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Seasonal trends in the Early Twentieth Century Warming (ETCW) in a centennial instrumental temperature record from Central Europe

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Abstract

The goal of the present paper is to investigate whether any objectively defined and statistically significant changes can be discovered in one of the longest homogenized instrumental temperature records in East-Central Europe. Thus, it is hoped that the present analysis will add to earlier attempts and elucidate the persistence of the warming period observed in the early 20th century. Similar to the global tendency, the Early Twentieth Century Warming (hereinafter, ETCW) period can be identified between 1931 and 1951 in the annual mean temperature time series of Keszthely, a small town in Hungary. The Mann-Kendall trend test was used to determine whether a monotonic trend was present, as it is not possible to regard the residuals of the linear trend as normally distributed. A significant rising trend can be observed in the warming period in spring of the years between 1925 and 1951. In case of summer and autumn, this period cannot be characterized as having any significant identifiable trend. A rise in the mean can, however, be recognized. Overall, the specific regional manifestation of the global ETCW may clearly be illustrated in this study via detailed statistical analysis of the temperature records for Keszthely, a location with one of the longest temperature records in Hungary. However, other regions surrounding Hungary show similar climatic trends, emphasizing the fact that the behaviour presented here is not unique to Central and Eastern Europe.

Keywords: change-point detection, Early Twentieth Century Warming (ETCW), temperature records, time series analysis

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Introduction

Changes in weather and climate patterns due to anthropogenic forced global climate change have direct and indirect effects on human life and socio-economic systems. The final two decades of the 20th century, along with the first two decades of the 21st, have been successively warmer than any decade preceding 1850. What is more, global surface temperatures between 2001 and 2020 were 1.1 °C higher than 1850–1900 (IPCC, 2021). This increase in temperatures can be traced back to the beginning of the past century, occurring in two distinct periods, from the mid-1920s to mid-1940s (Przybylak, R. *et al.* 2021) and from 1978 to the present day (Delworth, T.L. and Knutson, T.R. 2000). However, between these two periods of accelerated warming, a stagnation was observed from the 1940s to the 1970s, and a less steep trend from 2000 to approximately 2013 (Hegerl, G.C. *et al.* 2018).

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Out of these warming periods the one in the first decades of the 20th century was the more prominent, called the "Early Twentieth Century Warming" (ETCW) (Hegerl, G.C. *et al.* 2018). It was found that, besides other factors, natural variability made a large contribution to the ETCW, and particularly to regional anomalies in the 1920s and 1930s. Nonetheless, the ETCW represents a phase of a robust surface warming globally (Semenov, V.A. and Latif, M. 2012), which we might add, was concentrated in higher latitudes (Yamanouchi, T. 2011). On the regional scale, the warming observed the early 20th century displays a noticeable maximum at higher latitudes in the Northern Hemisphere (Delworth, T.L. and Knutson, T.R. 2000).

Exploring regional temperature features over the course of the ETCW is much more enlightening than looking at the global mean (Brönnimann, S. 2009). The ETCW was most evident in the Arctic, and in winter (Bokuchava, D.D. and Semenov, V.A. 2021), with the Arctic surface temperature warming more than twice as fast as global temperatures (Svendsen, L. *et al.* 2018). Atmospheric circulation fluctuations are important for the early 20th century Arctic warming (Tokinaga, H. *et al.* 2017). A considerable part of regional manifestations of the ETCW appeared outside of the Arctic, including across the USA, Western Europe, and the North and South Atlantic (Hegerl, G.C. *et al.* 2018; Bokuchava, D.D. and Semenov, V.A. 2021). The end of the ETCW in Central Europe was marked by summer heatwaves, droughts, and cold winters (Hegerl, G.C. *et al.* 2018). The ETCW was probably caused by the combined effects of long-term natural climate variations in the North Atlantic and North Pacific and the influence of natural radiative forcing, as well as the growing concentration of greenhouse gases in the atmosphere (Bokuchava, D.D. and Semenov, V.A. 2021). Utilizing a Bayesian change-point detection method, a change-point can be observed in the data of Greenland ice cores at the beginning of the 20th century (centred on 1933) (Hatvani, I.G. *et al.* 2022).

Research of climate features during the ETCW is mainly based on conventional weather observations from the continental surface, measurements taken at sea by ships, and some climate proxy data; even if data-saving initiatives aim at supplementing the global climate record in this period (Allan, R. *et al.* 2011 – in: Hegerl, G.C. *et al.* 2018), the main sources of information about climate change remain ordinary measurements. The existing historical observations recorded by national meteorological and hydrological services, although considered to be incomplete, may nonetheless augment our knowledge of key climate processes and climate change (Dee, D. *et al.* 2021).

Meteorological instruments have been widely used since 1850 in Europe, the Eastern USA and some other regions, including, sporadically, the oceans (Stott, P. *et al.* 2018). Instrumental meteorological measurements were conducted from the 18th century in Italy, Belgium, Sweden, Spain, and Russia (Moberg, A. *et al.* 2000; Camuffo, D. and Jones, P.D. 2002). National weather yearbooks began to be published around 1860 in many countries (Jones, P.D. 2001). Instrumental temperature time series are available from 1760 for the Alpine zone (Böhm, R. *et al.* 2001). The longest instrumental temperature time series in the Czech Republic is for Prague-Klementinum, starting in 1775 (Brázdil, R. *et al.* 2012). In Poland, the mean annual temperature records for the periods 1779–1998 (Warsaw) and 1792–1995 (Cracow) are analysed by Przybylak, R. (2010). In Budapest, regular meteorological observations started in 1780 (Camuffo, D. 2018). Official instrumental meteorological observations began in 1851 in Austria, and in 1870 in Hungary (this was the epoch of the Austro-Hungarian Monarchy). Keszthely station was one of the earliest working stations in the Hungarian network, a network that was organized according to the Western European standards of the time. It is also interesting because there is a special microclimate at that location in consequence of the presence of the nearby large lake, Balaton.

Despite the long time series, in the literature there is a marked lack of research dealing with the ETWC in Central Europe.

The aim of the present study is to explore the presence of objectively defined and statistically significant changes occurring in one of the longest East-Central European homogenized instrumental temperature records. Hence, the present study complements previous efforts and elucidates the persistence of the observed warming period in the early 20th century.

Materials and methods

Keszthely centennial homogenized temperature time series

The Keszthely (E 17°14′, N 46°44′ – *Figure 1*) monthly temperature time series spans 1871 to 2018 and was measured at the long-established Georgikon Academy of Agriculture in Keszthely, and later, at a meteorological station of the Hungarian Meteorological Service. Keszthely is located on the northern shore of Lake Balaton, a 17,000–19,000-year-old water body and the largest shallow lake in Central Europe (surface area: about 600 km^2, average depth: 3.25 m). As the last overall publication dealing with the climate of Balaton was published 50 years ago (Béll, B. and Takács, B. 1974), and due to the absence of a permanent measuring network around the lake, the meteorological dataset of weather conditions over and around the lake originates from two permanent lakeshore meteorological stations (Keszthely and Siófok) that have made observations over the long term (Anda, A. *et al.* 2023). Using the categories of the Koppen-Geiger classification, the climate of Keszthely is temperate continental (Cfb), with an annual long-term mean air temperature of 10.5 °C, with a monthly minimum of -1.03 °C during January, and a maximum of 21.14 °C in July. The average annual precipitation sum is 673.3 ± 137.9 mm, though with a large monthly variation of between 32.7 and 76.1 mm in the driest January, and wettest July, respectively. In winter, the lake may be covered with ice, sometimes thicker than 0.5 m, factor impacting the air temperature during early spring.

The time series explored here were quality controlled and homogenized by the Hungarian Meteorological Service. Homogenization was conducted using the MASH tool (Szentimrey, T. 1999, 2008), which eliminates errors and inhomogeneities while filling the gaps in the data (Izsák, B. and Szentimrey, T. 2020). The MASH procedure was originally developed for the homogenization of monthly series. It is a relative method and depending on the distribution of the meteorological elements under examination, additive (e.g., for temperature) or multiplicative (e.g., for precipitation) models can be employed (Szentimrey, T. 2006).

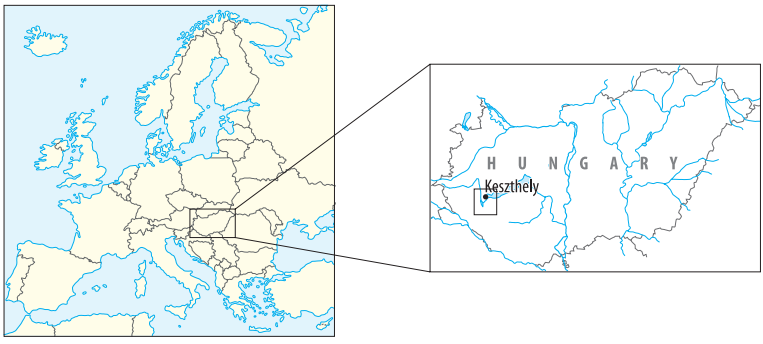


Fig. 1. Location of Keszthely, Hungary (46°44′N, 17°14′E, elevation 114.2 m above Baltic Sea level).
Source: Redrawn from Kocsis, T. *et al.* 2020.

Methodology

After giving an overall description of the Keszthely mean temperature time series (K_T) regarding long-term trends (see the first part of section 'Results and discussion'), the data was aggregated into annual and seasonal (winter: DJF, spring: MAM, summer: JJA, autumn: SON), and abrupt changes in the time series were sought using change-point analysis. There are numerous change-point detection techniques applied in the exploration of climatic (proxy) variables (e.g., Ducré-Robitaille, J.-F. *et al.* 2003; Reeves, J. *et al.* 2007; Ruggieri, E. 2013; Topál, D. *et al.* 2016; Hatvani, I.G. *et al.* 2020), and of these, Bayesian change-point analysis (BCPa) (see the second part of section 'Results and discussion') was selected for the present study, due to its ability to provide uncertainty estimates of the number (even multiples) and timing of change-points, a key advantage over a frequentist approach (Ruggieri, E. 2013). In the segments, thus, determined, numerous aspects of the mean temperature time series are described and assessed for the presence of prevailing significant trends.

Preprocessing and change-point analysis

To achieve common variability and increase the signal-to-noise ratio relative to the magnitude of the supposed changes a 10-year low-pass filter was applied to all the time series. This aided the detectability of valid change-points (Ruggieri, E. and Antonellis, M. 2016; Ruggieri, E. 2018). The time series were then centred and subjected to the linear model of the Bayesian change-point algorithm of Ruggieri, E. (2013) (BCPa for short).

The BCPa involves three key steps:

1. The calculation of the probability of the data given by the model between any two time points. This encompasses all potential climate regimes (in terms of timing) within the dataset.

2. The utilization of the probabilistic calculations from step 1 as building blocks to assemble these segments recursively, incrementally adding one possible change-point at a time.

3. The application of Bayes' rule to calculate the posterior distribution of the parameters of interest – here the number and location of change-points – as well as the parameters of the regression model in each interval (Hatvani, I.G. *et al.* 2020).

In a nutshell, BCPa can generate the posterior distribution on both the number and location of change-points in a data set. For an additional overview on change-point analysis (see Ruggieri, E. 2013, 2018).

In terms of parameterization, the model has several parameters which need to be specified, including those of the prior distribution of regression coefficients and the residual variance, which are known as hyper-parameters (Quiang, R. and Ruggieri, E. 2023). Here, the parameterization followed that the method of Hatvani, I.G. *et al.* (2022) on climate proxy time series, specifically:

– prior on the regression coefficients $k_0 = (0.001, 0.01)$;
– prior on the variance of the residuals, $v_0 = 1$, σ_0 = variance of each time series;
– the minimum distance between successive change-points, $d_{min} = 10$ steps (years in the present case);
– the maximum number of change-points $k_{max} = 50$;
– the number of sampled solutions, *num. samp* = 10,000.

The prior parameters were deliberately selected to represent a minimum of prior information, allowing the inference to be primarily driven by the actual data. In general, in any case where the model is sensitive to the k_0, v_0, and σ_0 parameters, the number of change-points is influenced while their location or distribution is left unaffected. In simpler terms, adjusting these parameters can modify the detection threshold of the model, but will not result in the shift of a change-point from one section of the data to another. For a detailed explanation of the parameters, the reader is referred to Ruggieri, E. (2013) and the supplemental online material of Hatvani, I.G. *et al.* (2022).

Because BCPa determines the probability of a change-point at a given location – thus, providing uncertainty estimates – and the change-point time series obtained were passed through a 5-year centralized rolling summary function in order to cumulate the probability dispersed between consecutive years. This cumulative probability is the probability of the change-point(s) shown in the study. Only "practically certain" change-points with a 5-year sum probability > 80 percent were considered in the evaluation. In addition, a 5-year window was considered when evaluating the coincidence of the differently aggregated *T* time series, as was done in Hatvani, I.G. *et al.* (2022), but even more rigorously.

Trend analysis and descriptive stats

The aim was to determine the general tendencies of the time series. As the temperature data underwent homogenization using MASH, there was no need to check the data for homogeneity.

The common linear regression (trend) based on ordinary least squares method was used, along with a control to conform to the demand of normal distribution of the residuals using the Shapiro-Wilk normality test (Shapiro, S.S. and Wilk, M.B. 1965). The decision over significance was made at the 5 percent significance level. Beside the tendencies, absolute deviation from the mean was calculated for every year on annual, seasonal, monthly levels to obtain information about the tendencies of the variability. After searching for change-points in the time series, they were segmented according to the change-points. Any tendencies in the segmented time series were determined using linear trend. In cases where the distribution of the residuals is significantly different from normal distribution, the Mann-Kendall (MK) non-parametric trend test was applied to determine the tendency of the segments at α = 5 percent. The simple MK trend test is based upon the work of Mann, H.B. (1945) and Kendall, M. (1975), and it is closely related to Kendall's rank correlation coefficient.

A detailed description of the methodology of the simple MK trend test is given by Gilbert, R.O. (1987), and Hipel, K.W. and McLeod, A.I. (1994). The test statistic is based on *S*, which represents the number of signs between the elements of the times series. A positive value for *S* means that there is a rising trend, a negative value for *S*, the contrary. With the help of descriptive statistics (mean, standard deviation) and trend analysis, the reasons for the presence of a change-point were explored. The simple MK trend test does not consider the possible autocorrelation of the data. The presence of positive autocorrelation in the data increases the chance of detecting trends when actually none exist, and vice versa (Hamed, K.H. and Rao, A.R. 1998). This effect of the existence of autocorrelation in data is often ignored: Hamed, K.H. and Rao, A.R. (1998) supposed a modified non-parametric trend test suited to auto-correlated and gave a detailed description of it. Modified MK trend test for auto-correlated. In the case of the detection of a non-parametric trend, Sen's slope estimator (Sen, P.K. 1968) was applied. This is a non-parametric method that can calculate the change per unit time (direction and volume). Sen's method uses a linear model to estimate the slope of the trend (Da Silva, R.M. *et al.* 2015). In the case of a proven autocorrelation in the dataset, the modified version of the MK trend test was applied *(Figure 2).* AR1 values were higher than the critical value for the annual mean temperature data, for summer seasonal mean time series, and July *(Figure 3).* The autocorrelation of the data and the normal distribution of the residuals were taken into account in the analysis of the variability as well.

The trend estimations and the change-point analysis were performed in the *R* statistical environment (R Core Team, 2019). The modified *MK stats* and *trend* packages were used for trend analysis, *band-pass* filtering was performed with the *band-pass* function of the *astrochron* package (Meyers, S.R. 2014) and change-point detection was performed using the Bayesian change-point algorithm (Ruggieri, E. 2013).

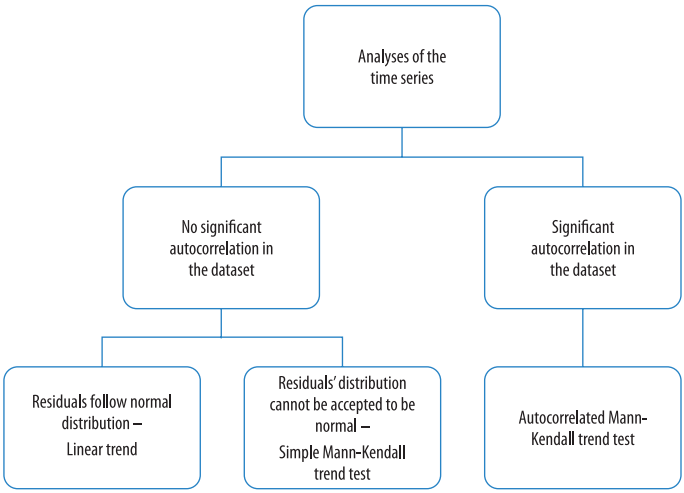


Fig. 2. Decision making flow-chart for choosing method. *Source*: Authors' own elaboration.

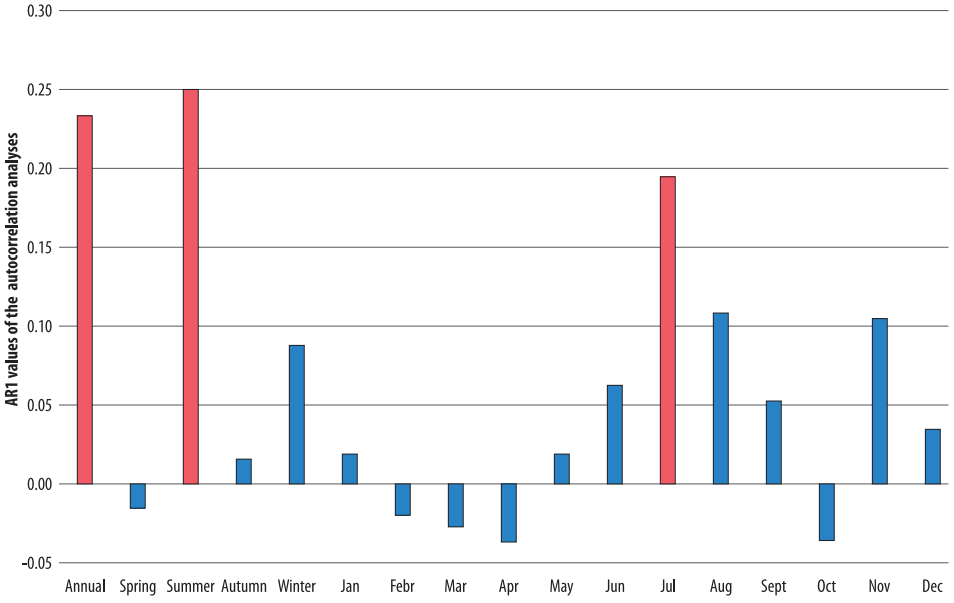


Fig. 3. Autocorrelation (AR1) of the time series (significant autocorrelations are in red). *Source*: Authors' own elaboration.

Results and discussion

Overall tendencies in the centennial Keszthely mean temperature time series (K_T)

The autocorrelation was taken into account using the Hamed and Rao method (Hamed, K.H. and Rao, A.R. 1998) for the analysis of the annual mean temperature data as the presence of autocorrelation was proved and an overall significant monotonic increasing tendency (*Figure 4*, A – Sen's slope: 0.004, $S = 1905$, $p = 2.506\ 10^{-02}$) was found for the annual mean, corresponding to a rise on aver-

age of 0.4 °C per 100 years. Significant trends were seen for the winter and spring (*Figure 4*, E – winter, Sen's slope: 0.0084, S = 1305, p = 2.896 10^{-02}), with the simple MK test and *Figure 4*, B – spring, slope: 0.0048, $t(146)$ = 2.234, p = 2.703 10^{-02}, with a linear trend), with an increase of 0.84 °C and 0.48 °C per 100 years, respectively. Regarding the summer and autumn, no overall significant ($p > 0.05$) trend was observed. Among the months, linear increasing trends were detected in January (slope: 0.0119, $t(146)$ = 2.259, p = 2.534 10^{-02}) and in November (slope: 0.0086, $t(146)$ = 2.197, p = 2.956 10^{-02}), respectively.

Variability was assessed by examining the absolute deviation from the mean (annual, seasonal, monthly, respectively). The distributions of the residuals cannot be accepted to be normal, therefore the MK test was used. Significant autocorrelation can be detected in the analysed data in September, so an autocorrelated MK test was applied. It is interesting to see the tendencies of the variability, but the only significant monotonic trend can be detected in December. The absolute deviation from the mean temperature in December displays a significant linear decreasing trend (Sen's slope: -0.0042, S = -1235, p = 4.070 10^{-02}). This means that in December, fewer extremities occur.

Abrupt changes and decadal trends in the Keszthely mean temperature time series (K_T)

A change-point can be found in the annual mean temperature data in 1895, with a probability of 99 percent, and another in 1931 with 90 percent probability. The change-point (CP) in 1931 is in good coincidence with the beginning of the ETCW. In 1952, a negative shift can be seen with 80% probability. This may be considered as indicating the end of the ETCW period (see *Figure 4*, A). In the seasonal data, change-points can be detected in 1925 with 99 percent probability in spring, in 1927 in the summer mean temperature and in 1924 in the average temperature of winter. In the time series of autumn, a CP can be seen in 1924 with 80 percent probability. In autumn, a change-point can be seen in 1969 with 99 percent probability. A secondary CP can be identified in 1952 and 1953 in the spring and summer time series, respectively. These change-points are also in good agreement with dates for the beginning (Delworth, T.L. and Knutson, T.R. 2000) and end (Przybylak, R. *et al.* 2021) of the ETCW (see *Figure 4*, B-D). The period of the ETCW can be detected in the annual data and in spring and summer, but in autumn and winter only the beginning can be identified, while the end is missing.

The time series were divided at the CPs that have a probability of 80 percent at least. The year in which the CP was detected becomes the first year of each separate period. Linear trend, or MK trend, was fitted, and the slope coefficient was examined at the 10 and 5 percent significance levels *(Table 1).* Among the separated parts of the annual mean temperature, significant periods of increase can be observed between 1931 and 1951, and 1985 and 2018. The timing of the first is contemporary with the ETCW. The second is the significant temperature rise being experienced nowadays.

The previous division was also applicable to the times series of the seasons, as well. In spring all of the separate periods show significant rising tendencies at the 10 percent significance level. A significant increasing trend can be found in the period of the ETCW. Surprisingly, in the summer the ETCW period does not exert a significant influence, but the previous and the next period displayed significant change. Between 1871 and 1926 a significant decreasing trend may be observed in the summer mean temperature (see *Table 1*). The average temperature, however, is higher than the mean of both the previous and subsequent periods. Between 1953 and 2018 a significant temperature rise can be detected *(Figure 5).* This result is somewhat at odds with the findings of Hegerl, G.C. *et al.* (2018), namely, that in Central Europe droughts and heatwaves marked the end of the ETCW in the late 1940s and early 1950s. Studies analysing the time series of the Palmer Drought Severity Index (PDSI)

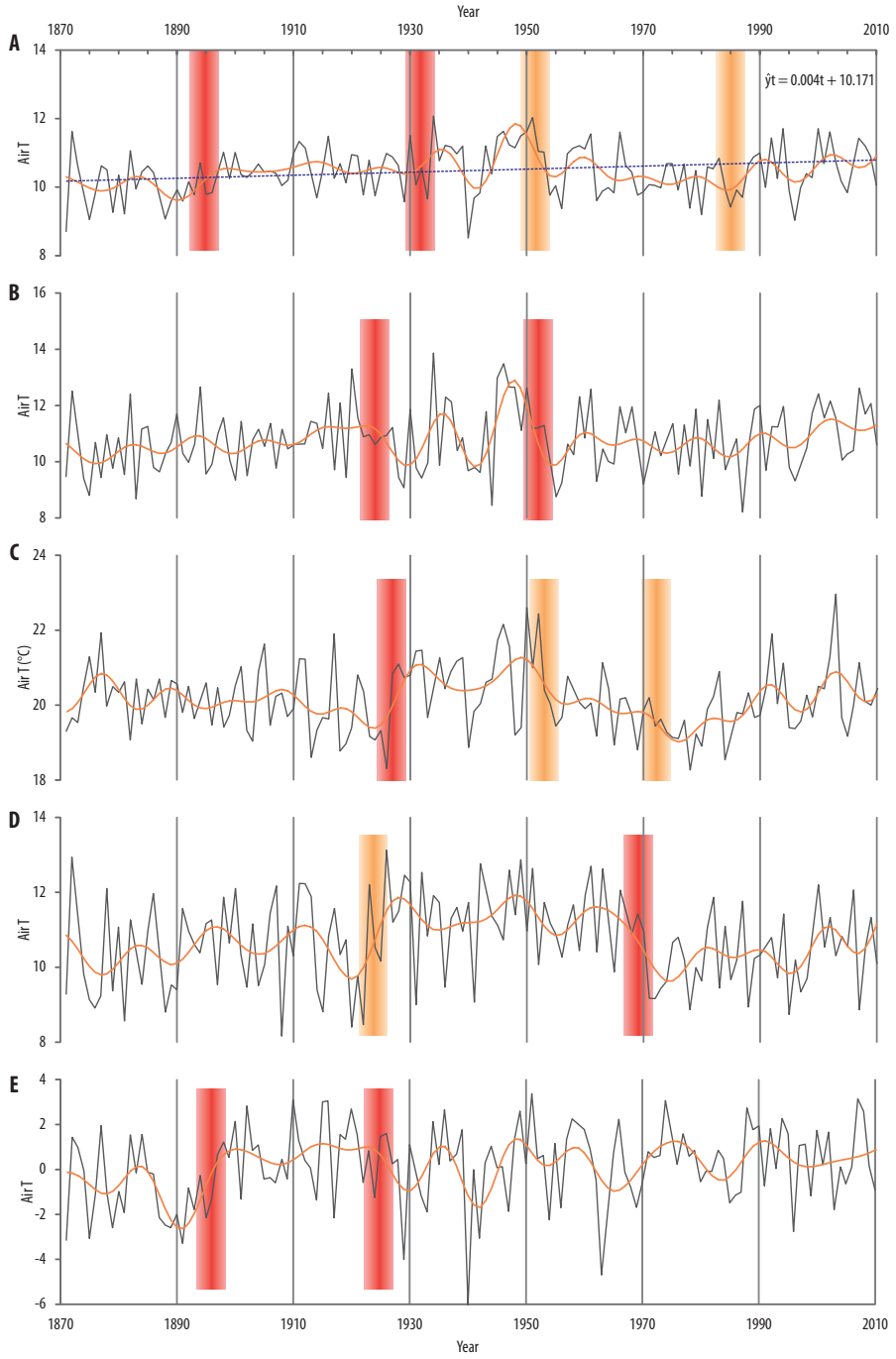


Fig. 4. Keszthely annual (A), spring (B), summer (C), autumn (D), and winter (E) raw (grey), 10-year low-passed (orange) temperature time series spanning 1871–2018. Change-points of posterior probability > 80%, and < 90% are indicated in orange, and those > 90% with a red vertical column. The blue line in part (A) is the linear trend of the annual time series. *Source*: Authors' own elaboration.

Table 1. Segments of the time series in which trends can be identified

Annual	*1871–1894*	*1895–1930*	*1931–1951** (Sen's slope = 0.059)*	*1952–1984*	*1985–2018** (slope = 0.042)*
Spring	1871–1924** (slope = 0.018)		1925–1951* (slope = 0.062)	1952–2018** (slope = 0.018)	
Summer	1871–1926** (slope = 0.014)		1927–1952	1953–2018** (slope = 0.018)	
Autumn	1871–1923		1924–1968	1969–2018** (Sen's slope = 0.024)	
Winter	1872–1895	1896–1923	1924–2018		

*Significant at 10%, **at 5% significance level.

for the 20th century in Hungary state that significant wet sub-periods are detectable in the first half of the 20th century, while dry breaks occurred in the second half of the century (Horváth, Sz. *et al.* 2005). Szinell, C.S. *et al.* (1998) also confirmed that droughts generally occurred more frequently in the second half of the century in Hungary. Szinell, C.S. *et al.* (1998) analysed the PDSI series between 1881 and 1995, and found no change at Keszthely stations in terms of drought. Makra, L. *et al.* (2005) detected significant wet periods in the first part of the 20th century (between 1901 and 1940) for East Hungary. Hegerl, G.C. (2018) also mentions that the ETCW period was also a period of cold winters.

The Hungarian Meteorological Service publishes the time series of extreme cold and hot indices for Keszthely, among other stations in the country, on its homepage (www.met.hu). The graphs published on the website suggest that in the ETCW period days of extreme cold (e.g., number of cold days, number of frosty days) and the number of hot days were more frequent. Examining only the data for autumn, the ETCW cannot actually be detected. The only significant period is between 1969 and 2018, with an increasing trend in the seasonal mean temperature data. In the time series for winter, no significant trend can be detected in any segment. The beginning of the last segment (1924) is contemporary with the beginning of the ETCW, but the end cannot be detected.

With help of the descriptive statistics (mean, standard deviation) of the segments shown in *Table 2*, and trend analysis, the reasons for the presence of a change-point were explored. The change-point in the annual data in 1895 was probably caused by a rise of the mean, and a decline in SD. Between 1931 and 1951, a significant increasing trend is accompanied by a rise in the mean and in SD. From 1952, the mean and SD are lower than in the preceding segment. Between 1985 and 2018, a significant increasing trend can be identified as the reason for the change-point. In spring, all three segments display a significant increasing trend, and between 1925 and 1951, a higher mean and SD are observable. A cooling period can be found in summers between 1871 and 1926, while from 1927 the mean and SD are higher than previously. This is probably the reason for the change-point in 1927. The last period of the examined time series displays a significant rising trend. The change-point in autumn, 1924, may be the consequence of a rise of the mean and decline in the SD, implying a lower degree of autumn temperature variability compared with warmer years. The period 1969–2018 shows a significant increasing trend according to the MK trend test. In the three segments of the winter, an upward shift in the mean followed by a downward shift can be seen. In case of SD, the opposite pattern can be detected.

For the ETCW period, significant rising trends can be detected in the annual mean temperature and in spring. The mean temperature is higher than the previous or subsequent periods' average in the case of the annual data,

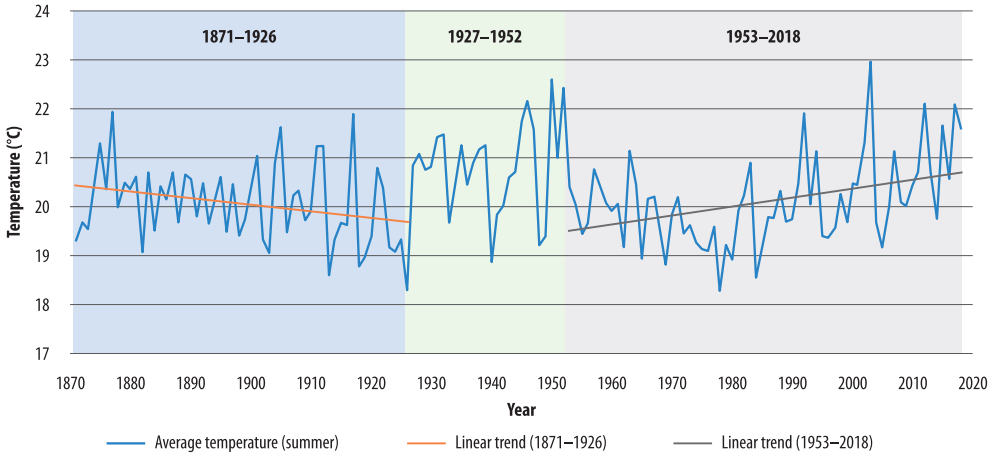


Fig. 5. Trends within segments in the summer season. *Source*: Authors' own elaboration.

Table 2. Mean (M) and standard deviation (SD) of the segments defined in Table 1

Seasons	M ºC /SD ºC/ (Period)				
Annual	*10.023 /0.707/ (1871–1894)*	*10.513 /0.509/ (1895–1930)*	*10.852 /0.893/ (1931–1951)*	*10.360 /0.642/ (1952–1984)*	*10.740 /0.803/ (1985–2018)*
Spring	10.644 /1.011/ (1871–1924)		11.036 /1.464/ (1925–1951)	10.860 /1.071/ (1952–2018)	
Summer	20.053 /0.818/ (1871–1926)		20.829 /0.943/ (1927–1952)	20.009 /0.897/ (1953–2018)	
Autumn	10.469 /1.215/ (1871–1923)		11.344 /1.009/ (1924–1968)	10.560 /1.194/ (1969–2018)	
Winter	-0.975 /2.094/ (1872–1895)	0.715 /1.583/ (1896–1923)	0.367 /1.856/ (1924–2018)		

and also individually in spring, summer and autumn, too. In comparison, the last part of the 20th century (i.e., well within the current warming period) displays significant warming tendencies for spring, summer and autumn, while the mean temperatures of these periods are slightly lower than those in the ETCW period. These facts suggest that in the ETCW period a shift in the mean was observable, while in the current warming period, a slow but significant increasing tendency is occurring.

Keszthely has local importance as a tourist destination and as a biodiversity reservation in Hungary. The high dependence of Keszthely weather on lakeshore conditions determines its characteristics, and this is likely to continue. The significant declining precipitation trend, together with rising temperature trends, may cause declining lake water levels, disturbing tourist activities. The specialty of its meteorological dataset lies in its unique uninterrupted length of 150 years (Kocsis, T. and Anda, A. 2006), and its particular importance in the assessment of the water quality of the largest shallow freshwater lake in Central Europe, Lake Balaton (Hatvani, I.G. *et al*. 2022), including its semi-constructed water protection sys-

tem. Worldwide, wetlands cover 5–8 percent of total land surface (Mitsch, W.J. *et al.* 2013), including the Kis-Balaton wetland in the neighbourhood of Keszthely, and these wetlands constitute 20–30 percent of the total global carbon pool. They therefore play a crucial role in climate change mitigation (Dang, A.T.N. *et al.* 2021). The release of a wetland's CO_2 may also augment the local impacts of global warming.

