Hungarian Geographical Bulletin

Volume 72 Number 3 2023

Research Centre for Astronomy and Earth Sciences
GEOGRAPHICAL INSTITUTE

HUNGARIAN GEOGRAPHICAL BULLETIN

Quarterly Journal of the
GEOGRAPHICAL INSTITUTE
RESEARCH CENTRE FOR ASTRONOMY AND EARTH SCIENCES

Indexed by Elsevier-GEOBASE®, Elsevier-SCOPUS®,
EBSCO Information Services, CAB Abstracts, Current Geographical Publications,
Scimago Journal & Country Rank, Google Scholar

HUNGARIAN GEOGRAPHICAL BULLETIN 72 2023 (3)

CONTENT

Igor Kostenko, Alexander Nikiforov and *Evgeny Abakumov:* Comparative characteristics of the meadow soils of the Crimean mountain plateaus 209

Anna Kis, Péter Szabó and *Rita Pongrácz:* Spatial and temporal analysis of drought-related climate indices for Hungary for 1971–2100 223

Oleksiy Gnatiuk and *Mykola Homanyuk:* From geopolitical fault-line to frontline city: changing attitudes to memory politics in Kharkiv under the Russo-Ukrainian war 239

Ildikó Egyed and *Zsuzsanna Zsibók:* Exploring firm performance in Central and Eastern European regions: a foundational approach 257

Dalma Schmeller and *Gábor Pirisi:* Green capital East of the Leitha? The chances and disadvantages of major cities in the Pannonian Basin to win the European Green Capital Award 287

Book review section

Pánek, J. (ed.): Geoparticipatory Spatial Tools. (*Katinka Tóbiás*) 311

DOI: 10.15201/hungeobull.72.3.1 Hungarian Geographical Bulletin **72** 2023 (3) 209–222.

Comparative characteristics of the meadow soils of the Crimean mountain plateaus

Igor KOSTENKO[1], Alexander NIKIFOROV[1] and Evgeny ABAKUMOV[2]

Abstract

The results of studies of mountain-meadow soils of the Crimean Mountain plateaus (yailas) within the range of heights from 580 to 1,493 m a.s.l. are presented. The aim of the research is a comparative analysis of the full-profile soils of the mountain meadows distributed on the western and eastern parts of the Main Ridge of the Crimean Mountains and their correspondence to similar soils of nearby mountain ranges. According to the results obtained, the soils of the western yailas are classified as Phaeozems and Umbrisols, while the eastern ones are mostly classified as Chernic Phaeozems. Chernic Phaeozems differ from Phaeozems and Umbrisols by higher values of the humification rate and the optical density of humic acids. In the humus horizons of Phaeozems and Umbrisols, the average values of the of humification rate varied from 21 to 31 percent, and Chernic Phaeozems from 27 to 34 percent. The optical density varied from 12.7 to 18.7 in Phaeozems and Umbrisols, and from 22.2 to 24.2 in Chernic Phaeozems. The climatic feature of the western yailas is the predominance of winter precipitation, or their relatively uniform distribution between warm and cold seasons, while at the eastern yailas the precipitation of the warm season prevails which may be responsible for the revealed differences in soil properties.

Keywords: Phaeozems, Chernic Phaeozems, Umbrisols, climate, acidity, humus state

Received October 2022, accepted June 2023.

Introduction

The soils of mountain meadows are formed on the plateau or *yailas* (mountain pastures) of the Main Ridge of the Crimean Mountains, having a total area of about 346 km² and confined to the heights of 600–1,545 m a.s.l. These massifs are mainly composed of marble-like limestone and partly conglomerates of Upper Jurassic age (Yena, V.G. *et al.* 2007). The southern part of Crimea belongs to the northern edge of the territory with a Mediterranean climate also classified as hot dry-summer climates or Csa according to the Köppen-Geiger classification (Peel, M.C. *et al*. 2007).

The first mention of mountain-meadow soils we found in Bogoslovsky, N.A. (1987), who described soil on the Ai-Petri plateau, similar in colour and profile structure to the chernozem, but completely leached of carbonates. In subsequent decades, the morphology, the main physical, physical-chemical and chemical properties of mountain-meadow soils were studied and the first attempts to classify them were made (Antipov-Karataev, I.N. and Prasolov, L.I. 1932; Klepinin, N.N. 1935; Mikhailovskaya, O.M. 1939; Kochkin, M.A. 1967; Polovitsky, I.Y. and Gusev, P.G. 1987; Dragan, N.A. 2004).

In recent years, interest in the soils of mountain meadows of the Crimea signifi-

[1] Nikitskiy Botanical Gardens, National Scientific Center, Russian Academy of Sciences, Russia.
[2] Faculty of Biology, Department of Applied Ecology, Saint Petersburg State University, 199034, 16th line of Vasilyevsky Island 29, Saint Petersburg, Russia. Corresponding authors' e-mails: e.abakumov@spbu.ru, e_abakumov@mail.ru

cantly decreased, so in the literature, very little information can be found about the current state of the soils of the mountain plateaus, large areas of which are subject to transformation under anthropogenic pressure (Kostenko, I.V. 2018).

Taking into account the period in the most of the research has been carried out, the questions of diagnosis and classification of such soils according to the modern soil classification systems remain unresolved up to the date. As a result, the authors could refer to the soils of the same territories as different types (Antipov-Karataev, I.N. and Prasolov, L.I. 1932; Klepinin, N.N. 1935; Mikhailovskaya, O.M. 1939; Kochkin, M.A. 1967), since the criteria for their diagnostics had not yet been developed.

According to the Classification and Diagnosis of Soils of the USSR (1977) the meadow soils of the cold and moist mountain regions of temperate latitudes (alpine and subalpine zones) under mesophilic meadows were referred to type of mountain-meadow soils characterized by high acidity, low base saturation, and high soil organic matter (SOM) content. These soils cover the peaks and slopes of mountain ridges and are formed on unsaturated sialitic weathering products of dense sedimentary and massively crystalline rocks. Among them, less acidic and more saturated dark-coloured soils are distinguished, which are formed on leached eluvium of carbonate rocks.

The meadow soils of the temperate humid mountain regions on leached eluvium of carbonate rocks were referred to mountain-meadow chernozem-like soils. Their main features are the closed to black colour of humus horizon with high SOM content, medium acidity and base saturation, and no secondary carbonates in the soil profile.

According to the World Reference Base (WRB) for soil resources (IUSS Working Group WRB, 2015), the soils of mountain meadows with dark, humus-rich surface horizons, which are free of secondary carbonates and less rich in bases in comparison with Chernozems should be referred to Phaeozems. Phaeozems cover the order of 190 million ha worldwide, mainly in the humid and subhumid parts of the plains (WRB, 2015), and in many countries of the Mediterranean region (Soil Atlas of Europe, 2005; Zdruli, P. *et al*. 2010). The mountain-meadow chernozem-like soils should be referred to as the Chernic Phaeozems, a soil with a thick, well-structured, very dark-coloured surface horizon that is the special case of the mollic horizon (WRB, 2015). Chernic Phaeozems are typical for the forest-steppes of plains (National Atlas of Soils of the Russian Federation, 2011; Chizhikova, N.P. *et al*. 2018; Rukhovich, D.I. *et al*. 2018; Mendyk, L. *et al.* 2020; Tóth, T. *et al*. 2022), where Phaeozems are neighbour to Chernozems and occur in depressions with additional runoff that intensifies leaching of carbonates beyond the Luvic horizon of soils (Khitrov, N. *et al*. 2019). There are some evidences on the distribution of Chernic Phaeozems in Botswana's tropics and subequatorial Tanzania (Romanens, R. *et al*. 2019; Jackson, Z. 2021).

The soils with dark, humus-rich surface horizons, but high in acidity and low in bases, should be referred to Umbrisols. These soils develop on weathering material of siliceous or strongly leached basic rocks in the humid climate of mountainous region (Dumig, A. *et al*. 2008; Miechówka, A. *et al.* 2021; Zech, W. *et al.* 2022). In the Mediterranean Umbrisols occur mainly in some regions of Portugal, Spain, and Italy and occasionally are found in the Balkans (Lässiger, M. *et al*. 2008; Zdruli, P. *et al*. 2010; Costantini, E.A.C. *et al*. 2013a; Carballas, T. *et al*. 2016). In the Bieszczadi Mountains of Poland Umbrisols are spread at an elevation about 1,200 m with a mean annual temperature 4 °C and precipitation rate of 1,200–1,300 mm (Musielok, J. *et al*. 2019). These climatic conditions are very close to those of the Crimean Mountains above 1,400 m a.s.l., so Umbrisols may be found above this elevation on the strongly leached products of solid limestone weathering that are the dominant parent rock of the Main Ridge of the Crimean Mountains (Kochkin, M.A. 1967).

The research aims to compare the full-profile soils of the mountain meadows distributed on

the western and eastern parts of the Crimean Mountains and their correspondence to similar soil groups of nearby mountain ranges.

Materials and methods of investigation

The studies were conducted on the western yailas of the Main Ridge of the Mountainous Crimea: Baydar, Ai-Petri, and Gurzuf, as well as on Chatyr-Dag and Dolgorukov yaila, which are part of the system of eastern yailas *(Figure 1).* The range of heights in the places of soil sampling varied from 580 m a.s.l. on the Baydar yaila and up to 1,493 m on the Gurzuf yaila.

The modern relief of the yailas was formed under the influence of karst processes, the action of which led to the formation of a hilly surface with many depressions filled with weathering products of the Upper Jurassic limestone. The thickness of the aluvial-deluvial deposits varies in depressions from 60 to 150 cm, and the thickness of the eluvium on the elevated parts of the plateau rarely exceeds 50–60 cm (Kochkin, M.A. 1967).

Climatic conditions in the Crimean Mountains are well studied due to the presence of dozens of meteorological observation points, which functioned in the entire range of altitudes of the Main Ridge (see Scientific and Applied Reference Book on Climate of the USSR, 1990). Precipitation and temperature were closely correlated with altitude (R^2 = 0.83–0.98), which made it possible to calculate the values of climatic indicators for the objects of research using regression equations *(Table 1).*

Despite the average annual rainfall of the western and eastern parts of the Main Ridge being close, they differ greatly in the sea-

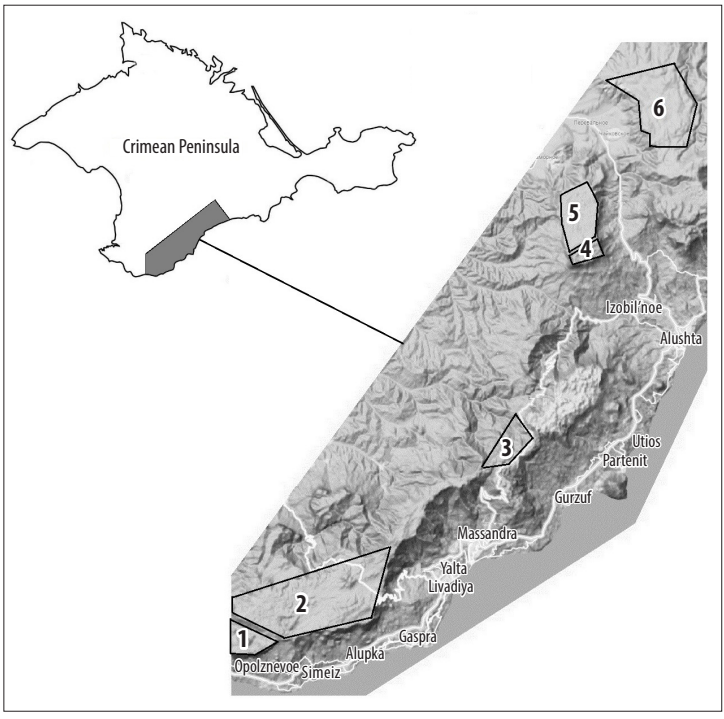


Fig. 1. Location of the research objects (yailas) within the Main Ridge of the Crimean Mountains. 1 = Baydar; 2 = Ai-Petri; 3 = Gurzuf; 4 = Upper Chatyr-Dag; 5 = Lower Chatyr-Dag; 6 = Dolgorukov

*Table 1. Hydrothermal conditions in the places of soil pits**

Profile number, part of the Main Ridge	Temperature, °C			Precipitation, mm		
	XI–III	IV–X	I–XII	XI–III	IV–X	I–XII
Baydar yaila						
1370, Western	0.0	19.6	9.3	423	383	806
Ai-Petri yaila						
1251, Western	–3.6	15.5	5.8	648	404	1,052
Gurzuf yaila						
1385, Western	–5.6	12.1	4.3	506	555	1,061
Upper Chatyr-Dag yaila						
1361, 1369, Eastern	–5.1	13.4	4.7	439	590	1,029
Lower Chatyr-Dag yaila						
1306, Eastern	–2.7	16.8	6.7	420	590	1,010
Dolgorukov yaila						
1372, Eastern	–2.2	17.7	7.3	416	495	911

*According to calculated data.

sonal redistribution. According to the calculated data (see *Table 1*), in the western part, precipitation of the cold season dominates which is typical to the Mediterranean climate (Aschmann, H. 1973), while in the eastern part, most of the precipitation falls in summer.

Meadow steppes, which occupy most of the open spaces of the plateau, form the basis of the Crimean yailas vegetation cover. Tree vegetation on the yailas, except for the lowest Baydar yaila, is fragmentary, confined to the relief elements, protected from the adverse effects of strong winds (Plugatar, Yu.V. 2015). The vegetation composition of meadow steppe communities of the western yailas in the research sites is generally similar to the species composition of the eastern ones (up to 75% of the total species in the plant communities), but there are significant differences in the dominant between them. Thus, *Cariceta humilis* formation is typical for the western yailas and Chatyr-Dag meadow steppe, while *Festuceta callieri* is typical for the eastern part of the Main Ridge.

Soils were described and sampled under meadow vegetation in depression and on the gentle slopes where no sights of soil material washout were observed. These soils were developed on leached skeleton-free weathering products of dense Upper Jurassic limestone. Samples were obtained in continuous order along the entire profile every 10 cm.

In soil samples, pH in KCl suspension was determined at the soil-to-solution ratio 1:2.5; the soil organic carbon (TOC) content was determined according to the dichromate titration method (Walkley, A.J. and Black, I.A. 1934; Kogut, B.M. and Frid, A.S. 1993). This method is aimed for classical organo-mineral soils, thus, we have used it in our work (Polyakov, V. *et al.* 2017). Humic acids (HA) were isolated according to the IHSS protocol (Swift, R.S. 1996 – https://humic-substances.org/isolation-of-ihss-soil-fulvic-and-humic-acids/), were determined by wet digestion method with colourimetric determination of organic carbon according to Practical Guide to Agrochemistry, 2001 (edited by Orlov, D.S. and Grindel, N.M., in Russian); the optical density of the HAs was measured in a solution diluted to a carbon concentration of 50 mg/L ($Ec^{mg/ml}$) with colourimetric determination at a wavelength of 430 nm (Plotnikova, T.A. and Ponomareva, V.V. 1967). The humification rate (HR) of organic matter (OM) was calculated as the percentage of carbon of HA from TOC (Grishina, L.A. and Orlov, D.S. 1978). Particle size distribu-

tion was determined by pipette (sedimentation) method with pyrophosphate dispersion of samples (Shein, E.V. 2001); exchange acidity (H^++Al^{3+}) (Exac) by alkaline titration of 1 M KCl extract; exchange Al^{3+} (Alex) in this extract by colourimetric method with xylene orange; hydrolytic acidity (HAc) according to the modified pH-metric method of Kappen (Yagodin, V.A. *et al.* 1987). The degree of base saturation (BS) was calculated as a percentage of Ca^{2+}+Mg^{2+} from their sum with HAc. The content of dithionite-soluble (non-silicate) iron (Fe_{dit}) was determined according to Coffin; oxalate-soluble (Fe_{ox}) according to Tamm (Zonn, S.V. 1982). Soil optical properties were studied by scanning the wet samples applied to a transparent film (Kostenko, I.V. 2014; Kostenko, I.V. and Opanasenko, N.E. 2020). RGB colour model values were calculated for the obtained scans and used for statistical calculations and visualization of soil horizon colours. The relationship between colour intensity and RGB values is inverse; therefore, the darker the soil, the lower the RGB values.

Statistical analysis

The statistical analysis for a large number of samples was performed using the STATISTICA 6 package. Multiple linear regression analysis was used to establish the main soil factors affecting soil colour intensity, presented as R-RGB values. To demonstrate differences in the effect of organic matter on the colour of chernic and umbric or mollic soil horizons TOC content was plotted against R-RGB values.

Results and discussion

Most of the territory of the Baydar yaila (see *Figure 1*) is covered with forest vegetation, so the full-profile meadow soils were found in a closed depression of about 6 ha, confined to the southern part of the plateau. Such an extensive meadow-steppe area is the only one for this elevation range within the Main Ridge of the Crimean Mountain. The main reason for the formation of a meadow-steppe ecosystem within the depression is the close groundwater table (Nikiforov, A.R. and Kostenko, I.V. 2019), which creates a competitive advantage for the growth of herbaceous species. A similar introduction of the meadow ecosystem into the mountain forest belt under the influence of a complex of external factors has been observed in other mountain regions (Munroe, J.S. 2012). The located within a depression soil profile of Phaeozem 1370 *(Figure 2, Table 2)* consisted of a dark grey with a brownish tint Ah horizon, greyish brown AB horizon, brown with a greyish tint B horizon underlain by pale-brown, carbonate (2% $CaCO_3$) BC horizon. The granular structure was observed in the humus layer of soil while subangular in Bw and BC horizons. The profile was slightly differentiated in texture, so the Bw horizon did not match the criteria of an argic horizon. Within the leached part of the profile, the soil was slightly acidic, deeper – neutral with a high degree of saturation with bases. Fe_{dit} content increased with depth as clay content increased, and Feox content decreased *(Table 3).* The HR of organic matter corresponded to the "average" level, according to Grishina's and Orlov's classification (1978). The values of $Ec^{mg/ml}$ in the Ah horizon were significantly lower compared to the soils of the eastern part of the Main Ridge *(Table 4).*

Ai-Petri yaila is one of the largest plateaus of Crimea, with a very diverse mountain landscape and soils. But in the 20th century, after the construction of the road from Yalta to Bakhchisarai across the plateau, the vegetation and soil cover of yaila was exposed to unfavourable anthropogenic impact for a long time. The most fertile soils were actively exploited as farmland, and then most of them were afforested with *Pinus Sylvestris L.* The preserved meadow areas are still regularly mowed, despite the protected 1974 status of the plateau. Up to date, only small areas of meadows adjacent to natural and artificial forest plantations have remained outside of anthropogenic influence, one of which has been used for soil research.

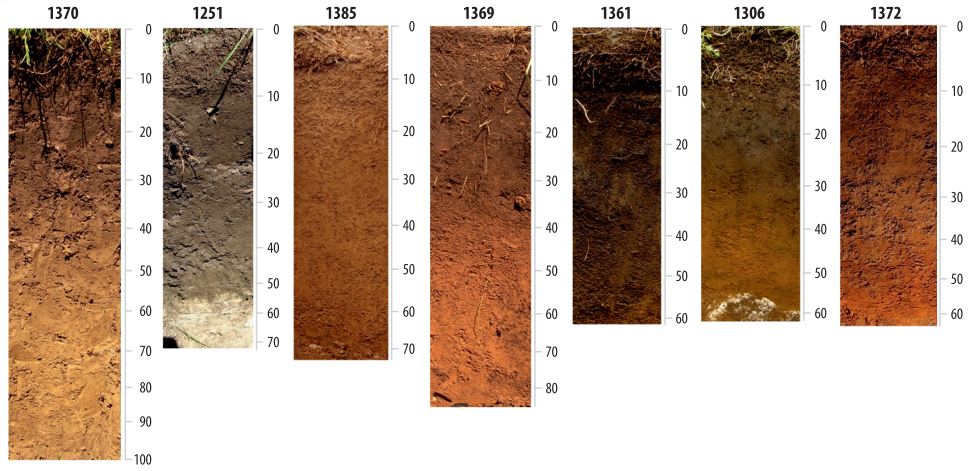


Fig. 2. Profiles of Phaeozems (1370, 1251), Umbrisols (1385, 1369), and Chernic Phaeozems (1361, 1306, 1372) of the Crimean Mountain plateaus

Table 2. Characteristics of the research objects

Profile number, Height a.s.l.	Plateau, relief, plant association, coordinates	Soil types, according to WRB, 2015
1370 580 m	Baydar yaila, sink bottom, *Briza media* + *Poa pratensis* + *Festica pratensis,* 44°25,390′N, 33°50,552′E	Calcaric Leptic Phaeozem (Clayic)
1251 1,122 m	Ai-Petri yaila, plateau, *Arrhenatherum elatius* + *Elytrigia repens,* 44°28,469′N, 34°0,953′E	Cambic Endoleptic Rendzic Phaeozem (Clayic)
1385 1,493 m	Gurzuf yaila, plateau, *Carex humilis* + *Festuca callieri,* 44°35,336′N, 34°12,334′E	Luvic Leptic Umbrisol (Clayic)
1361 1,379 m	Upper Chatyr-Dag, hollow bottom, *Poa pratensis* + *Persicaria bistorta* + *Alchemilla tytthantha,* 44°44,979′N, 34°18,821′E	Luvic Leptic Chernic Phaeozem (Clayic)
1369 1,394 m	Upper Chatyr-Dag, hollow bottom, *Phleum pratense* + *Poa pratensis,* 44°44,886′N, 34°18,332′E	Luvic Leptic Umbrisol (Clayic)
1306 961 m	Lower Chatyr-Dag, slope 10°, *Festuca callieri* + *Elymus reflexiaristatus,* 44°47,789′N, 34°17,170′E	Luvic Leptic Chernic Phaeozem (Clayic)
1395 846 m	Dolgorukov yaila, hollow slope 4–6°, 44°51.918′N, 34 21.942′E	Retic Chernic Phaeozem (Epiloamic, Endoclayic)

The profile of Phaeozem 1251 *(*see *Figure 2,* and *Table 2)* included a dark grey, loose, leached Ah horizon sharply transitioning to a light grey with olive shade C horizon of soil-forming rock consisting of the debris of marl, which contained an average of 42 percent carbonates. The granular structure was recognized in Ah horizon which is typical for humus-rich upper soil layers. The occurrence of loose marl directly under the Ah horizon caused its low acidity and high BS *(*see *Table 3).* The described soil was somewhat inferior to the virgin soil of profile 1370 in the content of TOC in horizon Ah, but due to the greater thickness of the humus horizon,

Table 3. Morphology, physical and chemical properties of analysed soils

Profile	Horizon	Depth, cm	Colour, moist	Structure*	Textural class	pH_{KCl}	$Ca^{2+}+Mg^{2+}$	HAc	Exac/Alex	BS, %	Fe_{dit}	Fe_{ox}
							cmol + kg-1				mg/100 g	
1370	Ah	0–10	2.5Y 2.5/1	G	Silty Clay Loam	5.65	31.0	4.4	–	88	1,548	460
	A	10–30	2.5Y 4/1	G	Silty Clay Loam	5.66	29.6	3.9	–	88	1,709	391
	AB	30–50	5Y 4/2	G	Silty Clay	5.81	28.9	2.1	–	93	1,906	199
	Bw	50–80	5Y 6/2	SB	Silty Clay	6.15	28.5	1.1	–	96	1,957	126
	BC	80–100	5Y 6/3	SB	Silty Clay	6.92	–	–	–	–	1,947	83
1251	Ah	0–10	2.5Y 2.5/2	G	Silty Clay	5.66	35.2	4.0	–	90	–	–
	A	10–50	5Y 3/1	G	Silty Clay	5.50	35.8	3.9	–	90	–	–
	C	50–80	2.5Y 6/2	SB	Silty Clay	–	–	–	–	–	–	–
1385	Ah	0–10	2.5YR 4/1	G	Silty Clay Loam	4.06	13.3	14.2	3.02/2.11	48	2,585	428
	A	10–30	2.5Y 4/3	G	Silty Clay Loam	3.90	10.4	15.1	7.42/5.90	41	2,684	414
	AB	30–50	2.5Y 5/4	G	Silty Clay	3.86	13.3	13.8	7.53/6.46	49	2,692	294
	Bt	50–70	2.5Y 4/3	SB	Silty Clay	3.93	23.2	10.7	4.27/3.22	68	2,808	235
1361	Ah	0–10	2.5Y 3/1	G	Silt Loam	4.48	25.1	13.1	1.52/1.68	66	1,860	568
	Ah1	10–30	2.5Y 3/3	G	Silty Clay Loam	4.11	19.4	13.3	2.91/2.21	59	2,026	585
	ABt	30–50	2.5Y 5/4	SB	Silty Clay	4.11	21.0	10.8	2.28/1.94	66	2,140	462
1369	Ah	0–10	7.5YR 2.5/1	G	Silt Loam	3.92	14.8	16.4	2.43/1.51	47	1,869	441
	A	10–30	7.5YR 4/1	G	Silty Clay Loam	3.78	10.7	15.4	6.30/5.43	41	2,050	411
	AB	30–50	7.5YR 4/3	G	Silty Clay	3.71	10.8	15.6	8.75/7.93	41	2,120	273
	Bt	50–80	7.5YR 4/4	SB	Silty Clay	3.79	21.5	10.1	4.90/4.01	68	2,103	174
1306	Ah	0–10	5Y 2.5/1	G	Silt Loam	4.54	36.1	13.8	0.30/0.12	72	1,956	317
	Ah1	10–30	10YR 2/1	G	Silty Clay Loam	4.07	29.6	15.3	2.20/1.56	66	2,240	322
	Bt	30–50	10YR4/4	SB	Silty Clay	4.15	31.4	8.5	1.70/1.28	79	2,183	187
1395	Ah	0–10	5 YR 2.5/1	G	Silt Clay Loam	4.95	28.4	8.7	–	77	2,232	338
	Ah1	10–40	5YR 2.5/1	G	Silt Clay Loam	4.61	24.7	9.7	–	72	2,328	334
	AB	40–60	2.5 YR 4/3	SB	Silt Clay Loam	4.48	18.5	6.0	–	76	2,056	262
	Bt	60–100	5 Y 6/2	AB	Silty Clay	4.43	25.6	4.8	–	84	2,241	263

*Structure: G = granular, SB = subangular blocky, AB = angular blocky.

Table 4. Indicators of humus status and optical characteristics of mountain meadow soils of the Crimea

Profile	Horizon	Depth, cm	TOC	HR	$Ec^{mg/ml}$	R	G	B	Colour of soil samples
			%						
1370	Ah	0–10	5.92/38.6*	21	11.5	60	52	29	
	A	10–30	4.13	23	14.6	69	60	35	
	AB	30–50	1.86	22	17.8	90	78	46	
	Bw	50–80	1.09	17	20.0	117	102	57	
	BC	80–100	0.95	–	–	105	92	54	
1251	Ah	0–10	5.31/41.0	21	16.9	58	47	18	
	A	10–50	3.42	25	17.5	64	54	34	
	C	50–80	0.81	22	15.9	136	118	77	
1385	Ah	0–10	5.19/30.1	27	10.9	64	46	17	
	A	10–30	2.67	32	13.0	75	54	20	
	AB	30–50	1.71	30	10.1	94	70	31	
	Bt	50–70	1.01	33	5.6	108	77	35	
1361	Ah	0–10	11.3/63.5	24	17.7	27	20	4	
	Ah1	10–30	6.16	28	24.4	35	24	5	
	ABt	30–50	2.93	24	24.0	64	46	16	
1369	Ah	0–10	8.84/45.3	18	15.8	44	32	12	
	A	10–30	4.43	22	20.1	56	43	19	
	AB	30–50	1.67	18	16.2	87	62	26	
	Bt	50–80	0.89	8	7.1	107	74	34	
1306	Ah	0–10	7.45/38.7	30	18.1	27	19	4	
	Ah1	10–30	3.61	36	26.6	34	23	7	
	Bt	30–50	1,64	16	19.0	88	60	23	
1395	Ah	0–10	8.79/52.5	32	18.2	26	17	4	
	Ah1	10–40	4.82	46	21.8	30	21	6	
	AB	40–60	1.10	46	26.0	71	48	17	
	Bt	60–100	0.78	29	14.8	105	67	26	

*SOM stocks in the layer of 0–50 cm, kg/m^2.

it surpassed it in the total organic matter stocks in the 0–50 cm layer. Both soils had practically equal HR, but the soil of profile 1251, formed in colder and wetter conditions, was distinguished by higher values of $Ec^{mg/ml}$ and due to this, a slightly greater intensity of colouring of Ah horizon (see *Table 4*).

