} n_i\left(\tau^i - \tau^R\right)^2 / \sum_{i=1}^{n} n_i\right\}^{1/2} \quad (1)$$

$$V_2 = \left\{\sum_{i=1}^{n} n_i\left(\tau^i - \tau^R\right)^2 + \left(\tau_3^i - \tau_3^R\right)^2\right\}^{1/2} / \sum_{i=1}^{n} n_i \quad (2)$$

$$V_3 = \left\{\sum_{i=1}^{n} n_i\left(\tau_3^i - \tau_3^R\right)^2 + \left(\tau_4^i - \tau_4^R\right)\right\}^{1/2} / \sum_{i=1}^{n} n_i \quad (3)$$

where n is the number of sites; n_i is the record length at site i; τ^i, τ_3^i, τ_4^i are the sample L-Cv, L-Cs, L-Ck at site i; n_i is the record length at site i; τ^R, τ_3^R, τ_4^R are the

Table 1 – Geographical characteristics for observed stations

Station	Elevation (m a.s.l.)	Location (River-km)	Basin Area (km²)
Brus	417.9	69.96	213
Bivolje	141.9	5.97	958

Table 2 – Probability density and quantiles functions of the probability distributions

Distribution	Probability density function f(x)	Quantile function F(x)
Normal	$f(x) = \frac{exp\left(-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2\right)}{\sigma\sqrt{2\pi}}$	$F(x) = \varphi\left(\frac{x-\mu}{\sigma}\right)$
Log-Normal	$f(x) = \frac{exp\left(-\frac{1}{2}\left(\frac{\ln x-\mu}{\sigma}\right)^2\right)}{x\sigma\sqrt{2\pi}}$	$F(x) = \varphi\left(\frac{\ln x-\mu}{\sigma}\right)$
Gumbel	$f(x) = \frac{1}{\sigma}exp\left(-z - exp(-z)\right)$	$F(x) = exp\left(-exp(-z)\right)$
Pearson III	$f(x) = \frac{1}{\beta^{\alpha}\Gamma(\alpha)}(x-\mu)^{\alpha-1}exp\left(-\frac{(x-\mu)}{\beta}\right)$	Explicit analytical form is not available
Log-Pearson III	$f(x) = \frac{1}{X\lvert\beta\rvert\Gamma(\alpha)}\left(\frac{\ln(x)-\gamma}{\beta}\right)^{\alpha-1} exp\left(-\frac{\ln(x)-\gamma}{\beta}\right)$	$F(x) = \frac{\Gamma_{\ln((x)-\gamma)/\beta\ \ (\alpha)}}{\Gamma(\alpha)}$

Table 2a – Explanation of symbols used in Table 2

Symbol	Explanation	Symbol	Explanation
x	Value of the random variable (discharge)	β	Scale parameter for Pearson III and Log-Pearson III distributions
X	Random variable representing discharge	γ	Location parameter for Log-Pearson III distribution
μ	Mean or location parameter of the distribution	$f(x)$	Probability density function (PDF)
σ	Standard deviation or scale parameter of the distribution	$F(x)$	Cumulative distribution function (CDF) or Quantile function
z	Standardized variable for Gumbel distribution: $z = \frac{x-\mu}{\sigma}$	$\varphi(\cdot)$	Standard normal cumulative distribution function (CDF)
α	Shape parameter for PIII and LPIII distributions	$\Gamma(\cdot)$	Gamma function

sample L-moments at site i, corresponding to the coefficients L-Cv (L-moment coefficient of variation), L-Cs (L-moment skewness), and L-Ck (L-moment kurtosis), respectively; and τ^R, τ_3^R, τ_4^R are the corresponding regional average L-moments. The region is regarded as "acceptably homogeneous" if $V_i < 1$, "possibly heterogeneous" if $1 \leq V_i < 2$ and "definitely heterogeneous" if $V_i \geq 2$ (Hosking,Wallis 1997).

The L-moments method was used to estimate distribution parameters (Khan, Rahman, Karim 2023). The most commonly employed method to calculate the L-moments is via probability weighted moments (PWMs). PWMs primarily were defined by Greenwood et al. (1979), and later by Hosking (1990):

$$\beta_r = E\{X[F(x)]^r\} \tag{4}$$

where, β_r is the r^{th} order PWMs and $F(x)$ characterizes the CDFs of x. Sample estimators (β_i) of the first four PWMs are explained in Hosking, Wallis (1997):

$$\beta_0 = m = \frac{1}{n}\sum_{j=1}^{n} X_j \tag{5}$$

$$\beta_1 = \sum_{j=1}^{n-1}\left(\frac{n-j}{n(n-1)}\right) X_j \tag{6}$$

$$\beta_2 = \sum_{j=1}^{n-2}\left(\frac{(n-1)(n-j-2)}{n(n-1)(n-2)}\right) X_j \tag{7}$$

$$\beta_3 = \sum_{j=1}^{n-3}\left(\frac{(n-j)(n-j-1)(n-j-2)}{n(n-1)(n-2)(n-3)}\right) X_j \tag{8}$$

where X_j represents the j^{th} value of the AMS arranged in descending order, so with X_1 is the largest and X_n the smallest. Regarding PWMs, the initial four L-moments, signifying the mean, scale, skewness, and kurtosis of the distributions, are established through linear combinations of PWMs (Hosking, Wallis 1997):

$$\lambda_1 = \beta_0 \tag{9}$$
$$\lambda_2 = 2\beta_1 - \beta_0 \tag{10}$$
$$\lambda_3 = 6\beta_2 - 6\beta_1 + \beta_0 \tag{11}$$
$$\lambda_4 = 20\beta_3 - 30\beta_2 + 12\beta_1 - \beta_0 \tag{12}$$

Finally, the L-moment ratios defined by Hosking, Wallis (1993) are specified below:

$$LC_v = \tau_2 = \frac{\lambda_2}{\lambda_1} \tag{13}$$

$$LC_s = \tau_3 = \frac{\lambda_3}{\lambda_2} \tag{14}$$

$$LC_k = \tau_4 = \frac{\lambda_4}{\lambda_2} \tag{15}$$

where τ_2 is the L coefficient of variation, τ_3 is the L coefficient of skewness, τ_4 is the L coefficient of kurtosis.

To identify the distribution that yields the most accurate quantiles, the widely accepted L-moment ratio diagram method was applied (Fig. 3). This method is widely recognized for selecting the best-fit probability distribution for regional datasets (Ilinca, Anghel 2022; Anderson 2019).

The appropriate distribution is selected by comparing the proximity of sample L-Cs and L-Ck values to the theoretical curves of candidate distributions (in

the case of three-parameter distributions), or by comparing the sample mean to theoretical points (for two-parameter distributions) (Domanski et al. 2023; Gielczewski, Piniewski, Domanski 2022; Ahmad et al. 2016). If the region is homogeneous, sample points on the L-moment ratio diagram tend to cluster closely.

However, when several distributions appear suitable, the L-moment diagram alone may not clearly indicate the best fit. Therefore, a numerical goodness-of-fit test is applied to objectively determine the most appropriate frequency distribution. In this study, the *Z*-statistic was used as the goodness-of-fit measure for identifying the most appropriate regional distribution (Sahu, Kant Verma, Ahmad 2022; Zakaria, Shabri 2013). It is based on the comparison of sample- and population-L-Ck values for the different distributions:

$$Z = \left(\tau_4^{DIST} - \tau_4^R\right)/\sigma_4 \tag{16}$$

where σ_4 is the standard deviation of the sample L-Ck values, τ_4^{DIST} is the population-L-Ck value for a particular candidate distribution, τ_4^R is the regional sample average of the L-Ck values (Ahmad et al. 2019). The test is performed by means of a comparison with a quantile of the standard normal distribution. We adopted a significance level of 5%, which means that a candidate distribution is considered suitable if $|Z| < 1.96$. The best fit to the observed data indicates the most appropriate distribution (Leščešen, Dolinaj 2019; Ahmad et al. 2016).

For clarity, CDFs chart was created to further validate the results and strengthen their credibility (Figure 4). This diagram visually compares the distribution of observed discharge values with those estimated using different probability distributions (Anderson 2019). The *x*-axis represents the cumulative probability of occurrence, while the *y*-axis represents the discharge values. The empirical cumulative probabilities $F_e(x)$ were calculated using the Weibull plotting position formula:

$$F_e(x) = \frac{m}{N+1}$$

where m is the rank of the observation in ascending order (the smallest value $m = 1$) and N is the total number of observations (Hosking, Wallis 1997). This method provides an unbiased estimation of empirical probabilities, particularly suitable for extreme value analysis.

The uncertainty of trend and return level estimates is expressed by 95% confidence intervals. For trend analysis (Fig. 2), confidence limits were derived for Sen's slope, whereas for return levels (Figure 5 and 6) they were obtained from L-moment–based quantile estimation.

The best-fitting distribution function for the 60-year data series was determined using K–S, CvM and χ^2 tests (Petrović, Leščešen, Radevski 2024; Martinenko et al. 2021; Kousar et al. 2020; Urošev et al. 2016). The K-S test is a frequently employed method for assessing the consistency of probability distribution, delivering

reliable results even with limited sample data. The approach involves computing the value of D_{max}, the maximum unconditional deviation between the cumulative extent of two distributions, followed by comparison with the critical value of D to either accept or reject the proposed hypothesis (Kovačević, Marković, Babić 2014). When comparing multiple theoretical distributions, the one with the lowest D_{max} is considered the best fit to the empirical data. The K-S test goes as follows:

$$D_{max} = |F_e(x) - F_t(x)| \tag{17}$$

where $F_e(x)$ is the empirical cumulative distribution function (observed data) and $F_t(x)$ is the theoretical cumulative distribution function (candidate distribution).

Similarly, the CvM test evaluates the concordance between empirical and theoretical distributions. The test statistic w^2 is calculated as:

$$w^2 = \frac{1}{12N} + \sum_{i=1}^{N} |F_e(x) - F_t(x)|^2 \tag{18}$$

where N is the number of observations. Smaller values of w^2 indicate closer conformity to the empirical data. To check the agreement of the empirical and theoretical distribution of flood occurrence rates the test χ^2 was used:

$$\chi^2 = \sum_{k=1}^{k} \frac{(f_{e,k} - f_{t,k})^2}{f_{t,k}} \tag{19}$$

where $f_{e,k}$ is the empirical frequency in class k, $f_{t,k}$ is the theoretical frequency in class k, and K is the number of classes of the random variable. The degrees of freedom for the χ^2 statistic are calculated as $\upsilon = K - p - 1$, where p is the number of parameters of the fitted distribution. The analyzed data are grouped in six classes, so that each class comprises of at least five data points.

The critical value $\chi^2_{1-\alpha}$ is obtained from standard Chi-squared tables for the given degrees of freedom υ and significance level α. If $\chi^2 < \chi^2_{1-\alpha}$, the hypothesis of agreement between empirical and theoretical distributions is accepted.

The statistical significance of the trend in maximum series was analyzed using the non-parametric Mann–Kendall (MK) test (Kendall 1975; Mann 1945). The MK test is widely used to detect a statistically significant trend in hydrological and climatic variables, particularly in streamflow series (Higashino, Stefan 2019; Radevski et al. 2018; Bezak, Brilly, Šraj 2016; Kovačević-Majkić, Urošev 2014). The magnitude of the trend was determined by using Sen's slope test (Sen 1968), which examines the sign differences between earlier and later data points. The null hypothesis H_0 assumes no trend, while the alternative H_1 assumes a monotonic trend. First, we calculated sign differences S, after that variance $\mathrm{Var}(S)$, and in the end MK test statistic Z_t.

The Mann–Kendall statistics and its variance can be presented as:

$$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sgn(X_j - X_i) \tag{20}$$

$$sgn(X_j - X_i) = \begin{bmatrix} 1, \text{if } (X_j - X_i) > 0 \\ 0, \text{if } (X_j - X_i) = 0 \\ -1, \text{if } (X_j - X_i) < 0 \end{bmatrix} \tag{21}$$

$$\text{Var}(S) = \frac{n(n-1)(2n+5) - \sum_{k=1}^{n} t_k(t_k-1)(2t_k+5)}{18} \tag{22}$$

The standardized statistics Z_t for this test can be calculated by the following equation:

$$Z_t = \begin{bmatrix} \frac{S-1}{\sqrt{\text{Var}(S)}}, \text{if } S > 0 \\ 0, \text{if } S = 0 \\ \frac{S+1}{\sqrt{\text{Var}(S)}}, \text{if } S < 0 \end{bmatrix} \tag{23}$$

where n is the total length of data, X_j and X_i are the time series of the annual and/or seasonal values of the discharge in years $j = i + 1, i + 2, i + 3, \ldots, n$ and $i = 1, 2, 3, \ldots, n - 1$, where $j > i$, and n is the last year in the time series, while t_k is the number of data in the k-th tied group.

The positive values of Z_t indicate upward (increasing) trends in time series, and the negative values show downward (decreasing) trends. Trends (Z_t statistics) are then tested against some critical values ($Z_{t\,1-\alpha}$) to show whether they are statistically significant or not. If α is the Type I error rate, where $0 < \alpha < 0.5$, and $Z_{t\,1-\alpha}$ is the $1-\alpha$ quantile of the standard normal distribution (provided in statistical books or statistical software packages), then H_0 will be rejected, and replaced with the alternative H_1 if $Z_t \geq Z_{t\,1-\alpha}$ for the upward, or $Z_t \leq -Z_{t\,1-\alpha}$ for the downward trend.

Results and discussion

The first step was to calculate the basic statistics of the AMS data (mean, median, maximum, standard deviation, skewness and kurtosis) for the two gauging stations. The positive skewness values indicate that the AMS data at these stations deviate from a normal distribution (exhibiting right skewness; Table 3). These basic statistics were then used to select the frequency distributions for deriving the probability of exceeding a certain discharge value (Leščešen et al. 2022).

Trend analysis of the AMS data at the two gauging stations is presented in Figure 2. To determine a trend, the MK test was applied. At the Bivolje station, a statistically significant decreasing trend was detected ($p = 0.005$), significant at 0.1, 0.05, and 1% levels, but not at the more stringent level of 0.001. The Sen's slope of –1.28 m³/s/year indicates an average annual decrease in discharge of approximately 1.28 m³/s (Table 4). The standard error of 0.38 suggests relatively good precision of the slope estimate. In contrast, data from the Brus station show

Table 3 – Descriptive statistics for the AMS data from the two gauging stations on the Rasina River

Station	n	Mean (m^3/s)	Median (m^3/s)	Maximum (m^3/s)	STD (m^3/s)	Skewness	Kurtosis
Brus	60	32.14	22.9	121	24.57	0.42	0.25
Bivolje	60	103.11	86	291	71.79	0.25	0.05

n – number of observations; STD – standard deviation; Skewness – coefficient of skewness; Kurtosis – coefficient of kurtosis

Table 4 – Man–Kendall test statistics for the Rasina River

Station	Sen's slope $m^3/s \cdot year^{-1}$	SE $m^3/s \cdot year^{-1}$	Z_t-value of trend	p-value
Brus	–0.027	0.098	–0.204	0.838
Bivolje	–1.279	0.383	–2.787	0.005

Sen's slope – magnitude of monotonic trend estimated by Sen's method; SE – standard error of Sen's slope; Z_t-value – standardized test statistic of the Mann–Kendall test; p-value – significance level of the trend

no statistically significant trend in annual maximum discharges ($p = 0.838$). Sen's slope is very close to zero (–0.027), indicating a practically negligible decreasing trend. Therefore, while a significant declining discharge trend was established at Bivolje, which may have implications on water supply and water resource management, discharges at Brus remained stable over the observed period with no evidence of trend change. The negative trends may result from reduced snowmelt in surrounding mountains (Kopaonik, Goč, Željin, Jastrebac), the main sources for right-bank tributaries. The presented results are consistent with other studies, which project decreasing discharge trends for major rivers in Serbia, as well as in central and southern Europe (Leščešen et al. 2022; Stagl, Hattermann 2015; Kovačević-Majkić, Urošev 2014).

Homogeneity test results for the Rasina River basin are presented in Table 5. Based on these results, it can be concluded that the study region is acceptably homogeneous, as all V_i values are below the critical threshold of one, and no further data inspection is necessary.

Once regional homogeneity is confirmed, regional L-moments were calculated as the weighted average of the L-moments from the two gauging stations (Dubey 2014). These regional L-moments were computed across all gauging stations, with weights corresponding to the record length at each station. This ensures that longer records contribute proportionally more to the regional estimates, providing a more reliable basis for distribution selection. Figure 3 shows a scatter plot of observed L-moments for the two gauging stations (Brus and Bivolje), with lines for theoretical distributions, highlighting the best-fitting one. Since the sample L-moments are unbiased, the sample points should be distributed both above and below the theoretical line of the fitted distribution (Sahu, Kant Verma,

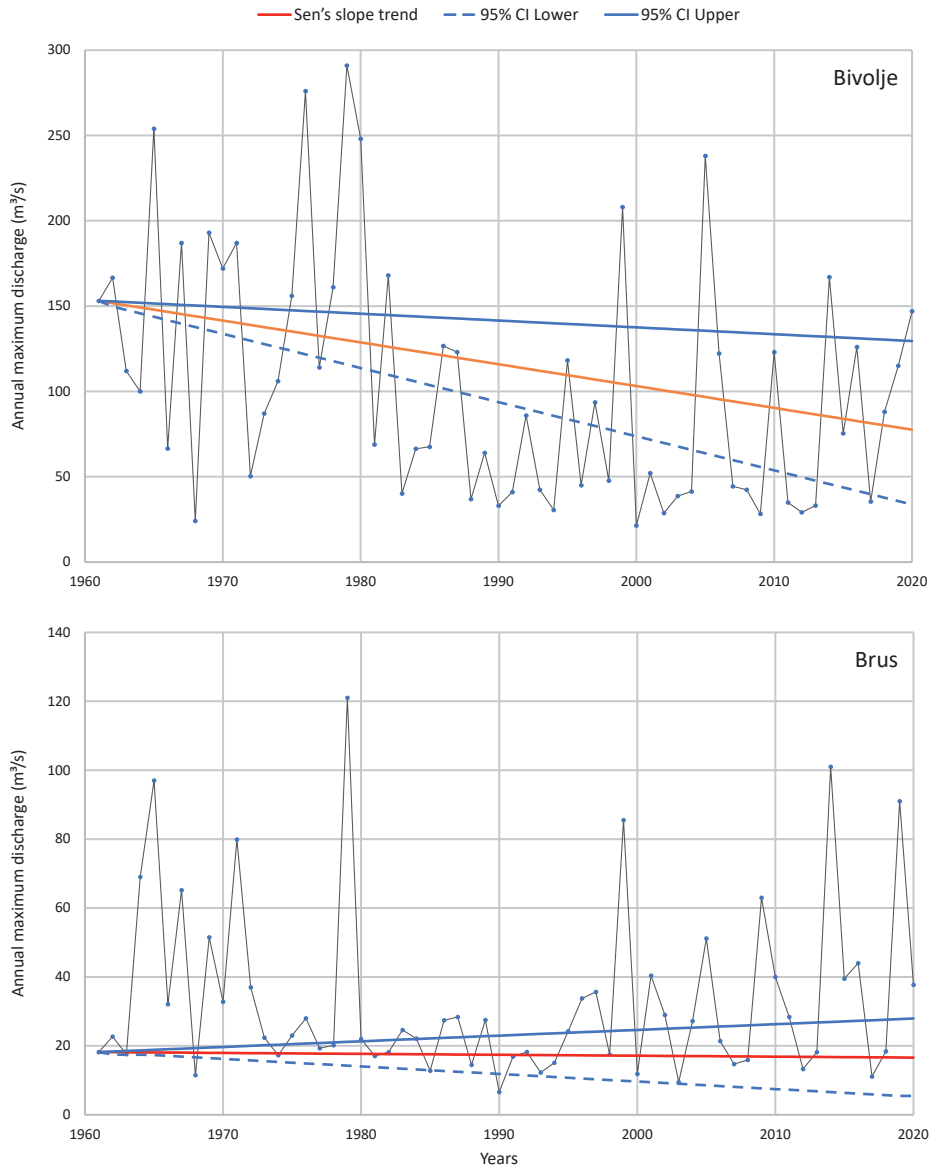


Fig. 2 – Time series of maximum annual discharges at the Rasina River from 1961 to 2020 at Bivolje (up) and Brus (down)

Ahmad 2022). The L-Cv values for the region were between 0.37 and 0.39, with a mean value of 0.38. The L-Cs range was between 0.25 and 0.42, with a mean value of 0.33; whereas the L-Ck range was 0.05 and 0.25, with a mean value of 0.15. The results show that there is no clear variation of L-Ck and L-Cs within the basin.

Table 5 – Homogeneity test of the Rasina River for flood volumes

τ^R	τ_3^R	τ_4^R	V_1	V_2	V_3
0.986	0.986	0.987	0.0058	0.0155	0.0173

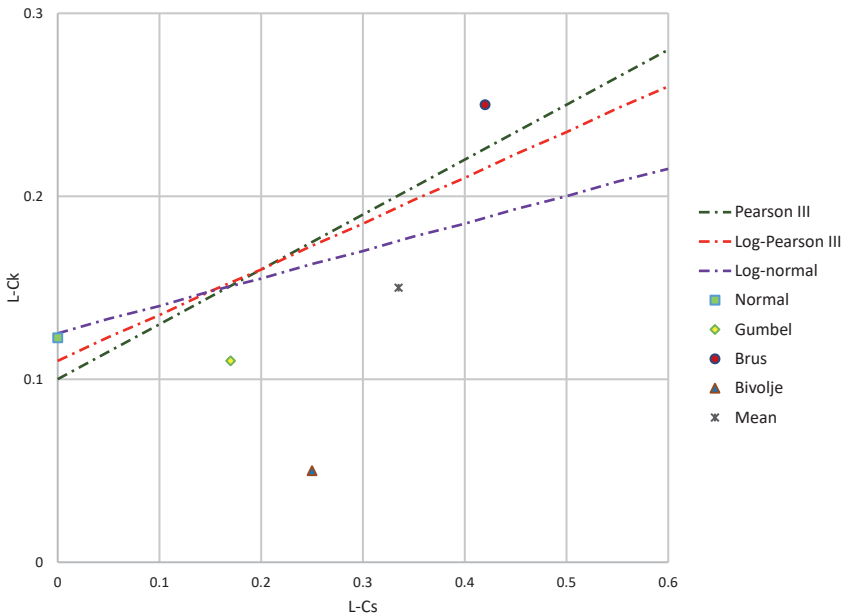


Fig. 3 – Scatter plot of observed L-moments for the two selected gauging stations (Brus and Bivolje, 1961–2020) in the Rasina River basin, with lines for theoretical distributions

Most data points display a tendency to group around the PIII and LPIII distribution functions. Figure 3 indicate that the PIII and LPIII distributions provide the best fit to the observed AMS data for the Brus and Bivolje stations (Amirataee, Montaseri 2013).

To identify a regional distribution applicable to ungauged rivers, the *Z*-statistic was calculated. The results show that the *Z*-statistic for all five distributions is less than the critical value ($|Z|$): Normal ($Z = -0.13$), Log-Normal ($Z = 1.11$), Gumbel ($Z = 0.25$), Pearson III ($Z = 0.23$), and Log-Pearson III ($Z = 0.09$). Since the absolute value of *Z* for the Log-Pearson III distribution is the lowest, this provides additional evidence that this distribution is suitable for the Rasina River basin as a whole.

In order to examine the goodness-of-fit of the selected distribution to the empirical data, the CDF were calculated for the analyzed hydrological stations (Figure 4). This diagram visually compares the distribution of observed discharge values with those estimated using different probability distributions. The *x*-axis

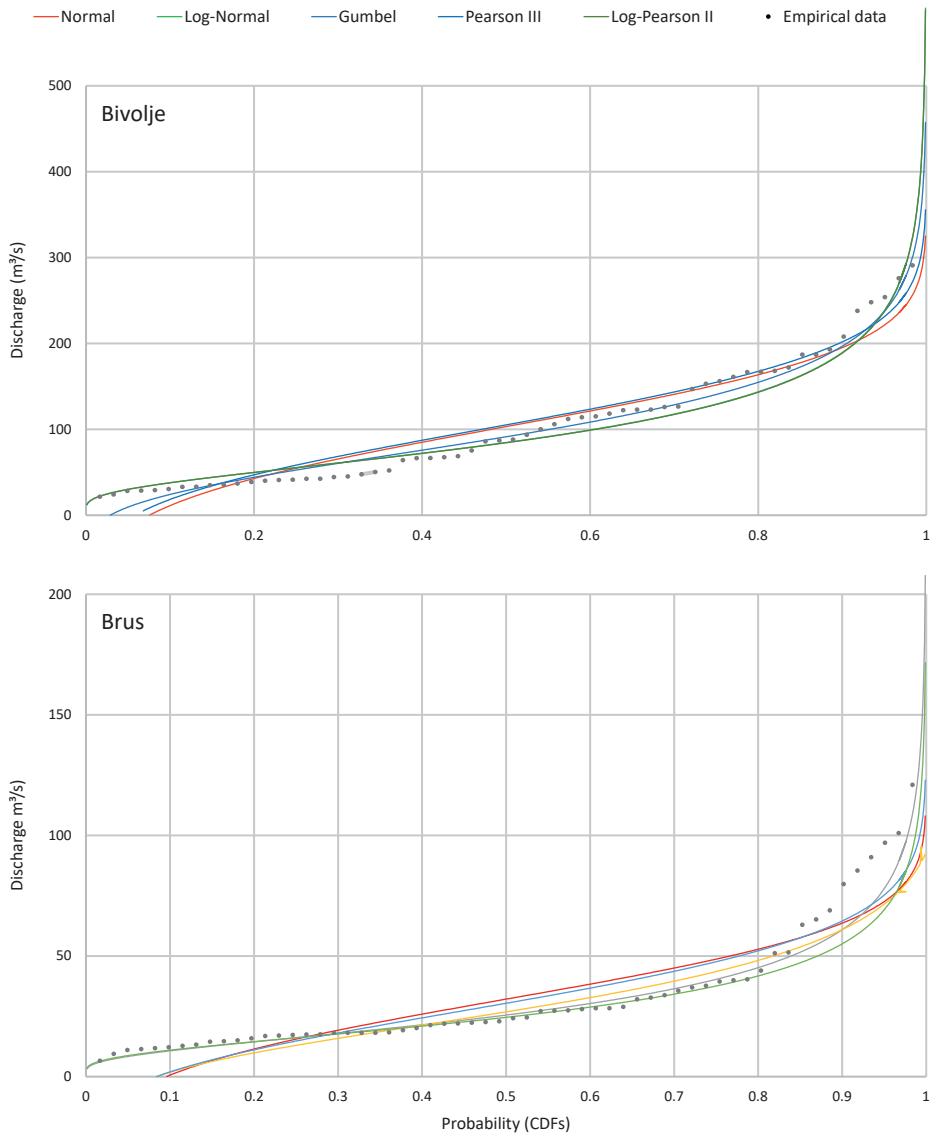


Fig. 4 – CDFs of empirical data and fitted candidate distributions for the stations Brus and Bivolje in the Rasina River basin

represents the cumulative probability of occurrence, while the y-axis indicates the discharge values. The CDF diagram shows that the Normal distribution deviates significantly from the observed discharge values, indicating a lack of fit. In contrast, other distributions show a considerable overlap with the observed discharge data, indicating a better fit. Figure 4 shows thatPIII and LPIII distributions have

Table 6 – Fit statistics and distribution selection for river discharge data

Station	Distribution	Goodness-of-Fit Test					
		K–S		CvM		χ^2	
		Stat.	p-value	Stat.	p-value	Stat.	p-value
Brus	Normal	0.217	0.007	0.844	0.006	29.452	0
	Log-Normal	0.097	0.628	0.121	0.492	2.642	0.619
	Gumbel	0.087	0.753	0.389	0.077	11.932	0.018
	Pearson III	0.111	0.453	0.091	0.633	5.992	0.199
	Log-Pearson III	0.063	0.973	0.030	0.977	2.081	0.721
Bivolje	Normal	0.141	0.186	0.278	0.156	20.033	0.0004
	Log-Normal	0.113	0.430	0.159	0.363	7.489	0.112
	Gumbel	0.121	0.341	0.151	0.388	9.911	0.042
	Pearson III	0.100	0.582	0.107	0.554	5.176	0.270
	Log-Pearson III	0.108	0.490	0.134	0.442	5.754	0.218

the best fit for the entire range of empirical data. Similar results for best-fit distributions have been obtained in Serbia for the Danube River (Urošev et al. 2016), the Kolubara River (Milanović-Pešić 2020), as well as for major tributaries of the Južna Morava (e.g., Vlasina) and Velika Morava Rivers (e.g., Jasenica, Lepenica) (Gavrilović, Milanović-Pešić, Urošev 2012).

To validate the graphical interpretation, formal goodness-of-fit tests (K–S, CvM and χ^2) were conducted (Table 6).

At the Brus station, the K–S test indicates acceptable agreement at the 0.05 significance level for LN, GUM, PIII, and LPIII distributions, with LPIII providing the best fit (D_{max} = 0.063). At Bivolje station, all distributions showed acceptable agreement, with PIII providing the best fit (D_{max} = 0.100).

Furthermore, the CvM goodness-of-fit test confirm that the LPIII distribution provides the best overall fit to the data at the Brus station, followed by the PIII and LN distributions. The N distribution is rejected as inadequate, while the GUM distribution may be considered, though it is not optimal. At the Bivolje station, all tested distributions yielded *p*-values greater than 0.05, indicating that the null hypothesis cannot be rejected. Among these, the PIII distribution produced the lowest w^2 statistic and the highest *p*-value, suggesting it most closely aligns with the empirical data. LN, GUM and LPIII are also acceptable alternatives at this station.

The χ^2 test further supports these findings. At the Brus station, the LPIII distribution showed the highest agreement with the empirical data, while at the Bivolje station, the PIII distribution showed the best fit. According to the χ^2 statistics, both stations exhibit favorable correspondence with four tested theoretical distributions: LN, GUM, PIII, and LPIII.