Similar to global trends, the ETCW period can be detected between 1931 and 1951 in the annual mean temperature time series of Keszthely: between 1925 and 1951 a significant increasing trend is observed for spring mean temperature, and although in the case of summer and autumn, this period cannot be described as displaying any significant trends, an upward shift in the mean can be observed.

Similar to the regional results presented in this paper, evidence of significant increments in temperature between 1920 and 1950, then starting from 1985 until nowadays, are also reported in Italy (Herrera-Grimaldi, P. *et al*. 2018). Brunetti, M. *et al*. (2000) analysed the time series of annual mean temperature for the period of 1866–1995 and reported that the Italian climate has become warmer and drier, especially in the South, since about 1930. In the continental mid-latitudes of the Northern Hemisphere warm anomalies are often accompanied by dry conditions. So, besides warming trends during the ETCW, southeast of the present study area, in Bulgaria, several dry periods were detected in the 1940s by Alexandrov, V. *et al.* (2004). Moreover, in the 1930s the East European Plain was affected by intense long-lasting droughts (Popova, V. *et al.* 2022), and these are also considered to be connected to the ETCW. While the previously mentioned studies report droughts linked to the ETCW period, in Hungary Makra, L. *et al.* (2005) detected significant wet periods in the first part of the 20th century (between 1901 and 1940), while dry periods were found in the second half of the century, that is, including under the current warming period. Unfortunately, no literature could be found on investigations of the ETCW and its effects on the Central European region, nor on the Carpathian-Basin, nor on Hungary itself.

Conclusions

This paper wanted to fill the gap between the wide number of studies about the effects of ETCW in the Artic and limited investigations concerning its impact on Europe. Keszthely, with its uninterrupted temperature records since 1871, serves as a focal point for analysing long-term temperature trends. The research uncovers evidence of ETCW in Keszthely's annual, spring, and summer temperatures, but its indicators remain elusive during fall and winter. Furthermore, the study notes that the characteristics of ETCW in Central Europe slightly differ from those reported for the broader region. Unfortunately, due to a lack of studies on ETCW in the Carpathian Basin, comparisons could not be made, highlighting a critical area for future research.

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Disproportionate exposure to urban heat island intensity – The case study of Győr, Hungary

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Abstract

Extensive research has shown that urbanisation has a profound effect on the local climate system, leading to the formation of urban heat island. Exposure to urban heat islands poses a major health risk, and there is a growing body of literature recognising that urban population groups with particular demographic characteristics living in specific types of residential environments are disproportionately affected. By combining surface urban heat island data from the Global Surface Urban Heat Island Explorer with neighbourhood-level data on demographics and the type of housing, this study assesses disproportionate exposure to surface urban heat island intensity in the city of Győr, Hungary. Results of the study highlight the importance of targeted interventions for environmental justice, especially in areas characterised by housing estates, high population density and high ageing index.

Keywords: urbanization, residential environment, local climate, urban heat island, Győr, Hungary

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Introduction

On a global scale, an increasing share of the population lives in cities, accounting for 57 percent in 2022 (World Bank, 2023a). Forecasts indicate a continued growth with nearly 68 percent of the world's population projected to live in cities by 2050 (UNCTAD, 2022). By 2030, growing urban land consumption is expected to increase the world's new urban built-up area by 1.2 million km² (World Bank, 2023b). The largely artificial materials that build up the urban surface lead to permanent changes in thermal characteristics. As a result, cities consistently experience higher temperatures compared to their rural surroundings, leading to the phenomenon known as the urban heat island (UHI) effect (Howard, L. 2007).

According to the World Meteorological Organization report, extreme weather and climate change has led to a five-fold rise in extreme weather events and disasters over the past 50 years (WMO, 2021). Prolonged extremely high temperatures, referred to as heatwaves, are becoming more extensive and intensive (WMO, 2023) and can intensify the urban heat island effect, leading to even higher local temperatures and impacting human health adversely (Yang, J. *et al.* 2016). Tong, S. *et al.* (2021) have shown that urban populations face more significant health risks during heatwaves compared to those living in rural or suburban areas. Furthermore, urban heat islands disproportionately affect vulnerable groups (Hsu, A. *et al.* 2021).

In Hungary, over the past two decades, urban-scale analyses based on local measure-

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ments have been conducted predominantly focusing on the capital, and comparative analyses of Hungarian regional centres have been made using satellite imagery. The study of the urban heat island phenomenon from the perspective of environmental justice has only gained attention recently and, mainly in Budapest (Buzási, A. 2022). Consequently, this study aims to further understanding of the urban heat island phenomenon by linking socio-economic and housing data with urban heat island intensity metrics in Győr (Raab), which is one of the less studied cities concerning urban heat islands. Through analysing the spatial and social patterns of SUHII this study aims to answer how inequalities in exposure to SUHII emerge across various types of living environments, income and ageing index groups.

Literature review

The higher temperatures in a city compared to surrounding rural areas, referred to as the urban heat island (IPCC, 2007) is a microclimatic phenomenon influenced by several factors such as vegetation area, urban geometry and human activities. The difference in temperature measured by subtracting the average urban temperature from the average rural temperature is referred to as urban heat island intensity (UHII) (Hendel, M. 2020). The surface urban heat island intensity (SUHII) is derived from the differences in land surface temperature (LST), while the atmospheric urban heat island intensity (AUHII) is derived from the differences in air temperature (Gawuc, L. *et al.* 2020).

Although first mentioned in the early 19th century by Howard in his work on London's urban climate titled *The Climate of London* (first published in 1818) (Howard, L. 2007), the comprehensive study of the urban heat island phenomenon has gained research interest only from the early 1950s onward, using diverse methodologies, models, and simulation techniques (Wu, Z. and Ren, Y. 2019). Systematic reviews by Stewart, I.D. (2011), and Wu, Z. and Ren, Y. (2019) trace the development of approaches from local observations of daily and seasonal air temperature patterns through local measurement trips to incorporating satellite-based imagery to analyse land-surface temperature and to implementing machine learning techniques for UHI prediction.

Although it was not applied until the early 1970s (Krishna, R. 1972), modern studies on UHI predominantly use remote sensing. For instance, Cheval, S. *et al.* (2022) used MODIS data to analyse heat islands in Romanian cities with populations exceeding 30,000 inhabitants. In addition to MODIS, Landsat satellite is a frequently sutilised resource. Amindin, A. *et al.* (2021) used Landsat 4, 5, 7 and 8 satellite imagery to map land surface temperature, urban heat field variance index (UTFVI) and UHI index. Kopecká, M. *et al.* (2021) analysed land use/land cover change based on Urban Atlas data in three cities in Slovakia and their effect on temperature change. Apart from satellite imagery, urban-scale analyses typically rely on local measurements (e.g., Liu, L. *et al.* 2017).

Over the past two decades, urban-scale analyses have been conducted in Hungary for the cities of Budapest, Szeged, and Debrecen, primarily based on local measurements. Though not exhaustive, the UHI in Szeged has been studied by Bottyán, Z. *et al.* (2004), and Molnár, G. *et al.* (2017). Szegedi, S. and Kircsi, A. (2003) focused on the influence of different large-scale weather situations on the formation and spatial structure of the heat island in Debrecen, while László, L. (2017) examined long-term changes in meteorological conditions in the Debrecen region. Similarly, the UHI dynamics in Budapest have been studied by Pongrácz, R. *et al.* (2016), Additionally, Buzási, A. (2022) analysed the vulnerability of 23 districts of Budapest to heatwaves using a weighted indicator method.

In the last two decades, research interest has shifted towards studying the impacts of urban heat island (UHI). This shift encompasses the assessment of different exposures

from the viewpoint of environmental justice and the exploration of mitigation strategies. Within the existing literature, the impacts of urban heat island can be broadly classified into two categories: impacts on human beings and impacts on the microclimate of an urban area (Khan, A. *et al.* 2021). Major impacts on human health include increased cardiovascular and pulmonary stress, heightened susceptibility to heat-related illnesses such as heat stroke and other cerebrovascular damage particularly among outdoor workers (Piracha, A. and Chaudhary, M.T. 2022). These symptoms are more pronounced in vulnerable groups such as children, the elderly and individuals with pre-existing medical conditions (Portier, C.J. *et al.* 2013).

Previous findings indicate that the factors possibly affecting exposure to urban heat islands include age, income, gender, housing tenure, and ethnicity (Mashhoodi, B. 2021). A number of techniques have been developed to study disproportionate exposure. Creating and mapping a vulnerability index for specific case study areas seems to be one of the most well-established methods. Wolf, T. and McGregor, G. (2013) created a heat vulnerability index (HVI) for London and have demonstrated that high vulnerability correlates with factors such as high-density housing, poor health status and welfare dependency. Morabito, M. *et al.* (2015), focusing on the elderly (people aged 65 or over), developed a heat-related elderly risk index (HERI) for major Italian cities. Their findings revealed that areas characterised by hazardous risk levels also have the highest total and elderly population densities.

Similarly, Macintyre, H.L. *et al.* (2018) have shown that vulnerable groups such as the elderly and those with pre-existing health conditions are located in the hotter parts of their study region, the West Midlands. They highlighted the location of hospitals, care homes, schools, and childcare centres in areas with higher than the average air temperatures. Holec, J. *et al.* (2021) combined simulated temperature data of the MUKLIMO model with mobile phone data as a proxy for the population density of Bratislava. Their findings are consistent with existing research emphasising the heightened vulnerability of elderly, children and people with low income.

Research has also shown that ethnic minorities are more exposed to the urban heat island effect (Mitchell, B.C. and Chakraborty, J. 2015), and social conditions affect the urban surface heat distribution (Huang, G. and Cadenasso, M.L. 2016).

Local studies emphasise the significance of making a distinction between spatial scales to identify causes and construct effective strategies for mitigating adverse effects. (Mashhoodi, B. 2021). Environmental justice literature places increased emphasis on informed urban policies and strategies, as well. This requires bridging the knowledge gap and open communication between local communities, policymakers and researchers in a given area (Hsu, A. *et al.* 2021). This study aims to bridge the knowledge gap within the context of the case study of Győr, through analysing factors of disproportionate exposure to surface urban heat island intensity.

Methodology

To achieve the research aim identified earlier and to leverage research methods from previous studies on the topic (e.g., Hsu, A. *et al.* 2021; Mashhoodi, B. 2021) this study puts forward the following interconnected research questions:

a) What are the spatial intra-urban patterns of SUHII in the city of Győr? Do certain types of living environments experience elevated SUHII? What intra-urban inequalities emerge across various types of living environments?

b) Are certain socio-economic groups over- or underexposed to SUHII? Which socio-economic groups are over- or underexposed?

To answer these questions, this study first looks at the spatial and social patterns of SUHII in Győr, and analyses the variance of SUHII based on five independent variables. While creating a vulnerability index for the

case study area is a common method to study this topic (e.g., Wolf, T. and McGregor, G. 2013; Morabito, M. *et al.* 2015), and would provide the most comprehensive characterisation of exposure to SUHII in Győr, this research elects instead to apply statistical analysis to a random selection of points in the city with the purpose of studying the phenomenon with a social science approach. In the next paragraphs, the methods used to select the case study city and analyse the exposure are presented.

Selection of the case study city

As of 2022, Budapest, the capital city of Hungary, had a population of 1,630,320 inhabitants. In addition to Budapest, the country has eight regional centres, with seven of them having a population of over 100,000 inhabitants each. These urban centres display unique economic, social, and human capital and infrastructural attributes distinct from their surroundings (Rechnitzer, J. and Berkes, J. 2021). The classification presented by Rechnitzer, J. and Berkes, J. (2021) offers a distinctive grouping of these regional centres. The authors categorised them into four groups: cities with a development path based on a new industrial base are Győr and Székesfehérvár; revitalised, traditional cities are Miskolc and Debrecen; cities in transition are Kecskemét and Nyíregyháza, while cities finding their path are Szeged and Pécs.

The grouping by Rechnitzer, J. and Berkes, J. (2021) holds significant merit in the selection process, given that the specific development trajectories of these regional centres have fundamentally determined their urban structure and land use, all of which are recognised as determining factors in the formation and intensity of the urban heat islands. Integrating the development trajectory of a city into the study adds a layer of context and understanding on the emergence and consequences of certain equilibria, a point often missing in studies, as pointed out by critics in the environmental justice literature (e.g., Noonan, D.S. 2008). Consequently, Győr, a city with a development path based on a new industrial base offers the opportunity to research exposure to surface urban heat island intensity within a regional centre characterised by higher levels of urbanisation, infrastructure development and a diverse urban landscape, which could result in more complex patterns of heat distribution.

Data processing

The dependent variables of this research are the average daytime and nighttime SUHII intensity for the year 2019. Leveraging the Google Earth Engine platform and the Global Surface UHI Explorer, SUHII intensity data at the neighbourhood level were retrieved and processed for a set of 100 randomised points within Győr. Using the MODIS 8-day TERRA and AQUA land surface temperature (LST) products, the Landscan urban extent database, the Global Multi-resolution Terrain Elevation Data 2010, and the European Space Agency (ESA) Climate Change Initiative (CCI) land cover data imagery, Chakraborty, T. and Lee, X. (2019) developed a simplified algorithm for estimating surface urban heat island intensity on a global scale. The algorithm was operationalised within the Google Earth Engine platform. The resulting database, the Global Surface UHI Explorer provides data for more than 9,500 urban clusters to calculate UHI intensity, making it one of the most comprehensive characterisations of the surface urban heat island intensity to date.

The variables are yearly mean daytime and nighttime SUHII at a resolution of 300 m × 300 m. According to Chakraborty, T. and Lee, X. (2019) the average 8-day per pixel LST retrieval is constrained to clear sky conditions, with an average LST error of less than or equal to 3 Kelvin (1 km x 1 km), as such it could significantly alter the estimated surface UHI. LST pixels are automatically resampled to 300 m x 300 m grids to match the resolution of the land cover data from the European Space Agency Climate Change Initiative (ESA

CCI). After calculating spatial mean LST for the subsets urban land use and other land use, their difference is the surface UHI. The data is then used to estimate LST at 0130, 1030, 1330, and 2230 local time (LT) through the algorithm developed by Chakraborty, T. and Lee, X. (2019). Mean daytime SUHII is derived from the mean LST values at 1030 and 1330 LT, while the mean nighttime SUHII is based on the mean LST at 0130 and 2230 LT.

The 100 points are uniformly random in the city and were generated using the ee.FeatureCollection.randomPoints function within the Earth Engine API. Following the specification of the city's geometry and the number of random points desired, the function generated a collection of 100 points subjected to further analysis.

As seen in the review of literature, variables representing lower socio-economic status are consistently associated with greater urban heat exposure. In this study, socio-economic neighbourhood-level data for the 100 randomised points at the highest resolution (100 m) were drawn from the GeoX database for the latest available year, 2019. It is important to note that the differences in resolution between the socio-economic and SUHII intensity data may impact the correlation analysis.

The independent variable "ageing index" showcases the typical age composition of people living in the area, thus, shows the ratio of groups, who are likely to be the most vulnerable to SUHII impacts. Variables representing population distribution and economic levels are "population density" and "per-capita income", while variables representing the housing status of the analysed points are the "type of living environment" and "type of residential area". The grouping of residential areas stems from the data source GeoX database, based on the classification of permanent population at the door-level in 100 x 100 cells and on how many dwellings there are. The type of living environment independent variable encompasses the type of residential area, the age composition of the population in the neighbourhood and estimated annual net income per capita.

To analyse SUHII intensity distribution, the derived SUHII metrics were merged with neighbourhood-scale income, population and living environment data for the randomised points. Subsequently, the analysis had three stages: first, the analysis of the spatial distribution of surface urban heat islands in Győr; second, comparing median SUHII intensity across groups with different socio-economic features; and third, assessing vulnerability through correlation.

The case study city Győr

Győr is the centre of the West Transdanubia region, located at the confluence of three rivers. This geographical feature has played a significant role in the development of Győr, but also has determined the structure of the city. Its location made it an important distribution centre for grain and livestock trade. The transition from a trading town to an industrial city in the 19th century led to a twofold increase in population and to the emergence of a medium-sized (large), modern city (Balázs, P. 1980). Győr was characterised mainly by its manufacturing culture, the rapid revival of which contributed to the successful reception of foreign investment in the 1990s. The establishment of several large companies in the same decade led to increased migration and commuting to the city and a change in its image. This transformation reshaped the city's demographic landscape, giving rise to the phenomenon of suburbanisation (Rechnitzer, J. and Berkes, J. 2021).

The proportions of the functional belts have changed. Non-residential buildings have been built and their share is now higher than the share of residential buildings (Csapó, T. 2021).

Roughly half of the urban area (including green areas not classified as such by land use) is non-residential, but industrial in nature. As seen in *Figure 1* the urban fabric of Győr consists of large suburban areas. Single-family housing accounts for nearly 60 percent of the city's residential area as a result of the an-

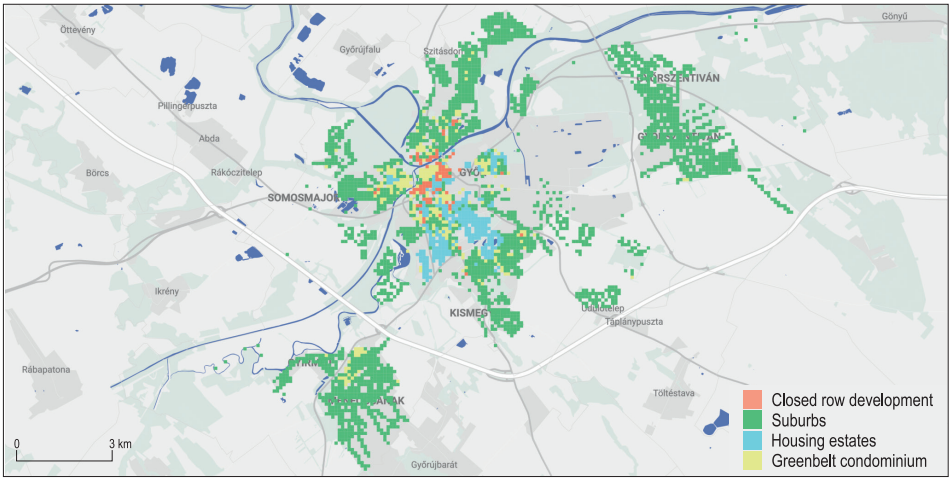


Fig. 1. Types of residential areas in Győr. *Source:* GeoX and TEIR. Authors' own elaboration.

nexation of nearby settlements. Multi-storey block development is also significant, accounting for 25–30 percent of the city's built-up area. Detached family houses are characteristic above all in the outer residential belt, while multi-storey blocks are concentrated in specific urban areas. Closed-row development is limited, covering mainly the historic core of the city (Lenner, T. *et al.* 2015).

The city has a continental climate. The average annual mean temperature in 2019 was 12,5 °C. The months of June to August experienced the highest temperatures, ranging from 22,6 to 23,2 °C. The average precipitation for the year amounted to 40 mm, with May having the highest precipitation. Based on the period of 2001 to 2020, the annual average global irradiance is 4,588 MJ/m², with over 650 MJ/m² in the months of June and July and the annual wind average is 1.96 m/s (HungaroMet, 2024).

The population is concentrated in the centre of the city, with densities as high as 100–1649 inhabitants per 0.01 km², while suburban areas register a lower average population density of 1–49 inhabitants per 0.01 km². The population of Győr demonstrates an ageing trend, particularly pronounced in the historical core of the city, with an ageing index of over 300 inhabitants aged 63 or older for every 100 people aged 0–14.

Certain areas of the city have a high concentration of residents with incomes above average, often situated near the riverbanks and green areas, which are cold spots of the city in terms of SUHII. Areas near the industrial parts of the city accommodate residents with incomes below average, aligning them with hotspots of the city in terms of SUHII. After providing an overview of statistics on the 100 random points, the next part of this study explores the interplays and provides a detailed analysis of the social and spatial patterns of SUHII in the city.

Analysis and results

First, descriptive of the sample points are provided to provide further context, focusing on the distribution of sample points across types of residential areas, living environments and demographic groups.

Descriptive statistics of the sample points

The spatial distribution of the 100 sampling points generated could not be influenced due to the Google Earth Engine platform's operating mechanism. The points in Győr were as

follows (*Figure 2*). It can be observed that the distribution of the points is not uniform. Google Earth Engine distributes random sampling points over the entire city. For the research, area types specific to Győr were defined. Their names and the distribution of sampling points in each category are shown in *Table 1*.

The categorisation in *Table 1* also includes urban areas that are not considered residential (e.g., industrial), accounting for 34 percent of the 100 random sample points and are not subject to further analysis. The number of sampling points for the study of residential areas was determined according to the categorisation used by the data sources (GeoX and TEIR), based on the type of residential area and the type of living environment. The analysis of spatial patterns of SUHII was based on these variables.

The distribution of the points across types of residential areas (*Table 2*) is explained by the nature of the city's built-up area. As discussed, the dataset resulting from random point generation is more skewed towards suburban areas, which influenced the methodology used to analyse exposure to SUHII.

To conduct research, it is necessary to separate the different types of living environments,

*Table 1. Number of sample points found in the different categories of areas**

Type of area	Frequency	Percent
Riverside	3	3
Green area	6	6
Residential area	38	38
Downtown residential area	29	29
Service/business district	5	5
Industrial area	15	15
Roadside	1	1
Railway lines	3	3

*N = 100. *Source:* GeoX and Google Earth Engine Platform. Authors' own elaboration.

Table 2. Number of sample points found in the different types of residential areas

Type of residential area	Frequency	Percent
Garden suburbs	48	73
Greenbelt condominium	8	12
Downtown closed row buildings	6	9
Housing estate	4	6
Total	*66*	*100*

Source: GeoX and Google Earth Engine Platform. Authors' own elaboration.

Table 3 shows how many of the 100 sample points generated by Google Earth Engine fell into a type of living environment. Based on the categorisation determined by the data source GeoX, almost 40 percent of the residential

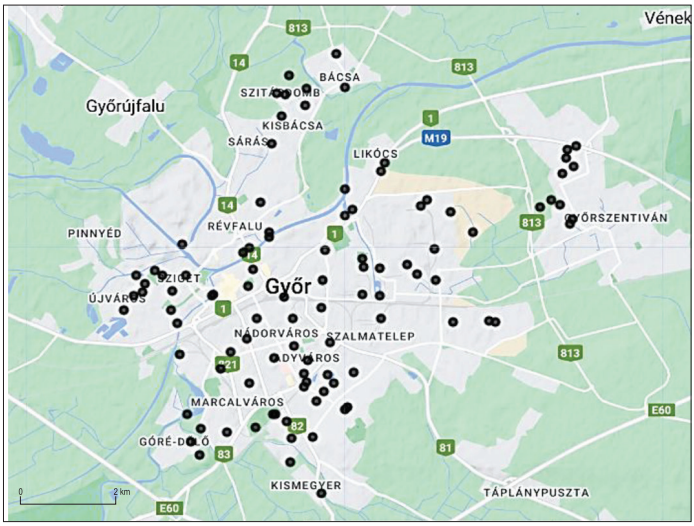


Fig. 2. The distribution of sample points across Győr. *Source:* Google Earth Engine Platform. Authors' own elaboration.

Table 3. Number of sample points found in the different types of living environment

Type of living environment	Frequency	Percent
Rich-suburban-adult	17	26
Rich-suburban-with children	4	6
Rich-green zone-adult	13	20
Rich-downtown-adult	26	39
Rich-residential complex-with young children	2	3
Average-low-price condominium-adult	2	3
Average-downtown-adult	2	3
Total	***66***	*100*

Source: GeoX and Google Earth Engine Platform. Authors' own elaboration.

sample points fall within the rich-downtown-adult category, which means that these points are found in inner-city areas characterised by higher than average income, higher population density and the dominant age group is adults.

By pairing the categories in *Table 3* with the suburban and downtown residential area subcategories, a new distribution of measurement points was created, which refines the analysis results. As seen in *Table 4*, suburban residential areas in the city cover a wide variety of built-up areas and living environments for all types of income ranges and age groups. The numbers in *Table 4* reveals that the classification of living environments does not always align with the type of residential area expected for that particular living environment in the city. For instance, the rich-suburban-adult quality of life and living environment could also emerge in downtown residential areas, as it falls into this category. The reverse is also true for rich-downtown-adult living environment and suburban residential area.

A summary of the socio-demographic data from the measurement points is shown in *Table 5*. Description of estimated annual net income per person reveals that almost 60 percent of the measurement points fall within the highest income brackets (over 1,400 thousand HUF) and the lowest income bracket has the smallest percentage in the dataset. It can also be seen that there is an ageing population in 76 percent of the neighbourhoods of the measurement points. The population density correlates with data for Hungarian cities of similar size.

Table 6 shows the data for the demographic categories studied (see *Table 5*) for the number of measurement points in different types of residential areas. Most of the measurement points are in the garden suburbs section,

Table 4. Number of sample points found in different types of living environment within the subcategories of suburban and downtown residential areas

Type of living environment/type of area	Suburban residential area	Downtown residential area	Total
Rich-suburban-adult	16	16	17
Rich-suburban-with children	4	0	4
Rich-green zone-adult	12	1	13
Rich-downtown-adult	2	24	26
Rich-residential complex-with young children	1	1	2
Average-low-price condominium-adult	2	0	2
Average-downtown-adult	0	2	2
Total	*37*	*29*	***66***

Source: GeoX and Google Earth Engine Platform. Authors' own elaboration.

Table 5. Demographic data of the analysed sample points

Indicators	Categories	Frequency	Percent
Estimated annual net income per person, in thousand HUF	< 1,000	1	2
	1,100–1,199	5	8
	1,200–1,299	4	6
	1,300–1,399	18	27
	1,400–1,499	20	30
	> 1,500	18	27
Ageing index, persons	0	16	24
	1–99	10	15
	100–199	20	30
	200–299	14	21
	> 300	6	9
Population density, number of persons per 0,01 km²	1–24	29	44
	25–49	15	23
	50–99	12	18
	100–199	7	11
	> 200	3	5

Source: GeoX and Google Earth Engine Platform. Authors' own elaboration.

Table 6. Demographics of people living in different types of residential areas

Indicators	Categories	Garden suburbs	Greenbelt condominium	Downtown closed-row buildings	Housing estate	Total
Estimated annual net income/ person (1000 HUF)/types of residential areas	< 1,000	1	0	0	0	1
	1,100–1,199	4	1	0	0	5
	1,200–1,299	3	1	0	0	4
	1,300–1,399	13	1	1	3	18
	1,400–1,499	13	3	3	1	20
	> 1,500	14	2	2	0	18
Total		*48*	*8*	*6*	*4*	***66***
Ageing index, number of people aged > 63 per 100 people aged 0–14	0	16	0	0	0	16
	1–99	8	1	1	0	10
	100–199	11	3	3	3	20
	200–299	9	3	1	1	14
	> 300	4	1	1	0	6
Total		*48*	*8*	*6*	*4*	***66***
Population density, number of people /0.01 km²	1–24	26	3	0	0	29
	25–49	13	2	0	0	15
	50–99	8	3	1	0	12
	100–199	0	0	5	2	7
	> 200	1	0	0	2	3
Total		*48*	*8*	*6*	*4*	***66***

Source: GeoX and Google Earth Engine Platform. Authors' own elaboration.

with the number of measurement points for the other categories being significantly fewer. The obvious reason for this is the predominance of the suburban character of the city. *Table 6*, similarly to *Table 4*, shows that residents from all types of income brackets and age groups choose to live in the suburban residential areas of the city.

Spatial and social patterns of SUHII

In order to develop an understanding of SUHII in Győr, first, we looked at patterns of average daytime and nighttime SUHII across various types of areas, residential areas and living environments. This provided us with a comprehensive overview. Subsequently we

analysed the relationship between SUHII and socio-economic variables, as these variables are recognised in the body of literature as determining factors for residents' choices of living locations (Mashhoodi, B. 2021).

Based on the patterns of annual daytime SUHII (*Figure 3*), industrial areas tend to have an intensity as high as 4.5 °C, while green areas on the outskirts of the city had temperature differences of 0 to -1.5 °C compared to the surrounding rural areas. The map of the annual daytime SUHII for 2019 also suggests that areas in the inner residential belt had a wider distribution of SUHII values, with possible localised heat islands or hotspots in areas of the city core. Patterns of annual nighttime SUHII suggest that heat retention in downtown areas leads to a more pronounced heat island effect during the night.

Literature on disproportionate exposure to UHII often compares subgroups within the population, usually through comparing the means of the top and bottom deciles. In the case of the surface urban heat island data we processed, we took into account the spatial heterogeneity and the attributes of the sample used. Areas characterised by housing estates are underrepresented, and areas characterised by garden suburbs are overrepresented, leading to a skewed, not normal distribution. Given this distribution, we compared medians of average daytime and nighttime SUHII values across various types of living environments and socio-economic groups, as the median is less affected by outliers, rendering it more suitable for analysing variations. As seen in *Figure 9*, the median daytime SUHII ranged from 0.8 to 2.1 °C in 2019, whereas the night time SUHII ranged from 0 to 1 °C.

The visual comparison of medians (*Figure 4*) indicates that the garden suburbs within the city experience a lower heat island effect during both daytime and nighttime compared to other types of residential areas. Among these, areas characterised by housing estates had the highest temperature differences in 2019. It is in these types of residential areas, particularly in districts like Gyárváros or Újváros, where lower-educated and older neighbourhoods are concentrated (Municipality of Győr, 2014).

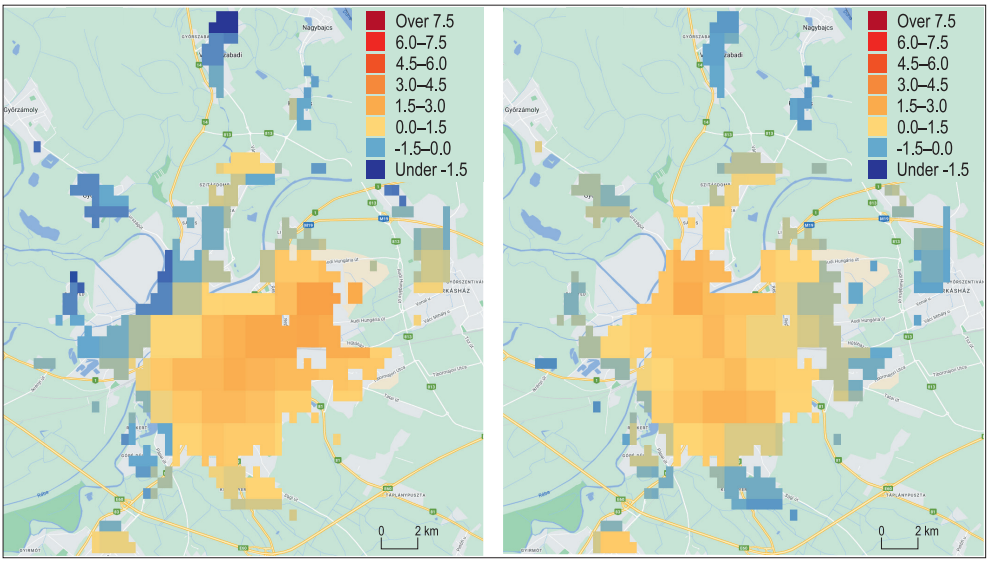


Fig. 3. Patterns of annual daytime (left) and nighttime (right) SUHII. *Source:* Global Surface UHI Explorer database provided by Yale Center for Earth Observation. Authors' own elaboration.

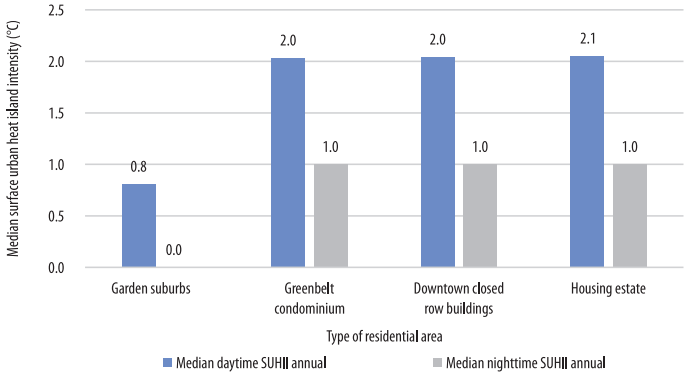


Fig. 4. Median SUHII across types of residential areas, 2019. *Source:* Authors' analysis.

Neighbourhoods characterised by garden suburbs are diverse in terms of year of construction, condition and size (Lenner, T. *et al.* 2015). The effect size calculation for the Kruskal-Wallis test we ran reveals that approximately 17.3 percent of the total variability in daytime SUHII scores can be attributed to the differences between residential areas and 21.6 percent of the total variability in nighttime SUHII scores.

Providing further context, *Figure 5* on median daytime and nighttime SUHII across types of living environments shows that rich suburban and average green-belt condominium neighbourhoods experienced lower daytime SUHII intensities, ranging from 0.4 to 0.9 °C. In contrast, regardless of the income situation of the people living there, downtown neighbourhoods experienced higher temperature differences, exceeding 2 °C. While other areas registered median nighttime SUHII values at 0 °C, downtown areas experienced a median nighttime SUHII value of 1 °C. This suggests that these neighbourhoods experience a more noticeable heat island effect during both daytime and nighttime hours. The effect size of eta2 = 0.119 indicates that approximately 11.9 percent of the total variability in daytime SUHII scores and 23.1 percent of the total variability in nighttime SUHII can be attributed to differences between the types of living environments. These results suggest that there are clear differences in exposure based on the type of residential area, but income might not be a determining factor of disproportionate exposure in Győr. However, understanding which socio-demographic factors are associated with higher SUHII requires further analysis.