Gurzuf yaila is a part of the Crimean Natural Reserve, where soils are subject to much less anthropogenic influence compared to mountain plateaus outside of protected areas. On the other hand, the reserve status contributes to the constant growth of the wild boar population, which regularly destroys the sod layer, interrupting the normal course of the soil-forming process.

Located in a small depression on Gurzuf yaila, the profile of Umbrisol 1385 (see *Figure 2*, and *Table 2*) consisted of grey with brown tint Ah horizon, brown with grey tint AB horizon and brown Bt horizon underlay by a mixture of limestone debris with clay. The texture class of this Umbrisol varied from Silty Clay Loam to Silty Clay, so the Bt horizon met the criteria of argic horizon. A granular structure was observed in the humus layer of soil while subangular in the Bt horizon. This soil was formed in the coldest and most humid conditions at the top level of the Crimean Mountains, promoting the intensive leaching of carbonates and bases. As can be seen from the data in *Table 3*, the pH values of the described soil are markedly lower

compared to the soils of Baydar and Ai-Petri yailas, and HAc respectively higher, which along with the low bases content caused the BS within most of the profile less than 50 percent. Exac also reached high values, the proportion of Al^{3+} in which ranged from 70 to 85 percent (see *Table 3*). The content of Fe_{dit} and Fe_{ox} in Umbrisol of Gurzuf yaila was much higher as compared to Phaeozem of Baydar yaila *(see Table 3).*

TOC in profile 1385 was lower than in the profiles of 1370 and 1251. In addition to the relatively low humus content, the organic matter of profile 1385 was characterized by very low values of $Ec^{mg/ml}$. The combination of these factors caused a lower colour intensity of Ah horizon in comparison with the soils of the Baydar and Ai-Petri plateaus *(see Table 4).*

The soils described above occur within a single mountain range, which stretches from the Baydar valley in the northeast direction for about 50 km along the south-eastern coast of Crimea and is contingently divided into separate yailas. Chatyr-Dag and Dolgorukov mountain ranges are located apart and separated from the western part of the Main Ridge by deep gaps *(see Figure 1).*

Chatyr-Dag is divided into upper and lower plateaus, both of which are part of the Crimea Nature Reserve. The upper plateau rises about 300 m above the lower one and, unlike the rest of the Crimean yailas, is available only for hiking that contributed to the preservation of soils in their original state.

In a small hollow on the upper plateau of Chatyr-Dag, profile 1361 of Chernic Phaeozem was studied *(see Figure 2,* and *Table 2).* It consisted of a dark grey, close to black in the wet state Ah, and greyish-brown AB horizons, underlain by limestone debris. Granular and subangular structure was observed throughout the profile. The texture class of the soil varied from Silt Loam in the Ah horizon to Silty Clay at the bottom, indicating the presence of the Argic horizon in the lower part of the profile *(see Table 3).* According to the values of pH, HAc, and Exac/Alex, this soil is more acidic compared to Phaeozems of Baydar and Ai-Petri yailas because it was formed in conditions of excessive moisture at the height of more than 1,400 m a.s.l. *(see Table 1).*

The content of TOC and stocks of SOM in the 0–50 cm layer of Chernic Phaeozem, as well as HR and $Ec^{mg/ml}$ values, greatly exceed these soil indicators in Phaeozems of 1370 and 1251 soil profiles. Due to a combination of these factors, the Ah horizon of 1361 soil profile had a more intense colour compared to the soils of the western yailas *(see Table 4).*

In a deeper and wetter hollow 650 m west of the Chernic Phaeozem, the profile of Umbrisol was described (*Table 2*, profile 1369). It consisted *(see Figure 2)* of dark grey with brown tint Ah horizon, followed by brown with grey tint AB and brown Bt horizons, underlain by limestone debris *(see Table 3).* The granular structure was observed in humic and subangular in Bt soil horizons. The texture class was similar to the profile of Chernic Phaeozem. This soil was formed in wetter conditions than Chernic Phaeozem, so it was characterized by higher values of acidity and very lower values of BS, which are more typical for the forest of the Crimean Mountain Plateaus (Kostenko, I.V. 2014). The content of Fe_{dit} was lower and Fe_{ox} was almost the same as compared to the Umbrisol 1385 profile. To both profiles of Umbrisols, the high level of Exac/Alex was typical *(see Table 3).*

Despite the formation under a thick grass stand in similar positions along the relief, the indicators of the humus state of the two soils on the upper plateau of Chatyr-Dag also differed markedly. The profile 1369 of Umbrisol contained almost one and a half times less of SOM and had lower the HR both $Ec^{mg/ml}$ values, which resulted in a less intense colouring of the humus horizon as compared to the Chernic Phaeozem profile 1361 *(see Table 4).*

At the northern extremity of the lower Chatyr-Dag a Chernic Phaeozem in the meadow area located inside the forest massif was studied (profile 1306, see *Figure 2*, and *Table 2*). Its profile consists of a dark grey, black in the wet state, very loose horizon Ah and a brown, dense horizon Bt, underlain by the dense limestone. Like the soils of Gurzuf

and upper Chatyr-Dag these profiles were strongly differentiated in texture, having argic horizon at the contact with continuous rocks *(see Table 3)*. A few years later, the soil cover in these areas was destroyed by wild boars, which dug up the soil to the rock in some places, disrupting the natural sequence of soil horizons.

Chernic Phaeozems of upper and lower Chatyr-Dag, despite the different thermal regime *(see Table 1)*, characterized by close pH, HAc and Exac/Alex values, and slightly differed in BS due to higher bases content in profile 1306. The content of Fe_{dit} in the soil of the plateaus differed insignificantly, and a greater amount of Fe_{ox} was noted in profile 1361 *(see Table 3)*.

The TOC content and the total SOM stocks in profile 1306 were lower as compared to the Chernic Phaeozem of the upper plateau. However, the HR and Ecmg/ml values of the profile 1306 were markedly higher, resulting in the Ah horizon colouring intensity close to that of profile 1361 with its much higher TOC content *(see Table 4)*.

The Dolgorukov yaila is separated from Chatyr-Dag by the Salgir river valley and is not part of the Crimea Nature Reserve. As a result, its soil cover has been under strong anthropogenic pressure (grazing, mowing, removal of the fertile layer, use as a military training ground, etc.) for a long period. This makes it challenging to choose undisturbed soils, which can occur only in different hollows and sinkholes.

One more example of Crimean Mountain Chernic Phaeozem was described at the slope of hollows (profile 1395, see *Figure 2*, and *Table 2*). This profile consists of a dark gray, black in the wet state Ah horizon, brown with a whitish tint horizon B (Greyzemic), and brown Bt horizon under continuous limestone rock. This profile is different from other soils of mountain meadows by the thickness of more than 1 m and by the whitish plaque on the faces of aggregates in AB horizon.

Compared to the Chernic Phaeozems of Chatyr-Dag, the soil of profile 1395 is characterized by higher pH, lower HAc, Exac/Alex, and higher content of both forms of Fe *(see Table 3)*. TOC content and stocks of SOM of profile 1395 were intermediate between profiles 1361 and 1306, HR much higher and $Ec^{mg/ml}$ close to them. According to the RGB values, the intensity of colouration all of the Chernic Phaeozem was very close but greatly different from that of Phaeozem and Umbrisols *(see Table 4)*. The latter is confirmed by scattering of R-RGB values in samples of chernic and other horizons of the Mountain Crimea meadow soils *(Figure 3)*. According to these data soils with the same TOC content different greatly in R-RGB because of higher HR both $Ec^{mg/ml}$ values of chernic horizons organic matter.

The multiple regression analysis of the data for a large number of samples of Phaeozems and Umbrisols showed that the R-RGB values also were influenced by the content of Fe_{dit}. The content of humic acids carbon (HA) and $Ec^{mg/ml}$ was used for these calculations. The results of calculation for Phaeozems and Umbrisols revealed a high coefficient of determination (R^2 = 0.86; n = 147) and both high correlation for carbon of HA (r = -0.92), $Ec^{mg/ml}$ (r = -0.76) and medium for Fe_{dit} (r = 0.51). For the Chernic Phaeozems obtained similar results for the coefficient of

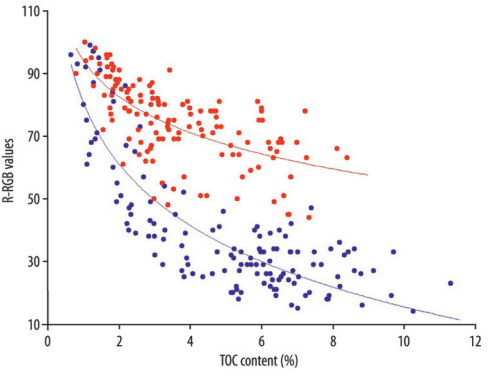


Fig. 3. The influence of TOC content on R-RGB values in soils samples of chernic (blue circles, n = 147), and mollic + umbric (red circles, n = 147) soil horizons

determination (R^2 = 0.92; n = 147) both correlation for carbon of HA (r = -0.96), $Ec^{mg/ml}$ (r = -0.75), and very low for Fe_{dit} (r = 0.21). The latter is explained by the influence of dark-coloured OM of chernic horizons, which masks free iron and carbonates, weakening their effect on soil colour.

A comparative analysis of the soils of the mountain meadows of the Crimea and nearby mountain systems revealed both a number of common features and significant differences due, above all, to their confinement to different natural zones. Thus, mountain-meadow soils (Phaeozems, Umbrisols) of the highlands of the Northern Caucasus are formed within the 1,500–3,500 m altitude, which is higher than the maximum elevations of the Crimean plateaus, in conditions of a humid and cool climate with an average annual temperature of -2.9 – +2.3 °C and an amount of precipitation of about 900 mm (Molchanov, E.N. 2010; Volokitin, M.P. 2012). The mountain-meadow chernozem-like soils (Chernic Phaeozems) in the central part of the North Caucasus occur below 1,100–2,000 m (Molchanov, E.N. 2008), in the western Caucasus from 1,200 to 3,100 m, and in the eastern Caucasus from 1,700 to 2,800 m (Fiapshev, B.Kh. 1977; Molchanov, E.N. 2008). Judging by the published data, the mountain-meadow subalpine soils of the Caucasus (Molchanov, E.N. 2010) are close to the Umbrisols of Crimea, confined to the highest plateau positions on Gurzuf yaila (profile 1385) and upper Chatyr-Dag (profile 1369) by values of acidity and composition of exchange bases. At the same time, the Phaeozems of the Crimea differ from similar soils of the Western and Eastern Caucasus (Molchanov, E.N. 2010) by higher acidity and lower BS. The content of TOC in Ah horizons of mountain-meadow subalpine and chernozem-like soils of the Caucasus, according to the available data (Molchanov, E.N. 2008; 2010), is close to its amount in the Phaeozems and Chernic Phaeozems of the Crimean Mountains.

In general, mountain-meadow soils (Umbrisols, Phaeozems) developed on carbonate soil-forming rocks are confined to cool and moist habitats of the alpine and subalpine zones of the Caucasus, while chernozem-like soils (Chernic Phaeozems) are confined to warmer and drier ones (Classification and Diagnosis of Soils of the USSR, 1977; Fiapshev, B.Kh. 1977; Molchanov, E.N. 2008, 2010). Therefore, mountain-meadow soils differ from chernozem-like soils by higher acidity and lower BS. In the Crimea, where the top of yailas does not reach the lower level of the subalpine belt of close latitudes (Grebenshchikov, O.S. 1974), this pattern is broken, as Phaeozems and Umbrisols are formed in the whole range of thermal conditions in the western part of the Main Ridge. Thus, the Phaeozem of the Baydar yaila was formed under warmer and drier conditions compared to the Chernic Phaeozems of Chatyr-Dag and Dolgorukov yailas *(*see *Table 1).* The latter can be explained by the difference between the eastern and western parts of the Main Ridge in the seasonal distribution of precipitation, as mentioned above.

The feature of the soils of the Crimean mountain meadows is that they are formed in the altitude range corresponding to the forest zone, the upper limit of which at latitudes close to the Crimea is within 1,700–2,300 m a.s.l. (Grebenshchikov, O.S. 1974). So, based on the climatic indicators of the Crimean mountain plateaus, they should be covered with forest vegetation. However, pollen analysis by Artyuschenko, A.T. and Mishnev, V.G. (1978) revealed that there had been no forest belt on the yailas since the Pleistocene. The vegetation in the past, as now, consisted of shrubs and herbaceous plants, and tree species grew mainly in closed depressions where they were not subjected to the adverse effect of strong winds.

In other mountain systems at such heights, Umbrisols and Phaeozems are predominantly formed under forest and shrub vegetation, as evidenced by the data of Costantini, E.A.C. *et al*. (2013b), Giordano, A. (2013), Carballas, T. *et al*. (2016), and Zech, W. *et al*. (2022).

The relief of the Crimean plateaus, with a predominance of gentle slopes and various depressions, is favourable for accumulat-

ing loose, non-skeletal weathering products of limestone, whose thickness can reach 1.0–1.5 m or more. Additional moisture influx contributes to the intensive leaching of bases beyond the soil horizons and the formation of neutral soils within the lower altitudes (500–700 m a.s.l.) and strongly acidic soils within the upper (1,300–1,500 m a.s.l.) mountain belt. But as usual, mountain soils contain some amount of skeletal particles and are neutral or slightly alkaline when form on carbonate rocks (Classification and Diagnosis of Soils of the USSR, 1977; Zdruli, P. *et al*. 2010; Carballas, T. *et al*. 2016; Musielok, J. *et al*. 2019).

Conclusions

Fully developed soils of the Crimean mountain plateaus, according to WRB are represented by Phaeozems and Umbrisols with the mollic horizon (mountain-meadow and mountain-meadow dark-coloured soils in classification of 1977 year) and by Chernic Phaeozems (mountain-meadow chernozem-like soils), formed on sialitic weathering crust of dense Upper Jurassic limestone.

The virgin variants of these soils are characterized by similar values of humus content and thickness of the humus horizons but differ in the intensity of their colouration, which is caused by higher values of soil organic matter HR and $Ec^{mg/ml}$ values of Chernic Phaeozems compared to Phaeozems and Umbrisols with mollic horizon. With increasing altitude above sea level, an increase in acidity of mountain soils, characteristic of the vertical-zonal series, was observed.

Phaeozems and Umbrisols are common on Baydar and Ai-Petri plateaus, where they are formed in conditions of the Mediterranean type of precipitation distribution with a maximum in the cold season, and on Gurzuf plateau in conditions of relatively uniform seasonal moisture.

Chernic Phaeozems are found on the lower Chatyr-Dag and on the Dolgorukov yailas, where the maximum precipitation occurs in the warm season, which is also typical for the Chernozems of plains. Upper Chatyr-Dag is a transition zone between the Umbrisols and Chernic Phaeozems, since a combination of both groups of soils characterizes its territory.

The peculiarities of the meadow soils of the Mountain Crimean in comparison to Phaeozems and Umbrisols of mountain systems of nearby mountain systems are that Crimean meadow soils have formed in warmer and drier conditions besides the limits of alpine and subalpine belts on strongly leached non-skeletal fine earth depositions. Virgin Umbrisols and Phaeozems occur only under meadow vegetation, whereas disturbed Phaeozems also are widely distributed under artificial forest plantations.

REFERENCES

Antipov-Karataev, I.N. and Prasolov, L.I. 1932. Soils of the Crimean State Forest Reserve and adjacent territories. In *Proceedings of the Soil Institute named after V.V. Dokuchaev*. Leningrad, Publishing House of the Academy of Sciences of the USSR, 141–150. (in Russian)

Artyuschenko, A.T. and Mishnev, V.G. 1978. *The History of Vegetation of the Crimean Yaila and Adjacent to the Yaila Slopes in the Holocene*. Kyiv, Naukova Dumka. (in Russian)

Aschmann, H. 1973. Distribution and peculiarity of Mediterranean ecosystems. In *Mediterranean Type Ecosystems.* Ecological Studies 7. Eds.: di Castri, F. and Mooney, H.A., Berlin–Heidelberg, Springer, 11–19. Available at https://doi.org/10.1007/978-3-642-65520-3_2

Bogoslovsky, N.A. 1987. A few words on the soils of the Crimea. *Proceedings of the Geological Committee* 16. (8–9): 279–289. (in Russian)

Carballas, T., Rodríguez-Rastrero, M., Artieda, O., Gumuzzio, J., Díaz-Raviña, M. and Martín, Á. 2016. Soils of the temperate humid zone. In *The Soils of Spain.* Ed.: Gallardo, J.F., Berlin, Springer, 49–144. Available at https://link.springer.com/chapter/10.1007/978-3-319-20541-0_3

Chizhikova, N.P., Gamzikov, G.P. and Chechetko, E.S. 2018. Specific features of profile distribution and crystallochemistry of phyllosilicates in soils of the Cisbaikal forest-steppe. *Eurasian Soil Science* 51. (1): 96–111. Available at https://doi.org/10.1134/S1064229318010052

Classification and Diagnosis of Soils of the USSR 1977. Moscow, Kolos. (in Russian)

Costantini, E.A.C., Barbett, R.I, Fantappiè, M., L'Abate, G., Lorenzetti, R. and Magini, S. 2013a. Pedodiversity. In *The Soils of Italy*. Eds.: Costantini, E.A.C. and Dazzi C., Dordrecht, Springer Science and Business Media, 105–178. Available at https://doi.org/10.1007/978-94-007-5642-7

Costantini, E.A.C., Fantappié, M. and L'Abate, G. 2013b. Climate and pedoclimate of Italy. In *The Soils of Italy*. Eds.: Costantini, E.A.C. and Dazzi C., Dordrecht, Springer Science and Business Media, 19–37. Available at https://doi.org/10.1007/978-94-007-5642-7

Dragan, N.A. 2004. *Soil Resources of the Crimea*. Scientific monograph, 2nd edition and extra. Simferopol, DOLYA. (in Russian)

Dumig, A., Schad, P., Kohok, M., Beyerlein, P., Schwimmer, W. and Kogel-Knabner, I. 2008. A mosaic of non-allophanic Andosols, Umbrisols and Cambisols on rhyodacite in the southern Brazilian highlands. *Geoderma* 145. 158–173. Available at https://doi.org/10.1016/j.geoderma.2008.01.013

Fiapshev, B.Kh. 1977. Genetic features of mountain-meadow chernozem-like soils of central part of Northern Caucasus. *Soil Science* 3. 25–34. (in Russian)

Giordano, A. 2013. Vegetation and land use. In *The Soils of Italy*. Eds.: Costantini, E.A.C. and Dazzi C., Dordrecht, Springer Science and Business Media, 57–92. Available at https://doi.org/10.1007/978-94-007-5642-7

Grebenshchikov, O.S. 1974. On vegetation zonality in the Mediterranean mountains in the latitudinal band of 35–40°N. *Problems of Botany* 12. C. 128–134. (in Russian)

Grishina, L.A. and Orlov, D.S. 1978. System of indicators of humus condition of soils. In *Problems of Soil Science*. Moscow, Nauka, 42–47. (in Russian)

IUSS Working Group WRB 2015. *World Reference Base (WRB) for Soil Resources 2014*. Update 2015. International soil classification system for naming soils and creating legends for soil maps. World Soil Resources Reports No. 106. Rome, FAO.

Jackson, Z. 2021. Land evaluation and suitability assessment for crops produced in Butuguri area, Butiama district in Mara region, Tanzania. *Afribary*. Africa's Online Library. Lagos, Afribary Ltd. Available at https://afribary.com/works/land-evaluation-and-suitability-assessment-for-crops-produced-in-butuguri-area-butiama-district-in-mara-region-tanzania-1

Khitrov, N., Smirnova, M., Lozbenev, N., Levchenko, E., Gribov, V., Kozlov, D., Rukhovich, D., Kalinina, N. and Koroleva, P. 2019. Soil cover patterns in the forest-steppe and steppe zones of the East European Plain. *Soil Science Annual* 70. (3): 198–210. Available at http://ssa.ptg.sggw.pl/issues/2019/703

Klepinin, N.N. 1935. *Soils of the Crimea*. Simferopol, State Publishing House of the Crimean ASSR. (in Russian)

Kochkin, M.A. 1967. Soils, forests and climate of the Crimean Mountains and the ways of their rational use. In *Proceedings of the State Nikitsky Botanical Garden* 38. Yalta, NBG. (in Russian)

Kogut, B.M. and Frid, A.S. 1993. Comparative evaluation of methods for determining the content of humus in soils. *Pochvovedenie* 9. 119–123.

Kostenko, I.V. 2014. *Atlas of Soils of the Crimean Mountains*. Kiev, Agrarnaya Nauka.

Kostenko, I.V. 2018. Influence of artificial forest plantations on mountain-meadow soils of the Crimea. *Eurasian Soil Science* 5. 515–525. Doi: 10.7868/S0032180X180500

Kostenko, I.V. and Opanasenko, N.E. 2020. Comparative characteristic of mountain-forest and mountain-meadow soils of Dolgorukovskaya Yaila (Mountain Crimea). *Soil Science* 7. 791–802. Doi: 10.31857/ S0032180X20070072

Lässiger, M., Scheithauer, J. and Grunewald, K. 2008. Preliminary mapping and characterisation of soils in the Pirin Mountains (Bulgaria). *Journal of Mountain Science* 5. 122–129. Available at https://doi.org/10.1007/s11629-008-0133-9

Mendyk, L., Hulisz, P., Świtoniak, M., Kalisz, B. and Spychalski, W. 2020. Human activity in the surroundings of a former mill pond (Turznice, N Poland): Implications for soil classification and environmental hazard assessment. *Soil Science Annual* 71. (4): 371–381. Available at https://doi.org/0.37501/soilsa/131617

Miechówka, A., Zadrożny, P., Mazurek, R. and Ciarkowska, K. 2021. Classification of mountain non-forest soils with umbric horizon: A case study from the Tatra Mountains (Poland). *Soil Science Annual* 72. (1): 134619. Available at https://doi.org/10.37501/soilsa/134619

Mikhailovskaya, O.M. 1939. Soils of mountainous Crimea. In *Soils of Forest-steppe and Steppe Regions*. Soils of the USSR, Vol. 3. Ed.: Prasolov, L.I., Moscow, USSR Academy of Sciences, 357–375. (in Russian)

Molchanov, E.N. 2008. Formation of mountain-meadow chernozem-like soils of high mountains of Northern Caucasus. *Soil Science* 12. 1438–1452.

Molchanov, E.N. 2010. Mountain-meadow soils of high mountains of Western Caucasus. *Eurasian Soil Science* 12. 1433–1448.

Munroe, J.S. 2012. Physical, chemical, and thermal properties of soils across a forest-meadow ecotone in the Uinta Mountains, Northeastern Utah, U.S.A. *Arctic, Antarctic, and Alpine Research* 44. (1): 95–106. Available at https://doi.org/10.1657/1938-4246-44.1.95

Musielok, J., Drewnik, M., Szymacski, W. and Stolarczyk, M. 2019. Classification of mountain soils in a subalpine zone: A case study from the Bieszczadi Mountains (SE Poland). *Soil Science Annual* 70. (2): 170–177. Available at https://doi.org 0.2478/ssa-2019-0015

National Atlas of Soils of the Russian Federation 2011. Moscow, Astril AST. Available at https://soil-db.ru/soilatlas/ (in Russian)

Nikiforov, A.R. and Kostenko, I.V. 2019. Soil and vegetation of the karst sinkhole of the western spur of the Ai-Petri plateau in the Mountain Crimea. *Ecosystems* 19. (49): 54–60.

Peel, M.C., Finlayson, B.L. and McMahon, T.A. 2007. Updated world map of the Köppen-Geiger climate classification. *Hydrology and Earth System Sciences* 11. 1633–1644. Available at https://doi.org/10.5194/hess-11-1633-2007

Plotnikova, T.A. and Ponomareva, V.V. 1967. Simplified version of method for determination of optical density of humus substances with one light filter. *Soil Science* 7. 73–85. (in Russian)

Plugatar, Yu.V. 2015. *Forests of the Crimea*. Monograph. Simferopol, IT ARIAL. (in Russian)

Polovitsky, I.Y. and Gusev, P.G. 1987. *Soils of the Crimea and Increasing their Fertility*. Simferopol, Tavria. (in Russian)

Polyakov, V., Orlova, K. and Abakumov, E. 2017. Evaluation of carbon stocks in the soils of Lena River Delta on the basis of application of "dry combustion" and Tyurin's methods of carbon determination. *Biological Communications* 62. (2): 67–72. Available at https://doi.org/10.21638/11701/spbu03.2017.202

Romanens, R., Pellacani, F., Mainga, A., Fynn, R., Vittoza, P. and Verrecchi, E. 2019. Soil diversity and major soil processes in the Kalahari basin, Botswana. *Geoderma Regional* 19. e00236. Available at https://doi.org/10.1016/j.geodrs.2019.e00236

Rukhovich, D.I., Rukhovich, A.D., Rukhovich, D.D., Simakova, M.S., Kulyanitsa, A.L. and Koroleva, P.V. 2018. Application of the spectral neighborhood of soil line technique to analyze the intensity of soil use in 1985–2014 (by the example of three districts of Tula Oblast). *Eurasian Soil Science* 51. (3): 345–358. Available at https://doi.org/10.1134/S1064229318030110

Scientific and Applied Reference Book on Climate of the USSR 1990. Series 3. Multiyear data. Part 1-6. Vol. 10. Ukrainian SSR. Book 1. L., Kiev, Gidrometeoizdat. (in Russian)

Shein, E.V. (ed.) 2001. *Field and Laboratory Methods for the Study of Physical Soil Properties and Regimes: Methodological Guide, 2001.* Moscow, Publishing House of Moscow State University. (in Russian)

Soil Atlas of Europe 2005. Brussels, European Soil Data Centre (ESDAC), JRC, European Commission.

Swift, R.S. 1996. Organic matter characterization. In *Methods of Soil Analysis. Part 3. Chemical Methods.* Eds.: Sparks, D.L., Page, A.L., Helmke, P.A. and Loepert, R.H., SSSA Book Series No 5., Madison, WI, USA, SSSA–ASA, 1011–1069. Available at https://doi.org/10.2136/sssabookser5.3.c35

Tóth, T., Novák, T., Makó, A., Gallai, B., Czigány, Sz., Árvai, M., Mészáros, J., Kocsis, M., László, P., Koós, S. and Balog, K. 2022.Class separability, correlation to biomass, parsimony and homogeneity of classes as criteria to decide on the goodness-of-classification when comparing Hungarian soil classification to World Reference Base inside a slightly saline plot. *Agrochemistry and Soil Science* 71. (1): 149–182. Available at https://doi.org/10.1556/0088.2022.00121

Volokitin, M.P. 2012. Mountain-meadow soils of the Central Caucasus and the influence of vegetation on their formation. *Izvestiya Samara Scientific Center of the Russian Academy of Sciences* 14. (5): 36–44. (in Russian) Available at https://cyberleninka.ru/article/n/gornolugovye-pochvy-tsentralngo-kavkaza-i-vliyanie-rastitelnosti-na-ih-formirovanie/viewer

Walkley, A.J. and Black, I.A. 1934. Estimation of soil organic carbon by the chromic acid titration method. *Soil Science* 37. 29–38.

Yagodin, V.A., Deryugin, I.P. and Zhukov, Y.P. 1987. *Practical Guide to Agrochemistry*. Moscow, Agropromizdat. (in Russian)

Yena, V.G., Yena, Al.V. and Yena, An.V. 2007. *Discoverers of the Crimean Land*. Simferopol, Business Inform. (in Russian)

Zdruli, P., Kapur, S. and Çelik, I. 2010. Soils of the Mediterranean region, their characteristics, management and sustainable use. In *Sustainable Land Management.* Eds.: Kapur, S., Eswaran, H. and Blum, W., Berlin–Heidelberg, Springer, 125–142. Available at https://doi.org/10.1007/978-3-642-14782-1_4

Zech, W.,·Schad, P. and·Hintermaier-Erhard, G. 2022. *Soils of the World*. Berlin–Heidelberg, Springer. Available at https://doi.org/10.1007/978-3-540-30461-6

Zonn, S.V. 1982. *Iron in Soils (Genetic and Geographical Aspects*). Moscow, Nauka. (in Russian).