A key objective of the FFA is to determine the quantile in the extreme upper tail of the best-fit distribution. Return level plots were generated using the PIII

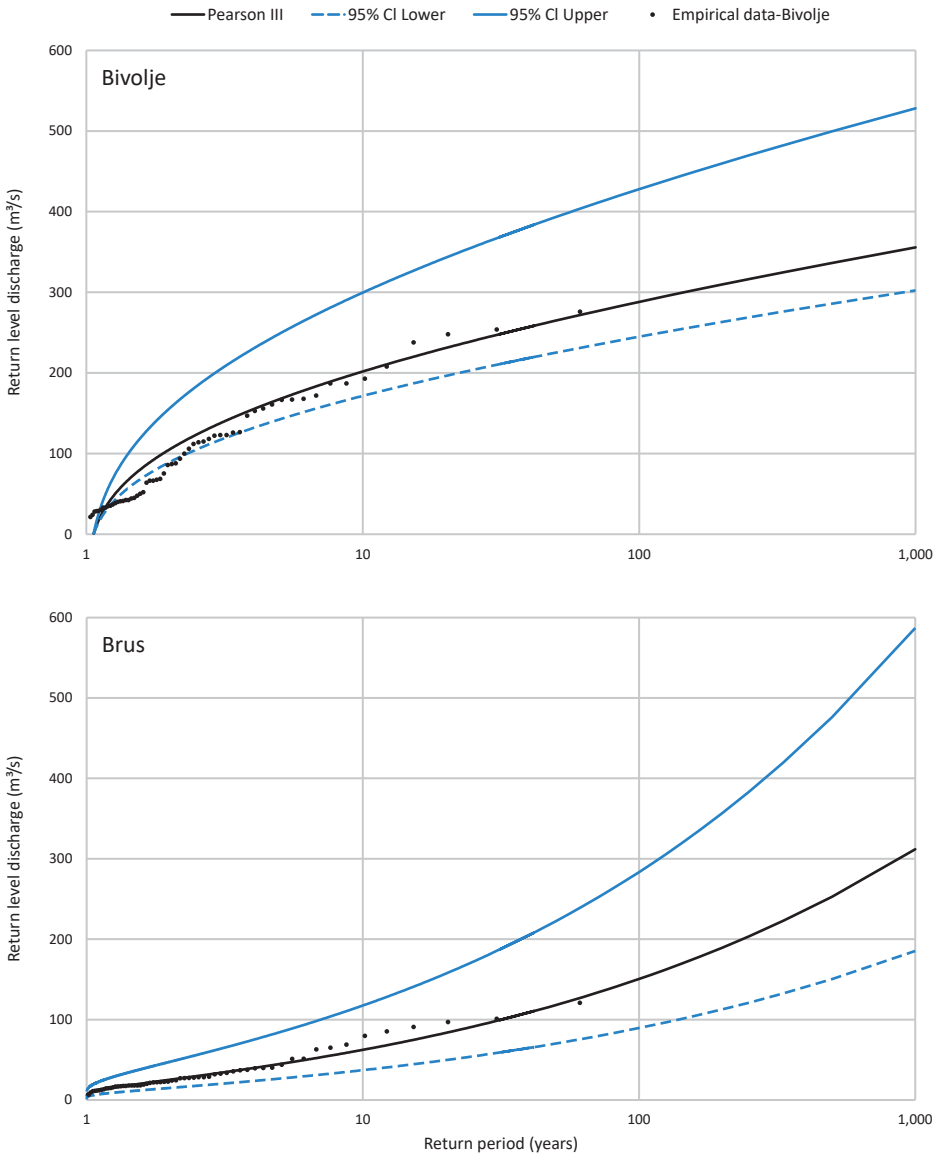


Fig. 5 – Estimated at-site return levels with 95% confidence bounds for the Brus (LPIII) and Bivolje (PIII) gauging stations in the Rasina River basin

distribution for the Bivolje station and the LPIII distribution for the Brus station, based on AMS. The empirical data closely follow the model lines of these distributions, indicating a good fit between the observed discharge data and the selected models. The LPIII distribution slightly better captures the higher

extremes due to the log-transformation, which is commonly applied in hydrological modeling. Using the quantile function and the parameter values specific to the best-fit distribution at each gauging station, we calculated the quantile estimates corresponding to return periods of 5, 10, 25, 50, 100, 200, 500, and 1,000 years, with 95% confidence intervals (Gnjato et al. 2025.). The 95% confidence intervals are relatively narrow for shorter return periods (up to approximately 100 years), reflecting greater certainty in these estimates. At Bivolje, empirical data show greater variability for longer return periods, indicating a less accurate fit of the PIII distribution. Wider confidence intervals than at Brus suggest increased uncertainty for rare extremes, likely due to local hydrology or limited data, warranting caution for long-term predictions (Fig. 5).

Based on the best-fitting theoretical distribution, the probability of exceedanceof maximum discharges (floods) in the Rasina River basin was calculated (Fig. 6). The maximum discharge of 121 m^3/s recorded at the Brus station corresponds to a probability of exceedanceof p = 2.38%, or a return period of approximately 42 years. At the Bivolje station, the maximum observed discharge corresponds to a probability of p = 2.35%, or a return period of 42.5 years. The annual maximum discharge with a 99.9% probability at Brus is approximately 4.3 m^3/s, while for a 90% probability it is around 11.6 m^3/s. At Bivolje, the corresponding discharges are 14.2 m^3/s (99.9%) and 31.3 m^3/s (90%), respectively.

The analysis demonstrates increasing discharge values across different return periods. These findings underscore the importance of accurate probability distributions in estimating extreme flood magnitudes, which are essential for effective risk management strategies in the Rasina River basin.

Conclusions

In this study, the FFA method based on L-moments was applied using various theoretical distributions fitted to AMS flow records from two hydrological stations in the Rasina River basin. The aim was to determine the most appropriate distribution type for different data sets. To calculate the regional frequency of AMS flows (i.e., flood risk parameters), flood quantiles and return levels were estimated with a 95% confidence interval. The results show that the *Z*-statistics for all considered distributions (N, LN, GUM, PIII, and LPIII) is in good agreement with the test requirement ($|Z| < 1.96$) at both stations. Since the absolute value of *Z* to the LPIII distribution is the lowest ($Z = 0.09$), this provides additional evidence that this distribution is suitable for the Rasina River basin as a whole.

Goodness-of-fit tests, including K–S, CvM and χ^2 identified the most suitable probability distributions for modeling river discharge maxima. At the Brus station, the LPIII distribution showed the highest agreement with empirical data, while

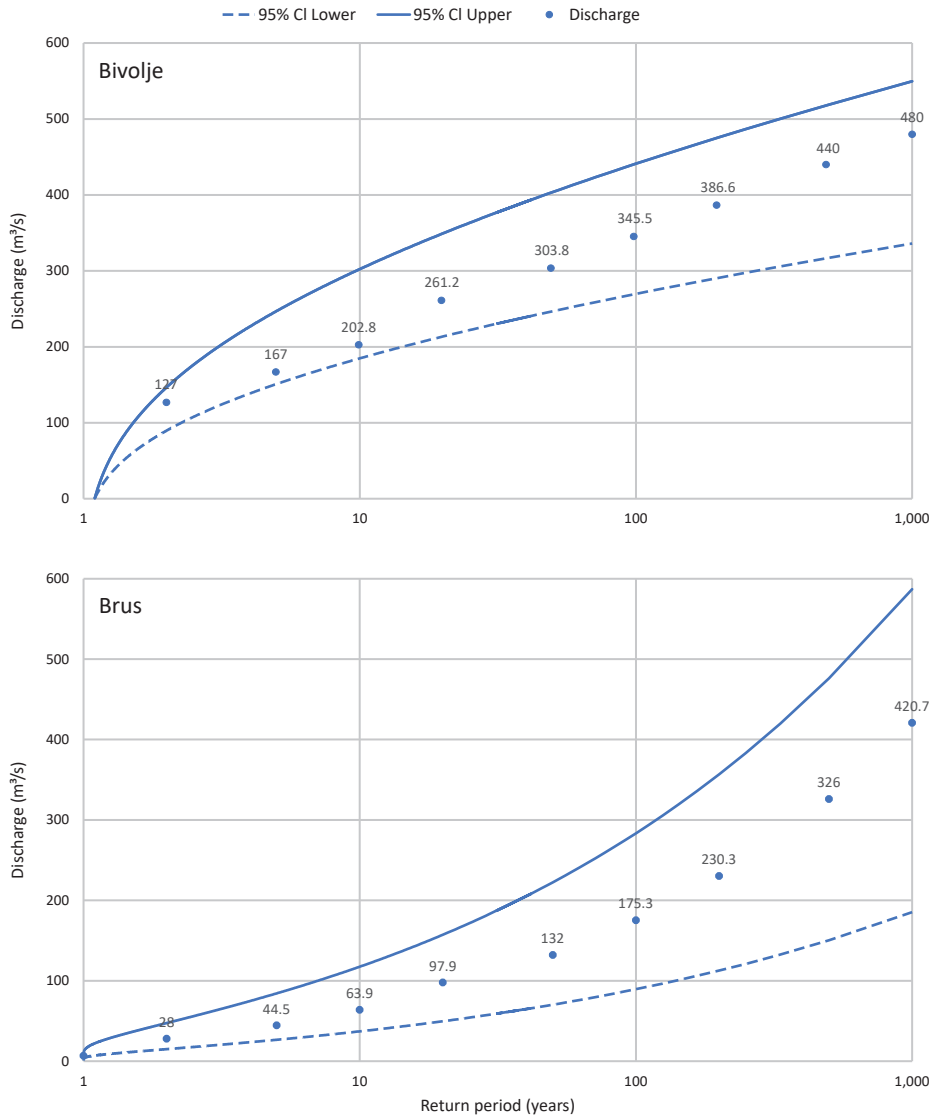


Fig. 6 – Estimated return discharge levels for different return periods for the Brus and Bivolje gauging stations in the Rasina River basin

at the Bivolje station, the PIII distribution provided the best fit. CDF diagrams visually confirmed these results, and the calculated return periods for extreme flood events offered valuable insights into potential runoff magnitudes for different return intervals. The evaluated time series (1961–2020) is sufficiently long and representative for the applied statistical indicators and for the analysis of

annual maximum discharges. The MK test indicated a decreasing trend in water discharge, with a statistically significant negative trend at Bivolje (Sen's slope –1.28 m^3/s/year).

Extreme flows at the upstream Brus station remained relatively stable throughout the observation period, reflecting near-natural flow conditions in the upper basin. Observed trends in extreme flows are generally consistent with long-term changes in mean and seasonal discharges reported in the literature for the Rasina River and comparable basins in Serbia and southeast Europe (Stričević, Martić-Bursać, Gocić 2024; Leščešen et al. 2022; Kovačević-Majkić, Urošev 2014). At the Bivolje station, decreasing extreme flows correspond with reported declines in average and seasonal discharges, whereas at the Brus station, minor fluctuations primarily reflect natural hydrological variability.

The differences between the two gauging stations reflect both natural variability and local catchment characteristics, including water regulation and abstraction in the upper and middle parts of the basin related to the Ćelije and Paljevštica water supply systems, as well as spatial variability in precipitation and runoff generation. Similar behavior has been documented in regional studies, which indicate that regulated river sections and smaller catchments often exhibit stronger negative trends and higher variability in extreme flows compared to less influenced or near-natural river reaches (Gnjato et al. 2025; Milanović-Pešić et al. 2025). This study provides detailed information on hydrological variable trends and flood estimation along the Rasina River basin over recent decades, which is useful for future regional and local planning and the integrated use of water resources. The results of this study offer valuable insights that enable more reliable estimation of design discharges for different return periods when designing hydraulic structures, potentially reducing the risk of failure and minimizing environmental damage and losses caused by future floods. An adequate combination of scientific analysis, hydro-construction works, and preventive measures is essential to ensure effective management and optimal protection of flood-affected areas in Serbia.

References

ACHARYA, B., JOSHI, B. (2020): Flood frequency analysis for an ungauged Himalayan river basin using different methods: a case study of Modi Khola, Parbat, Nepal. Meteorology Hydrology and Water Management, 8, 2, 46–51. https://doi.org/10.26491/mhwm/131092

AHMAD, I., FAWAD, M., AKBAR, M., ABBAS, A. (2016): Regional frequency analysis of annual peak flows in Pakistan using linear combination of order statistics. Polish Journal of Environmental Studies,, 25, 6, 1–10. https://doi.org/10.15244/pjoes/63782

ALFIERI, L., BISSELINK, B., DOTTORI, F., NAUMANN, G., ROO, A., SALAMON, P., WYSER, K., FEYEN, L. (2017): Global projections of river flood risk in a warmer world. Earth's Future, 5, 171–182. https://doi.org/10.1002/2016EF000485

ALFIERI, L., FEYEN, L., SALAMON, P., THIELEN, J., BIANCHI, A., DOTTORI, F., BUREK, P. (2016): Modelling the socio-economic impact of river floods in Europe, Natural Hazards and Earth System Sciences,16, 1401–1411. https://doi.org/10.5194/nhess-16-1401-2016

AMIRATAEE, B., MONTASERI, M. (2013): Evaluation of L-moment and ppcc method to determine the best regional distribution of monthly rainfall data: case study northwest of Iran. Journal of Urban and Environmental Engineering, 7, 2, 247–252. https://doi.org/10.4090/juee.2013.v7n2.247-252

ANDERSON, S.T. (2019): Statistical L-moment and L-moment ratio estimation and their applicability in network analysis. PhD Dissertation, ir Force Institute of Technology, Wright-Patterson Air Force Base, Ohio, USA.

ANGHEL, C.G., ILINCA, C. (2023): Predicting flood frequency with the LH-moments method: a case study of Prigor River, Romania. Water, 15, 1–33. https://doi.org/10.3390/w15112077

ANWAT, K.V., HIRE, S.P., PAWAR, V.U., GUNJAL, P.R. (2021): Analysis of magnitude and frequency of floods in the Damanganga basin: western India. Hydrospatial Analysis, 5, 1, 1–11. https://doi.org/10.21523/gcj3.2021050101

ARNELL, W.N., GOSLING, N.S. (2014): The impacts of climate change on river flood risk at the global scale. Climatic Change, 1–16. https://doi.org/10.1007/s10584-014-1084-5

BAUER, K., SAGA Development Team (2020): System for Automated Geoscientific Analyses (SAGA) – GIS software, http://www.saga-gis.org (18. 1. 2026).

BERTOLA, M., VIGLIONE, A., LUN, D., HALL, J., BLOSCHL, G. (2020): Flood trends in Europe: are changes in small and big floods different? Hydrology and Earth System Sciences, 24, 1805–1822. https://doi.org/10.5194/hess-24-1805-2020

BEZAK, N., BRILLY, M., ŠRAJ, M. (2016): Flood frequency analyses, statistical trends and seasonality analyses of discharge data: a case study of the Litija station on the Sava River. Journal of Flood Risk Management, 9, 2,, 154–168. https://doi.org/10.1111/jfr3.12118

BLOSCHL, G., HALL, J., VIGLIONE, A., PERDIGAO, R. A. P., PARAJKA, J., MERZ, B., LUN, D., ARHEIMER, B., ARONICA, G. T., BILIBASHI, A. (2019): Changing climate both increases and decreases European river floods. Nature, 573, 108–111. https://doi.org/10.1038/s41586-019-1495-6

CORINE Land Cover database (CLC2012), European Commission.

DERAMAN, W.H.A.W., ABD MUTALIB, N.J., MUKHTAR, Z.N. (2017): Determination of return period for flood frequency analysis using normal and related distributions. IOP Conf. Series: Journal of Physics: Conf. Series 890, 1, 1–11. https://doi.org/10.1088/1742-6596/890/1/012162

DIMITRIJEVIĆ, LJ. (2010): Hydro-geographical study of the Rasina River, Master thesis, Faculty of Geography, University of Belgrade.

DOMANSKI, P.D., JANKOWSKI, R., DZIUBA, K., GORA, R. (2023): Assessing control sustainability using L-moment ratio diagrams. Electronics, 12, 2377, 1–19. https://doi.org/10.3390/electronics12112377

DUBEY, A. (2014): Regional flood frequency analysis utilizing L-moments: a case study of Narmada basin. InternationalJournal of Engineering Research and Applications, 155–161.

ENGELAND, K., WILSON, D., BORSANYI, P., ROALD, L., HOLMQVIST, E. (2018): Use of historical data in flood frequency analysis: a case study for four catchments in Norway. Hydrology Research, 49, 2, 466–486. https://doi.org/10.2166/nh.2017.069

ENGLAND, F.J., COHN, A.T., FABER, A.B., STEDINGER, R.J., THOMAS, O.W., BAKER, M., VEILLEUX, G.A., KIANG, E.J., MASON, R.R. (2019): Guidelines for determining flood flow frequency–Bulletin 17C. U.S. Geological Survey Techniques and Methods, book 4, U. S. Geological Survey, Reston, Virginia. https://doi.org/10.3133/tm4B5

FISCHER, S., SCHUMANN, A.H. (2021): Multivariate flood frequency analysis in large river basins considering tributary impacts and flood types. Water Resources Research, 57,1–25. https://doi.org/10.1029/2020WR029029

GAVRILOVIĆ, LJ. (1981): Floods in Serbia in the 20th century: causes and consequences. Special issues, 52. Serbian Geographical Society, Belgrade.

GAVRILOVIĆ, LJ., DUKIĆ, D. (2002): Rivers of Serbia. Serbian State of Textbooks, Belgrade.

GAVRILOVIĆ, LJ., MILANOVIĆ-PEŠIĆ, A., UROŠEV, M. (2012): A hydrological analysis of the greatest floods in Serbia in the 1960–2010 period. Carpathian Journal of Earth and Environmental Sciences, 7, 4,107–116.

GIELCZEWSKI, M., PINIEWSKI, M., DOMANSKI, P. (2022): Mixed statistical and data mining analysis of river flow and catchment properties at regional scale. Stochastic Environmental Research and Risk Assessment, 36, 2861–2882. https://doi.org/10.1007/s00477-022-02169-3

GNJATO, S., LEŠČEŠEN, I., POPOV, T., TRBIĆ, G. (2025): Comprehensive flood frequency analysis of major Sava River affluents in Bosnia and Herzegovina: risks, and implications for water resources management. IDŐJÁRÁS, 129, 2,161–175. https://doi.org/10.28974/idojaras.2025.2.3

GREENWOOD, J.A., LANDWEHR, J.M., MATALAS, N.C., WALLIS, J.R. (1979): Probability weighted moments: definition and relation to parameters of several distributions expressable in inverse form. Water Resources Research, 15, 5, 1049–1054. https://doi.org/10.1029/WR015i005p01049

HALL, J., BLOSCHL, G. (2018): Spatial patterns and characteristics of flood seasonality in Europe. Hydrology and Earth System Sciences, 22, 3883–3901. https://doi.org/10.5194/hess-22-3883-2018

HIGASHINO, M., STEFAN, G.H. (2019): Variability and change of precipitation and flood discharge in a Japanese river basin. Journal of Hydrology: Regional Studies, 21, 68–79. https://doi.org/10.1016/j.ejrh.2018.12.003

HOSKING, J.R.M. (1990): L-moments: Analysis and Estimation of Distributions using Linear Combinations of Order Statistics. Journal of the Royal Statistical Society: Series B, 52, 1, 105–124. https://doi.org/10.1111/j.2517-6161.1990.tb01775.x

HOSKING, J.R.M., WALLIS, J.R. (1993): Some statistics useful in regional frequency analysis. Water Resources Research,29, 2, 271–281. https://doi.org/10.1029/92WR01980

HOSKING, J.R.M., WALLIS, J.R. (1997): Regional frequency analysis: an approach based on L-moments. Cambridge University Press, UK. https://doi.org/10.1017/CBO9780511529443

HU, L., NIKOLOPOULOS, E.I., MARRA, F., ANAGNOSTOU, E.N. (2023): Toward an improved estimation of flood frequency statistics from simulated flows. Journal of Flood Risk Management, 16, 2, 1–13. https://doi.org/10.1111/jfr3.12891

ILINCA, C., ANGHEL, C.G. (2022): Flood-frequency analysis for dams in Romania. *Water*, 14,18, 1–23. https://doi.org/10.3390/w14182884

IONITA, M., NAGAVCIUC, V. (2021): Extreme floods in the eastern part of Europe: large-scale drivers and associated impacts. Water, 1122, 1–26. https://doi.org/10.3390/w13081122

JONKMAN, S.N., CURRAN, A., BOUWER L.M. (2024): Floods have become less deadly: an analysis of global flood fatalities 1975–2022. Natural Hazards, 120, 6327–6342. https://doi.org/10.1007/s11069-024-06444-0

KENDALL, M.G. (1975): Rank correlation methods, 4th ed. Charles Griffin, London.

KHAN, Z., RAHMAN, A., KARIM, F. (2023): An assessment of uncertainties in flood frequency estimation using bootstrapping and Monte Carlo simulation. Hydrology, 10, 1–16. https://doi.org/10.3390/hydrology10010018

KOUSAR, S., KHAN, R.A., HASSAN, U.M., NOREEN, Z., BHATTI, H.S. (2020): Some best-fit probability distributions for at-site flood frequency analysis of the Ume River. Journal of FloodRisk Management, 13, 1–11. https://doi.org/10.1111/jfr3.12640

KOVAČEVIĆ, M., MARKOVIĆ, LJ., BABIĆ, L. (2014): Statistical modeling of extreme values: application to calculate extreme flow at River Rasina. Construction Materials and Structures, 57, 4, 21–29. https://doi.org/10.5937/grmk1404021K

KOVAČEVIĆ-MAJKIĆ, J., UROŠEV, M. (2014): Trends of mean annual and seasonal discharges of rivers in Serbia. Journal of the Geographical Institute "Jovan Cvijić" SASA, 64, 2, 143–160. https://doi.org/10.2298/IJGI1402143K

LEHMKUHL, F., SCHUTTRUMPF, H., SCHWARZBAUER, J., BRULL, C., DIETZE, M., LETMATHE, P., VOLKER, C., HOLLERT, H. (2022): Assessment of the 2021 summer flood in central Europe. Environmental Sciences Europe, 34, 1, 1–6. https://doi.org/10.1186/s12302-022-00685-1

LEŠČEŠEN, I., DOLINAJ, D. (2019): Regional flood frequency analysis of the Pannonian Basin. Water, 11, 1–15. https://doi.org/10.3390/w11020193

LEŠČEŠEN, I., ŠRAJ, M., BASARIN, B., PAVIĆ, D., MESAROŠ, M., MUDELSEE, M. (2022): Regional flood frequency analysis of the Sava River in south-eastern Europe. Sustainability,14, 9282, 1–19. https://doi.org/10.3390/su14159282

MANN, H.B. (1945): Non-parametric tests against trend. Econometrica, 13, 245–259. https://doi.org/10.2307/1907187

MARTIĆ-BURSAĆ, N., STRIČEVIĆ, LJ., NIKOLIĆ, M., IVANOVIĆ, R. (2016): Statistical analysis of average, high and low waters of the Toplica River. Bulletin of the Serbian Geographical Society, 96,1, 26–45. https://doi.org/10.2298/GSGD1601026M

MARTINENKO, A., JEVREMOVIĆ, V., VRANIĆ, P., POPOVIĆ, J., PEJIĆ, M. (2021): Statistical tests and their application in geodesy. Technology, Our Civil Engineering, 75, 147–154. https://doi.org/10.5937/tehnika2102147M

MASSERONI, D., CAMICI, S., CISLAGHI, A., VACCHIANO, G., MASSARI, C., BROCCA, L. (2021): The 63-year changes in annual streamflow volumes across Europe with a focus on the Mediterranean basin. Hydrology and Earth System Sciences, 25, 5589–5601. https://doi.org/10.5194/hess-25-5589-2021

MILANOVIĆ-PEŠIĆ, A. (2020). Hydrological aspects of the floods in the Kolubara River basin (Serbia) – analyses and flood mitigation measures. In: Nedkov, S. et al. (eds.): Smart Geography. Springer, Cham, 117–127. https://doi.org/10.1007/978-3-030-28191-5_10

MILANOVIĆ-PEŠIĆ, A., JAKOVLJEVIĆ, D., RAJČEVIĆ, V., GNJATO, S. (2025): Assessment of hydroclimatic trends in southeast Europe – examples from two adjacent countries (Bosnia & Herzegovina and Serbia). Időjárás, 129, 1, 69–87. https://doi.org/10.28974/idojaras.2025.1.5

MORLOT, M., BRILLY, M., ŠRAJ, M. (2019): Characterisation of the floods in the Danube River basin through flood frequency and seasonality analysis. Acta Hydrotechnica, 32, 57, 73–89. https://doi.org/10.15292/acta.hydro.2019.06

NOTO, L., LA LOGGIA, G. (2009): Use of L-moments approach for regional flood frequency analysis in Sicily, Italy. Water Resources Management, 23, 2207–2229. https://doi.org/10.1007/s11269-008-9378-x

PARAJKA, J., KOHNOVAB, S., BALINTH, G., BARBUCF, M., BORGAE, M., CLAPSI, P., CHEVALD, S., DUMITRESCUD, A., GAUMEC, E., HLAVCOVAB, K., MERZA, R., PFAUNDLERG, M., STANCALIED, G., SZOLGAYB, J., BLOSCHLA, G. (2010): Seasonal characteristics of flood regimes across the Alpine–Carpathian range.Journal og Hydrology, 394, 1–2, 1–13. https://doi.org/10.1016/j.jhydrol.2010.05.015

PETROVIĆ, A.M., LEŠČEŠEN, I., RADEVSKI, I. (2024): Unveiling torrential flood dynamics: a comprehensive study of spatio-temporal patterns in the Šumadija Region, Serbia. Water, 16, 7, 991, 1–19. https://doi.org/10.3390/w16070991

QGIS Development Team (2023): Quantum GIS (QGIS) 3.40. Open-source GIS software for spatial data entry, analysis and visualization. https://qgis.org (18. 1. 2026).

RADEVSKI, I., GORIN, S. (2017): Floodplain analysis for different return periods of river Vardar in Tikvesh valley (Republic of Macedonia). Carpathian Journal of Earth and Environmental Sciences, 12, 1, 179–187.

RADEVSKI, I., GORIN, S., TALESKA, M., DMITROVSKA, O. (2018): Natural regime of streamflow trends in Macedonia. Geografie, 123, 1–20. https://doi.org/10.37040/geografie2018123010001

RAHMAN, A.S., RAHMAN, A., ZAMAN, M.A., HADDAD, K., AHSAN, A., IMTEAZ, M. (2013): A study on selection of probability distributions for at-site flood frequency analysis in Australia. Natural Hazards, 69, 3, 1803–1813. https://doi.org/10.1007/s11069-013-0775-y

RHMSS (2023): Republic Hydrometeorological Service of Serbia, https://www.hidmet.gov.rs/ (10. 12. 2024).

SAHU, R., KANT VERMA, M., AHMAD, I. (2022): Regional frequency analysis using L-moment methodology – a eview, In: Pathak, K.K. et al. (eds.): Recent trends in civil engineering. Springer Nature Singapore Pte Ltd., Singapore, 811–832. https://doi.org/10.1007/978-981-15-5195-6_60

SAMANTARAY, S., SAHOO, A. (2020): Estimation of flood frequency using statistical method: Mahanadi River basin, India. H2Open Journal, 3, 1, 189–207. https://doi.org/10.2166/h2oj.2020.004

SEN, P.K. (1968): Estimates of the regression coefficient based on Kendall's tau. Journal of the American Statistical Association, 63, 324, 1379–1389. https://doi.org/10.1080/01621459.1968.10480934

SHAH, I.A., PAN DAS, N. (2024): Evaluation of probability distribution methods for flood frequency analysis in the Jhelum basin of north-western Himalayas, India. Cleaner Water, 2, 1–14. https://doi.org/10.1016/j.clwat.2024.100044

SMITH, A., SAMPSON, C., BATES, P. (2015): Regional flood frequency analysis at the global scale. WaterResources Researsh, 51, 539–553. https://doi.org/10.1002/2014WR015814

SNIZHKO, S., BERTOLA, M., OVCHARUK, V., SHEVCHENKO, O., DIDOVETS, I., BLOSCHL, G. (2023): Climate impact on flood changes – an Austrian-Ukrainian comparison. Journal of Hydrology and Hydromechanics., 71, 3, 271–282. https://doi.org/10.2478/johh-2023-0017

SORS (2021): Statistical Office of the Republic of Serbia. http://www.stat.gov.rs (5. 7. 2025).

STAGL, J., HATTERMANN, F. (2015): Impacts of climate change on the hydrological regime of the Danube River and Its tributaries using an ensemble of climate scenarios. Water, 7, 6139–6172. https://doi.org/10.3390/w7116139

STOJKOVIĆ, M., KOSTIĆ, S., PROHASKA, S., PLAVŠIĆ, J., TRIPKOVIĆ, V. (2017): A new approach for trend assessment of annual streamflows: a case study of hydropower plants in Serbia. Water Resources Management, 31, 4, 1089–1103. https://doi.org/10.1007/s11269-017-1583-z

STRIČEVIĆ, LJ. (2015): Water resources of Rasina county and their impact on regional development. PhD thesis, Faculty of Sciences and Mathematics, University of Niš.

STRIČEVIĆ, LJ., MARTIĆ-BURSAĆ, N., GOCIĆ, M. (2024): Trend analysis of temperature, precipitation and river discharge in the Rasina river basin, Serbia. VI Congress of Macedonian Geographers with International Participation, Macedonian Geographical Society, 29.–30. 5. 2024. https://doi.org/10.37658/MGD24021s

TRAMBLAY, Y., MIMEAU, L., NEPPEL, L., VINET, F., SAUQUET, E. (2019): Detection and attribution of flood trends in Mediterranean basins. Hydrology and Earth System Sciences, 23, 4419–4431. https://doi.org/10.5194/hess-23-4419-2019

UNDRR (2025): Floods. In: Global Assessment Report 2025. United Nations Office for Disaster Risk Reduction, https://www.undrr.org/gar/gar2025/hazard-exploration/floods (10. 5. 2024).

UROŠEV, M., LEŠČEŠEN, I., ŠTRBAC, D., DOLINAJ, D. (2016): Extreme hydrological situations on Danube River: Case study Bezdan Hydrological Station (Serbia). In Proceedings of the 4th IAHR European Congress, Liège, Belgium. International Association for Hydro-Environment Engineering and Research.

USGS (n.d.): SRTM Digital Elevation Data, https://www.earthexplorer.usgs.gov (18. 1. 2026).