The visual comparison of median SUHII across income groups suggests that in the case of Győr, a higher income level does not presuppose lower exposure to SUHII. As shown in *Figure 6*, the median daytime SUHII intensity ranges from 0.6 to 1.8 °C, whereas nighttime SUHII values range between 0 and 1 °C. We observed that neighbourhoods falling within the lower quantile of the income bracket experienced 0.7 °C higher intensities during daytime and 1 °C higher during nighttime, in comparison to neighbourhoods in the upper quantile of the income group. Notably, top-quantile neighbourhoods experienced a moderate surface urban heat island intensity, while those with an income between 1,100 and 1,399 thousand HUF had lower median SUHII intensities. From observing the data, it is not possible to deduce a general trend of decreasing SUHII with increasing income and the application of the Spearman's correlation revealed no statistically significant association ($p = 0.824$) between income and daytime SUHII scores, nor between income and nighttime SUHII scores ($p = 0.929$).

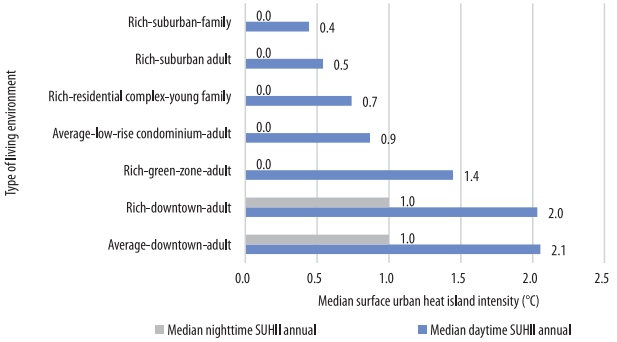


Fig. 5. Median SUHII across types of living environments, 2019. *Source:* Authors' analysis.

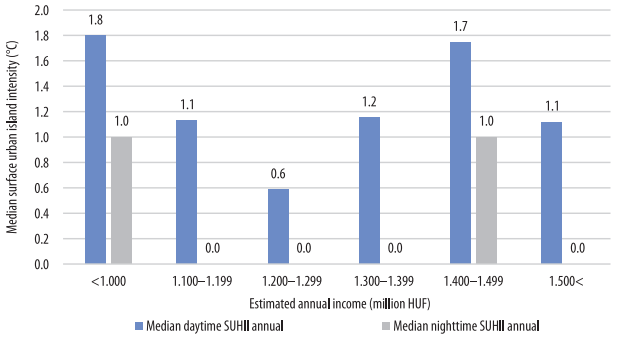


Fig. 6. Median SUHII across income groups, 2019. *Source*: Authors' analysis.

The higher values observed in neighbourhoods with incomes under 1 million HUF, and between 1.4 and 1.5 million HUF can be explained by the urban characteristics and land use in these income brackets. Nearly 50 percent of neighbourhoods with these income ranges are found in downtown areas, within the inner city, characterised by medium to high population densities exceeding 50 inhabitants per 0.01 km². These areas are predominantly closed-row buildings, housing estates and green-belt condominiums.

The observation of differences among ageing index groups indicates certain inequities. Notably, there is a difference of 1.6 °C between groups with the highest ageing index and groups with the lowest ageing index (*Figure 7*). The graphical depiction of the relationship between the two variables shows that as the ageing index increases, median daytime and nighttime SUHII values increase, as well. Specifically, neighbourhoods with an ageing index of 300 or greater had a SUHII of 2.1 °C. These findings align with existing literature (e.g., Hsu, A. *et al.* 2021), which highlights that older populations are more vulnerable to the surface urban heat island phenomenon.

Within Győr, neighbourhoods with the highest ageing index primarily comprise the city-core characterised by closed-row developments, a mix of multi-storey blocks, condominiums, and semi-detached or detached family houses. The Spearman's rho correlation coefficient of 0.289 evidences a weak positive relationship between daytime SUHII intensity and ageing index. However, it is important to note that there is no statis-

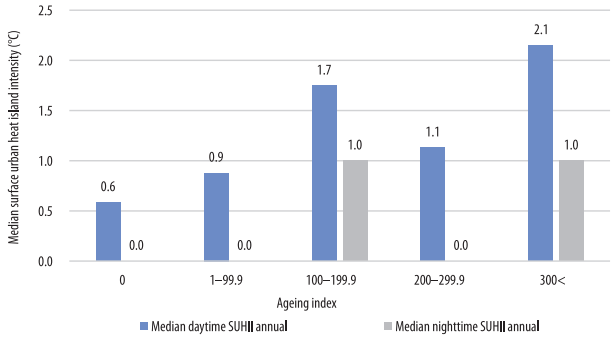


Fig. 7. Median SUHII across ageing index groups, 2019. *Source*: Authors' analysis.

tically significant relationship between the nighttime SUHII and the ageing index. It can be concluded that areas with a higher concentration of people aged 63 and above experienced higher daytime SUHII (0.462, $p < 0.01$), and areas with a higher concentration of people aged 0–14 experienced lower daytime SUHII (0.364, $p < 0.01$).

Likewise, the graphical depiction of population density shows a trend, wherein areas with a higher population density tend to have elevated daytime SUHII values compared to neighbourhoods with lower population density (*Figure 8*). Notably, areas with the highest population density had a daytime SUHII of 2.1 °C, which is 1.5 degrees hotter than areas with a population density of 1 to 24 inhabitants within a 100 × 100-meter cell. Moreover, areas with a population density exceeding 50 inhabitants similarly experienced temperatures 1 °C hotter than low-density neighbourhoods. The Spearman's rho correlation analysis shows a statistically significant relationship, the coefficients of 0.525 and 0.540 show that among the socio-demographic variables, population density has the strongest positive relationship with daytime and nighttime SUHII.

Discussion

Using established methods, this research analysed the relationship of SUHII with socio-economic and urban living environment factors based on random points generated

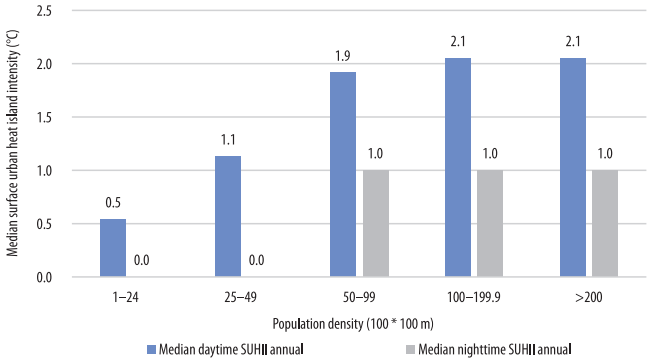


Fig. 8. Median SUHII across population density groups, 2019. *Source:* Authors' analysis.

using the Google Earth Engine platform. The study identified distinct daytime and nighttime SUHII patterns across various types of residential areas and living environments. Notably, sample points in suburban areas of Győr experienced comparatively lower temperature differences compared to other residential areas, whereas areas with housing estates had the highest surface urban heat island intensity. These findings coupled with the data on living environments, emphasise the significance of urban layout in influencing patterns of SUHII. Our results align with the works of Wolf, T. and Mcgregor, G. (2013), Morabito, M. *et al.* (2015) or Macintyre, H.L. *et al.* (2018) linking increased vulnerability with higher ageing index and greater population density. However, the current study's findings do not support results indicating a correlation between lower income and increased vulnerability.

The results align with the results of Buzási, A. (2022) who also identified a high ratio of elderly people as a common vulnerability in the districts of Budapest. It is important to note that in the literature, these socio-economic groups are often seen to be contributing to exaggerating SUHII, as they may lack the resources or knowledge to mitigate the urban heat island effect (Dialesandro, J. *et al.* 2021). Moreover, neighbourhoods with high population density may lack the adequate ratio of greenery and impervious surfaces to mitigate the SUHII effect. While the age composition of Győr is more favourable than the national average, making it less vulnerable to summer heat waves, with the ageing population, the elderly population density will increase in the future. This highlights the importance of incorporating these findings when planning strategies of mitigation.

Győr, in its climate strategy (Municipality of Győr, 2021), emphasises climate protection awareness raising among the population, however, this may not fully be sufficient for socio-economic groups with limited resources. While the strategy recognises the existence of urban heat island hotspots in downtown areas, comprehensive mapping of the phenomenon is lacking. Although these downtown areas are seen as green space deficit zones and are subject to foreseen greening initiatives such as green roofs, roof gardens or green walls, we recommend identifying neighbourhoods with cumulative vulnerability based on population density and ageing index and formulating targeted interventions accordingly.

In addition to exploring grants that can be used to support community green spaces, we recommend providing communities with better opportunities to maintain existing green spaces and exploring how the benefits and costs of various mitigation initiatives are distributed across different neighbourhoods in the city.

While our study focuses on Győr, other middle-sized cities in Hungary may show different patterns of SUHII. Therefore, further research is required across other regional centres of Hungary and incorporating additional socio-demographic and building variables. These efforts will provide a more comprehensive understanding of disproportionate exposure and the ways SUHII patterns developed based on distinct development paths of various middle-sized cities. Additionally, this study has certain limitations as it relies on the Global Surface UHI Explorer, which measures land surface temperature differences and as such offers only a one-sided description of the urban heat island phenomenon (Wu, Z. and Ren, Y. 2019).

Furthermore, the algorithm by Chakraborty, T. and Lee, X. (2019) was developed to create a globally consistent UHI database, leading to a generalised selection of the rural reference, which calls for caution when analysing SUHII in urban clusters. SUHII data is estimated using the average 8-day per pixel LST, but retrieval is constrained to clear sky conditions only, which influences the reliability of the SUHII data. Thus, air temperature measurements or estimation through modelling is important for an in-depth analysis.

Our findings offer a limited understanding of vulnerability as we primarily focused on age, income and population density. Previous findings suggest that health status, ethnicity and welfare dependency represent additional

risk factors. Due to the data's availability only at the neighbourhood level (100 x 100 m) in groupings, the analysis makes assumptions regarding the variance of socio-economic data, presuming homogeneity inside a given neighbourhood. Furthermore, income data retrieved from the GeoX database is an estimate downscaled from municipal data to the neighbourhood level, thereby impacting the reliability of our results. Due to the differences in resolution between the socio-economic (100 x 100 m) and SUHII intensity data (300 m x 300 m), the results of the correlation analyses could be inflated and should be interpreted with caution.

Other influencing factors such as building height and proportion of vegetation, are not captured in our research. Despite the limitations of our research, focusing on social and economic variables furthers our understanding of the urban heat island phenomenon in Hungary. The combination of methods and the inclusion of other influencing factors offers a direction for future research expansion. An aspect to follow-up is how greening initiatives outlined in the city's climate strategy may mitigate the urban heat island effect.

Conclusions

This study set out to better understand how certain socio-economic and urban living environment factors influence exposure to surface urban heat island intensity in a city with a development path based on a new industrial base. Leveraging the Google Earth Engine platform and the Global Surface UHI Explorer, SUHII intensity data at the neighbourhood level were retrieved and processed for a set of 100 randomised points within Győr. Although the methodology of this study and the data used call for caution, the results are in line with previous studies and show that population density has the strongest relationship with daytime and nighttime SUHII, and that neighbourhoods with an ageing index of 300 or greater experience the highest urban heat island intensity.

The findings of this research highlight the importance of identifying neighbourhoods with cumulative vulnerability and formulating targeted interventions to mitigate the adverse effects of urban heat islands in the city of Győr. Despite its limitations, the insights gained from this study may be of assistance to formulating these targeted interventions. Further research is needed to investigate other factors, such as building and vegetation characteristics influencing vulnerability to SUHII in the city of Győr. In addition, future work should be extended to other major cities in Hungary.

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'I can hear the wind and feel it touch me on the nose': The search for agency of the environment in the dialogue between human and nature. The case of Austin, TX

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Abstract

This study explores specific relationships between humans and nature and seeks an extended 'social construction of nature' in the direction of place agency. The research assumes that place can be in agented action and a reciprocal relationship with human and non-human beings. The study's main aim is to identify whether, from the perspective of contemporary city users, a partnership with the biotic and geographical environment is possible both within and outside the city. From this aim arises a research question: Does an inhabitant of a large city realize the possibility of a dialogue involving an 'exchange of meanings' between two entities of interaction that are often highly different (human and non-human beings)? The research uses a questionnaire survey (to recognize general quantitative opinion) and in-depth interviews with selected respondents (to look for deeper explanations). Results show that some urban respondents can see some environmental elements (in and out of the city) as agents and can describe the relationship human-environment in case of a reciprocal action called dialogue.

Keywords: human, place, dialogue, agency, urban dwellers, Austin, TX

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Introduction

In the 2021 Oscar-winning documentary 'My Octopus Teacher', Craig Foster says: "You are in touch with this wild place, and it's speaking to you. Its language is visible". With these words, Foster points out that not only more than human beings, but also the environment is trying to conduct a kind of dialogue with us. Of course, one may say that these words are a metaphor spoken by a documentary filmmaker and a naturalist. Nevertheless, not only film producers or artists notice that the human-oriented narrative of the world is no longer sufficient to explain the complexity of the relationship between human beings and the biotic and geographic environment (Hall, M. 2011; Castree, N. 2014; Peil, T. 2014; Escobar, A. 2019; Adams, P.C. and Kotus, J. 2022).

Nowadays, the social construction of nature (Eder, K. 1996; Demeritt, D. 2022) goes beyond human-centred visions (Stedman, R.C. 2003; Keskitalo, E.C.H. 2023), while recognizing the agency of the biotic and geographical environment is an important part of building interspecies interactions on our planet. As a result of these scientific considerations, in recent decades an approach has been established in social geography in which we are all "living in more-than-human world" (Whatmore, S. 2002, 159; Keskitalo, E.C.H. 2023) and 'more-than-human cities' (Luther, E. 2020; Perrotti, D. 2020). Especially cities and their inhabitants seem to be a very interesting area of research in this area (Acosta, R. *et al.* 2023).

Adapting Beatley's term (Beatley, T. 2016), Escobar posits that "Earth has been

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banished from the city" (Escobar, A. 2019, 132), and consequently draws attention to the essence of the debate about the 're-earthing of our cities'. Urban biotic and geographic environment "afford individuals relaxation, nature enjoyment and an escape from city life. Perhaps the most significant contribution is to the mental well-being of urban residents" (Budruk, M. *et al.* 2009, 825). It is true, nevertheless, above all the biotic and geographic environment of urban settlements is an assemblage of more-than-human beings. A narrative about the biotic and geographical environment as 'a significant other' and 'agent' in relations with humans may be noticed by poets or writers (Thoreau, H.D. 2017; Cavendish, M. 2019), and should be noticed by scholars (Larsen, S.C. and Johnson, J.T. 2013; Wright, S. *et al.* 2016; Escobar, A. 2019), but can it also be noticed by ordinary inhabitants in everyday urban life (Pincetl, S. and Gearin, E. 2005) where human-made structures are dominant and human-oriented thinking is permanent? What arguments are used by proponents and opponents of the thesis of dialogue with the biotic and geographical environment? These questions outline the field of discussion in this article.

The specific aim of the research is to identify whether, from the perspective of the contemporary '*homo urbanus*' (Cribb, J. and Cribb, J. 2017; Carta, M. 2022), a partnership with the biotic and geographical environment is possible both within and outside the city. Does an inhabitant of a large city realize the possibility of a dialogue involving an 'exchange of meanings' between two, often extremely different (human and non-human beings), entities of interaction (Deleuze, G. and Guattari, F. 1994; Latour, B. 2014)?

To clarify the issues discussed from the perspective of 'place agency', I present synthetic definitions of basic terms used in the study*: place*, *agency of a place*, *dialogue with place*, and *homo urbanus*. I understand '*a place*' as a real entity consisting of an assemblage of geo-environmental components (parts of rivers, lakes, mountains, forests, or swamps) interacting with non-human beings, humans, and material elements. The place can act on its rights in the context of an extended understanding of agency. '*The agency of a place*' is an attribute of a place as a non-human being. Agency understood in this way is the ability of a place as a geo-environmental entity to make changes and influence human and non-human beings. The place can be in continually agented action called '*A dialogue with place*.' Such a dialog is a reciprocal conversation between humans (or non-humans) and place. The concept of dialogue is a metaphorical description of the mutual interactions of two self-determining, agented partners (Bohm, D. 1996). In this understanding, dialogue is not an actual conversation but an exchange of meanings between two partners and their transformations under the influence of causative actions. I understand the acceptance of place's agency as the perception of place in dialogue.

A dialogue perceived in this way can be dynamic and short-lived, take place over an extended period, or be a form of bilateral relationship occurring continuously. In such a dialogue, human entities exercise their agency to change the environment, but environmental entities also change us and oppose humans, to some extent teaching us and shaping our attitudes (Larsen, S.C. and Johnson, J.T. 2016). Finally, '*homo urbanus*' is a person permanently connected with the city: living in it (in my research) or visiting it for rest and leisure.

Theoretical background

With the drastically deteriorating state of our planet's biotic and geographical environment, the question of human-nature relationships is being asked by a growing number of scholars. It is one of the core issues of debate in many scientific disciplines (Lorimer, J. and Driessen, C. 2014; Schlottmann, Ch. *et al*. 2017). In the current of geographical debates on nature-human relations, especially in the area of human geography, one can find very different, often extreme, views. This

involves different social perspectives on approaches to nature and the role of humans on earth (Callicott, J.B. 1982; Smith, M.J. 2005; Selin, H. 2013; Basak, S.M. *et. al*. 2022), and the views and profiles of different social entities (Frost, W. 2002; Dono, J. *et. al.* 2010; Gifford, R. and Sussman, R. 2012; Selin, H. 2013; Majumder, R. *et al*. 2023). On the one hand, the continuum of discussion is closed by the widely criticized for decades (Correia, D. 2013), very radical and often socially harmful theses referring to the geographical determinism of the 1920s (Huntington, E. 1924; Diamond, J.M. 1999, 2002). On the other hand, there are views that are explicitly human-centred and treat nature functionally and materially (Norgaard, R.B. 2010; Daily, G.C. 2013). In the bracket of these two extreme narratives, we can increasingly find approaches towards human-nature relations that note the symmetrical positions of human and environmental partners, or even environmental agency (Mills, W.J. 1982; Hitchings, R. 2003; Carter, B. and Charles, N. 2013, 2018; Larsen, S.C. and Johnson, J.T. 2013, 2016; Hovorka, A.J. 2018). So far, the most attention has been paid to human-animal relations. Researchers take up various aspects of the issue, from the historical approach (Lorimer, J. and Whatmore, S. 2009) through the relational approach (Lorimer, J. 2010) to the activist approach (Cretan, R. 2015).

In recent decades, the geographical discussion has evolved towards the reciprocal coexistence of humans and various animal species. This results in a redefinition of the geography of animals in favour of the more-than-human beings approach (Hovorka, A.J. 2018). The causative approach to the more-than-human world becomes so cognitively crucial that the environmental debate in this context expands to include subjective interpretations of other bio and geo-environmental partners (Greenhough, B. 2014). Referring to the tradition of indigenous group research, researchers increasingly pay attention to the agented view of, e.g., places (Boldonova, I. 2016; Larsen, S.C. and Johnson, J.T. 2016; Wright, S. *et al.* 2016).

In the context of the dramatic state of our planet, there is no doubt that understanding the depth of the human-nature relationship becomes a very important activity. Researchers working on this issue write that knowledge: 'how people think, talk and write about nature is crucial for understanding the diversity of public perceptions of environmental issues' (Andersen, G. *et al.* 2022).

Social researchers use different approaches and methods to study human-nature contacts. However, irrespective of the adopted concepts or methods, the upper end of the scale of social attitudes is increasingly being extended, moving towards reciprocal and agency-based human-nature relationships. Buijs, A.E. (2009) looks for three components in his interviews with his subjects: values, beliefs, and value orientations, which allow him to construct 'images of nature'. As a result of his research, he formulates five ideal types of images: wilderness image, autonomy image, inclusive image, aesthetic image and functional image. The first two types refer to 'hands-off' attitudes, the last two are anthropocentric attitudes. From the perspective of the topic addressed in this paper, the type separating the four categories mentioned above seems most interesting. 'The inclusive image' is "firmly based in inclusive notions of nature and culture. Nature and culture are interrelated and mutually dependent and all living beings, including humans, are defined as nature" (Buijs, A.E. 2009, 427).

In another study, an international group of researchers (Braito, M.T. *et al.* 2017) formulates three dimensions of human-nature relations and a set of seven social attitude types: master, steward, partner, participant, user, apathy and nature distant guardian. Among the identified social attitudes, we also find distinctly human-oriented types, as well as types that describe a more symmetrical relationship with nature. Speaking in a slightly different vein, the already cited Anderson, G.K. and colleagues (2022) note that the study of the relationship between human and nature provokes the sketching of a vision of the latter as: 'fragile patient' or

'reactive', 'autonomous agent'. In particular, the last two terms draw attention to a situation in which the biotic and geographical environment of our planet and human live in one more-than-human world. This line of debate is directly inspired by the research of Larsen, S.C. and Johnson, J.T. (2016, 1), who claim that "place and self are co-constituted" and that "place speaks, creates and teaches" us as humans.

It is this way of narrating the biotic and geographical environment that became the starting point of the research, the results of which I present in this paper. If we assume that the scale of social attitudes towards nature extends between 'user' and 'partner', the presented results of quantitative and qualitative research attempt to explore and concretize the essence of the human-nature partnership reduced to a mutual exchange of meanings. An exchange that takes the form of a dialogue or conversation.

Methodology

The research consisted of two phases, both realized in Austin, TX. In the first research activity I conducted a survey in which I asked people living in Austin the question "Is dialogue with non-human beings or objects possible? In this case, dialogue is understood as a kind of exchange of meanings between symmetrically understood partners?" This was a closed question in which respondents were asked to refer to 10 possible dialogue entities. Each time they answered yes or no to the question. A survey questionnaire was completed by 302 adults[2].

Each time, I personally interacted with the respondent and provided them with a QR code that redirected them to the SurveyMonkey website. On this portal, respondents filled in the survey questionnaire digitally, virtually 100 per cent using their smartphone. Out of nearly a thousand QR codes distributed using this method redirecting to the survey at SurveyMonkey, I received 302 returns.

In the second phase, I selected 20 citizens of Austin, TX *(Table 1)* for in-depth interviews from among those who participated in the first phase and agreed to take part in a further study[3].

The scenario for in-depth interviews involved asking one initial question around which the subsequent conversation developed. The question was 'for what reasons do you imagine that a symmetrical exchange of meaning between you, as a human, and nature is possible or are you convinced that such a dialogue is impossible?'. Respondents could choose to meet face to face or via Zoom communications platform. In the text of the article, selected anonymized excerpts from the statements of coded respondents are presented. In one case, a third person participated in the interview, in addition to the respondent. This was the respondent's partner, who also spoke from time to time during the interview. Her contribution was used in the analysis and presentation of the citations. Naturally, with the consent of the concerned parties. After conducting 20 interviews, I concluded that the interviews had exhausted the question and, in accordance with the principles of qualitative research methodology, I did not select any more respondents (Lincoln, Y.S. and Guba, E.G. 1985; Sandelowski, M. 1995; Creswell, J.W. and Poth, C.N. 2019).

[2] Structure of research group N = 302. By gender: *female* 54.21%, *male* 45.79%, *transgender* 0.66%, *non-binary/non-conforming* 0,99%, *prefer not to respond* 2.98%. By age: *18–24* 15.23%, *24–34* 22.85%, *35–45* 25.83%, *46–55* 18.21%, *56–65* 9.60%, *66–75* 4.30%, *over 75* 0.99%, *prefer not to respond* 2.98%. By education: *nursery school to 8th grade* 0.33%, *some high school* 8.61%, *bachelor's degree* 44.04%, *master's degree* 29.14%, *doctorate degree* 10.93% *prefer not to respond* 6.95%.

[3] All participants of the study are protected by the code of ethics of scientific research due to rules of project UMO-2018/31/B/HS4/00059. Each participant could withdraw from the study at any stage. The participants are anonymous; after the recording of the conversation, an anonymous transcription was made, and the recordings were permanently destroyed.

Table 1. Encoded profiles of study participants

Code/ Person	Age	Gender	Self-declaration of mindset/ thinking	Short answers to the question about human - environment dialogue
P1	47	Female	artistic/humanistic mindset	yes
P2	53	Female	artistic/humanistic mindset	yes
P3	35	Female	scientific mindset	yes
P4	63	Female	artistic/humanistic mindset	yes
P5	32	Female	–	yes
P6	34	Male	scientific mindset	no
P7	35	Female	artistic/humanistic mindset	yes
P8	42	Female	–	yes
P9	52	Female	artistic/humanistic mindset	yes
P10	28	Female	scientific mindset	no
P11	17	Male	scientific mindset	no
P12	29	Female	scientific mindset	no
P13	40	Female	scientific mindset	no
P14	32	Female	artistic/humanistic mindset	yes
P15	34	Female	artistic/humanistic mindset	yes
P16*	58	Male	scientific mindset	Detailed answer**
P17	35	Male	scientific mindset	Detailed answer**
P18	52	Female	scientific mindset	no
P19	35	Male	scientific mindset	yes
P20	40	Male	scientific mindset	no

*Partnership, the partner actively participated in the conversation. **I start to think about dialogue at the end of that interview. *Source*: Author's own research.

The role of nature in the city (not only): Is dialogue with non-human beings possible and how it might proceed?

With whom human can have a dialogue?

Looking at the answers given by the respondents of the quantity survey *(Figure 1)* it can be seen that:

- among the surveyed Austin residents, there is a great deal of empathy and understanding for animals as entities that can dialogue with humans in a partnership exchange of meaning;
- among the surveyed Austin residents, there is a sizeable – close to 50 percent – realization that environmental entities such as rivers, forces of nature, sand dunes and plants can be partners in dialogue with human;
- according to the respondents, among the material entities of dialogue, only AI is a comparably important dialogue partner similar to environmental entities;
- the rating of the individual environmental partners that make up the bio-environment and the geo-environment are correlated *(Table 2)*, as are the ratings of the material entities that make up the world of matter (including the digital world). In contrast, there is no clearly significant correlation between the two sets.

It can be argued that the social construction of nature from the perspective of the surveyed residents of the Texas capital takes into account attitudes of dialogue (understood as an exchange of meanings) between bio-environmental and geo-environmental partners. With only the position of animals in the social assessment of the possibilities for mutual dialogue being very pronounced and differing in the ratings from the other assessed partners.

I decided to seek the answer to this question about the social arguments 'for' or 'against' through in-depth interviews with selected respondents.

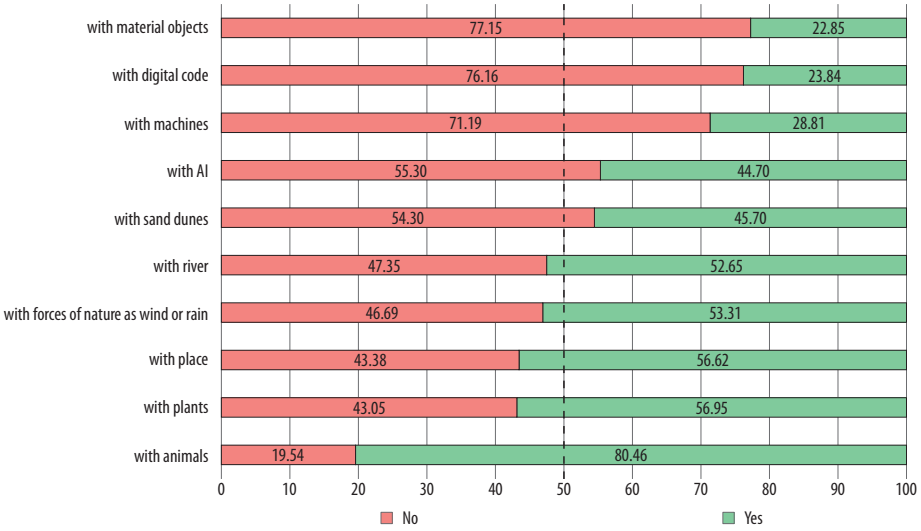


Fig. 1. Dialogue as a kind of exchange of meanings between symmetrically understood partners, in percent (N = 308). *Source*: Author's own elaboration.

Views of surveyed city dwellers on the possibility of dialogue with the biotic and geographical environment: an in-depth look at the nature of the relationship

At the outset, it should be noted that for all my interviewees, the environment, both inside and outside the city, is important. Each interviewee considered the biotic and geographical environment to be a necessary world for life and spoke with concern about its state. Many expressed their fascination with what nature in and out of the city can offer human during their encounters. Many of my respondents, even those very sceptical about dialogue with environmental partners, owned a dog or cat.

During each conversation, the question was asked about my interviewees' favourite places in Austin. In most cases, respondents indicated natural areas, describing their positive experiences in Buttercup Creek Forest, Batron Creek or more centrally-located parks such as Zilker or Mayfield Park and Natural Reserve. My interviewees were particularly impressed by the animals they encountered in these places. One interlocutor said:

'Once we were walking with my entire family when we heard a sound of cracking sticks and we froze in place to start to listen where that sound was coming from and we found a fox, a mama fox that was building some sort of little hatch. We were not sure why it was doing it, until we realized it had two little baby foxes. So, it was building some sort of little hatch for their family. It was amazing.' (P_20_40_M)

During the in-depth interviews, I did not doubt for a moment that the respondents had positive references to nature. And yet, the question about the possibility of dialogue with environmental entities aroused a lot of emotion and provoked different thoughts and answers.

Skeptical views: The biotic and geographical environment cannot be the entity of dialogue

Nearly half of the 20 interviewees said that nature above all was relaxation and they found it difficult to imagine having any dialogue with it, apart from the relationship with animals. One interviewee noted:

'I don't expect inspiration from an urban natural place. Such places are for me to forget, to calm down,

*Table 2. Cross-correlation of correlation of the evaluations of the different types of dialogue**

N = 302	Animals	Plants	Place	Natural forces: wind, rain	River	Sand dunes	Machines	Material objects	AI	Digital code
Animals	1.00000	0.49931	0.41130	0.34239	0.40249	0.38494	0.20279	0.18857	0.27505	0.17769
Plants	0.49931	1.00000	0.68291	0.63409	0.70242	0.69009	0.27245	0.37753	0.21672	0.25100
Place	0.41130	0.68291	1.00000	0.70761	0.68206	0.68217	0.36497	0.46039	0.16878	0.25451
Natural forces: wind, rain	0.34239	0.63409	0.70761	1.00000	0.82728	0.76518	0.37546	0.44603	0.18728	0.28996
River	0.40249	0.70242	0.68206	0.82728	1.00000	0.84330	0.39825	0.46869	0.18572	0.29715
Sand dunes	0.38494	0.69009	0.68217	0.76518	0.84330	1.00000	0.44393	0.43491	0.23144	0.29794
Machines	0.20279	0.27245	0.36497	0.37546	0.39825	0.44393	1.00000	0.69873	0.53103	0.57068
Material objects	0.18857	0.37753	0.46039	0.44603	0.46869	0.43491	0.69873	1.00000	0.38317	0.54692
AI	0.27505	0.21672	0.16878	0.18728	0.18572	0.23144	0.53103	0.38317	1.00000	0.55977
Digital code	0.17769	0.25100	0.25451	0.28996	0.29715	0.29794	0.57068	0.54692	0.55977	1.00000

*p < 0,05. *Source:* Author's own research.

not to talk. Places are passive and this works the other way around [from place dialogue] in my opinion. In a place such as a park, I don't need to have any conversation, dialogue. I don't think about being part of nature, about being in some kind of symbiosis. I rather use nature to relax, to calm down. I can't imagine talking with a place, plants or river. The only exception here are animals like dogs or cats. Place is constant, unchanging and that gives me security. But whether it's dialogue and the place says something, I don't know. This is just my perception of it. A very subjective situation.' (P13_41_F)

Another respondent spoke in a similar vein:

'I go there (to the park) just to relax, most of the time I go there in the mornings, before I start my day, so it's a good way to kind of put me in a good mood to start the day. I just go with an open mind, to see what I find, I'm not looking for anything particular and those are the best ones. Because then the unexpected happens.' (P_20_40_M)

In both of the interviews referenced, respondents emphasized that they viewed urban natural areas in Austin as places with a specific function. For them, nature is an important component of the city space, but it has its utilitarian function of recreation, rest and relaxation.

Another interviewee speaks even more unfavourably about the dialogue with nature and its constituent entities:

'Place or other living organisms can distract me. So maybe they can also talk. But I rather doubt that this is a dialogue. The bustling places, e.g., the 6th Street in Austin, are loud, bustling, lots of people, ads, smells and sounds. I can't focus my thoughts there and I can't see the dialogue with myself or the place at all over there. My mind is busy with other stimuli and recognizing them, defining them. Though maybe it is on the 6th Street that the place talks to me – it sends me many signals and I compare them, respond with behaviour, choices, and look for confirmation of those choices in other information from the place. For me in nature there is no clarity of message to which I can respond and interact.' (P6_34_M)

The man allows for the possibility of an interactional relationship with the built environment. According to him, these types of places are overflowing with messages and even provoke an interactional relationship. He himself says he likes to listen to birds singing or the sound of trees or a flowing

stream, but for him it is a kind of intoxicating sound through which he can immerse himself in his thoughts:

'Maybe because I'm a stricter and analytical person, I don't see it on the basis that a place is talking to me. It seems to me more that in such quiet places, with nature, with environment, I am able more to have some kind of dialogue with myself. An internal one.' (P6_34_M)

For him, dialogue with place is the 'poetic naming' of a functional relationship with nature in the space of the city, in which, as he says:

'I can sit back, relax and I can have some thoughts.' (P6_34_M)

A young high school interviewee also responds negatively to the question about opportunities for dialogue with bio-environmental and geo-environmental partners. Interestingly, this respondent recalls his childhood experience saying:

'When I was a little kid, I imagined the place was alive. I explored every place in my neighbourhood at that time. It was something unknown and I was kind of opening another door and getting to know this place. This could be such a dialogue. When I was little, I always wanted to climb every hill and see what there was. But can you actually talk to the place or more, to the environment? I don't think so. I can imagine that kind relations to animals but not for other elements.' (P11_17_M)

In the autobiographical view, the respondent points out that he remembers this type of environmental relationship from his childhood. By getting to know his neighbourhood and areas further away, he was able to feel an interactional relationship. However, he believes this was the result of a childhood imagination that he lost as he grew older.