DOI: 10.15201/hungeobull.72.3.2 Hungarian Geographical Bulletin **72** 2023 (3) 223–238.

Spatial and temporal analysis of drought-related climate indices for Hungary for 1971–2100

Anna KIS, Péter SZABÓ and Rita PONGRÁCZ[1]

Abstract

The lack of precipitation may cause severe damage in different sectors, especially in agriculture and forestry, therefore, its analysis is a key element of adaptation strategies in the changing climate. In the present study, we selected different climate indices as important indicators for forests to investigate the current and future wet and dry conditions in summer in Hungary. For the historical period (from 1971), the observation-based HuClim dataset is used, which already shows a slight drying trend in the past 50 years, especially in June. For the future, regional climate model simulations from the EURO-CORDEX program are used, taking into account two different RCP scenarios (a business-as-usual scenario and an intermediate mitigation scenario, i.e., RCP8.5 and RCP4.5, respectively). Since mitigation starts to affect the climate system after about 20 years, results do not differ substantially for the two scenarios until 2060, however, the simulated changes highly depend on the applied RCP scenario in the late 21st century. Based on the De Martonne Index, a large expansion of semi-arid conditions is projected for the future in July and even more in August. The analysis of the Forestry Aridity Index shows that the steppe category will become dominant in 2081–2100, while the category optimal for beech may disappear entirely from Hungary according to the RCP8.5 scenario.

Keywords: De Martonne Index, Forestry Aridity Index, climate change, summer, HuClim, precipitation

Received April 2023, accepted September, 2023

Introduction

Climate change is not only the future generations' problem; its effects can already be detected, and their consequences are able to cause losses and damages in the natural ecosystems as well as in socio-economic issues. An increase of hot extremes has been detected since the 1950s in almost every region of the world, including Europe, and there is high confidence in the anthropogenic contribution to this observed change. Furthermore, precipitation extremes and droughts have become more frequent and more intense over most land areas (IPCC, 2021).

Water plays a key role in our lives, as it is essential for plants, animals and humans. Global warming affects the water cycle on a regional and global level. Both the excess and lack of water may cause severe problems, meanwhile, water has a high potential in managing climate change effects (e.g., in the case of agriculture, forestry, health or energy sector; WMO, 2021). On the one hand, devastating floods or inland water, flash floods, and landslides may emerge because of intense rainfall. On the other hand, precipitation deficit and drought is a critical factor that already causes problems regarding agriculture or water supply. Moreover, the compound effects of irregularly distributed precipitation and higher daily temperatures may have severe consequences.

[1] ELTE Eötvös Loránd University, Institute of Geography and Earth Sciences, Department of Meteorology. Pázmány P. sétány 1/A. 1117 Budapest, Hungary. E-mails: kiaqagt@staff.elte.hu, szabo.p.elte@gmail.com, prita@nimbus.elte.hu

In 2022 (from January to September), substantially less than the usual rainfall occurred in many regions, including Europe (WMO, 2022). The summer was exceptionally hot and dry in Northern America, China and Europe. These conditions favoured wildfires, which caused serious damages, e.g., in Portugal and in France; the total burned area was 110,000 ha in 2022 until 15th October. In August, several European rivers (e.g., Danube, Rhine, Loire) fell to critically low levels. The summer of 2022 was drier in the European continent compared to the 1991–2020 reference period in terms of soil moisture, precipitation and relative humidity as well, except for the south-eastern areas (Copernicus Climate Change, 2022). In Hungary, water restrictions were applied to certain regions, and even drinking-water supply difficulties emerged in some settlements in June and July. In addition, these extremely hot and dry conditions negatively affected agricultural production: yield losses occurred, especially in the case of maize.

Because of the importance and severe consequences of precipitation deficiency, which can be worsened by concurrent high temperatures, our study focuses on drought in the summer half-year, characterized by different indices. Beside severe drought, the De Martonne Index, and the Forestry Aridity Index is analysed, as the climate is a determining factor in the distribution of different tree species. Climatological, hydrological and soil characteristics are often considered unchanged in forestry, however, in the last few decades, climate change has intensified, so climate classification regarding forestry should be revised (Führer, E. 2017). Water availability is a critical factor for the different species, if it is aggravated by extremely high temperature, then it can have severe impacts on the health of forests. The main objectives of this study include a detailed analysis of the above-mentioned indices. Namely, we address the following questions: (i) How did/will the spatial extension of the different categories of these indices change? (ii) In which month(s) is the greatest the projected drought change? (iii) What is the difference between the simulations under the RCP4.5 and RCP8.5 scenarios?

Next, data and methods are described, and then our results are presented with a discussion. Finally, the main conclusions are drawn.

Data and methods

Observations and climate model simulations

The present study focuses on Hungary for the period 1971–2100. Hungary lies in Central Eastern Europe (~45.7–48.6°N; 16–23°E), its territory is about 93,000 km^2. For the analysis of the past 50 years (i.e., 1971–2020), the high-quality, observational database of HuClim (https://odp.met.hu/) is used. The daily data are homogenized and interpolated to a regular 0.1° grid.

As for the investigation of the future, climate model simulations can be used. We selected six simulations from the EURO-CORDEX database (Jacob, D. *et al.* 2014) with 0.11° horizontal resolution. Since the choice of global climate models (GCMs) shows greater uncertainty in the simulation results than the choice of regional climate models (RCMs) over Central Europe (Szabó, P. and Szépszó, G. 2016), four GCMs (EC-EARTH, CNRM-CM5, IPSL-CM5A-MR and NorESM1-M) provided the necessary initial and boundary conditions for the selected RCA4 RCM. Furthermore, another RCM was chosen, namely, the RACMO22E model, which was driven by two GCMs (EC-EARTH and CNRM-CM5). Beside internal climate variability and model physics, the third greatest source of climate model simulations' uncertainty is the applied scenario (Hawkins, E. and Sutton, R. 2009). Therefore, two different RCP scenarios are taken into account in the present study, namely, a scenario with starting mitigation from around 2040, RCP4.5, and a business-as-usual scenario, with no mitigation in the 21st century, RCP8.5 (van Vuuren, D.P. *et al.* 2011). In order to use the same horizontal resolution, HuClim data were interpolated to the same grid as

the RCM simulations by the bilinear method. In addition, the area of Hungary was masked in the simulations' fields.

The analysed indices

Three different indices are analysed in this study, describing dry climatic conditions. Depending on the indicators, they were calculated for every grid point for the entire time period (1971–2100), on a monthly, half-year and annual basis. The necessary basic variables for calculating the selected indices were daily precipitation and mean temperature for every grid point.

Severe droughts particularly affect forests and cultivated plants in summer and autumn. We selected a drought indicator, which is simple yet powerful. As a basis, we calculated dry days (DD, when daily precipitation is below 1 mm) first since it correlates moderately or highly with other simple and more complex drought indicators, and precipitation (e.g., Zhuang, Y. *et al.* 2020; Hansel, S. *et al.* 2022). Note that this 1 mm threshold eliminates the drizzle effect (e.g., Polade, S.D. *et al.* 2011), which may have caused a problem in the simulations otherwise. Then, we selected the dry half-years (DHF) of spring and summer together (MAMJJA), when the number of dry days was above the median value of 1971–2020 separately for both spring (MAM) and summer (JJA). Then, the values above the mean value of dry half-years in 1971–2020 were defined as severe droughts (SD), as follows:

$$SD = DHF \mid DHF > mean\ (DHF^{1971–2020}),$$

where $DHF = DD_{MAM} + DD_{JJA} \mid DD_{MAM} > median\ (DD_{MAM}{}^{1971–2020})\ \&\ DD_{JJA} > median\ (DD_{JJA}{}^{1971–2020})$.

We kept this threshold of dry days for the future as well. The resulting time series corresponds well with the lack of precipitation and other drought indices: when there is a high number of dry days, the total precipitation is usually low, while evaporation is high for the MAMJJA period, which is important for the cultivated summer and autumn plants and forests.

The De Martonne Index (DMI) can be determined for different time scales, i.e., years, seasons or months (Gavrilov, M.B. *et al.* 2019). In general, it is applied to a yearly scale, but in this study, a monthly scale was chosen instead, as there are substantial differences between June and August, for instance. The index is calculated for the three summer months separately using the following formula:

$$DMI = \frac{12\,P}{10 + T},$$

where P means the monthly precipitation total (mm), and T indicates the monthly mean temperature (°C). The results are categorized on the basis of the following thresholds (Milovanovic, B. *et al.* 2022): arid (DMI < 10), semi-arid (10 ≤ DMI < 20), Mediterranean (20 ≤ DMI < 24), semi-humid (24 ≤ DMI < 28), humid (28 ≤ DMI < 35), very-humid (35 ≤ DMI < 55) and extremely humid (55 < DMI). If DMI is greater than 30, the conditions are optimal for forests, moreover, ideal DMI values for beech are between 35 and 40 (Satmari, A. 2010).

Furthermore, the simplified Forestry Aridity Index (FAI – Führer, E. *et al.* 2011) was determined for Hungary, which represents the climate marker species. It can be calculated by the following formula:

$$FAI = 100 \cdot \frac{T_{VII–VIII}}{\Sigma P_{V}^{VII} + \Sigma P_{VII}^{VIII}},$$

where $T_{VII-VIII}$ means the average temperature in July and August, and indicate the precipitation total from May to July and from July to August, respectively. Five categories can be defined based on different threshold values: beech (FAI < 4.75), hornbeam-oak (4.75 ≤ FAI < 6), sessile oak and Turkey oak (6 ≤ FAI ≤ 7.25), forest-steppe (7.25 < FAI < 8.5), and steppe (8.5 < FAI).

As absolute threshold values are used to distinguish the different categories, bias-

correction of the RCM simulations has an important role. In order to eliminate the systematic errors emerging from climate model simulations (Christensen, J.H. *et al.* 2008), a simple bias-correction method was applied to the raw results, based on the relative delta-method. We used the following formula:

$$Index_{corrected}^{future} = \frac{Index_{model}^{future}}{Index_{model}^{past,mean}} \cdot Index_{observation}^{past,mean},$$

where *"past"* refers to the period 2001–2020 regarding the calculation of DMI and FAI, and 1971–2020 regarding severe droughts, *"mean"* indicates the temporal mean, *"model"* denotes the selected individual climate simulation, and *"observation"* is the HuClim database. The correction is executed for each index, each grid point, each RCM simulation and each month (for DMI only) separately. The simple bias correction is applied to the indices instead of the raw simulation output variables in order to avoid possible inconsistency that may emerge if we correct temperature and precipitation separately. Similar approach is widely used in the literature, e.g., Casanueva, A. *et al.* (2014), Rocheta, E. *et al.* (2014).

The study investigates the changes in the past, for which two 20-year-long historical periods, 1971–1990 and 2001–2020, are compared. In order to analyse the projected future changes, the average values for four 20-year-long time periods (2021–2040, 2041–2060, 2061–2080, 2081–2100) are calculated. We used 20-year-long periods instead of the usual 30-year-long periods, hence we could make a comparison within the observation period as well. We note that Wilks, D.S. and Livezey, R.E. (2013) found that using alternative periods is appropriate in the case of temperature, while for precipitation, Kis, A. and Pongrácz, R. (2023) found that the 15-year-long period is capable to represent the variability of the 50-year-long data. We focused only on the summer months (June, July and August) or the spring + summer half-year (from March to August), as water deficit is the most critical in these seasons for cultivated plants and forests. Temperature is higher, evaporation is more enhanced, and at the same time, water is a key mitigation factor, e.g., in the case of heatwaves. Furthermore, several crops need appropriate water supply at this time of the year in order to grow properly.

Results

In the following subsections, our results are presented for each index separately. Maps show the spatial distribution of the indices, averaging the analysed 20 years and all of the selected model simulations, i.e., they present a multi-model mean. However, in order to show the uncertainty emerging from the choice of the model, diagrams are also included, which present the range of the projected changes, indicating the individual climate model simulations and the different scenarios.

Validation

As climate model simulations usually show biases compared to the reference data, a bias-correction method was applied to eliminate the systematic errors for all indicators in this study. In this section, we compare the calculated indices with and without bias-correction, for which HuClim serves as a reference.

Considering the spatial extent of the different DMI categories, we can conclude that raw simulations usually show biases *(Figure 1)*. For example, the very-humid category is well represented in July and August, but an overestimation occurs in June (26% vs. 5%). Raw simulations underestimate the spatial extent of the semi-humid and the humid categories in all three summer months. The Mediterranean category is well represented in July, while an overestimation occurs in June and an underestimation in August. Raw climate model simulations greatly overestimate the spatial extent of the semi-arid category, especially in June and July, when, according to HuClim, no grid point falls to this category.

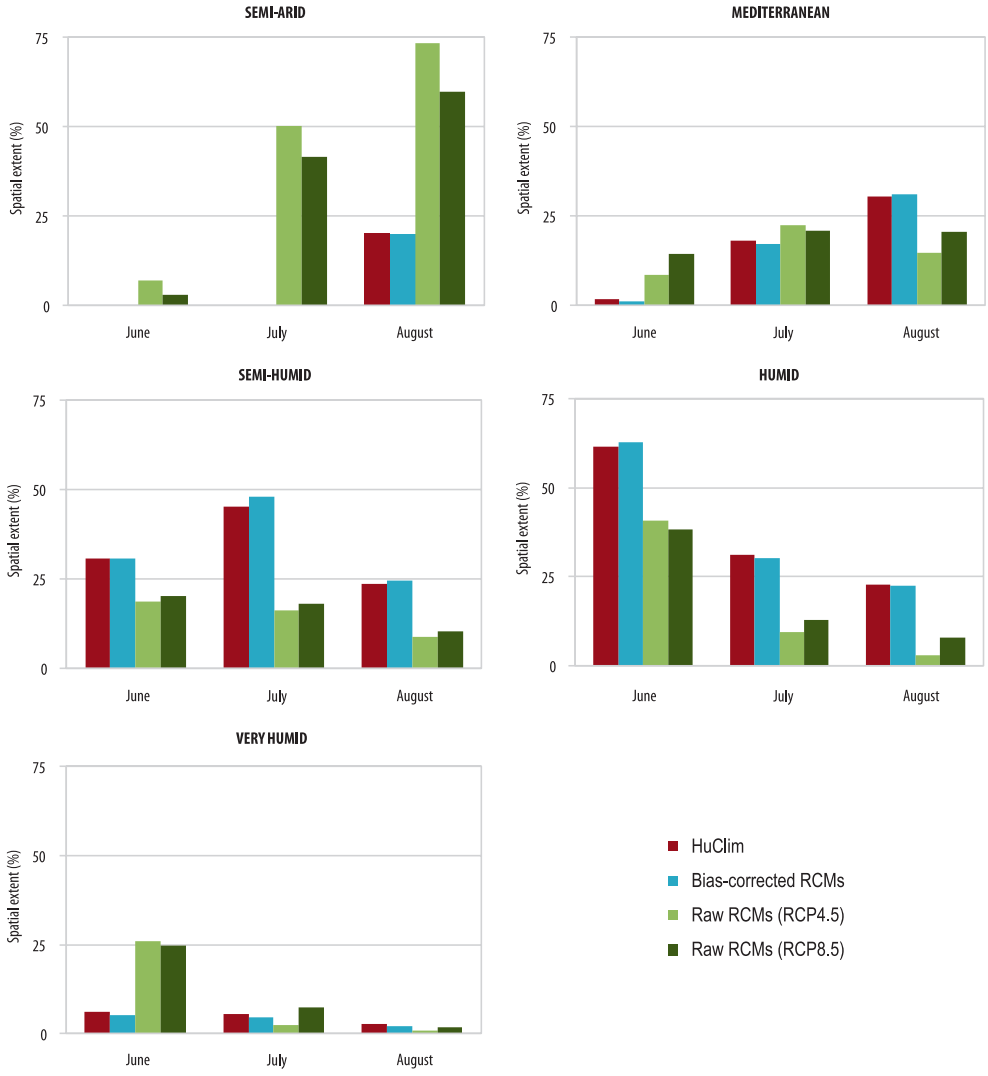


Fig. 1. Validation results of the spatial extent (in %) of DMI for Hungary, 2001–2020, separately for the three summer months, based on the multi-model means of the bias-corrected and the raw climate model simulations compared to the HuClim database.

In the case of FAI, raw climate model simulations overestimate the dry categories, i.e. steppe and forest-steppe (*Figure 2*). At the same time, the sessile-oak and Turkey-oak category is substantially underestimated, namely, the raw simulations show ~20 percent spatial extent, while HuClim and the bias-corrected simulations show ~45 percent.

Severe drought

First, severe droughts in Hungary are presented. Generally, in the last two decades, more precipitation occurred in Hungary over the course of consecutive spring and summer than in 1971–1990, but rain fell on fewer days, which resulted in higher precipitation

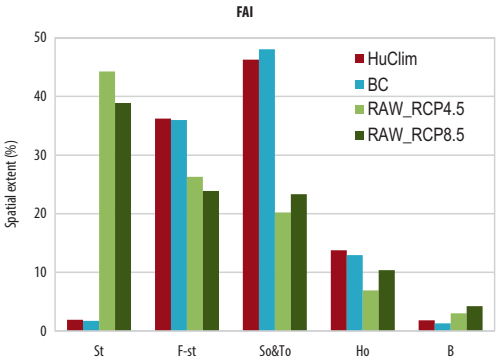


Fig. 2. Validation results of the spatial extent (in %) of the FAI index for Hungary, 2001–2020 based on the multi-model mean of the bias-corrected and the raw climate model simulations compared to the HuClim database. St = Steppe; F-st = Forest-steppe; So&To = Sessile oak and Turkey oak; Ho = Hornbeam oak; B = Beech.

intensity, lower number of wet days, and higher number of dry days. These changes may be unfavourable for plants, as a less intense rainfall infiltrates into the soil more effectively, compared to a very intense precipitation event. Additionally, a substantial increase can be detected in the number of severe droughts if we compare the periods 1971–1990 and 2001–2020 *(Figure 3)*. Severe droughts occurred the most often in the north-eastern and western parts of Hungary in the last 20 years, while in 1971–1990, the northern regions were more exposed to the lack of precipitation or higher evaporation. Drought means high risk to forestry and agriculture, as yield losses or even plant destruction may emerge due to water scarcity.

According to the multi-model mean, if the RCP4.5 scenario is followed until the end of the 21st century, a further increase of severe droughts can be avoided, moreover, the frequency of severe droughts may even decrease compared to the observations. In the case of RCP8.5, slightly (significantly) more frequent severe drought is likely to occur in 2041–2060 (2081–2100) compared to the RCP4.5 scenario with intermediate mitigation. Frequency values are the highest in the southern and eastern parts of the country (with currently mostly agricultural areas) in 2041–2060 following the RCP8.5 scenario, while severe droughts occur in the south-western areas (with more forests in this region) in 2081–2100. One may note that the maps based on observations show higher spatial variability than the model means, and that even if we follow the high-emission scenario by the end of the 21st century, frequency values may not be higher than the observations of 2001–2020. This is the consequence of (i) averaging several model means instead of selecting one

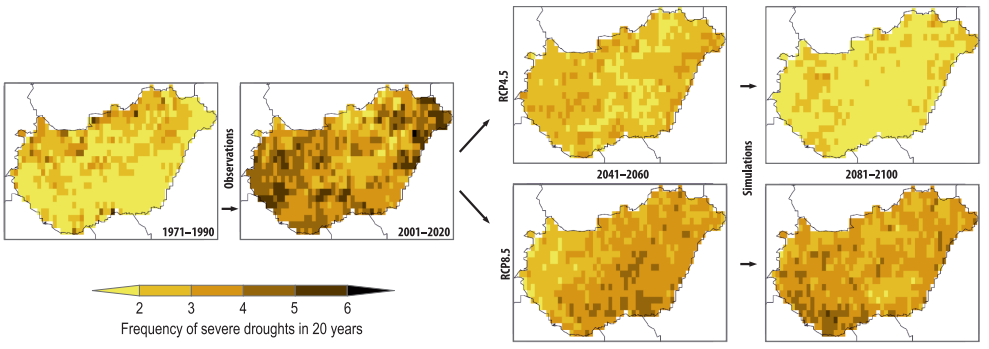


Fig. 3. Spatial distribution of severe drought frequency in Hungary in 1971–1990 and 2001–2020 based on HuClim, and in 2041–2060 and 2081–2100 according to the multi-model mean of the selected climate model simulations, taking into account the RCP4.5 and RCP8.5 scenarios.

particular model simulation, and (ii) the high internal variability of precipitation.

If we analyse the frequency of severe droughts based on the individual model simulations *(Figure 4)*, it can be seen that particularly by 2081–2100 in the case of RCP8.5 the model selection has a great role: the model uncertainty is greater than the model mean itself. In general, the variability between the model simulations is somewhat smaller for the RCP4.5 scenario than RCP8.5. The number of years when severe drought occurs can reach 5, 6 or even 8 within 20 years according to several simulations under the RCP8.5 scenario – this is higher than the mean value for the observed 2001–2020. All in all, there is a high uncertainty in the projection results, but 5 out of 6 models project higher values for RCP8.5 than for RCP4.5 after 2040, and only 1 or 2 models simulate lower values after 2060 than the observations in 2001–2020.

De Martonne Index

In this chapter, results based on the De Martonne Index are shown. We note that the two tails of the categories, which are introduced in Section 2, namely, the arid and the extremely humid categories, cannot be found in Hungary (or only in 1–2 grid points) in the investigated time period.

In general, the wettest month in summer is June in Hungary (~70 mm/month). In this month, the spatial extensions of very-humid and humid categories are reduced for 2001–2020 compared to the period 1971–1990 *(Figure 5)*. Further reductions are projected for 2041–2060 and 2081–2100, according to both RCP scenarios. As a result of these changes, the very-humid category is limited to the western and northernmost parts of Hungary in future time periods. Note that these categories are ideal for forests

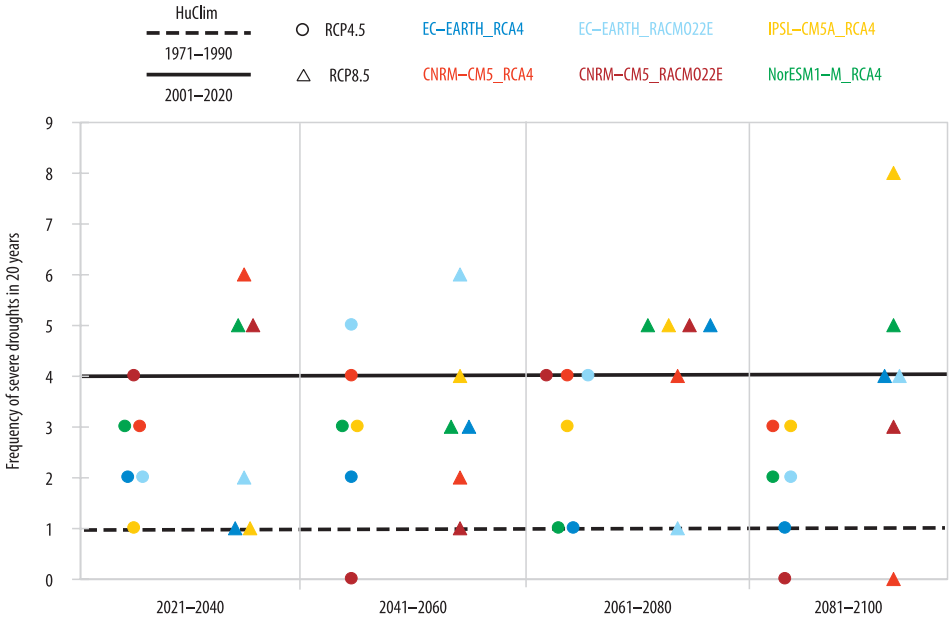


Fig. 4. Projected frequency of severe droughts in Hungary according to the individual RCM simulations (indicated by different colours) taking into account the RCP4.5 (circle) and RCP8.5 (triangle) scenarios. The reference values based on observations are indicated by a dashed (1971–1990) and a solid (2001–2020) black line.

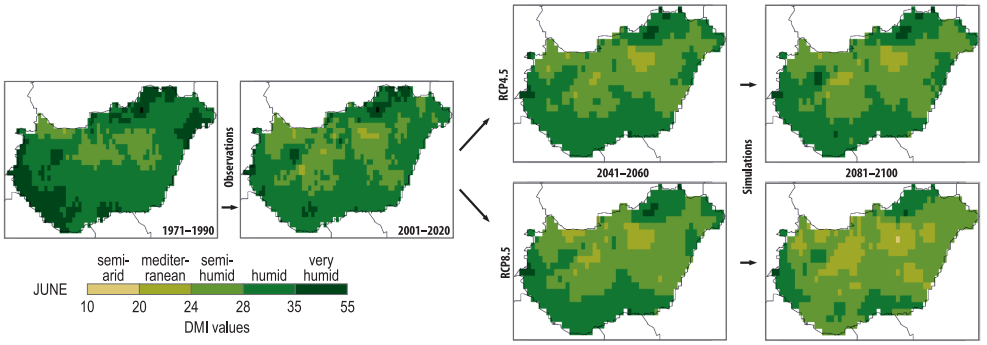


Fig. 5. Spatial distribution of DMI categories in June in Hungary in 1971–1990 and 2001–2020 based on HuClim, and in 2041–2060 and 2081–2100 according to the multi-model mean of the selected climate model simulations, taking into account the RCP4.5 and RCP8.5 scenarios.

(30 < DMI), and climatic conditions are appropriate for beech within the very-humid category (DMI: 35–40). In general, DMI is greater than 24 in June, however, the Mediterranean category appears in more grid cells in the future time periods, especially in the case of RCP8.5 by the end of the 21st century in the lowland areas. Moreover, even the semi-arid category (which was not present at all earlier) appears in one grid cell.

July is generally warmer and drier in Hungary than June. Consequently, dominantly lower DMI values occurred in July in 1971–1990 in the central parts of Hungary, while DMI was greater than 20 in 2001–2020 in every grid point *(Figure 6).* So on the basis of the observations, substantial changes can be recognized within the historical period, namely, the spatial extent of humid categories increased. In the future, similar values and spatial patterns are projected for 2041–2060 to 2001–2020 regardless of the applied scenario: humid and very-humid conditions in the north-eastern and westernmost parts of Hungary, the Mediterranean category occurring in the southern and north-western areas, and semi-humid grid cells in the central regions. However, there are likely to appear substantial differences by 2081–2100 between the simulations under RCP4.5 and RCP8.5. More specifically, in the case of the RCP4.5 scenario, the spatial distribution of the categories of DMI are very similar to 2001–2020, but if RCP8.5 is taken into account, semi-arid category appears in the south-eastern, central-eastern parts of Hungary and in the north-western lowland region. Furthermore, the Mediterranean category expands substantially, while humid and very-humid grid cells will be found only in the westernmost and northernmost regions.

In August, in the Great Hungarian Plain the dominant DMI category is semi-arid in 1971–1990, and it will be in the whole country in the future time periods *(Figure 7).* However, in 2001–2020 a small reduction appears in this drier category, while the Mediterranean category occupies a greater area. A west-east gradient can be identified in all of the investigated periods, namely, there are higher DMI values in the western parts of the country (humid and very-humid), and heading towards the east, DMI decreases, until it reaches the semi-arid category. So, the spatial distribution of DMI categories is very similar for the two different scenarios, however, there are differences in the spatial extent of each category: in the case of RCP8.5, the area of the humid category is very limited, while semi-arid expands to the northern and western regions.

Figure 8 summarizes the future spatial extent of the different DMI categories for each of the three summer months, based on the individual climate model simulations.

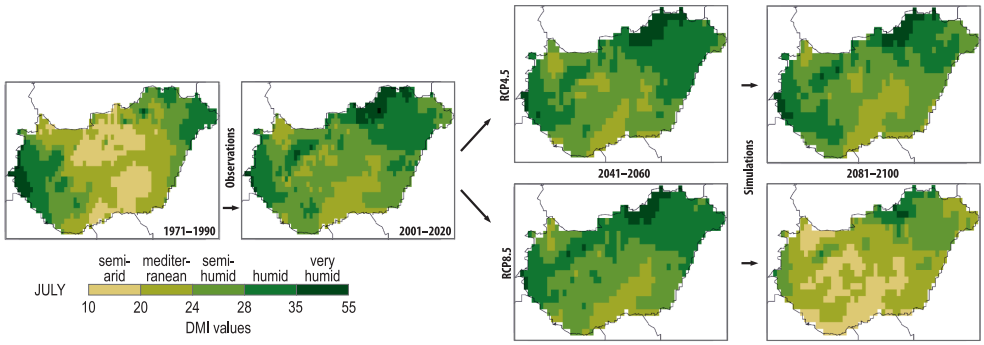


Fig. 6. Spatial distribution of DMI categories in July in Hungary in 1971–1990 and 2001–2020 based on HuClim, and in 2041–2060 and 2081–2100 according to the multi-model mean of the selected climate model simulations, taking into account the RCP4.5 and RCP8.5 scenarios.