VARLAS, G., PAPADAKI, C., STEFANIDIS, K., MENTZAFOU, A., PECHLIVANIDIS, I., PAPADOPOULOS, A., DIMITRIOU, E. (2023): Increasing trends in discharge maxima of a Mediterranean River during early autumn. Water, 15, 1022. https://doi.org/10.3390/w15061022

VASILEVSKI, D., RADEVSKI, I. (2014): Analysis of high waters on the Kriva Reka River, Macedonia, Acta Geographica Slovenica, 54, 2, 363–377. https://doi.org/10.3986/AGS54209

VUJOVIĆ, R. (1995): Waters of Serbia – development plans and several realizations in water management. IRO Building Book, Belgrade.

ZAKARIA, Z.A., SHABRI, A. (2013): Regional frequency analysis of extreme rainfalls using partial L-moments method. Theoretical and Applied Climatology, 113, 1–2, 83–94. https://doi.org/10.1007/s00704-012-0763-2

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Enhancing real estate decision-making: a similarity-based approach for property valuation and recommendation

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ABSTRACT Although similarity metrics have proven valuable in information retrieval and recommendation systems, their application to real estate has been limited. This study examines 1,014 benchmark land lots in Gwangjin-gu, Seoul, and identifies similar lots using Euclidean distance and cosine similarity. Nine land attributes, including site area, road width, and geographical descriptions are used to compute similarity. Being textual data, geographical descriptions are converted into numerical representations using an embedding model. It was found that the land lots identified as similar by Euclidean distance and cosine similarity are nearly identical, suggesting the effective applicability of both metrics to the real estate industry. In addition, we used industry standards to rigorously evaluate the performance of a similarity-based approach and demonstrated that it outperforms the traditional regression model. Our findings indicate that these metrics can enhance property valuation and recommendation by reducing subjectivity and increasing the efficiency of selecting similar land lots.

KEY WORDS similarity metrics – Euclidean distance – cosine similarity – property valuation – property recommendation – Seoul

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1. Introduction

Similarity metrics such as Euclidean distance and cosine similarity have been extensively applied across various industries. They have been useful for information retrieval, particularly in improving the relevance of search results by facilitating document comparisons (Wang, Dong 2020). The most notable commercial success is in their application to recommendation systems (Patel, Patel 2020), wherein these metrics suggest items such as books, movies, or dating matches.

Despite their potential applicability, similarity metrics have been understudied in the real estate sector. For instance, in property valuation, the sales comparison approach is commonly used to estimate prices. This method begins by selecting recently sold properties that match the subject closely in terms of size, zoning, location, and other characteristics. The selected properties, known as sales comparables, are then used to determine the value of the subject property. The accuracy of this valuation depends entirely on the relevance of the selected properties. Currently, practitioners select the sales comparables manually, which can lead to bias and inconsistency because the selection criteria may vary between practitioners. This subjective aspect of property selection is also present on real estate website platforms when candidate houses are recommended to users. This study aims to enhance the use of similarity metrics and reduce subjectivity in the real estate sector.

Using the concepts of Euclidean distance and cosine similarity, we identify similar lots from a sample of 1,014 benchmark land lots in Gwangjin-gu, Seoul. Nine attributes, including site area, road width, and geographical descriptions like "Near the southern side of the National Hospital," are used to compute similarity. Our findings demonstrate the effectiveness of applying similarity metrics to the real estate industry.

This study makes two key contributions. First, it comprehensively examines similar and dissimilar sales comparables and provides a nuanced perspective on how different metrics shape the process of selecting sales comparables. Second, using industry standards, the study evaluates the performance of instance-based valuation and demonstrates their potential as a robust alternative to conventional model-based valuation. By addressing these understudied areas, this study contributes to the development of more refined valuation and recommendation systems.

The remainder of this paper is structured as follows. Section 2 reviews similarity metrics and conversion techniques for textual data. Section 3 describes the dataset and methodology used in this study. Section 4 presents the results of the similarity metrics and discusses their implications for the real estate sector. Finally, Section 5 concludes the paper and suggests directions for future research.

2. Literature review

2.1. Similarity metrics

A similarity metric is used to quantify the similarity between two objects or data points. It quantifies the distance between points in a multidimensional space. Numerous similarity metrics have been developed in the literature; however, there is no universal similarity metric that is relevant to all tasks (Faisal, Zamzami 2020; Legendre, Legendre 2012). Therefore, a relevant metric must be selected by considering the characteristics of a specific task. Table 1 lists some commonly-used similarity metrics.

We used two similarity metrics: Euclidean distance and cosine similarity. Both metrics involve relatively straightforward calculations and provide intuitive interpretations (Leskovec, Rajaraman, Ullman 2020). In addition, both metrics are widely used in a broad range of fields, including natural language processing and recommendation systems (Fauzan et al. 2022; Singh et al. 2020).

Table 1 – Commonly-used similarity metrics

Name	Description	Usage
Euclidean distance	Straight-line distance between points in an n-dimensional space	Used in financial decision-making, demonstrating how Euclidean distance can be integrated into investment selection and evaluation problems (Merigo, Casanovas 2011).
Manhattan distance	Sum of absolute differences between coordinates, such as city block paths	Applied to recommendation systems for customer behavior analysis and personalized hotel recommendations (Uyanık, Orman 2023).
Canberra distance	Weighted version of Manhattan distance	Permata et al. (2025) employed Canberra distance within k-means clustering to segment customers and compared the results with those obtained through alternative distance metrics.
Chord distance	Similarity measure after normalizing vector lengths to unit lengths	Used to quantify dissimilarity between companies' accounting information as part of clustering for stock picking and investment analysis (Thrun 2022).
Hamming distance	Number of positions with different symbols (used in binary data)	Kuswardana et al. (2025) used Hamming distance to segment customers based on transaction attributes (e.g., payment method and order type).
Cosine similarity	Cosine of angle between vectors, indicating directional similarity	Albone (2024) applied cosine similarity to identify groups of customers with similar preferences and behaviors.
Jaccard similarity	Similarity of sets by comparing the intersection to union	Kosub (2019) demonstrated that Jaccard similarity satisfies the triangle inequality and, therefore, constitutes a valid metric on finite sets.
Dot product	Sum of element-wide multiplications, indicating magnitude and direction	Used in collaborative filtering and matrix factorization models to predict user preferences (Gunathilaka et al. 2025).

Euclidean distance is the straight-line distance between two vectors in a multidimensional space. The equation for calculating the Euclidean distance between two vectors $\boldsymbol{a}$ and $\boldsymbol{b}$ is as follows:

$$d(\boldsymbol{a}, \boldsymbol{b}) = \sqrt{(a_1 - b_1)^2 + (a_2 - b_2)^2 + \cdots + (a_n - b_n)^2} \quad (1)$$

It is a straightforward similarity metric in that it literally reflects the distance between each of the values of the vectors being compared; if the Euclidean distance is small, then the values of each coordinate in the vectors are close. This does not hold for cosine similarity in general. The Euclidean distance works well when the magnitude of the vectors and spatial relationships are important (Singh, Singh 2021). However, this method is sensitive to outliers and scale (Huang et all. 2020).

Cosine similarity is a measure of the angle between two vectors (Lahitani, Permanasari, Setiawan 2016). It is computed by taking the dot product of the vectors and dividing it by the product of their magnitudes, as follows:

$$similarity(\boldsymbol{a}, \boldsymbol{b}) = \cos\theta = \frac{\boldsymbol{a} \cdot \boldsymbol{b}}{\|\boldsymbol{a}\| \|\boldsymbol{b}\|} \quad (2)$$

where a and *b* are the vectors being compared, "•" stands for the dot product, and ||a|| and ||b|| stand for the vectors' lengths. This metric is useful when the direction of the vectors is more important than their magnitude; unlike the Euclidean distance, it is robust to scale differences (Kryszkiewicz 2014). The metric is commonly used in text analysis and recommendation systems. However, it ignores vector magnitude, which may be crucial depending on the context.

This study addresses land lots, which are essentially tied to spatial relationships. Consequently, the use of Euclidean distance is necessary. However, land lots can differ significantly in attributes, such as price and size, necessitating a scale-robust metric, such as cosine similarity. Therefore, both metrics need to be utilized in the analysis, as they provide complementary perspectives on the relationships between land lots.

2.2. Use of similarity metrics in property valuation

Similarity metrics play a central role in property valuation, particularly in the sales comparison approach, which relies on identifying and adjusting comparable properties. Early studies have emphasized qualitative and quantitative techniques to operationalize similarities in valuation practices. Barańska (2009) proposed a two-step valuation framework in which comparable properties are first selected based on similarity metrics, followed by value estimation using those comparables. A key insight of this work is that valuation accuracy does not necessarily improve with an increasing number of attributes. Instead, focusing on a limited set of important characteristics can lead to more robust price predictions. This

finding underscores the significance of attribute selection in sales comparison approach.

Building on traditional comparison methods, De Ruggiero and Salvo (2011) advanced the adjustment grid method by formalizing a similarity metric and introducing a reliability metric. Their approach quantifies not only how similar comparable properties are to the subject property, but also how reliable each comparable is within the valuation sample. By identifying anomalies and reducing their influence, these similarity and reliability metrics contribute to more consistent price estimates. This study highlights the reduction of subjectivity in valuation through a systematic similarity assessment.

Recent research has reflected a methodological shift toward data-driven similarity metrics. Li et al. (2023) employed neural networks to compute the similarity between geospatial elements, including linear features (e.g., rivers and roads) and polygonal features (e.g., land parcels and buildings). This research used Euclidean distance as its primary similarity metric. Its significance lies in how neural networks significantly reduced the need for manual feature engineering and data format conversion, thereby streamlining the comparison process.

Extending this trajectory, Renigier-Biłozor and Janowski (2024) proposed a human–machine synergy framework that conceptualizes property similarity across heterogeneous data types, including numerical attributes, textual descriptions, and images. By incorporating convolutional neural networks for visual data and large language models for text, their study broadens the notion of similarity beyond traditional tabular data. Collectively, these studies illustrate the evolution from rule-based similarity measures to AI-assisted approaches that enhance the scope and precision of property valuation.

As demonstrated in prior studies, the selection of sales comparables is a crucial initial step in determining property value. Currently, this selection is performed manually, introducing potential practitioner bias. Real estate platforms typically recommend properties to clients based on filters such as price and construction year, which could inadvertently exclude clients' preferences during the initial screening. This study reduces subjectivity and improves efficiency in the real estate sector by leveraging similarity metrics.

2.3. Conversion of textual data to numerical representations

Similarity metrics can only be applied to numerical data. It is difficult to apply them to textual data (qualitative data), such as customer reviews and property descriptions, because of the absence of a predefined format. Thus, similarity metrics have been primarily used for numerical data in outlier detection (Radovanović, Nanopoulos, Ivanović 2014) and time series analysis (Silva et al. 2018).

However, with the increasing popularity of large language models (LLMs), techniques for converting textual data into numerical representations have advanced rapidly. Numerous conversion models, that is, embedding models, are currently available. Embedding models transform high-dimensional textual data into low-dimensional vectors, thereby capturing semantic meanings and relationships (Li et al. 2020). In natural language processing, words or sentences are converted into dense vectors by these models that dramatically facilitate mathematical operations by mapping discrete data (such as words) into continuous vector spaces (Yang et al. 2014).

Term frequency–inverse document frequency (TF-IDF) is a statistical measure used to evaluate the importance of a word in a document relative to a collection of documents. It is one of the earliest models for textual representation that focuses on the frequency of terms while reducing the weight of commonly used words (Aizawa 2003, Ramos 2003). Following TF-IDF, word embedding models such as Word2Vec have emerged; they represent words in a continuous vector space and capture the semantic similarities between words by placing similar words closer together in the vector space. Word2Vec uses neural networks to learn word associations, thereby significantly improving the quality of text representations (Mikolov et al. 2013). More recently, transformers such as bidirectional encoder representations from transformers (BERT) and generative pre-trained transformers (GPT), have revolutionized natural language processing by using self-attention mechanisms to capture contextual relationships in texts more effectively (Rodrawangpai, Daungjaiboon 2022; Vaswani et al. 2017). Transformers can process entire sentences simultaneously, allowing for a better understanding and generation of the human language.

Textual data in the real estate industry, such as property descriptions in listings, offer valuable information, but have been underutilized because of the absence of structured data representations. This study converts descriptions of geographical locations into numerical representations using an embedding model, making them readily available for similarity metrics. Therefore, this study contributes to real estate literature by incorporating textual data to calculate property similarities, an approach rarely seen in the literature.

3. Data and method

3.1. Study area and dataset

Gwangjin-gu, one of 25 districts in Seoul, was selected as the study area. Gwangjin-gu is a typical district in Seoul with regard to land price levels and resident incomes. Figure 1 shows the study area and locations of the land lots.

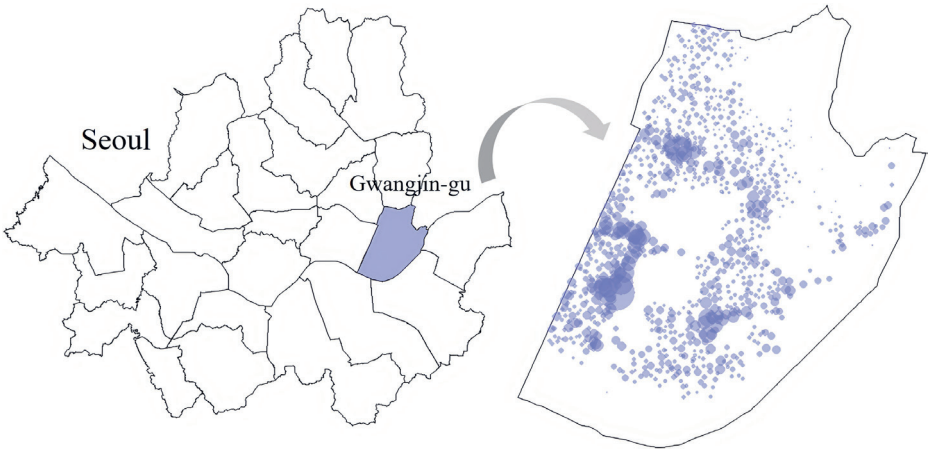


Fig. 1 – Study area and locations of land lots. The circle sizes are proportional to their unit prices.

The circle sizes in the figure are proportional to the unit prices of the land lots. Expensive land lots are concentrated in the western part of the study area, which corresponds to the main boulevard. The sparsely populated areas correspond to preserved and mountainous areas.

The land lots shown in Figure 1 are benchmark lots. The benchmark lot data were obtained from the Ministry of Land, Infrastructure, and Transport (MOLIT).[1] MOLIT conducts annual surveys of these benchmark lots, making the results publicly available for stakeholder use in transactions and investments, as well as for monitoring real estate market trends. The price data were taken from 2022 surveys by licensed property appraisers. While the data encompass price information and various land characteristics such as lot area and zoning, they lack information on the distance to subway stations, which is important for property valuation and recommendation. This information was collected separately[2] and added to the dataset. Table 2 shows the summary statistics of the 1,014 benchmark land lots.

Based on the median values from the table, a typical lot in Gwangjin-gu can be described as a land lot with an area of 180.0 m² and probable price of 2,600,000 KRW/m² (approximately 1,900 USD/m²). This lot is most likely located in the second residential zone, adjacent to a 7-meter-wide road. It is situated 466.9 and 581.4 meters from the nearest subway station and railway, respectively.

The dataset includes the description of the benchmark lots' geographical locations. Table 3 presents examples of these descriptions. As shown in the table, it provides valuable information about the accessibility and connectivity of a lot,

[1] The data are publicly available at https://www.data.go.kr/data/15004246/fileData.do.
[2] Subway station data are available at https://data.kric.go.kr/rips/M_01_01/detail.do?id=32.

Table 2 – Summary statistics (n = 1,014)

	Min.	Median	Mean	Max.
Unit price (KRW/ m²)	20,500	2,600,000	3,120,000	21,300,000
Site area (m²)	69.0	180.0	584.2	69,292.0
Road width (m)	0 (no road)	7	11	32
Distance to station (m)	27.2	466.9	476.4	1,458.8
Distance to railway (m)	5.5	581.4	486.7	640.0
Zoning (number of lots, proportion)	open space zone (14, 1.4%), 1st residential zone (118, 11.6%), 2nd residential zone (590, 58.2%), 3rd residential zone (168, 16.6%), quasi-residential zone (85, 8.4%), commercial zone (39, 3.8%)			

Table 3 – Examples of the description of geographical location

Lot #	Description of geographical location
6	Near the southern side of the National Hospital.
37	Near the northern side of Junggok Traditional Market.
429	Near the northern side of the Gwangjin Post Office.
845	On the southwest side of Sejong University.
997	On the northern side of Konkuk University Station (Subway line 2).

which can influence its price. For example, the description of land lot 997 suggests that it is easily accessible from the main transportation hub (Konkuk University Station). Therefore, excluding this information could result in an incomplete comparison of land characteristics. This study adds "description of geographical location" to the list of comparisons by converting it into numerical form.

3.2. Methodology

Nine variables are used as comparison components: unit price, site area, road width, distance to station, distance to railway, geographical coordinates X and Y, zoning, and description of geographical location.[3] All variables are numerical data

[3] In the Korean real estate market, factors such as price, road width, and zoning are crucial for land valuation and were included in this study. Attributes such as distance to transportation hubs were included based on available data. While additional factors like school district reputation and foot traffic could enhance valuation accuracy, they were omitted due to data limitations. The selection of these nine attributes balances valuation practices with data availability, providing a robust framework for analyzing property similarities within the scope of this study.

except for zoning and description of geographical location: zoning is categorical, and description of geographical location is textual. To facilitate the calculations, zoning is encoded based on the price levels in each zone as follows: open space zone is coded as 1, 1st residential zone as 2, 2nd residential zone as 3, 3rd residential zone as 4, quasi-residential zone as 5, and commercial zone as 6. This coding generally aligns with average price levels in each zone.

BERT is used to convert the textual data (description of geographical location). BERT is a transformer-based model designed to pre-train deep bidirectional representations by considering both the left and right contexts in all layers (Devlin et al. 2019). Although early embedding models like Word2Vec and TF-IDF have their merits, particularly in scenarios with simpler text data, BERT's ability to capture contextual and semantic information makes it better suited for this study. BERT ensures that textual data is meaningfully incorporated into similarity metrics. Unlike earlier models, which may struggle with rare words or polysemy, BERT can effectively handle these challenges by leveraging contextual embeddings. BERT has several variants, and a relevant variant is selected considering the performance and computational burden. The BERT variant selected in this study has 12 layers (transformer blocks), 768 hidden units per layer, and 12 attention heads.[4] Owing to the 768 hidden units per layer, the output embedding vector has 768 dimensions, resulting in a 1,014 × 768 matrix.

The 768-dimensional embedding vector can be directly fed into the calculation for similarity metrics. However, to enhance computational efficiency, the embedding vector is reduced to smaller dimensions using principal component analysis (PCA). PCA statistically converts a large number of dimensions into smaller dimensions that continue to contain most of the larger sets' information (Jolliffe 2002). By reviewing the variance explained by each principal component, the number of principal components is set to 10, which explains 65.1% of total variance.

Euclidean distance and cosine similarity are then applied to the nine variables to compute the similarity values among the land lots.

4. Results

4.1. Specifications of the reference land lot

To calculate the similarity values between the data points, a reference data point needs to be first established. The reference point serves as a standard against

[4] Specifically, the BERT-base-uncased version is used for analysis. The "base" version of BERT has a total of 110 million parameters, and "uncased" means that the text is converted to lowercase before tokenization. This version balances performance and computational efficiency.

Table 4 – Specifications of the reference land lot

Unit price (KRW/ m²)	Site area (m²)	Road width (m)	Distance to station (m)
2,600,000	180.0	7	466.9
Distance to railway (m)	Zoning	Geographical coordinate X	Geographical coordinate Y
581.4	2nd residential zone	207,635.142	449,023.161
Description of geographical location			
[−0.1339, −0.7720, −0.0329, 0.0001, 0.0134, −0.1375, 0.0387, −0.0308, 0.0418, −0.0333]			

which similarity values for all other data points are computed. Table 4 presents the specifications of a reference lot in Gwangjin-gu using the median values for each variable. For example, the unit price in the table represents the median price of the 1,014 land lots included in this study. The most frequently observed description was selected to describe the geographical location of the reference land lot. We use this imaginary lot as the reference land lot, which serves as the standard for comparison.

4.2. Comparison of the reference land lot with comparables

Table 5 shows the results when Euclidean distance is employed for comparison: five most similar and dissimilar comparables. In Euclidean distance, a value close to zero means that the two vectors being compared are very similar, while the larger the value, the more different the vectors.

The most similar comparables chosen are close to the reference lot for all the attributes presented in the table. In particular, the categorical variable zoning is identical for both the reference lot and five comparables, all of which are in the 2nd residential zone. Conversely, the most dissimilar comparables differ significantly from the reference lot for most of the attributes shown in the table.

Figure 2 illustrates the locations of the comparables presented in Table 5. The five most similar comparables are positioned close to the reference lot, whereas the most dissimilar comparables are located at a relatively greater distance. This outcome was expected because geographical coordinates X and Y were employed as a component of the comparison. Using geographical coordinates to calculate the Euclidean distance ensures geographical proximity to the reference lot.

Table 6 shows the results when cosine similarity is employed for comparison: five most similar and dissimilar comparables. In cosine similarity, a value close to one means that the two vectors being compared are very similar, whereas a value around zero indicates that the vectors are dissimilar. Cosine similarity can have negative values, and a value close to –1 indicates that the vectors are opposites.

Table 5 – Comparables selected by Euclidean distance

Land lot	Unit price (KRW/m²)	Site area (m²)	Road width (m)	Dist. to Stn. (m)	Dist. to Rw. (m)	Zoning	Similarity value
Reference	2,600,000	180.0	7	466.9	581.4	2nd resi.	0.00
Most similar comparables	3,040,000	155.7	6	569.4	614.8	2nd resi.	0.64
	2,490,000	185.8	6	587.6	564.7	2nd resi.	0.69
	2,110,000	191.7	6	476.7	562.3	2nd resi.	0.71
	2,140,000	145.5	7	500.0	603.6	2nd resi.	0.77
	2,270,000	113.4	6	572.1	599.1	2nd resi.	0.78
Most dissimilar comparables	5,050,000	35,977.0	32	182.4	2.1	quasi-resi.	11.07
	21,300,000	889.9	32	91.7	30.3	commercial	12.41
	28,500	52,407.0	0	1,038.4	639.9	open space	14.75
	35,500	57,960.0	10	887.7	587.4	open space	16.10
	20,500	69,292.0	0	693.3	588.6	open space	19.08

Note: Dist. to Stn., Dist. to Rw., 2nd resi., and quasi-resi. indicate the distance to station, distance to railway, 2nd residential zone, and quasi-residential zone, respectively. Geographical coordinates *X* and *Y*, and description of geographical location are not shown for brevity.

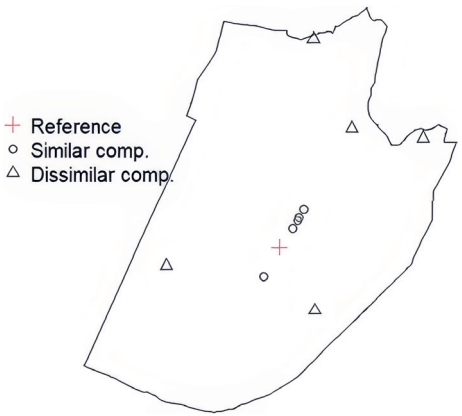


Fig. 2 – Locations of comparables selected by Euclidean distance

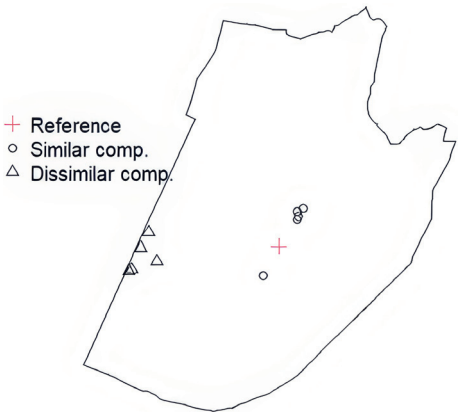


Fig. 3 – Locations of comparables selected by cosine similarity

In short, cosine similarity ranges from –1 to 1, and the larger the value, the more similar the vectors.

As with Euclidean distance, the most similar comparables exhibit attributes similar to the reference lot, as illustrated in the table. The stars in the last column indicate comparables that were also detected using Euclidean distance. The most dissimilar comparables are notably different from the reference lot for most attributes shown in the table, similar to Euclidean distance. However, dissimilar

Table 6 – Comparables selected by cosine similarity

Land lot	Unit price (KRW/m²)	Site area (m²)	Road width (m)	Dist. to Stn. (m)	Dist. to Rw. (m)	Zoning	Similarity value
Reference	2,600,000	180.0	7	466.9	581.4	2nd resi.	1.000
Most similar comparables	1,740,000	245.0	6	540.1	626.5	2nd resi.	0.885
	2,140,000	145.5	7	500.0	603.6	2nd resi.	*0.882
	2,110,000	191.7	6	476.7	562.3	2nd resi.	*0.881
	2,270,000	113.4	6	572.1	599.1	2nd resi.	*0.877
	3,040,000	155.7	6	569.4	614.8	2nd resi.	*0.870
Most dissimilar comparables	5,550,000	762.7	32	551.6	314.4	3rd resi.	–0.753
	5,560,000	916.7	28	268.2	5.8	3rd resi.	–0.766
	4,620,000	211.9	25	510.2	328.9	3rd resi.	–0.801
	5,330,000	375.5	32	502.2	16.7	3rd resi.	–0.813
	4,200,000	209.6	28	621.3	282.1	3rd resi.	–0.822

Note: Dist. to Stn., Dist. to Rw., 2nd resi., and 3rd resi. indicate the distance to station, distance to railway, 2nd residential zone, and 3rd residential zone, respectively. Geographical coordinates *X* and *Y*, and description of geographical location are not shown for brevity.

comparables appear to share common attributes. For instance, their unit prices range from 4,000,000 to 5,500,000 KRW, and they are all in the 3rd residential zone.

Figure 3 shows the locations of the comparables listed in Table 6. As with Euclidean distance, the five most similar comparables are situated close to the reference lot, while the most dissimilar comparables are further west of the reference lot.

4.3. Evaluating the performance of Euclidean distance and cosine similarity

Relying on a single reference land lot is insufficient for a definitive evaluation of the effectiveness of similarity metrics. This study compares the performance of Euclidean distance and cosine similarity in land price estimation using the k-nearest neighbor (KNN) method. The process involves two steps. First, the prices of land lots are estimated by selecting the k most comparable lots using Euclidean distance calculations and averaging their prices. Second, the same procedure is repeated using cosine similarity calculations. Subsequently, the performance of both metrics is evaluated using the mean absolute percentage error (MAPE) and coefficient of dispersion (COD), which are widely recognized criteria for assessing valuation accuracy (IAAO 2013; Numan, Yusoff 2024).

The MAPE represents the average percentage difference between the predicted and observed prices, with lower values indicating higher accuracy. Although no

Table 7 – Performance comparison of KNN and regression models on the test dataset

Evaluation criterion	KNN with Euclidean distance	KNN with cosine similarity	Regression model
MAPE	18.5	17.1	25.9
COD	19.1	17.3	26.3

universal threshold exists for MAPE, Numan and Yusoff (2024) reported that values between 10% and 20% are generally considered acceptable for practical application. COD assesses the consistency of price estimates, with a lower COD signifying more reliable valuation. According to IAAO (2013) guidelines, COD values below 20% and 25% are acceptable for urban and rural land lots, respectively. The formulas for MAPE and COD are as follows:

$$MAPE = \frac{1}{n}\sum \left|\frac{prediced\ price - observed\ price}{observed\ price}\right| \times 100 \tag{3}$$

$$COD = \frac{1}{n}\sum \frac{|ratio - median\ ratio|}{median\ ratio} \times 100, where\ ratio = \frac{prediced\ price}{observed\ price} \tag{4}$$

The dataset of 1,014 land lots is divided into training (70%, 709 lots) and test (30%, 305 lots) data. The performance of the two similarity metrics is assessed using the test dataset. For comparison, a standard regression model is also applied, which uses the unit price of each land lot as the dependent variable and the comparison components from the similarity calculations as independent variables.[5] The results of the KNN and regression models for the test dataset are presented in Table 7.[6]

The results indicate that KNN with cosine similarity outperforms KNN with Euclidean distance, while the standard regression model performs the least effectively. To visually confirm these findings, Figure 4 illustrates the goodness-of-fit of the three models. The similarity-based models (Euclidean distance and cosine similarity) show predicted prices that closely align with the observed prices, whereas the standard regression model exhibits a greater deviation from the observed values.

While the relatively small sample size of 305 land lots prevents a definitive conclusion about which similarity metric is more effective for land price estimation, the results suggest that the similarity-based approach outperforms traditional regression models. Moreover, the performance of this approach meets industry standards, as evidenced by criteria such as the MAPE and COD.

[5] They include site area, road width, distance to station, distance to railway, geographical coordinates X and Y, zoning, and description of geographical location.

[6] For KNN, the parameter k was set to 5 based on performance assessments during KNN training.