Evolving views: it is rather difficult to imagine a dialogue between environment and human, although...

During my interviews, many of those interviewed stressed that the topic of dialogue with nature, understood as many different entities, from animals and plants to places and the geographical environment: dunes, rivers or forces of nature, compelled deeper reflection. In two cases, respondents themselves began to change their minds about dialogue with biotic and geographical environmental entities during the interviews.

There was an interesting conversation with a former marine and keen hunter. This was the only interview involving a third party – the respondent's partner. This person declared himself from the beginning to be a sceptic for some kind of in-depth, reciprocal relationship between the entities of nature and himself. The respondent expressed his concern for the environment, but he said:

'I'm probably not that deep. I'm more of a 'black and white' type of human. I look at the sky in my city and think it will rain, there will be a storm, the weather will change. I need to hide from the rain. When I'm at the ocean and I see huge waves I think 'this is not a good time to swim'. I'm sure it's no dialogue. It is rather my knowledge. When hunting, I have to watch nature. I have to listen to the silence, pay attention to the signals. To react to what I notice. I don't call it a conversation or a dialogue. But yes, as I track game, the place tells me a lot. But I wouldn't call it a dialogue. I recognize the signals. These are feelings and knowledge rather than a conversation. It's the same in the city. I pay attention to certain signals and draw conclusions.' (P16_58_M)

The sentences about the signals sent by the environment and how to read them provoked me to develop this thread. In his story, the interviewee identifies a relationship between himself and the environment based on mutual signals:

'Yes, more than anything you just listen to. I've been in deer stands and you stood there, it's very quiet and you are waiting for something to change and I don't call it a dialogue, maybe it's the same thing, I just call it; you're just listening with all your senses, more with ears than anything.'

Although he is not sure whether this type of relationship can be called a dialogue. It is, according to the respondent, the ability to recognize certain signs in the environment. At this point, my interviewee's partner took the floor

and tried to look at the story from the perspective of dialogue or conversation by saying:

'It is dialogue, because you are waiting for some signal, something and then if you see or hear something, then you change and respond to that. Unfortunately, your final answer is hunting them.' (woman participate in that IDI)

To which the respondent replied:

'Sometimes no. Sometimes the animal was too close or did something. I kicked him and I said, you win. So, it was like you have an agreement with nature maybe. It's like okay, I get my shot and missed and you're free, kind of like a dialogue with an animal rather than with nature, or animal-nature. So maybe you're right - this is an invisible conversation. I need to think more about this.'

The second respondent who went through an evolution of his views during the interview also started with a declaration of nature worship and no chance of any dialogue with place, wind or river:

'A very difficult question and one answer comes to my mind - no. I find it hard to imagine how a place, river or wind can have a dialogue with a person. I love nature and have been involved with it since childhood. I don't like anything about the city. If I have to say whether people and places can have a dialogue in the city, then I strongly say no. In cities I like parks, especially the wild ones. I'm happy when I see a turtle, a heron. But is it actually dialogue with place or another element of the natural world? It's hard for me to imagine. I need green places and I go to the park to satisfy it. Nature makes an impression on me.' (P17_35_M)

The same respondent also doubts a dialogue between human and nature and wild environment, outside the city:

'Every person perceives a place differently and it is very subjective. If one place can say something different to everyone, does that mean it speaks different dialogues, is in different dialogues? It's hard for me to imagine.'

Although, when asked further about his experience of diverse relationships with the environment, he begins to cite examples that are nowhere near as clear-cut as his skeptical declarations:

'Hm... once when I drove through the desert in Arizona, I had an impression of the vastness of space, the great impact of physical spatiality on my mind. Huge reserves of empty space. I might even call it a mystical experience. And there are a lot of these grand-scale places here in the States that make impressions on people. But is it a dialogue? Perhaps it is indeed an encounter with nature - dialogue with some natural forces or beings. I'm driving and suddenly I have to react, think about something else. Something tells me to react. It is an interesting and amazing conclusion for me'.

Both respondents also declared themselves to have scientific mindset. However, in the course of the conversations they had with themselves, they noticed that they were becoming convinced of a different point of view. Perhaps they did not even change their minds about their relationship to the environment or their perception of the environment as much as they began to look deeper, differently at the environment itself. Above all, on a diverse entity, made up of different entities. Secondly, the entity self-determines and compels them to respond as people.

Approval views: nature can be and is a biotic and geographical dialogue partner

Slightly more than half of my interviewees agreed from the outset that dialogue with nature or its biological and geographical components is not only possible, but takes place continuously and independently of us humans. In their stories, they highlighted specific examples where they see such dialogue and, somewhat contrary to my expectations, these were not examples focusing on the relationship with animals. One respondent said:

'When I am at the seaside I always have to go into the water, even if only for a moment. When I leave, I have to come to the seaside and say goodbye. If I stand on wet sand, I can feel the waves hitting my legs with varying degrees of intensity. I feel a living planet. And in this place, there can actually be a dialogue, and a materialized, concrete one at that. Maybe it's because you feel the immediate reaction of the water in this case, the water splashing, pushing. In built places, in the city? I think it's more difficult here.' (P8 42_F)

The respondent actually chose a very dynamic example that vividly illustrates the point of dialogue with the biotic and geographical environment. It is not about conversation or the communicative exchanges of ideas we know from social interaction. In the case of the respondent's relationship, the dialogue with the sea or with the place takes place as an exchange of meanings and agency between the two subjects of the relationship.

Some respondents made the dialogue relationship with environmental entities dependent on the characteristics of the human partner. The respondents pointed out that the perception of dialogue depends on the sensitivity, the perception of the world, the personality of the person, but also on the demographic or social profiles of the person, e.g., where they live or grew up. One respondent excerpted it this way:

'It depends on the sensitivity of the person – to being able to talk to a place. If you spend a lot of time in nature you can read it and you penetrate those first layers. And then I can imagine the dialogue. I see a partner and I understand it. It's probably similar in the city. I think that reminds me of how the level of your relationship with nature has to do with how much time you spend in it. And if you live in a city, where you are not able to do that as much, then it's harder to develop that without ever experiencing it. You have people that maybe grow up in a way where they are really good at tracking and watching signs in nature for what has happened, what animals were just through here and they have a deeper sense of communicating with nature and understanding their surroundings. I guess that's what it means to me.' (15_34_F)

Naturally, the term 'dialogue with nature' is a certain semantic simplification. The essence is the range of meaning behind the phrase and the kind of partnership with the environment and the recognition of its self-determining qualities. One respondent did not talk about dialogue but interaction:

'I guess between me and environment is kind of interaction. I feel welcomed and my interaction with the area depending on which park or which section of the park I am at, or who is with me, might determine which area I am going to go and enjoy. If it's raining and I'm out there with the dogs, we tear a path up because it's just mud and we walk around, if there's animals out, you can interact with them, I don't know if that's a dialogue with environment, place, plants, but there's deer and it can be dialogue with this animal. So, dogs can chase the deer, go around and stuff.' (P19_35_M)

The mechanism of the processes behind these terms converge. It is a kind of agency-based activity of the partner that forces a reflection or even a conscious change in behaviour, views and attitudes. One respondent explicitly calls this an 'exchange of meanings':

'Since we are talking about Barton Springs and just having a day there when the weather is nice, everything is going well, just being thankful or having a sense of thanks towards the weather, experience, the atmosphere, and surroundings. To me, that's kind of like having a conversation with the environment. The appreciation of it, acknowledging it when you are still within the experience, not later on. I can see how, translation wise, it can be a little bit difficult. Maybe the conversation is not the right words but an exchange of meanings or being in touch with nature.' (P18_52 _F)

One respondent recounts how her dialogue with the natural environment in the city takes place:

'In the city, the water talks to me, like another person. Water makes different sounds, and they are a representation of the state of the environment. (P7_35_F).

Conclusions

I wondered whether residents of a large city are able to think of the biotic and geographical environment as active partners in dialogue. The completed survey revealed surprisingly positive public attitudes towards animals (Basak, S.M. *et. al.* 2022). I must honestly admit that, knowing the reality of what has been happening for decades, the extermination of more animal species and the destruction of the environment on our planet, I feared that the opinions and views of the respondents would not be so positive. When evaluating the human-animal conver-

sational relationship, respondents clearly declare the possibility of dialogue understood as a symmetrical exchange of meanings between different beings. The number of positive indications, accepting environmental dialogue with partners other than animals, is lower, but still surprisingly positive (Anderson, G.K. *et al.* 2022). In my opinion, the respondents' positive attitude towards interpreting the relationship with environmental entities such as animals, but also rivers, plants, forces of nature or sand dunes as a dialogue is a very important signal of a change in human thinking about the environment (Buijs, A.E. 2009; Beatley, T. 2016; Braito, M.T. *et al.* 2017; Escobar, A. 2019).

Perhaps such positive opinions and attitudes are related to the fact that the survey was conducted among residents of Austin, TX. The residents of Texas' capital city are regarded as a pro-environment community, and they emphasized this very often in private conversations with me during my research stay. The city itself was ranked very high, 10th in 2020, in the 'Most Dog-Friendly Cities in America'[4]. In this respect, the 'city-dweller-nature' environmental relations study carried out in Austin can be linked to the identification of pro-environmental attitudes among a very mature community. Nevertheless, the answers to the posed question can still be interpreted in the context of the ability of contemporary 'homo urbanus' to build conversational relationships with environmental entities.

The general questionnaire survey was deepened in interviews. From the interviews, it appears that a very important factor shaping the views held by my interviewees towards the human-nature relationship is a certain subjective level of empathy towards the environment. Supporters of the human-nature dialogue thesis point out that they have an artistic, humanistic and emotionally sensitive personality. They are able to look at the environment around them outside the usual patterns and express these emotions in conversation. They have a kind of in-depth reflection on the biotic and geographical environment. At the same time, they very rationally point to those situations or events that can testify to the reality of human-nature dialogue, e.g., contact with sea waves or observation of vegetation over time.

Very often, opponents of a peer and conversational view of the environment say that park areas are areas of relaxation and recreation for them. They do not look at urban green spaces as an accumulation of living biological organisms and subject to the processes of natural forces, but as a functional design created by human for human.

One of the younger interviewees indicated that as a child he was able to imagine a dialogue with a place or environment. Now, however, years later, he looks at it differently. This may suggest that in the process of education and socialization, instead of developing our competences of respecting other entities that make up the more-than-human world, we lose these skills and acquire beliefs specific to the Western World. We become human-oriented beings in the social process and we have lost awareness that we live among other living beings and geo-environmental entities.

Summarizing the considerations and findings in this paper, it can be concluded that our planet – the Earth – is a living organism. It is not just a metaphor, but a fact based on biological, geographical, chemical and physical evidence. This living organism co-creates a network of agency-centred links between different biotic and geographical entities. One of them is that the human species is shaped and equipped in this way, not in any other way. Recognizing that we are immersed in nature and co-creating (or destroying) it. It's a matter of being socially open to the environment and redefining its narrative by ourselves. In my opinion, changing the perception of non-human nature is the first step to understanding that other bio and geo-environmental entities can have their own agency in action.

[4] https://smartasset.com/mortgage/most-dog-friendly-cities-in-america-2020

Study limitations

In-depth interviews were intended to clarify the opinions contained in the questionnaire survey. Quality research on a larger scale should consider differences in gender, age, and education and be with representatives of different geographical regions, cultures, and ethnic origins. However, large-scale qualitative research is expensive and requires a large team of researchers or a long-time approach. My research includes residents of the capitol of the Texas. They are instead a voice in the discussion rather than evidence confirming particular hypotheses.

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Formal urbanisation in East-Central Europe

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Abstract

The East-Central European region has undergone a unique urbanisation process during socialist and post-socialist periods. These peculiarities result from social and economic development delays, which the state has tried to remedy through massive interventions. One such intervention is urban reclassification, where the state promotes certain places it deems crucial, granting them urban status, often without actual development or urban characteristics. Due to its artificial character, this intervention is called formal urbanisation in our approach being a specific local feature of the urbanisation process. The visible result is the growth of the urban population, often only by administrative causes, with the reclassification of villages as towns. The emergence of numerous small towns, which we refer to as newest towns, has significantly influenced urbanisation, altered the concept of towns and cities[3], and generated significant debates. In this paper, we compare the formal urbanisation of the socialist and post-socialist eras, trying to estimate the added value of formal urbanisation in the latter period. We compare the administrative backgrounds of formal urbanisation in selected ECE countries for similarities and differences. Throughout the research, we analyse their formal urbanisation involving approximately 800 municipalities promoted since 1990 in Poland, Czechia, Hungary, and Romania, trying to identify common and unique features in the processes. Based on historical determination, modernisation, and integration into new spatial processes, considering demographic and functional changes, we developed types of formal urbanisation. Our research has revealed several common factors in the reclassification process, such as local initiatives, while we have also identified disparities between principles and practices and varying levels of control from regional and national actors. The study has also led to a deeper understanding of formal urbanisation in the context of the urbanisation process as a whole.

Keywords: post-socialist urbanisation, formal urbanisation, urban reclassification, newest towns, types of reclassification

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Introduction

The term 'formal urbanisation' was initially adopted to describe a particular aspect of urban growth in Hungary during the late 20th and early 21st century. This was discussed by Pirisi, G. (2009), Pirisi, G. and Trócsányi, A. (2009), and had previously been used by Kovács, Z. in a similar context. In our approach, *formal urbanisation is a specific aspect of the urbanisation process*. *It means the growth of urban population by administrative causes only, with the reclassification* (Kulcsár, J.L. and Brown, D. 2011) *of former villages as towns,*

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[3] As per the European literature, in this study, the term 'town' is used to refer to municipalities that are classified as urban but are relatively smaller in size and spatial importance as compared to a 'city'. Therefore, the term 'town' is used exclusively when discussing urban reclassification, as new towns usually fall under the small-town category once they are granted urban status, even if they grow quite populous before or during the reclassification, apart from some exceptional cases such as suburbanisation.

by a legal act. While urbanisation, both the population growth and the functional and social transformation normally happens gradually, *formal urbanisation is a single act that makes a settlement and its citizens urban,* creating a visible and important threshold. The term 'formal' refers to its formality for the citizens involved: they became urban dwellers, but in the short term, nothing changes, unlike the caption on the official letters, coat of arms, and also on the facade of the refurbished town hall.

Because it is a legal act and also a political decision, it makes only sense to talk about formal urbanisation in countries where the reclassification is not an automatic, statistical process. The tradition, of giving privileges to selected communities, dates back to the Middle Ages or earlier, and even though the urban rank does not have the same advantages as before modernity, the highly selective nature of formal urbanisation has survived. *Formal urbanisation therefore is always an attempt to intervene in the urbanisation process with political and legal acts.* It could complete or replace other activities in regional and urban policies, without realising significant and expensive investments.

The term formal urbanisation is a bit more often used in another meaning, contrasting it with informal urbanisation, referring to processes in developing countries (Mabin, A. 1991; Zhu, Y. 1998). Hereby, within this paper, we apply formality not as the contrary of informa- lity but as the metaphor of the direct intervention of the state in the urbanisation process by reclassifying certain places.

Formal urbanisation is a specific part of the overall urbanisation process, however, there is no single and universal theory describing urbanisation itself. While some scholars focus on the transformation of the settlement network and the changing distribution of population, others investigate the development of urban spaces. According to Brenner, urbanisation involves processes of concentration and expansion (Brenner, N. 2013). However, for a long time, scholars mainly focused on the concentration and deconcentration processes, such as spatial distribution and migration of the population. The most influential theory is the urban cycles theory, which still provides a framework for many researchers (Klaassen, L.H. *et al.* 1981; Van den Berg, L. *et al.* 1982). This theory played an essential role in interpreting the urbanisation of ECE countries (Enyedi, Gy. 2011). Understanding formal urbanisation requires examining the stages of relative and absolute deconcentration because the reclassification of towns mainly occurs in semi-peripheral, rural spaces, and partly in expanding urban agglomerations.

Since the 1990s, the *model of differential urbanisation* has offered an alternative interpretation of the processes of concentration and deconcentration. Geyer and Kontuly described three stages (primate, intermediate, and small city phases), out of which the third one could provide a background for formal urbanisation (Geyer, H.S. and Kontuly, T. 1993). However, population growth does not necessarily occur in towns affected by formal urbanisation, but the idea is that the focus of urbanisation shifts towards spaces outside the urban cores and agglomeration, which is reflected in formal urbanisation as well. However, empirical results do not always confirm this theory (Geyer, H.S. and Kontuly, T. 1993), and applications for ECE countries are limited (Tammaru, T. 2003).

There are various theoretical approaches to describe the new trends of urbanisation that are happening outside the core cities. Initially, Berry introduced the concept of counter-urbanisation which later developed into more complex theories (Berry, B.J.L. 1980). Richardson's ideas about the deconcentration of industry (Richardson, H.W. 1980) that triggers polarisation reversal in regional and urban development formed the basis of theories of polycentric urbanisation (Davoudi, S. 2003). The discussion about the 'borrowed size' of smaller urban settlements claims that smaller towns outside of agglomerations

could grow larger by 'borrowing' resources and development impulses from networked primate cities (Burger, M.J. *et al.* 2015; Malý, J. 2016; Meijers, E.J. *et al.* 2016) and is also an aspect of urban decentralisation. It is challenging to differentiate between similar concepts. Follmann, for example, describes peri-urbanisation (Allen, A. 2003; Simon, D. 2020) as an 'umbrella concept' for similar approaches (Follmann, A. 2022). In his interpretation, peri-urbanisation could be both territorial and functional, and a transitional category for urbanising places, future towns, or semi-urban spaces. Due to its flexibility, this concept is relatively often used for ECE countries (Hirt, S. 2007a; Biegańska, J. and Szymańska, D. 2013). Efforts are being made not only to adopt the concept of peri-urbanisation to the contemporary processes of ECE countries but also to integrate elements of theory into the still more commonly used model of urban cycles. While investigating similarities and differences between suburbanisation and peri-urbanisation in Poland, Zborowski and his co-authors concluded that a fifth state must be added to the classical four-state model of urban cycles. The new peri-urbanisation phase finds its place between suburbanisation and desurbanisation and could be characterised by decentralisation above centralisation and alongside slow counter-urbanisation (Zborowski, A. *et al.* 2012).

The polycentric urban development model suggests that small and medium-sized towns outside of the central agglomeration will experience population growth due to differential urbanisation and counter-urbanisation. However, the overall population decline and significant outmigration in the ECE region make it difficult for even these transitional spaces beyond the metropolitan borders to experience local growth. This demographic situation creates a clear difference between the urbanisation of ECE countries and that of Western European countries (Steinführer, A. and Haase, A. 2007).

To gain a better understanding of urbanisation processes in countries beyond major cities, we should shift our focus from population changes and migrations to the social, functional, and symbolic transformations that occur. The concept of peri-urbanisation, which describes the areas outside of urban centres, can be used to help us understand these processes. In China, the term 'semi-urbanisation' is often used to describe the unique aspects of their urbanisation processes, which are characterised by an intermediate position between urban and rural areas (Chen, M. *et al.* 2019). This term not only applies to the population living in these areas but also to the landscapes that blur the lines between towns and villages (Liu, S. *et al.* 2004). Similarities can be seen between China's urbanisation processes and those of formal urbanisation, particularly in the nationwide rural settlement consolidation projects that have been conducted (Qianyi, W. *et al.* 2023). These processes have led to social transformations such as modernisation and changes in lifestyle and habitus, which are collectively referred to as 'in situ urbanisation' (Ginsburg, N.S. *et al.* 1991; Zhu, Y. 1998, 2002).

Urban reclassification reached such a scale in Hungary at the beginning of the 21st century that, in addition to the intense interest in politics and public opinion, it attracted the professional attention of several disciplines. As one visible result of that scientific debate, the use of the term formal urbanisation itself dates back to this period. In this context, Kocsis reviewed the European practice of urban reclassification around the turn of the millennium, and it became clear from this study that post-socialist Europe in its transition was following a fundamentally different path from the West (Kocsis, Zs. 2008). The question then became a focus of the authors' interest (Trócsányi, A. and Pirisi, G. 2009.), and a closer look at the practices of post-socialist countries followed. Our analysis showed that in this region it was still – or again – becoming a noteworthy practice, with varying degrees of intensity, to elevate

some constitutionally equal municipalities to a higher administrative level by individual and unquestionable decisions of central power (Konecka-Szydłowska, B. 2016; Veress, N.Cs. 2016; Konecka-Szydłowska, B. *et al.* 2018; Karsai, V. and Trócsányi, A. 2019).

Our research is centred around five countries that form the core of a region that is difficult to define. This region is located between the current Russian border and the former Iron Curtain and overlaps with various historical and geographic regions of Europe. Despite the four decades of state socialism, these countries' common roots and path dependencies go much deeper. We acknowledge Szűcs's concept of East-Central Europe (Szűcs, J. 1983, 1994), which recognizes the joint historical development of the region. It is a historic macroregion of Europe where local societies have successfully adapted norms and models from the core countries of Western Europe. Even though the later development of these societies was primarily influenced by the powers of the Eastern and South-Eastern peripheries of the continent, East-Central Europe retained its essential similarity to the core region and fundamental differences from the Eastern peripheries.

In this paper, the authors try to explain the significance of formal urbanisation in selected East-Central European (ECE) countries, focusing on the post-socialist era. We will argue that formal urbanisation is an integrated part of the overall urbanisation process before and after the political and social transition of 1990. After the political transformation, formal urbanisation became a part of the urban deconcentration processes, overlapped the processes of sub- and counter-urbanisation and contributed to forming a peri-urban space. The authors think formal urbanisation has not yet been contextualised about socialist or post-socialist urbanisation trends and models. In our work, we attempt:

1. to compare the formal urbanisation in the socialist and post-socialist era,

2. define the importance and calculate the added value of the formal urbanisation in the post-socialist era,

3. highlight similarities and differences in the administrative background of formal urbanisation in the selected countries,

4. describe different types of the newest towns generated by formal urbanisation.

The Hungarian Government ensures the actuality of the paper, the once largest creator of 'newest towns'[4] (Konecka-Szydłowska, B. *et al.* 2018) silently decided to put a drastic end to the wave of promotion, and the number of towns has plateaued since (with only two new towns since 2013). It is not the end of formal urbanisation, but probably the beginning of the end, after years of being chroniclers of a contemporary process, that gives us a perfect chance to take a wider distance and scope and attempt to interpret formal urbanisation as a part of the overall urbanisation process of East-Central European countries.

Data and methods

The paper analyses the formal urbanisation of five selected East-Central European countries: the four Visegrad countries completed with Romania. The selection was somewhat arbitrary. Formal urbanisation played an essential role in all these countries except Slovakia, creating a significant pool of the newest towns in the post-socialist era. The data needed for the most fundamental analysis were available for these countries, and some earlier results also helped the interpretation. The limitation of the research to these countries results from a compromise. One can find the newest towns in other European post-socialist countries, too. Still, the different historical backgrounds (Post-Soviet and Post-

[4] In this paper, we use the term 'newest town' to distinguish them from previously physically newly developed or created counterparts, the new towns of the post-war period. Their novelty does not refer to their existence, but merely to their urbanity and legal classification.

Yugoslav development) and difficulties in building up a comprehensive database guided the authors to narrow this selection.

The study makes the difference between the socialist and post-socialist eras. Although 1989–1990 (with the fall of the Iron Curtain) is widely accepted as the turning point in history, and by the end of 1990, every selected country had a democratic, elected government, we count post-socialist formal urbanisation with 1991 as a starting year. Data collection happened in 2022–2023, and the latest population data usually refer to 2022.

The list of the newest towns and the year of their promotion has been compiled from various secondary sources: the official list of national statistical offices, with direct data service to the authors (Czechia, Hungary), publications (Krzysztofik, R. and Dymitrow, M. 2015), websites (Poland: *Nadania*…, 2023), and legal sources (Romania: *LEGE nr.351*; *Lista orașelor...),* and it reflects the status of the first half of 2023. Despite all the efforts, the database may contain minor mistakes in specific cases, but according to our knowledge, it represents the general view of formal urbanisation correctly.

This paper has used statistical data based solely on population numbers. These figures were sourced from various online databases, such as the 2021/2022 census or other yearly data services (INS 2021; CZSO 2022; Statistical Office of the SR 2022, Statistics Poland 2023).

Most countries use a multi-level concept of urbanity in their public administration. Differences between cities and towns (*municipiu* and *oraș* in Romania, cities with *powiat* rights in Poland, statutory cities in Czechia, etc.) or between towns and market towns (*město* and *městys* in Czechia) were not taken into account, and all of them was treated as urban places.

Historical background: formal urbanisation during the socialist era

Is there a specific socialist urbanisation in the countries of East- and East-Central Europe? The existence of a 'socialist city' is usually not a matter of much doubt. Not only because urban planners of the Eastern bloc used this term to describe their efforts and struggle to create the utopistic spatial framework of the socialist society. But the phrase has also been used widely by researchers from both East and West (Turnock, D. 1974; French, R.A. and Hamilton, I. 1979; Demko, G.J. and Regulska, J. 1987a; Hausladen, G. 1987) while the socialist city, not only in prototypical, 'green field' form but the more standard version of transformed cities were doubtless existing realities, the question of their urbanisation is much more complicated. Was there a unique 'socialist urbanisation' or just an 'urbanisation under socialism'? In their famous paper, Konrád and Szelényi published the theory of 'under-urbanisation' and became one of the most cited authors of socialist urbanisation (Konrád, Gy. and Szelényi, I. 1974). Later, more papers confirmed the concept of underurbanisation and emphasised the unique nature of socialist urbanisation (Kansky, K.J. 1976; Fuchs, R.J. and Demko, G.J. 1979; Fuchs, R.J. 1980).

Enyedi, however, somewhat later interpreted the process much more like urbanisation during socialism as an integral part of the global urbanisation model (Enyedi, Gy. 1990, 1996). Therefore, the stages of the global urbanisation process (Van den Berg, L. *et al.* 1982) would also appear in this region – only with an unavoidable delay and asynchronous even among the ECE countries.

What was the role of formal urbanisation in this era and region? Its significance is clear by numbers only. According to the data given by Kovács, Z. (2010), during the socialism until 1990, the number of officially classified towns tripled in Hungary, increased 2,5 times in Bulgaria and had spectacular growth in Romania (70%), Slovakia (64%) and Poland (20%). Exceptions were the historically most developed and urbanised regions of the Eastern Bloc: the (contemporary) Czechia and the (late) GDR.

Many of these newly recognised towns are matter-of-fact new towns, products of central planning and design. The number of new towns founded in the era could exceed 200 in the ECE countries excluding the Soviet Union (Szirmai, V. 2017), but these are still the lesser part of the growth concerning the urban 'stock' (which is about 450 units between 1945 and 1990).

In the mid of the 1970s, Konrád and Szelényi interpreted the gap between the non-agricultural employees and the urban residents as a sign of under-urbanisation, highlighting the enormously increased number of commuters, who are not to be confused with the subjects of the later suburbanisation (Konrád, Gy. and Szelényi, I. 1974). Living in rural places and working in the urban industry: Szelényi described this group as the new working class (Szelényi, I. 1981). Therefore, both the decrease of the rural and the growth of the urban population were slower than expected, and even the 'changing definition of urban areas' (in our words: formal urbanisation) took a part in it (Fuchs, R.J. 1980). The original concept of underurbanisation emphasised limited rural-urban migration and moderate population growth; however, from the 1970s, the discrepancy between the rank and function of certain places became more and more visible in Hungary (Tóth, J. 1980, 2008; Beluszky, P. and Győri, R. 1999). Under-urbanisation, therefore, gained a partly different, new meaning, too: the lack of officially recognised, 'urban-ranked' places compared to places with central functions and dominantly urban, non-agricultural populations. In the 1980s, these functionally urban places became beneficiaries of the accelerating reclassification process and were gradually promoted to towns.

However, with all these connections to under-urbanisation, formal urbanisation in these decades let itself be interpreted according to Enyedi's abovementioned approach. If we focus on *the two identified major groups affected by formal urbanisation*, the type of socialist cities, more accurately socialist small towns[5] and the functionally and economically strengthened more traditional small towns, they not only symbolise two different stages in the spatial planning of socialist countries but also could be connected to two different stages of the urbanisation model. *The first group* is connected to a decent rural-urban migration with intensive concertation of people, mainly the industrial workforce. It, therefore, could be interpreted as part of the first stage of urbanisation. *The second group* could be linked with the second phase of urbanisation: the relative deconcentration, where Enyedi emphasised in his approach that the deconcentration is not equal to suburbanisation but affects the less urbanised, rural hinterlands, wherever secondary cities and small towns became local poles of urban growth (Enyedi, Gy. 2011). Similarly, the theory of 'differential urbanisation' (Geyer, H. and Kontuly, T. 1993) highlighted the role of intermediate and small cities in the later stages of urbanisation. In our case, a typically moderate migration from surrounding ruralities to the small centres/towns occurs, and a minor but essential migration of white-collar workers and intellectuals from cities to towns (Szelényi, I. 1981). Comparing the two groups, formal urbanisation is a collateral effect in the first case when the town was built around an investment; the rank had secondary importance: a milestone and a reason for a celebration, but not the key to further development. In the second case, however, the positive correlation between rank and development, as described above, could be crucial.

[5] A list of new or socialist towns could be cited from the block like Komló (gained town rank in 1951), Várpalota (1951) Kazincbarcika (1954) in Hungary; Partizánske (1948), Detva (1965) Nová Dubnica (1960) in Slovakia; Tychy (1951) in Poland; Victoria (1954) in Romania, etc. In fact, in the years of gaining the town rank, the majority of promoted settlements were rather rural, although the later (industrial, infrastructural and housing development projects granted them rapid (urban) growth.

The post-socialist urbanisation

Even if 34 years have passed after the political changes in the forerunner countries of East-Central Europe, and even if a significant number of papers are published on this field, the research of the post-socialist urbanisation remained imbalanced both geographically – ECE countries dominate the discourse – and thematically, thus, case-study bases approaches dominate the analyses (Sýkora, L. and Bouzarovski, S. 2012; Frost, I. 2018).

The earliest case studies focused on capital cities: Prague (Sýkora, L. 1999; Temelova, J. 2007), Warsaw (Bourdeau-Lepage, L. and Huriot, J.M. 2002; Weclawowicz, G. 2005), and Budapest (Kovács, Z. 1998, 2009a,b) are pretty overrepresented in scientific literature, and later other capital cities (Bucharest, Belgrade, Sofia) joined this analysis (Vujović, S. and Petrović, M. 2007; Hirt, S. 2007b, 2008; Light, D. and Young, C. 2010; Marcińczak, Sz. *et al.* 2014). Much less attention was given to smaller cities (Young, C. and Kaczmarek, S. 2008; Haase, A. and Rink, D. 2015). The transformation was conceptualised mainly based on the processes and problems of the capital cities (Kovács, Z. 1999; Sailer-Fliege, U. 1999; Tosics, I. 2005; Stanilov, K. 2007; Hirt, S. 2013; Berki, M. 2014; Farkas, R. and Klobucnic, M. 2021). The transformation of the housing market, the effects of privatisation, the changing role and practice of planning, the change of public and symbolic spaces and the switching patterns of urban land use are the main elements of the theoretical concepts of post-socialist urban development (Egedy, T. and Ságvári, B. 2021). The overall transformation of the urban system including the emergence of new towns of reclassification got much less attention (Pirisi, G. and Trócsányi, A. 2012; Szilágyi, F. 2012; Mitrică, B. *et al.* 2014; Bocheński, T. 2023).

Exceptions are papers focusing on internal migration, population concentration, and deconcentration. Especially in Hungary (Brown, D.L. *et al.* 2005) and Poland (Zborowski, A. *et al.* 2012), these processes are well described and analysed. Results are similar in both countries: the surplus in the migration balance was significant in the 1970s for the major cities and entirely disappeared by the end of the 1980s. Deconcentration of the population has started, and the rural settlements have become net gainers of the restructuring. The crisis of the cities, especially some industrial and/or artificial, planned new towns, is among the reasons moving back to rural areas was a possible reaction of the lower classes to the economic distress (Brown, D.L. *et al.* 2005). But mainly, it is 'classical' suburbanisation which was to be observed all over the ECE countries and was responsible for the – relative – deconcentration of the population (Kok, H. and Kovács, Z. 1999; Timár, J. and Váradi, M.M. 2001; Hirt, S. 2007a; Sławomir, K. *et al.* 2015; Ouředníček, M. *et al.* 2019). Also, especially after 2010, there was evidence of counter-urbanisation as part of the rural restructuring processes (Šimon, M. 2014; Csurgó, B. *et al.* 2018). However, the deconcentration processes did not affect all rural areas, not even many small towns, where shrinking was typical in Hungary (Pirisi, G. and Trócsányi, A. 2014) and occurred in Poland, too (Bartosiewicz, B. *et al.* 2019). Also, deconcentration did not last too long: in Hungary, the migration balance of Budapest (and the other cities' and towns' aggregated value, too) turned to positive in 2006, and in 2016, it became slightly negative once again – probably affected by the government's specific decision in its new housing policy. Reurbanisation (and gentrification) in the whole region became a spectacular and scientifically well-represented phenomenon, not only in capital cities but in regional centres, too (Kovács, Z. *et al.* 2013; Haase, A. *et al.* 2017; Kurek, S. and Wójtowicz, M. 2018; Sławomir, K. and Wójtowicz, M. 2018).