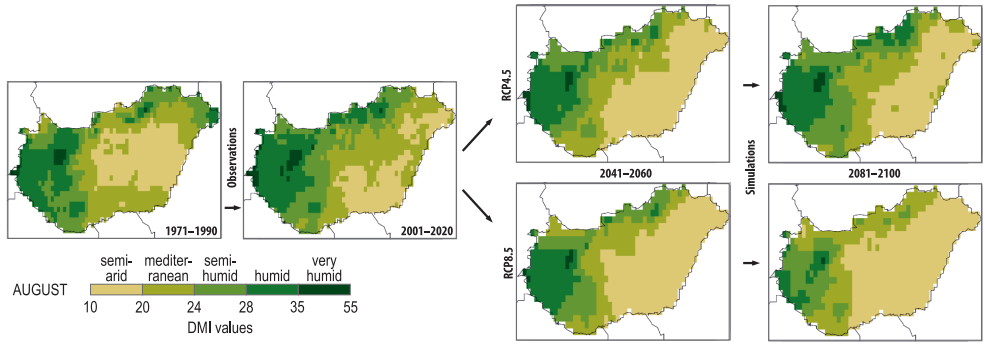


Fig. 7. Spatial distribution of DMI categories in August in Hungary in 1971–1990 and 2001–2020 based on HuClim and in 2041–2060 and 2081–2100 according to the multi-model mean of the selected climate model simulations, taking into account the RCP4.5 and RCP8.5 scenarios.

The semi-arid category is clearly the most dominant in August. According to the majority of the simulations, an increasing trend is projected for the future in the spatial extent of this dominant category, which can reach even 70–80 percent by the end of the 21st century, based on RCP8.5. In July, only a few simulations (under the RCP8.5 scenario) imply an increase compared to the period 1971–1990. In June, the spatial extent of the semi-arid category is almost negligible, but there are some individual simulations that project a substantial increase for 2081–2100.

The simulated changes of the Mediterranean category are different in the three summer months. In general, an increase is projected for June, a decrease for August, and a quasi-stationary state for July (or more precisely, the sign of the change depends on which historical period provides the reference). In the case of the semi-humid category, the range of the model uncertainty is smaller, and there is no discrepancy between the two scenarios. Similar to the Mediterranean category, an increase (decrease) is likely to occur in the spatial extent in June (in August), while the predicted change in July depends on the reference period. The humid category is projected to decrease in June according to almost all the simulations under both scenar-

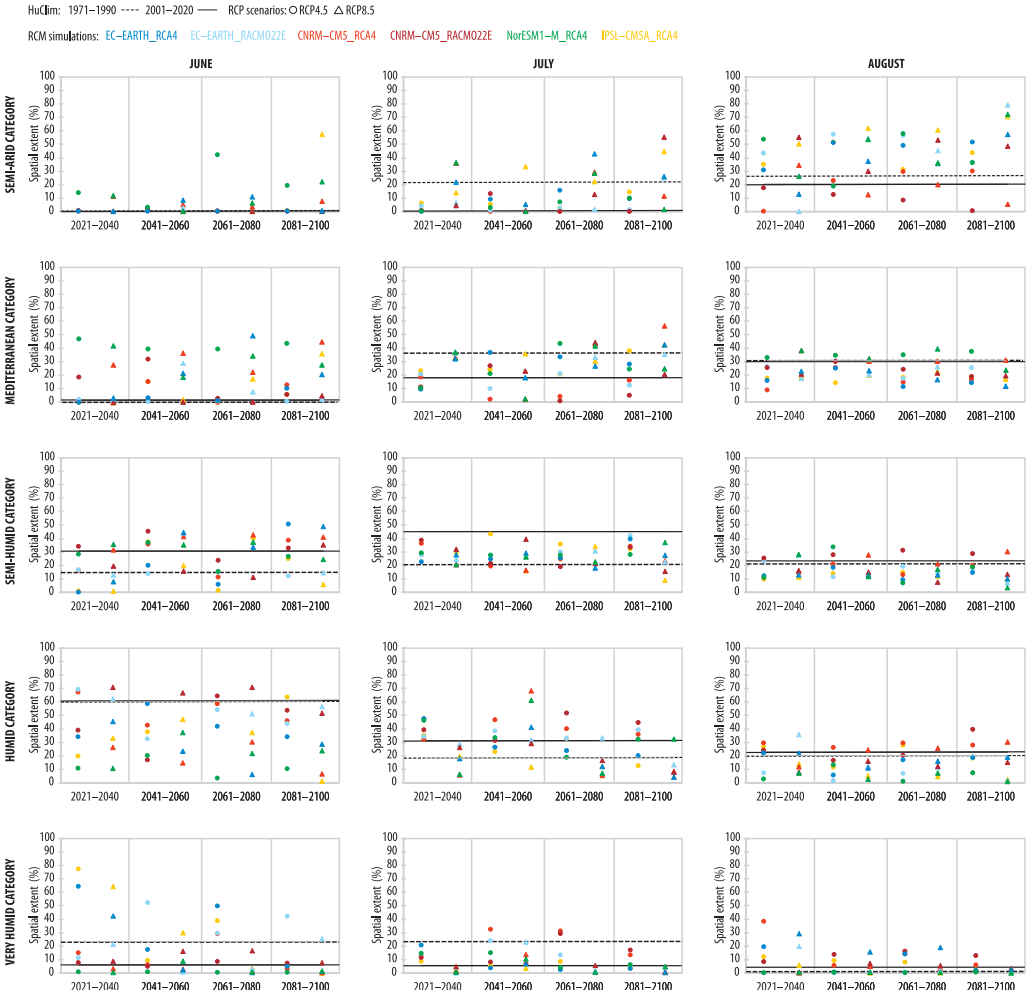


Fig. 8. Projected DMI categories in Hungary in June, July and August, according to the individual RCM simulations (represented by different colours) taking into account the RCP4.5 (circle) and RCP8.5 (triangle) scenarios. The reference values based on observations are indicated by a dashed (1971–1990) and a solid (2001–2020) black line.

ios: in some periods, its spatial extent will become less than 10 percent according to some of the individual simulations. In August, a decrease is projected in general too, but we note that this category has a smaller ratio in the historical periods (~20%), so the relative changes are also smaller. In July, an increase in the spatial extent of the humid category can occur in the middle of the 21st century. The very-humid category's spatial extent is projected to be smaller as we are heading to the future in all three months.

Forestry Aridity Index

Finally, the results related to the FAI are presented. In the historical periods, ideal conditions for hornbeam oak appeared in the western parts of Hungary and in the northern, mountainous areas *(Figure 9).* Beech can be

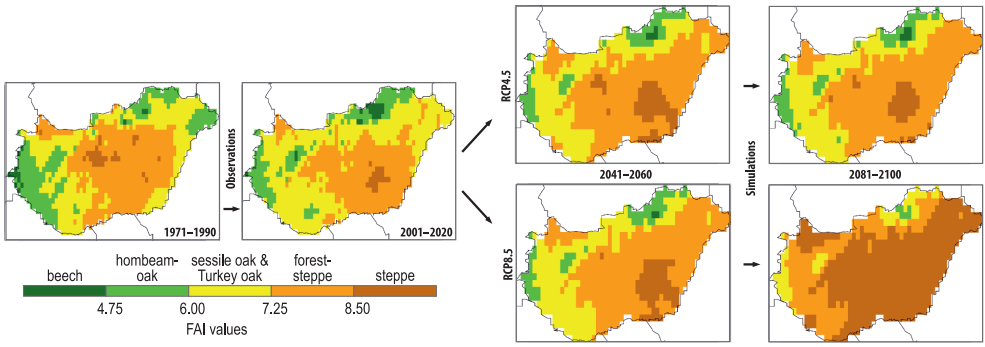


Fig. 9. Spatial distribution of FAI categories in Hungary in 1971–1990 and 2001–2020 based on HuClim, and in 2041–2060 and 2081–2100 according to the multi-model mean of the selected climate model simulations, taking into account the RCP4.5 and RCP8.5 scenarios.

found also in these regions, but its extent is much smaller. Forest-steppe is the dominant category in the central parts of the country and also in the north-western lowlands. The change of the distribution of FAI in the last 50 years in Hungary is unfavourable, and its cause is primarily the increasing temperature (Führer, E. 2017). For 2041–2060, the two applied scenarios show similar changes: beech is likely to disappear from the western regions, while steppe is projected to expand in the south-eastern parts of the Hungarian Great Plain. By the end of the 21st century, in the case of RCP4.5 the simulated changes are very similar to the period 2041–2060. However, if we take into account the RCP8.5 scenario, the spatial distribution of FAI categories is substantially different. Specifically, beech is predicted to disappear entirely from Hungary and hornbeam oak will be limited to a small area in the northern mountains of the country. The extent of sessile oak and Turkey oak reduces, while forest-steppe will appear in the western and northern parts of Hungary. The lowland areas are projected to be steppe, which will be the dominant FAI category in Hungary according to the simulations used in this study.

Figure 10 presents the relative spatial extent of each FAI category based on the individual climate model simulations. The greatest changes can be seen in the case of steppe, for which the spatial extent was smaller than 5 percent in the historical periods, while in 2081–2100, it is 52 percent on average (with one extremely high simulated value, i.e., 93%) under the RCP8.5 scenario. The other substantial change is projected for beech, whose spatial extent was already low in the historical periods (< 2%), but it can even disappear from the area of Hungary by the end of the 21st century under RCP8.5. The projected relative extent of forest steppe varies between 30 and 40 percent according to the multi-model mean, which is similar to the values of the historical period. The number of grid cells, which is suitable for sessile and Turkey oak, generally shows a decreasing trend compared to the historical period, especially in the case of RCP8.5 by 2061–2080 and 2081–2100. The spatial extent of hornbeam oak is also likely to be smaller in the future periods, according to most of the simulations; it is projected to be less than 4 percent in the last two 20-year-long periods in the 21st century if RCP8.5 is taken into account.

Discussion

Raev, I. *et al*. (2015) defined the vulnerability of forests in relation to the value of DMI for Bulgaria, where the current climate is not

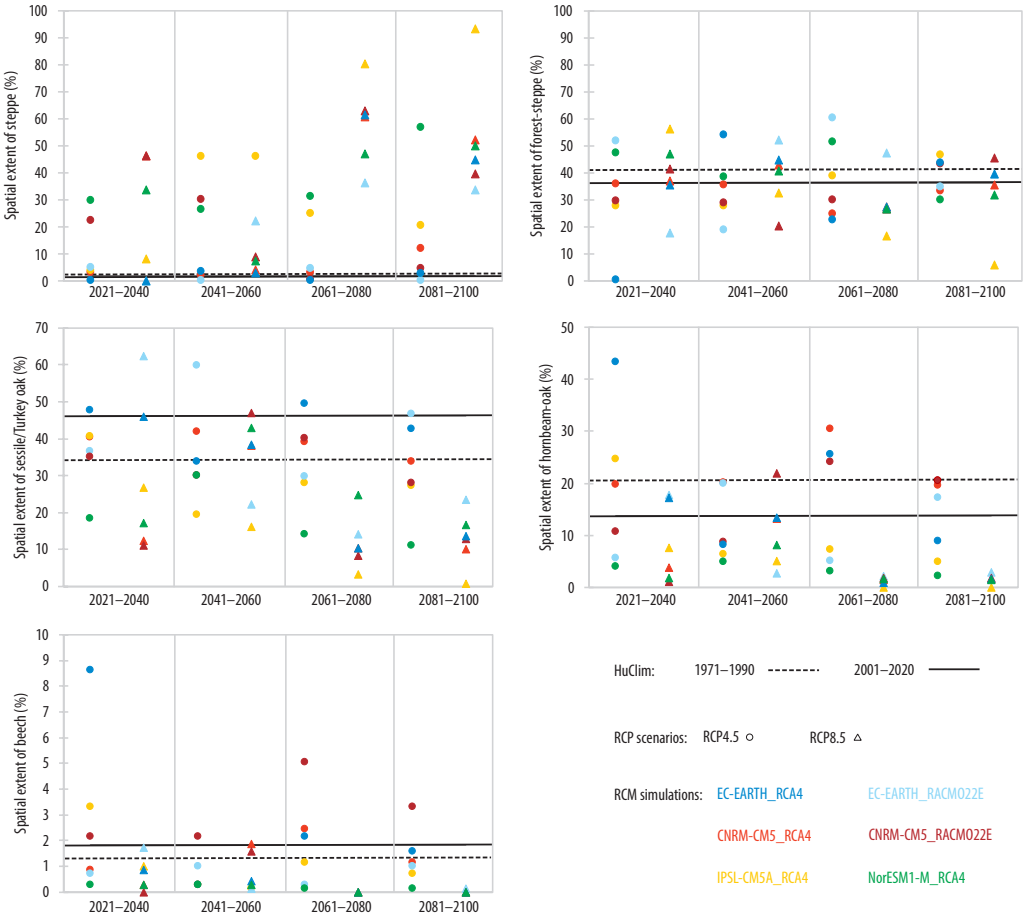


Fig. 10. Projected FAI categories in Hungary according to the individual RCM simulations (indicated by different colours) taking into account the RCP4.5 (circle) and RCP8.5 (triangle) scenarios. The reference values based on observations are indicated by a dashed (1971–1990) and a solid (2001–2020) black line.

very different from Hungary even though the location is somewhat to the southeast relative to Hungary. In the current climate most of the forests fall into the "high" to "medium" vulnerability category (DMI: 25–35), but in the future, the dominant category will be "high" (DMI: 25–30) in the case of RCP2.6 and RCP4.5, and "very high" (DMI: 10–25) if RCP8.5 is taken into account. So similarly to Hungary (based on our results), drier DMI categories are likely to expand in Bulgaria as well, which is unfavourable for forests (DMI < 30). The possible shift of DMI towards drier categories implies that adaptation strategies must be planned in sectors where water is essential, e.g., agriculture. As an example, the study of Paltineanu, Cr. *et al.* (2007) can be mentioned that used DMI values for an agricultural application, namely, the relationship between DMI and irrigation demand is analysed for different crops in Romania. The results show that irrigation is usually needed in those regions, where DMI is below 35. Evidently, the smaller the DMI value, the more water is needed for irrigation. These small values are projected to

dominate the majority of the Great Hungarian Plains by the late 21st century, for which stakeholders in agriculture must plan ahead, and develop their own adaptation strategies to handle the changing conditions. This is especially important because the lack of precipitation is already a problem in the region: a questionnaire completed by Biró, K. *et al.* (2021) in Hungary showed that more than 60 percent of the responders experienced decreased productivity due to drought periods. Moreover, according to the analysis of Buzási, A. *et al*. (2021) there are already three counties in Hungary that are highly vulnerable, but poorly prepared for droughts.

Although Móricz, N. *et al.* (2013) used a different and only one single climate model to calculate the Ellenberg Index, they also concluded that beech forests are likely to disappear almost entirely from Hungary by the end of the 21st century, moreover, the ideal area for sessile oak is projected to be shrunken. Similarly to these conclusions, our results also show that the extent of sessile oak and Turkey oak reduces, while forest-steppe will appear in the western and northern parts of Hungary.

In our study, newer model simulations and scenarios (RCPs) were taken into account, but the main conclusions are fostered by former results as well. More specifically, based on 12 RCM simulations taking into account the SRES A1B emission scenario (which is between RCP4.5 and RCP8.5), Führer, E. *et al.* (2017) concluded that in the 21st century, forest-steppe will expand, while the other three categories are likely to be shrunken – furthermore, a new category, called steppe (FAI > 8.5), is introduced, which is projected to appear in Hungary in the southern regions. The study of Führer, E. *et al.* (2011) investigated FAI separately for the Transdanubian region in Hungary, and showed that only 10 percent of beech will remain in summer and the relative spatial extent of hornbeam oak will be half as much as in the reference period, while forest-steppe will occupy an area four times greater than in the past few decades.

The potential risk of drought on forests was also highlighted by Hlásny, T. *et al.* (2014), who used 10 RCM simulations taking into account the above-mentioned SRES A1B emission scenario, and projected a warming with drying trend for Hungary. However, such drought risk is present not only in Hungary, but also elsewhere in Central Europe. For instance, the future distribution of forests was analysed for Serbia on the basis of FAI (Stojanovic, D.B. *et al.* 2014). According to their results, more arid conditions are likely to occur in the investigated region in the future, and therefore, the most vulnerable among the currently present tree species is Pedunculate oak due to climate change.

The Hungarian foresters are dominantly aware of the effects of the projected climate change according to an interview-based study (i.e., Jankó, F. *et al.* 2022), however, the number of respondents who have already initiated adaptations is rather low. These applied adaptations so far include changing the composition of the forest area. The study showed that there is an agreement to enhance forest diversity and eliminate monoculture. The international survey of Sousa-Silva, R. *et al.* (2018) also concluded that stakeholders in forestry think that climate change will affect forests, but only 36 percent of foresters modified their management practices.

Conclusions

Different climate indices related to drought are calculated for Hungary, based on the HuClim observations and six climate model simulations, taking into account the RCP4.5 and RCP8.5 scenarios. As water deficit can be critical, especially if it is combined with high temperature values, spring and summer months are investigated. According to our results, the following conclusions can be drawn:

– Generally, more precipitation fell on fewer days in Hungary during spring and summer in the last two decades than in 1971–1990.
– According to the multi-model mean, a further increase of severe droughts can be avoided if we follow the RCP4.5 scenario,

while in the case of RCP8.5 severe droughts are likely to occur more frequently.
– In June, the very-humid category of DMI (which can be ideal for beech) will be limited to the western and northernmost parts of Hungary in the future time periods according to the simulations.
– In July, semi-arid and Mediterranean categories will be dominant by the end of the 21st century under the RCP8.5 scenario.
– In August, the semi-arid DMI category will clearly become the most dominant category, reaching even 70–80 percent spatial extent by the end of the century, based on RCP8.5.
– FAI shows that the steppe category will be the dominant category in Hungary by 2100, while the beech optimum could disappear entirely from around 2060 according to the RCP8.5 scenario.

The overall projected drying trend in Hungary implies that water management should focus on retaining water, as it is critically essential for drinking water supply, agriculture, and therefore, reliable food supply, ecosystems, forests and natural vegetation. If we can store water surplus either from excessive, high-intensity rainfalls or from wet years or during autumn and winter, it can be usefully exploited in drought periods or in periods with higher evaporation. Furthermore, because of the changing climatic conditions, the plantation of drought-tolerant species (both in agriculture and forestry) should be considered in regional/national adaptation strategies. Adaptation could mean a more diverse tree species mixture and the introduction of new species which are more adaptable to the changing climate, but more information on these species would be necessary for better forest management. Irrigation may also be a solution to water scarcity, however, the availability of water may be a limiting factor. Thinning forests can reduce fire risk and increase the health and growth of the remaining trees (Vilá-Cabrera, A. *et al.* 2018).

In the case of agriculture, climate-smart agriculture tools (e.g., bio innovation such as plant breeding, development of new seeds, or precision agriculture by effectively reducing impacts) can foster both adaptation and mitigation (Biró, K. *et al.* 2021). These are key elements for future strategies, since in addition to the necessary adaptation, agriculture also must contribute to global mitigation efforts, as some anthropogenic emissions are associated with agricultural activity.

REFERENCES

Biró, K., Szalmáné Csete, M. and Németh, B. 2021. Climate-smart agriculture: Sleeping beauty of the Hungarian agribusiness. *Sustainability* 13. 10269. Available at https://doi.org/10.3390/su131810269

Buzási, A., Pálvölgyi, T. and Esses, D. 2021. Drought-related vulnerability and its policy implications in Hungary. *Mitigation and Adaptation Strategies for Global Change* 26. 11(2021). Available at https://doi.org/10.1007/s11027-021-09943-8

Casanueva, A., Frías, M.D., Herrera, S., San-Martín, D., Zaninovic, K. and Gutiérrez, J.M. 2014. Statistical downscaling of climate impact indices: testing the direct approach. *Climatic Change* 127. 547–560. Available at https://doi.org/10.1007/s10584-014-1270-5

Christensen, J.H., Boberg, F., Christensen, O.B. and Lucas-Picher, P. 2008. On the need for bias correction of regional climate change projections of temperature and precipitation. *Geophysical Research Letters* 35. L20709. Available at https://doi.org/10.1029/2008GL035694

Copernicus Climate Change 2022. *Seasonal review: Europe's record-breaking summer*. Climate Change Service, ECMWF. Available at https://climate.copernicus.eu/seasonal-review-europes-record-breaking-summer

Führer, E., Horváth, L., Jagodics, A., Machon, A. and Szabados, I. 2011. Application of a new aridity index in Hungarian forestry practice. *Időjárás* 115. (3): 205–216.

Führer, E., Gálos, B., Rasztovits, E., Jagodics, A. and Mátyás, Cs. 2017. Erdészeti klímaosztályok területének várható változása (Expectable changes in the area of forest climate classes). *Erdészeti Lapok* 152. (6): 174–177.

Führer, E. 2017. Az erdészeti klímaosztályok új lehatárolása öko-fiziológiai alapon (New way of separation of forest climate classes on eco-physiological basis). *Erdészeti Lapok* 152. (6): 173–174.

Gavrilov, M.B., Lukic, T., Janc, N., Basarin, B. and Markovic, S.B. 2019. Forestry Aridity Index in Vojvodina, North Serbia. *De Gruyter, Open Geosciences* 11. 367–377. Available at https://doi.org/10.1515/geo-2019-0029

Hansel, S., Hoy, A., Brendel, C. and Maugeri, M. 2022. Record summers in Europe: Variations in drought and heavy precipitation during 1901–2018. *International Journal of Climatology* 42. (12): 6235–6257. Available at https://doi.org/10.1002/joc.7587

Hawkins, E. and Sutton, R. 2009. The potential to narrow uncertainty in regional climate predictions. *Bulletin of the American Meteorological Society* 90. (8): 1095–1108. Available at https://doi.org/10.1175/2009BAMS2607.1

Hlásny, T., Mátyás, Cs., Seidl, R., Kulla, L., Merganicová, K., Trombik, J., Dobor, L., Barcza, Z. and Konopka, B. 2014. Climate change increases the drought risk in Central European forests: What are the options for adaptation? *Lesnicky Casopis / Forestry Journal* 60. 5–18. Available at https://doi.org/10.2478/forj-2014-0001

IPCC 2021. Summary for policymakers. In *Climate Change 2021: The Physical Science Basis*. *Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Eds.: Masson-Delmotte, V., Zhai, P., Pirani, A., Connors, S.L., Péan, C., Berger, S., Caud, N., Chen, Y., Goldfarb, L., Gomis, M.I., Huang, M., Leitzell, K., Lonnoy, E., Matthews, J.B.R., Maycock, T.K., Waterfield, T., Yelekçi, O., Yu, R. and Zhou, B., Cambridge, UK and New York, USA, Cambridge University Press, 3–32. Available at https://doi.org/10.1017/9781009157896.001

Jacob, D., Petersen, J., Eggert, B., Alias, A., Christensen, O.B., Bouwer, L.M., Braun, A., Colette, A., Déqué, M., Georgievski, G., Georgopoulou, E., Gobiet, A., Menut, L., Nikulin, G., Haensler, A., Hempelmann, N., Jones, C., Keuler, K., Kovats, S., Kröner, N., Kotlarski, S., Kriegsmann, A., Martin, E., van Meijgaard, E., Moseley, C., Pfeifer, S., Preuschmann, S., Radermacher, C., Radtke, K., Rechid, D., Rounsevell, M., Samuelsson, P., Somot, S., Soussana, J-F., Teichmann, C., Valentini, R., Vautard, R., Weber, B. and Yiou, P. 2014. EURO-CORDEX: New high-resolution climate change projections for European impact research. *Regional Environmental Change* 14. 563–578. Available at https://doi.org/10.1007/s10113-013-0499-2

Jankó, F., Bertalan, L., Pappné Vancsó, J., Németh, N., Hoschek, M., Lakatos, M. and Móricz, N. 2022. Seeing, believing, acting: Climate change attitudes and adaptation of Hungarian forest managers. *iForest* 15. (6): 509–518. Available at https://doi.org/10.3832/ifor3958-015

Kis, A. and Pongrácz, R. 2023. Analyzing the influences of the selection of the RCP scenario and the reference period on the evaluation results of EURO-CORDEX simulations for Hungary. *International Journal of Climatology* 1–19. Available at https://doi.org/10.1002/joc.8184

Milovanovic, B., Schubert, S., Radovanovic, M., Vakanjac, V.R. and Schneider, C. 2022. Projected changes in air temperature, precipitation and aridity in Serbia in the 21st century. *International Journal of Climatology* 42. (1): 1985–2003. Available at https://doi.org/10.1002/joc.7348

Móricz, N., Rasztovits, E., Gálos, B., Berki, I., Eredics, A. and Loibl, W. 2013. Modelling the potential distribution of three climate zonal tree species for present and future climate in Hungary. *Acta Silvatica & Lignaria Hungarica* 9. (1): 85–96.

Paltineanu, Cr., Tanasescu, N., Chitu, E. and Mihailescu, I.F. 2007. Relationships between the De Martonne aridity index and water requirements of some representative crops: A case study from Romania. *International Agrophysics* 21. (1): 81–93.

Polade, S.D., Pierce, D.W., Cavan, D.R., Gerchunov, A. and Dettinger, M.D. 2014. The key role of dry days in changing regional climate and precipitation regimes. *Scientific Reports* 4. 4364. Available at https://doi.org/10.1038/srep04364

Raev, I., Alexandrov, V. and Tinchev, G. 2015. Assessment of drought related climate change impacts on forests in Bulgaria. *Silva Balcanica* 16. (1): 5–24.

Rocheta, E., Evans, J.P. and Sharma, A. 2014. Assessing atmospheric bias correction for dynamical consistency using potential vorticity. *Environmental Research Letters* 9. 124010. Available at https://doi.org/10.1088/1748-9326/9/12/124010

Satmari, A. 2010. *Lucrări Practice de Biogeografie* (Practical applications of biogeography). Timişoara, Eurobit. Available at: http://www.academia.edu/9909429/05_indici_ecometrici

Sousa-Silva, R., Verbist, B., Lomba, A., Valent, P., Suskevics, M., Picard, O., Hoogstra-Klein, M.A., Cosofret, V-C., Bouriaud, L., Ponette, Q., Verheyen, K. and Muys, B. 2018. Adapting forest management to climate change in Europe: Linking perceptions to adaptive responses. *Forest Policy and Economics* 90. (5): 22–30. Available at https://doi.org/10.1016/j.forpol.2018.01.004

Stojanovic, D.B., Matovic, B., Orlovic, S., Krzic, A., Trudic, B., Galic, Z., Stojnic, S. and Pekec, S. 2014. Future of the main important forest tree species in Serbia from the climate change perspective. *Southeast European Forestry* 5. (2): 117–124. Available at http://dx.doi.org/10.15177/seefor.14-16

Szabó, P. and Szépszó, G. 2016. Quantifying sources of uncertainty in temperature and precipitation projections over different parts of Europe. In *Mathematical Problems in Meteorological Modelling: Mathematics in Industry*. Eds.: Bátkai, A., Csomós, P., Faragó, I., Horányi, A. and Szépszó, G., Cham, CH, Springer International Publishing, 207–237. Available at https://dx.doi.org/10.1007/978-3-319-40157-7_12

Van Vuuren, D.P., Edmonds, J., Kainuma, M., Riahi, K., Thomson, A., Hibbard, K., Hurtt, G.C., Kram, T., Krey, V., Lamarque, J-F., Masui, T., Meinshausen, M., Nakicenovic, N., Smith, S.J. and Rose, S.K. 2011.