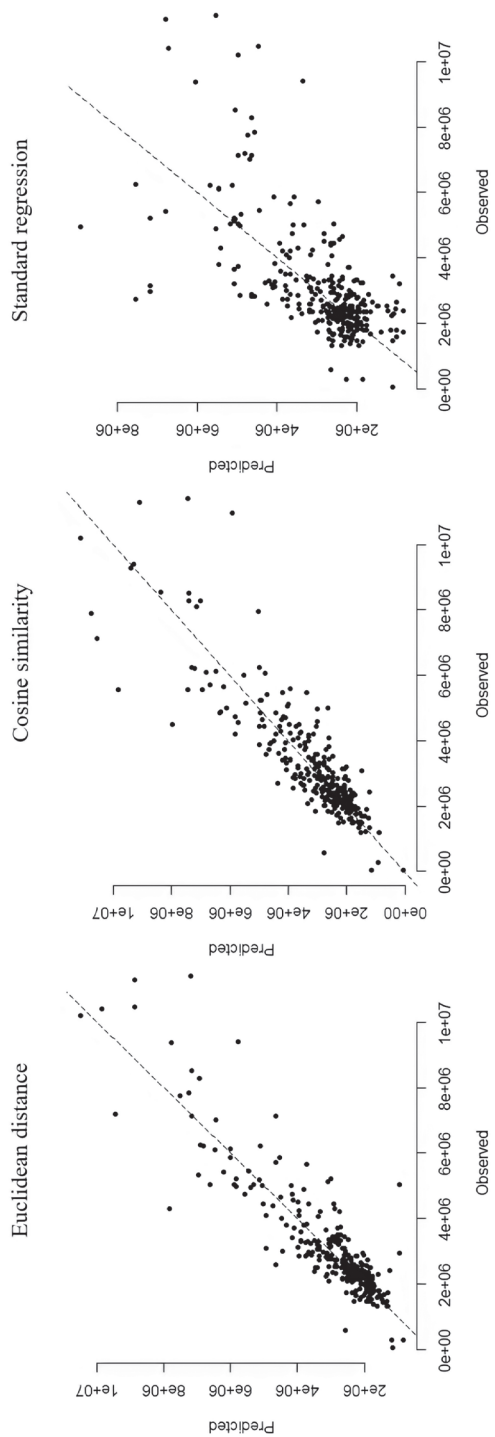


Fig. 4 – Goodness-of-fit for KNN and regression models on the test dataset

5. Discussion

The most similar comparables selected by the two similarity metrics are almost identical, with four of the five overlapping (Tables 5 and 6). However, the most dissimilar comparables identified by the two metrics are distinct, with no overlap. When using Euclidean distance, the most dissimilar comparables are significantly different from the reference lot for various attributes. This difference is more apparent in geographical coordinates. In Figure 2, dissimilar comparables are located far from the reference land lot and scattered across the study area. This is because Euclidean distance penalizes large differences both in magnitude and direction, leading to a dispersed distribution of dissimilar comparables.

By contrast, cosine similarity measures the cosine of the angle between two vectors, focusing solely on direction, not magnitude. The most dissimilar comparables selected by cosine similarity (as with Euclidean distance) differ from the reference lot for various attributes. However, the cosine similarity resulted in a clustered set of dissimilar comparables. As shown in Table 6, they share three common attributes: price range (4,000,000–5,500,000 KRW/m^2), road width (25–32 m), and zoning (3rd residential zone). This pattern is more apparent in the geographical coordinates. As shown in Figure 3, the comparables are clustered in one corner of the study area. The comparables that are directionally different from the reference lot are considered dissimilar even if they are not necessarily the farthest in terms of actual magnitude. This led to dissimilar comparables being grouped into a particular area with similar directional deviations from the reference lot. These findings offer insight into the behavioral differences between the two metrics and highlight the importance of metric selection in spatial analyses.

Beyond the analysis based on a single reference land lot, this study rigorously evaluated the performance of a similarity-based approach using MAPE and COD. The similarity-based approach surpasses the traditional regression model and aligns with industry benchmarks. This empirical evidence reinforces the superiority of instance-based valuation over model-based valuation. Model-based valuation, such as linear regression, relies on learning explicit functions or parameters during training, which may introduce limitations owing to the underlying assumptions. However, instance-based valuation, such as KNN, operates by directly comparing new instances to stored examples, avoiding the need for rigid assumptions (e.g., linearity or homogeneity). Their flexibility makes them particularly robust in scenarios where data relationships are complex. Thus, this study advocates for the broader adoption of instance-based valuation in mass appraisal and automated valuation systems, particularly in contexts where land prices are influenced by intricate and localized factors.

The application of similarity metrics extends beyond valuation to the enhancement of property recommendation systems. Current real estate platforms

typically employ sequential filter-based searches, in which users incrementally apply criteria such as price or size. This approach risks the premature exclusion of properties that may align with user preferences. By leveraging similarity scores to present candidates holistically – considering all attributes simultaneously – the likelihood of overlooking ideal properties in the early search stages is significantly reduced. This shift could improve user satisfaction and the efficiency of property matching.

We calculated the similarity values using nine comparison components: unit price, site area, road width, distance to station, distance to railway, geographical coordinates X and Y, zoning, and description of geographical location. Each component was assigned an equal weight to calculate its similarity value. However, the weights can be adjusted for each component to integrate domain-specific knowledge. For example, in South Korean land valuation, road width and zoning are typically considered critical factors in determining land prices; hence, these two components may be given higher weights than the others. Therefore, for Euclidean distance, Equation (1) can be modified as follows:

$$d_w(\boldsymbol{a}, \boldsymbol{b}) = \sqrt{w_1(a_1 - b_1)^2 + w_2(a_2 - b_2)^2 + \cdots + w_n(a_n - b_n)^2} \tag{5}$$

where denotes the weight assigned to each component. Weights can be derived from expert surveys, Bayesian estimation, or correlations between attributes and prices. This adaptability enables practitioners to tailor similarity metrics to sector-specific requirements and enhance the accuracy in diverse applications.

This study bridges two critical gaps in the literature. First, it provides a comprehensive analysis of both similar and dissimilar comparables, offering a nuanced understanding of the influence of different metrics on comparable selection. Second, it rigorously evaluates the performance of instance-based valuation against industry standards, highlighting their potential as a viable alternative to traditional model-based valuation. By addressing these understudied aspects, this study paves the way for more refined valuation and recommendation systems.

6. Conclusion

Although similarity metrics have significant potential, their application to the real estate sector has been largely overlooked. This study shows that these metrics can be leveraged for property valuation and recommendation. By analyzing 1,014 benchmark land lots in Gwangjin-gu, Seoul, and using nine key land characteristics (including geographical descriptions converted into numerical representations via an embedding model), we found that Euclidean distance and cosine similarity metrics yielded nearly identical results for the most similar comparables. This suggests that both the metrics can be effectively employed in

the real estate industry. However, the most dissimilar comparables identified by these metrics differed.

Our findings indicate that similarity metrics can enhance property valuation and recommendation by reducing the subjectivity involved in selecting sales comparables and minimizing the risk of missing a user's preferred property during the initial search. Furthermore, these metrics can be tailored to align with domain-specific knowledge by assigning different weights to each land attribute, thereby increasing their relevance across various real estate sectors.

The dataset used consists of 1,014 benchmark land lots, which may not be sufficiently large to capture the full diversity of real estate characteristics. A larger dataset could provide more generalizable results. Additionally, the focus on a single district, Gwangjin-gu in Seoul, limits the applicability of the findings to other regions with potentially different market dynamics. Future research should consider expanding the dataset size and geographical scope to include diverse urban and rural areas, thereby enhancing the generalizability of similarity metrics in the real estate industry.

References

AIZAWA, A. (2003): An information-theoretic perspective of TF-IDF measures. Information Processing & Management, 39, 1, 45–65. https://doi.org/10.1016/S0306-4573(02)00021-3

ALBONE, A. (2024): Building customer and product networks with cosine similarity in graph analytics for deep customer insight. Engineering, MAthematics and Computer Science Journal, 6, 3, 215–218. https://doi.org/10.21512/emacsjournal.v6i3.11693

BARAŃSKA, A. (2009): Qualitative and quantitative methods for assessing the similarity of real estate. Value in the process of real estate management and land administration. Towarzystwo Naukowe Nieruchomości, Olsztyn, 31–42.

DE RUGGIERO, M., SALVO, F. (2011): Misure di similarità negli adjustment grid methods. Aestimum, 58, 1, 47–58.

DEVLIN, J., CHANG, M.W., LEE, K., TOUTANOVA, K. (2019): BERT: Pre-training of deep bidirectional transformers for language understanding. arXiv preprint arXiv:1810.04805.

FAISAL, M., ZAMZAMI, E.M. (2020): Comparative analysis of inter-centroid k-means performance using Euclidean distance, Canberra distance and Manhattan distance. Journal of Physics: Conference Series, 1566, 1, pp. 012112). IOP Publishing. https://doi.org/10.1088/1742–6596/1566/1/012112

FAUZAN, R., LABIB, M.I.A., JOHANNIS, J.O.T., NOOR, S. (2022): Semantic similarity of Indonesian sentences using natural language processing and cosine similarity. In 2022 4th International Conference on Cybernetics and Intelligent System, IEEE, pp. 1–5. https://doi.org/10.1109/ICORIS56080.2022.10031416

GUNATHILAKA, T.M.A.U., MANAGE, P.D., ZHANG, J., LI, Y., KELLY, W. (2025): Addressing sparse data challenges in recommendation systems: A systematic review of rating estimation using sparse rating data and profile enrichment techniques. Intelligent Systems with Applications, 200474. https://doi.org/10.1016/j.iswa.2024.200474

HUANG, R., CUI, C., SUN, W., TOWEY, D. (2020). Poster: Is Euclidean distance the best distance measurement for adaptive random testing? In 2020 IEEE 13th International Conference on Software Testing, Validation and VerificationIEEE, pp. 406–409. https://doi.org/10.1109/ICST46399.2020.00049

IAAO (2013): Standard on ratio studies. Kansas City, MO: International Association of Assessing Officers.

JOLLIFFE, I.T. (2002): Principal component analysis for special types of data, New York: Springer, 338–372.

KOSUB, S. (2019): A note on the triangle inequality for the Jaccard distance. Pattern Recognition Letters, 120, 36–38. https://doi.org/10.1016/j.patrec.2018.12.007

KRYSZKIEWICZ, M. (2014): The Cosine similarity in terms of the Euclidean distance. In Encyclopedia of Business Analytics and Optimization. IGI Global, 2498–2508. https://doi.org/10.4018/978-1-4666-5202-6.ch223

KUSWARDANA, D.A., PRASETYA, D.A., TRIMONO, T., DIYASA, I.G.S.M., AWANG, W.S.W. (2025): Customer transaction clustering with k-prototype algorithm using Euclidean-Hamming distance and elbow method. International Journal of Advances in Data and Information Systems, 6, 2, 259–275. https://doi.org/10.59395/ijadis.v6i2.1381

LAHITANI, A.R., PERMANASARI, A.E., SETIAWAN, N.A. (2016): Cosine similarity to determine similarity measure: Study case in online essay assessment. In 2016 4th International Conference on Cyber and IT Service Management, IEEE, 1–6. https://doi.org/10.1109/CITSM.2016.7577578

LEGENDRE, P., LEGENDRE, L. (2012): Ecological resemblance. In Developments in Environmental Modelling, 24, 265–335. https://doi.org/10.1016/B978-0-444-53868-0.50007-1

LESKOVEC, J., RAJARAMAN, A., ULLMAN, J.D. (2020): Mining of massive data sets. Cambridge University Press. https://doi.org/10.1017/9781108684163

LI, B., ZHOU, H., HE, J., WANG, M., YANG, Y., LI, L. (2020): On the sentence embeddings from pre-trained language models. arXiv preprint arXiv:2011.05864. https://doi.org/10.18653/v1/2020.emnlp-main.733

LI, P., YAN, H., LU, X. (2023): A Siamese neural network for learning the similarity metrics of linear features. International Journal of Geographical Information Science, 37, 3, 684–711. https://doi.org/10.1080/13658816.2022.2143505

MERIGO, J.M., CASANOVAS, M. (2011): Induced aggregation operators in the Euclidean distance and its application in financial decision making. Expert Systems With Applications, 38, 6, 7603–7608. https://doi.org/10.1016/j.eswa.2010.12.103

MIKOLOV, T., CHEN, K., CORRADO, G., DEAN, J. (2013): Efficient estimation of word representations in vector space. arXiv preprint arXiv:1301.3781.

NUMAN, J.A., YUSOFF, I. M. (2024): Identifying the current status of real estate appraisal methods. Real Estate Management and Valuation, 32, 4, 12–27. https://doi.org/10.2478/remav-2024-0032

PATEL, K., PATEL, H.B. (2020). A state-of-the-art survey on recommendation system and prospective extensions. Computers and Electronics in Agriculture, 178, 105779. https://doi.org/10.1016/j.compag.2020.105779

PERMATA, R.P., ALIFAH, A.N., SANJAYA, I.M.W.A. (2025): Optimizing k-means clustering through distance metric simulation for strategic enrollment segmentation in private universities. CAUCHY: Jurnal Matematika Murni dan Aplikasi, 10, 2, 616–629. https://doi.org/10.18860/cauchy.v10i2.33089

RADOVANOVIĆ, M., NANOPOULOS, A., IVANOVIĆ, M. (2014): Reverse nearest neighbors in unsupervised distance-based outlier detection. IEEE Transactions on Knowledge and Data Engineering, 27, 5, 1369–1382. https://doi.org/10.1109/TKDE.2014.2365790

RAMOS, J. (2003): Using TF-IDF to determine word relevance in document queries. In Proceedings of the First Instructional Conference on Machine Learning, 242, 1, 29–48.

RENIGIER-BIŁOZOR, M., JANOWSKI, A. (2024): Human-machine synergy in real estate similarity concept. Real Estate Management and Valuation, 32, 2, 13–30. https://doi.org/10.2478/remav-2024-0010

RODRAWANGPAI, B., DAUNGJAIBOON, W. (2022): Improving text classification with transformers and layer normalization. Machine Learning With Applications, 10, 100403. https://doi.org/10.1016/j.mlwa.2022.100403

SILVA, D.F., GIUSTI, R., KEOGH, E., BATISTA, G.E. (2018): Speeding up similarity search under dynamic time warping by pruning unpromising alignments. Data Mining and Knowledge Discovery, 32, 988–1016. https://doi.org/10.1007/s10618-018-0557-y

SINGH, R.H., MAURYA, S., TRIPATHI, T., NARULA, T., SRIVASTAV, G. (2020): Movie recommendation system using cosine similarity and KNN. International Journal of Engineering and Advanced Technology, 9, 5, 556–559. https://doi.org/10.35940/ijeat.E9666.069520

SINGH, R., SINGH, S. (2021): Text similarity measures in news articles by vector space model using NLP. Journal of The Institution of Engineers (India): Series B, 102, 329–338. https://doi.org/10.1007/s40031-020-00501-5

THRUN, M.C. (2022): Exploiting distance-based structures in data using an explainable AI for stock picking. Information, 13, 2, 51. https://doi.org/10.3390/info13020051

UYANIK, B., ORMAN, G.K. (2023): A Manhattan distance-based hybrid recommendation system. International Journal of Applied Mathematics Electronics and Computers, 11, 1, 20–29. https://doi.org/10.18100/ijamec.1232090

VASWANI, A., SHAZEER, N., PARMAR, N., USZKOREIT, J., JONES, L., GOMEZ, A.N., POLOSUKHIN, I. (2017): Attention is all you need. Advances in Neural Information Processing Systems, 30.

WANG, J., DONG, Y. (2020): Measurement of text similarity: A survey. Information, 11, 9, 421. https://doi.org/10.3390/info11090421

YANG, B., YIH, W. T., HE, X., GAO, J., DENG, L. (2014): Embedding entities and relations for learning and inference in knowledge bases. arXiv preprint arXiv:1412.6575.

DATA AVAILABILITY

The data used in this study are publicly available and can be accessed at https://www.data.go.kr/data/15004246/fileData.do and https://data.kric.go.kr/rips/M_01_01/detail.do?id=32.

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Where have the Hungarian minority parties gone? Ethnicization and limited minority mobilization in the 2023 parliamentary election in Slovakia

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ABSTRACT This article examines why Hungarian minority parties in Slovakia failed to gain parliament seats in the 2023 election despite their formal unification. Using municipal-level data from 16 districts in southern Slovakia, we analyze spatial patterns of support for the main ethnic Hungarian party, Szövetség-Aliancia, and the factors associated with its vote. The results show that Szövetség-Aliancia's electoral support remains overwhelmingly ethnicized, with a strong and uniform effect of ethnic cleavage. However, the analysis also reveals considerable internal heterogeneity in mobilization within the minority. Voter turnout was systematically lower in ethnically heterogeneous municipalities, indicating uneven electoral mobilization and widespread abstention among the minority electorate. The findings show that although ethnic voting persists, limited mobilization, rather than interparty competition suggested by the nested competition and ethnic outbidding models, has become the key constraint on minority political representation.

KEY WORDS electoral mobilization – ethnic parties – ethnicization – Hungarian minority in Slovakia – nested competition – Szövetség-Aliancia

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1. Introduction

Political parties representing the Hungarian minority in Slovakia played an important role in key political moments of the country. They participated in several government coalitions, helped push through fundamental political reforms, and contributed to Slovakia's democratization. For instance, the Party of the Hungarian Coalition (SMK–MKP; Strana maďarskej koalície – Magyar Koalíció Pártja) was involved in removing autocratic Prime Minister Vladimír Mečiar from power in 1998 and participated in Slovakia's accession to NATO and the EU six years later. Most-Híd, a party that aimed to *bridge*[1] Hungarian and Slovak communities in Slovakia, built its parliamentary successes on coexistence rhetoric and accentuated the pro-EU policy. Nevertheless, despite such political integration at the central level, these parties were unable to fully overcome their ethnic-regional character and remained dependent on electoral mobilization and support mostly from the Hungarian national minority in southern Slovakia (Plešivčák 2011).

The 2020 parliamentary election represented a major turning point; it was the first election in the modern history of Slovakia in which the Hungarian minority parties failed to enter the parliament. Consequently, the minority party structure underwent a reorganization, with SMK–MKP and Most-Híd negotiating a cooperation and unification so that the failure would not be repeated. It resulted in the creation of a new Hungarian minority party – The Hungarian Alliance (Szövetség-Aliancia, Magyar Szövetség – Maďarská Aliancia). The 2023 parliamentary election was thus marked by reflection on whether these efforts had been successful. The pre-election campaign was characterised by concerns and pessimistic expectations (Gál 2023; Belej Majerčínová 2023a), which materialized when the Hungarian minority parties were again unsuccessful in entering the parliament (Harrach 2024). Given the potential constituency of almost 8.5% of the minority electorate in the case of voting according to both self-declared nationality and mother tongue (Štatistický úrad 2021), the combined result of 4.5% for all Hungarian minority parties raises the question of what the limits are of the ethnic Hungarian electoral mobilization in Slovakia. This question is, in its general sense, relevant also beyond the case of the Hungarian national minority parties in Slovakia, as limited mobilization behind some regional parties in the last two decades constrained their long-term aims (e.g. Lepič 2017, Agnew 2018) and the ability to represent the minority community (e.g. Kiss, Székely 2016; Fittante, Himmelroos 2025b).

[1] Most-Híd literally means bridge in Slovak and Hungarian languages, respectively.

2. Research gap and objectives

Since the beginning of Slovakia's democratization in 1989, research in electoral geography has been the subject of several studies. Most authors have focused on the political regionalization of Slovakia based on election results and explanation of their spatial patterns (e.g. Krivý, Feglová, Balko 1996; Plešivčák 2011, 2014). In this respect, Madleňák (2012) emphasized the ongoing importance of the ethno-national cleavage in Slovakia's politics (see also Kostelecký 2001), partially reinforced by the left-right political oppositions. He also contextualized this opposition within the broader range of cleavage effects, including attitudinal, that are capable of cross-cutting the ascriptively delimited societal categories (see also Lijphart 1984, Inglehart 2008). Among the recent studies, Kevický and Daněk (2020) and Kevický and Suchánek (2023) have addressed the role of voter turnout, its spatial dimension at the district level, and the effect of ethnicity on turnout differences in the parliamentary elections between 1996–2016 and in 2020, respectively. Finally, Gyárfášová (2018), Gyárfášová and Hlatky (2023), and Ondruška (2022) examined the recent rise of populist and anti-establishment parties, the importance of leaders for the party choice among voters, and the consequences for (in)stability of the party system in Slovakia.

In this article, we build upon the findings of this literature, but, at the same time, emphasize that there are still gaps in research, particularly when it comes to the geographically nested (see Harbers, Ingram 2017) and detailed analysis of the Hungarian minority's electoral preferences and behaviour. The historically strong support for Hungarian minority parties in southern Slovakia, especially in municipalities with a high proportion of ethnic Hungarians, has indeed been confirmed by several studies (see Plešivčák 2011, Madleňák 2012). We argue, however, that the patterns of electoral support for Hungarian minority parties, and the reasons behind such voting, must be examined not only in the "groupist" terms (see Brubaker 2002) of the ethno-national cleavage but also with regard to the differences in electoral mobilization and voting behaviour within the minority, with the underlying aim to overcome the constraints of methodological nationalism.

Plešivčák (2011) expressed conviction that we can expect the continued dominance of the Hungarian ethnic parties in regions predominantly inhabited by the Hungarian national minority. This ethno-national differentiation of voting enabled by the politicization of national identity corresponds to the premise that ethnicity is one of the fundamental drivers behind political mobilization of the electorate (e.g. Rokkan, Urwin 1983; Horowitz 1985). However, it is clear from the results of the last two parliamentary elections that the Hungarian national minority in Slovakia either voted also for the non-minority parties or did not vote at all (Gyurovszky 2025, Harrach 2024). It demonstrates the internal heterogeneity of

the Hungarian minority community and raises questions about the factors that direct such a cross-cutting.

This article therefore aims to analyse the voting behaviour of the Hungarian minority in the 2023 parliamentary election in southern Slovakia, measured at the level of municipalities (N = 1,012), and contribute to understanding the failure of the Hungarian minority parties, in particular Szövetség-Aliancia. The main objectives are to (1) map the spatial patterns of electoral support for Szövetség-Aliancia, (2) identify the factors that influenced the election results of this party, in particular the strength of ethnic voting, and (3) examine the (un)evenness of minority electoral mobilization in the party's favour.

3. Ethnic parties, cleavages, and (in)equalities in electoral mobilization

The presence of ethnic minority parties within the political spectrum of a country is widely considered to contribute to the stability of democratic systems and, at the same time, to the reduction of political conflict in (not only) post-communist Europe (e.g. Fittante, Himmelroos 2025a; Flesken 2018; Koev 2019; Rovny 2023; Spirova 2012; Svraka 2025). This is because these parties often present a moderate voice in the political arena and enable political incorporation of otherwise neglected minorities. Gradual demise of the Hungarian minority parties in Slovakia therefore instigates not only the questions of stability but also that of (dis)integration: To what extent are the Hungarian minority voters segmented in ethnic voting for "their" parties compared to other state-wide parties, and how (un)equal is minority electoral mobilization in support for these parties? To provide the background for our analysis, in this section, we conceptualize ethnic parties and discuss theoretical assumptions concerning the ethnic segmentation of their voting base vis-a-vis other factors, and the minority's cohesion (or lack thereof) in their electoral behaviour.

The classic definition of ethnic party, developed by Chandra (2004, 2011) and replicated in other accounts (e.g. Strijbis, Kotnarowski 2015; Steward 2019; Svraka 2025), is that ethnic party appeals to voters as the champion of interests of a particular ethnic category (or set of categories) while excluding others, and makes such appeal central to its mobilizing strategy. This definition requires that for political parties to be considered ethnic, their programme, manifestos, appeals, demands, and political goals must be of ethno-cultural nature; their organization, leadership, and membership is from a particular ethnic group, and party constituency is predominantly composed of individuals belonging to particular ethnic category (Ishiyama, Breuning 2011; Higashijima, Nakai 2016). Apparently, not only minority parties but also those aiming to represent the state majority may be classified as ethnic if they have corresponding characteristics (Tarkhani 2024). In

this regard, the definition of ethnic group which the ethnic party aims to represent is made ascriptively in the party's rhetoric, building on the premises of a given nationalism. This normative categorization is frequently at odds with the actual ethnic identification of individuals, and for this reason we consider the target electorate to be a possibly heterogeneous ethnic category, not necessarily a group in an identarian and behavioural sense.

In any case, the definition indicates that not only the party organization and appeals but also its support base is of an importance for party classification as ethnic. Horowitz (1985) even claims that ethnic party must have an ethnic support base, even though this is only one of the ethnic party attributes. We understand this relationship as an interaction: Ethnic party attempts to represent the assumed interests of an ethnic category considered to be a group, and if it is successful, this group mobilizes in the party's favour. In this circumstance, the ethnic party support develops along the ethnic cleavage, meaning that the party gains votes predominantly from a particular ethnic category (Zuber 2013; see also Tanaka 2025). From the perspective of voters, in this scenario they prioritize ethnicity in their decision-making and electoral behaviour. Such ethnic voting externally distinguishes ethnic group's preferences from other ethnic categories in the electoral system. But the thesis of ethnic voting builds on an improbable assumption of homogeneity within the ethnic category and implicates groupism.

Given the frequent occurrence of intra-ethnic heterogeneity, the phenomenon of ethnic voting must be distinguished from electoral mobilization (see Strijbis, Kotnarowski 2015). According to these authors, electoral mobilization can be understood as "the degree to which ethnic parties are able to mobilize their targeted ethnic group" so that the individuals belonging to this category vote for "their" ethnic party. In contrast to the indicator of ethnic voting, measuring electoral mobilization allows us to examine the internal cohesion (or lack thereof) of the ethnic category in electoral support for a party. Importantly, if electoral mobilization in favour of an ethnic party is unequal within the ethnic category in question, we have to consider an alternative scenario for a non-mobilized segment of the minority – support for other than ethnic parties, voter abstentions, or both.

The occurrence of distinct preferences within the ethnic category, which then manifest in different voting behaviours, is similar to the concept of nested competition (Zuber 2012). It delineates a situation in which one ethnic party shifts its appeals in an integrative and cross-ethnic direction when its ethnic competitor manifests growing radicalization. As such, the model of nested competition challenges the premises of ethnic outbidding model (e.g. Zuber, Szöcsik 2015). Nevertheless, given that parties do not build their appeals in a vacuum but always in interaction with the electorate, we posit that the range of party and voter behaviours is wider than both models suggest and, moreover, may vary across time and space. While one fraction within the ethnic category remains solid in

its support for a radicalizing ethnic party, other segments may shift between supporting inclusive majority parties and de-aligning from the electoral system if the inclusive minority parties are not available or not trusted. Even the reasoning behind de-aligning may be driven by different motivations – from general disillusion and feelings that parties do not represent one's interests, through focus on the integration at the local level, to ethno-national kin-state affiliations and election boycott (Waterbury 2020). Our approach therefore contributes to the literature by partially challenging the premises of the nested competition and ethnic outbidding models (e.g. Zuber 2012, 2013; Tarkhani 2024; Stroschein 2011; Spáč, Zagrapan 2025). Moreover, both the power-sharing consociational and the state-centralizing integration models may fail to succeed when ethnic categories are considered only in singular and immutable terms (Lijphart 1979; Dostál, Jelen 2015).

In the analysis that follows, we attempt to explain the gradual decline in the Hungarian minority party support in Slovakia using the aforementioned premises. After mapping the strongholds of Szövetség-Aliancia's support in the 2023 parliamentary election, we analyse the extent to which its support in southern Slovakia is explained by the ethnic cleavage vis-a-vis the influence of other factors. Consequently, we investigate the extent to which the Hungarian minority in Slovakia was internally homogeneous in its preferences for this party. Given that other Hungarian minority parties are nowadays marginal, which disqualifies the potential explanatory power of the ethnic outbidding and the nested competition models, our main aim is to analyse (in)equality in the minority's electoral mobilization in terms of electoral abstentions. Indeed, as argued by Steward (2019), ethnic parties may become marginalized at the central level not only by electoral rules, which frequently favour state-wide parties (such as the 5% threshold), but also by ineffective electoral mobilization within the category which the party aims to represent.

4. Political developments of the Hungarian minority parties in Slovakia after 1989

To understand the position in which the political parties aiming to represent the Hungarian minority in Slovakia – and mainly Szövetség-Aliancia – entered the 2023 parliamentary election, it is essential to introduce the buildout of the minority party structure. This development, in fact, (in)directly influences voter behaviour and its spatial differentiation, including electoral mobilization and thus participation. Since the early 1990s, the Hungarian minority in Slovakia has been represented by a plethora of parties and entities (see Fig. 1).

The evolution of the Hungarian minority's political party structure can be divided into four phases. The first phase, from 1989 to 1998, was characterized by

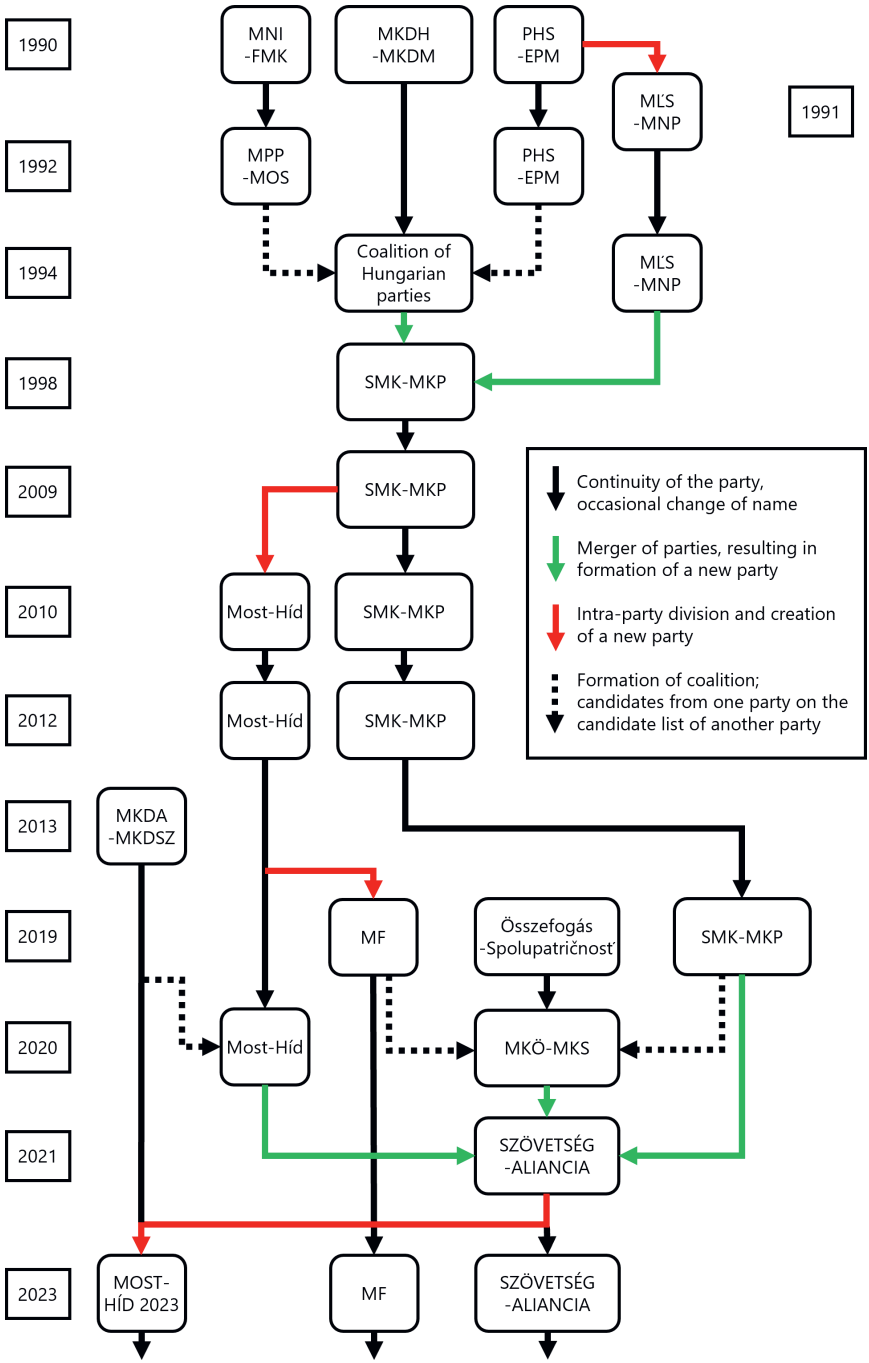


Fig. 1 – The development of political representation of Hungarian minority in Slovakia. The figure was adjusted and updated based on Everett a Redžič (2021).

several smaller ethnic Hungarian parties, some of which cooperated with each other and formed electoral coalitions. For most of the 1990s, Hungarian minority parties were in opposition to the government, with the only exceptions being the first government of Vladimír Mečiar (1990–1991) and subsequent government of Ján Čarnogurský (1991–1992).