Suburbanisation, counter-urbanisation and reurbanisation – processes that represent stages of the Western European urbanisation. Is there anything unique in the local processes at the scale of the urban

system? As we have seen, most of the research focuses 'explicitly' on post-socialist urbanisation, selecting the scale of the (large) city and finding a sort of regional peculiarity as a result of multiple transformations (Sýkora, L. and Bouzarovski, S. 2012). Other approaches emphasise the hybrid nature of ECE-urbanisation (Taubenböck, H. *et al*. 2019), and some researchers reject the post-socialist context and emphasise the global nature of the post-socialist processes using the uneven development approach (Timár, J. 2007; Smith, A. and Timár, J. 2010). This debate affects the heart of the modernisation of the region. The adaption of competing approaches of traditional, homogenising modernisation, multiple modernities defined by path dependencies and entangled modernity give various possibilities of different interpretations (Wiest, K. 2012).

If we accept that the East-Central European countries' modernisation path was somewhat different from the Western European countries and their current urbanisation has some unique features, we may also accept the term post-socialist development and urbanisation. It is unnecessary because all the contemporary phenomena need to be interpreted as a consequence of the era between 1945 and 1989: path dependencies may go deeper into the history of the semi-peripheries of Europe. Formal urbanisation, as we interpret it, also preserved some archaic features. However, formal urbanisation was part of both socialist and post-socialist development. In many ways, the post-socialist formal urbanisation is closely related to the era of socialist development. Therefore, in this case, we believe the term post-socialist urbanisation is the best framework for the analysis – at least at the stage that followed but not necessarily derived from the urbanisation of the socialist era.

The role of formal urbanisation in the post-socialist era has been affected by the changing demographic conditions, which have not been favourable for urban growth. According to Sobotka, T. and Fürnkranz-Prskawetz, A. (2020), the natural population decrease has become the most important factor in Hungary, Romania, and Poland, and this has been accompanied by significant outmigration, especially after the EU integration in some of these countries. *Table 1* provides more information on this trend.

The comparison of the total and urban population change reveals some differences among the selected countries. In Hungary, the urban population figure grew, even with a 6 percent natural decrease in the population, while in Slovakia, we found a decreasing urban population in a growing population figure. The rate of urbanisation moderately decreased in Poland and Czechia, somewhat more in Slovakia, while Romania was able to realise a minimal and in Hungary a significant increase.

This visible divergence in the countries' urbanisation (with Czechia, Poland and Slovakia on the one, Hungary and Romania on the other hand) has to be reasoned at the 'lower end' of the urban hierarchy: the population change of the large and middle-sized cities is very similar, except

Table 1. Demographic aspects of post-socialist urbanisation in selected countries, 1990–2020)

Selected countries	Ratio, 2020/1990			Rate of urbanisation, %	
	Total population	Urban population	Population of cities/ towns over 20,000	1990	2020
Czechia	1.01	1.02	0.92	75.2	74.1
Hungary	0.94	1.03	0.95	65.8	71.9
Poland	0.99	0.97	0.80	61.3	60.0
Romania	0.83	0.85	0.97	53.2	54.2
Slovakia	1.03	0.98	0.97	56.5	53.8

Source: Based on authors' calculation. Total population data: Eurostat database, urban population data UN World Urbanization Prospects – definition of urban hereby refers to national classifications. Population of cities/towns over 20,000 – limitation refers to 2020, data taken from citypopulation.de.

Table 2. Formal urbanisation after 1990 in selected ECE countries

Selected countries	Total number of urban settlements		Reclassified settlements between 1991 and 2022		Population of reclassified settlements		
	1990*	2022	Number	Share to urban settlements, %	Total	Share to urban population in 2022, %	Average size
Czechia	434	837	403	48.15	673,258	8.82	1,671
Hungary	164	348	184	52.80	1,211,246	17.63	6,582
Poland	824	979	155	15.83	468,222	2.05	3,020
Romania	259	319	60	18.80	487,196	5.30	8,120
Slovakia	135	141	6	4.25	29,217	1.05	4,869
Total	*1,816*	*2,624*	*808*	*30.79*	*2,869,139*	*5.83*	*3,551*

*Including towns promoted in 1990. *Source*: Authors' calculation, based on the national statistical offices' data services. Urban population is calculated as the sum of the population of settlements with urban rank. In the case of Czechia, all types of urban settlements (statutarní mesto / statuary cities, mesto / towns, městys / market towns) were considered.

Poland. Therefore, looking at the effects of formal urbanisation, it may be visible in the gap between the change in the rate of urbanisation and the conversion in the population of major cities and towns.

Slightly more than three decades after the political transition, more than 800 settlements have been reclassified as towns in the five investigated ECE countries *(Table 2)*. These 808 newest towns had more than 2.87 million inhabitants in 2022, which exceeds 5.8 percent of the total urban population of these countries. Therefore, formal urbanisation became the primary source of growth that replaced the traditional urban population increase after 1990. The case of Hungary is emergent, but there is a significant contribution in Czechia and Romania, too. These nearly three million new urban residents created by formal urbanisation halved the decrease of the urban population in the region. Even though differences between countries are apparent, the average population size of the newest towns varies from 1,671 (CZE) to 8,120 (ROM).

Similarities and differences in the regulation of formal urbanisation

In addition to the countries analysed above, formal urbanisation can be found in almost the entire post-socialist region. Its formal nature means that it is defined by a legal framework, which we have tried to explore through an attempt to understand the practice in a dozen countries[6]. Its formal nature means that it is defined by a legal framework, which we have attempted to explore through an attempt to understand the practice in a dozen countries. For reasons of geographical proximity, we also looked at Austria's administrative system and the regulation of urbanisation, which showed markedly different characteristics, thus, confirming the phenomenon's post-socialist nature. The following conclusions can be drawn after studying the formal urbanisation frameworks of the countries under study.

One of the significant demands of the political changes around 1990 was the abolition of central regulation of spatial processes, the demand for territorial decentralisation in general, and the increase of municipal autonomy, which was enacted into law in almost all countries until 1995, sometimes linked to the constitution (e.g., in Hungary, the fundamental rights of settlements are equal), sometimes within the framework of a comprehensive law on

[6] Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, Hungary, Lithuania, Poland, Romania, Serbia, Slovakia, Slovenia, Ukraine.

local governments, in other cases supported by sectoral regulations, but generally with a permissive attitude to make up for the earlier shortfall and with a nomenclature adapted to international urban concepts or the spatial development system in the spirit of EU harmonisation. A common feature is that, although the decision to award the town rank is taken at the highest level (president, parliament, ministries), the right and the possibility to take the initiative rests with the municipality/settlement/community concerned. In some countries studied, the town rank confers privileges (differentiated state support, a share of tax revenue, state institutions, the right to self-government or other authorities) and responsibilities. Still, the scope of these advantages seems to be generally thinning, and the rank is increasingly becoming just a title.

Each of these regulations considers the town a complex phenomenon, so in addition to size, it usually prescribes/assesses development, dynamism, infrastructure, spatial structure and, finally, additional specific characteristics. In Hungary, there is – in theory – no minimum population threshold; in Lithuania 500, in Bulgaria 1,000 for holiday resorts and 3,500 otherwise, in Poland 2,000, in Lithuania and Slovenia 3,000, in Czechia 3,500, in Romania and Slovakia 5,000, while in Croatia, for example, a population of 10,000 is required. Despite this, one can find tiny, small towns in the region[7], and even some of the newest ones of the post-socialist period (Pálháza, H – 1,048, Kiten, BG – 1,131, Přebuz, CZ – 73, Wiślica, PL – 477, Opatowiec, PL – 313 inhabitants).

Development is usually measured in terms of infrastructure (percentage of paved roads, sewerage connections, rate of fully comfortable housing units) and less and less in terms of population (education, employment), but it is also usually measured in terms of institutional facilities (hospital, high school, police station, commercial accommodation, etc.). In connection with geographical concepts of the towns and cities, the regulations usually require a spatial organisation function that extends beyond the municipality's boundaries. This can be reflected in the organisation of public administration (regional centres, town centres), institutions (hospitals, decentralised public institutions, etc.) and employment (commuters' share). Tourism, which is difficult to define but often appears as a significant regional role, is subject to differentiated regulation and/or permissive practices in the countries studied. Partly linked to tourism, heritage elements are a link between present practices and the (glorious) historical past. An even stronger connection is the fact that no country takes the title/rank away – not any downgraded municipalities for non-compliance with the law[8] – from settlements that have lost much of their role, economic power and not least their population, so that it is possible that Melnik in Bulgaria, for example, with its 234 inhabitants, is still a (museum) town today. A specific (post-)socialist (or East-Central European) feature is that there are defined exceptions everywhere in the legislation (for historical, political, economic, territorial, geographic, and territorial-political reasons). Still, the criteria are generally so soft or flexible that even with fixed thresholds, the decision-makers on the award of the town rank have sufficient leeway. In this way, formal urbanisation has also become a scene for political games. Although the urban title is worth less and less in practice, not all

[7] Quite small towns (villages with urban status) can be found in many places in Europe, from Germany to Croatia, from the Netherlands to Bulgaria, and from France to Czechia. A fundamental post-socialist feature, however, is that while the less populous towns of the West have sometimes dwindled over the centuries, retaining their former status, their tiny counterparts in the East have recently gained their urban status due to modern developments.

[8] The only example in the region in Romania is Băneasa in Constanța county, which reclaimed its municipal village status 13 years after being reclassified to a town. It held the town rank between 10 April 2004 and 17 January 2019, when it was reclassified (back) following a local referendum held on 11 June 2017.

players realise this, and many municipalities are still making considerable sacrifices to be reclassified.

Types of formal urbanisation

The range of settlements that have been promoted to urban status by formal urbanisation is sufficiently numerous to attempt to identify internal characteristics and structural types. This is attempted below *(Table 3).*

During the socialist development, modernisation through industrialisation was the primary driving factor for formal urbanisation, however, it was not the only driving factor. The development paths of the newly promoted towns were convergent but not identical. On the other hand, post-socialist formal urbanisation is characterised by a high level of heterogeneity in the settlements involved, and their development is also divergent. The region has a unique position, transitioning from a sort of socialism to a form of global capitalism while integrating into the European Union. It is part of the global core but still considered the periphery of this centre, demonstrating a real semi-peripheric nature The formal urbanisation of the area reveals delayed development, anachronistic attitudes, vulnerability and resilience amidst deep structural crises, and successful adaptation to global challenges. Despite the complexity and chaos of this process, we have identified three types of formal urbanisation: a historically determined path, a type resulting from delayed modernisation, and a type of new spatial polarisation.

Historical determined formal urbanisation

In the countries under investigation, modernisation was closely tied to the struggle for a nation-state during the 19th and partly 20th centuries. In the 20th century, only a few regions of the investigated area (Hungary and the historical Romanian regions of Oltenia, Muntenia and Moldova) belonged to the same country for the entirety of the century. The frequent changes in government led to ongoing administrative reforms, which sometimes resulted in the revision of urban ranks and privileges. This meant that towns and cities were sometimes stripped of their urban status. For instance, in Poland, many towns were demoted in 1869–1870, widely interpreted as the Imperial Russian authorities' repression of local autonomy (Sokołowski, D. 2014). More towns were downgraded in 1934, and some were stripped of their status shortly after World War II. Out of the 828 towns that were once degraded in Poland, 240 were restituted until 2015 (Krzysztofik, R. and Dymitrow, M. 2015), and 56 have been restituted since then. In other words, our calculations show that over 80 percent of newly promoted Polish towns have a *restitutional background*. Restitution is sometimes part of administrative changes,

Table 3. Types of post-socialist formal urbanisation

Indicators	Historical determined	Delayed modernisation	New spatial polarisation
Population change	Low and shrinking	Stagnating or shrinking	Growing, even booming
Functional changes	Lack of general central functions except in some exceptional cases	Conserved functions with growing microregional importance	Improving central functions in particular, but not every aspect
Subtypes	Restitutional towns	Small rural towns	Suburban towns
	Heritage/Image towns	–	Recreation towns
	Ghost towns	–	New company towns

where former amalgamations have been dissolved, and new, independent towns have been promoted. Restitution in Poland has resulted in the smallest new towns in the region: Opatowiec, with its population of 313, can be compared with smaller villages; however, a dozen other small towns population from this category are not reaching the population of 1,000.

Restitution is a well-discussed issue among urban geographers in Poland, and the process is documented in detail. However, in Czechia, there is hardly any analysis available on formal urbanisation and restitutions. Even though historical reasons could also play a significant role in the Czech formal urbanisation. The category of 'městys' (market towns) is unique and seems to be a fitting category. Individual town histories refer in almost every case to the administrative change as the place 'regained its town status'. These places typically have low population figures, even lower than the Polish average. A representative example is Lipnice nad Sázavou, a market town with less than 700 inhabitants in Kraj Vysočina. It has a spectacular castle founded around 1310, and the town rights were granted in 1370. Later, however, it remained a small rural town completely burned down with a castle in 1869 and lost all town rights. Its market town status was regained in 2019 based on historical foundations. In Slovakia, four of the six promoted towns had some historical urban privileges until the end of the 19th century, but it seems it was not the primary factor. In Hungary, restitution has never been an explicit goal in formal urbanisation. However, town candidates must describe in their applications their roles in the administration throughout history. This may refer to the fact that historically, there was a significant cut among the places with urban privileges in 1871/1886. Therefore, there is a relatively high but never specified ratio among the newly promoted towns with an urban past.

Historical paths play a significant role in determining formal urbanisation beyond just the restitution process. In Hungary, heritage sites such as Visegrád (former royal castles) or Pannonhalma (first abbey founded in 996) have become towns that refer to their historical heritage. In Romania, where restitution was unimportant, regional policy goals determined formal urbanisation, resulting in many towns with *important historical heritage* or past cultural functions, such as Tismana[9] and Sălișteː Additionally, recent history can also influence urbanisation. For instance, some villages in the socialist era were industrialised but not formally urbanised. Promotion in these cases happened after the collapse of local heavy industries as a form of compensation or an attempt to break the negative trends. Such towns, mixed in society, spatial structure, and retaining some elements of their bright past, are unique elements of the urban network. Examples of this type include Bélapátfalva (former cement industry), Sajóbábony (chemical industry, explosives) in Hungary, Tułowice (porcelain factory closed, city status granted later in 2018), and Wojkowice (promotion preceded the collapse of mining and cement industry) in Poland.

It is perhaps an exaggeration to call *ghost towns* the settlements experiencing the most intense depopulation, yet they are probably

[9] Tismana represent a specific historic route of urban development. During the Byzantine era, Nicodemus of Tismana built a monastery in the 1300s, which made it an important religious centre. Tismana boasts traditional craftsmanship and a beautiful natural setting, with some of its areas belonging to the Domogled-Valea Cernei National Park and also bordering the Retyezat National Park. In 1973, the Minister of Tourism declared Tismana a 'tourism village' to repair the degradation of its status as a climatic locality at the village level. However, until that order, Tismana was not open to foreign tourists due to the Securitate's prohibition against accommodating them in private homes. Nonetheless, the 'tourism village' title enabled slow development, with the preservation of the historical heritage, even during the Ceaușescu era, providing a good foundation for the subsequent development. Tismana gained the town rank in 2004, and now administers ten villages and is home to 1,903 people, with a total population of 5,027 people.

the ones that most clearly mark the dichotomy of glorious past and decaying present. There are no classic ghost towns at the municipal level among the newest towns, but there are some among the new ones. Pripyat is a clear example of the broader region, with a population that once approached 50,000 but has now officially fallen to zero, making the once thriving industrial town an emblematic abandoned city. However, in each of the countries in the region under study, there are sectors of settlements, usually far from the centre, in well-isolated, hidden, defensible areas and where, for example, the former Soviet army has established mini towns (military barracks, airfields, ammunition depots etc.). After the withdrawal of the Soviet military, these formerly artificially kept alive settlements became deserted ghost towns. Perhaps the most typical example of this type is Kłomino in Poland, once home to 5,000 people, now with around 12, according to statistics.

Even though some places have lost and regained old privileges due to turbulent history or late compensation for interrupted urbanisation, the historical type characteristically implies low population figures. Many of these towns do not qualify as a relative concentration of population in rural areas. Moreover, if formal urbanisation is based on historical merits or traditions, new towns usually decline in population. In Poland, between 2011 and 2021, 77 percent of the newest towns that were restituted had a decline in their population. Non-restitutional new towns had a small, aggregated population growth, while the restitutional ones had a slight aggregated loss.

Formal urbanisation and delayed modernisation

The second type of formal urbanisation is essentially a later iteration of socialist urbanisation that was extended into the 1990s and beyond. As mentioned, formal urbanisation in the planned economy era was not restricted to new industrial towns. *Small rural centres* could also undergo urban reclassification in the second half of this period.

After the political changes, the trend towards formal urbanisation continued, but the reasons behind it became more complex. In Hungary and Romania, regional development policies encouraged the establishment of further newest towns, but the justifications for doing so varied. In Romania, the goal was to increase the rate of urbanisation to meet EU standards (Benedek, J. 2006). This led to a wave of formal urbanisation in 2004, with more than half of the newest towns in the country being promoted as part of the preparation for European integration (Săgeată, R. 2010). Hungary had a similar situation, with around one-third of the newest towns belonging to this type. Examples of these new towns include Bátaszék, Enying, Csákvár, and Gyönk, which typically serve as the centre of their micro-region, performing various administrative, educational, or retail functions (Trócsányi, A. *et al.* 2018). These places are functionally weak and socially mixed, combining rural and urban attitudes and values (Veress, N.Cs. 2016). There is still much debate about the level of urbanity and the taxonomy of these official urban places (Dövényi, Z. 2005).

There is a significant overlap between this type and the historical one above. This is because the restitutional towns in Czechia and Poland also serve as rural centres despite having a limited population (Konecka-Szydłowska, B. 2016). Like many larger Hungarian rural centres, the newest towns with restitutional backgrounds sometimes have a more (inherited) urban-built character.

These semi-urban places sometimes face the problem of shrinking (Bartosiewicz, B. *et al.* 2019), and they do not serve even as small-scale centres of population concentration. However, it does not imply that the newest towns classified under this type are entirely unsuccessful. In 2008–2009, the European Union's regional development sources became available in larger quantities,

which helped some towns to improve their spatial position by investing in renewing public institutions and infrastructure and creating a more urban character (Vaishar, A. *et al.* 2015; Horeczki, R. and Egyed, I. 2021). Although these investments were typically insufficient to prevent the towns from shrinking, they did help to stabilise their positions in terms of public services and other tertiary functions. Moreover, these newest towns are the most resilient elements of the rural landscape and can sustain most of the social structures and urban functions, while the surrounding villages are depopulating and becoming isolated, resembling urban mesas in the eroding rural wasteland (Máté, É. 2017; Alpek, B.L. *et al.* 2022).

The urbanisation of the new spatial polarisation

Restitution based on past development and small rural centres also represents a concept of 20th-century urbanisation. The political transformation coincided with globalisation, which fundamentally transformed the framework and possibilities of urbanisation, too. Authors sometimes defined it as a new stage of the urbanisation cycle (Enyedi, Gy. 2011) and emphasised the dominance of the global processes and globalised core-periphery relations over the post-socialist roots (Nagy, E. 2005; Nagy, G. *et al.* 2012), furthermore, interpreted these processes based on the theory of uneven development (Timár, J. and Váradi, M.M. 2001; Smith, A. and Timár, J. 2010).

The primary and most spectacular process has been the relative deconcentration of the population around the major cities. *Suburbanisation created new types of urban spaces including the newest towns.* Suburbanisation in the ECE countries did not begin after the political transformation but was somewhat constrained and suppressed during the decades of socialism. As a result, a 'suburban revolution' (Stanilov, K. and Sýkora, L. 2014) emerged after 1990 and was powerful enough to create numerous suburban places, leading to the reclassification of some of the newly emerged places – which was only an exceptional phenomenon before 1989.

Like the industrial towns of the 1950s and 60s, suburban types are the most typical elements of the post-socialist era. The population growth resulting from the migration is extreme, at least on the ECE scale. Among the newest towns, for example, Veresegyház in Budapest agglomeration has grown from 6,300 (in 1990) to 20,600 (2021); Gyömrő from 11,500 to 20,500; Halásztelek from 6,200 to 12,000. Králův Dvůr (in the vicinity of Prague) from 5,600 to 10,000; Siechnice (next to Wróclaw) from 4,000 (2002) to 10,000 (2021); Popești-Leordeni (Bucharest-South) from 15,000 (2002) to 53,000 (2021). Despite the advance of formal urbanisation and rapid population growth, some settlements have resisted reclassification or have not gained the central government's support; therefore, the largest villages[10] in the study area are primarily over 10,000 inhabitants and dominantly belong to the suburban type. A striking example is Florești (Cluj-Napoca agglomeration), with its population of over 50,000 and a poorly managed mix of urban and rural characteristics.

Although suburban-type newest towns appear in every researched country, in Hungary and Romania are considered the most typical countries for this type of formal urbanisation. This is not necessarily an indication of the intensity of suburbanisation itself in these countries but instead reflects the structure of their suburban space and also their national practices of formal urbanisation. For example, the number of suburban newest towns can also depend on previous reclassification, as only a few settlements in Hungary and Romania had town status before 1990. Additionally, there are well-studied cases where suburbanisation occurs within the city limits and does

[10] Florești in Romania – 52,735 (2021), Kozy in Poland – 13,024 (2017), Solymár in Hungary – 10,951 (2022), Smižany in Slovakia – 8,838 (2021), Bystřice in Czechia – 5,291 habitants (2023).

not result in suburban towns (Kubeš, J. and Nováček, A. 2019; Szmytkie, R. 2021; Vasárus, G.L. and Lennert, J. 2022). It is important to note that suburban areas are not limited to the capitals but can also be found in less complex agglomerations around second-tier cities, such as Świątniki Górne next to Kraków, Modřice South of Brno, or Kozármisleny next to Pécs.

Several of the latest suburban towns have relatively diminutive, traditional rural cores, with the former villages nearly vanishing into the vast expanse of new residential areas. Conversely, some towns possessed or still possess small urban centres before their suburbanisation growth. Although these communities experience growth, success and affluence theoretically, they often encounter difficulties rectifying their unbalanced development, addressing environmental issues (Kovács, Z. *et al.* 2020), enhancing their infrastructural capabilities, and improving their urban functions.

The second typical form of the urbanisation of the new polarisation involves the development of recreational functions. *Recreation and tourism* have had a complex role in urbanisation, as tourist attractions and recreational opportunities in rural areas can drive economic growth and create employment (Leśniewska-Napierała, K. and Napierała, T. 2017). This can help make tourism-affected communities more resilient to demographic decline. However, this does not necessarily mean that these holiday resorts become the subject of intense population concentration due to rural-to-urban migration. Property prices in these towns are often high, indicating a permanent demand from urban residents. The trend typically begins with summer or second homes (Hoogendoorn, G. and Visser, J. 2010; Leetmaa, K. *et al.* 2012), followed by permanent migration (Makowska-Iskierka, M. 2015) and gentrification of these towns (Donaldson, R. 2009). However, the incoming population is usually much older than the traditional demographic composition. This type of urbanisation, which places the focus on the well-being of citizens, seems to be an emerging trend in overall small-town development (Ježek, J. 2011; Kwiatek-Sołtys, A. and Mainet, H. 2014; Fertner, C. *et al.* 2015; Majewska, A. *et al.* 2022). The relative population growth might have been quick after the transition, but these towns are still small (Harkány with a population of 5,060; and Zalakaros 2,234 in Hungary, Krynica Morska 1,183 in Poland; Geoagiu 5,000 in Romania; Lázně Toušeň 1,400 in Czechia) – partly, because larger spa towns gained urban rank before 1990, especially in Czechia.

Spa towns are great examples of in situ urbanisation from three different perspectives. Firstly, tourists and seasonal residents demand services not usually available in smaller settlements, such as middle-sized supermarkets, specialised health and beauty services, real estate agencies, and better transport accessibility. Even though these services may be driven by seasonal demand, they are also available in the winter and serve permanent residents. Secondly, local governments invest in physical upgrades to improve the appearance of towns and create new public spaces and parks, which are visible signs of urbanisation or the desired urban image. Thirdly, the involvement of local citizens in the tourism industry as employees or entrepreneurs accelerates the spread of urban habits and lifestyles, leading to improvements in the private built environment, language skills, business experiences, and personal contacts with foreigners. Spa towns used to be pioneers of the private economy during the socialist era and have remained outposts of urbanisation in rural areas even after the transition.

The reindustrialisation of the region characterizes the third sub-type. This process of spatial restructuring has been a significant part of the region's economic transformation (Gorzelak, G. 1996), resulting in the emergence of new types of core-periphery relations (Pavlínek, P. 2004; Pénzes, J. 2013). During the reindustrialisation

process that began in the mid-1990s, some places emerged as winners of this structural change. While the tertiary sector dominates significant cities, *these newest towns gained new functions as industrial hubs* (Nagy, Cs. *et al.* 2020), and a few even have become part of the most industrialised settlements. The sudden increase in economic activity and employment, therefore increased tax revenues, accompanied by essential infrastructure development, has brought rapid and specific modernisation to these places. There is a significant overlap between the suburban newest towns and the industrial ones, with many of the suburban towns becoming economic centres, primarily in transport and logistics, sometimes in the assembly industry. A notable example is the town of Göd, Northeast of Budapest, which gained town rank in 1999 and currently hosts one of the largest plants in Hungary's rapidly expanding EV battery industry.

Location, i.e., proximity to large cities or dynamic economic regions and access to the highway network and/or regional airports, is a significant factor contributing to this development type's success. In Hungary, examples of such successful types include Újhartyán and Jánossomorja; in Romania, Ghimbav (near Brașov) and Tăuții-Măgherăuș (near Baie Mare); and in Poland, Rzgów (near Łódz). Additionally, smaller-scale examples like Nesvady (near Nitra) in Slovakia demonstrate this type's effectiveness. Apart from location, successfully mobilising local resources and endogenous social capital has also played a crucial role in the economic development of specific areas, such as Bóly in South-Western Hungary (Horeczki, R. 2014).

Industrial newest towns experience a gradual increase in population and undergo changes in the labour market. In the past, residents used to commute to larger cities for industrial jobs, but now, these towns attract not only commuters but also temporary residents. As a result, these towns face the challenge of integrating newcomers into their closed society shortly. This issue is not limited to people from different regions but also from distant countries since the domestic labour market is fully utilised due to well-known demographic trends.

Discussion

This paper attempts to analyse formal urbanisation as an integral component of post-socialist urbanisation. By highlighting certain aspects of pre-1989 development, we argue that formal urbanisation has deep roots in the region's history. Due to a delayed economic and social progression and a semi-peripheral position in Europe, modernisation has been (and may still be) imperative for the countries between the Baltic and the Black Sea. Historical events have interrupted and slowed urbanisation, and in some cases (in Poland), it even reversed. Central governments have used formal urbanisation as a tool to regulate and fine-tune spatial processes in their efforts to modernise[11]. The process of socialist urbanisation was both overdue and forced, and these characteristics are reflected in formal urbanisation as well. In some cases, particularly in Hungary, formal urbanisation was *a subsequent development,* where awarding the urban rank was a late recognition of urban development. In the post-socialist period, this appeared in the form of the restitutional type. However, in the socialist era, *concurrent* and *pre-emptive* approaches also appeared, and they were fulfilled in the post-socialist decades. The concurrent formal urbanisation closely follows the trends

[11] The semi-peripheral nature of formal urbanisation is confirmed by the fact that trends in Portugal are very similar to those in Romania and Hungary. Portugal, which is easily comparable in size and development to Hungary, has 581 municipalities with urban status, of which nearly 300 were granted the rank after accession to the EC, while until then the process was relatively modest. The Portuguese urban reclassification legislation is also very similar to the practice in the countries investigated in that it includes the freedom of the final decision-maker and the possibility of flexible interpretation and exceptions.

of general urbanisation, which involves population, economic growth, and societal transformation. The types connected with the new spatial polarisation could be interpreted as recognising current processes among the post-socialist models. In this case, gaining the town rank is both a recognition of recent development and a designation of the further path. Pre-emptive action spans the period before and after the changes of 1990, and in both eras, it is seen by the governments as an opportunity for development. Before 1990, it meant a spatial focus for domestic socialist development objectives, while after the changes of 1990, it has opened the way for channelling EU funds, mainly in Romania and Hungary.

From a central perspective, both subsequent and concurrent formal urbanisation represent minimal interventions in spatial development, as they only serve to reinforce and recognise existing processes. However, political choices regarding selecting potential new towns can be instrumental in influencing the central government's approach to urbanisation. This involves deciding which communities should be promoted and supported and which should not. The practice in Eastern Europe shows that even if there are strong professional governmental ideas about the role and importance of urbanisation, these are often overridden by current political processes, which makes it very difficult for the researcher to explore the essence of urbanisation policies.

Pre-emptive formal urbanisation paves the way for a more substantial intervention in spatial development. It was a common practice in the era of socialist new towns and has recently been found useful as a tool for development, too. In this case, the *newly acquired status itself should create urbanity.* Promoting rural communities with limited central functions does not recognise successful development but rather the lack of it. *It does not simply support overall urbanisation, but sometimes the formal changes are the only visible signs of it.*

The creation of the newest towns, even if it is unofficially suspended in Hungary, cannot come to an end and perhaps remains part of political discussion in the future, too. Besides the antagonistic interests of the stakeholders involved in the process, it is also a theoretical issue, which makes socialist and post-socialist formal urbanisation different. During the decades of socialist urbanisation, there was a significant and explicit difference between urban and rural spaces. The post-socialist transformation resulted in *deconcentration of the urbanity* in all aspects, significantly washing out sharp differences, and smoothing the once definite step between urban and rural spaces into a gentle slope.

Formal urbanisation has a connection with the urban deconcentration process through suburbanisation and peri-urbanisation. The polycentric development of post-suburban spaces, including emerging edge cities, is part of the suburbanisation process (Szabó, T. *et al.* 2014; Kovács, Z. *et al*. 2019). As Kubeš and Ouředníček highlighted, suburbs in ECE countries usually have a mixed character and could be described as "village-core suburbs" (Kubeš, J. and Ouředníček, M. 2022). In these places, formal urbanisation speeds up certain places' transformation into semi-suburban or suburban small towns. Formal urbanisation also leads to the formation of peri-urban spaces, which Follmann interprets as a transitional category or rural-urban transition zone (Follmann, A. 2022). Although these newly urbanised towns may not be able to concentrate enough population to avoid their shrinking, they are *catalysts of the social transformation of rural spaces* (Halamska, M. and Stanny, M. 2021; Heffner, K. and Twardzik, M. 2022), and they spread the urban habitus (Jóvér, V. 2023).

When we evaluate formal urbanisation as a *spatial development tool,* we can observe that it has become a less effective intervention. Formal urbanisation played a crucial role in counterbalancing the overall decline of towns during the transition period and was responsible for the significant growth of the urban population, particularly in Hungary and

Romania. Earlier implementations of formal urbanisation also helped to slow down the outmigration from small towns and perhaps contributed to reducing the concentration of population in major urban regions, although it is challenging to prove this hypothesis. Upon reflecting on the uncertain effects on regional development, it is necessary to reconsider two further factors when seeking the true meaning of formal urbanisation.

Firstly, from the perspective of central governments, formal urbanisation may not be considered a powerful, but rather *a cost-effective tool in regional policy*. Upgrading villages to towns does not usually impose a significant financial burden on them (Karsai, V. and Trócsányi, A. 2019). It is important to note that formal urbanisation, in normal circumstances, could serve as a tool for spatial development. Still, it should not be relied upon as the sole solution, as it happened in some instances.

Secondly, formal urbanisation has been *a significant field of local initiatives*, even during the era of centralisation, beyond the goals and possibilities of central governments. After 1990, formal urbanisation accelerated significantly because local governments were provided more political freedom. This interpretation suggests that formal urbanisation is a bottom-up process, and the right question to ask is not 'Why does the country need more and more towns?' but 'Why do local communities initiate an often-unsuccessful process of assessing their development at a national level through the urban reclassification process?' As governments shifted their attitudes from subsequent to concurrent and pre-emptive urbanisation, the role of local communities also changed from passive to active and later to proactive approaches.

Our preliminary research shows that local communities do not always see a significant net financial gain after promotional efforts. While individual political ambitions may sometimes be a factor, the popularity of achieving town rank suggests more profound influences at play. It is possible that collective memories from the socialist era, when town rank could impact its finances and development, as well as historical experiences with proximity to power, may contribute to these attitudes. Achieving town rank places communities on the map, secures them a seat at the table with government representatives, and opens up new avenues for public investment. By maintaining close ties with the central government, these communities in East-Central Europe can increase their resilience.

Conclusions

Urbanisation in East-Central Europe was once delayed, resulting in a less urbanised spatial structure and society than Western Europe's benchmarks. This relative lack of urban centres is linked to overall weaknesses in spatial development, which persisted throughout the 20th and 21st centuries. The artificial acceleration of urbanisation was a tool used in central planning and spatial policies during both the socialist and post-socialist eras. Formal urbanisation, which involves the reclassification of settlements and their promotion to towns, can be interpreted as a kind of in situ urbanisation that leads to an increase in the urban population without migration or natural growth. Although not exclusively, this phenomenon is typically seen in East-Central Europe and carries some anachronism. During the planned economies era, formal urbanisation was strictly controlled by the state and was mostly limited to the rise of socialist new towns in most countries. After the transformation of 1989/1990, formal urbanisation was liberalised and gained a different focus, creating many more newest towns than expected.