The representative concentration pathways: An overview. *Climatic Change* 109. (5): 5–31. Available at https://doi.org/10.1007/s10584-011-0148-z

Vilá-Cabrera, A., Coll, L., Martínez-Vilalta, J. and Retana, J. 2018. Forest management for adaptation to climate change in the Mediterranean basin: A synthesis of evidence. *Forest Ecology and Management* 407. 16–22. Available at http://dx.doi.org/10.1016/j.foreco.2017.10.021

Wilks, D.S. and Livezey, R.E. 2013. Performance of alternative "normals" for tracking climate changes, using homogenized and non-homogenized seasonal U.S. surface temperatures. *Journal of Applied Meteorology and Climatology* 52. 1677–1687. Available at https://doi.org/10.1175/JAMC-D-13-026.1

WMO 2021. *2021 State of Climate Services. Water.* WMO-No. 1278. Geneva, CH, World Meteorological Organization. Available at https://library.wmo.int/doc_num.php?explnum_id=10826

WMO 2022. *WMO Provisional State of the Global Climate 2022*. Geneva, CH, World Meteorological Organization. Available at https://library.wmo.int/doc_num.php?explnum_id=11359

Zhuang, Y., Fu, R. and Wang, H. 2020. Large-scale atmospheric circulation patterns associated with U.S. great plains warm season droughts revealed by self-organizing maps. *Journal of Geophysical Research: Atmospheres.* 125. e2019JD031460. Available at https://doi.org/10.1029/2019JD031460

DOI: 10.15201/hungeobull.72.3.3 Hungarian Geographical Bulletin **72** 2023 (3) 239–256.

From geopolitical fault-line to frontline city: changing attitudes to memory politics in Kharkiv under the Russo-Ukrainian war

Oleksiy GNATIUK[1] and Mykola HOMANYUK[2]

Abstract

The article investigates changing attitudes to memory politics in Ukrainian city of Kharkiv. In February 2022, with the outbreak of the full-scale Russo-Ukrainian war, this geopolitical fault-line city became a frontline city with significant potential outcomes for urban identity and local geopolitical preferences, including attitudes to the national memory politics. The research is based on the comparative analysis of the two surveys among residents of Kharkiv, conducted in spring-summer 2018 and in autumn 2022 – before and after the full-scale war. The results of the surveys are analysed by means of descriptive statistics and binary logistic regression. Additionally, two focus groups were held in order to receive additional justification when interpreting the results of the survey. The research shows that the attitudes to Ukrainian nation-centric memory narrative, including both decommunisation and decolonisation, have significantly improved. Nevertheless, public attitudes to the memory politics in the frontline city are highly reflexive in nature and deeply embedded in the context of the ongoing war. The geopolitical divide, which existed before the war, has largely transformed into a cultural one, namely heterogeneity of attitudes to the Russian cultural heritage in the city. This softened albeit still existing divide has, to some extent, materialised in physical space and runs between the ardent supporters of decommunisation and decolonisation that massively fled from the atrocities of the war and their opponents who at most choose (or were obliged) to stay in the front-line city. The study reveals that military conflicts may either activate hidden geopolitical divides in geopolitical fault-line cities or contribute to their transformation or even disappearance.

Keywords: memory politics, geopolitical fault-line city, decommunisation, decolonisation, Russo-Ukrainian war, Kharkiv

Received February 2023, accepted June 2023.

Introduction

For decades after Ukraine's declared independence in 1991, and especially after the Orange Revolution in 2004, the largest cities of south-eastern Ukraine were divided in terms of conflicting geopolitical orientations and identities: pro-western/pro-European and pro-Russian/pro-Soviet. Such cities are typical geopolitical fault-line cities (Gentile, M. 2019; Zorko, M. and Novak, N. 2019): their inhabitants, living in the same neighbourhoods and walking the same streets, espouse controversial and conflicting geopolitical attitudes and narratives, correlating with ethnic or language identities only partially (Kulyk, V. 2011, 2019; Portnov, A. 2015; Kuzio, T. 2019). Even after the beginning of the Russo-Ukrainian hybrid warfare in 2014, these cities still hosted significant non-pro-Western contingents, if not outright pro-Russian, holding views incompatible with European vision for Ukraine (Gentile, M. 2020a,b). The sharpened tensions be-

[1] Department of Economic and Social Geography, Faculty of Geography, Taras Shevchenko National University of Kyiv. 64/13 Volodymyrska Street, 01601, Kyiv, Ukraine. oleksii.gnatiuk@knu.ua

[2] Department of Geography and Ecology, Faculty of Biology, Geography and Ecology, Kherson State University. 27 Universytetska Street, 73003, Kherson, Ukraine. E-mail: mgomanyuk@ksu.ks.ua

tween contradictory geopolitical narratives, imposed by both the Ukrainian government and by the Kremlin propaganda, and then interpreted through the lens of local urban identity, were reflected, *inter alia*, in ambiguous, incoherent, and chaotic local policies of identity and commemoration. In particular, strong pro-Soviet sentiments and alienation from the newly-created Ukrainian national narrative in geopolitically divided cities of the country manifested in predominantly negative attitudes to the national policy of decommunisation (Musiyezdov, O. 2022), and in specific implementation of this policy, namely pursuing highest possible depoliticisation and deideologisation of the urban symbolic landscape (Gnatiuk, O. 2018; Kudriavtseva, N. 2020; Kutsenko, D. 2020).

The outbreak of the full-scale Russian invasion into Ukraine in February 2022 opened a fundamentally new page in the life of Ukrainian geopolitical fault-line cities within the government-controlled territory – a page of urbicide, which is commonly understood as violent politics towards buildings and other elements of urban material environments (Coward, M. 2009). Some of these cities, like Mariupol, were significantly damaged by the Russian military forces, while others, like Kharkiv, turned into front-line cities suffering from constant shelling and, thus, also experiencing tangible destruction. Also, there are rear cities such as Dnipro, nevertheless regularly wounded by missile attacks. Notably, missiles, air bombs, shells, hardships and innocent deaths made no difference for supporters of the European choice and those nostalgic for the Soviet era, and even those pro-Russian adherents who secretly or openly called "Putin, come!" just before the invasion, and equally targeted symbolically significant urban places regardless of geopolitical narrative(s) inscribed to them by the residents.

In this way, military atrocities could lead to just another rethinking of geopolitical attitudes by the inhabitants of Ukrainian geopolitical fault-line cities; it is known that hybrid Russo-Ukrainian conflict unleashed in 2014 has induced transformation of urban identity in Mariupol (Gnatiuk, O. *et al.* 2022). In particular, one could expect for tangible pro-Western or, at least, anti-Russian breakthrough in their hearts and minds. The attitudes to memory politics, including continuing decommunisation and a new trend of decolonisation (generally equated to de-Russification and emerging exactly as an answer to the Russian aggression) can be considered as a vivid marker of such a hypothesised shift. If confirmed, such a shift may be interpreted as a start of disappearance of a geopolitical divide in such cities as one of the possible ways of their post-war evolution. Noteworthy, sociopolitical trajectories of Ukrainian geopolitically divided cities are of pivotal importance not only for the future of Ukrainian national-state building and opposing Russian geopolitical projects (Minakov, M. 2017; Kuzio, T. 2019; Kravchenko, V. and Musiyezdov, O. 2020), but also for the entire European and the global geopolitical order (Gentile, M. 2017).

Kharkiv (population ca. 1.4 million) is the second largest Ukrainian city, located in the eastern part of the country, in the direct proximity to the Russian border (app. 30 km). The city belongs to the Ukraine's largest, most significant and diversified industrial, scientific, and cultural centres, hosting highly skilled elite of engineers and specialists. Kharkiv's borderland status appeared to be one of the city's most stable components, emerging in public life in times of geopolitical cataclysms and becoming less visible in times of internal stability (Kravchenko, V. 2020). Geographical location of Kharkiv, together with its human and economic potentials, make it an important player in the process of national re-identification and geopolitical reconfiguration of the purely defined Ukrainian-Russian borderland (Zhurzhenko, T. 2016; Kravchenko, V. and Musiyezdov, O. 2020), which, in turn, might make the eastern border of Europe more visible (Schmidtke, O. and Yekelchyk, S. 2008). In this paper, focusing on a city of Kharkiv, we explore changing attitudes to memory politics in Ukrainian geopolitical fault-line city under the hot phase of the war.

Comparing the results of two surveys among city residents in spring-summer 2018 and in autumn 2022, we seek to reveal the change of public attitudes among Kharkivites to decommunisation and decolonisation as principal elements of the contemporary Ukrainian nation-centric memory politics. Employing binary logistic regression, we search for predictors of the individual's support for decommunisation/decolonisation.

The rest of the paper is structured in following way. We start with explanation of national context of decommunisation and decolonisation policies in Ukraine with specific focus on their implementation and perception in geopolitical fault-line cities. The following section contains a detailed contextual characteristic of Kharkiv as a geopolitical fault-line city and local context of memory politics. After that, the data and methods are outlined. In the next section we are presenting and discussing empirical results of the study. The paper ends with concluding remarks summarizing the main findings.

Memory politics in Ukraine and geopolitical fault-line cities

The memory politics in post-Soviet Ukraine until the Revolution of Dignity in 2014 was deeply contradictory and oscillating between competing ideologically charged narratives of the past (Shevel, O. 2011; Fedinec, C. and Csernicsko, I. 2017). As Portnov, A. (2013) puts it, "The search for a strategy that would legitimise the new independent Ukraine and its post-Soviet elite without provoking national, linguistic and/or religious conflict, while all time with an eye to Russia, was all about improvisation". The vector of memory politics swings along with presidential cycles from a significant pluralism of memory politics strategies (1994–2005) to a newly born Ukraine-centric narrative (2005–2009) and to a one more turn to rather ambivalent politics with combining ethnic symbolism with nostalgia for Soviet legacy (2010–2014) (Ivanenko, V. and Kryvoshein, V. 2022). This situational pluralism of memory "functioned not so much as a space for dialogue, but rather as a collision of different, closed, and quite aggressive narratives that exist because they cannot destroy their competitors" (Portnov, A. 2013), and competing interest groups in Ukrainian politics have long manipulated with these divisive historical narratives with the purpose of electoral mobilisation (Zhurzhenko, T. 2022).

Due to different historical backgrounds of the different parts of the country, the divide between controversial and hardly irreconcilable Ukraine-centric and pro-Soviet/pro-Russian narratives had its regional dimension, expressed in well-known formula "two Ukraines" (a nationally-conscious (western) Ukraine and a pro-Russian "creole" eastern Ukraine), exploited and artificially enhanced by both pro-Russian politicians in Ukraine and Russian propaganda (Portnov, A. 2013; Fedinec, C. and Csernicsko, I. 2017; Kuzio, T. 2019). This divide can be clearly traced in regional variation of attitudes to the Soviet symbolic legacy. In particular, in western Ukraine, almost all street names related to the communist regime were erased already in early 1990s, in central Ukraine the renaming was limited and related only to the central parts of cities, and in southern and eastern Ukraine, with some exceptions, the renaming of streets practically did not occur, and the communist toponymy was preserved almost entirely (Gnatiuk, O. 2018). Local political elites in geopolitical fault-line cities of the south-eastern Ukraine cultivated Soviet version of Ukrainian history with clear pro-Russian/pro-Soviet sentiments. In line with this narrative, particularly negative emotional response accompanied three names: Hetman Ivan Mazepa, who switched from the Russians to the Swedes in 1708 in the Great Northern War, Symon Petliura, one of the leaders of the Ukrainian Revolution in 1917–1921, and Stepan Bandera, a leader of the radical wing of the Organisation of Ukrainian Nationalists – the archetypical antiheroes of imperial and Soviet version of the Ukrainian past (Portnov, A. 2013).

The Revolution of Dignity in 2013–2014 and the subsequent Russian hybrid aggression contributed to the de-legitimation of the Soviet-nostalgic narrative (Zhurzhenko, T. 2022). Moreover, the issue of Soviet and Russian legacy began to be considered important as an element of national security (Fedinec, C. and Csernicsko, I. 2017). On 9 April 2015, Ukrainian Parliament passed the Law "On Condemnation of Communist and National Socialist (Nazi) Totalitarian Regimes and Prohibition of Propaganda of Their Symbols", giving decommunisation the status of a state politics. The Law regulated the obligatory change of names referring to the post-communist legacy, including geographical names, monuments, and other communist memorabilia. The government's intentions to finally get rid of the traces of the communist past were based on severe sanctions for non-compliance or breaking the law in this regard. Principal responsibility for the implementation of the Law was assigned to the local governments (Kuczabski, A. and Boychuk, A. 2020).

This obligatory decommunisation has been at large brought to life and dramatically changed symbolic landscape of Ukraine. Nevertheless, decommunisation in Ukraine was not received by society in an unambiguously positive way for both ideological and legal reasons interfering with issues of culture and ethnicity (Fedinec, C. and Csernicsko, I. 2017; Kuczabski, A. and Boychuk, A. 2020; Zhurzhenko, T. 2022). The geopolitically divided cities of the south-eastern Ukraine were among the most dissatisfied communities, as they were obliged to redefine their local identity and memory, which were not always compatible with a national narrative for commemoration (cf. Różycki, B. (2017) for decommunisation in Poland). Sociological polls conducted in 2016–2020 showed notable regional differences in attitude to decommunisation with support in the western regions almost twice higher than in the eastern regions (Marples, D. 2018; Musiyezdov, O. 2022). Some of the local governments, which were responsible for implementation of decommunisation laws and, thus, could influence the specific outcome at the local level, have tried unsuccessfully to boycott, avoid or implement decommunisation only formally and without enthusiasm (Kuczabski, A. and Boychuk, A. 2020). As Kovalov, M. (2022) points out, the interactions of subnational veto players involved in the renaming process and the work of local toponymic commissions help to understand compliance and opposition to decommunisation. The authorities and regional political elites often manipulated the provisions on decommunisation to address their tactical challenges (Kutsenko, D. 2020). In particular, local political elites generally chose a strategy of maintaining political neutrality when choosing new names, including avoiding commemorating "builders of Ukrainian independence" (see Marples, D. 2018), and giving preference to Kievan Rus and Cossack legacy as the most equally well acceptable by all Ukrainians regardless of ideology and electoral preferences, or even appealing to the legacy of the Russian imperial era or the same Soviet period (Gnatiuk, O. 2018). Similarly, the decrease of political and military place names in favour of toponymy exhibiting local topographical features, as well as peculiarities of local industry and culture, can be interpreted as a desire among renaming commission members to lower the degree of ideologisation and avoid any future renaming situations (Kudriavtseva, N. 2020). However, it should be noted that restoration of pre-socialist commonly used names and introduction of non-commemorative neutral names as dominant renaming strategies sometimes occur in relatively small post-socialist cities that hardly can be defined as geopolitically divided, e.g., Banská Bystrica (Bitušíková, A. 2022).

The full-scale Russian invasion into Ukraine in February 2022 has called into being a new rethinking of memory politics coming under the flag of decolonisation, generally understood as de-Russification – elimination of Russian cultural symbols from the symbolic space of the country, correcting in this way existing

imbalances between Ukrainian and Russian cultural markers (see, e.g., Gnatiuk, O. and Melnychuk, A. (2020)) and making room for commemoration of national Ukrainian heroes, including builders and defenders of the Ukrainian state. Notably, there are attempts to conceptualise ongoing Russo-Ukrainian war as a war of decolonisation (Barkawi, T. 2022). From the very beginning decolonisation was largely bottom-up and spontaneously emerging process, which can be considered as a measure of post-colonial transitional justice and simultaneously symbolic rebound to Russia in response of military invasion. In April 2022, more than 65 percent of Ukrainians supported changing street names associated with Russia or the USSR, and 71 percent supported dismantling monuments associated with Russia (Rating Sociological Group, 2022). Although de-Russification covered almost all government-controlled territories of Ukraine, there is a still remarkable contrast between quickly advancing west and the centre of the country and lagging south-east (Gnatiuk, O. and Melnychuk, A. 2023).

Kharkiv as a geopolitical fault-line city and local context of memory politics

Since the middle of the 17th century, Kharkiv became the most influential component of the historical Ukrainian-Russian borderland with its porous boundaries and elusive or hybrid identities, which has been a subject of symbolic and political reconfiguration and reinterpretation (Kravchenko, V. 2020). During its steady progressive development, Kharkiv became a modern, multi-ethnic, and culturally diverse city. The city was a capital of a historical region Sloboda Ukraine and an important administrative centre under the Russian Empire in the 19th century. Later, it served as a capital of the short-lived Soviet Donetsk-Kryvyi Rih Republic (1917–1918), and functioned as a capital of Soviet Ukraine (1919–1934), after which it was replaced by Kyiv (Kravchenko, V. and Musiyezdov, O. 2020). In Soviet times, Kharkiv developed into a major industrial, educational, and scientific centre, where Russian functioned as the main language of communication, culture, and science (Musiyezdov, O. 2009; Pletnyova, G. 2020).

In independent Ukraine, Kharkiv largely remained international and cosmopolitan city without the strong predominance of any national culture – both Ukrainian and Russian, as well as acute tensions between them (Musiyezdov, O. 2009; Filippova, O. and Giuliano, E. 2017). In 2001, according to the last all-Ukrainian population census, the major ethnic groups in Kharkiv were Ukrainians (62.8%) and Russians (33.2%), followed by a tiny minority of Jews (0.7%). In the same year, 65.9 percent and 31.8 percent of Kharkivites indicated Russian and Ukrainian as their native languages, respectively. However, in Ukraine, identification in terms of a native language does not strongly correlate with everyday linguistic practices. According to 2018 survey (own data), 98.5 percent of respondents chose to be asked in Russian and only 1.5 percent percent in Ukrainian; as a language spoken at home, 88.6 percent indicated Russian, 5.4 percent Surzhyk (mix of Russian and Ukrainian), 3.3 percent both Russian and Ukrainian, and only 1.8 percent – only Ukrainian. In 2013, five years before, the figures were merely the same: 87.5, 5.6, 4.9, and 1.1 percent, respectively. At the same time, in 2018, 88.5 percent of respondents felt Ukrainian and 27.6 percent felt Russian. According to 2022 survey (own data), before the full-scale Russian invasion, 66.8 percent of Kharkivites spoke Russian, 29.9 percent – both Ukrainian and Russian, and 3.3 percent – only Ukrainian, while in November 2022 these figures, where 34.8, 47.7, and 17.4 percent, respectively.

The majority of Kharkivites opposed the imposition of Ukrainian national ideology being dissatisfied with its interpretation of Kharkiv as "the one of the Russified cities of Eastern Ukraine", inclining instead to the idea of the "uniqueness" and "self-sufficiency" of Kharkiv (Musiyezdov, O. 2009). The city maintained close economic links

with Russia, while at the same time boasting a booming Western-oriented information technology industry. Kharkivites, in their majority, traditionally voted for pro-Russian political parties and has been largely indifferent to the Ukrainian pro-Western movements (Pletnyova, G. 2020). The concept of Kharkiv as a "First [Ukrainian] Capital", as well as the centre of industry and science, which shaped largely during the Soviet era, remains of crucial importance for contemporary urban identity (Musiyezdov, O. 2020). Not surprisingly, Kharkiv's urban toponymic space has not changed much in 1991–2014 because local authorities, as well as local citizens, did not consider the Soviet monuments and toponyms as a strange marker of occupation or coloniser (Kutsenko, D. 2020). Simultaneously, over time, the Soviet monuments and the Soviet names of urban objects lost their "semantic sense" and became almost invisible for locals (Gaidai, O. *et al.* 2018).

In 2014, Kharkiv was a site of strong protests against the Euromaidan and subsequent Revolution of Dignity that unfolded in Kyiv. The protests in the city were dangerous for the Ukrainian state because of a serious Russian-led attempt at creating a "Kharkiv People's Republic". However, unlike the neighbouring Donetsk and Luhansk regions, this attempt was unsuccessful due to the more active pro-Ukrainian community, decisive action of the Ukrainian Special Forces, as well as the actions of the local political and economic elites (Stebelsky, I. 2018; Buckholz, Q. 2019; Nitsova, S. 2021). During the Russo-Ukrainian hybrid warfare, Kharkiv became important logistical, medicine and military centre that accepted large numbers of internally displaced persons from the war-affected Luhansk and Donetsk regions, as well as military hospitals for wounded soldiers (Musiyezdov, O. 2022).

However, the same as after the Orange Revolution in 2004 (Zhurzhenko, T. 2011), Kharkiv once again became an arena of multiple colliding and contested geopolitical and ethno-national narratives, contributing to the activation of the semi-hidden fault-line between the pro-European and pro-Russian fractions (Zhurzhenko, T. 2015; Filippova, O. and Giuliano, E. 2017; Stebelsky, I. 2018; Malykhina, S. 2020). According to the 2017 survey's results, in view of their strong attachment to locality and region, Kharkivites tended to be particularly critical of the post-Euromaidan policies and remain ambivalent in their attitudes toward the Ukrainian state and nation (Kulyk, V. 2016). At the same time, it was demonstrated empirically that opposition to the Western geopolitical vector in Kharkiv did not necessarily entail support for Russia, and that large number of Kharkivites did not closely link the loyalty to Ukraine as an independent state to neither Europe nor Russia; instead, growing numbers of citizens did not want to make a choice between Russia and the EU (Filippova, O. and Giuliano, E. 2017).

The conflict of geopolitical narratives in Kharkiv was evidenced not only by the protests and rallies, but also by the ambiguous and contradictory implementation of the national decommunisation policy, including the most vivid and demonstrative example of dismantling of Marshal Zhukov's monument and renaming Marshal Zhukov Avenue (Kutsenko, D. 2020; Malykhina, S. 2020; Zhurzhenko, T. 2015). The public attitudes to decommunisation in Kharkiv (almost 270 streets, 7 districts and 6 metro stations were renamed in 2015–2016) were mostly negative and, notably, much more negative than in Dnipro, the other large Ukrainian geopolitically divided city in the centre-eastern Ukraine (Musiyezdov, O. 2022). At the same time, minority of community activists declared an active war on the communist legacy in Kharkiv. For instance, in April 2015, a group of activists single-handedly demolished the monument to Bolshevik leader Nikolai Rudnev and renamed the square around to *Maidan Nebesnoji Sotni* [Heavenly Hundred Square]. Also, in 2019, public activists dismantled the monument to Marshal Zhukov without any authorisation from the city administration. The (re)naming of toponymy under decommunisation in Kharkiv

revealed polycentricity and, to certain extent, chaotic functioning of local policies of commemoration and politicisation, resulting in heterogeneity of the newly emerged toponymic landscape both in terms of renaming techniques and in terms of memory/amnesia policies (Golikov, A. 2020).

Nevertheless, Kharkiv could not escape the wave of public demands for the decolonisation of the symbolic space, which swept the country with the beginning of the full-scale Russian invasion. In March 2022, an open letter was published by local journalists to the Mayor with a request to change urban toponyms related to the Russian and Soviet geographical and cultural context. The author of the letter argued for the need to decolonise the symbolic space of the city by the fact that "... war is everywhere, including on the information front. Kharkiv is burning, and this fire turns to ashes everything somehow connecting the city with Russification and Sovietism. For sure, Kharkiv will never, even in someone's sick imagination, be either a 'Russian' or a 'Soviet' city" (Suspilne Novyny, 2022a). In April 2022, responding to this open letter, the Mayor said that "… in a situation of a war unleashed against us, toponyms related to the Russian Federation should disappear from the map of Kharkiv ... ... I am sure that the defenders of Kharkiv and Ukraine should be immortalised on the map of our city … … I am sure that the new street names will always remind us and our children of what Ukraine has done and what contribution Kharkiv made to the struggle for our honour and dignity, for the independence of the country, for the right of the Ukrainian people to exist" (Suspilne Novyny, 2022b). Later, the city administration began collecting proposals for renaming streets associated with Russia. On 11 May 2021, three streets and a district with names associated with Russia were renamed by the city council: *Moskovskyi Prospekt* [Moscow Avenue] became *Prospekt Heroiiv Harkova* [Heroes of Kharkiv Avenue], *Bilhorodske shose* [Belgorod Highway] became *Kharkivske shose* [Kharkiv Highway], *Bilhorodskyi uzviz* [Belgorod Descent] became *vulytsia Heroiv Riatuvalnykiv* [Heroic Rescuers Street], and *Moskovskyi Raion* [Moscow District] became *Saltivskyi Raion* [Saltivka District, after the largest mass housing estate in Kharkiv] (Suspilne Novyny, 2022c). In July 2022, the Kharkiv toponymic group, which included representatives of the public, published proposals for the de-Russification of Kharkiv toponymy, emphasizing the need to return a number of historical names, some of which are unique to Kharkiv and are not present in other cities of Ukraine (Suspilne Novyny, 2022d). However, no other decisions regarding decommunisation were adopted during 2022, making the decolonisation in Kharkiv quite sluggish compared not only to the cities of the western and central parts of the Ukraine, but to some other geopolitically divided cities such as Kryvyi Rih and Dnipro, where 183 and 77 toponyms respectively have been renamed in 2022. In this way, Kharkiv remains the city with the largest number of street names somehow related to Russia – more than 500, according to the expert estimations (Kharkiv Today, 2022). At the time of preparing the paper, it became known that about 20 more streets are expected to be renamed by the city council.

In 2022–2023, a lot of public initiatives and actions related to the symbolic space occurred in Kharkiv. They include, first of all, the arbitrary demolition of monuments and pressure on the city authorities with such proposals. For instance, a list of demolished monuments includes those to Soviet Marshal Zhukov (on 17 April 2022), Alexander Nevsky (on 19 May 2022), and Soviet writer Alexander Ostrovsky (5 January 2023). On 9 November 2022, the city authorities, following an appeal by Konstiantyn Nemichev, the commander of the Kraken Special Unit, dismantled monument to Alexander Pushkin. In the field of street renaming, the most active position was taken by the Kharkiv Toponymic Group headed by Maria Takhtaulova, an employee of the Ukrainian Institute of National Remembrance. The group proposed a complete de-Russification

and de-Sovietisation of the city's streets. The Department of Toponymy of the Kharkiv City Council received dozens of letters from public organizations, institutions and national cultural societies with proposals to commemorate prominent Kharkiv residents and fallen heroes via street naming. Artists also joined the process: the famous modern Ukrainian writer Serhii Zhadan took a selfie against the background of the Pushkin monument "without hinting at anything", while the artist Hamlet Zinkovskyi made a series of graffiti on Pushkin Street with the proposed new name – British Street.

Data and methods

The research is based on the two surveys among residents of Kharkiv, conducted with different purposes and methodology, but nevertheless allowing comparative analysis. The first survey (n = 1,258, aged 18+) was held in 2018, i.e. during the hybrid Russo-Ukrainian military conflict. The data were collected through personal interviews by the Kyiv-based Centre for Social Indicators (CSI). The sample relies on a household-based sampling frame (only one person was selected within each household). The second survey was conducted by Kharkiv-based New Image Marketing Group in November 2022 (n = 914, aged 18+) partly in face-to-face technology at the place of residence (76%), and partly remotely with those residents who are temporarily outside the city (24%) (ratio of people who moved and left was determined according to the data from the city administration). The face-to-face survey employed a combined route sample with a probability selection of starting addresses and with a quota selection based on the sex-age distribution of respondents in households. The remote survey used quota selection was based on an online panel.

To assess the attitudes of Kharkivites to the decolonisation in Kharkiv in 2022, we used a set of the 2022 survey questions with regard of: (1) general support to renaming streets in Kharkiv, (2) attitudes to changing specific categories of urban place names, as well as concrete urban place names, and (3) street names that should definitely disappear and should definitely emerge on the city map. To evaluate the shift in attitudes to decommunisation and decolonisation politics in Kharkiv, we compared the answers to the similar questions in the 2018 and 2022 surveys. The fact that questionnaires of 2018 and 2022 used different sets of questions constitutes the main methodological problem of this part of research and prompted to cautious conclusions.

Then, we employed binary logistic regression in order to determine the predictors of positive/negative individual attitudes to decommunisation/decolonisation in 2018 and in 2022. Regression models were built for the following dependent variables (DV):

For 2018 survey: DV1: Support for renaming streets with Soviet names in Kharkiv; DV2: Support for renaming *Dzerzhynskyi District* [after Felix Dzerzhinsky, creator of the Soviet secret police and one of the Red Terror architects] to *Shevchenkivskyi District* [after Taras Shevchenko, the greatest Ukrainian poet and painter]; DV3: Renaming of the *Radianska* [Soviet] metro station to *Maidan Konstytutsiji* [Constitution Square].