The second phase began in 1998 with the merger of most Hungarian parties into the Party of the Hungarian Coalition (SMK–MKP), mainly fuelled by their opposition to Mečiar's nationalist policies. Although SMK–MKP overcame the initial fragmentation of Hungarian minority parties and became part of the government between 1998 and 2006, two factions gradually formed within it. The first faction consisted mainly of politicians from the officialdom, better integrated into the Slovak political and economic circles, while the second was more conservative, with better connections to Hungary as a kin-state (Székely 2014). The former was represented by party chairman Béla Bugár, while the latter by its honorary chairman Miklós Duray. Bugár was a charismatic leader who was often criticized within the SMK–MKP's ranks for being more popular among ethnic Slovaks than Hungarians. Conversely, the more liberal faction criticized Duray's hardline pro-Hungarian ethnic policies, as well as his close relationship with Viktor Orbán and his Fidesz (Kopeček 2007, Székely 2014). Growing polarization consequently led to the SMK–MKP's split in 2009 and the formation of a new, liberal political party, Most-Híd.

This split marks the beginning of the third phase, characterized by rivalry between these two political parties. SMK–MKP took a much more radical, exclusivist stance and focused on the kin-state affiliations. In contrast, Most-Híd aimed for inclusion, cooperation across the ethnic divide, and mutual coexistence (Everett, Redžič 2021; Spáč, Zagrapan 2025). Although SMK–MKP did not succeed in any further parliamentary elections, it still maintained a relatively strong position at the local and regional levels (Mesežnikov 2020). Most-Híd succeeded in the 2010 election, after which the party became incumbent in the Iveta Radičová's centre-right government. The party also entered parliament following the 2012 and 2016 elections, both of which were won by Robert Fico and his party Smer – Sociálna Demokracia (Smer–SD; lit. Direction – Social Democracy). After the 2016 election Most-Híd signed a coalition agreement with Smer–SD, ultra-nationalist Slovak National Party (SNS; Slovenská národná strana), and conservative #SIEŤ (Mesežnikov 2020). This move angered not only a large part of its constituency, but also led to an inner split, when a former minister of agriculture Zsolt Simon left Most-Híd and later in 2019 founded his own party – Hungarian Forum (MF; Magyar Fórum – Maďarské forum; Hospodárske noviny 2019). The resentment was further exacerbated after Most-Híd decided not to leave the coalition nor to support early election following the murders of journalist Ján Kuciak and his spouse Martina Kušnírová (Mesežnikov 2020). In response to the inability

of parties to agree on a joint candidate list before the 2020 parliamentary election, a new political movement, Togetherness (Összefogás–Spolupatričnosť) was formed, which eventually agreed with SMK–MKP and MF on a joint candidate list. This list was created by transforming Togetherness to Hungarian Community Togetherness (MKÖ–MKS; Magyar Közösségi Összefogás – Maďarská komunitná spolupatričnosť; Pravda 2019). In the end, neither MKÖ–MKS nor Most-Híd were successful in their goal of entering the parliament in 2020.

The fourth phase began after the unsuccessful 2020 election bid, when the situation forced representatives of Togetherness, SMK–MKP and Most-Híd to negotiate. In March 2021, they announced a merger and an establishment of a new political party, Szövetség-Aliancia (Postoj 2021). Paradoxically, this merger made Szövetség-Aliancia the party with the largest membership base in Slovakia, with 14,217 declared members (SITA 2022). Despite efforts by the Hungarian parties to achieve unity by joining forces in Szövetség-Aliancia, another split soon occurred. Internal party conflict over the creation of a joint candidate list for the early parliamentary election in 2023 led to the departure of several members, particularly from the liberal platform Most-Híd. The splinter group subsequently founded Most-Híd 2023 and signed cooperation with Slovak party Modrí – ES, creating a Modrí, Most-Híd list (Belej Majerčínová 2023b). Szövetség-Aliancia dominated the election campaign in the Hungarian minority areas, and its vice-chairman György Gyimesi was the most prominent figure of the campaign on social media (Szicherle 2023). Gyimesi's posts focused primarily on criticizing liberal democracy, opposing arms deliveries to Ukraine, and blaming Brussels for its policies on immigration and sexual minorities. He used narratives similar to those of Hungary's ruling party Fidesz, led by Viktor Orbán. Hungary as a claimed kin-state directly intervened in the campaign when, during the election week, the Hungarian Minister of Foreign Affairs and Trade, Péter Szijjárto, visited the border regions in southern Slovakia inhabited predominantly by the Hungarian minority and urged people to vote Szövetség-Aliancia (Szicherle 2023). Another main theme of the election campaign was the regional development of southern Slovakia, with most contributions on this topic being bilingual, attempting to target both ethnic Hungarian and Slovak voters living in these regions. After all, inter-ethnic cooperation at the local level has been noted in other studies (Spáč, Zagrapan 2025). However, given the election results, neither the support of a kin-state partner nor the attempt to surpass the ethnic cleavage brought the party's success.

5. Data and methods

When selecting the study area, it was necessary to consider the spatial distribution of the Hungarian minority in Slovakia. This ensured that the research primarily

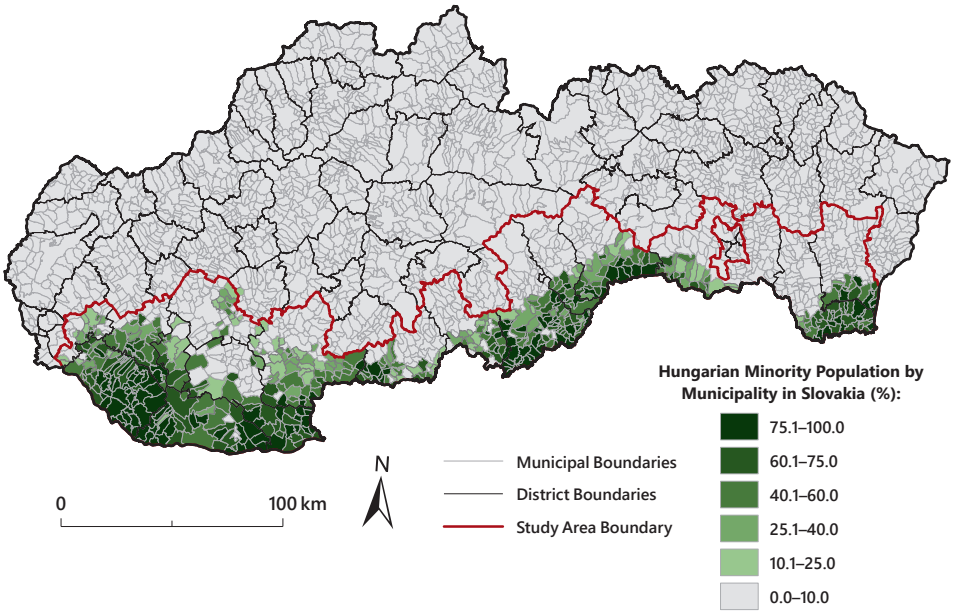


Fig. 2 – Delimitation of the study area and the share of the Hungarian minority population in Slovakia's municipalities. The source for all the base data used for maps is Geoportál (2024).

covered areas where the Hungarian national minority lives, while maintaining sufficient data variability for the analysis. In literature, 16 districts (*okresy*) located in southern Slovakia are most often used when studying the Hungarian minority (see Fig. 2). This is employed, for example, by the Forum Minority Research Institute, which conducts regular sociological surveys and opinion polls focused solely on the Hungarian minority. Mészarosová-Lampl (2019) and Székely (2014) refer to these districts as those with an ethnically mixed population. Several of these districts are identified in the research of Madleňák (2012) and Plešivčák (2011) as the core or periphery of electoral support for the Hungarian minority parties.

These districts are namely (west to east): Senec, Dunajská Streda, Galanta, Šaľa, Komárno, Nové Zámky, Nitra, Levice, Veľký Krtíš, Lučenec, Rimavská Sobota, Revúca, Rožňava, Košice-okolie, Trebišov, and Michalovce. The official administrative boundaries served for defining the extent of the study area. The decision to select entire districts and not merely the municipalities with a predominantly ethnic Hungarian population was based on the need to increase the variability of the sample under study, which allows to properly examine the effects of ethnonational cleavage on voting behaviour.

In order to achieve the most fine-grained data variability, municipalities were appointed as the level of analysis. The study area contains a total of

1,012 municipalities, representing more than one-third of all 2,891 municipalities in Slovakia. This selection includes virtually all municipalities with a significant proportion of the Hungarian national minority. Two general problems of any aggregate data analysis are associated with the definition of the scale level, namely the MAUP effect and the risk of ecological fallacy. A detailed scale level of municipalities is beneficial for minimizing the MAUP problem. The risk of ecological fallacy always persists in an aggregated data analysis. However, the risk of misinterpretation is reduced when explanation focuses on the analysed spatial units, not extrapolating to individuals' behaviour.

In the 2023 election, three political parties attempted to represent the Hungarian minority in Slovakia: Szövetség-Aliancia, Most-Híd 2023, and the MF. Szövetség-Aliancia received a total of 4.38% of the vote (see also Table 2). The other two Hungarian minority parties, which ran in coalitions with one or more other political entities, received less than 0.4% of the vote combined. Specifically, Most-Híd 2023, in coalition with Modrí – ES, received 0.26%, and MF, in coalition with several Slovak parties, received 0.11% (Štatistický úrad 2023). Due to the dominance of Szövetség-Aliancia among Hungarian minority parties and the fact that the two minor parties ran in coalitions with non-Hungarian parties in the election, we focus our analysis on Szövetség-Aliancia.

The main source of demographic and socioeconomic data was the 2021 Population and Housing Census. According to this census, as of January 1, 2021, there were 422,065 people of self-declared Hungarian nationality living in Slovakia, representing 7.75% of the total population. The 2021 census was, however, the first in Slovakia where residents could also declare a second nationality. An additional 34,089 residents declared Hungarian nationality as their second nationality. In total, 456,154 people declared Hungarian nationality as either their first or second nationality. This represents 8.37% of the population of Slovakia. Another important indicator of belonging to the Hungarian national minority is language. Hungarian was listed as the mother tongue by 462,175 people, representing 8.48% of the population of Slovakia (Štatistický úrad 2021).

Individual independent variables that entered the analysis were chosen based on the general conceptual premises of the cleavage theory (e.g. Lipset, Rokkan 1967; Kriesi 1998) and its modifications adapted to the specifics of Slovakia's society and politics (see Kostelecký 2001, Madleňák 2012). Apart from ethnonational cleavage, proxied by the indicator of self-declared Hungarian nationality, we examined the effects of ethno-religious cleavage (Calvinist faith), regional cleavage (distance from Bratislava), economic cleavage (university education, unemployment rate), and urban-rural cleavage (number of inhabitants). For each cleavage, we considered several proxies and eventually selected the aforementioned due to the fact that they represent the markers of the Hungarian minority and contributed to the explanatory power of the model. In addition, we included

Table 1 – Descriptive statistics of the analyzed variables

Variables	Variable dimension	Mean	Minimum	Maximum	Std. deviation
Electoral support of Szövetség-Aliancia	%	21.55	0.00	92.72	26.49
Hungarian nationality	%	29.63	0.00	95.24	32.86
Reformed Church	%	7.14	0.00	72.53	13.06
University education	%	10.51	0.00	33.98	5.69
Distance from Bratislava	km	192.78	11.47	379.44	110.04
Unemployment rate	%	6.81	0.51	31.12	4.78
Age 65+	%	16.46	2.95	34.78	4.35
Number of inhabitants	ln	6.53	2.64	11.28	1.07
Election turnout	%	62.16	27.74	91.89	10.98

one demographic (post-productive age) and one political (voter turnout) control variable. Descriptive statistics of all analyzed variables are shown in Table 1.

In order to examine the relationship between respective independent variables and voting support for Szövetség-Aliancia, a multiple linear regression using OLS was employed. Based on estimating the regression line by choosing the parameters that minimize the sum of squared residuals, this method implicitly assumes the same relationship between variables across all units of analysis. However, given both the incompact of shape of the area under study and the general tendencies of spatial analysis, a certain degree of non-stationarity should be anticipated (e.g. Lepič 2017). For this reason, we complemented the global statistical approach of the linear OLS regression by the local estimates of the coefficients using geographically weighted regression (GWR; Fotheringham, Brunsdon, Charlton 2002; Spurná 2008a). This allowed us to assess the degree to which the effects of respective cleavages are uniform (or locally varying) across the analysed area. Since GWR is a local method, therefore calculating parameter estimates for regression coefficients in each unit, we had to determine surrounding parameters for each local coefficient estimation. Adaptive core of bi-square kernel bandwidth was employed. One of the main interpretative advantages of combining OLS and GWR regressions is that both methods use standardized coefficients ranging within the interval <–1; 1>, where – 1 equates to maximum negative while 1 to maximum positive association between variables. The total explanatory power and quality of the model is measured using the values of adjusted R-Square and AICc, respectively.

Spatial autocorrelation in the global form of Moran's I and its local equivalent LISA was employed in order to examine the degree and patterns of clustering in support for Szövetség-Aliancia, voter turnout, and the spatial association of residuals from the OLS regression model (Anselin 1995). Moran's I ranges within

the interval <–1; 1>, where –1 represents the maximum negative and 1 is the maximum positive spatial autocorrelation. Values close to 0 signify no spatial association. If the value is sufficiently distant from zero, spatial distribution of the phenomenon under study is not random (Spurná, 2008b).

The local indicators of spatial association (LISA) allow visualization of the spatial clustering of the examined variable, thus answering the question of where the low and high values of a phenomenon are clustered. To determine spatial proximity and ascribe units to clusters, a spatial weights matrix had to be established. We have chosen the threshold inverse distance of 10 km as a spatial weights matrix due to the fact that this specific matrix and distance were calculated by us as the most suitable for municipal structure of southern Slovakia.

6. Results

The 2023 parliamentary election in Slovakia was won by Smer–SD with 22.94% of the vote, followed by Progressive Slovakia (PS; Progresívne Slovensko) with 17.96% (see Table 2, which also displays the results of other parties). Voter turnout in the election was 68,51%. Although Szövetség-Aliancia surpassed the MKÖ–MKS's

Table 2 – Party results in the 2023 parliamentary election in Slovakia

Party	Votes	Votes (%)	Municipalities won	Municipalities won (%)	Mandates
SMER–SD	681,017	22.94	1,685	57.57	42
PS	533,136	17.96	180	6.15	32
HLAS–SD	436,415	14.70	280	9.57	27
OĽANO A PRIATELIA, KÚ a ZA ĽUDÍ	264,137	8.89	197	6.73	16
KDH	202,515	6.82	177	6.05	12
SaS	187,645	6.32	2	0.07	11
SNS	166,995	5.62	9	0.31	10
REPUBLIKA	141,099	4.75	5	0.17	0
SZÖVETSÉG – ALIANCIA	130,183	4.38	386	13.19	0
Demokrati	87,006	2.93	0	0.00	0
SME RODINA	65,673	2.21	4	0.14	0
ĽSNS	25,003	0.84	1	0.03	0
KSS	9,867	0.33	0	0.00	0
Piráti	9,358	0.31	0	0.00	0
Modrí, Most-Híd	7,935	0.26	0	0.00	0
MF, ODS, ZR, RK, DS	3,468	0.11	1	0.03	0

election result from 2020, it likewise failed to pass the 5% threshold for entering the parliament. The party received a total of 130,183 votes, which equates to 4.38% of all valid votes cast. Paradoxically, in purely spatial terms, Szövetség-Aliancia was the second most successful party after Smer–SD in the number of municipalities won (386 municipalities, 13.19% of the total; see Table 2 and Figure 3).

6.1. Spatial patterns of electoral support for Szövetség-Aliancia

Looking at the results of the 2023 election specifically in southern Slovakia (Fig. 3), a clear weakening of the relative support for all Slovak majority parties can be seen compared to the country's average. Although Smer-SD was also the strongest party in the study area, the second came Szövetség-Aliancia, which won 16.97% of the vote here, a significant increase compared to its country-wide result (Štatistický úrad 2023). The geographical core of Szövetség-Aliancia's support was concentrated in municipalities along the border with Hungary, and specifically in three main clusters (Fig. 3)[2].

The biggest cluster of Szövetség-Aliancia's support is located in the southern part of western Slovakia, in the Little Danubian Lowland, and specifically on the Žitný ostrov (Csallóköz). It stretches alongside the border with Hungary from suburban municipalities around Bratislava in the west to the town of Šahy, and comprises seven districts, namely, (west to east) Dunajská Streda, Galanta, Šaľa, Komárno, Nové Zámky, Levice and Veľký Krtíš. Within this cluster, the biggest towns are Komárno, Dunajská Streda, Kolárovo, Štúrovo, Veľký Meder, Hurbanovo and Šahy. The cluster boundaries correspond to the core areas of support of SMK–MKP and Most-Híd identified in research of Plešivčák (2011) and Madleňák (2012).

The second cluster is located in the southern part of central-eastern Slovakia, in the Lučenec-Košice Depression and the Slovak Karst. It stretches as a belt along the border with Hungary from the eastern part of the Lučenec district, crossing south areas of the Rimavská Sobota, Revúca and Rožňava districts, with small southwestern part of the Košice-okolie district marking its eastern border. Biggest towns within this cluster are Fiľakovo, Tornaľa and Jesenské. The municipalities in this cluster have a considerably lower population than the other two clusters.

[2] Since LISA delimits clusters based on statistical significance susceptible to the level of analysis and scale of units, we emphasize caution when interpreting the precise cluster boundaries. For instance, many towns that include significant Hungarian minority population and experienced relatively higher support for Szövetség-Aliancia, such as Šamorín, Galanta, Šaľa, Nové Zámky, Želiezovce, Rimavská Sobota, Rožňava, and Moldava nad Bodvou, belong to non-significant cluster, a result that might be influenced by the specifics of statistical calculations.

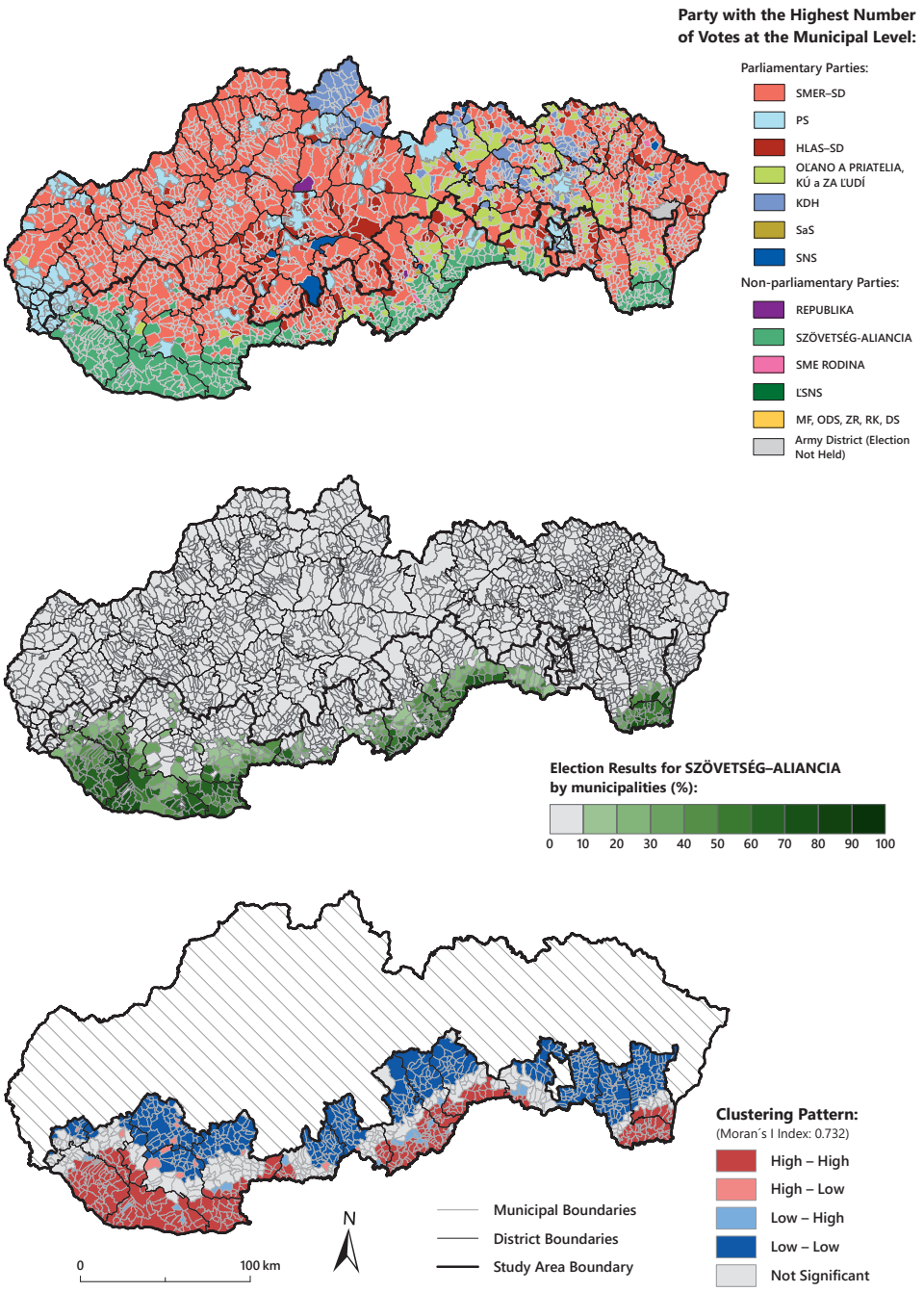


Fig. 3 – Election winners, results of Szövetség-Aliancia, and LISA analysis of Szövetség-Aliancia's support in the 2023 parliamentary election

The third and the smallest cluster of the high support for Szövetség-Aliancia is located in the Eastern Slovak Lowland, mainly in the area between the rivers Bodrog and Tisa. The main part of this cluster is located in the Trebišov district with a small part overstretching to the southern part of the Michalovce district. Towns belonging to this cluster are Kráľovský Chlmec, Veľké Kapušany and Čierna nad Tisou. Similarly to the previous, this cluster has mainly rural characteristics.

Worth highlighting are also outliers to the given pattern. Coloured pink in Figure 3 are ethnic Hungarian municipalities surrounded by areas with a higher proportion of ethnic Slovaks. Similarly, many outliers coloured light blue are ethnic Slovak municipalities in areas predominantly inhabited by ethnic Hungarians. Municipalities where electoral support for Szövetség-Aliancia was low due to the local success of other Hungarian minority parties or Slovak majority parties also belong to this category.

6.2. Ethnicization of electoral support for Szövetség-Aliancia

With regard to the effect of ethnicization, Figure 4 displays a graph of strong and positive correlation between the proportions of Szövetség-Aliancia's support and self-declared Hungarian nationality in municipalities of southern Slovakia. This evidence indicates that support for the party corresponds to the premises of ethnic voting. Interestingly, the regression curve has a character of the quadratic function, which indicates a relationship slightly other than linear. Adjusted R-Square of the quadratic regression curve is 0.920, while it would be 0.914 for the linear relationship. Such quadratic growth suggests a certain contextual effect beyond the examined ethnic structure, even though our quantitative analysis does not allow us to determine what type of contextual effect it is (see also Rodon, Guinjoan 2018).

The linear OLS regression model (Table 3) generally confirms the dominant effect of self-declared Hungarian nationality for explaining Szövetség-Aliancia's support. We present two statistical models: In model 1 the variable of Hungarian nationality was omitted, while it was included in the full model 2 to complement the effects of other predictors. This model 2 is thereby crucial for the comprehensive interpretation of individual effects. The results show that the Hungarian nationality variable had by far the greatest effect on support for Szövetség-Aliancia (standardized beta coefficient = 0.933). Specifically, when the proportion of people declaring Hungarian nationality increases by 1 percentage point (pp) in a municipality, the share of Szövetség-Aliancia's support will increase on average by 0.752 pp, all other variables constant. Adding this variable to the model also significantly increased the total explanatory power measured by adjusted R-Square from 45% (model 1) to 92% (model 2), all while improving the quality of the model

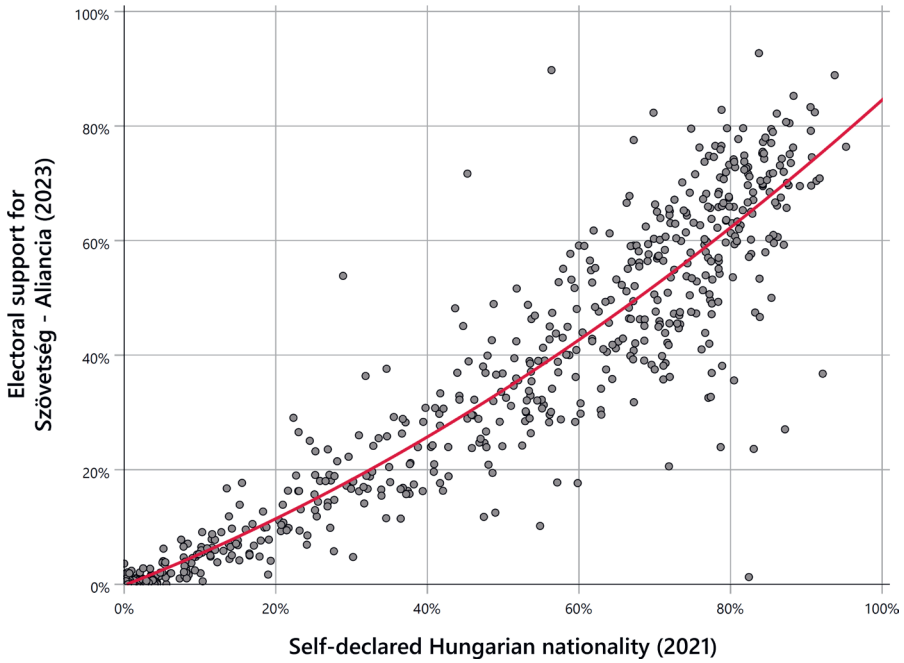


Fig. 4 – Correlation between the proportions of Szövetség-Aliancia gains and Hungarian minority in municipalities within the study area

evidenced by a considerable decrease in the AICc value. Controlling for the potential spatial non-stationarity in the effects of predictors measured by GWR, we can conclude that the effect of Hungarian nationality is strikingly uniform across the entire study area. This is evidenced in the fact that using GWR did not result in increasing the model's explanatory power (92%), nor did it improve the model's quality measured by AICc. In contrast, using GWR in model 1 without Hungarian nationality resulted in a profound improvement of its explanatory power, which means that other predictors have selective and non-stationary effects. Finally, the uniform effect of Hungarian nationality across the study area also led to the disappearance of clustering in regression residuals measured by Moran's I spatial autocorrelation (from 0.5 to 0.1). Such a decisive effect of the Hungarian nationality variable largely corresponds to the results presented by Kostelecký (2001) on the determinants of support for the coalition of Hungarian minority parties in the 1990s. It confirms that a large part of the Hungarian minority population keeps articulating their interests through ethnic parties, maintaining the politicization of ethno-national cleavage.

While the effects of other variables were significant and moderately strong in model 1 (without Hungarian nationality), they all slumped in explanatory

Table 3 – Standardized beta coefficients from linear regression model between the 2023 election support for Szövetség-Aliancia and respective predictor variables

Variables	Model 1	Model 2
Hungarian nationality	–	0.933***
Reformed Church	0.494***	0.057***
University education	-0.185***	-0.043**
Distance from Bratislava	-0.337***	0.030**
Unemployment rate	0.134***	-0.029*
Age 65+	0.185***	0.013
Number of inhabitants	0.103***	0.014
Election turnout	-0.150***	0.025
Adjusted R2	0.448	0.918
AICc	8,911.824	6,978.893
Adjusted R2 (GWR)	0.772	0.922
AICc (GWR)	8,221.094	6,940.474
Moran's I (residuals)	0.494	0.121
N	1,012	1,012

Note: *p < 0.05; **p < 0.01; ***p < 0.001

power and some even lost significance after this variable was added in model 2. This confirms the dominance of the Hungarian nationality variable and merely supplemental effects of other predictors. Of those, the proportion of Calvinists (Reformed Church) had the strongest effect (0.494 in model 1). This is likely because in Slovakia, this denomination is specific to the Hungarian ethnic minority. Its coefficient in model 2 (0.057) even indicates that there is a weak but significant effect of Calvinist faith beyond the ethno-national cleavage. A possible explanation is the current political profile of Szövetség-Aliancia, which adopted a Christian-conservative rhetoric during the election campaign.

Similarly to the previous variable, the effect of higher education decreased in model 2, but it remained significant (–0.044). Its negative direction means that a higher proportion of people with university education in a municipality results in lower support for Szövetség-Aliancia. Such direction arguably results from the party's rhetoric and campaigning with regard to populism, nationalist value attitudes, and lack of general strategy (Gyurovszky 2025).