Formal urbanisation became the primary driving factor of urban population growth in Romania and Hungary due to a decrease in overall population or a slow increase in other countries, as well as the emergence of suburbanisation, which caused larger cities to decline. In the five studied countries, over 2.87 million people and 800 settlements

were involved in this process, resulting in a 30 percent increase in the number of urban settlements. This means formal urbanisation has had an even more significant impact on the region than during the socialist era, leaving a lasting mark.

Our research has discovered several common factors in the reclassification process, such as local initiatives, disparities between principles and practices, and varying levels of control from regional and national actors. Furthermore, we have identified characteristic types of formal urbanisation through qualitative analysis of motives, goals, and parameters. These types reflect different stages and challenges of urbanisation in the region. We believe promoting so-called restitutional towns, heritage, or image towns is a post-fact correction of the former urbanisation process. This is because many of the newest towns are historically determined. In the second type of delayed modernisation, reclassification tries to extend and complete the efforts of spatial policies of the planning economy based on the development of central places. Finally, new spatial polarisation is evident in formal urbanisation through the reclassification of certain places that are increasingly connected to new economic structures.

In recent times, there has been a shift in the approach towards formal urbanisation. Previously, the central government regulated and controlled it as part of the overall spatial policy. However, now, it is more locally governed and tends to precede or replace direct spatial policy. Although the effectiveness of the entire formal urbanisation process can be debated, its significance is more prominent at the local than at the national level.

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On intra-urban differences in the destinations of emigrants from the Municipality of Malaga (Spain): An approximation based on the municipal register of inhabitants

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Abstract

Emigrants who left the Municipality of Malaga in the 2017–2021 period went to multiple destinations, mostly municipalities located in the province of Malaga itself, more specifically in its metropolitan area. Average housing prices in these metropolitan municipalities are highly variable, and, in this context, it is reasonable to assume that there will be a relationship between the income levels of emigrants and their destination. Based on a special processing of the Municipal Register of Inhabitants of the Municipality of Malaga, we show how a relationship can effectively be found between the average household income (AHI) of the census tract of origin of the emigrants and the average price of housing in the destination municipality, both for the whole group of emigrants and for selected age groups – children and young adults. A relationship that points to an overrepresentation of municipalities with high housing prices in the sections with the highest income, and vice versa.

Keywords: residential migration, municipal register of inhabitants, average household income, Municipality of Malaga

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Introduction

Residential migration processes, defined as changes in residence within the same metropolitan area that do not involve a modification of individuals' living spaces (Bayona-i-Carrasco, J. and Pujadas-i-Rúbies, I. 2014), have been the subject of numerous studies applied to the Spanish context. Most of these studies (Susino, J. and Duque-Calvache, R. 2013; De Oliveira Neves, G. *et al.* 2019; Bayona-i-Carrasco, J. and Pujadas-i-Rúbies, I. 2020; Torrado, J.M. *et al.* 2021) analyse municipalities as the unit of analysis, using the statistics of residential variations and/or population censuses as primary sources. The impact of the crisis on these movements has also been examined by Pozo Rivera, E. and Rodríguez Moya, J.M. (2018) for the case of Madrid, as well as intra-metropolitan migrations among specific population groups, such as the foreign population in Madrid and Barcelona (Bayona-i-Carrasco, J. *et al.* 2013; Thiers-Quintana, J. and Gil Alonso, F. 2020).

Previous research treats the municipalities of origin of emigrants as a homogeneous entity, failing to identify areas (sets of census tracts or other sub-municipal spatial units) within them, delimited by the municipality mostly chosen by emigrants leaving those areas. In this sense, it is generally agreed that emigration from major Spanish urban centres is largely driven by dissatisfaction with current housing or the need to acquire housing, issues that, in many cases, can only be ad-

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dressed by moving to peripheral municipalities. Indeed, referring to the early 21st century situation, Nel-Lo, O. (2004) stated that the significant differences in housing prices between the cores of metropolitan areas (including Malaga) and their peripheries were fundamental to explaining centre-periphery migration, along with accessibility, which ultimately also influences housing prices.

On the other hand, income largely determines the type and location of housing that can be accessed. In the Spanish context, within a free-market framework with limited policies addressing socio-residential disparities, access to housing is highly unequal among different social groups. As indicated by Andújar Llosa, A. *et al.* (2015), the characteristics of the housing that the population can afford and its suitability for household needs are closely related to available resources and the household's position in the social structure. The existing residential stock in the municipalities forming Spanish metropolitan areas is diverse in terms of characteristics and quality, leading to segmented offerings. Therefore, we can argue that the purchasing or rental capacity of the migrant determines their destination municipality based on the average housing price in that municipality. Duque-Calvache, R. *et al.* (2017) further suggest that when there is a greater range of available housing in the metropolitan periphery, mobility diversifies. This diversity can be understood through different average housing prices, which are not homogeneous among metropolitan municipalities. Given that income is also not uniformly distributed within central municipalities, it is reasonable to assume a relationship between household income level and destination municipality. This reality should have spatial representation at the census tract level.

In Spain, the available body of knowledge regarding the relationship between income and the destination of emigrants from large urban centers is very limited. Contributions in this direction include those of Bayona-i-Carrasco, J. and Pujadas-i-Rúbies, I. (2010), who use microdata from the Municipal Register of Inhabitants of Barcelona, and Salom-Carrasco, J. (2018), who uses microdata on residential variations obtained from the Valencia City Council. The originality of our research lies in intending to relate the average household income (AHI) by census tract that left the Municipality of Malaga and the destination municipality of that emigration, grouped according to the average price per m^2 of housing for purchase.

Specifically, our objective is to relate the AHI levels of census tracts from which emigrants left the Municipality of Malaga in the period 2017–2021 to the major destination municipalities, grouped according to the price per m^2 of existing housing.

Located in the south of Spain, in the Autonomous Community of Andalusia, the Municipality of Malaga is the one with the largest population in the province of the same name (578,061 inhabitants in 2021), and is among the 10 with the largest population in Spain *(Figure 1).* It is, furthermore, the nucleus of one of the most dynamic metropolitan areas in the country, and presents certain particularities: it coincides with the presence of a municipality greater than 500,000 inhabitants – Malaga, object of our study –, which acts as a metropolitan nucleus, together to a set of cities that should be considered average, developed under the shelter of tourist activity and that today make up a continuum built in the western coastal portion of the province: the Costa del Sol. This issue is important, since, although in They are currently part of the Malaga metropolitan area (Feria Toribio, J.M. 2015), part of their dynamism is due to tourism, not metropolitan overflow.

As indicated by Gil Alonso, F. and Bayona-i-carrasco, J. (2012), Malaga was in the group of urban areas that were systematically experiencing, since the end of the last century, greater population increases in their peripheries than in their centres, increasing the rate of population increase in the latter in the first decade of this century. As a consequence of this, the turn of the century would find this space in the phase of absolute de-concentration – following the well-



Fig. 1. Location of the study area. *Source*: Authors' own elaboration on Google Maps images.

known model of Hall, P. (1984) –, according to Nel-Lo, O. (2004), which meant the overflow of the metropolitan fact beyond from the Municipality of Malaga to those closest to it, towards the Guadalhorce Valley (municipalities of Alhaurín de la Torre or Cártama, in which this process of residential de-concentration has been especially relevant). The large increases in the population of these metropolitan municipalities occurred in short intervals of time, hand in hand with a continuous increase in the urbanized area dedicated to residential use, which has progressively spread to municipalities further away from the metropolitan core.

As we have just indicated, the overflow of the residential function has taken place in the valley of the Guadalhorce river, municipalities of Alhaurín de la Torre, Cártama, Alhaurín el Grande and Coín at first (decade of the 1980s), continuing later on Álora, Pizarra, Almogía and Casabermeja, progressively further north and away from the Municipality of Malaga. And it will be from the end of the 1990s, with the improvement of communications, when the eastern municipalities of Rincón de la Victoria, and, to a lesser extent, Vélez Malaga, join this dynamic. Currently (2021), the population of these municipalities is disparate, ranging between 82,971 inhabitants in Vélez Malaga and 3,738 in Casabermeja. The number of those registered in the western municipalities is also uneven, among which Marbella is the largest (149,031 residents) and Torremolinos, with 67,878, the one with the smallest population. Let us remember that these western municipalities owe their dynamism to tourist activity – hence their comparatively high population volumes – but, like those

located in the Guadalhorce Valley, they are a place of reception for emigrants from the Municipality of Malaga and are functionally linked to it.

Sources and methodology

In the Spanish context, the main sources commonly used to obtain information about migratory movements are two: the statistics of residential variations and population censuses. The former contains information on migratory movements at the municipal level, available for an extensive period. The latter allows obtaining the same information from a set of questions, grouped into two categories in the latest population census (2021) under the headings: "places of residence" and "years of arrival and places of origin", but the information about the municipality of destination is rather scarce (the concrete destination is not available) and not useful in our context.

A third source that can be used for migratory studies is the municipal register of inhabitants; it is a counting source, so there are no sample problems, and the first hand accessible information allows us to know, at the level of census tract, the relationship between place of birth and residence. The utility of all these sources is considerable, and a detailed description of their advantages and disadvantages applied to migratory studies can be found in Palomares-Linares, I. *et al.* (2017). However, these sources cannot reveal the specific census tract of origin and the destination municipality of emigrants (statistical confidentiality affects the aforementioned sources) unless special processing is requested from those administrations or bodies that have that information.

In our case, we have had special processing of the municipal registers of inhabitants from 2017 to 2021 requested from the city of Malaga; from this, we have obtained residential departures and arrivals at the scale of urban census tract, and the municipalities – and, where applicable, countries – to which departures were directed. With this information, combined with population volumes obtained from the continuous register statistics, it is possible to know the migratory balances and migration rates of each tract, identifying differences between census tracts regarding the destination municipalities of their emigrants. An issue of some importance is related to the confinement that the Spanish population suffered between March and June 2020, which, as has been revealed in other areas of the province of Malaga (Larrubia-Vargas, R. *et al.* 2023), influenced residential mobility patterns. However, in our case the influence is subsumed in the study period itself, five years from 2017. In this sense, it is possible to assume that the migrations that were interrupted by confinement took place in the years immediately following, so in any case, are included in the time frame of our research.

To complement all this, we have also used the AHI at the urban census tract level, from the Household Income Atlas (INE, 2022a), for the year 2020, the latest available at the time of writing these paragraphs.

As we will see later, another variable that we have used in our research is the price of housing in the destination municipalities of the emigrants. We have two options: rental price and purchase price. For the first option, we have information derived from the rental price index, prepared by the Ministry of Housing and Urban Agenda (Ministerio de Vivienda y Agenda Urbana, 2024). However, the fact that it does not offer information on some of the municipalities under study has led us to reject it. On the other hand, it is convenient to indicate that the option of purchasing a habitual residence is more profitable in the long term than renting (Domínguez Martínez, J.M. and López del Paso, R. 2006), while, for young people, renting does not represent a great advantage over property (Echaves García, A. 2017). So, the second option, the sale price of the home in the destination municipalities, seems appropriate. We have obtained the information from the housing price report prepared by the website "Idealista", and accessible, at a municipal level, on its website, and their

methodology for obtaining prices can be consulted at https://bitly.ws/3aLIo. In any case, we must indicate that the values are average prices, that is, the source does not differentiate between prices according to the type of housing, location, or state of conservation: characteristics that are highly variable not only between the different municipalities, but also inside these. However, despite all this, we believe that its use has more advantages than disadvantages.

Finally, we will note that the statistical treatment to which we have subjected the information has been straightforward but consistent and, in our understanding, sufficient for the purpose of our research. We have calculated emigration and immigration rates, used the Pearson correlation coefficient, and the location quotient (LQ), the latter with the aim of identifying the "specialization" of Malaga census tracts according to the destination municipality of their emigrants.

Results

Emigration and immigration rates and migratory balances

In the 2017–2021 five-year period, a total of 94,311 residential arrivals and 74,929 departures were recorded in the Municipality of Malaga, resulting in a positive migratory balance of 19,382. In this general context, the values corresponding to different census tracts were highly disparate. Referring to the migratory balance, in the negative spectrum, they oscillated between -64 and -1 for the entire period, while in the positive spectrum, they ranged from 1 to 401. However, as depicted in *Figure 2*, most census tracts experienced positive balances. The spatial distribution of those that did not forms a discontinuous border starting from the eastern end of the municipality and, after affecting a set of non-contiguous tracts not bordering the coastline – roughly around Miraflores del Palo – undergoes significant development north of the city centre and on both banks of the Guadalmedina river (*Figure 3* highlights the landmarks mentioned in the text). The border continues through those outlined in the neighbourhoods at the western end of the Bailén Miraflores district, and from here, it extends mostly through sparsely populated areas in the west of the capital, except for a set of small census tracts in the western area of the built fabric around the Puerta Blanca neighbourhood.

There was also a significant variability in the figures corresponding to emigration and immigration rates; therefore, and to facilitate readability, we have grouped the census tracts into two categories: those with values lower than those of the municipality, and those with higher values. The spatial distributions of both are presented in figures 4 and 5, respectively. The basic characteristics of those corresponding to areas with higher emigration rates, than the municipality *(Figure 4)* are relatively straightforward: they are distributed almost continuously along the east and west coastlines, with a greater penetration towards the interior in the former.

Additionally, there is a compact cluster of neighbourhoods encompassing the central and northern pericentral areas, including neighbourhoods such as La Victoria, El Ejido, and Capuchinos, all east of the Guadalmedina river. On the opposite bank, this cluster continues, composed of neighbourhoods articulated by three major communication axes: from north to south, Martínez Maldonado/Carlos de Haya Avenue, Andalucía Avenue, and Heroes de Sostoa Street. As we move westward, its spatial continuity progressively dissolves, with the approximate western limit being the current Juan XXIII Avenue. It is, therefore, a cluster of neighbourhoods that encompasses the bulk of the expansion of the Malaga urban fabric to the west, which took place mainly during the 1950s and 1960s, in which both private and public initiatives played a fundamental role; this built fabric is supplemented by a series of self-sufficient neighbourhoods in the interior areas of this conglomerate. On the other hand, the spatial

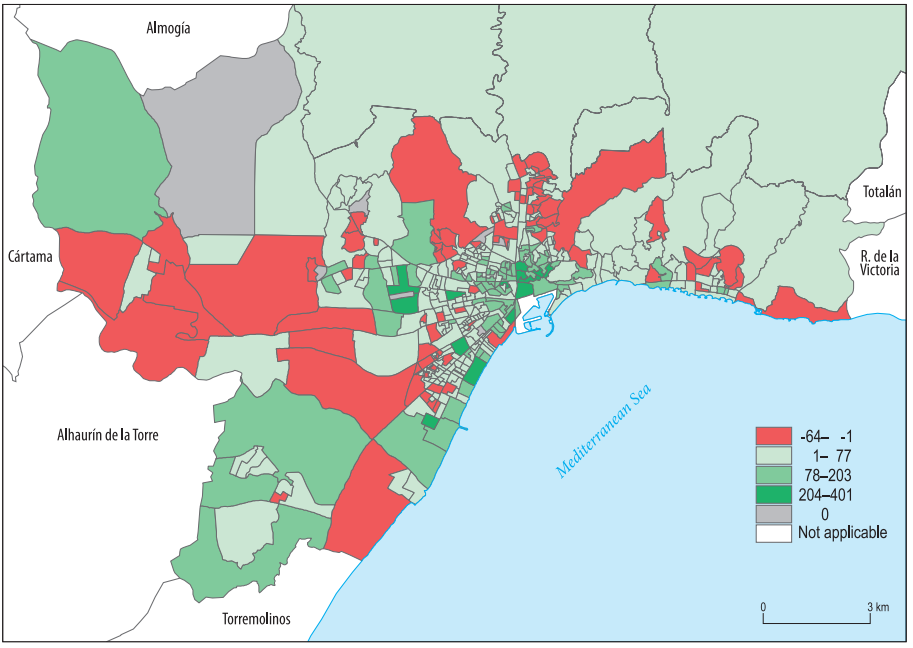


Fig. 2. Migration balances of census tracts for the Municipality of Malaga, 2017–2021. *Source*: Authors' own elaboration on the municipal population registers, 2017–2021.

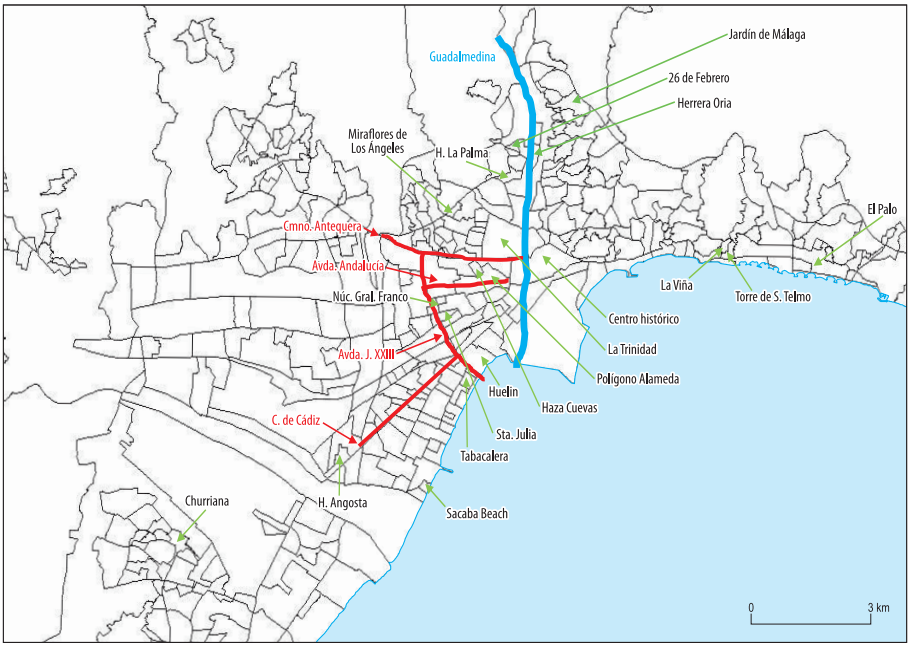


Fig. 3. Location of landmarks mentioned in the text. *Source*: Authors' own elaboration.

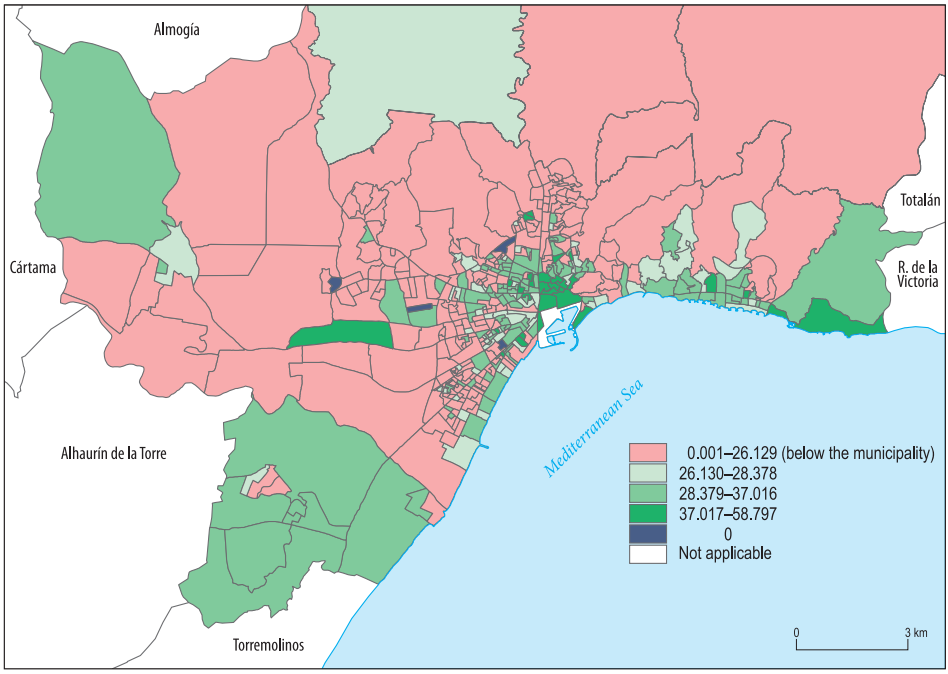


Fig. 4. Emigration rates in the Municipality of Malaga for the period 2017–2021 (emigrants per one million person). *Source:* Authors' own elaboration on the municipal population registers, 2017–2021.

distribution of neighbourhoods with immigration rates higher than those of the municipal aggregate (184 in total) is very similar to the former, with only detailed differences, such as greater fragmentation on the eastern coastal strip or greater continuity in the western strip, reflecting the new real estate developments located there *(Figure 5).*

The spatial distributions of both rates being similar would indicate the most dynamic areas of the municipality concerning migratory movements. Census tracts where comparatively high values of departures are combined with similarly high values of arrivals; a comparison with the migration balance map (see *Figure 1*) shows that the result is positive balances, albeit meagerly positive. The sections with the highest balances are located along the Antonio Banderas Promenade – the site of significant real estate developments in recent years – or the neighbourhoods adjacent to the centre in its northern portion, which experienced an increase in the number of dwellings within the context of the so-called Special Plan for Protection and Interior Reform of the Centre. However, even in these cases, the maximum value of the migration balance is 401 people over 5 years.

Destinations of emigrants

Having established this general framework, it is time to investigate the destinations of emigrants from Malaga in the period 2017–2021. *Table 1* displays them, grouped into broad categories. It can be observed that over half of the departures had the province of Malaga as their destination, specifically 53.12 percent. The rest of Spain absorbed 26.95 percent of the movements (primarily directed to Madrid, with 5,504 movements), followed at a distance by those directed to the rest of Andalusia (12.76%), and foreign destinations, constituting the remaining 7.17 percent.

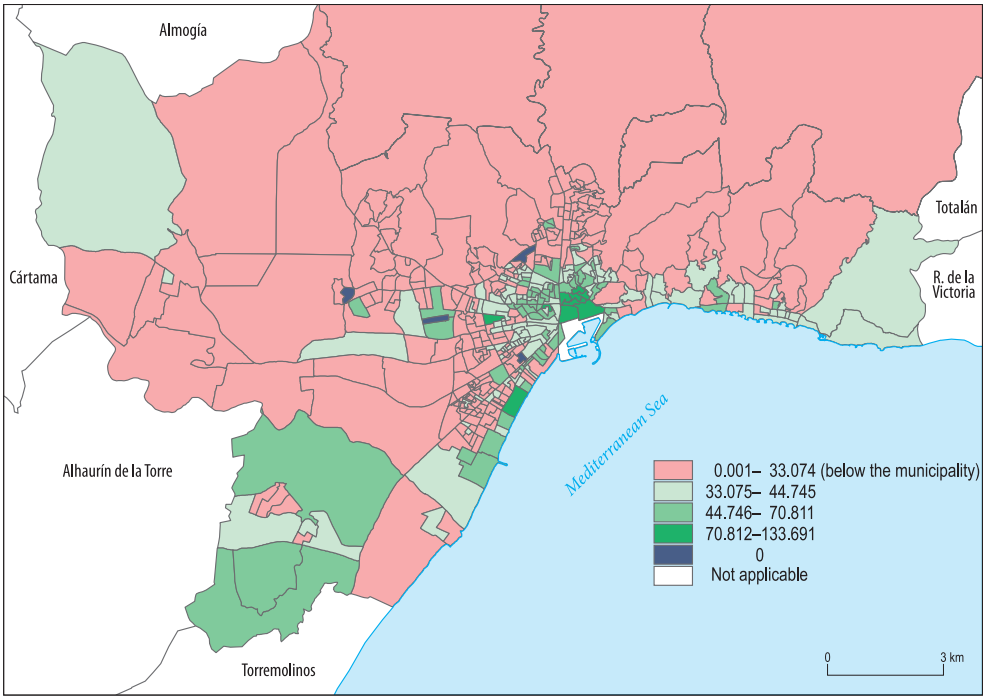


Fig. 5. Immigration rates in the Municipality of Malaga for the period 2017–2021 (immigrants per one million person). *Source*: Authors' own elaboration on the municipal population registers, 2017–2021.

*Table 1. Volume and destination of emigrants**

Indicator	Malaga	Rest of Andalusia	Rest of Spain	Foreign	*Total*
Numbers	39,799	9,564	20,197	5,369	*74,929*
Proportion, %	53.12	12.76	26.95	7.17	*100.00*

*Absolute values and percentages for period 2017–2021. *Source:* Municipal population registers, 2017–2021.

Once we have established that the province of Malaga was the primary destination, in order to identify the specific municipalities to which emigrants predominantly headed, we first calculated the percentage of the total each municipality has accommodated. While nearly all municipalities in Malaga have been a destination for some emigrants from the capital, significant differences in numbers exist. For instance, 7,425 individuals, constituting 18.65 percent of the total, migrated to Rincón de la Victoria, contrasting with minimal figures such as 2 for Genalguacil, or 4 for Benalauría. Therefore, we have focused solely on those municipalities to which at least 1 percent of the total emigrants recorded between 2017 and 2021 have headed towards the province, and their list is provided in *Table 2*.

As evident in *Table 2*, 16 out of the 101 municipalities comprising the province were the destination for more than four out of five emigrants from the city of Malaga (specifically 85.74%), indicating a concentration in this flow. Given the size of the destination

Table 2. Number of emigrants from the Municipality of Malaga by destination municipality, and percentage of the total emigrants for the period 2017–2021

Municipality	Numbers	%	Municipality	Numbers	%
Alhaurín de la Torre	3,946	9.91	Fuengirola	1,488	3.74
Alhaurín el Grande	901	2.26	Marbella	1,389	3.49
Almogía	458	1.15	Mijas	1,778	4.47
Álora	453	1.14	Pizarra	623	1.57
Benalmádena	3,315	8.33	Rincón de la Victoria	7,425	18.66
Cártama	3,497	8.79	Vélez Malaga	2,747	6.90
Casabermeja	479	1.20	Torremolinos	4,322	10.86
Coín	672	1.69	*Total*	*34,124*	*85.74*
Estepona	631	1.59			

Source: Municipal population registers, 2017–2021.

municipalities, and their affiliation with the Malaga metropolitan area, these migratory movements cannot be considered as urban-rural migration in the sense described by Rivera Escribano, M.J. (2007) for movements detected from Pamplona (Autonomous Community of Navarre) to small settlements. Instead, they are part of a population relocation process within an extensive urban area. This concentration is indicative of residential migration, as the list of municipalities is included in those that, according to Feria Toribio, J.M. (2015), are part of the Malaga-Marbella Metropolitan Area. Studies on daily mobility based on mobile phone data (INE, 2022b) highlight the significant flows directed from these municipalities to specific mobility areas in the capital and its surroundings, where a substantial number of job opportunities are concentrated. Therefore, this is indeed a residential mobility that, while changing the individual's actual residence, does not necessarily imply a change in their workplace or even consumption patterns.

Nevertheless, it is also apparent that the attractiveness is not uniform across all municipalities. Rincón de la Victoria attracted nearly 1 in 5 emigrants, while, at the other extreme, Álora only attracted 1.14 percent, which still amounts to 453 movements.

On another note, housing prices in these municipalities are far from homogeneous. On average, prices in, for example, Marbella are higher than those in Almogía. In this regard, there is no doubt that a critical variable regarding access to housing is the household income. Income facilitates both initial access to housing – whether through purchase or rental – and the maintenance of it – in rental or mortgage situations. Additionally, income enables a change of residence if the current housing does not meet the household's needs or expectations, or if they have had to leave it due to a forced situation – such as non-renewal of the lease or an inability to meet mortgage payments, etc.

Therefore, it is appropriate to correlate the AHI of the census tract from which the urban emigrants originated *(Figure 6)* with the price (in EUR per m^2) of housing for sale in the destination municipality, considering only the 16 municipalities listed in *Table 2*. This price per m^2 was obtained from the website "Idealista" (2023), representing averages of housing costs per m^2 for sale. While corresponding rental prices for all relevant municipalities are not available, at least for the period 2001–2011, 85 percent of the population moving towards the Malaga–Marbella Metropolitan Area chose homeownership, whether fully paid or with a mortgage (Duque-Calvache, R. 2015). These departures were also driven by individuals from the lower-middle social class who sold their homes in the capital and, with the capital gains obtained, acquired property on the outskirts (Montosa Muñoz, J.C. 2012). The values are presented in *Table 3*, with the corresponding data for the Municipality of Malaga included for comparison.

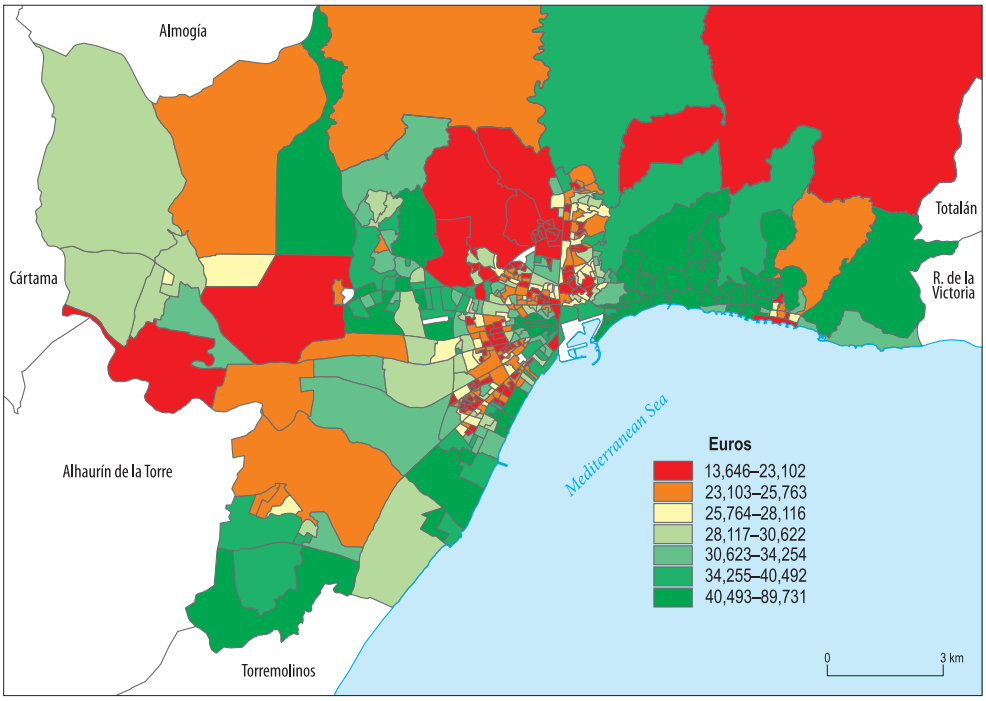


Fig. 6. Average household income in the Municipality of Malaga, 2020. *Source:* Authors' own elaboration on database of INE, 2022.

Table 3. Average price per m² of housing for sale, 2023

Municipality	Price, EUR per m²	Municipality	Price, EUR per m²
Alhaurín de la Torre	1,905	Fuengirola	2,892
Alhaurín el Grande	1,449	Marbella	4,121
Almogía	1,022	Mijas	2,440
Álora	1,044	Pizarra	1,076
Benalmádena	2,673	Rincón de la Victoria	2,179
Cártama	1,661	Vélez Málaga	2,291
Casabermeja	1,330	Torremolinos	2,499
Coín	1,533	Malaga capital	2,365
Estepona	2,944		

Source: Idealista, 2023.

Based on these values, we have categorized the municipalities into four groups according to price range: from 1,000 to 1,500 EUR per m² (Almogía, Álora, Casabermeja, and Pizarra), from 1,500 to 2,000 EUR per m² (Alhaurín de la Torre, Alhaurín el Grande, Cártama, and Coín), from 2,000 to 2,500 EUR per m² (Mijas, Rincón de la Victoria, and Vélez Malaga/Torre del Mar), and over 2,500 EUR per m² (Benalmádena, Estepona, Fuengirola, Marbella, and Torremolinos).

The number of residential departures in each census tract varies widely, ranging from 56 to 417, and in most of them, the population has moved to municipalities in all four price groups. Therefore, in correlating the

census tracts with the destination of their emigrants, rather than working with absolute numbers, we have opted for the use of a simple statistical tool, the LQ. Through its values, we can identify which census tracts exhibit an over-representation of emigrants for each group of destination municipalities – values that are comparable across tracts, irrespective of the volume of emigrants from each section. With this information, we conducted a correlation analysis between the LQ values and the AHI of each census tract, using the correlation coefficient. The results are presented in *Table 4*.

*Table 4. Values of the correlation coefficients between the AHI and LQ, by groups of municipalities according to the price of housing**

Price, EUR per m²	Correlation coefficient
1,000–1,500	-0.337
1,500–2,000	-0.290
2,000–2,500	0.423
over 2,500	-0.155

*AHI = Average household income, LC = Location quotient. *Source:* Authors' own elaboration.

As evident in the table, there is a statistically significant correlation between the AHI and the LQ values in three of the housing price ranges, with the exception being municipalities with values exceeding 2,500 EUR per m². The contrast sign is also as anticipated: negative in the first two ranges and positive in the third. Consequently, there is a negative correlation between income and high LQ values in municipalities with lower housing prices, becoming more significant with lower prices. Conversely, the correlation is positive when considering the group of municipalities with housing prices ranging from 2,000 to 2,500 EUR per m², and notably, this correlation is the strongest. In other words, higher income is associated with a lower emigration rate to municipalities with low housing prices, and vice versa.

For the cartographic representation of LQ values and to simplify interpretation, we opted to group values into two main categories. Values below 1 represent sections where the number of departures is lower than expected compared to the municipal total, labelled as "under-representation" in the legend. Values above 1 correspond to sections that have produced emigrants to the studied municipality group in a higher proportion than expected, identified as "over-representation" in the legend. Additionally, a third category, with a value of 0, groups sections from which no registered individuals moved to the corresponding municipality group, labelled as "no emigrants" in the legend.