For 2022 survey: DV1: Support for further renaming streets in Kharkiv; DV2: Support for dismantling the monument to Marshal Zhukov [Marshal of the Soviet Union, Chief of the General Staff, Minister of Defence, member of the Presidium of the Communist Party]; DV3: Support for dismantling the monument to Alexander Pushkin [Russian poet, playwright, and novelist, considered by many to be the greatest Russian poet and the founder of modern Russian literature].

Our independent variables, the same for three regression models, were the following:

(1): Sex: male (ref. female) as a standard demographic control;

(2): Age: 30–59; 60+ (ref. 18–29) as a standard demographic control, although it was suspected, based on previous studies (see Marples, D. 2018; Musiyezdov, O. 2022) that older age cohorts will show more negative attitudes to decommunisation and decolonisation;

(3): Language of communication used before the full-scale war: only Ukrainian; only Russian (ref. both Ukrainian and Russian): – to test the hypothesis that assessment of decolonisation correlates with individual linguistic preferences;

(4): Support for EU and/or NATO ascension: yes (ref. no) – to test the hypothesis that assessment of decolonisation correlates with individual geopolitical preferences;

(5): Education: higher education (ref. other) – as it was know from the previous studies that better education is related to higher support for decommunisation (only for 2018 survey);

(6): Place of location: refugees abroad; internally displaced persons (IDPs) in Ukraine (ref. Kharkiv) – to test the hypothesis that assessment of decolonisation depends on individual's proximity to the war-affected city (only for 2022 survey).

Additionally, on 30 October 2022, two online focus groups were held with 18 Kharkiv residents (8 female, 10 male), average age 40, age range from 19 to 65 years, representing different social strata, as well as people who stay in Kharkiv or temporarily left the city. The results of focus groups were used as additional justification when interpreting the results of the survey.

Results

Changing attitudes to nation-centric memory politics in the frontline city

In 2018, only 12.8 percent of Kharkiv residents supported renaming streets with communist names. In autumn 2022, 60.1 percent of Kharkivites supported de-Russification and decolonisation of Ukraine, and 56.1 percent supported further renaming of streets in Kharkiv, which is comparable to the nationwide figures (Rating Sociological Group, 2022). Given the fact that general tolerance for the communist ideological symbols in Ukraine always was lower than that of the Russian cultural markers, these figures indicate that the attitude towards post-Soviet rethinking of the symbolic space of the city has changed radically. In particular, we may cautiously assert that before the full-scale Russian invasion decommunisation and decolonisation were supported by the minority of Kharkiv residents, while after the invasion the supporters constitute nearly a half of the city population.

The answers to the questions about the renaming of a specific toponyms point to similar trend. For instance, in 2018, only 25.8 percent of Kharkiv residents supported the decision to rename *Dzerzhynskyi District* to *Shevchenkivskyi District*. The renaming of the *Radianska* metro station to *Maidan Konstytutsiji* gained the support of only 16.3 percent of respondents. However, in 2022, 79.4 percent of surveyed Kharkiv residents expressed their support for renaming *Moskovskyi Prospekt* to *Prospekt Heroiiv Harkova*, 78.1 percent supported renaming of *Bilhorodske shose* to *Kharkivske shose*, and 77.2 percent supported renaming of *Bilhorodskyi uzviz* to *vulytsia Heroiv Riatuvalnykiv*. Considering the attitudes towards these specific place names, it can be seen that before the full-scale war decommunisation was supported by a clear minority of Kharkiv residents, while after the Russian invasion in 2022, decolonisation, which is a more radical step compared to decommunisation, is supported by the absolute majority of Kharkivites.

Shifting a focus from place names to monuments, we also observe tangible changes in the public attitudes to decommunisation and decolonisation. In 2018, only 8.2 percent of Kharkivites residents supported the removal of Lenin monuments, another 24.2 percent considered it appropriate to move them to another place, and 60.7 percent of respondents – the overwhelming majority – strongly condemned a practice of "Leninfall" (see Pshenychnykh, A. 2019; Gaidai, O. 2021). In 2022, 9.2 percent of Kharkiv residents supported the complete dismantling of the Pushkin monument, another 33.1 percent supported the idea of moving it to another place (a museum or a sculpture park), while

almost 55 percent would leave it standing in the usual place. At the same time, 57 percent of respondents supported dismantling the monument to Zhukov in April 2022. In this way, the attitude towards the Pushkin monument in 2022 practically coincides with their attitude towards the Lenin monument in 2018. Taking into account the fact that Pushkin as an artist is a much less odious person than Lenin, the communist leader, as well as the support for the dismantling of the monument to Zhukov, another symbol of the communist regime, being of crucial importance for pro-Russian audience in Kharkiv (Kutsenko, O. 2020) it can be assumed that the tolerance for monuments to the communist and Russian prominent figures in Kharkiv significantly and proportionally decreased.

In general, the focus group participants expressed positive attitudes to the decommunisation as erasure of the Soviet symbols. It is more difficult to find a consensus on names that are somehow connected with Russia. Plans to rename the streets invoke conflicting reactions – from enthusiastic support to bewilderment why this should be done at all. Most of the opinions of focus group participants are somewhere in between: if street names should be changed, then it is better to postpone and implement somehow selectively, weighing the pros and cons. Reasons why street renaming doesn't seem like a good idea are the following: (1) It's very expensive, and in times of war there are higher priorities; it should be postponed until after the war; (2) Respect should be shown to the older generation, for whom the former street names mean a lot and evoke nostalgic feelings; (3) Some commemorated figures, despite their Soviet or Russian origin, have globally recognised scientific or cultural merits that cannot be cancelled by renaming; (4) Renaming may be just another reason for a split in the public mind, it can provoke conflicts and disputes; (5) Ukrainian names will not necessarily raise patriotic moods, while Kharkiv residents still are wary of some pages of Ukrainian history, so before renaming, public sentiments should be studied. As for the monuments, there were few supporters of radical measures among the focus group participants. Opinions were more often voiced that the issue of monuments is now generally irrelevant, it can be thought about after the war. Also, some participants said that it is not necessary to demolish monuments at all, except for the most odious ones. The proposal to create a park of the history of monuments in Kharkov, where to bring all the monuments that disappear from the streets, looks like a possible compromise. If the monuments are nevertheless dismantled, their place may be taken by equivalent, but already Ukrainian monuments. Alternatively, a fountain or flower bed may appear at the place, or the place can remain empty.

Rehabilitation of "Banderites", "soft" decolonisation, and Kharkiv-centrism

Table 1 shows that in 2022 the support for renaming streets named after Russian and Soviet military and political figures, as well as streets with names related to the geography of Russia, is generally twice as high as support for renaming streets after Russian and Soviet writers and poets, cultural figures and, especially, scientists. The level of support for both general categories of toponyms and specific street names confirms this thesis. It means that tolerance for individual Soviet and Russian cultural markers may differ significantly and depends on the relationship of a particular marker (e.g., a prominent person) to the realms of politics, state building, and warfare. It is interesting that the figure of Gagarin, given low demand for renaming Gagarin Avenue, is obviously perceived primarily as an outstanding person – the first cosmonaut – whose triumph was contributed by including Kharkiv residents as residents of Soviet Ukraine, and not as a figure used by the Soviet regime for the promotion of communist ideology.

In general, the majority of Kharkivites share "soft" approach to decolonisation (Gnatiuk, O. and Melnychuk, A. 2023) – they are ready to get rid of the markers of Russian

Table 1. Support for change of street names related to the Russian geography and culture, 2022

Do you think that the following street names in Kharkiv should be changed?		Confidently agree, %	Rather agree, %	Rather disagree, %	Confidently disagree, %
Related to the geography of Russia		43.0	16.6	11.6	28.8
Related to the Soviet Union and Soviet ideology		41.0	14.1	14.3	30.5
Commemorating	military leaders of the Russia Empire	42.1	12.8	10.6	34.5
	Soviet military leaders	41.8	14.4	10.9	32.8
	Soviet poets and writers	25.4	12.9	16.3	45.4
	Russian writers	24.1	11.1	15.8	49.1
	Russian cultural figures	26.6	14.8	14.8	43.9
	Russian scientists	21.4	10.7	18.1	49.8
	Soviet scientists	20.0	11.6	19.1	49.2
Gagarin Avenue		12.1	8.8	18.7	60.4
Marshal Zhukov Avenue		41.7	12.1	9.2	36.4
Pushkin Street		20.4	10.4	12.3	57.0

geography, state building, and warfare, but still keep positive or neutral attitudes to the Russian figures of culture and science. These interpretations have been proved by the focus groups. According to the focus groups, the presence of Russian culture in Kharkiv evokes different feelings: from tolerant (*"Pushkin or Dostoevsky are not politicians, not military men, and not the Soviet legacy"*) to extremely intolerant, complete disgust for everything Russian, because *"every person who experienced this* [war atrocities] *in Kharkiv does not want any reminders of them* [Russian figures, places, etc.]*"*. Furthermore, some participants admitted that they *"lost the desire to buy goods with names that contain a reminder of Russia, they don't want to listen to the music of Russian performers, songs in Russian, etc."*

Table 2 shows high support of Kharkiv residents for commemoration of the heroes of the ongoing war with Russia (≈ 60–70%), including tangible values for confident support (≈ 40%). At the focus groups, people expressed opinions that the names of Ukrainian heroes and glorified combat units of the Russo-Ukrainian war definitely should be present in the toponymy of the city, but *"there is no need to hurry with this"*. Firstly, *"the reminder of the war will be very painful for a long time to come; this war needs to become a bit of history"*. Secondly, *"in the haste of renaming, one can admit injustice, and forget the names of those heroes who, no less than others, deserve the right to be commemorated"*. Extremely high support for naming streets after the new hero cities (Hero City of Ukraine is a Ukrainian honorary title awarded "for outstanding heroism" to ten cities in March 2022) may be interpreted in the following way: Kharkivites consider their city as one of the hero cities and want to express the solidarity with the other cities that suffered from the Russian aggression.

Notably, support for commemoration of Mazepa, Petliura, and Bandera (≈ 20–30%, including ≈ 40–50% of confident support) is significantly lower but nevertheless seems to be extremely high for traditionally Soviet-era oriented city as Kharkiv was until 2022. The explanation could be that under war with Russia, these archetypically anti-Russian figures (Portnov, A. 2013) became symbols of Ukrainian resistance to the invasion, "joining" the ranks of the defenders of Ukraine, and, thus, have been "rehabilitated" in the eyes of many Kharkivites – in fact, Bandera in Ukraine under the war became a mass culture protagonist and has little to do with the real historical figure. However, a little less than half of the respondents still categorically deny the expediency of commemorating

Table 2. Attitudes to naming streets in Kharkiv, 2022

Who (or what) should be commemorated via naming streets in Kharkiv?	Confidently agree, %	Rather agree, %	Rather disagree, %	Confidently disagree, %
Servicemen of the Ukrainian Armed Forces who died in the war	43.3	25.8	11.5	19.4
Military units (brigade) of the Ukrainian Armed Forces	38.0	24.1	14.0	24.0
Azov Regiment (defenders of Mariupol)	43.7	16.6	11.4	28.3
New hero cities of Ukraine (Mariupol, Volnovakha, Mykolaiv, Bucha, etc.)	46.3	22.1	9.4	22.2
Famous volunteers	25.2	22.2	18.5	34.1
Ivan Mazepa	33.4	19.3	14.2	33.2
Symon Petliura	22.9	16.0	18.2	43.0
Stepan Bandera	27.8	15.9	13.2	43.1
Foreign leaders who support Ukraine (Boris Johnson, Joseph Biden)	18.4	17.0	16.8	47.8

these "builders of Ukrainian nation". A cautious conclusion can be drawn that Kharkiv hosts a large contingent that is not clearly pro-Russian and, moreover, at large supports the novel Ukrainian national-centric narrative written during the current war, but is not ready to accept the traditional figures of such a narrative demonised for decades by first Soviet and then Russian propaganda, including as "Banderites" (Laruelle, M. 2015). Notably, the focus groups showed that naming streets after such figures remains a controversial idea among the older Kharkivites, although young people often welcome such renaming. The attitude to commemoration of the foreign leaders who support Ukraine in the war – so called gratefulness naming (Gnatiuk, O. and Basik, S. 2023) is mostly negative. According to the focus-group discussion, this happens because Kharkivites consider rather unacceptable naming streets after the people who are still alive.

Nevertheless, giving ideologically neutral names remains the most popular general principle with respect to street naming in Kharkiv remains neutral names – the only position supported by the majority of the respondents, while commemorative naming receives less support among the Kharkivites *(Table 3)*. Both focus groups discussed the idea that it would be better to abandon the practice of naming streets for famous people altogether – because of a great temptation to revise these names due to political expediency. This seeking for highest possible ideological neutrality corresponds to the studies of Ukrainian geopolitical fault-line cities before the full-scale Russian invasion (Gnatiuk, O. 2018; Kudriavtseva, N. 2020; Kutsenko, D. 2020). The second most acceptable principle is to commemorate famous Kharkivites (the idea was also mentioned during the focus groups), which once again emphasises the appeal to the local urban identity and "uniqueness" (Musiyezdov, O. 2009). The ideas of commemorating the heroes of the ongoing Russo-Ukrainian war and the paradigmatic "builders of Ukraine" receive merely equal support. Finally, low support for return of pre-Soviet names may be cautiously interpreted as a desire of Kharkivites to break up with the Russian imperial narrative.

Notably, the focus group participants emphasised that the renaming of a street is easier to accept if people are informed about the biography of a commemorated person, especially his/her links with a city. It is especially important for the residents of this specific street: *"I was very indignant when my Ordzhonikidze Avenue was renamed until I found out who the*

Table 3. General vision of principles for decolonization of street names in Kharkiv, 2022

What common ideas of street renaming should prevail in Kharkiv?	Agree,%	Disagree, %
Return of pre-Soviet names (those existed before 1917)	19.7	80.3
Commemoration of heroes, cities and military units in the current war with Russia	31.1	68.9
Ideologically neutral street names (e.g. Sunny Street, Chestnut Street, Calm Street)	52.0	48.0
Neutral number names (1st Street, 2nd Street – as in New York)	14.1	85.9
Commemorating figures related to the struggle for the Independence of Ukraine	32.4	77.6
Commemoration of famous Kharkivites	42.1	57.9

architect Alyoshin was. He was the architect who built the city of Kharkiv, and I told all my neighbours about it".

Geopolitical divide: From blurred line to spatial separation

According to the binary logistic regression models *(Table 4)*, reliable predictors of positive attitudes to decommunisation in 2018 were person's geopolitical preferences (support of EU/NATO accession), higher education, and, quite surprisingly, belonging to older age cohorts (however, analysis of the cross-tabs for dependent variables and the age covariate shows that this correlation may be considered as insignificant). The language seems to be less important predictor; nevertheless, correlation between speaking only Russian and negative attitude to decommunisation is stronger and more significant than correlation between speaking only Ukrainian and positive attitude to decommunisation. This proves that divide in Kharkiv is still manifested primarily in terms of geopolitical attitudes, while ethnic and language considerations play secondary rule (Gentile, M. 2017; Kulyk, V. 2019; Kuzio, T. 2019).

Reliable predictors of negative attitudes to decolonisation in 2022 *(Table 5)* were old age and speaking only Russian, while speaking Ukrainian is, once again, relatively weak predictor of positive attitudes. Strong and statistically significant predictors of the positive attitudes were geopolitical preferences and location outside of Kharkiv, both in Ukraine or abroad. This means that the most confident supporters of eradicating Russian symbolic legacy are Ukrainian speaking (and, giving the regression results for 2018, highly educated) people, supporting Ukraine's EU/NATO accession, who left the city fleeing from the war atrocities.

At first glance, it may be concluded that people who are far from the front-line city are able to pay more attention to ideological issues, while those who left in the city are concentrated on the personal survival and consider memory politics issues as untimely. However, we found a significant positive correlation between a person's current location outside the city and individual geopolitical preferences. At the same, predominantly negative attitude of those inhabitants who remained in Kharkiv to joining the EU/NATO cannot be explained by the argument that such actions are untimely or of low priority since they would obviously tilt the scales on the Ukrainian side and stop the horrors of the war. On the contrary, we expect that people living under the constant Russian shelling are more inclined to stop this nightmare via enforcing Ukraine's geopolitical position. This leads to the possibility of a scenario that people supporting the Western vector of Ukraine's geopolitics had greater opportunities and/or desire to leave Kharkiv when the warfare began. On the contrary, pro-Soviet/pro-Russian geopolitically oriented people in south-eastern Ukraine are, on average, older and low educated (Gentile, M. 2015), and had lower possibilities or desire to flee. Therefore,

Table 4. Binary logistic regression results: predictors of individual attitudes to decommunisation in 2018

Independent variables (covariates)	Odds coefficient = Exp (B)		
	Support for renaming		
	DV1: Streets with Soviet names	DV2: Dzerzhynskyi district	DV3: Radianska metro station
Male (ref. female)	1.209	1.210	1.159
Age 30–59 (ref. 18–29)	1.506	1.622*	1.914*
Age 60+ (ref. 18–29)	1.464	1.723*	3.119***
Spoken language: Ukrainian only (ref. both Ukrainian and Russian)	1.629	1.481	1.751
Spoken language: Russian only (ref. both Ukrainian and Russian)	0.609	0.365***	0.681
Support for EU and/or NATO ascension: yes (ref. no)	8.933***	6.511***	7.521***
Education: higher education (ref. other)	1.760**	1.376*	1.606**
Constant	0.038***	0.193***	0.040***
Hosmer-Lemeshow Test (Sig.)	0.774	0.775	0.703
Nagelkerke R Square	0.247	0.245	0.221

*p < 0.05; **p < 0.01; ***p < 0.001.

Table 5. Binary logistic regression results: predictors of individual attitudes to decolonisation in 2022

Independent variables (covariates)	Odds coefficient = Exp (B)		
	DV1: Support for further renaming streets in Kharkiv	DV2: Support for dismantling the monument to Marshal Zhukov	DV3: Support for dismantling the monument to Alexander Pushkin
Male (ref. female)	0.888	0.929	0.808
Age 30–59 (ref. 18–29)	0.721	0.717	0.815
Age 60+ (ref. 18–29)	0.298***	0.478**	0.465**
Spoken language: Ukrainian only (ref. both Ukrainian and Russian)	2.605	2.147	1.391
Spoken language: Russian only (ref. both Ukrainian and Russian)	0.788	0.773	0.654*
Support for EU and/or NATO ascension: yes (ref. no)	9.730***	8.710***	8.947***
Place of stay: Ukraine except Kharkiv (ref. Kharkiv)	5.500***	3.415***	5.599***
Place of stay: abroad (ref. Kharkiv)	2.947***	4.191***	4.581***
Constant	0.265***	0.279***	0.276***
Hosmer-Lemeshow Test (Sig.)	0.742	0.378	0.206
Nagelkerke R Square	0.322	0.273	0.307

*p < 0.05; **p < 0.01; ***p < 0.001.

the lower level of support for nation-centric memory politics among those who remained in Kharkiv should be explained not by the direct impact of the warfare (shelling, destruction, economic situation in the city), but by the fact that most active supporters of decolonisation may mostly left the city. In this way, the geopolitical fault line, which was previously dissolved among the city inhabitants, now lies largely between those who left the city and those who remained. Indeed, this exposes a potential problem related to the "right to the city" – more specifically – the right to define the memory and identity politics in Kharkiv during and after the war. For instance, those who remain may claim themselves as "true city patriots" and deny the rights of "traitors" and "cowards" who fled, while the latter may argue that their ardent pro-Ukrainian position should be given a priority. Nevertheless, it will be important to involve into a dialogue on the post-war memory politics in Kharkiv all strata of inhabitants regardless of their current place of residence and geopolitical attitudes.

Conclusions

Positive shift in attitudes to decolonisation and growing support to the Ukrainian nation-centric memory politics in Kharkiv is directly related to the emerging image of Russia and Russians as the "negative other". The main factor for identification to common/similar identity for a group of people often is the question of driving force of insecurity (Cerutti, F. 2006). For Kharkivites, since February 2022, Russia became a constant threat endangering their lives and living environment. The "builders of Ukrainian independence" were partially rehabilitated among the pro-Soviet-in-the-past Kharkivites exactly for being anti-Russian icons. The backlash of "othering" a military adversary is not something new in the history – it was observed including in the other post-socialist military conflicts, first of all in former Yugoslavia (see, e.g., Mihaylov, V. 2020; Zorko, M. 2020). For instance, in Croatia, negative stereotyping of the Serbs and Serbia was fostered by the 1991–1995 war. Consequently, in the early 1990s, notions about Serbian culture and geography were erased from the Croatian streetscape, including the street names referring to prominent Serbs and Serbian cities (Šakaja, L. and Stanić, J. 2017).

Nevertheless, most of Kharkiv residents share "soft" and "inclusive" approach to decolonisation (Gnatiuk, O. and Melnychuk, A. 2023): sharing a nation-wide demand to eradicate Russian cultural markers, they express higher tolerance to the Russian cultural figures not directly related to the realms of politics, state building, and warfare. Also, priority is given to local urban context, and merits to the city of a (potentially) commemorated person could be seen as an indulgence of being Russian or the pro-Russian position.

In view of the findings, post-war memory politics and identity building in Kharkiv could be grounded on the Russo-Ukrainian war context, positioning Kharkiv as one of the centres of national resistance, inscribing in this way a city into Ukrainian national narrative – a task that remained extremely problematic for decades (Kravchenko, V. 2020; Musiyezdov, O. 2020). The dividing line from mostly (geo)political has transformed into a cultural one: heterogeneity in relation to the Russian cultural heritage. Approximately a half of Kharkiv residents consider Russian culture (but not a Russian state) as part of their own one, and the other half renounces it. At the same time, public attitudes to the memory politics in the frontline city are highly reflexive in nature and deeply embedded in the context of the ongoing war. Therefore, the current pattern of attitudes may change once again when the war comes to an end and emotional calved thrive.

Besides establishing that supporters of Ukraine-centric memory politics in Kharkiv are pro-Western, younger, and better educated, we found that softened albeit still existing geopolitical and cultural divide in war-affected Kharkiv has, to some extent, materialised in physical space and runs between the ardent supporters of decommunisation and decolo-

nisation that massively fled from the war and their opponents who at most choose to stay in the front-line city. This reformatted division inevitably raises the question about the "right to the city" – namely who have legal and moral grounds to define the future post-war reconstruction and transformation of the urban space, including its symbolic component.

Our final consideration refers to the future of Ukrainian geopolitical fault-line cities. Although geopolitical divide in Kharkiv already has only softened compared to the pre-war state, it is possible to speculate that the Russo-Ukrainian war has launched the gradual process of its disappearance, and, thus, we have a change to witness in real time the final stage of evolution of a geopolitical fault-line city. After all, the main dividing line between the more pro-western and more pro-Russian regions of Ukraine has gradually shifted eastwards since 1991 (Kulyk, V. 2016). Of course, future trajectories of geopolitically divided cities in Ukraine and beyond within the post-Soviet space largely depend on the outcome of the war, which is hardly predictable at the moment of writing this paper. Nevertheless, while military conflicts often produce ethnonationally divided cities, as it was in former Yugoslavia, they may either activate hidden geopolitical divides in geopolitical fault-line cities or contribute to their disappearance.

Acknowledgements: This article was funded by (1) Petro Jacyk Non-Resident Scholars Program (Munk School's Centre for European, Russian, and Eurasian Studies, University of Toronto), project "The Politics of Memory in Ukraine: Current Situation and Post-War Prospects", and (2) Norwegian Research Council NORRUSS grant 287267 "Ukrainian Geopolitical Fault-line Cities: Urban Identity, Geopolitics and Urban Policy."

REFERENCES

Barkawi, T. 2022. War and decolonization in Ukraine. *New Perspectives* 30. (4): 317–322. Doi: 10.1177/2336825X221132935

Bitušíková, A. 2022. Transformations of place, memory and identity through urban place names in Banská Bystrica, Slovakia. *Hungarian Geographical Bulletin* 71. (4): 401–417. Doi: 10.15201/hungeobull.71.4.6

Buckholz, Q. 2019. The dogs that didn't bark. *Problems of Post-Communism* 66. (3): 151–160. Doi: 10.1080/10758216.2017.1367256

Cerutti, F. 2006. *Identitet i Politika* (Identity and Politics). Zagreb, Politička Kultura.

Coward, M. 2009. *Urbicide. The Politics of Urban Destruction*. Oxon, Routledge.

Fedinec, C. and Csernicsko, I. 2017. (Re)conceptualization of memory in Ukraine after the Revolution of Dignity. *Central European Papers* 1. 46–71.

Filippova, O. and Giuliano, E. 2017. *'Neither with Europe nor with Russia': tracking views in Kharkiv.* Visnyk of V.N. Karazin Kharkiv National University. Series "Sociological studies of contemporary society: methodology, theory, methods." 39. 269–274.

Gaidai, O., Sklokina, I. and Kasianov, G. (eds.) 2018. *Polityka i Pamiat. Dnipro–Zaporizhia–Odesa–Kharkiv. Vid 1990-h do Siohodni*. Lviv, FOP Shumylovych.

Gaidai, O. 2021. Leninfall in Ukraine: How did the Lenin statues disappear? *Harward Ukrainian Studies* 38. (1–2): 45–69.

Gentile, M. 2015. West oriented in the east-oriented Donbas: A political stratigraphy of geopolitical identity in Luhansk, Ukraine. *Post-Soviet Affairs* 31. (3): 201–223. Doi: 10.1080/1060586X.2014.995410

Gentile, M. 2017. Geopolitical fault-line cities. In *Migration and the Ukraine Crisis: A Two-Country Perspective.* Eds.: Pikulicka-Wilczewska, A. and Uehling, G., Bristol, E-International Relations. Available at www.e-ir.info/wp-content/uploads/2017/06/Migration-and-The-Ukraine-Crisis-E-IR.pdf

Gentile, M. 2019. Geopolitical fault-line cities in the world of divided cities. *Political Geography* 71. 126–138. Doi: 10.1016/j.polgeo.2019.03.002

Gentile, M. 2020a. Diabolical suggestions: Disinformation and the curious scale of nationalism in Ukrainian geopolitical fault-line cities. *Geopolitics.* Doi: 10.1080/14650045.2020.1830766

Gentile, M. 2020b. The 'elephant' in Mariupol: what geopolitical moods prevail in the city. *Vox Ukraine*. Available at https://voxukraine.org/en/the-elephant-in-mariupol/

Gnatiuk, O. 2018. The renaming of streets in post-revolutionary Ukraine: Regional strategies to construct a new national identity. *Acta Universitatis Carolinae Geographica* 53. (2): 119–136. Doi: 10.14712/23361980.2018.13

Gnatiuk, O. and Melnychuk, A. 2020. Geopolitics of geographical urbanonyms: Evidence from Ukrainian cities. *Acta Universitatis Carolinae Geographica* 55. (2): 255–268. Doi: 10.14712/23361980.2020.19

Gnatiuk, O., Mezentsev, K. and Pidgrushnyi, G. 2022. Rethinking of identity under war: Pryazovia renaissance and regional centre ambitions in Mariupol before 2022. *Hungarian Geographical Bulletin* 71. (3): 271–286. Doi: 10.15201/hungeobull.71.3.4

Gnatiuk, O. and Basik, S. 2023. Performing geopolitics of toponymic solidarity: The case of Ukraine.

Norsk Geografisk Tidsskrift/Norwegian Journal of Geography. E-publication on 6 February 2023. Doi: 10.1080/00291951.2023.2170827

Gnatiuk, O. and Melnychuk, A. 2023. De-Russification of urban namescapes in Ukraine: Rigged trial or justice restored? *Names: A Journal of Onomastics* (in print).