The effects of distance from Bratislava and unemployment rate, with Beta coefficients of – 0.336 and 0.134 respectively in model 1, developed in an opposite direction following the introduction of Hungarian nationality in model 2. In general, support for Szövetség-Aliancia moderately declines with increasing distance from Bratislava. This may be surprising, but it is due to the greater concentration

of the Hungarian minority in the areas of south-western Slovakia, which are relatively close to the capital. In model 2, a weak positive (and significant) effect was observed. Apparently, when controlling for the distribution of the Hungarian minority, support for Szövetség-Aliancia slightly increased with growing distance from Bratislava. In the Hungarian minority areas in the vicinity of Bratislava, the right-liberal parties such as Most-Híd, but also Slovak right-wing liberals like SaS or SDKÚ-DS, have historically achieved higher election gains than populist parties (Madleňák 2012). The 2023 parliamentary election then saw the rise of PS in this suburban area.

Regarding the unemployment rate, introduction of the Hungarian nationality variable in model 2 meant that the coefficient decreased to –0.029, although it remained significant. Beyond the effect of ethnicity, Szövetség-Aliancia was marginally more successful in municipalities with lower unemployment. This may be surprising given that similar populist-nationalist ethnic parties electorally exploit areas with higher unemployment (e.g. Rink, Phalet, Swyngedouw 2009), but the party's centre-right economic positioning may have contributed to this outcome.

6.3. Unevenness of the Hungarian minority's electoral mobilization

The evidence presented in the previous section shows a significant extent of ethnic voting for Szövetség-Aliancia. This fact does not necessarily mean, however, that it is supported by all people from the Hungarian minority community, as many defy electoral mobilization in the party's favour. The spatial distribution of voter turnout in the 2023 election is illustrated in Figure 5, where municipalities are coloured deriving from the state-wide mean of 68.51%. Clearly, a below-average voter turnout is concentrated in the municipalities with a significant ethnic Hungarian population. Electoral participation in the study area was 61.46%, but if we look at the municipalities where the Hungarian minority accounted for more than 30%, the turnout further dropped to 56.87%. This trend is also confirmed by the Pearson correlation between voter turnout and the nationality structure in municipalities within the study area. For the Hungarian minority, the relationship was – 0,312, but for Slovak nationality, it was clearly positive (0,376).

It is evident from the LISA analysis in Figure 5 that the concentration of high voter turnout is clustered in predominantly Slovak ethnic areas and the suburban areas of Bratislava and Košice. In contrast, there are two big clusters of low voter turnout, one in the central part of southern Slovakia and one in eastern Slovakia. Both of them to a large extent overlap with two clusters of high electoral support for Szövetség-Aliancia. However, both clusters of low turnout stretch more to the north, to ethnically heterogeneous areas. The third cluster of high support for Szövetség-Aliancia in Žitný ostrov (Csallóköz) belongs mostly to

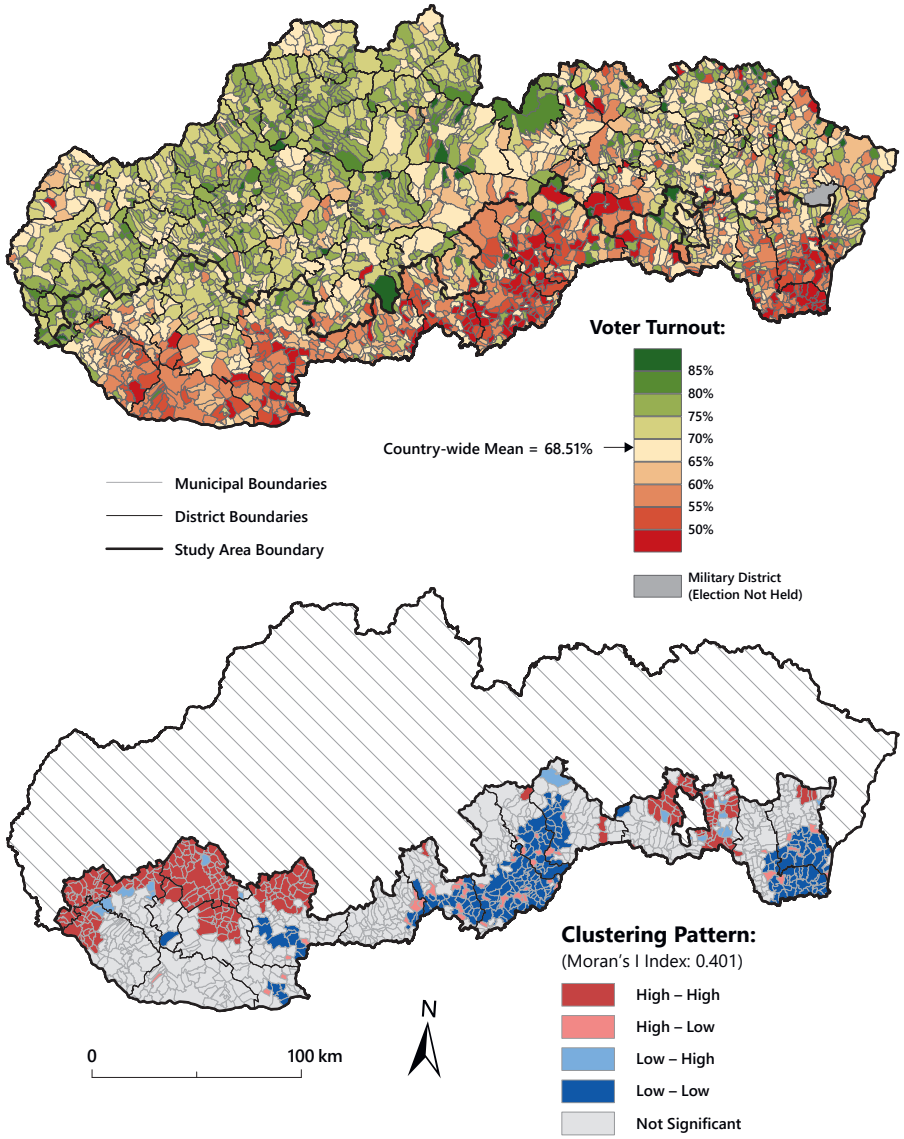


Fig. 5 – Voter turnout and its spatial clustering (LISA) in the 2023 parliamentary election

the non-significant category of clustering. We argue that this may result from the scope of analysis consisting of 16 districts in southern Slovakia. Should the whole Slovakia be included as a study area, the low clusters would include all Hungarian-minority areas. This finding is in accordance with the conclusion of Kevický and Suchánek (2023) that higher electoral participation in municipalities

with a higher proportion of ethnic Slovaks indicates lower interest in elections among national minorities.

If we move beyond the groupist categories of analysis, however, the evidence indicates that electoral mobilization is actually lowest in ethnically heterogeneous areas. The correlograms in Figure 6 show the relationship between voter turnout and (a) the proportion of Hungarian national minority and (b) the index of fractionalization in municipalities of southern Slovakia. As suggested, the correlation between turnout and Hungarian nationality is generally negative, but it cannot be said that participation simply decreases with the increasing representation of the Hungarian minority in a municipality. Instead, the regression curve resembles quadratic rather than linear function. Apparently, turnout is highest in ethnically non-Hungarian areas. It then drops with the gradual increase in the proportion of Hungarian nationality, but it again slowly rises in municipalities where the Hungarian minority makes up more than 60% of inhabitants.

To provide a more detailed insight, we calculated the index of ethnic fractionalization (Fearon 2003), both in its original quantitative form and as a categorical variable (with a margin of 0.33) Moreover, in the category of ethnically homogeneous areas, we distinguished ethnic Hungarian and Slovak municipalities. The outcome (Figure 6b) confirms the previous assumption that ethnically heterogeneous areas in particular experience lower turnout (57.6% on average) than both homogeneously ethnic Slovak and Hungarian municipalities (66.2% and 60.5%, respectively). ANOVA confirmed significant differences between all these three categories. Observed differences in the degree of electoral participation therefore result not only from ethnic differences per se but also from a complex ethnic structure and, arguably, inter-ethnic contact in heterogeneous municipalities. Returning to the LISA map in Figure 5, this evidence is supported by clustering of low electoral support in the ethnically heterogeneous areas of Levice or Galanta districts.

Given that most individuals of Hungarian nationality in Slovakia live in municipalities with a heterogeneous ethnic structure, this finding can largely explain the failure of Szövetség-Aliancia to enter the parliament. Moreover, it indicates that many ethnic Slovaks living in these mixed municipalities are also more susceptible to abstaining from elections than those in ethnically homogeneous areas.

7. Discussion and conclusion

The main finding of our analysis is that although the Szövetség-Aliancia's vote is spatially concentrated and predominantly ethnicized in a sense that there is a profound effect of ethnic cleavage behind the party support, this ethnic voting is far from being uniformly community-wide. Considerable parts of the Hungarian

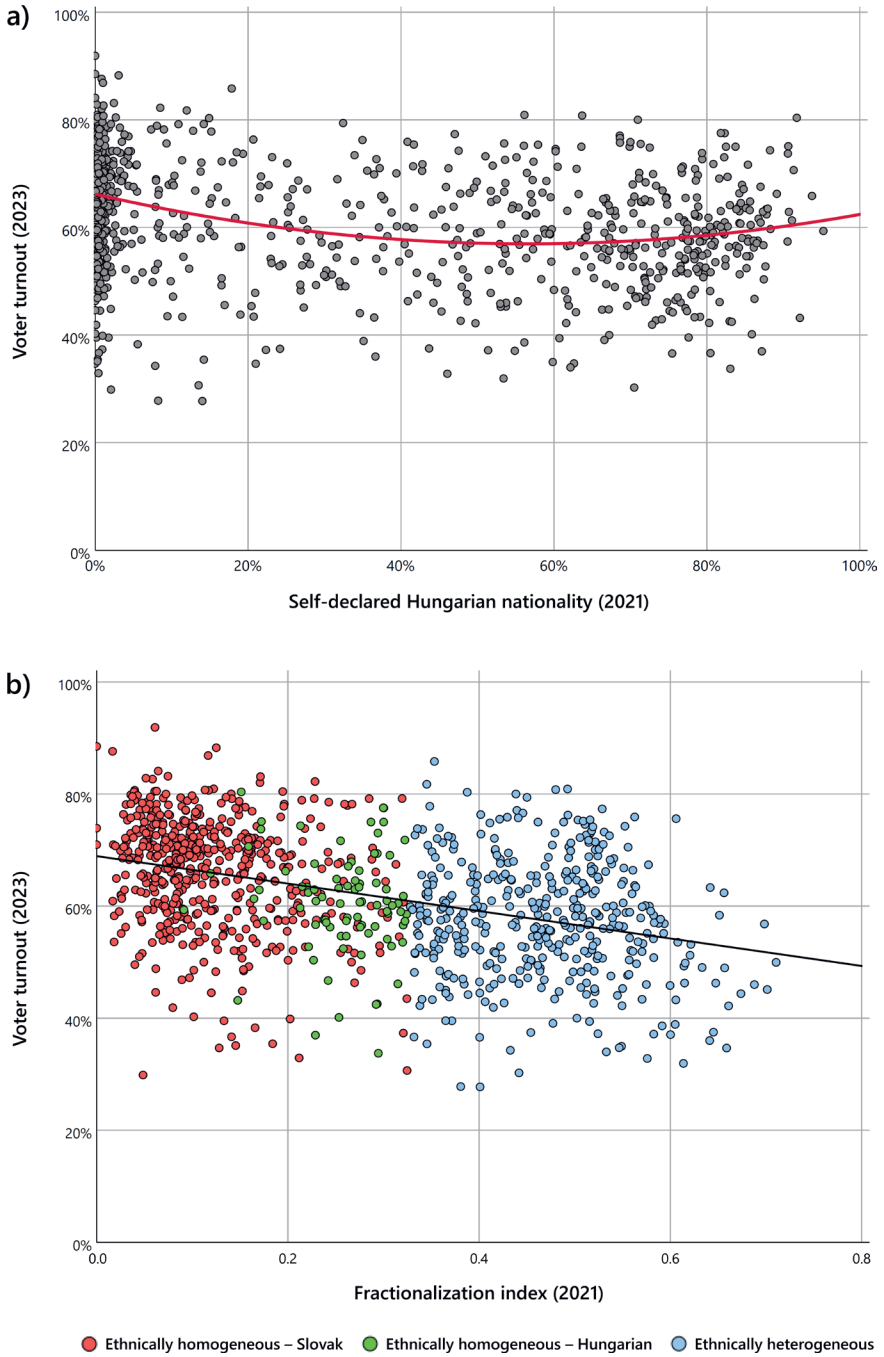


Fig. 6 – Correlation between voter turnout in the 2023 election and ethnic composition of municipalities in the study area

minority population did not mobilize in favour of the party and instead abstained from the election altogether. These segments did not support any alternative liberal minority party, as premised by the nested competition model, nor did they support any radical alternative, as proposed by the model of ethnic outbidding, because the Hungarian minority parties in Slovakia do not follow the outbidding logic. If contextualized within similar cases of national minority regions and parties across Europe, it is clear that the Hungarian minority in Slovakia is somewhat specific, and to understand its preferences and behaviour, the nested competition model must be conceptually broadened. Moreover, voting abstentions do not seem to be random, as we identified a pattern where particularly ethnically mixed municipalities experienced lower participation. This evidence resembles a specific form of differential abstentions known from other cases of national minority regions in Europe (e.g. Liñeira, Vallès 2014). It is also consistent with other findings that suggest ethnic heterogeneity is associated with lower voter turnout (e.g. Förster 2018). Although this literature typically attributes lower turnout to isolation and lower social capital in these areas, we discuss several alternative explanations of this phenomenon.

Firstly, the recent developments of the political-ideological positioning among parties in Slovakia, resembling the trends in a large part of today's Europe (e.g. Rodríguez-Pose 2018), put the increasing emphasis on ethno-nationalist campaigning. Such chauvinistic mobilization, however, contrasts with the experiences of inter-ethnic encounters in many mixed municipalities (e.g. Valentine 2008), which may deter people from voting nationalists. In particular, the positioning of Szövetség-Aliancia as a populist-nationalist and kin-state oriented party as well as recent discreditation of liberal Most-Híd party members due to their governmental cooperation with populist Smer–SD and ultra-nationalist SNS caused that many Hungarian minority voters could not find a party that would properly represent their interests (Lampl 2023, Gyurovszky 2025). These abstentions also occurred despite the targeted mobilization efforts by Slovak liberal and progressive parties.

In addition, Mészárosová-Lampl (2019) and Lampl (2023), citing opinion polls conducted by the Forum Minority Research Institute in 2019 and 2023, point to a general sense of disinterest in politics among some people from the Hungarian minority. This apathy likely results from a disappointment with the divisions within the Hungarian political representation, mistrust in politicians, polarization of society, and a feeling that parties do not properly represent interests of the respondents' region. Many Hungarian minority voters would prefer a single ethnic minority party to represent their interests or a cooperation between the Hungarian minority parties in Slovakia. This unity was initially supposed to be brought by Szövetség-Aliancia, but it eventually failed to fulfil its position as an inclusive party. It instead recently radicalized in terms of its ethno-national positioning and became more oriented towards Orbán's Fidesz. Nevertheless, there are

no survey data available to conclude that such disaffiliation of the minority voters is specific to those living in ethnically heterogeneous municipalities in Slovakia. Further research is needed to elaborate on this finding.

From the perspective of the nested competition model, it is evident that minorities are indeed frequently divided over political issues, with some systematically avoiding radicalizing rhetoric, thus disproving the ethnic outbidding model. At the same time, the demand-side voter preferences may be at odds with the supply-side party offers, so these distinct minority preferences are not necessarily expressed by voting for another, more liberal party. For this reason, we recommend expanding the scope of the nested competition model to account for this potential scenario.

Finally, we admit that other reasons behind such systematic demobilization of the electorate cannot be completely ruled out. This especially concerns the effect of peripherality, particularly if we look at the intra-regional differentiation of the study area. A large part of the territory which the Hungarian minority in Slovakia inhabits directly correlates with the peripheral location. This can be seen in the delimitation of peripheral regions of Slovakia according to Halás (2014) or Stražovec (2024), where the areas in the southern part of eastern Slovakia, both ethnically Hungarian and heterogeneous, suffer from cumulative peripherality. This is confirmed by Kevický and Suchánek (2023), who associate lower electoral participation with increased unemployment and lack of university education, two typical aspects of peripherality.

Our analysis contributed to the insight into the ethnicization of voting support for Szövetség-Aliancia and the inequality of electoral mobilization in favour of the party within the minority community. We are nevertheless aware that such exploratory statistical analysis cannot authoritatively explain motivations and reasoning behind voters' preferences and behaviour, both in the ethnically heterogeneous areas and beyond. Future research should address these questions in detail if we are about to understand not only the prospects of the Hungarian minority and its political representation in Slovakia but also the opportunities for improved socio-political integration in the country.

References

AGNEW, J. (2018): Too many Scotlands? Place, the SNP, and the future of nationalist mobilization. Scottish Geographical Journal, 134, 1–2, 5–23. https://doi.org/10.1080/14702541.2017.1413206

ANSELIN, L. (1995): Local indicators of spatial association – LISA. Geographical Analysis, 27, 2, 93–115. https://doi.org/10.1111/j.1538-4632.1995.tb00338.x

BELEJ MAJERČÍNOVÁ, A. (2023a): Volebný seriál: Jednotu Maďarov narušil Gyimesi. Má Aliancia šancu? Jej cieľom je silná menšina aj zmena Ústavy, https://spravy.pravda.sk/

parlamentne-volby-2023/clanok/681009-volebny-serial-jednotu-madarov-narusil-gyimesi-ma-aliancia-sancu-cielom-je-silna-mensina-aj-zmena-ustavy (6. 10. 2025).
BELEJ MAJERČÍNOVÁ, A. (2023b): Na svete je strana Modrí, Most – Híd. Dzurinda potvrdil dohodu so Sólymosom. https://spravy.pravda.sk/domace/clanok/668798-na-svete-je-modri-most-hid-dzurinda-potvrdil-dohodu-so-solymosom/ (5. 10. 2025).
BRUBAKER, R. (2002): Ethnicity without groups. European Journal of Sociology, 43, 2, 163–189. https://doi.org/10.1017/S0003975602001066
CHANDRA, K. (2004): Why ethnic parties succeed. Cambridge University Press, Cambridge. https://doi.org/10.1017/9781108573481
CHANDRA, K. (2011): What is an ethnic party? Party Politics, 17, 2, 151–169. https://doi.org/10.1177/1354068810391153
DOSTÁL, P., JELEN, L. (2015): De-Russianisation of the Western post-Soviet space: Between the thick and thin nationalising processes. Geopolitics, 20, 4, 757–792. https://doi.org/10.1080/14650045.2015.1057815
EVERETT, J., REDŽIČ, E. (2021): Seeking representation: the development of Hungarian minority parties in Serbia and Slovakia. Журнал политической философии и социологии политики., Полития. Анализ. Хроника. Прогноз, 2, 101, 163–182. https://doi.org/10.30570/2078-5089-2021-101-2-163-182
FEARON, J. (2003): Ethnic and cultural diversity by country. Journal of Economic Growth, 8, 195–222. https://doi.org/10.1023/A:1024419522867
FITTANTE, D., HIMMELROOS, S. (2025a): Ideological backtracking in ethnic parties: The case of the Swedish People's Party of Finland. Nations and Nationalism, 31, 1018–1034. https://doi.org/10.1111/nana.13075
FITTANTE, D. HIMMELROOS, S. (2025b): Co-ethnic core intermediaries: Swedish speakers in Finnish party politics. Journal of Ethnic and Migration Studies, 51, 13, 3501–3519. https://doi.org/10.1080/1369183X.2024.2401585
FLESKEN, A. (2018): Ethnic parties, ethnic tensions? Results of an original election panel study. American Journal of Political Science, 62, 4, 967–981. https://doi.org/10.1111/ajps.12385
FOTHERINGHAM, A.S., BRUNSDON, C., CHARLTON, M. (2002): Geographically weighted regression: The analysis of spatially varying relationships. Wiley, London.
FÖRSTER, A. (2018): Ethnic heterogeneity and electoral turnout: Evidence from linking neighbourhood data with individual voter data. Electoral Studies, 53, 57–65. https://doi.org/10.1016/j.electstud.2018.03.002
GÁL, M. (2023): Az egész EU a szlovákiai parlamenti választásra figyel, a magyar esély háromból semmi, https://nepszava.hu/3210513_szlovakia-parlamenti-valasztas-2023-europai-unio-magyarok-esely (11. 11. 2025).
GEOPORTÁL (2024): Územné a správne usporiadanie – Základná úroveň / ZBGIS – Administratívne hranice, https://www.geoportal.sk/sk/zbgis/na-stiahnutie/ (22. 8. 2025).
GYÁRFÁŠOVÁ, O. (2018): The fourth generation: from anti-establishment to anti-system parties in Slovakia. New Perspectives. Interdisciplinary Journal of Central & East European Politics and International Relations, 26, 1, 109–133. https://doi.org/10.1177/2336825X1802600111
GYÁRFÁŠOVÁ, O. HLATKY, R. (2023): Personalized politics: evidence from the Czech and Slovak republics. Electoral Studies, 81, 102567. https://doi.org/10.1016/j.electstud.2022.102567
GYUROVSZKY, L. (2025): Magyar pártoktól szlovák pártok felé. Választói és pártmozgások 2006–2023 között. Fórum Társadalomtudományi Szemle, 27, 1, 19–30. https://doi.org/10.61795/fssr.v27y2025i1.02

HALÁS, M. (2014): Modelovanie priestorového usporiadania a dichotómie centrum–periféria. Geografie, 119, 4, 384–405. https://doi.org/10.37040/geografie2014119040384
HARBERS, I., INGRAM, M. (2017): Geo-nested analysis: Mixed-methods research with spatially dependent data. Political Analysis, 1–19. https://doi.org/10.1017/pan.2017.4
HARRACH, G. (2024): Egy kudarc boncképe: a felvidéki magyar politika 2023-as bukásának választásstatisztikája (2.). Kisebbségi Szemle, 9, 3, 7–39. https://doi.org/10.62153/ksz.2024.3.hg
HIGASHIJIMA, M., NAKAI, R. (2016): Elections, ethnic parties, and ethnic identification in new democracies: Evidence from the Baltic states. Studies in Comparative International Development, 51, 124–146. https://doi.org/10.1007/s12116-015-9187-1
HOROWITZ, D. (1985): Ethnic groups in conflict. University of California Press, Berkeley.
HOSPODÁRSKE NOVINY (2019): Zsolt Simon zakladá novú stranu: Chceme alternatívu pre Maďarov. https://hnonline.sk/slovensko/1872016-zsolt-simon-zaklada-novu-stranu-chceme-alternativu-pre-madarov (26. 10. 2025).
INGLEHART, R. F. (2008): Changing values among western publics from 1970 to 2006. In: Goetz, K.H., Mair, P., Smith,G. (eds.): West European Politics. Pasts, presents, futures. Routledge, 130–146. https://doi.org/10.1080/01402380701834747
ISHIYAMA, J., BREUNING, M. (2011): What's in a name? Ethnic party identity and democratic development in post-communist politics. Party Politics, 17, 2, 223–241. https://doi.org/10.1177/1354068810391157
KEVICKÝ, D., DANĚK, P. (2020): Kde sa chodí voliť? Faktory ovplyvňujúce geografické rozloženie volebnej účasti v slovenských parlamentných voľbách. Geografický časopis, 72, 1, 5–25. https://doi.org/10.31577/geogrcas.2020.72.1.01
KEVICKÝ, D., SUCHÁNEK, J. (2023): Examining voter turnout using multiscale geographically weighted regression: The case of Slovakia. Moravian Geographical Reports, 31, 3, 153–164. https://doi.org/10.2478/mgr-2023-0014
KISS, T., SZÉKELY, I. (2016): Shifting linkages in ethnic mobilization: The case of RMDSZ and the Hungarians in Transylvania. Nationalities Papers, 44, 4, 591–610. https://doi.org/10.1080/00905992.2016.1149157
KOEV, D. (2019): Why ethnic parties? A new theory of ethnic minority political strategy in Europe. Nations and Nationalism, 25, 1, 229–297. https://doi.org/10.1111/nana.12462
KOPEČEK, L. (2007): Politické strany na Slovensku 1989 až 2006. Centrum pro studium demokracie a kultury, Brno.
KOSTELECKÝ, T. (2001): Vzestup nebo pád politického regionalismu? Změny na politické mapě v letech 1992 až 1998 – srovnání České a Slovenské republiky. Sociologické texty, 1, 9.
KRIESI, H. (1998): The transformation of cleavage politics: The 1997 Stein Rokkan lecture. European Journal of Political Research, 33, 2, 165–185. https://doi.org/10.1023/A:1006861430369
KRIVÝ, V., FEGLOVÁ, V., BALKO, D. (1996): Slovensko a jeho regióny – sociokultúrne súvislosti volebného správania. Nadácia Médiá. Bratislava.
LAMPL, Z. (2023): Beszédes adatok a 2023-as parlamenti választás előtt. Fórum Társadalomtudományi Szemle, 25, 3, 73–90.
LEPIČ, M. (2017): Limits to territorial nationalization in election support for an independence-aimed regional nationalism in Catalonia. Political Geography, 60, 190–202. https://doi.org/10.1016/j.polgeo.2017.08.003
LIJPHART, A. (1979): Religious vs. linguistic vs. class voting: The "Crucial Experiment" of comparing Belgium, Canada, South Africa, and Switzerland. American Political Science Review, 73, 2, 442–458. https://doi.org/10.2307/1954890

LIJPHART, A. (1984): Democracies: Patterns of Majoritarian and Consensus Government in Twenty-One Countries. Yale University Press, Yale. https://doi.org/10.2307/j.ctt1ww3w2t

LIÑEIRA, R., VALLÈS, J. (2014): Differential abstention in Catalonia and the community of Madrid: A socio-political explanation of urban phenomenon. Revista Española de Investigaciones Sociológicas, 146, 69–92.

LIPSET, S.M., ROKKAN, S. (1967): Cleavage structures, party systems, and voter alignments. In: Lipset, S. M., Rokkan, S. (eds.): Party systems and voter alignments: Cross-national perspectives. Free Press, New York.

MADLEŇÁK, T. (2012): Regionálna diferenciácia volebného správania na Slovensku (1998–2010). VEDA, vydavateľstvo SAV, Bratislava.

MESEŽNIKOV, G. (2020): Politická reprezentácia etnických maďarov na Slovensku v období demokratickej transformácie: stav, trendy, výzvy. Міжнародний науковий вісник, Випуск, 2, 22, 7–22.

MÉSZÁROSOVÁ-LAMPL, Z. (2019): Tendencie volebného správania príslušníkov maďarskej menšiny na Slovensku. Studia Politica Slovaca, 12, 2, 22–38. https://doi.org/10.31577/SPS.2019-2.2

ONDRUŠKA, M. (2022): Nestabilita straníckeho systému Slovenskej republiky. Politické vedy, 25, 1, 130–155. https://doi.org/10.24040/politickevedy.2022.25.1.130-155

PLEŠIVČÁK, M. (2011): Postavenie regiónov Slovenska z hľadiska území volebnej podpory politických strán v parlamentných voľbách v rokoch 2002–2010. Geografický časopis, 63, 3, 227–251.

PLEŠIVČÁK, M. (2014): Socio-ekonomická kompozícia spoločnosti a jej vplyv na teritoriálne vzorce volebného správania – prípadová štúdia regiónov západného Slovenska. Sociológia, 46, 1, 25–59.

POSTOJ (2021): Maďarské strany sa zjednotili do strany Aliancia, https://www.postoj.sk/75043/madarske-strany-sa-dohodli-vznikne-ich-spolocny-subjekt-aliancia (21. 9. 2025).

PRAVDA (2019): Maďarské strany potvrdili spoluprácu podpisom memoranda, https://spravy.pravda.sk/volby-2020/clanok/534303-madarske-strany-potvrdili-spolupracu-podpisom-memoranda (6. 10. 2025)

RINK, N., PHALET, K., SWYNGEDOUW, M. (2009): The effects of immigrant population size, unemployment, and individual characteristics on voting for the Vlaams Blok in Flanders 1991–1999. European Sociological Review, 25, 4, 411–424. https://doi.org/10.1093/esr/jcn028

RODON, T., GUINJOAN, M. (2018): When the context matters: Identity, secession and the spatial dimension in Catalonia. Political Geography, 63, 75–87. https://doi.org/10.1016/j.polgeo.2018.01.004

RODRÍGUEZ-POSE, A. (2018): The revenge of places that don't matter (and what to do about it). Cambridge Journal of Regions, Economy and Society, 11, 189–209. https://doi.org/10.1093/cjres/rsx024

ROKKAN, S., URWIN, D. (1983): Economy, territory, identity: Politics of Western European peripheries. Sage, London.

ROVNY, J. (2023): Antidote to backsliding: Ethnic politics and democratic resilience. American Political Science Review, 117, 4, 1410–1428. https://doi.org/10.1017/S000305542200140X

SITA (2022): Aliancia–Szövetség má najväčší počet členov, ale členské jej neplatí nikto. Ako sú na tom ostatné strany? https://sita.sk/aliancia-szovetseg-ma-najvacsi-pocet-clenov-ale-clenske-jej-neplati-nikto-ako-su-na-tom-ostatne-strany/ (11. 10. 2025).