In *Figure 7*, we present the spatial distribution of values corresponding to departures to municipalities with lower housing prices for sale (1,000 to 1,500 EUR per m²; destinations including Almogía, Álora, Casabermeja, and Pizarra). In *Figure 8*, the destination municipalities have housing prices between 1,500 and 2,000 EUR per m² (Alhaurín de la Torre, Alhaurín el Grande, Cártama, and Coín). *Figure 9* depicts values of housing prices between 2,000 and 2,500 EUR per m² for sale in the destination municipality (Mijas, Rincón de la Victoria, and Vélez Malaga/Torre del Mar). We note that we will not delve into the last group of destination municipalities, as there is no correlation between the AHI per census tract and this group of destination municipalities.

The interpretations of the distributions are clear. Census tracts with over-representation in departures to municipalities in the first group are predominantly located to the west of the continuous urban fabric, forming a fringe with notable spatial contiguity extending through various neighbourhoods where households with low to very low average incomes reside. The correlation with income values provided by the INE (2022), presented in *Figure 6*, is noteworthy, not only in the western fringe we referred to but also in the grouping around Ciudad Jardín. Furthermore, neighbourhoods with under-representation are situated in the eastern portion of the municipality, over the higher income range of the capital. In this regard, it is interesting to note the existence of two clusters of sections in this eastern area that not only exhibit under-representation but,

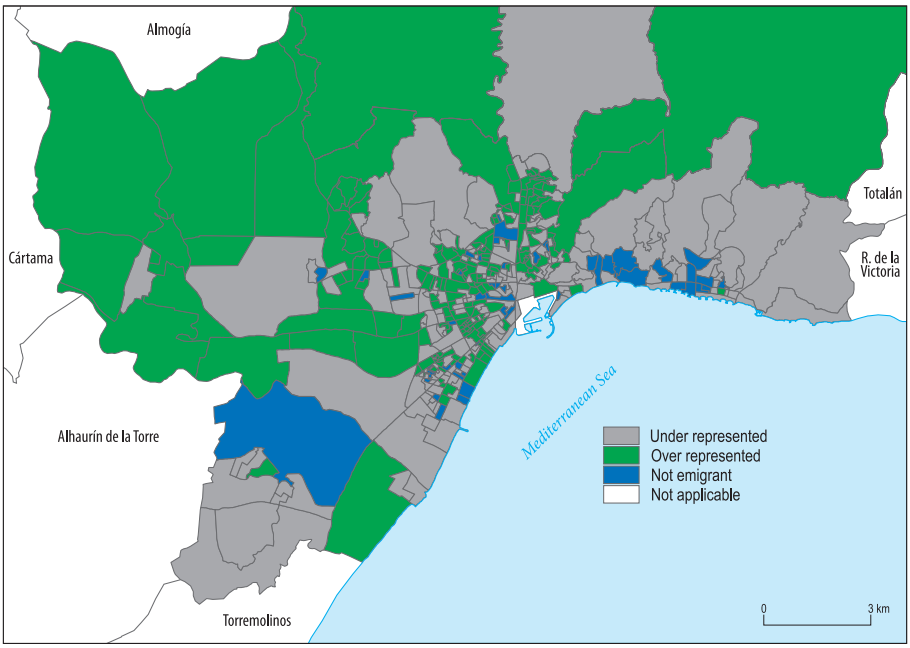


Fig. 7. Location quotients (LQ) of emigrants directed towards municipalities with housing prices between 1,000 and 1,500 EUR per m² in the Municipality of Malaga. *Source:* Authors' own elaboration.

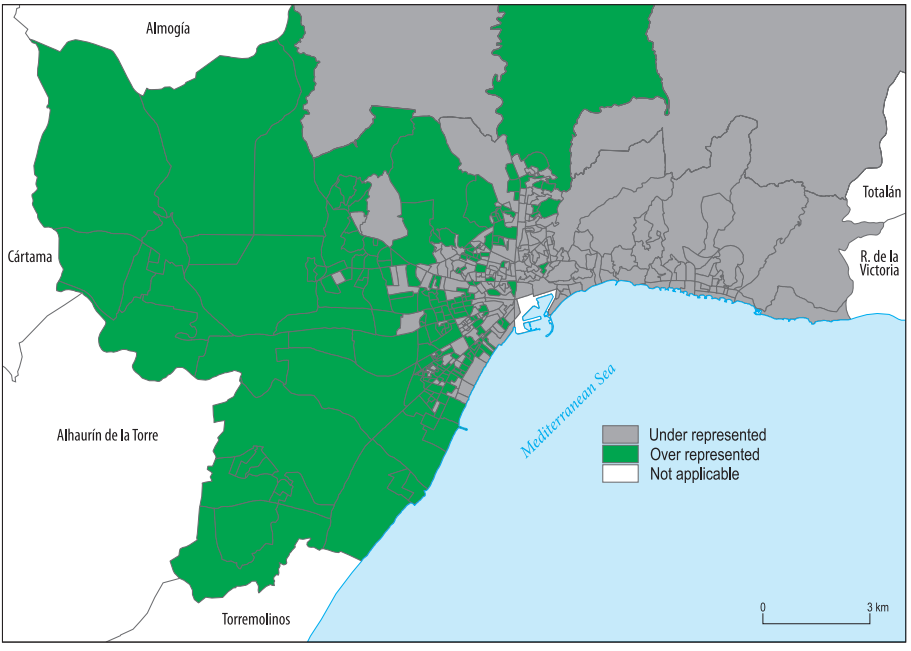


Fig. 8. Location quotients (LQ) of emigrants directed towards municipalities with housing prices between 1,500 and 2,000 EUR per m² in the Municipality of Malaga. *Source:* Authors' own elaboration.

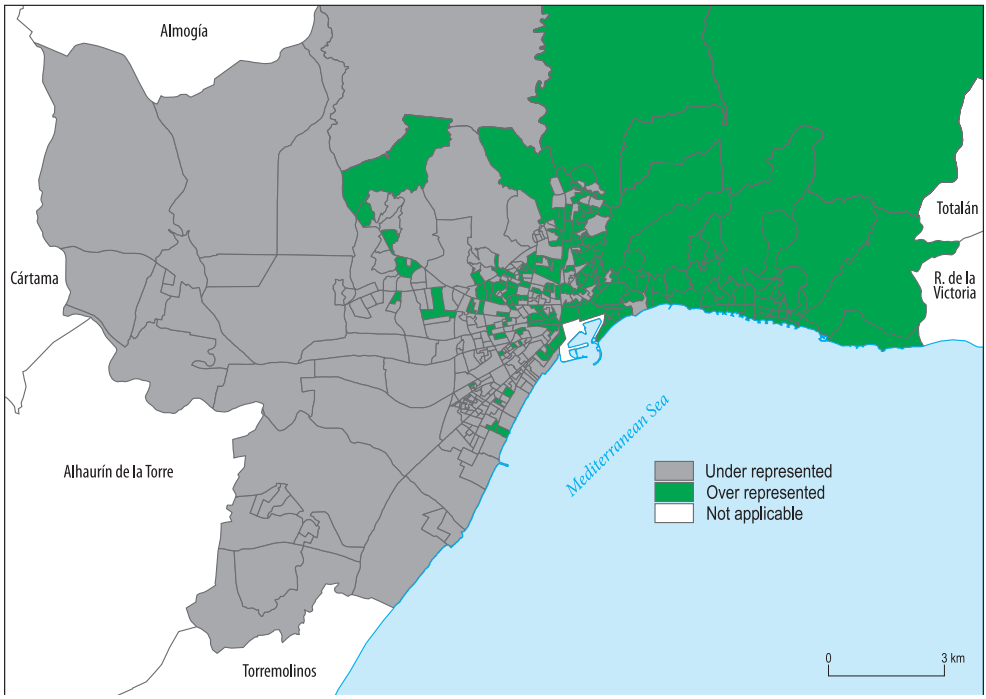


Fig. 9. Location quotients (LQ) of emigrants directed towards municipalities with housing prices between 2,000 and 2,500 EUR per m² in the Municipality of Malaga. *Source:* Authors' own elaboration.

during our study period, did not send any emigrants to municipalities with lower housing prices. These clusters largely correspond to sections with high AHIs.

Regarding the analysis of the distributions of emigrants heading towards the two subsequent groups of municipalities, it is highly convenient to conduct this analysis simultaneously. Indeed, it can be observed that both distributions are specular: sections with over-representation in emigration to municipalities with housing prices between 1,500 and 2,000 EUR per m² (see *Figure 8*) exhibit under-representation in emigration to the group with prices from 2,000 to 2,500 EUR per m² (see *Figure 9*), and vice versa. In other words, all urban sections have experienced population outflows, primarily directed towards the province of Malaga. However, those sections with the highest AHI have directed these flows towards municipalities with higher housing prices, whereas those with lower incomes have directed them towards places where housing prices are somewhat more affordable.

Conclusions

The destinations of emigrants leaving a municipality are diverse, given variations in motivations, preferences for location, characteristics of the intended housing, and available income for acquisition. However, most sources provide aggregated flows at the municipal level, and those offering some intra-municipal information are either affected by statistical secrecy – pertaining not only to the volume of departures but also to specific destinations – or by rounding resulting from sampling methods. Nevertheless, the existence of a wide variety of destinations reflects

the internal heterogeneity of the originating municipality. In our case, we identified this heterogeneity based on the AHI, which is not evenly distributed within the municipal urban fabric. In the context of residential migrations, where obtaining housing is the primary objective, income can be presumed as one of the key factors underlying the choice of the destination municipality. By utilizing population registry information at the urban census tract level, we have demonstrated a relationship between income level and destination municipality – specifically, housing prices – for emigrants.

Consequently, we are faced with what Mitchell, C.J.A. (2004) terms displaced urbanization, migration primarily motivated by the search for improved housing conditions at the destination; in this type of migration, the specific destination is not crucial for migrants, as they head to any area where they can meet their housing demands. Furthermore, as Aner, L.G. (2016) indicated for Copenhagen, income and housing influence migration patterns, with available income correlating with the destination, establishing a direct relationship.

This relationship is inverse for municipalities with more affordable housing prices – up to 2,000 EUR per m^2 – and direct for those with prices up to 2,500 EUR per m^2. These findings align with the segmentation of the Dutch rural space based on housing prices by Bijker, R.A. *et al.* (2013), who found that in less popular rural areas, the average income of residents is lower than in the other two types. Migrants heading to more popular rural areas had higher incomes and were more highly educated. Moreover, as Branden, M. (2013) suggests, income determines whether a person who wants to move has the means to do so. In our case, it determines the destination of migration, i.e., the AHI determines whether a person who wants to move to a municipality with high housing values can do so. Of course, the distance between municipalities of origin and destination is a variable that influence on the destination (Farkas, R. and Klobucnik, M. 2021; Kolcsár, R.A. *et al.* 2022). But in a context, as ours, in which, in general terms, the farther is the dwelling, the cheaper is, the relation between available income and price of the new house includes, implicitly, the distance.

Nevertheless, we must not lose sight of the fact that the housing offer in destination municipalities is not homogeneous; different price ranges can be found in all of them. However, the fact that we first obtained statistical correlations between income and housing price per m^2, and second, that the trend indeed indicates that sections with higher average household income send emigrants "in excess" to municipalities with higher prices, and vice versa, highlights the significance of this variable.

One might question whether this type of movement will ultimately result in maintaining levels of residential segregation based on income, albeit on a larger scale. In other words, the reality present in the Municipality of Malaga would extend to the entire metropolitan area. In this regard, Torrado, J.M. *et al.* (2021) have raised this possibility at a metropolitan scale in five major Spanish metropolitan areas. According to the authors, wealth is being centralized, and poverty is being suburbanized, increasing the tendency toward the emergence of a dual city. In our case, the polarization would not be so much spatial – since the movements we have analysed are centrifugal in all cases – as it would be related to the quality of housing. Examining destinations at a finer scale than the municipal level, specifically at the census tract level for arrival municipalities, could allow us to delve deeper into this issue.

To conclude, we will indicate that there remain issues that, based on the research we present, can be addressed: the presence of an immigrant population, basically of a labour nature, is a fact in the Municipality of Malaga, and we can consider not only the participation they have in the emigration flows, but also whether their destination patterns are similar, or not, to the general situation that we have just described. Another as-

pect of interest is to investigate the migratory flows of households in relation to the destination municipalities, since we can assume that the physical characteristics of the home vary according to its composition. Elements of great interest that can be addressed taking our results as context.

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Forces of energy welfare in Central Europe: The Russian war in Ukraine as a game changer

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Abstract

The Russian war in Ukraine has changed global geopolitical priorities and the policies of individual countries. The consequences of this ongoing war will be felt for decades to come, including the militarisation of states and the strengthening of political-military alliances. This article explores the effects of this conflict through the lens of energy welfare, which is used as an essential litmus test for the transforming economies of the Visegrad Group (V4) countries in Central Europe. Energy security and the energy transition have become critical topics, and energy security and its impact on social welfare affect the sensitive areas of policy choices that will determine the direction of development in this part of Europe. The V4 countries – Poland, the Czech Republic, Slovakia and Hungary – illustrate a wide range of domestic and geopolitical orientations that place individual countries in different decision-making situations. The ideological and political forces determine the scope for achieving energy welfare and are, therefore, the subject of this article. Based on macroeconomic and survey data results, the article's primary research query examines how the V4 countries' reliance on Russian fossil fuels affects their political attitudes and societal perceptions of the conflict in Ukraine, and the implications for their energy security and welfare in the face of the European Green Deal efforts. The different strategies adopted by the four countries considered translate into energy transition pathways to a low carbon economy described in the European Green Deal and strategies to provide energy at a reasonable price at the expense of a coherent European policy towards Russian aggression.

Keywords: Russian war in Ukraine, energy welfare, just transition, Visegrad Group (V4 countries)

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Introduction

The Russian invasion on Ukraine on 24 February 2022 shattered the public's dreams of peaceful coexistence and recovery from the coronavirus pandemic, and the consequences will be felt around the world for many years to come (Bäcker, R. and Rak, J. 2022; Sági, M. 2022; Uwishema, O. *et al.* 2022). Due to the proximity of military action, this conflict "has challenged Europeans' most basic assumptions about their security, brought the spectre of nuclear confrontation back to their continent and disrupted the global economy, leaving energy and food crises in its wake" (Ash, T.G. *et al.* 2023, 2). All European Union (EU) countries have been affected by the war in Ukraine because economic, political and cultural relations with Russia have been significantly reduced. However, Poland, Hungary, Slovakia and the Czech Republic – the four Central European countries referred to as the Visegrad Group (or V4 countries) – are experiencing the immediate threats of the conflict even more due to their geographical proximity to Ukraine and close ties with Russia.

Since, until recently, Russia had very close political and economic relations with Germany, the EU country that has the largest economy and sets the fundamental di-

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rection of European policy, most commentators have analysed the German *Zeitenwende* ('turning point') in the context of the Russian war in Ukraine (Blumenau, B. 2022; Bunde, T. 2022; Angenendt, M. and Kinski, L. 2023; Helferich, J. 2023; Mader, M. and Schoen, H. 2023). In contrast, this article focuses on the V4 countries and their dependence on Russia for energy security and welfare in light of the ongoing conflict (see Iacobuta, G.I. and Onbargi, A.F. 2022, 6).

We decided to use energy issues as a lens to analyse the political positions of the V4 governments and societies due to the multifaceted nature and interpenetration of various determinants that have led individual governments and the public to support either Ukraine or Russia in this conflict. This choice was by no means meant to downplay the casualties of the Russian onslaught, its implications for global food security (Behnassi, M. and El Haiba, M. 2022) or the geopolitical changes to the balance of power in Europe (Siddi, M. 2022) and the world (Wang, Y. *et al.* 2022). In the article, we aimed to show the impact of the armed conflict on the energy welfare of the V4 countries, which is rooted in the policy initiatives of the European Green Deal (EGD).

Energy welfare is a component of social welfare related to meeting the energy needs of individuals and groups in society. These needs, which include powering heating and cooling sources, cooking, lighting, electrical appliances and transport, determine the critical dimensions of modern societies' broader social welfare and national energy security issues.

It is essential to be aware that, according to the United Nations Economic and Social Council (ECOSOC), energy is "crucial for achieving almost all the Sustainable Development Goals, from its role in the eradication of poverty through advancements in health, education, [the] water supply and industrialisation, to combating climate change" (ECOSOC 2016, 11). In light of the Russian war in Ukraine and geopolitical tensions, the EU is intensifying its efforts to decrease its dependence on Russian fossil fuels. In 2021, Russia supplied over 40 percent of the gas, 46 percent of the coal, and 27 percent of the oil consumed by the EU (European Commission, 2022).

This situation of dependence on fossil fuels highlights the importance of accelerating the EU's transition to a diversified, resilient energy mix with increased reliance on renewable energy and energy efficiency measures. This aspect, in turn, makes visible the V4 countries' links, sympathies and political-economic antipathies concerning the Russian Federation, which affect not only the positions of their ruling parties and businesses but also their societies.

Materials and methods

This study investigates the impact of the Russian war in Ukraine on energy dynamics and social welfare in the V4, which, with the exception of the Czech Republic, directly border Ukraine *(Figure 1).* Data were collected from various sources, including Eurostat's macroeconomic indicators of primary production by energy source, IEA national reliance on Russian fossil fuel imports, Eurobarometer surveys, and existing scholarly literature. All this to answer the main research question consisting of two parts: How does the dependence of V4 countries on Russian fossil fuels, particularly in their energy mixes and technology supply chains, influence their political attitudes and societal perceptions towards the Russian war in Ukraine, and what implications does this have for their energy security and welfare in the context of efforts towards the European Green Deal?

To assess public attitudes towards the conflict and EU responses, Eurobarometer survey data were analysed, focusing on questions related to EU support for Ukraine and sanctions against Russia. A comparative analysis approach was employed to examine energy mixes, dependencies on Russian hydrocarbons, and political responses across the V4 nations.

Scholarly literature provided theoretical frameworks and empirical evidence, guiding the interpretation of findings within the broader energy security and social welfare context.



Fig. 1. Geographical position of the V4 countries, with Ukraine in their eastern neighbourhood

Energy welfare as a component of (nature-based) social welfare

Energy welfare is part of energy security (Kammen, D.M. 2020), which is "highly context dependent (and includes various factors), such as a country's special circumstances, level of economic development, perceptions of risks, as well as the robustness of its energy system and prevailing geopolitical issues" (Ang, B.W. *et al.* 2015, 1078). From a sociological perspective, energy welfare concerns the needs of a society whose "quality of life depends on uninterrupted energy supply" (Ang, B.W. *et al.* 2015, 1078) and increasingly includes respect for the role of the environment in meeting human needs (Nathwani, J. and Kammen, D.M. 2019; Baranowski, M. 2022a). In other words, energy welfare is a component of nature-based social welfare, which aims to respect nature by initially reducing and eventually eliminating the use of fossil fuels in the energy mix as planned in the EGD targets (Schunz, S. 2022; Almeida, D.V. *et al.* 2023; Piasecki, A. 2023). Therefore, an essential element of energy transformation is a just transition that combines the transfer to renewable energy sources with egalitarian access to it at the national and household levels. Its opposite in the form of energy inequalities or energy-related inequalities fits into welfare scarcity (Sovacool, B.K. and Dworkin, M. 2012; Bouzarovski, S. and Simcock, N. 2017; Baranowski, M. 2019).

Since citizens' material living conditions (and subjective well-being) (cf. Baranowski, M. 2019) set the framework for state institutions (Bilan, Y. *et al.* 2020), which are also guided by directives related to external security and international agreements, energy issues are political. Energy issues can also be described as social because they are economic, technological and environmental, as well as related to people's quality of life and habits *(Figure 2)*.

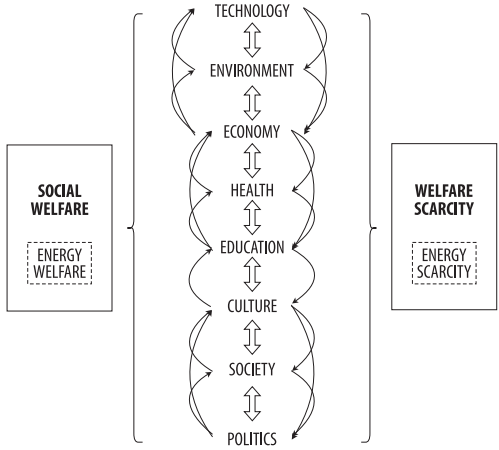


Fig. 2. Energy welfare as a component of social welfare and its dimensions. *Source*: Adapted from Baranowski, M. 2019.

The dimensions of an individual's societal functions that influence social welfare/scarcity are shown in *Figure 2.* The complex nature of energy welfare, which is a subset of social welfare, is determined by a set of contingent factors, i.e., linkages between the environment and technology and the economy as well as linkages between health, culture and social relations, education and politics. Therefore, when examining the energy welfare of the V4 countries in the context of the Russian aggression against Ukraine, it is important to consider the wider implications of this phenomenon on the quality of life in the V4 countries and, consequently, on political perceptions of the conflict.

V4 countries and energy issues

According to political commentators, the V4 countries do not currently constitute a monolith, primarily because of "the growing divergence between Poland and Hungary – (which are) dropping fast in most measures of what makes a liberal democracy – and Slovakia and the Czech Republic, both of which have seen recent government changes sending them back into the EU mainstream" (Bayer, L. and Cienski, J. 2022). There are more dissimilarities, and close cooperation between these countries is hindered by their significantly different political attitudes towards the Russian war in Ukraine. These differences are evident when juxtaposing the views of the prime ministers of Slovakia and Poland, who were both elected at the end of 2023. Slovak Prime Minister Robert Fico has been described as a 'pro-Moscow leader' (Goryashko, S. 2024), while Polish Prime Minister Donald Tusk is a supporter of the "full mobilization of the free world, the Western world, to help Ukraine in this war" (Dickinson, P. 2023).

The V4 alliance, established in 1991, was built on the countries' shared experience of the post-Soviet bloc and common goals and ambitions (Cienski, J. 2012; Bauerová, H. and Vošta, M. 2020; Utama, M.A. and Ramadhani, A. 2022). This alliance has enabled more than three decades of cooperation between these countries, especially Poland and Hungary. However, in the face of Russian aggression against Ukraine, it is worth analysing the coherence-divergence of the political attitudes of the V4 countries through the prism of energy welfare, a critical component of energy security, i.e., economic growth and development (Graff, M. *et al.* 2019; Kasperowicz, R. *et al.* 2020; Baranowski, M. 2022b; Dobbins, A. 2022; Klitkou, A. *et al.* 2023). It is also important to be aware that Ukraine "has immediate borders with the Visegrad region" and, over the last few years, has "developed remarkable economic, political and cultural relations with the V4 states" (Kucharczyk, J. and Meseżnikov, G. 2015, 11).

Therefore, when considering energy welfare/scarcity in the context of the war in Ukraine, it is worth bearing in mind the following statement by Beare, M. (2018, np):

> "[M]odern energy is the lifeblood of the modern economy, central to almost every economic activity, from manufacturing to transport to schooling to communicating, and, thus, integral to any country's development. It is also one of the main topics on the table at COP24, where policymakers, stakeholders and climate experts will meet to discuss policy relating to climate change."

Energy policy is therefore related to key policy decisions that determine the competitiveness of the economy and guarantee the material welfare of society as a whole (Grossmann, K. and Kahlheber, A. 2017). It is also linked to global and regional initiatives to halt climate change and achieve EU climate neutrality by 2050, which requires each EU country to reduce its greenhouse gas emissions by at least 55 percent by 2030. These initiatives include the EGD and the RePowerEU plan to reduce reliance on Russian fossil fuels. Specifically, RePowerEU was initiated in the wake of the war in Ukraine, with the aim of accelerating the energy transition in Europe (De Jong, M. 2023; Vezzoni, R. 2023).

Energy issues must be taken very seriously because they affect society's social welfare and subjective well-being. The problems of energy poverty and energy inequality, often referred to in terms of 'fuel poverty' or 'domestic energy deprivation' (cf. Bouzarovski, S. and Petrova, S. 2015, 31–40), are, in fact, about "a household's inability to secure a socially- and materially-necessitated level of energy services in the home" (Bouzarovski, S. *et al.* 2017, 1). These are fundamental issues for the public because they directly affect the cost of housing and the price of food and industrial goods (including fuel). In other words, they determine the cost of living.

V4 countries' energy mixes and dependence on Russian hydrocarbons

Even in the wealthiest European countries, citizens are "impacted by the functioning of the energy market, the welfare system, housing policy, health policy and practice, and by the distribution of wealth, as well as by the membership of particular social groups that experience intersecting inequalities" (Middlemiss, L. 2020, 110). While examining energy welfare, especially in the context of climate challenges and the Russian war in Ukraine, it is worth taking a closer look at the energy mixes of the V4 countries. The structure of the energy mixes and strategies for the transition towards climate neutrality affect foreign policies and public opinion.

Slovakia, Hungary and the Czech Republic have nuclear power plants, and Poland has made the decision to build nuclear power plants *(Figure 3).* Nuclear energy represents the largest share of the energy mixes in Slovakia and Hungary (58.3% and 37.9%, respectively), and it is the second largest share in the Czech Republic (31.3%) after fossil fuels. The largest share of fossil fuels (71.5%) was found in electricity production in Poland. In addition, Hungary produces energy from natural gas (11.1%) and crude oil (10.2%), accounting for more than 20 percent of its energy mix. In terms of the share of renewable energy, Slovakia (33.8%) and Hungary (32.2%) are the leaders and are significantly ahead of the Czech Republic (23.0%) and Poland (21.3%). The share of renewable energy is significant in the geopolitical context because it indicates political energy independence with a few caveats, such as the critical raw materials necessary for clean energy technologies (cf. Klitkou, A. *et al.* 2023).

Regarding fossil fuels, natural gas and nuclear energy, the V4 countries are dependent on Russian hydrocarbons and associated technologies. For example, the nuclear power plants in the V4 countries run on Russian-made fuel rods made by the TVEL Fuel Company (owned by Rosatom). Thus, the V4 countries' energy mixes and dependence on Russian fossil fuels and energy technologies since the collapse of the communist bloc demonstrate the vulnerability of these economies and the welfare of their populations to relations with the Kremlin.

In addition, it is important to examine energy carrier imports from Russia in order to understand the dependency structure shaping energy welfare/scarcity in the V4 countries. This is mainly because the European embargo on Russian hydrocarbons affects countries that, until recently, had close ties with the Russian Federation. Slovakia and Hungary are still the V4 countries with the highest levels of dependence on Russian hydrocarbons *(Figure 4).* Although Poland and the Czech Republic import far less non-renewable fuel from the country, Russia was an important trading partner for all four countries in terms of energy carriers before the attack on Ukraine.

Given the fragmentary nature of assessing the attitudes of the public and the governments of the V4 countries towards the war and the parties involved based on the energy sector alone, it is worth remembering that "the EU imported around 40% of its natural gas, more than one-quarter of its oil and about half its coal from Russia in 2019" (Tollefson, J. 2022, 233). In other words, the EU's dependence on Russian hydrocarbons was an important component of the competi-

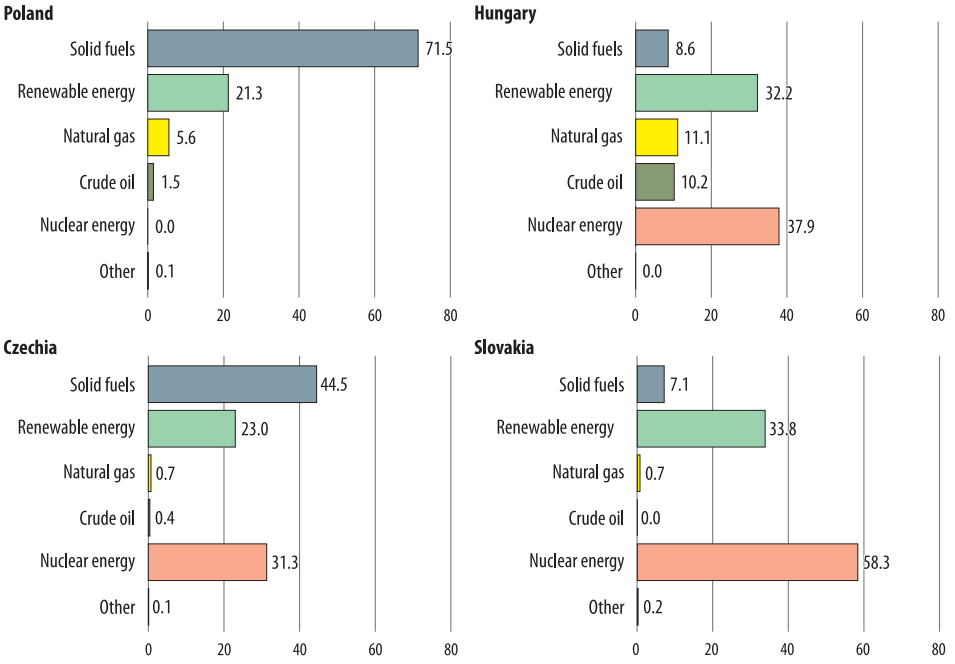


Fig. 3. Share of primary production by energy source, 2021. *Source*: Eurostat, 2023.

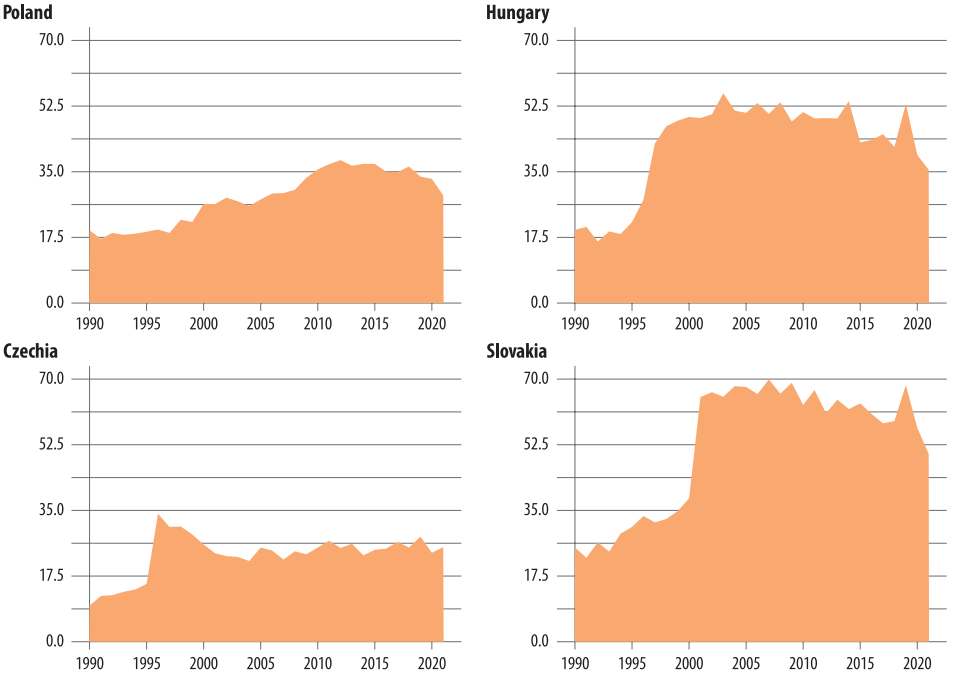


Fig. 4. National reliance on Russian fossil fuel imports (total fossil fuels). *Source*: International Energy Agency, 2023.

tiveness of European economies and political relations before the war (Baranowski, M. 2022c, 2023a). Germany before *Zeitenwende* is the most telling example of this practice. Germany pursued energy policy that focused solely on its own interests, e.g., individually negotiated low prices for Russian gas, and seemed to conflict with other EU countries' objectives, e.g., the Nord Stream 2 project (De Jong, M. 2024).

V4 countries' attitudes towards the Russian Federation after the invasion of Ukraine

In terms of the political response to the Russian war in Ukraine, which Acemoglu, D. (2023, np) described as "the biggest war in Europe since the end of World War II", the V4 countries formally adopted a critical assessment of the aggressor. Czech researchers Handl, V. *et al.* (2023, 508) shared the following description of the V4 countries' responses:

> "[T]hey called the Russian action 'a brutal, unprovoked and premeditated attack against a sovereign, peaceful democratic state', which represented 'an egregious violation of international law and the UN Charter, which undermines European security and stability' […] However, the positions of the individual countries and their leaders differed in their details."

Some political commentators believe that, until the populist right-wing takeovers in Poland and Hungary, the V4 countries "always came together in fundamental issues. Moreover, their stance was rarely fundamentally different from that pursued by the EU as a whole" (Meseznikov, G. 2022, np). The establishment of far-right governments in Warsaw and Budapest led to a political split in the V4 countries' vision of the EU (the so-called 2 + 2 format). However, the refugee crisis of 2015 led to a renewed consolidation of the V4 countries, as "all four countries took a strong anti-immigration stance and refused to take their fair share [of immigrants] as proposed by the EU" (Meseznikov, G. 2022, np).

Russia's attack on Ukraine divided the V4 countries in a 3 + 1 direction, with Hungary as the outsider (Meseznikov, G. 2022). However, since Slovakia and Hungary were, until recently, highly dependent on hydrocarbon imports from Russia (see *Figure 4*), both countries should be characterised as still having pro-Russian positions because energy prosperity is a critical determinant of political relations. Note that we are referring to official government positions and public opinion because, although important, the personal connections of leaders such as Hungarian Prime Minister Viktor Orbán and former Czech President Miloš Zeman do not represent the official positions of the government and the public.