Golikov, A. 2020. (Re-)naming and decommunisation in Ukrainian: Macropolicies, historical memory and the risks of mediatisation (Kharkiv case). *Ideology and Politics Journal* 15. (1): 33–62. Doi: 10.36169/2227-6068.2020.01.00003

Ivanenko, V. and Kryvoshein, V. 2022. Derzhavna polityka pamiati v suchasnij Ukrajini v umovakh informatsijnoji vijny (2014–2021 rr.). *HRANI* 25. (2): 16–21. Doi: 10.15421/172218

Kharkiv Today 2022. *Mista bez Pushkina. Chomu u Kharkivskij oblasti povilno jde derusyfikatsija?* Available at https://2day.kh.ua/ua/kharkow/mista-bez-pushkina-chomu-u-kharkivskiy-oblasti-povilno-yde-derusyfikatsiya

Kovalov, M. 2022. When Lenin becomes Lennon: Decommunization and the politics of memory in Ukraine. *Europe-Asia Studies* 74. (5): 709–733. Doi: 10.1080/09668136.2022.2078478

Kravchenko, V. 2020. Borderland city: Kharkiv. *East/West: Journal of Ukrainian Studies* 7. (1): 3–6. Doi: 10.21226/ewjus572

Kravchenko, V. and Musiyezdov, O. 2020. Kharkiv: The elusive city. *East/West: Journal of Ukrainian Studies* 7. (1): 3–6. Doi: 10.21226/ewjus567

Kuczabski, A. and Boychuk, A. 2020. Decommunization of urban toponymy in Ukraine: Causes and consequences. *Journal of Geography, Politics and Society* 10. (4): 8–16. Doi: 10.26881/jpgs.2020.4.02

Kudriavtseva, N. 2020. Reconfiguring identities within the cityscape: Ideologies of decommunization renaming in Ukraine. *Ideology and Politics Journal* 15. (1): 63–82. Doi: 10.36169/2227-6068.2020.01.00004

Kulyk, V. 2011. Language identity, linguistic diversity and political cleavages: Evidence from Ukraine. *Nations and Nationalism* 17. (3): 627–648. Doi: 10.1111/j.1469-8129.2011.00493.x

Kulyk, V. 2016. National identity in Ukraine: Impact of Euromaidan and the war. *Europe-Asia Studies* 68. (4): 588–608. Doi: 10.1080/09668136.2016.1174980

Kulyk, V. 2019. Identity in transformation: Russian-speakers in post-Soviet Ukraine. *Europe-Asia Studies* 71. (1): 156–178. Doi: 10.1080/09668136.2017.1379054

Kutsenko, D. 2020. Experience of implementing decommunization laws in Eastern Ukraine: A Kharkiv case. *Journal of Geography, Politics and Society* 10. (3): 55–64. Doi: 10.26881/jpgs.2020.3.06

Kuzio, T. 2019. Russian stereotypes and myths of Ukraine and Ukrainians and why Novorossiya failed. *Communist and Post-Communist Studies* 52. (4): 297–309. Doi: 10.1016/j.postcomstud.2019.10.007

Laruelle, M. 2015. The three colours of Novorossiya, or the Russian nationalist mythmaking of the Ukrainian crisis. *Post-Soviet Affairs* 32. (1): 55–74. Doi: 10.1080/1060586X.2015.1023004

Malykhina, S. 2020. Change and continuity in the urban semiosphere of post-Soviet Kharkiv. *East/West: Journal of Ukrainian Studies* 7. (1): 58–104. Doi: 10.21226/ewjus569

Marples, D. 2018. Decommunization, memory laws, and "builders of Ukraine in the 20th century". *Acta Slavica Iaponica* 39. (1): 1–22. Doi: 10.14943/ASI.39.1

Mihaylov, V. 2020. Ethnoterritorial divisions and urban geopolitics in post-Yugoslav Mostar. In *Spatial Conflicts and Divisions in Post-socialist Cities.* The Urban Book Series. Ed.: Mihaylov, V., Cham, Springer, 91–110. Doi: 10.1007/978-3-030-61765-3_6

Minakov, M. 2017. Novorossiya and the transnationalism of unrecognized post-Soviet nations. In *Transnational Ukraine? Networks and Ties that Influence(d) Contemporary Ukraine.* Eds.: Beichelt, T. and Worschech, S., Stuttgart, ibidem Press, 65–88.

Musiyezdov, O. 2009. *Kharkivska Identychnist: Ujavlennia pro Misto ta Joho Istoriju jak Chynnyky Identyfikatsiji.* Essay-urban. The Online Publication Series of the Centre for Urban History of East Central Europe 5. Available at: http://dspace.univer.kharkov.ua/bitstream/123456789/8939/2/Musiyezdov_ukr_5.pdf

Musiyezdov, O. 2022. Do national and geopolitical identities explain attitudes to decommunisation? A comparison of Dnipro and Kharkiv. In *Ukraine's Outpost: Dnipropetrovsk and the Russian-Ukrainian War.* Eds.: Kuzio, T., Zhuk, S.I. and D'Anieri, P., Bristol, England, E-International Relations, 164–190. Available at https://www.e-ir.info/publication/ukraines-outpost-dnipropetrovsk-and-the-russian-ukrainian-war/

Nitsova, S. 2021. Why the difference? Donbas, Kharkiv and Dnipropetrovsk after Ukraine's Euromaidan Revolution. *Europe-Asia Studies* 73. (10): 1832–1856. Doi: 10.1080/09668136.2021.1912297

Pletnyova, G. 2020. Linguistic diversity in Kharkiv: Between "pride" and "profit," between the local and the global. *East/West: Journal of Ukrainian Studies* 7. (1): 105–128. Doi: 10.21226/ewjus570

Portnov, A. 2013. Memory wars in post-Soviet Ukraine (1991–2010). In *Memory and Theory in Eastern Europe*. Eds.: Blacker, U., Etkind, A. and Fedor, J., New York, Palgrave Macmillan, 233–254. Doi: 10.1057/9781137322067_12

Portnov, A. 2015. Post-Maidan Europe and the new Ukrainian studies. *Slavic Review* 74. (4): 723–731. Doi: 10.5612/slavicreview.74.4.723

Pshenychnykh, A. 2019. Leninfall: The spectacle of forgetting. *European Journal of Cultural Studies* 23. (3): 392–414. Doi: 10.1177/1367549419871345

Rating Sociological Group 2022. *The Tenth National Survey: Ideological Markers of the War* (27 April 2022). Available at https://ratinggroup.ua/en/research/ukraine/desyatyy_obschenacionalnyy_opros_ideologicheskie_markery_voyny_27_aprelya_2022.html

Różycki, B. 2017. Renaming urban toponymy as a mean of redefining local identity: The case of street decommunisation in Poland. *Open Political Science* 1. 20–31. Doi: 10.1515/openps-2017-0004

Šakaja, L. and Stanić, J. 2017. The spatial codification of values in Zagreb's city-text. In *The Political Life of Urban Streetscapes: Naming, Politics, and Place.* Eds.: Rose-Redwood, R., Alderman, D. and Azaryahu, M., Abingdon, U.K., Routledge, 151–167.

Schmidtke, O. and Yekelchyk, S. (eds.) 2008. *Europe's Last Frontier? Belarus, Moldova, and Ukraine between Russia and the European Union*. New Yok, Palgrave Macmillan.

Shevel, O. 2011. The politics of memory in a divided society: A comparison of post-Franco Spain and post-Soviet Ukraine. *Slavic Review* 70. (1): 137–164. Doi: 10.5612/slavicreview.70.1.0137

Stebelsky, I. 2018. A tale of two regions: Geopolitics, identities, narratives, and conflict in Kharkiv and the Donbas. *Eurasian Geography and Economics* 59. (1): 28–50. Doi: 10.1080/15387216.2018.1428904

Suspilne Novyny 2022a. *Prybraty z vulyts "russkij mir": Kharkivjany zvernulys do Terekhova*. Available at https://suspilne.media/218427-pribrati-z-vulic-russkij-mir-harkivani-zvernulis-do-terehova/

Suspilne Novyny 2022b. *Kharkiv pozbudetsia toponimiv, povjazanykh z Rosijeju, i dast vulytsiam imena zakhysnykiv – Terekhov*. Available at https://suspilne.media/233285-harkiv-pozbudetsa-toponimiv-povazanih-z-rosieu-i-dast-vulicam-imena-zahisnikiv-terehov/

Suspilne Novyny 2022c. *U Kharkovi perejmenuvaly Moskovskyj rajon, prospect i dvi vulytsi povjazani z RF.* Available at https://suspilne.media/238147-harkivska-meria-pogodila-perejmenuvanna-cotiroh-toponimiv-u-misti-spisok/

Suspilne Novyny 2022d. *Kharkivska toponimichna hrupa proponuje povernuty v ramkakh derusyfikatsiji istorychni nazvy vulytsiam*. Available at https://suspilne.media/257857-harkivska-toponimicna-grupa-proponue-povernuti-v-ramkah-derusifikacii-istoricni-nazvi-vulicam/

Zhurzhenko, T. 2011. 'Capital of despair' – Holodomor memory and political conflicts in Kharkiv after the Orange Revolution. *East European Politics & Societies* 25. (3): 597–639. Doi: 10.1177/0888325410387646

Zhurzhenko, T. 2015. The fifth Kharkiv. *New Eastern Europe* 17. (3–4): 30–37.

Zhurzhenko, T. 2016. Borders and memory. In *The Routledge Research Companion to Border Studies*. Ed.: Wastl-Walter, D., London, Routledge, 85–106.

Zhurzhenko, T. 2022. Legislating historical memory in post-Soviet Ukraine. In *Memory Laws and Historical Justice*. Eds.: Barkan, E. and Lang, A., Cham, Palgrave Macmillan, 97–130. Doi: 10.1007/978-3-030-94914-3_5

Zorko, M. and Novak, N. 2019. Classifying divided cities: The need for geopolitical perspective? *Sociology and Space* 57. (2): 159–171. Doi: 10.5673/sip.57.2.3

Zorko, M. 2020. Divided space or divided Society? The case of Vukovar. In *Spatial Conflicts and Divisions in Post-socialist Cities.* The Urban Book Series. Ed.. Mihaylov, V., Cham, Springer, 75–90. Doi: 10.1007/978-3-030-61765-3_5

DOI: 10.15201/hungeobull.72.3.4 Hungarian Geographical Bulletin **72** 2023 (3) 257–285.

Exploring firm performance in Central and Eastern European regions: a foundational approach

Ildikó EGYED[1] and Zsuzsanna ZSIBÓK[1]

Abstract

Economic development in post-transition countries is dominated by the performance of capital cities, although second-tier cities are also important drivers of development. However, peripheral regions struggle with problems of adaptation and response, often leading to brain drain and economic decline. Industrial strategies highlight those tradable sectors of the economy that favour leading edge KIBS firms and advanced manufacturing, while neglecting the residentiary economy that is more sheltered from competition and provides jobs in local production and services sectors. Our research is inspired by the burgeoning literature of the 'foundational economy' approach to economic development, focusing on mundane economic activities providing essential goods and services, and we investigate the differences of economic performance across the NUTS3 regions in selected CEE countries. We study regionally aggregated, firm-level financial and employment data including sectoral classification of the companies with 10+ employees. Our position is that a well-functioning foundational economy is necessary for the whole local economy to work efficiently in the long run. Moreover, increasing productivity in the foundational economy should lead to more regionally balanced growth than an exclusive focus on the 'frontier firms' that are highly concentrated spatially as the regional productivity gap in the case of certain foundational activities is not necessarily large.

Keywords: foundational economy, regional policy, firm-level data, labour productivity, Central and Eastern Europe

Received June 2023, accepted August 2023.

Introduction

The decade after the global financial crisis and recession has brought new economic development challenges for Central and Eastern European (CEE) countries and their sub-national territorial units. The slow growth of the post-crisis recovery period was replaced by a high-pressure economy in the mid-2010s, which was brought to a halt by the 2020 coronavirus crisis. Against the backdrop of adverse demographic trends, including a shrinking and ageing population and the ensuing labour market tightness, CEE countries can no longer rely on extensive employment growth as a prerequisite for long-term economic growth, instead, productivity improvement should be a priority. Despite the fundamental role of foreign investments in the market and global value chain integration of the CEE macro-region and the associated economic growth and productivity gains, FDI by itself is insufficient to ensure sustained catching up (Gál, Z. and Lux, G. 2022). The CEE region is not homogeneous in this respect, since the Baltic States, Slovenia and Czechia have shown a solid convergence performance in terms of per capita GDP relative to the EU average and the Human Development Index. This heterogeneity is partly explained by the different institutional environment and the divergent growth models followed by the countries of the macro-region. As a result, the countries are not at the same stage of progress towards the 'high road' of competitiveness (Molnár, E. *et al*. 2020), while some of them may overcome the so-called middle-income trap (see Győrffy, D. 2022; Mátyás, L. 2022).

[1] Centre for Economic and Regional Studies, Institute for Regional Studies, 22 Papnövelde utca H7621 Pécs, Hungary. E.mails: egyed.ildiko@krtk.hu, zsibok.zsuzsanna@krtk.hu

Due to the post-1989 privatization or dissolution of potential national champions and the weakness of home-grown mid-sized firms, the FDI-driven model of so-called dependent market economies has no viable alternatives (Nölke, A. and Vliegenthart, A. 2009). Foreign multinational enterprises are at the forefront of market-driven reindustrialization, the patterns of which are highly heterogeneous across the regions (Nagy, B. *et al*. 2020). The weaknesses of FDI-driven models (relying on low labour costs, skilled labour, tax advantages and proximity to the West) are manifest in the absence of domestic innovation-leading companies and headquarters, compounded by a shrinking working-age population (Bodnár, G. *et al*. 2022). The economic development of post-transition countries is heavily dominated by the performance of their capital cities, although second-tier cities, as growth poles, are also important drivers of development. The presence of high-quality residential environments, improved connectivity, high-skilled occupations and increasing populations exert a positive impact on the employment dynamism of regions and cities outside the capital. However, regions left behind by economic transformation (Weresa, M.A. 2017) often struggle with problems of adaptation and response, leading to brain drain, population outmigration and economic decline. This tendency is reinforced by industrial strategies' overwhelming focus on the tradable sectors of the economy, favouring leading edge KIBS firms and advanced manufacturing, while conspicuously neglecting the residentiary economy (see Leaver, A. and Willams, K. 2014), a sector relatively sheltered from competition and a source of locally anchored production and services jobs acting as important 'stabilizers'.

Our research is inspired by the burgeoning literature on the 'foundational economy' approach to economic development (Russell, B. *et al*. 2022), i.e., mundane economic activities providing essential goods and services (see Bentham, J. *et al*. 2013), focusing on economic performance across NUTS3 regions in four CEE countries, namely, the Visegrád Four (Scott, J. 2021) with Czechia, Hungary, Slovakia and Poland. We consider the inclusion of a foundational approach in development policy to be highly beneficial in the CEE economic context, which is burdened by a dualistic economic structure (Nagy, Cs. *et al*. 2020), excessive spatial disparities and increasingly left-behind places, with no apparent signs of improvement in this respect over the last few decades. The foundational approach breaks with the singular notion of 'the economy', operating with multiple economies and zones of activities that show very different features. In line with the literature, our article starts from the view that a strong foundational economy can strengthen the cohesion of urban and local economies, furthermore, it can have a higher relevance for peripheral, disadvantaged regions, saving them from the circular and mutually reinforcing spiral of deterioration (Bosák, V. *et al*. 2023; Martynovich, M. *et al*. 2023).

The novelty of our research lies in exploring the role of the foundational economy in the CEE region based on firm-level data in a regional aggregation, as these aspects have not been scrutinized in the CEE regional science literature before. Given that the Visegrád countries are part of the Central European manufacturing core, the macro-region follows a different path towards the tertiarization of the economy relative to the Western European economies. Consequently, the weight and role of the foundational economy in the CEE region might show some specific features compared to those identified in the existing literature. In the next section we summarize the theoretical considerations underlying the research, then the empirical strategy will be introduced. In the fourth section empirical results and the discussion are presented and the last section concludes.

Theoretical considerations

In their Manifesto for the foundational economy published in the mid-2010s, the Foundational Economy Collective, a group of

Manchester-based researchers advocated for a fundamental renewal of economic policy, refocusing it from the coveted frontier high-tech sectors to the less glamorous zone of the *foundational economy* (FE), which provides existential goods and services designed to 'keep us safe, sound and civilized' (FE Collective, 2020). Inspired by the works of Polányi, K. (1944), and Braudel, F. (1981) the FE Collective militates for re-embedding the economy into social and environmental contexts, on the grounds that capitalism has been allowed to expand into areas of society where markets should not belong (Reeves, R. 2018, 25). Breaking with the GDP-oriented singular notion of the economy that emerged with the rise of national income accounting in the mid-20th century, the FE reframes the economy as diverse, composed of multiple zones of activities *(Table 1)* that show very different features and consumption patterns, and can be guided by economic principles other than market exchange (FE Collective, 2020).

Operating outside the sphere of market exchange and public provisioning, the unpaid sector of the *core economy* (family and community) comprises 40 percent of working time and is dominated by women; it is analogous to the Braudelian 'infra-economy of everyday life' where the majority of the world's population lived in the early modern period. Together with the core economy, the foundational zone emphasizes collective liveability and belonging, and is an important source of place attachment (MacKinnon, D. *et al.* 2022). The foundational zone encompasses the sphere of infrastructure-based collective consumption through locally grounded provisioning systems and services described as low risk, low return activities. Covered only partly by major databases yet a source of roughly 40 percent of jobs in European countries (nearly 70% when considering the overlooked economy), the FE produces mundane and sometimes taken for granted goods and services that are vital for everyday life and the satisfaction of human needs (Barnthaler, R. and Gough, I. 2023). As defined by Bowman, A. *et al*. (2014), FE goods

Table 1. The zonal view of the economy in a foundational perspective

Economy	Form of consumption	Examples	Business model	Source of revenue	Organisational mobility and mortality	Post-1980s public policy
Core Economy	Non-economic	Parenting (voluntary action, etc.)	Gifting: no charging or recovery of cost	Goodwill	Re-invented forms (e.g. divorce and marriage)	Volunteers
Foundational Economy	Daily essentials distributed via infrastructure of networks and branches	Material (e.g. food, utilities); Providential (e.g. health, care, social housing)	Was low risk, low return, long time horizon for public and private providers	Tax revenue for free at point of use or subsidised; or regulated private purchase	Low mobility and mortality as networks and branches 'ground' firms, stable demand	Privatisation, outsourcing, shareholder value
Overlooked Economy	Occasional purchases of mundane, cultural necessities	Holidays (a meal out, haircuts, etc.)	Financialised corporates vs SME and micro pro lifestyle and getting by	Discretionary from market income	High mortality in small firms and structural shifts	Below the policy radar if firms too small to take outside capital
Tradable Economy	(Aspirational) private purchase	Cars, electronics, private housing	high risk, high return, short time horizon	Market income from wages (state subsidy for R & D, training, etc.)	High mobility as footloose under free trade; cyclical demand	Business friendly, structural reform

Source: The Foundational Economy Collective, 2020.

and services are partly non-market, they are consumed by all citizens regardless of income, geographically distributed, and typically sheltered by local monopoly or politically franchised. While the *providential foundational economy* is about human interaction and essentially represents the modern welfare state (health and social care, education, police, public administration), the *material foundational economy* is more concerned with things, delivering 'essential need satisfiers', e.g., pipe and cable utilities, public transport, telecommunications, food distribution, housing or banking services. The FE is surrounded by an external zone of non-essential provisioning labelled as the '*overlooked economy*', which provides occasionally purchased comfort goods and services (e.g., haircuts, house repairs, holidays from work or a meal out) that are important to well-being.

The *export-oriented tradable economy*, described as the least welfare-critical zone, is associated with competitive success and economic growth-focused strategies, which either downplay the importance of sheltered and low-productivity FE sectors or present them as levers for increased productivity, with a view to increment GDP. FE theorists note how the overrated high-tech and R&D intensive industries have failed to deliver wealth and well-being for the majority of the population, employing around 4 percent of the workforce in European countries (FE Collective, 2018). The preoccupation of economic policy makers with high-tech and next generation industries follows from their depiction of the economy as an iceberg, giving visibility to the narrow zone of the tradeable economy, while a large part of the economy, despite its strategic importance for national prosperity, remains hidden from view (Ibid.). Whereas the building of the foundational economy in Western Europe was a century-long achievement dating back to the 1870s, its dismantling through neoliberal reforms from the 1980s has undermined both the material and moral basis of foundational provision, which is inherently normative, as stressed by the FE Collective. Neoliberal business-friendly regimes encouraged extractive corporates in FE sectors (such as transport, energy, telecommunications, or retail) that fail to adequately provide FE goods and services, without imposing any duties on them (Bentham, J. *et al*. 2013; Gough, I. 2020). To challenge the dominance of investment-averse, financialized and shareholder value-driven business models in the market-provided FE, there is a need for the remunicipalization of some commodified essential services, increasing the local accountability of economic actors and the reform of top-down, centralized policymaking (FE Collective, 2018; Hansen, T. 2022).

Another policy recommendation concerns implementing *social licensing* whereby the local state could subject FE businesses that provide welfare-critical services to various eco-social obligations (payment of living wages, fair treatment of suppliers, distribution of economic benefits, support for community activities, building local value chains, etc.) in exchange for their right to trade in partially sheltered sectors, on grounds that it is citizen tax revenues and direct household expenditure that sustain foundational activity (Froud, J. and Williams, K. 2019). A new social contract with the private sector, as argued by Marques, P. *et al*. (2018) would allow deprived areas to negotiate better deals for their communities. Social licensing proposals rest on the principle that regardless of ownership, all FE businesses should be treated as in the public domain, not by the means of renationalisation, which only changes ownership, but constitutional reforms (FE Collective, 2018; Gough, I. 2020). Accordingly, their primary focus should not be profitability, which always involves value extraction from the public realm but rather to ensure that wealth creation is generative and rooted (Berry, C. 2018; Evenhuis, E. *et al*. 2021). In this regard, the FE has many parallels with the Community Wealth Building movement, which stresses the key role of local anchor institutions in local wealth retention and fosters the creation of local cooperatives and locally owned firms with social value embedded in their practices (Crisp, R. 2022).

The literature on diverse economies that seeks to explore economic spaces of alterity and, more recently, well-being economies that encourages well-being-driven businesses with social and environmental goals, is similarly critical of exploitative and extractive business practices whose alliance with various forms of concentrated power can exert undue influence on trajectories of change (Gibson-Graham, J.K. and Dombroski, K. 2020; Fioramonti, L. *et al*. 2022). The FE's zonal view of the economy fits well with the *diverse economy* (DE) concept developed by Gibson-Graham, J.K. (2008) as a critique of capitalocentric models downplaying the role of non-market transactions and unpaid household work in the economy, and showing a blindness to alternative development paths pursued by places where waged economy is not the primary source of well-being to people. In post-socialist CEE countries, for instance, the survival of diverse economic activities plays a significant role in the social reproduction of households (Fabula, S. *et al*. 2021; Vigvári, A. 2023). Gibson-Graham's representation of the economy as an iceberg intends to unsettle the hegemony of capitalist practices by bringing visibility to multiple forms of labour and economic activities beneath the waterline that are usually hidden from view. For Novy, A. (2022), FE represents a promising new development vision contrasted with the short-term strategies of liberal globalism and nationalistic capitalism, both ill-equipped to provide adequate responses to the current social-ecological crisis. Bärnthaler, R. *et al*. (2021) interrogate the potential of FE to instigate a social-ecological transformation that may overhaul capitalist nature-society relations guided by an extractive logic, in favour of a good life within the planetary feasible.

The FE perspective seeks to refocus industrial policy from narrowly defined manufacturing sectors producing tradable and exportable goods and services to the foundational sectors that are key to rebalancing regional economic growth. Aiginger, K. (2015) claims that welfare increases in high income countries require industrial policy that is based on high road competitiveness, defined as the ability to promote beyond GDP goals while focusing on developed countries' comparative advantages. Low and high road strategies to regional development co-exist to this day, the former (neoliberal approach) centred on lowering costs (wages, taxes, energy), labour and environmental standards; the latter (mainstream progressive approach) relying on higher wages and productivity, boosting capabilities in education, innovation, ICT, and ecological excellence (Scandinavian style). As suggested by Berry, C. (2018), the subject of industrial policy should be conceived as a multi-layered economy, with the foundational sector representing a new economic entity in its own right. An FE-informed industrial policy (see Bowman, A. *et al*. 2015) that delivers social value would prioritize the essential needs of society and workers, such as access to universal basic infrastructure, alongside the advancement of early-stage research, energy supply, KIBS, and industrial growth, with the latter always generating conflict between winners and losers. This highlights the non-neutrality of state agency, which is always selective, empowering some actors or groups, identifying lead firms or key segments of value chains as the main drivers of capital accumulation, privileging certain spatial and temporal horizons, strategies, paths, and identities over others (Jessop, B. 2014; Teixeira, T. 2023).

Linking spatially uneven economic development to the neoliberal restructuring of capitalist production, Wigger, A. (2023) defines the state's role as a facilitator of business-driven industrial upscaling processes, subordinating the interests of research institutes, labour and society to large private interests. Before the pandemic, debates on new industrial policy and strategic autonomy brought into sharp focus the EU's strategic selectivity, its commitment to support advanced economies in developing frontier technologies at the expense of left-behind places, i.e. regions and cities outside the narrow scope of mission-oriented indus-

trial policies, which rely on R&D expenditure as the main driver of innovation-led growth. Morgan, K. (2021) claims that it is in this very space that the FE, due to its spatial and social inclusivity, makes its most important contribution. Left-behind places, as the contemporary manifestation of persistent geographically uneven development (Iammarino, S. *et al*. 2019; MacKinnon *et al.* 2022), are low or slow growth places where popular discontent and support for populist political forces, below average pay, employment and productivity, lower levels of educational qualifications and skills, higher levels of poverty and economic disadvantage coalesce (Rodríguez-Pose, A. 2018; Bertus, Z. and Kovács, Z. 2022).

As the FE is the part of the economy that is place-based, the theory fits well with the framework of progressive (if not radical) place-based policies targeting the reduction of territorial inequalities by promoting economic, social and institutional innovation, as it seeks to disrupt conventional growth-oriented local and regional development strategies that prioritise the inward attraction of firms and jobs. A report by the Heseltine Institute acknowledges that alongside the centrality of the tradable or commodity economy, the foundational economy and the social economy have an important role in the renaissance of lagging places (Boyle, M. *et al.* 2019). Given the increasing disconnect between growth and wages/living standards, the FE approach focuses on factors that directly enhance quality of life and liveability for citizens, i.e., public services, social capital, social infrastructure and environmental assets. As Froud, J. *et al*. (2020) note, productivity-enhancing regional or industrial policies are of little relevance in the context of low skills/low productivity foundational or mundane activities. In the case of some low pay activities, there is no automatic link between increased productivity and higher wages, nor is the policy goal of raising productivity in the FE sectors (such as health) necessarily meaningful. Rather than producing more competitive industries, the main purpose of the FE is to directly contribute to raising social standards in a region via the provision of stable, high-quality, sustainable, resilient, and low-cost foundational services (Evenhuis, E. *et al*. 2021; Essletzbichler, J. 2022). The FE takes up an estimated 30 percent of average household consumption expenditure, making all households essentially foundational consumers (Bowman, A. *et al*. 2014). Joining the long-evolving debate on the inadequacy of GDP/GVA metrics to reflect welfare and citizen well-being (see Calafati, L. *et al.* 2021), FE theorists argue that the metrics of foundational liveability – defined as household residual income after housing, utilities and transportation costs – should be the primary concern of economic policy rather than private consumption-driven economic growth. In a foundational perspective, citizen welfare depends less on tradables purchased through individual private income and more on collectively provided essential daily services, like energy, medical care, mobility infrastructure, education and social infrastructure, such as libraries and parks (Froud, J. *et al*. 2018).

Essentially, what distinguishes the FE from the competitive sectors is its overwhelming reliance on locally derived demand and incomes. Offering mostly locally anchored jobs, it acts as a major 'stabilizer' of local economies in periods of crisis, providing an important source of localized resilience (Martynovich, M. *et al*. 2023). By emphasizing the social use value of labour and the tacit skills of citizens, particularly those employed in low value, unpaid or underpaid sectors, the FE offers a novel approach to employment creation aimed at enhancing the quality of jobs, not simply their numerical increase (Bentham, J. *et al*. 2013; FE Collective, 2018; Forth, J. and Rincon Aznar, A. 2018). Given that future economic development is increasingly reliant on the qualitative contribution of production factors instead of extensive growth, we do not believe that the public sector has a crowding-out effect on private sector economic performance (Birch, K. and Cumbers, A. 2007), rather, a well-functioning public sector or broadly defined FE is necessary for the whole

regional and local economy to work efficiently. Moreover, as empirical evidence suggests (Bosák, V. *et al*. 2023), in the long run, an underdeveloped FE can undermine the further expansion of the competitive economy.