SPÁČ, P., ZAGRAPAN, J. (2025): Between Conflict and Cooperation: Electoral Strategies of Ethnic Parties. East European Politics and Societies, 39, 2, 262–286. https://doi.org/10.1177/08883254241235628

SPIROVA, M. (2012): European integration and minority politics: Ethnic parties at the EP elections. East European Politics, 28, 1, 76–92. https://doi.org/10.1080/21599165.2011.649357

SPURNÁ, P. (2008a): Geograficky vážená regrese: Metoda analýzy prostorové nestacionarity geografických jevů. Geografie, 113, 2, 21–35. https://doi.org/10.37040/geografie2008113020125

SPURNÁ, P. (2008b): Prostorová autokorelace. Všudypřítomný jev při analýze prostorových dat?. Sociologický časopis/Czech Sociological Review, 44, 4, 767–787. https://doi.org/10.13060/00380288.2008.44.4.08

ŠTATISTICKÝ ÚRAD (2021): Informácie a databáza Sčítania obyvateľov, domov a bytov k 1. 1. 2021, Štatistický úrad, Bratislava, https://www.scitanie.sk/ (21. 8. 2025)

ŠTATISTICKÝ ÚRAD (2023): Voľby do Národnej rady Slovenskej republiky 2023, informácie, databázy a výsledky. Štatistický úrad, Bratislava, https://volby.statistics.sk/nrsr/nrsr2023/sk/index.html (21. 8. 2025)

STEWARD, B. (2019): Ethnic party candidate performance in local elections: Evidence from Romania and Slovakia. Nationalism and Ethnic Politics, 25, 2, 152–172. https://doi.org/10.1080/13537113.2019.1602369

STRAŽOVEC, A. (2024): Identification of socioeconomically peripheral municipalities in Slovakia through formal regional taxonomy. Geographia Cassoviensis, 18, 2, 99–118. https://doi.org/10.33542/GC2024-2-01

STRIJBIS, O., KOTNAROWSKI, M. (2015): Measuring the electoral mobilization of ethnic parties: Towards comparable indicators. Party Politics, 21, 3, 456–469. https://doi.org/10.1177/1354068813487105

STROSCHEIN, S. (2011): Demography in ethnic party fragmentation: Hungarian local voting in Romania. Party Politics, 17, 2, 189–204. https://doi.org/10.1177/1354068810391161

SVRAKA, D. (2025): Ethnic party success: Why some minorities have successful ethnic parties and others do not?. European Journal of Political Research, 64, 1737–1758. https://doi.org/10.1111/1475-6765.70007

SZÉKELY, I.G. (2014): Dynamics of Party Politics, Electoral Competition and Cooperation within the Hungarian Minorities of Romania, Serbia and Slovakia. Dizertačná práca. Political Science Department, Central European University, Budapest.

SZICHERLE, P. (2023): What is the path forward for Slovakia's Hungarians? Centre for Democracy & Resilience. GLOBSEC.

TANAKA, S. (2025): The political economy of power-sharing: Patronage politics and ethnic party dominance in post-Dayton Bosnia. Democratization, 32, 6, 1450–1473. https://doi.org/10.1080/13510347.2025.2472846

TARKHANI, S. (2024): Examining the objectives of ethnic parties: A comprehensive analysis of the dynamics of ethnic party competition beyond the constraints of the outbidding model. Nations and Nationalism, 30, 629–648. https://doi.org/10.1111/nana.13040

VALENTINE, G. (2008): Living with difference: Reflections on geographies of encounter. Progress in Human Geography, 32, 3, 323–337. https://doi.org/10.1177/0309133308089372

WATERBURY, M. (2020): Kin-state politics: Causes and consequences. Nationalities Papers, 48, 5, 799–808. https://doi.org/10.1017/nps.2020.3

ZUBER, C. (2012): Ethnic party competition beyond the segmented market. Nationalities Papers, 40, 6, 927–944. https://doi.org/10.1080/00905992.2012.742988

ZUBER, C. (2013): Beyond outbidding? Ethnic party strategies in Serbia. Party Politics, 19, 5, 758–777. https://doi.org/10.1177/1354068811410368
ZUBER, C., SZÖCSIK, E. (2015): Ethnic outbidding and nested competition: Explaining the extremism of ethnonational minority parties in Europe. European Journal of Political Research, 54, 784–801. https://doi.org/10.1111/1475-6765.12105

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Proměny smyslu místa v dělnické kolonii Podprůhon ve středočeském Kladně

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ABSTRACT **Transformations of the sense of place in the Podprůhon workers' colony in Kladno (Central Bohemia)** – Sense of place in geography describes the relationship between people and their environment. This relationship undergoes significant changes in post-industrial landscapes with industrial heritage, as the original purpose of these areas no longer exists. This research focuses on changes in the sense of place in the Podprůhon workers' colony in Kladno, Central Bohemia, from the 1960s to the present. The main question is how the sense of place has evolved and what influenced the changes. The methodology combines visual and narrative analysis. Visual analysis of archival and current maps and photographs provides a temporal anchor. Narrative analysis captures subjective perceptions of the place based on interviews with residents. The results show that the sense of place is dynamic. In Podprůhon, the sense of place weakened with physical degradation and was later reinforced by renovation and community initiatives. The research confirms that physical and social changes have a fundamental impact on the formation and renewal of the identity of a place.

KEY WORDS sense of place – place identity – workers' housing colony – community participation – social change – post-industrial milieu – post-industrial landscape – Kladno – Czechia

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1. Úvod

Postindustriální krajiny v Česku, zejména ty s výrazným průmyslovém dědictvím, představují jedinečné geografické fenomény. Tyto oblasti vznikaly za velmi konkrétním účelem, zpravidla v souvislosti s těžbou či průmyslovou výrobní aktivitou (Lipský a kol., ed. 2022). S postupným útlumem či úplným zánikem těchto funkcí však dochází ke ztrátě jejich původního významu, tzv. smysl místa (Čermák 2025, Chromý 2003).

Smysl místa v geografických studiích představuje klíčový rámec pro pochopení vztahu mezi lidmi a jejich prostředím (Relph 1976, Tuan 1990). Smysl místa se v literatuře chápe jako mnohovrstevnatý koncept, přičemž např. Cohen (1994) zdůrazňuje sociální hranice a sdílené významy, zatímco Seamon (2018) akcentuje každodenní zkušenost a zakotvení v místě. V postindustriálních krajinách dochází často k výměně obyvatelstva. Nové skupiny přicházejí do území s odlišnými životními zkušenostmi, což může vést k degradaci původního smyslu místa, kam se přistěhovali (Vávra 2010; Šifta, Chromý 2017; Kašková, Kučera, Chromý 2016). Aby si postindustriální krajiny uchovaly svou jedinečnost a hodnotu, je nezbytné smysl místa posilovat (Ujang, Zakariya 2015).

Reprezentantem postindustriální krajiny, chápané jako sociálně a historicky formované prostředí, byla pro tento článek zvolena čtvrť Podprůhon ve středočeském Kladně. Jedná se o historickou dělnickou koloni, jež je postindustriálním místem s jedinečným charakterem a atmosférou průmyslového dědictví, která v průběhu posledních dekád prošla zásadními proměnami fyzického i sociálního prostředí. Původně dělnická kolonie vystavěná pro pracovníky kladenského průmyslu a těžby uhlí, si po dlouhá desetiletí uchovávala svou specifickou komunitní identitu a jedinečný ráz, který se stává z malých dělnických domků s dvorky a úzkými uličkami (Čermák 2022). V kontextu postindustriální transformace, respektive společenských změn po pádu komunistického režimu, Podprůhon čelil řadě výzev, včetně sociálních proměn a fyzické degradace v 80. letech 20. století. Přesto se ukazuje, že i když se smysl místa v určitých obdobích degradoval, může být díky iniciativám místních obyvatel znovu posílen.

V předkládaném výzkumu popisujeme, jaké faktory mají vliv na proměnu smyslu místa na příkladu Podprůhonu a jak se tento smysl vyvíjel v průběhu času. Klíčovými výzkumnými otázkami proto jsou: „Jak se smysl místa v Podprůhonu proměňoval v jednotlivých časových etapách od 60. let 20. století do současnosti?“ a „Jaké fyzické proměny prostředí a změny sociálních vztahů obyvatel byly s těmito proměnami smyslu místa spojovány?“. Získané výsledky v obecné rovině přispívají do diskuze o lepším pochopení faktorů, které se podílejí na vývoji smyslu místa, a vedou k identifikaci možných přístupů k formování a posílení identity podobných lokalit.

2. Konceptualizace smyslu místa

Dosavadní výzkumy smyslu místa se liší především v důrazu, který kladou na jeho jednotlivé složky – emocionální vazbu, sociální vztahy, historickou paměť či fyzické prostředí (Davis, Wagner 2025). Zatímco humanisticky orientované práce (Relph 1976, Tuan 1977) zdůrazňují subjektivní prožívání místa a existenciální rozměr zakotvení, pozdější studie se více zaměřují na sociální konstrukci významů a roli každodenních praktik a komunitních procesů (Proshansky, Fabian, Kaminoff 1983; Cohen 1994; Seamon 2018). Tyto přístupy poskytují teoretické východisko pro analýzu proměn smyslu místa v čase, což je hlavním cílem předkládané studie.

Konceptualizace smyslu místa se stala významnou od 70. let minulého století, kdy se humanističtí geografové zaměřili na subjektivní zkušenost a emocionální pouta k místu. Fenomenologický přístup, inspirovaný díly Heideggera (1962) a Husserla (1970), zdůrazňuje proces, při kterém se místo stává „domovem". Norberg-Schulzovo pojetí „genia loci" (1984, 1979) a práce Relpha (1976) a Tuana (1974, 1977) na téma „smyslu místa" dále rozšířily význam tohoto konceptu v oblasti geografie, architektury a společenských věd.

V současné geografii se smysl místa chápe jako subjektivní, mnohovrstevnatý vztah jednotlivců nebo skupin k určitému geografickému prostoru, jenž vzniká na základě zkušenosti, emocí, paměti a sociálních praktik (Tuan 1977, Cresswell 2004). Osobní připoutanost odkazuje na intenzivní citové spojení s místem, které se často vytváří prostřednictvím opakovaných zkušeností, významných událostí a interakcí s okolím (Qazimi 2014, Seamon 2018). Historické faktory zahrnují kolektivní vzpomínky, symboly a příběhy spojené s místem, které přispívají k jeho jedinečné identitě. Sociální faktory pak zdůrazňují význam komunitního života, sociálních sítí a kulturních praktik, které se v místě odehrávají (Cohen 1994). Faktory byly zpravidla analyzovány prostřednictvím terénních průzkumů, rozhovorů a analýz historických dokumentů, jak ukazují výzkumy autorů jako Proshansky a kol. (1978, 1983, 1987) a Altman a Low (1992).

Dělnické komunity a postindustriální transformace představují specifický kontext, ve kterém má smysl místa zvláštní význam (Šifta, Chromý 2017). V oblastech jsou často výrazné stopy minulosti, které propojují obyvatele s místem skrze kolektivní paměť a tradice (Seamon 2018). Industrializace utvářela místa s pevně danou identitou, která byla úzce spjata s pracovní činností, ale postindustriální transformace tato pouta zpravidla narušila. Ztráta pracovních míst, změny ve složení obyvatel a fyzická degradace prostředí vedly ke ztrátě původní identity místa (Relph 1976; Augé, Bixio 1995; Šifta, Chromý 2017). Naopak posilování smyslu místa je možné chápat jako aktivní proces, během něhož dochází k obnově či tvorbě emocionální a sociální vazby k prostoru skrze participaci, lokální praktiky, kulturní identifikaci a sdílené významy (Massey 2005, Halfacree 2007). Nicméně procesy

revitalizace, jako například přeměna průmyslových objektů na kulturní centra, mohou přispět k obnovení smyslu místa a vytvoření nové identity (Guyot, Seetha 2007; Ujang, Zakariya 2015).

Význam smyslu místa v kontextu postindustriálních transformací spočívá v jeho schopnosti propojit minulost s přítomností a vytvořit pevný základ pro budoucí rozvoj. Místa, která si zachovají svou jedinečnost a respektují své historické a kulturní hodnoty, mohou fungovat jako zdroj identity, sebeúcty a stability pro místní obyvatele (Lai, Said, Kubota 2013). Současně je však nezbytné tyto vazby adaptovat na nové sociální a ekonomické podmínky, což vyžaduje participativní přístup zahrnující do procesů plánování a revitalizace i rezidenty.

Smysl místa se v této studii nechápe jako přímý odraz fyzických či společenských změn prostředí, ale jako jejich subjektivní a kognitivně zprostředkovaná interpretace jednotlivými aktéry. Identické podmínky reálného světa tak mohou vést k odlišným významům místa v závislosti na zkušenostech, paměti a uvažování konkrétních obyvatel. Pro potřeby této studie se smysl místa chápe jako dynamický proces, který se proměňuje v závislosti na fyzických změnách prostředí a sociálních vztazích mezi obyvateli. Zatímco část dosavadních studií se soustředí na zachycení smyslu místa v jednom časovém řezu, méně pozornosti se věnuje jeho dlouhodobé proměnlivosti v kontextu postindustriálních transformací. Právě na tuto mezeru výzkum reaguje, když sleduje proměny smyslu místa v několika časových etapách a propojuje fyzickou a narativní dimenzi prostředí.

3. Metody výzkumu

Na základě kritického rozboru literatury byly pro analýzu proměn smyslu místa vymezeny analytické kategorie, které slouží jako spojovací rámec mezi teorií a empirickými daty. Jedná se zejména o (i) hranice místa, (ii) každodenní praktiky, (iii) kolektivní paměť, (iv) vnímání bezpečí a (v) vztah k fyzickému prostředí (Rezeg, Roche, Eveno 2025). Tyto kategorie strukturovaly interpretaci rozhovorů i práci s vizuálními prameny a jsou dále rozvíjeny v empirické části textu.

Metodika tohoto výzkumu kombinuje vizuální a narativní analýzu (viz Proshansky 1978, Twigger-Rosse 2003). Inspirací pro metodiku použitou ve výzkumu byly práce Altman a Low (1992), Relph (1976) a Tuan (1974, 1977), Breakwell (1983, 1986), Patterson a Williams (2005), které zdůrazňují význam kombinace přístupů kvantitativní a kvalitativní povahy. Vizuální analýza poskytuje kontext a časové ukotvení těchto změn. Obvykle se při tomto přístupu pracuje s analýzou starých archivních dokumentů a fotografií. Narativní analýza odhaluje subjektivní prožitky obyvatel a jejich vazby na místo, což bývá umožněno díky terénním průzkumům a rozhovorům. Propojení vizuální a narativní analýzy umožňuje pro místo

detailně zachytit fyzické i sociální proměny (Reichel 2010). Kombinace obou analýz také umožňuje identifikovat klíčové faktory ovlivňující proměnu smyslu místa, včetně vlivu fyzických změn prostředí, sociálních vztahů a kolektivní paměti. Tato kombinace také napomáhá získat ucelený obraz o dynamice smyslu místa a odhalit obecné vzorce, jež prohlubují porozumění subjektivním zkušenostem, ucelený pohled na smysl místa.

Vybrané metody výzkumu se zde aplikují na původně dělnickou čtvrť Podprůhon, která představuje místo s postindustriálním dědictvím ve středočeském městě Kladně. Předkládaná studie zkoumá proměny této čtvrti od 60. let 20. století až po současnost. Období je rozděleno do 3 časových etap (60.–70. léta, 80. léta až 2012, 2013 až současnost), které byly vymezeny na základě vyznaných milníků v historii místa. Prakticky byla práce na studii rozdělena do tří částí. První zahrnovala shromažďování a analýzu starých/historických i aktuálních zdrojů, jako jsou archivní prameny, plány, mapy, fotografie, letecké snímky a umělecká díla. Druhá byla věnována rozhovorům s obyvateli Podprůhonu. Třetí část byla zaměřena na srovnání všech získaných/shromážděných informací a formulování závěrečných poznámek.

3.1. Vizuální analýza

Na základě analýzy starých map, fotografií a dalších zdrojů ikonografické povahy, lze pozorovat prostorové změny prostředí. Tato část metodiky navazuje na přístupy, které rozvíjeli Norberg-Schulz (1984, 1979) nebo Patterson a Williams (2005), a klade důraz na zachycení proměn fyzického prostředí v čase. Na základě rozboru starých pramenů, zejména vizuálních, je možné celé sledované období rozdělit do dílčích lišících se etap, přičemž každá etapa reprezentuje klíčové fáze vývoje zkoumaného místa. Staré prameny slouží k nalezení milníků, které se odráží ve fyzických změnách místa. Lze předpokládat, že změna fyzického prostředí se odrazí také na tom, jak místo vnímají obyvatelé (Hudson 2006). Použité vizuální podklady jsou následně zasazeny, interpretovány a chápány v širších společenských a historických měnících se kontextech, jak to doporučují Proshansky, Fabian, Kaminoff (1983).

Klíčovým zdrojem informací pro vizuální analýzu byly archivní materiály z fondů Okresního archivu Kladno a Sládečkova vlastivědného muzea v Kladně a také ze sbírky fotografií Jiřího Hankeho, která dokumentuje každodenní život v Podprůhonu po celé sledované období. Z písemných pramenů, které ovšem zprostředkovávají i vizuální složku, posloužily k analýze odborná kniha „Paměť Podprůhonu" autorů Pospíšil, Baďura, Hájek (2019) a také sekundární pramen v podobě beletristické knihy od Františka Stavinohy (1981) a stejnojmenný seriál „Hvězdy nad Syslím údolím", který se natáčel přímo v Podprůhonu v roce 1986.

3.2. Narativní analýza

Narativní analýza je zde využita k zachycení způsobů, jakými si obyvatelé interpretují, pamatují a významově strukturovali své zkušenosti s místem. Získaná vyprávění nejsou chápána jako popis objektivní reality, ale jako kognitivní konstrukce, které odrážejí individuální smysl místa.

Na základě narativní analýzy byly provedeny rozhovory s rezidenty Podprůhonu. Rozhovory poskytují vhled do subjektivního vnímání a prožívání smyslu místa (Twigger-Ross, Uzzell 1996). Tato metoda navazuje na přístupy popsané Breakwellem (1983, 1986) nebo Altmanem a Lowem (1992). Cílem rozhovorů bylo zachytit subjektivní prožívání a vnímání změn smyslu místa. Analýza proto rozlišuje mezi změnami reálného fyzického a společenského prostředí a jejich subjektivním odrazem ve vnímání obyvatel, který je klíčový pro formování smyslu místa.

Rozhovory byly analyzovány tematicky, se zaměřením na opakující se motivy a významové vzorce. Pozornost byla věnována nejen četnosti výskytu témat, ale i jejich významu v narativní struktuře výpovědí a jejich proměnám v čase.

Rozhovory zahrnovaly 6 otevřených otázek (tab. 1) zaměřených na vlastní zkušenosti s místem. Pozornost byla v otázkách věnována také vzpomínkám spojeným s místem a vnímání jeho současného stavu. První otázkou každého rozhovoru byl dotaz na hranice čtvrti Podprůhonu, přičemž respondenti toto své vnímání hranic zakreslili do mapy/plánu. Zbytek rozhovoru byl vždy veden řízeně v polo-strukturované podobě, přičemž hlavní otevřené otázky byly doplněny 17 podotázkami umožňujícími ověření konzistence odpovědí a jejich zpřesnění. Výběr respondentů probíhal náhodnou selekcí, metodou sněhové koule a na základě existujících kontaktů, viz Hendl (2005). Respondenti byli rozděleni do skupin podle generací a délky pobytu v oblasti: starousedlíci (ST, 4 osoby), děti starousedlíků (DS, 3 osoby), vnoučata starousedlíků (VS, 2 osoby), přistěhovalci (PS, 3 osoby) a jejich děti (DP, 2 osoby). Starousedlíci jsou potomky horníků a hutníků, zatímco přistěhovalci se v rozhovorech představují jako podnikatelé s vysokoškolským vzděláním. Rozhovory probíhaly na konci roku 2021 a uskutečnily se u respondentů doma.

Délka rozhovorů se pohybovala mezi 30 až 60 minutami; celkem bylo nahráno přes 450 minut rozhovorů. Nahrávky byly přepsány a na základě četnosti byla v nahrávkách identifikována společná témata týkajících se smyslu místa (v další části textu jsou prezentována v rámci jednotlivých časových etap). Kredibilita interpretací byla dále posilována porovnáváním výpovědí mezi různými skupinami respondentů a sledováním jejich vnitřní konzistence napříč časovými etapami.

Empirická data jsou v této studii chápána jako podklad pro interpretaci smyslu místa, nikoli jako přímý popis objektivní reality. Analýza se zaměřuje na významy, které aktéři místu připisují, a na způsoby, jakými tyto významy strukturují jejich vztah k prostředí.

Tab. 1 – Otázky v rozhovorech

I. Kde vnímáte hranice své čtvrti? (zakreslení do mapy/plánu) i. Vymezoval jste se vůči jiným/sousedním čtvrtím?
Otázka sleduje, jestli je ve vztahu lokality, v níž respondent bydlí, vůči ostatním lokalitám nějaká bipolarita (odlišnost, napětí).
II. Navštěvujete pravidelně nějaká místa z vaší čtvrti? i. Proč daná místa navštěvujete? ii. Která z těchto místo jsou vaše oblíbená? iii. Proč jsou to vaše oblíbená místa? iv. Jak často navštěvujete daná místa?
Otázka sleduje, jaká místa mají respondenti oblíbena v současnosti, která místa jsou typická pro danou čtvrť a která danou čtvrť utváří.
III. Čeho si vážíte na Vaší čtvrti? i. Znáte nějaká umělecká díla z Vaší čtvrtě, nebo o Vaší čtvrti? ii. Podíleli jste se na vzniku anebo správě části čtvrti?
Tato otázka sleduje, na kolik si respondenti všímají svého okolí a jestli vnímají změnu v kvantitě uměleckých děl v průběhu času a jestli mají k dílům nějaký vztah. Kulturní statky upevňují vztah k místu. Lze očekávat, že respondenti si uměleckých děl všímají zejména v Podprůhonu, kde vznikají v rámci akce Kladenské dvorky nová umělecká díla určená pro instalaci ve veřejném prostoru.
IV. Čeho si vážíte na vaší čtvrti? i. Znáte nějaká umělecká díla z vaší čtvrtě, nebo o vaší čtvrti? ii. Podíleli jste se na vzniku anebo správě části čtvrti?
Otázka sleduje, nakolik si respondenti všímají svého okolí a jestli vnímají změnu v kvantitě uměleckých děl v průběhu času a jestli mají k dílům nějaký vztah. Kulturní statky upevňují vztah k místu. Lze očekávat, že respondenti si uměleckých děl všímají zejména v Podprůhonu, kde vznikají v rámci akce Kladenské dvorky nová umělecká díla určená pro instalaci ve veřejném prostoru.
V. Jak jste jako dítě a poté jako dospělý vnímal čtvrť, ve které jste vyrůstal? i. Proměnila se s časem tato čtvrť? ii. Proměňovala se čtvrť z vašeho pohledu pozitivně, nebo negativně?
Otázka sleduje vývoj místa v průběhu času z individuálního pohledu respondentů, což umožní srovnání několika subjektivních pohledů na danou lokalitu. Pohled respondenta v průběhu času se může proměňovat jak pozitivně, tak negativně. Lze očekávat, že čím více do historie půjdeme, tím více bude respondentova výpověď zkreslená. Vnímání lokalit by mohlo korespondovat s fyzickými proměnami lokalit a proměnami společnosti.
VI. Nachází se v okolí vašeho bydliště místa, kterým jste se vyhýbal? i. Proč jste se jim vyhýbal? ii. Vnímáte tato místa stejně i dnes? iii. Navštívil jste je někdy v nedávné době? iv. Proměnila se tato místa v průběhu času?
Otázka sleduje, zda se v okolí bydliště respondenta nachází místa, která jsou respondentem vnímána negativně. Otázka je průzkumného rázu; lze očekávat, že taková místa byla a jsou, ale v průběhu času se měnila.

4. Výsledky výzkumu

Podprůhon (obr. 1) je příkladem postindustriálního místa, jehož proměny odrážejí širší společenské a ekonomické změny v Česku. Kladenská čtvrť vznikla na konci 18. století na severním svahu údolí a sloužila pro pracovníky hutí a dolů. V době vzniku se Podprůhon nacházel za hranicemi Kladna, zatímco dnes se nachází v centru města. Místo bylo charakteristické úzkými, křivolakými ulicemi a jednoduchými rodinnými domy s malými dvorky, které společně vytvářely vesnickou atmosféru.

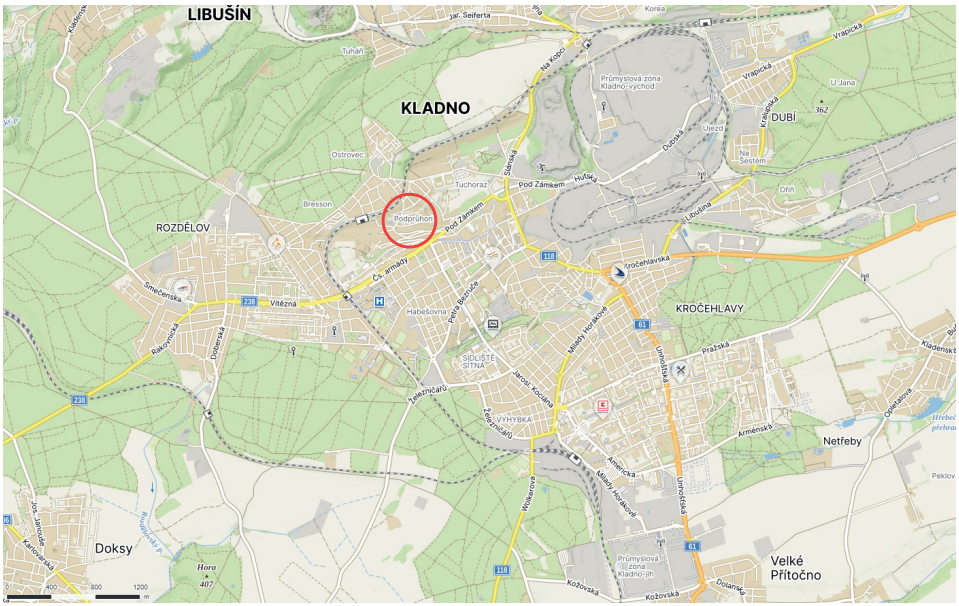
Pro vyjasnění místa, o kterém byl veden s respondenty rozhovor, sloužila první otázka týkající se představy, kde má Podprůhon podle respondentů hranice. Jejich chápání hranic je vykresleno na obrázku 2. Hranice Podprůhonu vnímají jeho rezidenti téměř všichni shodně. Drobné výjimky lze nalézt především na jižní straně údolí, kde se Podprůhon potkává s městskou částí Kladno-Ostrovec. Při vymezování hranic se objevily nejasnosti především s nově vybudovanými domy od roku 2010. Obyvatelé, kteří se v Podprůhonu narodili (resp. zde žijí od narození), do Podprůhonu tyto domy neřadí, zatímco lidé, kteří se sem přistěhovali nově, je do Podprůhonu zahrnují.

4.1. Časová etapa: 60. a 70. léta 20. století

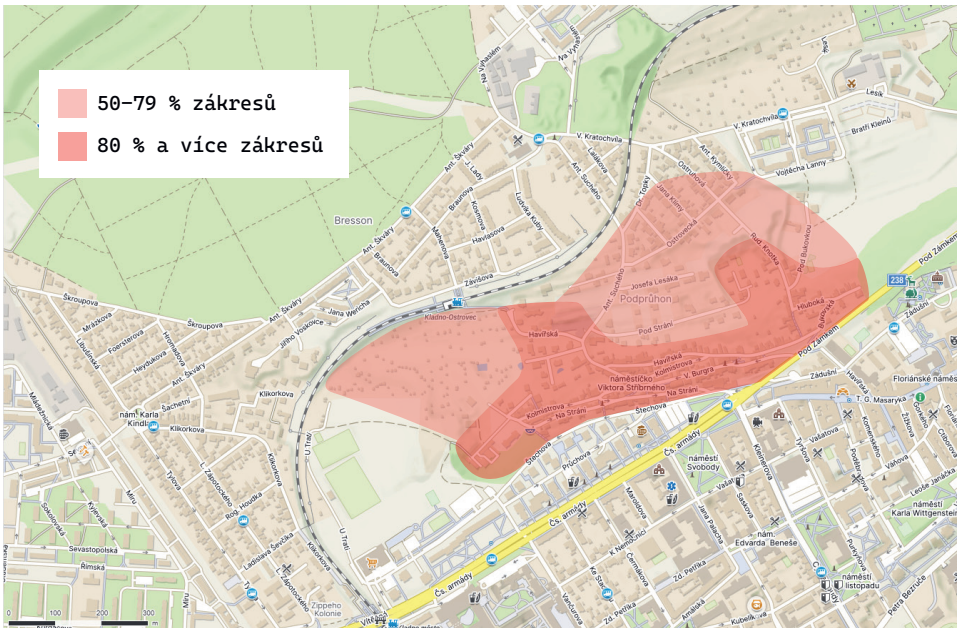
První etapa zahrnuje 60. a 70. léta 20. století, kdy si Podprůhon zachovával svou původní identitu jako (soudržná) dělnická komunita. Sociální skladba obyvatelstva Podprůhonu zůstávala neměnná a kolonie sloužila primárně pracovníkům průmyslových podniků v okolí. V této době si oblast uchovávala vesnický charakter s tradičním způsobem života, který se od svého vzniku na přelomu 19. a 20. století příliš nezměnil. Právě tato etapa reprezentuje poslední fázi kontinuity původní identity Podprůhonu před zásadními změnami, které následovaly v dalších dekádách.

V 60. a 70. letech 20. století si Podprůhon uchovával svou původní identitu a atmosféru, která byla pevně zakořeněna v tradicích komunitního života. Domy v Podprůhonu, postavené převážně dělníky, byly jednoduché, ale funkční, s malými dvorky, které byly často obklopené malými zahradami. Dvorky dělnických domků plnily funkci přechodového prostoru mezi soukromým a veřejným životem a přispívaly k udržení komunitního a „polovenkovského“ způsobu života v průmyslově formovaném městském prostředí. Podobné principy lze nalézt i u dalších evropských dělnických a hornických kolonií, kde byla prostorová organizace bydlení součástí širších sociálních a urbanizačních strategií.

Podle respondenta šetření, pana Karla (ST), byly studánky a pumpy nejen zdrojem vody, ale také místem, kde se lidé setkávali a vyměňovali si informace. *„Studánky byly centrem všeho, tam jsme se všichni potkávali.“* Zavedení vodovodní



Obr. 1 – Podprůhon na plánu Kladna (2023).
Zdroj: https://ags.cuzk.cz/geoprohlizec/



Obr. 2 – Vymezení Podprůhonu respondenty šetření (rezidenty) v roce 2022.
Zdroj: Čermák (2022)

sítě na konci 50. let tento způsob interakce proměnilo, ale udržování čistoty ulic a společenský život před domy zůstaly nedílnou součástí každodenního života.