Data from a Eurobarometer survey were analysed to understand public opinion in the V4 countries about the Russian war in Ukraine. To approximate the public's position on solidarity with Ukraine or the Russian Federation, the survey included the following question: "Overall, do you approve or disapprove of the European Union's support for Ukraine following Russia's invasion of Ukraine?" (Eurobarometer, 2022) *(Figure 5).*

The survey results revealed that 85 percent of Poles, and 68 percent of Czechs approved of the EU's support for Ukraine, while only 47 percent of Slovaks, and 56 percent of

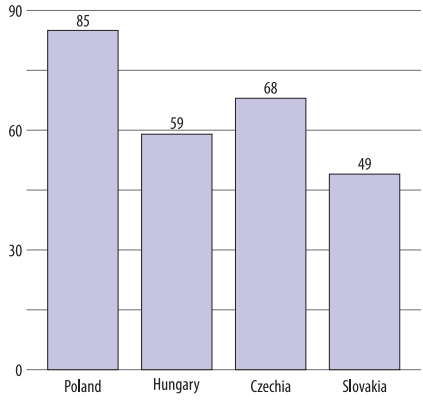


Fig. 5. Public approval of the EU's support for Ukraine (% – Total Approve). *Source*: Eurobarometer, 2022 (98.1 | EB042)

Hungarians shared this sentiment. These results correspond with the aforementioned 2 + 2 format of the V4 countries. A survey question about support for sanctions imposed by the EU on the Russian Federation had a similar distribution of responses; compared to people in Poland and the Czech Republic, those in Slovakia and Hungary were much less supportive of sanctions against Russia *(Figure 6).*

For the sake of accuracy, it should be noted that the distribution of responses to the survey questions concerning support for Ukraine and the imposition of sanctions on Russia do not directly align with the V4 countries' dependence on energy carriers and technology, especially technology and components related to nuclear power plants. However, considering other survey studies and the interpretation of their results (Baranowski, M. 2022a, c), one may be tempted to make such an interpretation. For example, Handl, V. *et al.* (2023, 509) shared the following conclusion:

> "[A] significant part of Slovak society belongs among the most pro-Russian people in the European Union. According to a poll conducted in July 2022, 52% of Slovaks want Russia to win the war. Thirty percent want Ukraine to win, and 18% don't know (Dennik, 2022). A significant reason for those Slovaks' stance is their country's dependence on Russian oil and gas, which before the war was 100%."

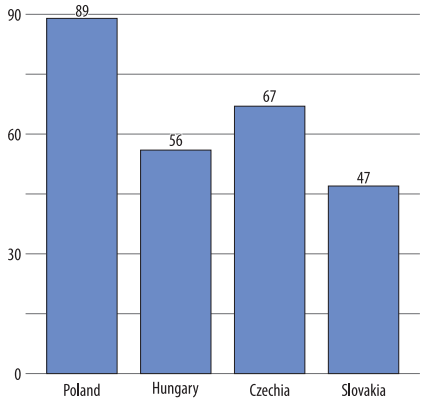


Fig. 6. Public approval of the actions taken by the EU to support Ukraine since the start of the war (% – Total Approve). *Source*: Eurobarometer, 2022 (98.1 | EB042)

More than just fossil fuels

The V4 countries present a spectrum of attitudes towards the Russian aggression against Ukraine, primarily through the prism of energy welfare, which, as described above, determines the foundations of individual and household functioning in the economic sphere. Politico-geographical factors, such as proximity to a war zone (Handl, V. *et al.* 2023, 505), are not without influence on intercountry relations. Similarly, transnational alliances, such as the EU, should not be underestimated, as they utilise "a sufficient degree of unity, central authority, and effective decision-making to defend the shared interests and values of Europeans" (Ash, T.G. 2023, 64). However, the devil is in the details, and energy dependencies often determine these details. As previously mentioned, the V4 countries have different energy mixes (see *Figure 2*). However, like the rest of the EU, they are committed to the energy transition to a low-carbon economy described in the EGD plan, which includes various pathways away from fossil fuels and towards renewable energy production.

Russia's case (as a hydrocarbon exporter) is proving to be crucial in many ways. Before its aggression against Ukraine, Russia's fossil fuels were a guarantor of the energy transition of the EU countries. Germany, in particular, was counting on the opening of the Nord Stream 2 pipeline until recently. Furthermore, as previously mentioned, the V4 countries imported vast amounts of hydrocarbons from Russia, and Russian companies supplied raw materials for nuclear power plants.

Russia's importance in the energy sector is also evident in a less articulated topic: the rare earth elements and critical minerals essential for the energy transition (Bazilian, M.D. 2018; Eyl-Mazzega, M.-A. and Mathieu, C. 2020; Gielen, D. and Lyons, M. 2022). Russia and its involvement with countries in Africa, South America and Asia that have reserves of these valuable elements are essential parts of the global balance of power related to access to rare earth miner-

als. According to the International Energy Agency (IEA), "the value of global trade in critical minerals will need to triple to achieve net-zero emissions by 2050" (Bordoff, J. and O'Sullivan, M.L. 2023, 118).

In addition, Russia's enriched uranium reserves, which are essential for the operation of nuclear power plants and a critical link in achieving countries' decarbonisation goals, show that Russia remains an important player in energy security. Suppose that the nuclear power plants in three of the four V4 countries are important sources of global energy production. In that case, the role of the Russian Federation as an intermediary for this resource may raise legitimate concerns. Even the United States depends on Russian nuclear fuel services, which, as American researchers have noted, "is a source of great discomfort and vulnerability, given the current geopolitical realities" (Bordoff, J. and O'Sullivan, M.L. 2023, 114).

Given the aforementioned entanglement of the energy welfare of the V4 countries with the import of energy sources and technologies from Russia, analyses of the attitudes of Central European societies towards the Russian war in Ukraine cannot downplay the energy security dimension.

Discussion and conclusions

According to a survey conducted by Ash, T.G. *et al.* (2023, 1–19), the Russian aggression against Ukraine "has consolidated »the West«". However, this consolidation has come at a massive cost in terms of human lives, refugee and humanitarian crises, and food and energy emergencies. It is important to remember that the European perspective is just one point of view and is a very diverse one in which different economic, political and military security visions clash. The V4 countries are an excellent example of this diversity, and their differing positions on the war itself and the parties involved can be seen through a particular lens, e.g., 3 + 1 or 2 + 2 formats.

Examining the energy welfare in the V4 countries in light of Russian aggression against Ukraine should make one realise that energy policy is an essential component of the economy and politics. A well-functioning economy shapes energy welfare, while a poor one produces energy scarcity. Energy policy is also directly linked to climate change and the shape of the energy transition towards zero-carbon economies. Thus, energy transition concerns nature-based social welfare, which is particularly important in light of "the dominant influence of economists and their reliance on cost-benefit approaches in energy decision[s]" (Laes, E. *et al.* 2023, 4). Also, the level of public support for reforms to enable the implementation of decarbonised electricity generation technologies affects all spheres of modern society.

The case study of the V4 countries in this article has shown that many factors related to energy security are rooted in country-level relations with Russia, resulting in different attitudes towards supporting Ukraine and EU sanctions against the Kremlin. First and foremost, trade in Russian energy carriers was (and to some extent still is) an essential part of individual European countries' relations with Russia. In addition, let us remember that "the V4 countries (except for Poland) have been even more dependent on Russian energy resources than Germany" (Handl, V. *et al.* 2023, 504).

Moreover, when considering the factors that affect energy welfare in the V4 countries, especially Poland and Hungary, it is worth bearing in mind that research has shown that dissatisfaction with life is mainly linked to populist sentiment (in the case of Finland, cf. Lindholm, A. and Rapeli, L. 2023). However, the consequences of political sympathies seem more understandable if the level of life satisfaction is moderated by economic competitiveness, the state of the environment and energy policy – which ultimately affects the price level of goods consumed. For energy-consuming countries, such as the V4, in particular, "rising energy prices mean higher production and transportation costs while

affecting capital market liquidity through inflation and interest rates, reducing social welfare levels" (Chen, Y. *et al.* 2023, 3083), and see also Antonakakis, N. *et al.* (2017). These phenomena can result in populist sentiments and smouldering radical political views, which can indirectly influence specific visions of the energy transition, in essence, the economic (and redistributive) model.

Since the energy security and welfare perspective is a single but important component of the broader picture of complex and dynamic (geo)political relations (Bompard, E. *et al.* 2017; Baranowski, M. 2023b; Cui, L. *et al.* 2023; Streeck, W. 2023), it is worth emphasising that other forces also shape the level of social welfare in a country. This article's focus on energy welfare and the V4 countries was intended to draw attention to the multidimensionality of energy issues in light of Russia's attack on Ukraine and their potential far-reaching consequences on the relations between EU countries as well as the pace and shape of the energy transition towards a low-carbon economy (EGD). As we have tried to show, understanding the individual interests and political ties of the V4 countries with energy welfare at the forefront is the foundation of veritable forces of potential change towards either a European Green Deal and energy independence from foreign powers or the opposite. The opposite option in the form of a 2 + 2 or 3 + 1 formula among the V4 countries may set a critical hurdle on the road to achieving climate neutrality combined with energy security and welfare.

The dependence of V4 countries on Russian fossil fuels significantly influences their political attitudes and societal perceptions towards the Russian war in Ukraine, with profound implications for their energy security and welfare in the face of efforts towards the EGD. The Visegrad countries, particularly Slovakia and Hungary, exhibit varying degrees of reliance on Russian energy resources, including hydrocarbons and associated technologies. This dependence shapes their political responses to the conflict, as evidenced by differing levels of support for Ukraine and EU sanctions against Russia. While Slovakia and Hungary have historically maintained closer energy ties with Russia, Poland and the Czech Republic have pursued diversification strategies, albeit with varying success (2 + 2 formula).

Public opinion within the V4 countries also reflects this divergence, with surveys indicating higher levels of support for Ukraine and EU sanctions among Poles and Czechs compared to Slovaks and Hungarians. This alignment with EU policies on Ukraine and Russia underscores the complex interplay between energy security, geopolitical factors, and societal perceptions. Furthermore, the energy transition outlined in the EGD presents both opportunities and challenges for the V4 countries. While reducing dependence on Russian fossil fuels is a crucial objective, it requires significant investment in renewable energy infrastructure and technology. This transition is essential for enhancing energy security and mitigating the risks associated with geopolitical tensions.

Overall, understanding the intersection of energy dependence, political attitudes, and societal perceptions is crucial for navigating the complexities of the Russian war in Ukraine and advancing towards a sustainable energy future. By addressing these challenges through collaborative efforts within the EU framework, the V4 countries can strengthen their resilience to external pressures and contribute to the realisation of the EGD's objectives.

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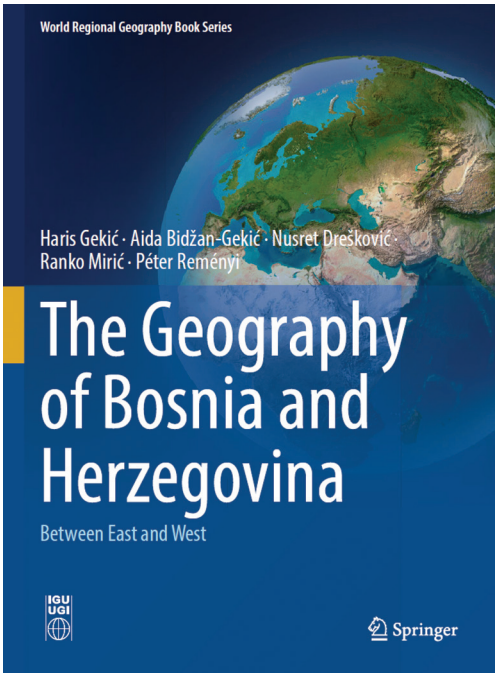
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BOOK REVIEW SECTION

Gekić, H., Bidžan-Gekić, A., Drešković, N., Mirić, R. and Reményi, P.: The Geography of Bosnia and Herzegovina: Between East and West. Cham, Springer, 2022. 413 p.

Bosnia and Herzegovina is a place of symbolic importance in the history of Europe. It is the place of encounters of peoples, religions, nations, and interests. However, these encounters often involved tensions, so the place the name represents was also associated with war conflicts. We associate it with wars in our minds because of the events of the last century. Whether it was the First World War, the great conflict of the beginning of the 20th century, or the Yugoslav War at the end of the century, the tiny country became the scene of tragic events in recent European history. Its inhabitants had to suffer the horror of genocide, too.

How does this country heal the wounds of the past in the 21st century? Can coexistence succeed after such a prelude? Could the bridge rebuilt in Mostar really be a symbol of finding each other, starting over, and reconciling? The public can be curious about these critical questions, and science can research the answers. We have these questions when we pick up this book and wait for the answers from the discipline of geography.



Especially because the subtitle of the volume (*Between East and West*) suggests precisely this connection (or its ambivalent realization), the country's intermediate position while placing it with an area of barely 50,000 km^2 and a population of nearly 4 million in a global context.

The above figures can also be found in the book since, according to the main title (*The Geography of Bosnia and Herzegovina*), the volume presents the country's geographical characteristics. Accordingly, the authors of the volume are all geographers. Most of them are employees of the University of Sarajevo, joined by a Hungarian author from the University of Pécs. The careful, detailed, and systematic presentation of the geographical features of Bosnia and Herzegovina can also be interpreted as part of a larger project. The volume published in 2022 is one of the publisher's regional geography series launched in 2015 (World Regional Geography Book Series). According to the publisher's website, 15 volumes have been published, including titles about some Balkan countries.

The impressive aim of the series is to show interested readers the regional geography of the world. On the one hand, this indicates the volume's methodology. Based on the characteristics of descriptive regional geography, we can obtain information about areas that form a unit based on specific characteristics and are separated from other areas. It is obvious in the case of this kind of geographical series that the political entities, the countries, demarcate the area to be investigated – as we can see in the current volume. At the same time, some titles in this book series, apparently only in the case of other continents than Europe, describe a group of countries instead of a single country, which means their geographical scope is very heterogeneous regarding areal extension, although they always focus on macroregions, i.e., countries and groups of countries. Another feature of the book series, at least its already published volumes, is the overrepresentation of European countries (9 volumes out of 15). This unevenness may arise from the geographical location of the publisher (Switzerland in Europe) and may change with future volumes.

Another characteristic of the book series is the prominent presence of the Balkan countries. In addition to Bosnia and Herzegovina, Albania, Serbia (cf. Demeter, G. 2024), and Slovenia also appear in separate volumes. That does not necessarily reflect a specific territorial focus. Rather the presentation of these countries fills a gap among regional geographical works. That resonates with the objectives of the International Geographical Union (IGU), the collaborating partner of the book series, an

international organization aiming to support geography as a scientific discipline, spread geographical knowledge widely, and promote the teaching of geography.

All of this may be important information for those who pick up this volume. The readers receive a handbook that contains detailed information according to the taxonomy of descriptive regional geography. The characteristics of this system are as follows. First, the investigated area is placed in the geographical space with the most basic geographical data (absolute and relative position, vertical and horizontal extent). After that, the physical and social geographical features are sharply demarcated from each other. The following sequence enumerates physical geographical features. It starts with the geological history of the territory, following the most significant geological events based on the geological time scale. The current morphological features of the given surface follow this information, i.e., the characteristics of climate, hydrogeography, and biogeography, along with the features of soils. The next major section focuses on human geographical features, mainly population geography, social geography, and economic geography, whereas political geography (the presentation of historical events and political features related to the area) and urban geography are also prominent elements. The quantitative predominance of socio-geographical information is usually typical. The description ends with the characteristics of the smaller territorial units within the given region. That means a shift from the macroscale to mesoregions and taking a complex point of view by combining physical and human geographical features of the given area.

The book provides a classic regional geographical characterization of the country. Its advantage is that it offers a comprehensive and complex picture with the help of various research aspects of geography. It provides a great opportunity to get to know the geographical characteristics of an area. Its systematic point of view makes the volume suitable for use as a handbook and a textbook, too.

This kind of scientific work also allows one to move away from negative war connotations mentioned in the introduction. It discusses the social problems of the past as part of a more extensive and complex geographical system, thus, enabling the reconsideration of information. The authors also want to rethink Bosnia and Herzegovina from alternative points of view, as they predict in the *Preface*. As much as possible, they would like to move the country away from the war narrative and present it from perspectives that emphasise the opportunities. Therefore, using the discourses of geography, with particular emphasis on its regional perspective, the authors present the results of many years of research in this book, including numerous field observations. They emphasise the importance of economic, social, and political factors, which were prioritised in the exploration of regional characteristics, so they predict for the reader the proportions of the appearance of regional geographical features in the volume.

The volume was intended for comprehensive use. According to the *Preface*, the authors wanted to create a handbook about Bosnia and Herzegovina that also functions as a textbook and is not only for scientists, teachers, and students practicing geography. The goal was to explore the country's geographical reality, especially its physical and anthropogenic beauties. That is both an opportunity and a limitation. The country's removal from the war narrative is apparent, but it also results in dichotomic simplifications, as it happens in the title and introduction (e.g., West and East, nature and society, city and countryside).

The table of contents following the introduction immediately helps the reader navigate the structure of the volume and its primary content. The book consists of five large parts, followed by an index. The latter helps use the volume like a handbook. The content of the individual parts was written in the spirit of classic regional geographical descriptions. The first part presents the absolute and relative geographical position of Bosnia and Herzegovina in two chapters. The second part collects the physical geographical features of the country in six chapters. The third part shows the country's general demographical, social, urban, and political characteristics in four chapters. The fourth part discusses economic features separately in two chapters. Finally, the fifth part discusses the different parts of the country in a complex manner in one chapter focusing on its geographical regions. The volume is clearly characterized by the predominance of human geographical characteristics, especially economic geographical characteristics.

The volume, therefore, consists of 15 chapters. At the beginning of each chapter, the abstract and related keywords summarise the chapter's content. The subsections help to divide the content, which is made more visible by figures and tables. Each chapter end with a list of literature related to the given topic. Although the length of the abstracts and the number of references is varied, the chapters' layout help the readers navigate the information.

Charts, photographs, and tables are excellent tools for acquiring knowledge, and fortunately, we can find many of them in the volume. At the same time, neither the authors nor the publisher sought an exact layout for these. The mainly map-based figures are of very different quality, often with a surprisingly simple and less informative way of representation and content. Their size varies greatly. The simplicity of the content does not justify the large size of most of the figures, and there are also cases when it is the other way around, with the information-rich figure becoming challenging to interpret due to the small size or inappropriate font size. Hence, the layout of the figures is very heterogeneous, which unfortunately reduces the quality of the publication and the possibilities of its use as a textbook. It is especially disturbing that the figures almost always alternate from the two-column layout but rarely fill the entire page (from this point of view, the human geography chapters are more exact as they strive to fill the space more

proportionately). The size of the photographs is also extremely varied, and in most cases, the size was not chosen based on the content. The layout of the figures changes from chapter to chapter, but not for the sake of usability. In a publication that fills gaps and provides detailed information, such a composition of the ratio of the illustration to the text is the weakness of the volume.

The first part (*Geographical Position, Borders and Size*) is only a fraction of the entire volume. The book's first chapter (*Geographical Position, Spatial Coverage, and Size*) provides a comprehensive picture of the absolute and relative geographical position of the country, illustrating the content with colourful figures and tables. The figures here are conspicuously large and less informative compared to their content. In the second chapter we can read about the country's borders. The short chapter illustrates the content with pictures, which, in turn, are smaller than the map-based figures in the previous chapter, even though they could have been more effective.

The second part (*Physical Geography*) is divided into longer chapters. The third chapter (*Geology and Geotectonics*) presents the country's geological characteristics. It is extremely rich in map-based figures and photos, but the quality of the figures is uneven. Moreover, the legend of the maps is only helpful to the experienced eye. The fourth chapter (*Geomorphology*) focuses on the versatility of the earth's surface, presenting the natural geographical beauties of the country and illustrating them with colourful photos. The fifth chapter (*Climatology*) discusses the country's climatic characteristics in detail. A series of charts help to illustrate the content, as do the map-based figures in which, however, the legend is often very small or difficult to decipher. In the sixth chapter (*Hydrography*), we can learn the hydrographic features, where larger images reveal the richness and beauty of the surface waters. The seventh chapter (*Pedogeography*) introduces the reader to the soil types, and the eighth chapter (*Biogeography*) presents the country's flora and fauna. The map-based representation in this chapter has finally been created in a more consistent layout and size, while there are relatively few photos, despite the opportunities offered by the topic, and they are specifically related to protected areas.

With the third part of the book, we enter the world of human geography. The ninth chapter (*Historical Geography*) summarizes the main historical events related to the territory of Bosnia and Herzegovina in chronological order, dividing the country's history into events that occurred before and since the 20th century. In addition to the informative and well-arranged illustrations, two map-based illustrations taking up the entire page width complete the story told in grandiose historical perspectives.

The tenth chapter (*Political Geography*) provides detailed information on the country's administrative and political system. The figures also really fill the space here, but there is often little information on them. In the eleventh chapter (*Population Geography*), richly illustrated with map-based figures, we get a comprehensive picture of the country's population dynamics and structure regarding age, gender, ethnic and religious composition, and economic activity. The exceptional merit of this chapter is that it also covers the changes caused by the COVID-19 pandemic. The twelfth chapter (*Urban and Rural Geography*) presents the geographical features of settlements in Bosnia and Herzegovina along the different characteristics of cities and countryside, with a large number of map-based figures and a series of photographs showing the characteristics of the settlement network.

The fourth part is entirely devoted to the economic geographical features of the country. The thirteenth chapter (*Natural Resources*) presents the natural resources by reinterpreting the physical geographical features that have already been discussed in detail. The fourteenth chapter (*Economic Development*) interprets the economic processes in the narrative of economic development. Among the economic sectors, services and mainly tourism play a prominent role. The chapter also presents the country's touristic regions, although the latter would fit more into the next part of the book.

The fifth part (*Geographic Regions of Bosnia and Herzegovina*) is the final one in the volume. Here, the fifteenth chapter (*Geographic Regionalization and Regions*) presents a complex regional geographical description of the country's mesoregions, richly illustrated with photographs.

The volume is a handbook for anyone who wants to get comprehensive knowledge about Bosnia and Herzegovina or expand or update their knowledge. It can be helpful for teachers and students alike, not only in geography but also in economics courses. The individual parts and chapters organize the information well. The content is created through the construction and application of extensive databases and can be considered an inexhaustible source of information. The figures follow a heterogeneous design, but their informativeness and attention-grabbing character are indisputable. The book offers a beautiful tour of Bosnia and Herzegovina with relevant and profound information.

Margit Kőszegi[1]

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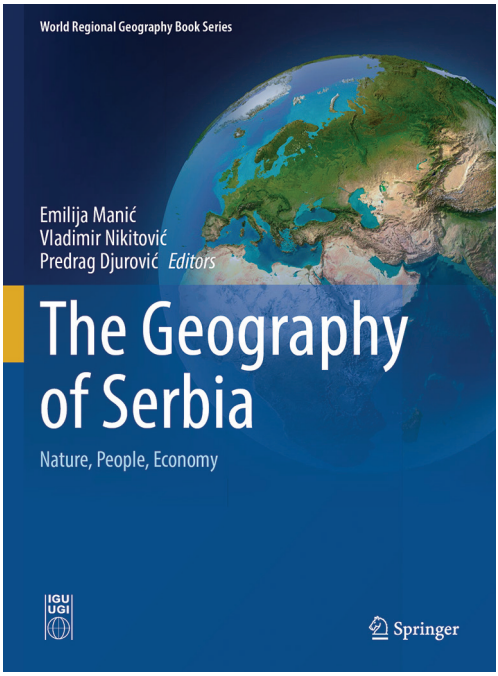
Demeter, G. 2024. Manić, E., Nikitović, V., Djurović, P. (eds.): The Geography of Serbia: Nature, People, Economy. A book review. *Hungarian Geographical Bulletin* 73. (1): 106–108. https://doi.org/10.15201/hungeobull.73.1.8

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Manić, E., Nikitović, V. and Djurović, P. (eds.): The Geography of Serbia: Nature, People, Economy. Cham, Springer, 2022. 317 p.

The geography of Serbia, a colourful volume full of maps and diagrams and illustrated with photos of excellent quality, was published in the "World Regional Geography Book Series" of Springer in 2022, similarly to the edited volume on Bosnia and Herzegovina (Gekić, H. *et al.* 2022), which has already been introduced and reviewed in the current issue of the Hungarian Geographical Bulletin (Kőszegi, M. 2024). Despite the numerous similarities, the structure of the volumes in the series is not strictly pre-defined. Therefore, in this review, we also address the series' consistency by comparing the two volumes.

As the editors Emilija Manić, Vladimir Nikitović, and Predrag Djurović write, they had two options to present the geography of Serbia – either to limit the number of contributors to have a coherent text that would reflect the concept of a few experts or to involve the best specialists for each chapter to deepen the analytical character of the text. The editors deliberately chose the second option. Hence, the content moved from subjective synthesis to analysis. The 23 chapters were written by 44 scholars, but this was not a wrong decision. This method allowed the editors to avoid fluctuations in the quality of the chapters, whereas target readers could browse, combine, and evaluate information. Most of the chapters are deep and well-written, as I can judge them by academic experience in history, human geography, and physical geography. My only critique involves the structural composition and limited interconnectedness between chapters in some cases where a process-oriented approach could have been applied. (That concerns chapters beginning with the historical past vs. chapters focusing on the present situation.) Most of the chapters – considering them as standing alone – are of good quality. That is even true for the chapter on archaeology (Dušan Mihailović, Dragana Antonović, and Aleksandar Kapuran). The text is not dull at all, and, thanks to its approach with a clear focus on novelties and good illustrations, it brings the history of consecutive and parallel ancient cultures closer to the unskilled reader. The chapter generally tries to put Serbia into an international context, interpreting events in a broader context. That is also true for the chapters on history (Radmila Pejić, Sofija Petković, and Dejan Radičević), and the comparative approach, in addition to the analysis of temporal trends, is also abundant in the geographical chapters. Hence, the reader can also make spatiotemporal comparisons.



However, a professional historian should mention some minor but typical mistakes here. The "Serbs settled in present-day Serbia" (p. 21) in the first sentence of the chapter is a biased term, as Serb is a modern ethnolinguistic category—it is better to talk about "Serb tribes" or "Slavic tribes as the predecessors of the modern Serbian nation," for instance. In Chapter 3.3, we read that "The Serbs sided with the Austrian army in the Great Turkish War (1683–1699) only to experience disappointment after the Austrian defeat" (p. 31). That is another typical mistake highlighting the volume's Serb-centric concept of history. First, to be correct, it was not the Austrian, but rather the Habsburg (international) army. Second, the sentence suggests that the Habsburgs lost the war of 1683–1699, which is not true – although they failed to liberate the Balkans after encouraging the Serbs under Ottoman rule to revolt. Still, the sentence talks about a defeat in general and not in connection with the Serbs. We may also read (as another infiltration of Serbian views on history) that Serbia was "disappointed by Russia's championing of Greater Bulgaria even at the expense of ethnically Serbian lands" (p. 34). The authors fail to specify these "ethnically Serbian lands" accurately. The Slavs of Macedonia deliberately took sides with Bulgaria then. Thus, they cannot be considered Serbs. Bosnia was occupied by Austria-Hungary (with Russian consent). The third possible region is Kosovo-Metohija. Figure 3.3 gives an excellent example that Bulgaria,

Montenegro, and Northern Macedonia vindicate a part of Serbian history for themselves, the reverse of which is also true, and it explains some of the tensions between these Slavic successor states of the Ottoman Empire. Also, many interpretations in Bulgaria claim precisely the opposite of the views of this chapter's authors, i.e., that Russia supported Greater Serbia at the expense of ethnically Bulgarian lands.

The chapter on engineering geo(morpho)logy (risk maps of natural hazards) is good, and the text and illustrations are helpful (Ivan Novković, Slavoljub Dragićević, and Mirela Djurović). Though it is far from my research field, I greatly enjoyed the biogeography chapter (Vladimir B. Stevanović). Illustrations are adequate; even the grid cells' resolution seems optimal for such a volume and page setting. As for the chapter on hydrology, some more graphs could have helped internalize the text better (Marko Urošev, Ana Milanović Pešić, Jelena Kovačević–Majkić, and Dragoljub Štrbac) – especially compared to the chapters on demography and economics, which are rich in charts. I also miss diagrams on the monthly distribution of precipitation and temperature average from different scenes from the climate chapter (Chapter 5 by Boško Milovanović, Gorica Stanojević, and Milan Radovanović). The sub-chapter on tourism (or rather cultural heritage, which dominates the text instead of a statistical analysis of the main destinations) is especially good thanks to the excellent photo material (Svetlana Popović, Dragan Stojković, and Radmila Jovanović). The editors' decision to treat it separately from the chapter on historical background and merge it with the chapter on finances and trade is a bit strange. However, it can be justified by the fact that the authors of the two chapters quite differ.

The volume objectively and adequately addresses the Kosovo problem. Its discussion (that appears in several chapters, including administration, history, and demography) is balanced, as it includes ethnic, historical, and legal argumentation, and it is not overheated. Likewise, the evaluation of the latest political events between 1990 and 2010 (including the NATO bombing) remains moderate. The authors draw interesting parallels between the 1940s and the 1990s: "the history of the Second World War in Yugoslavia, as well as on the territory of Serbia, was, to a large extent, the chronicle of a complex civil war in a country divided along ethnic, religious, and ideological lines" (p. 37).

What I miss from the volume is an investigation of the social background/tensions of the recent civil war (as the authors and editors labelled the wars) and a regional economic geographical analysis of the two Yugoslavia – i.e., a comparative approach to what was resolved and what problems persisted. For example, what would have happened if Nazi Germany had not attacked Yugoslavia? Could ethnic tensions have been overcome, or the state would have faced the same fate as in the 1990s or as a consequence of the Nazi occupation?

In connection with economic geography, the volume focuses on post-1990 dynamics (see, for example, the FDI data series), which is justifiable as the collapse of the communist regime put an end to a supranational entity and central economic planning. However, the volume could include more maps of main industrial centres from the 1930s and 1970s to track the changes. Regional internal disparities of the 1930s (see Bíró, L. 2010 on the Yugoslavian state in Hungarian, for example) remain underrepresented compared to the evaluation of the situation in the 1970s in Part IV (by Đorđe Mitrović).

Part III. Demography and *Part IV. Economy* are the helpful and well-established core of the volume. Daniela Arsenović and Vladimir Nikitović, then Mirjana Rašević and Marko Galjak, focus on the temporal dynamics and spatial patterns of topics like below-replacement fertility, postponement of childbearing, birth control, life expectancy, premature mortality, health conditions, and avoidable deaths. Vesna Lukić analyses migration processes, including the latest global migration events. Žaklina Stojanović wrote the chapter on agriculture and sustainability, Emilija Manić and Milena Lutovac on natural resources and manufacturing, Ivan Ratkaj on transportation, trans-European transport network, and transport investments. The keywords are usually well-selected and help identify topics and contents. The chapter on regional depopulation by Vladimir Nikitović addresses the question of peripheralisation from the dimension of depopulation. Chapter 22 (*Rural Areas and Rural Economy in Serbia* written by Marija Drobnjaković, Žaklina Stojanović, and Sonja Josipović) also maps peripheral rural regions (Figure 22.4) from a different perspective. Chapters on environmental pollution and nature conservation and urban problems also meet high standards (Vladimir Stojanović, Milana Pantelić, and Stevan Savić/Nikola Krunić, Aleksandra Gajić, and Dragutin Tošić). The chapter on regional disparities (Dejan Molnar) uses several indicators for 5-6 regions to illustrate inequalities without going into more profound calculations of the Gini- or Hoover index.

Maps, diagrams, and statistics are integral to a work focusing on geographical features. This volume offers a great variety of maps, most of which adequately illustrate the phenomena they are meant to visualize. Both the colour schemes and the depicted indicators are appropriate. However, some topics illustrated on maps would deserve more attention. Figure 5.1 (temperatures) seems to be a weaker solution, especially compared to other figures in the same chapter (or Figure 5.4. in the volume on the regional geography of Bosnia and Herzegovina, which looks way better with its continuous scaling). Some maps (9.2–9.3–9.4 hazard risk maps) are too small; they could have covered a whole page. In the case of geomorphology, I could even imagine a map of dou-

ble page size. On the other hand, some of the larger maps are pretty empty (like the administrative map of Serbia, Figure 4.3, which should have been filled with more content).

I generally miss a map on the geology of Serbia, and geology could have been worth a small chapter (especially compared to the volume on Bosnia and Herzegovina, which contains a more extensive chapter and ten maps on the geological background). At least some pages should have written about the genesis of rocks and landforms, mainly because the text – correctly – emphasizes Serbia's geomorphological diversity. Rocks and formations are mentioned among geoheritage sites (Chapter 9.2.1.) without giving any details on them either there or elsewhere. Given that morphology is determined by the classical triad of material, landform, and process (I used to add time as a fourth dimension), the relative insignificance of geology in this volume is unreasonable. A geological chapter could have contributed to a better balance between the physical geographical, social geographical, and regional geographical chapters. Figure 9.6. could have been larger, and in this case, the name of geoheritage sites could have been inserted. These names might be evident for Serbian readers, but the book is written for foreign readers, even though some typos and terms reveal that an originally Serbian text was translated into English. A map similar to topographic maps of atlases illustrating mountain ranges and significant physical geographical or cultural-ethnographical landscapes (like in the volume on Bosnia and Herzegovina) would also be helpful. I really miss a chapter on electoral geography and its connection with socio-economic features. (The volume on Bosnia and Herzegovina includes several maps illustrating recent outcomes of elections.)

Overall, despite these minor deficiencies, the volume is essential for all geographers, economists, and historians who are dealing with the problems of present-day Serbia or the Balkans, including political isolation, demographic decline, internal democratic deficits, and unilateral dependence on Chinese capital and Russian raw materials.

Gábor Demeter[1]

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2021–2023

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