Život v Podprůhonu byl tehdy velmi komunitní. Paní Karolína (ST) si pamatuje, jak se ženy scházely před domy, aby si povídaly, a přitom hlídaly děti. *„Ulice byly vždy čisté, nikdo by si nedovolil vyhodit odpad před dům“* zdůrazňuje paní Karolína. Pro děti byly ulice klíčovým prostorem k uskutečňování volnočasových aktivit. Hrály se zde kuličky nebo probíhaly menší konflikty s dětmi z okolních čtvrtí, jako bylo Nové Kladno nebo Ostrovec. Pan Ladislav (ST) připomíná, že *„halda byla místem, kde jsme s kluky z jiných částí města řešili spory“*. Oblíbenými místy dětí byly také Bukovka a Ořechovka, kde si trhaly ovoce. I přes postupné zavírání malých obchodů si čtvrť zachovávala svou atmosféru, kterou popisuje František Stavinoha ve své knize *Hvězdy nad Syslím údolím* (1981) jako klidnou a vesnickou.

V 70. letech 20. století však začala atraktivita Podprůhonu klesat. Výstavba moderních panelových domů v okolí nabízela lepší vybavení, což vedlo k odlivu některých obyvatel. Zhoršující se stav domů a infrastruktury byl předzvěstí úpadku čtvrti, který se plně projevil v následujících dekádách. I přes tyto změny si podle jednoho z respondentů, pana Karla (ST), *„čtvrť stále udržovala svou komunitní soudržnost a vesnický charakter, i když do ní začal pronikat první náznak změn, které později vedly k jejímu úpadku“*.

4.2. Časová etapa: 80. léta 20. století až rok 2012

Druhá etapa, zahrnující 80. léta 20. století až rok 2012, představuje zásadní zlom v historii Podprůhonu. Do oblasti se začali stěhovat nepřizpůsobiví obyvatelé, což vedlo ke změně sociální skladby lokality a koncentraci sociálně patologických jevů/problémů. V této etapě vedení města dokonce uvažovalo o demolici Podprůhonu, což mělo negativní dopad na místní komunitu i její vztah k lokalitě. Fyzická degradace místa a zhoršené podmínky bydlení přispěly k oslabení identity místa, zatímco původní obyvatelé se často odstěhovali, což vedlo k dalšímu narušení komunitních vazeb.

Výpovědi respondentů spojují oslabení smyslu místa s příchodem romského obyvatelstva, které je v jejich vzpomínkách často rámováno jako hlavní příčina sociálního úpadku čtvrti. Tento pohled však odráží subjektivní zkušenost a interpretaci aktérů. Z historického hlediska byl příchod Romů do Podprůhonu součástí širších státních zásahů do způsobu života romského obyvatelstva, zejména v souvislosti s politikou nuceného usazování a regulace bydlení v druhé polovině 20. století.

V 80. letech došlo k výrazné proměně sociální skladby obyvatelstva Podprůhonu. Což vedlo ke zvýšení sociálního napětí v místě a změně vnímání čtvrti. Podle paní Alžběty (DS) *„se děti začaly vyhýbat určitým částem čtvrti, zejména západní části,*

kde žily nové rodiny“. „Horní část Podprůhonu byla děsivá, domy byly opuštěné a sousedé neznámí,“ vzpomíná pan Martin (DS) a dodává *„Podprůhon se v této době téměř zcela uzavřel sám do sebe, protože kvůli romským sousedům se lidé báli do Podprůhonu chodit a odmítali tam navštěvovat i své známé. Podprůhon se stal místem s negativní pověstí, proto jsme se uzavírali na své dvorky.“* Tento negativní vývoj byl umocněn rozhodnutím města izolovat čtvrť výstavbou čtyřproudové silnice, která přerušila tradiční spojení Podprůhonu s centrem Kladna. Demolice části čtvrti a absence investic do infrastruktury vedly k jejímu fyzickému chátrání. V té době byla čtvrť také ovlivněna sociální stigmatizací, kterou dokumentuje televizní seriál *Hvězdy nad Syslím údolím* (1981).

Přesuny romského obyvatelstva do některých městských čtvrtí nebyly výsledkem individuální volby, ale důsledkem státní politiky zaměřené na ukončení kočovného způsobu života a prostorovou regulaci romských komunit. Tyto zásahy často vedly k narušení dosavadních sociálních vazeb a ke koncentraci sociálních problémů v konkrétních lokalitách, což následně ovlivnilo i jejich vnímání majoritní populací.

V této etapě se dvorky a zahrady staly klíčovými místy pro bezpečné setkávání obyvatel. Respondentka Iva (PS) vzpomíná na zahradu Viktora Stříbrného, kde se konaly první ročníky festivalu Kladenské dvorky. *„Bylo to jediné místo, kde jsme se cítili v bezpečí.“* Festival, který se v místě od 90. let koná každoročně, přispěl k zachování alespoň části komunitního ducha Podprůhonu, i když jeho celková pověst byla negativní. Sociální napětí mezi původními obyvateli a nově příchozími Romy odráželo hluboké problémy, kterým čtvrť čelila. I přesto, že na konci roku 1989 proběhla tzv. Sametová revoluce a společenská, politická, ekonomická situace se v zemi (i v lokální úrovni) změnila, identifikace s místem se v Podprůhonu nezměnila.

4.3. Časová etapa: od roku 2013 do současnosti

Třetí etapa, od roku 2013 do současnosti, je charakterizováno snahou o revitalizaci a obnovu Podprůhonu. Došlo k postupnému odchodu romského obyvatelstva z Podprůhonu, který souvisel s fyzickou přeměnou čtvrti a srostoucí atraktivitou území (hlavně pro bydlení). Rekonstrukce domů a veřejného prostoru vedly ke zvýšení hodnoty nemovitostí a cen pozemků, což se promítlo do změn struktury bydlení. Tyto procesy byly místními obyvateli často vnímány jako „odstěhování“, jejich konkrétní podoby však nelze redukovat na individuální rozhodnutí jednotlivců, ale je třeba je chápat v širším kontextu proměn bydlení a městské politiky. Do čtvrti se začali stěhovat noví obyvatelé a proběhly významné rekonstrukce, zahrnující plynofikaci, obnovu povrchů komunikací a modernizaci infrastruktury. Uvedené změny výrazně přispěly ke zvýšení kvality života a atraktivity místa.

Nové společenské aktivity a rostoucí participace místních obyvatel na zlepšování veřejného prostoru posílily smysl místa a přispěly k obnově identity Podprůhonu jako atraktivní a soudržné čtvrti.

Je třeba zdůraznit, že interpretace příchodu a odchodu romského obyvatelstva v této studii vychází primárně z výpovědí vybraných respondentů a odráží jejich zkušenost a paměť místa. Narativy respondentů jsou analyzovány jako součást formování smyslu místa, nikoli jako objektivní vysvětlení příčin společenských změn.

Od roku 2013 prošel Podprůhon výraznou transformací, která ovlivnila nejen fyzický vzhled čtvrti, ale také vnímání místa jako domova, historického dědictví a sociálního prostoru. Rozhovory s původními i novými obyvateli odhalily klíčová témata týkající se smyslu místa, rozdílů mezi generacemi, vlivu fyzické změny prostředí a proměny sociálních vztahů na komunitní vazby.

Původní obyvatelé často reflektovali svůj dlouhodobý vztah k Podprůhonu prostřednictvím vzpomínek na dobu, kdy čtvrť fungovala jako soudržná komunita s vesnickým charakterem. Podle paní Karolíny (ST) si někteří stále uchovávají *„vztah k místu, kde jsme prožili dětství a dospívání,“* a zdůrazňují význam kolektivní paměti. Pro ně je Podprůhon domovem, který navzdory proměnám zůstává místem spojeným s minulostí. Naproti tomu noví obyvatelé častěji vnímají čtvrť jako atraktivní lokalitu s potenciálem pro komunitní život, přičemž historické dědictví vnímají spíše esteticky než emocionálně. Paní Iva (PS) poznamenává: *„Přistěhovala jsem se sem kvůli atmosféře a klidu, ale vztah k historii jsem si začala vytvářet až díky festivalům a sousedským setkáním.“*

Vnímání Podprůhonu jako domova se mezi původními a novými obyvateli liší. Původní obyvatelé vidí čtvrť především jako prostor, který je úzce spjat s jejich rodinnou a místní historií. Noví obyvatelé však přinášejí odlišné perspektivy a přispívají k oživení čtvrti prostřednictvím investic do rekonstrukcí domů a podpory komunitních aktivit. Přestože tyto rozdíly mohou vést k odlišným očekáváním a pohledům na budoucnost. Festivaly jako Kladenské dvorky se staly platformou, která spojuje starousedlíky i nové rezidenty, při které spolek Podprůhon vystavuje nová umělecká díla do veřejného prostoru. Podle respondenta, pana Martina (DS), tyto akce *„pomáhají znovu budovat vztahy mezi lidmi, kteří by se jinak nepotkávali“.*

Historické dědictví Podprůhonu, reprezentované nejen architektonickými prvky (dělnické domky a křivolaké ulice), ale i vzpomínkami na staré časy, hraje klíčovou roli v udržení smyslu místa. Původní obyvatelé často zdůrazňují nostalgické vzpomínky na čisté ulice, vesnickou atmosféru a tradiční způsob života, který podle respondentky, paní Alžběty (DS), *„zmizel s příchodem nových domů a změnou infrastruktury“.* Noví obyvatelé naopak vnímají historické dědictví Podprůhonu jako součást jeho autenticity a unikátnosti, která zvyšuje např. hodnotu bydlení. Jejich přístup se zaměřuje na zachování architektonických prvků, ale méně často na kolektivní paměť, která je vlastní starousedlíkům.



Obr. 3 – Srovnání téhož místa v Podprůhonu (shora 60. léta 20. století, rok 2012, rok 2022). Proměna dnešního náměstí Viktora Stříbrného. Zdroj: Čermák (2022)

Komunitní vazby, které byly historicky silné, prošly zásadní proměnou. Původní obyvatelé si stále uchovávají vazby na rodiny a přátele, se kterými v místě sdíleli každodenní život po desítky let. Naproti tomu noví obyvatelé teprve začínají tyto vztahy budovat, přičemž klíčovým prvkem propojení se staly právě komunitní aktivity, jako jsou umělecké festivaly, sousedská setkání a revitalizace veřejných prostorů. Kolektivní paměť, zprostředkovaná zejména starousedlíky, přitom hraje důležitou roli v procesu přijímání nových obyvatel do komunity.

Dopad změny fyzického prostředí a společenského kontextu na Podprůhon je patrný nejen ve zlepšení infrastruktury a kvality života, ale i ve složení rezidentů. Noví obyvatelé, často ze střední třídy, přinášejí do místa investice a podporují kulturní život, což posiluje atraktivitu čtvrti. Přesto původní obyvatelé někdy vnímají tyto změny jako narušení autenticity a původního rázu místa. Podle pana Karla (ST) *„se Podprůhon změnil, už to není ta čtvrť, kde všichni znali všechny“*. Nastíněné rozdíly v pohledu na minulost a současnost odrážejí složitost procesu, ve kterém se formuje nový smysl místa.

Revitalizace Podprůhonu od roku 2013 tak přinesla nejen zlepšení fyzického prostředí místa, ale také proměnu sociálních vztahů a vnímání čtvrti jako místa k životu. Zatímco starousedlíci si uchovávají vztah k historickému dědictví a kolektivní paměti, noví obyvatelé přinášejí nové perspektivy a možnosti. Tento proces ukazuje, že smysl místa není statickým konceptem, ale dynamickým fenoménem, který je výsledkem interakce mezi minulostí, přítomností a vizemi budoucnosti. Podprůhon je tak živým příkladem toho, jak může být historická dělnická kolonie transformována v moderní prostor, který si uchovává svou jedinečnost i přes všechny změny (obr. 3).

Empirická zjištění napříč jednotlivými časovými etapami ukazují, že tyto analytické kategorie se v průběhu času proměňují jak samostatně, tak ve vzájemných vazbách, což potvrzuje dynamickou povahu smyslu místa popisovanou v úvodním kritickém rozboru literatury.

5. Závěr

Problematika smyslu místa je už více než pět dekád v ústředí zájmu humanisticky orientovaných geografů a zástupců dalších společenskovědních disciplín, které zkoumají vazby mezi lidmi a prostředím. Koncept místa se v této perspektivě chápe jako dynamický, proměnlivý a sociálně konstruovaný fenomén, který se utváří v každodenních praktikách, interakcích a kolektivní paměti.

Dosud nedostatečně probádanou oblastí je proces změn smyslu místa v čase, zejména v prostředích, která procházejí jak fyzickými, tak i sociálními (intenzivními, dynamickými) proměnami a změnami. Dělnické kolonie, které byly původně budovány jako specifické formy bydlení s výraznou sociální soudržností

lokálních komunit, představují jedinečnou laboratoř pro studium těchto proměn/změn.

Výše prezentovaný výzkum se snažil přispět do diskuse o významu časoprostorových (kontextů) změn smyslu místa prostřednictvím případové studie dělnické kolonie Podprůhon ve středočeském Kladně. Cílem výzkumu bylo zmapovat, jak se smysl místa proměňoval v průběhu posledních dekád a jaké faktory tuto proměnu ovlivnily. Hledali jsme odpovědi na otázky, zda se měnila intenzita i charakter vztahu obyvatel k místu a jaké události či procesy (rekonstrukce veřejného prostoru, sociální proměny obyvatelstva) tyto změny spustily. Vizuální analýza umožnila časové a prostorové ukotvení změn, zatímco narativní analýza odhalila subjektivní faktory, jako jsou vzpomínky, emoce a vnímání soudržnosti komunity. Ve výzkumu uplatněný přístup umožnil identifikovat/odhalit klíčové procesy, které proměny smyslu místa ovlivňují.

Výsledky výzkumu podporují tvrzení o dynamice vývoje smyslu místa uváděná ve studiích zaměřených na smysl místa (např. Massey 2005; Halfacree 2007; Guyot, Seetha 2007; Ujang, Zakariya 2015). V Podprůhonu lze sledovat oslabení i posilování smyslu místa. Dynamika tohoto fenoménu se ukázala na proměně z původně dělnické zástavby za hranicemi města, přes částečně vybydlené domy v periferii Kladna, až po nově zrekonstruované rodinné domy v centru města. Rezidenti při rozhovorech upozorňovali, že společně se změnou fyzického prostředí se v místě znatelně měnila také skladba rezidentů. K oslabení smyslu místa došlo podle rezidentů v 80. letech 20. století, kdy se fyzický stav místa zhoršoval a do místa se nastěhovali (či byli nastěhováni) Romové. Rezidenti uvedli, že v té době byl Podprůhon poměrně nebezpečnou částí města, což vedlo k uzavírání se do vlastních dvorků. Naopak k posílení smyslu místa došlo po rekonstrukci Podprůhonu v roce 2013 a odstěhování Romů. Nově příchozí rezidenti opravovali poničené domy, čímž přinášeli nové perspektivy k oživení prostředí a podpoře komunitních akcí. Aktivní spolupráce rezidentů se zdá klíčovým prvkem k úspěšné revitalizaci, respektive k posílení smyslu místa.

Kombinace vizuální a narativní analýzy umožnila sledovat jak fyzické, tak i sociální změny prostředí, díky čemuž bylo potvrzeno Cohenovo (1994) a Seamonovo (2018) tvrzení, že zásadní vliv na smysl místa (nejen postindustriální lokality) mají obě skupiny příslušných faktorů, jak fyzické, tak i sociální faktory (fyzické změny místa, estetika místa, sociální složení obyvatelstva, historická paměť). Navíc se na základě výzkumu ukazuje, že fyzické a sociální změny působí komplementárně ať už pozitivně, či negativně.

Z teoretického hlediska studie přispívá k české debatě o smyslu místa tím, že empiricky dokládá jeho výraznou časovou proměnlivost v kontextu postindustriálních transformací. Na rozdíl od přístupů zaměřených na relativně stabilní vztah jedince k místu ukazuje, že v obdobích fyzického a sociálního úpadku dochází k oslabení smyslu místa a k jeho prostorové redukci na bezprostřední okolí

bydliště (např. dvorek či dům). Tento poznatek nuancuje dosavadní teoretická pojetí smyslu místa v humanistické geografii a upozorňuje na význam dynamiky, paměti a každodenních praktik při jeho formování.

Z praktického hlediska studie nabízí podněty pro urbánní studia a plánovací praxi, zejména v oblasti revitalizace historických dělnických a postindustriálních čtvrtí. Výsledky ukazují, že fyzická obnova prostředí sama o sobě nevede automaticky k posílení smyslu místa, pokud není doprovázena podporou komunitních aktivit a možností každodenního setkávání obyvatel. Významnou roli zde sehrávají drobné prostorové prvky a poloveřejné prostory (např. dvorky), které mohou fungovat jako klíčová místa sociální interakce a obnovy vztahu k místu.

V procesu proměny smyslu místa jsme konkrétně zaznamenali značný vliv zejména faktoru příchodů Romů do Podprůhonu v 80. letech 20. století a v uspořádání komunitního života a oslabení smyslu místa. Porevoluční participace místních obyvatel vedla k revitalizaci a transformaci Podprůhonu z problematického místa, v němž se koncentrovaly problémy sociálně -patologické povahy, na atraktivní a oblíbenou část města, ve které dnes „kvete" komunitní život, kde se každoročně pořádají komunitní akce (např. Kladenské dvorky).

Fyzické změny, zejména rekonstrukce veřejných prostor a přestavby zanedbaných domů, byly prvním krokem k posílení smyslu místa. Tyto proměny vedly ke snížení sociálních a patologických jevů a problémů, které Podprůhon dlouhodobě zatěžovaly. Revitalizace čtvrti zároveň přinesla zvýšení její atraktivity pro rezidenty i návštěvníky a podpořila vznik nových míst vhodných pro komunitní aktivity a setkávání.

Za zmínku stojí tvrzení respondentů výzkumu, že při oslabení smyslu místa se rezidenti uzavírali na své dvorky. Toto tvrzení přináší podnětnou hypotézu k dalšímu ověření: Zmenšuje se oblast, ke které mají rezidenti smysl místa, když je oslaben původní smysl místa?

Výzkum v Podprůhonu tak potvrzuje, že smysl místa je dynamickým a sociálně konstruovaným fenoménem, který se v čase mění v kontextu měnících se fyzických i sociálních podmínkek. Ukazuje, že fyzické proměny prostředí a změny sociální skladby obyvatel působí komplementárně – mohou vztah k místu jak oslabovat, tak posilovat. Klíčovou roli hraje participace rezidentů a jejich schopnost využít fyzickou obnovu prostoru k posílení komunitních vazeb a kolektivní identity. Studie zároveň otevírá otázku zmenšování „mentálního rozsahu" místa v obdobích jeho degradace, což je podnět pro další výzkum. Obecně lze konstatovat, že úspěšná revitalizace prostředí by měla propojit fyzické zásahy s podporou komunitního života, čímž se zvyšuje šance na dlouhodobé posilování smyslu místa.

Literatura

ALTMAN, I., LOW, S. (1992): Place Attachment. New York. https://doi.org/10.1007/978-1-4684-8753-4

AUGÉ, M., BIXIO, A. L. (1995): Hacia una antropología de los mundos contemporáneos. Barcelona: Gedisa.

BREAKWELL, G. M. (1983): Threatened identities. Wiley, Chichester.

BREAKWELL, G. M. (1986): Political and attributional responses of the young short-term unemployed. Political Psychology, 575–586. https://doi.org/10.2307/3791257

COHEN, A. (1994): Culture, identity and the concept of boundary. Revista de Antropologia Social. Universidad Complutense de Madrid, 3, 1, 49–62.

CRESSWELL, T. (2004): Place. A Short Introduction, Oxford: Blackwell.

ČERMÁK, A. (2022): Proměny identity místa dvou kladenských dělnických čtvrtí od poloviny 20. století: Podprůhon a Nové Kladno. Diplomová práce. Přírodovědecká fakulta, Univerzita Karlova, Praha.

ČERMÁK, A. (2025): Vyprávění místa: vývoj konceptu. Acta Geographica Universitatis Comenianae, 69, 2, 223–234.

DAVIS, A., WAGNER, B. (2025): Understanding the role of 'sense of place' in the production and consumption of innovation districts. Innovation, 27, 4, 585–599. https://doi.org/10.1080/14479338.2024.2363258

GUYOT, S., SEETHA C. (2007): Identity of place, places of identities, change of place names in postapartheid South Africa. South African Geographical Review, 89, 1, 55–63. https://doi.org/10.1080/03736245.2007.9713873

HALFACREE, K. (2007): Trial by space for a 'radical rural': Introducing alternative localities, representations and lives. Journal of Rural Studies, 23, 2, 125–141. https://doi.org/10.1016/j.jrurstud.2006.10.002

HEIDEGGER, M. (1962): Being and Time. Oxford: Blackwell Publishing.

HENDL, J. (2005): Kvalitativní výzkum: základní metody a aplikace. Portál, Praha.

HUDSON, R. (2006): Regions and place: music, identity and place. Progress in human geography, 30, 5, 626–634. https://doi.org/10.1177/0309132506070177

HUSSERL, E. (1970): The crisis of European sciences and transcendental phenomenology. In: introduction to phenomenological philosophy. Northwestern University, Evanston.

CHROMÝ, P. (2003): Formování regionální identity: nezbytná součást geografických výzkumů? In: Jančák, V., Chromý, P., Marada, M. (eds): Geografie na cestách poznání. UK v Praze, PřF, KSGRR, Praha, 163–178.

KAŠKOVÁ, M., KUČERA, Z., CHROMÝ, P. (2016): Místo jako produkt: place branding a problémy jeho aplikace. Informace ČGS, 35, 2, 1–16.

LAI, L. Y., SAID, I., KUBOTA, A. (2013): The roles of cultural spaces in Malaysia's historic towns: The case of Kuala Dungun and Taiping. Procedia-Social and Behavioral Sciences, 85, 602–625. https://doi.org/10.1016/j.sbspro.2013.08.389

LIPSKÝ, Z., BIČÍK, I., KUPKOVÁ, L., JANČÁK, V., CHROMÝ, P., ed. (2022): Zmizelé krajiny Česka. ČGS, Praha, http://www.zaniklekrajiny.cz/images/publikace/krajina_blok_lores.pdf.

MASSEY, D. (2005): The spatial construction of youth cultures. Cool places, Routledge, 132–140. https://doi.org/10.4324/9780203975596–15

NORBERG-SCHULZ, CH. (1979): Genius Loci. Towards a Phenomenology of Architecture. Rizzoli International Publications, Inc. New York.

NORBERG-SCHULZ, CH. (1984): Genius loci. Odeon, Praha.

PATTERSON, M. E., WILLIAMS, D. R. (2005): Maintaining research traditions on place: Diversity of thought and scientific progress. Journal of Environmental Psychology, 25, 4, 361–380. https://doi.org/10.1016/j.jenvp.2005.10.001

POSPÍŠIL, Z., BAĎURA, F., HÁJEK, R. (2019): Paměť Podprůhonu: Historie, příběhy a lidé kladenské dělnické čtvrti. Halda, Kladno.

PROSHANSKY, H. (1978): The self and the city. Environment and Behavior, 10, 2, 147–169. https://doi.org/10.1177/0013916578102002

PROSHANSKY, H. M., FABIAN, A. K., KAMINOFF, R. (1983): Place-identity: Physical world socialization of the self. Journal of Environmental Psychology, 3, 1, 299–313. https://doi.org/10.1016/S0272-4944(83)80021-8

PROSHANSKY, H. M., FABIAN, A. K. (1987): The development of place identity in the child. In: Spaces for children: The built environment and child development. Boston, 21–40. https://doi.org/10.1007/978-1-4684-5227-3_2

QAZIMI, S. (2014): Sense of place and place identity, European Journal of Social Sciences Education and Research, 1, 1, 306–310. https://doi.org/10.26417/ejser.v1i1.p306–310

REICHEL, J. (2010): Kapitoly metodologie sociálních výzkumů. Grada, České Budějovice.

RELPH, E. (1976): Place and placelessness. Pion, London.

REZEG, A., ROCHE, S., EVENO, E. (2025): Toward a Sense of Place Unified Conceptual Framework Based on a Narrative Review: A Way of Feeding Place-Based GIS. Land, 14,1, 170. https://doi.org/10.3390/land14010170

SEAMON, D. (2018): Well-being and Phenomenology: Lifeworld, Natural Attitude, Homeworld and Place. Routledge handbook of well-being, Routledge, 103–111. https://doi.org/10.4324/9781315724966–11

STAVINOHA, F. (1981): Hvězdy nad Syslím údolím. Československý spisovatel, Praha.

ŠIFTA, M., CHROMÝ, P. (2017): The importance of symbols in the region formation process. Norsk Geografisk Tidsskrift–Norwegian Journal of Geography, 71, 2, 98–113. https://doi.org/10.1080/00291951.2017.1317285

TUAN, Y.-F. (1974): Topophilia: A Study of Environmental Perceptions, Attitudes, and Values. Englewood Cliffs: Prentice-Hall, University Press Columbia.

TUAN, Y.-F. (1977): Space and Place: The Perspective of Experience. University Press Minneapolis.

TUAN, Y.-F. (1990): Topophilia: A Study of Environmental Perception, Attitudes, and Values. Columbia University Press.

TWIGGER-ROSS, C. L., UZZEL, D. L. (1996): Place and identity process. Journal of Environmental Psychology, 16, 3, 205–220. https://doi.org/10.1006/jevp.1996.0017

TWIGGER-ROSS, C. L. (2003): Identity Theories and Environmental Psychology. In: Bonnes, M., Lee, T., Bonaiuto, M. (eds): Psychological Theories For Environmental Issues, Aldershot: Ashgate.

UJANG, N., ZAKARIYA, K. (2015): The Notion of Place, Place Meaning and Identity in Urban Regeneration. Procedia-social and Behavioral Sciences, 170, 1, 709–717. https://doi.org/10.1016/j.sbspro.2015.01.073

VÁVRA, J. (2010): Jedinec a místo, jedinec v místě, jedinec prostřednictvím místa. Geografie, 115, 4, 461–478. https://doi.org/10.37040/geografie2010115040461

SUMMARY

Transformations of the sense of place in the Podprůhon workers' colony in Kladno (Central Bohemia)

The study "Transformations of the sense of place in the Podprůhon workers' colony in Kladno (Central Bohemia)" examines the dynamics of the sense of place in a post-industrial landscape. In human geography and related disciplines, sense of place is understood as a comprehensive set of emotional, cultural, historical, and social ties between individuals and communities on the one hand and a certain place on the other. In the context of post-industrial areas whose original economic functions no longer exist, the sense of place transforms alongside physical and social changes in the environment.

The objective of the study was to map the transformation of the sense of place in the Podprůhon neighborhood of Kladno from the 1960s to the present and identify factors affecting these changes. The study's methodology combines visual and narrative analysis. Visual analysis works with old maps, photographs, plans, and works of art and provides a spatiotemporal grounding for physical transformations. Narrative analysis is based on semi-structured interviews with inhabitants of various ages and lengths of residence. The research sample was split into long-time residents, their children and grandchildren, and newcomers and their descendants. Responses were analyzed across three time periods: the 1960s and 1970s, 1980 to 2012, and the period after 2013.

Our findings indicate that during the first period Podprůhon maintained its character as a cohesive working-class community with a rural atmosphere. The social composition of the population was relatively homogenous, and day-to-day community life took place on the streets and in the courtyards. This period marked the last period of continuity of the neighborhood's original identity, although the first hints of this place's declining attractivity began to appear as the first prefabricated housing estates were built and local infrastructure neglected.

The second period, lasting from 1980 until 2012, marked a major turning point. In this period, socially disadvantaged groups of people moved into the area (or were concentrated there by the Communist regime), which led to an increase in social problems, the stigmatization of the neighborhood, and the flight of the original inhabitants. The result was a loss of community, the limited use of public space, and the severing of ties to adjacent neighborhoods, which was exacerbated by the construction of a four-lane (urban) road. Town leaders even considered demolishing Podprůhon. Nonetheless, this period saw the establishment of the Kladno Courtyards festival, which has at least partly preserved community life here. Overall, this period can be characterized as an era of a weakened sense of place.

The third period, starting in 2013 and lasting to the present, is associated with the gradual revitalization of the local community. The renovation of houses, the connection to the gas grid, road repairs, and the improvement of public space have increased quality of life in the neighborhood and by extension its attractiveness. New middle-class people began moving to Podprůhon, bringing with them investments and new forms of participation in public life. New residents view the neighborhood's historical legacy mainly through an aesthetic lens, whereas long-time residents emphasize the neighborhood's nostalgic dimension and collective memory. Community activities, especially the Kladno Courtyards festival, have become an impartment arena for both groups to meet and have contributed to creating a new identity of place.

The analysis confirms that sense of place is a dynamic, socially constructed phenomenon that transforms in relation to physical changes in the environment and the social composition of the

population. Both factors have a complementary effect: they can both strengthen and weaken the link to place. The revitalization of Podprůhon demonstrates that combining physical changes with support for community life can lead to the long-term strengthening of local identify. The research also addressed the question of "the mental scope" of place – in periods of decline, the place to which residents feel a connection shrinks (e.g., to their own yard), whereas during periods of revitalization, the place to which they feel a connection becomes once again the entire neighborhood.

Podprůhon is a model case of the transformation of a workers' colony into an attractive residential neighborhood that has managed to preserve part of its historical heritage and at the same time create new forms of community identity. The findings contribute to a deeper understanding of the processes of creating a sense of place and emphasize the significance of the active participation of residents in revitalizing post-industrial areas.

Fig. 1 Map of Kladno (2003). Source: https://ags.cuzk.cz/geoprohlizec/

Fig. 2 Boundaries of Podprůhon as described by respondents (residents) in 2022. Source: Čermák (2022)

Fig. 3 Comparison of the same place in Podprůhon (from top: in the 1960s, 2012, and 2022). The transformation of a square known today as náměstí Viktora Stříbrného. Source: Čermák (2022).

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Citace z časopisu: SJÖBERG, O. (2014): Cases onto themselves? Theory and research on ex-socialist urban environments. Geografie, 119, 4, 299–319.
Citace knihy: GREGORY, K. J. (2000): The changing nature of physical geography. Arnold, London.
Citace kapitoly z knihy: MARCOU, G. (1993): New tendencies of local government development in Europe. In: Bennet, R. J. (ed.): Local government in the new Europe. Belhaven Press, London, New York, 51–66.
Citace z Internetu: MANDELMAN, A. (2012): Wet Prairie: People, Land, and Water in Agricultural Manitoba, http://www.h-net.org/reviews/showrev.php?id=37027 (1. 1. 2016).
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