The FE as a moral enterprise (FE Collective, 2018) emphasizes universal entitlement to foundational goods and services that are essential to citizens' well-being and participation in society as a means to reducing inequalities, partially through taxing wealth and conspicuous (non-essential) consumption. This clearly resonates with the social equity argument for regional policy whereby no individual should be disadvantaged with respect to job opportunities, access to public services and affordable housing by virtue of living in one region rather than another. Barbera, F. *et al*. (2018) draw an analogy between the local commons and the civic infrastructure of goods and services that serve everyday needs, stressing the need for their de-commodification. FE theorists interpret foundational provision and entitlement as the practical application of the theory on human needs and human capabilities. The FE approach has informed recent UK-wide proposals for universal basic services (UBS), arguing that everyone should have access to life's essentials as a right not a privilege (see Coote, A. and Percy, A. 2020; Gough, I. 2020). The collective provision of UBS in areas such as childcare, adult social care, housing, transport and access to the Internet can be justified on equity, efficiency, solidarity as well as sustainability grounds (see Gough, I. 2020). UBS rely on interventionist states to ensure their citizens unconditional access to essential services and infrastructure; as argued by Gough, I. (2021), the state has the power to expand the foundational at the expense of the rentier economy by taxing non-labour incomes, e.g., wealth, land, corporations, pollution, unhealthy consumption, etc. The delivery of need satisfiers, defined as the particular goods, services, activities and relationships required to meet specific needs in a given social setting (Ibid. pp. 7) requires collective responsibility and 'foundational renewal'. For instance, the building of 'grounded cities' that emphasize the management of the mundane, sheltered activities of the FE for the benefit of all citizens, social innovations to meet basic needs over technical innovation geared at productivity growth, and the city's co-development with its hinterland (Engelen, E. *et al*. 2017). Foundational liveability, underpinned by UBS, is instrumental in switching the economy from a fixation on economic growth to a concern for human well-being within planetary limits (Coote, A. 2020), in order to support the transition to a low-carbon energy-services, well-being, and equity-oriented economy (IPCC 2022). To this end, national governments across the globe have subscribed to post-growth well-being economy agendas, particularly in high income countries, where further economic growth no longer drives increased human well-being, health, happiness or life satisfaction (Wilkinson, R. and Pickett, K. 2022). Decentering GDP growth as a core economic and political target, well-being economies frame development as an increment in multidimensional well-being and consider industrial investments of positive value for the economy insofar as they produce desirable well-being outcomes, such as improvements in the quality of work or a better work-life balance. WE proponents, like FE theorists, have recommended focusing on collective well-being as the main goal of economic policy, and, therefore, the need to expand socially productive sectors (e.g. health, education, care, conviviality) in tandem with downscaling ecologically and socially harmful economic activities (see Fioramonti, L. *et al*. 2022).

In line with the literature (see Bentham, J. *et al*. 2013; FE Collective, 2018; Nygaard, B. and Hansen, T. 2020; Hansen, T. 2022), we believe that the FE has a higher relevance for peripheral regions and cities where the economic and institutional conditions for highly productive ventures are lacking as the demand for FE services is non-cyclical; besides, organisations in the FE are territorially distributed by nature, likely to be present in

every municipality. Due to its social and spatial inclusivity, the FE approach, promising to build more grounded local and regional economies, has the potential to save left-behind places from the 'circular and mutually reinforcing spiral of deterioration' (MacKinnon, D. *et. al*. 2022; Martynovich, M. *et al*. 2023). In addition, policies improving the productivity of ordinary firms in the everyday economy (such as retail, hospitality, social care, tourism), can achieve more regionally balanced growth by creating a broader base of competitive firms than an exclusive focus on frontier firms with a high spatial concentration, as the regional productivity gap in the case of certain FE activities is not that significant. Integrating the FE approach into economic policy making would also increase the potential of peripheral/semi-peripheral CEE regions 'locked into' low value segments of GVCs to overcome the low innovation, low skills, low productivity trap (Galgóczi, B. *et al*. 2015), helping them to avoid race-to-the-bottom situations. With its marked social welfarist orientation emphasizing human capital, social investments, and the social consumption of essential goods and services over individual private consumption, the FE approach is particularly well-suited to the needs of peripheral regions with demographic challenges and reduced economic opportunities, capable of alleviating poverty by providing decent wages and promoting a renewal of key provisioning sectors of the economy.

Data and methods

Our empirical work utilises a database of firm-level financial data collected from four Central and Eastern European countries, the Visegrád Group, based on our institution's access to the Bureau van Dijk's Orbis Europe database. The covered period spans from 2016 to 2021 and the database consists of a total of 218,575 active firms from Czechia, Hungary, Slovakia and Poland having either over 10 employees or over 1,000,000 USD operating revenue.

The location information allows us to identify the NUTS3 region and the municipality in which the firms are headquartered. This information allows us to study the firms' performance according to a variety of territorial aggregations, from which we will focus on the national and the NUTS3 level. Also, information on the firms' sector of operation according to the NACE Rev.2 classification (4-digit codes) enables us to analyse the data in a detailed sectoral disaggregation. The set of variables collected from the Orbis Europe database were chosen to be relevant to the calculation of the firm-level labour productivity following the widely recognised guidance of Gal, P.N. (2013). Nonetheless, data availability issues highly constrain the pool of firms available for analysis. The results might not be fully representative for all of the regions. To overcome these shortcomings, we kept the level of regional disaggregation at the NUTS3 level and computed averages over the six years that were covered in our data set. For the sake of greater coverage, we omit dynamic analysis.

In order to study the functioning of the foundational economy in each region, we need to identify those economic activities that belong to the different 'zones' of the economy. A detailed classification published by The Foundational Economy Collective (FE Collective, 2019) will help us to do this. The classification assigns to each economic activity identified by the NACE codes their type according to which part (zone) of the economy they belong *(Table 2)*. The two categories within the foundational economy, as explained in previous sections, are the material activities and the providential activities, and similar in nature is the overlooked economy, which are supplemented by the tradable economy (called 'other activities'). This way we are able to identify the divergent economic structures and the associated development patterns among the regions of the CEE area.

The importance of the foundational economy is mostly evaluated with the distribution of economic performance between the different economic zones. For this reason, we compute some baseline distribution in-

Table 2. NACE Rev. 2 industry classification with respect to economic zones

Zone	Number of industries	Percentage of industry codes, %
Material	182	23.2
Providential	44	5.6
Overlooked	183	23.3
Tradable (other)	377	48.0
All industries	*786*	*100.0*

Note: A detailed list of industry classification is available in Martynovich, M. *et al*. (2023) online supplement (pp. 10–21), and The Foundational Economy Collective (2019). *Source*: Authors' own elaboration based on Martynovich, M. *et al.* (2023) online supplement.

dicators regarding the number of firms, the number of employees and the total operating revenues in a regional aggregation. This is the information available in the database for the widest range of companies. We supplement this with the evaluation of average income and employment that inform about the relative strength of the types of economic activity in each region. The location information and the sector of operation is available for almost all firms, but the coverage of employment and operating revenue data is only around 90 percent at an average *(Table 3).* For Czechia and Slovakia, the lower coverage is attributable to the reporting practices of public sector firms and institutions, as data in many cases are available only at a class level or as an estimation. When computing firm-level productivity measures, we sort out those firms (institutions) that report 'limited financials' *(Figure 1* and *2).*

A U-shaped relationship is observable between the relative development of the regions and the share of the manufacturing sectors within their total economy *(Figure 3).* In fact, the values exceeding 20 percent are regarded as high in a Europe-wide comparison. On the basis of this, and also considering the population size, we have grouped the 115 regions into five categories according to their level of development based on their per capita GDP level (in PPS) relative to the EU average in 2019 (see *Figure 1).* The capital regions are a distinct category, reaching 152 percent (Budapest), 163 percent (Bratislava), 206 percent (Prague) and 216 percent (Warsaw) of the average per capita GDP in the EU and having a low relative share of manufacturing within their economy. The second development category consists of 9 metropolitan regions with large non-capital cities, of which one is in Czechia (Jihomoravský kraj with Brno) and 8 in Poland (Miasto Kraków, Katowicki, Miasto Poznan, Miasto Szczecin, Miasto Wroclaw, Trojmiejski, Miasto Lódz and Warszawski zachodni), having above-EU average development and relatively low manufacturing sector. The third category represents the relatively developed non-capital regions (altogether 22), hereby referred to as 'intermediate' regions, with per capita GDP levels exceeding 70 percent of the EU average. They are mostly manufacturing regions with medium-sized

Table 3. The coverage of the firm-level database

Country	Number of			Total operating revenue, million USD	Coverage of	
	NUTS3 regions	firms	employees		employment data*, %	revenue data*, %
Czechia	14	60,083	3,324,593	603,794	80.6	92.0
Hungary	20	57,412	2,785,495	470,866	95.6	99.7
Slovakia	8	29,518	1,133,455	247,406	80.3	80.0
Poland	73	71,562	6,056,176	1,038,711	95.3	92.7
Total	*115*	*218,575*	*13,299,719*	*2,360,776*	*89.3*	*92.6*

*The column reports the proportion of companies for which data are available for at least one year.
Source: Authors' own elaboration based on Orbis data.

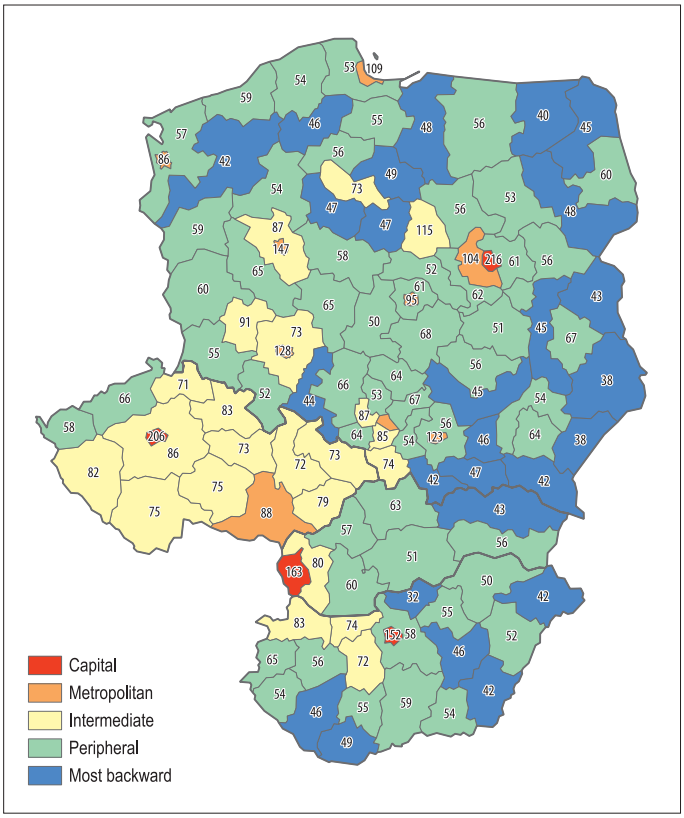


Fig. 1. Relative economic development of the NUTS3 regions in the Visegrád countries (per capita GDP in PPS, as a percentage of the EU-27 average), 2019. *Source*: Authors' own elaboration based on Orbis data.

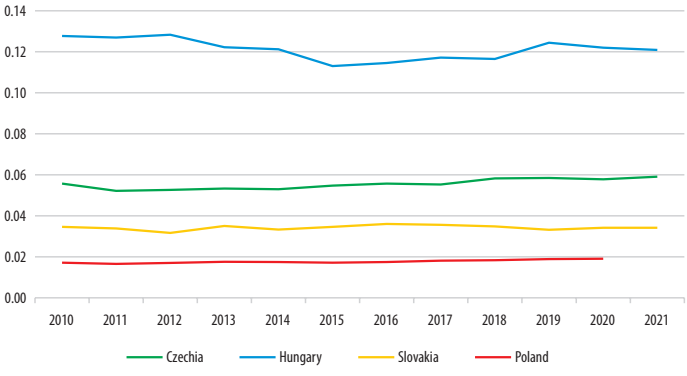


Fig. 2. The normalised Hirschmann-Herfindahl index of GDP concentration in the Visegrád countries, 2010–2021. *Source*: Authors' own elaboration based on Eurostat data (nama_10r_3gdp).

centres. Apart from Plocki and Legnicko-Glogowski regions in Poland, none of these exceed 90 percent of the EU per capita GDP, nevertheless, they are developed compared to other parts of their respective countries. The less developed regions were divided into two categories: 'peripheral' regions reaching between 50 and 70 percent and having remarkable manufacturing sector (altogether 54 regions); and the 'most backward' regions which are below 50 percent of the EU average per capita GDP and the weight of their manufacturing sector is moderate (altogether 26 regions, none of which are in Czechia).

To evaluate firm performance, we calculate employment, revenue and productivity indicators. Gal, P.N. (2013) considers total revenue-based labour productivity as the most widely available measure, whose major weakness is that it does not control for intermediate input usage. Value added based labour productivity takes care of this problem, as value added is the difference between output (sales, revenue) and intermediate inputs (including resold goods). However, labour productivity does not control for differences in capital intensity across firms, therefore, to control for capital intensity, total factor productivity (TFP) should be calculated.

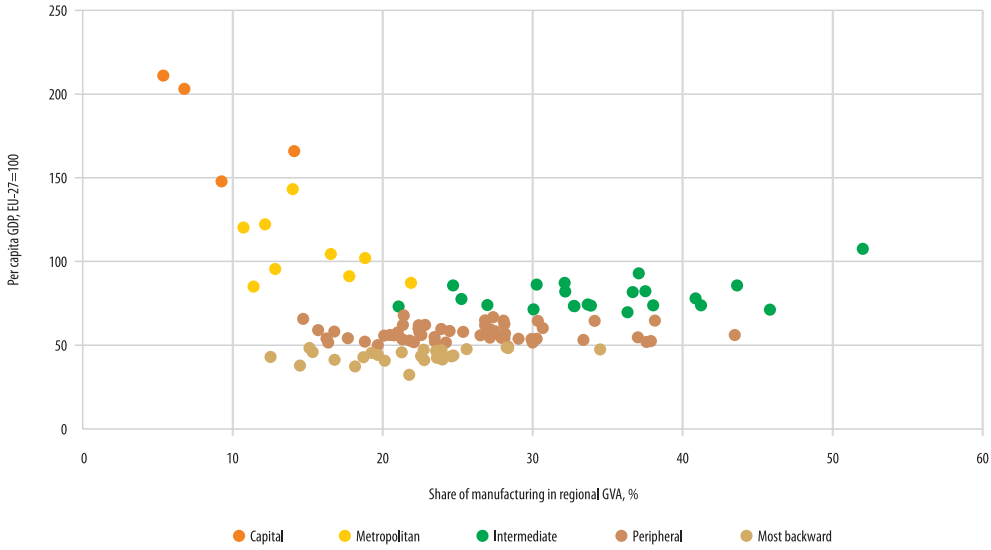


Fig. 3. The relationship between the share of manufacturing in GVA and relative development in the NUTS3 regions of the Visegrád countries (2016–2021) by region types. *Source*: Authors' own elaboration based on Eurostat [nama_10r_3gdp] and [nama_10r_3gva].

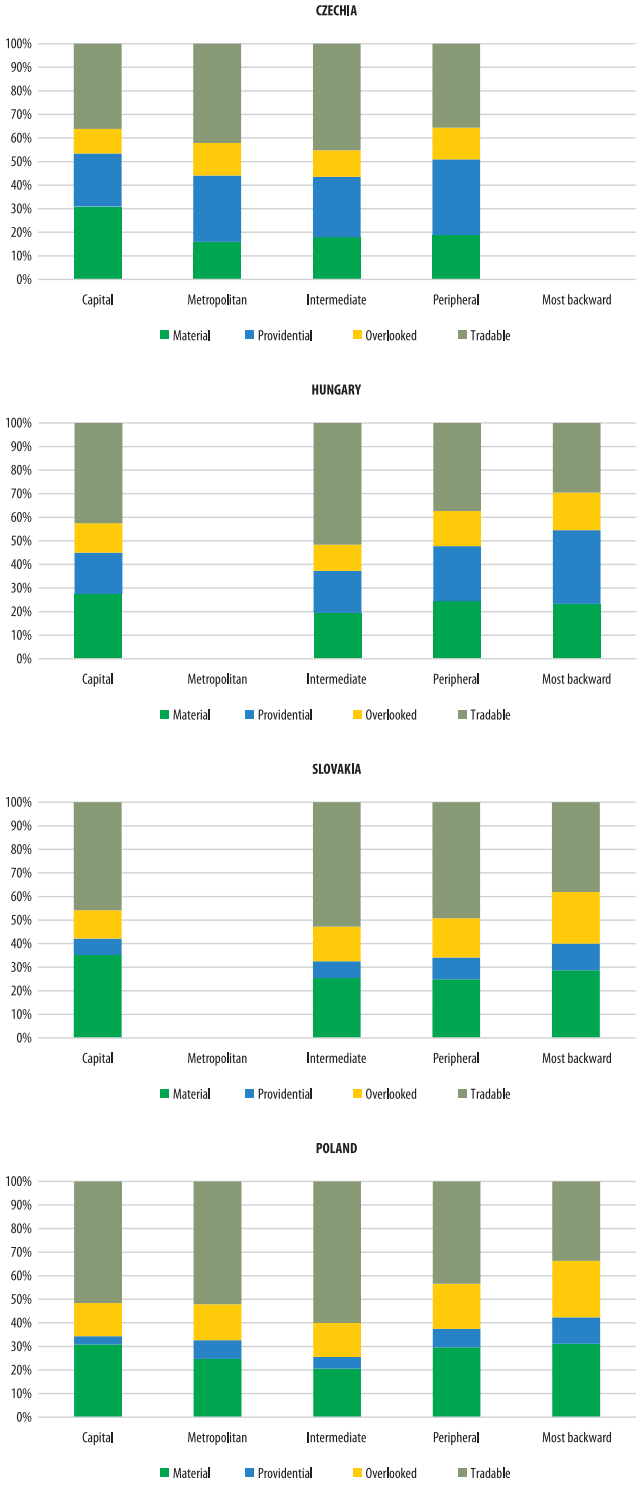
In this research we compute four kinds of measures for firm-level productivity. First, turnover-based labour productivity, which is the operating revenue divided by the number of employees. Likewise, a more accurate measure is value-added-based labour productivity, which is the value added divided by the number of employees. Nevertheless, the coverage of the value added data varies among the countries, being the lowest in Hungary (18%) and the highest in Poland (91%). Thirdly, value added is estimated by simply using its definition based on factor incomes as described by Gal, P.N. (2013), that is, the sum of the cost of employees and EBITDA. Fourthly, value added is calculated as the difference between total turnover and intermediate inputs, where the latter is approximated by the material costs. These indicators all measure labour productivity. Partly due to the different focus of our research and to data availability issues, TFP calculations will not be included at this stage of the research.

Results

In this chapter we first present a bunch of descriptive statistics about the weight and performance of the various types of economic activities according to the foundational approach in the regions of the selected CEE countries. Then, we analyse the efficiency of production according to multiple labour productivity measures across the regions.

Exploring the performance of different economic activity types in the CEE regions

The basic distribution measures mostly confirm our expectations about the weight of foundational activities (identified by the firms' NACE codes) in the different types of regions based on their relative development (*Figure 4*, and *Figure A1* and *A2* in the Appendix). Regarding the number of firms, tradable activities are most concentrated in the capitals



and metropolitan regions, but in terms of employment and, especially revenues, they are more represented in the intermediate regions in all four countries. The weight of material activities is relatively small in terms of the number of firms, but they represent the second largest category in terms of employment and revenues, especially in the capital regions. This is due to the centralised nature of material services provision and to the fact that a large part of the employment and revenues are recorded in the capital-based headquarters of the firms in the material sectors. In less developed regions, particularly in the most backward ones, providential and overlooked activities gain more importance, notably in terms of employment, and to a less extent in terms of revenues. While bearing in mind that the significant differences in the share of providential activities may arise from the different reporting practices of public institutions in the four countries, within-country, interregional differentials are still considered informative.

Interregional differences, based on the cross-sectional relative standard deviation *(Table 4)* are, generally, the highest in Poland, followed by Hungary and are the lowest in Czechia. Out of the four activity types, the spatial variation is relatively high in the providential and overlooked activities and it is the lowest in the trad-

Fig. 4. The distribution of employment between economic activities by region type, averages between 2016 and 2021. *Source*: Authors' own elaboration based on Orbis data.

Table 4. The relative interregional standard deviation of the share of FE and non-FE activities within the total economy

Country	Material	Providential	Overlooked	Tradable
Relative s.d. – the share of employees, %				
Czechia	25.8	13.3	17.4	13.2
Hungary	23.6	27.0	21.4	24.8
Slovakia	24.2	28.8	22.1	18.0
Poland	35.7	49.9	44.5	31.5
Relative s.d. – the share of firms, %				
Czechia	14.3	22.6	9.9	18.3
Hungary	20.7	27.4	10.1	21.6
Slovakia	21.4	40.8	13.4	13.0
Poland	27.9	28.4	17.2	22.0
Relative s.d. – the share of revenues, %				
Czechia	30.1	28.6	45.4	16.4
Hungary	35.4	39.8	50.4	29.2
Slovakia	25.7	29.4	46.8	14.0
Poland	41.2	58.0	78.8	36.1

Source: Author's own elaboration based on Orbis data.

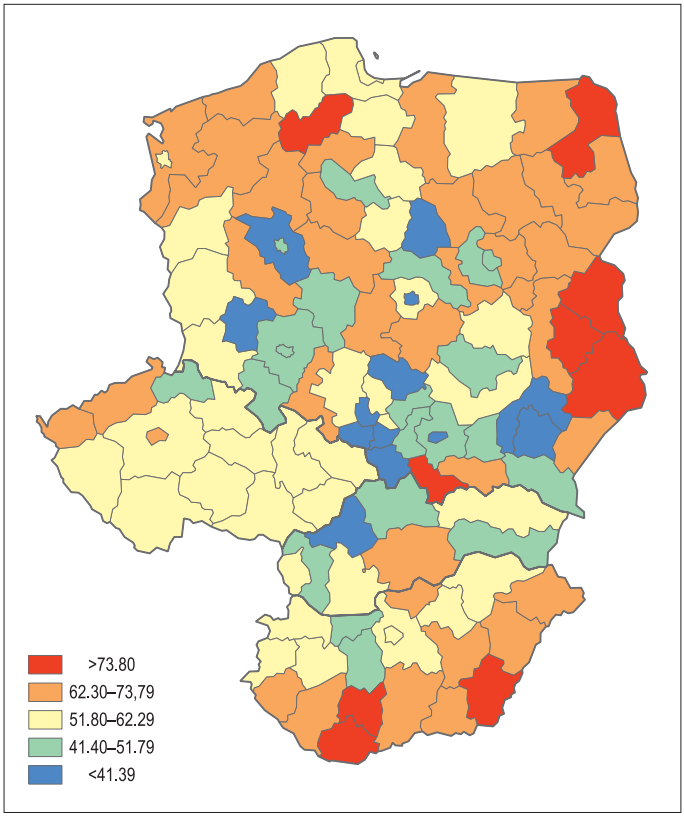


Fig. 5. The share of employees in foundational activities by NUTS3 regions in the Visegrád countries, averages between 2016 and 2021, in percent. *Source*: Authors' own elaboration based on Orbis data.

able activities. Concerning the three types of indicators, the highest interregional variation is observed in terms of the revenues and the number of employees.

The geographical differences regarding the share of employment in foundational activities within total employment significantly overlap with the differences of overall economic development measured by per capita GDP (see *Figure 1*), as confirmed by *Figure 5* below.

To gain deeper insights, we plot this relationship *(Figure 6)* and evaluate it with an OLS-regression between the share of employees in the foundational activities and the relative development of regions. Analogous regressions were also computed for revenues and the number of firms in the FE activities as a share of those in the total economy.

Due to their high level of development and the bal-

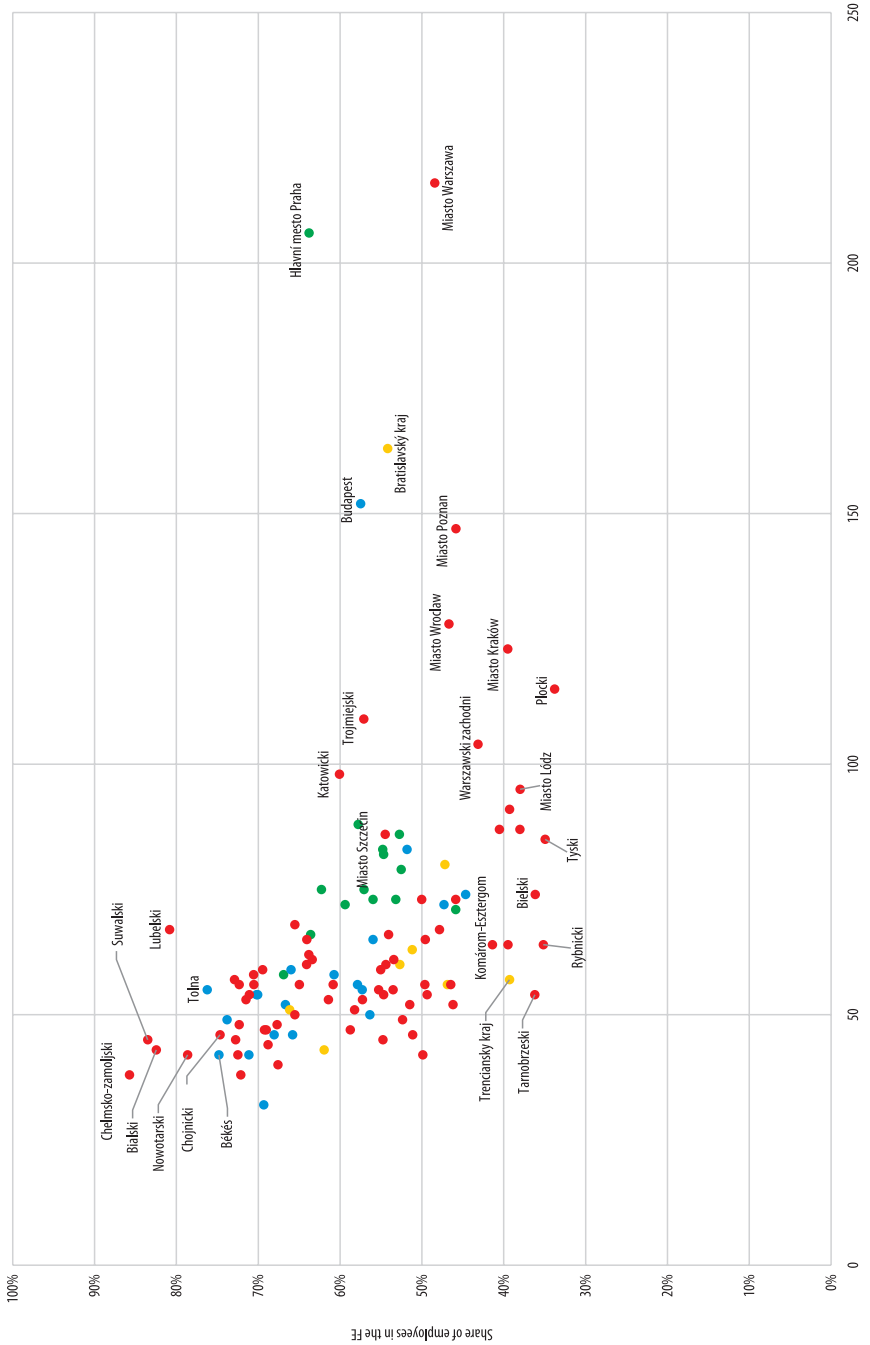


Fig. 6. The relationship between the share of employees in FE (averages between 2016 and 2021) and the relative per capita GDP in 2019 (PPS, EU-27 = 100).
Source: Authors' own elaboration based on Orbis data.

anced distribution of tradable and foundational activities within their economies, the four capital cities and a couple of Polish metropolitan regions emerge as outliers within the regions. This holds for the weight of FE in terms of employment and revenues, but not for the number of firms as the share of firms in FE activities relative to the total economy is the lowest in the capitals and metropolitan regions among the regions in each country, i.e., they do not depart from the general tendency described by the regression in this respect (see *Figure A1* in the Appendix). This result is in line with those of Martynovich, M. *et al*. (2023), who highlighted that the weight of FE, by its very nature, is in a strong, positive relationship with the population density. It is reasonable to assume that this additional factor causes the specialties of the capital and metropolitan regions. The overall correlation between the level of development and the weight of the foundational sectors is better captured if we exclude the capital cities from our computations. The relationship between the share of employees in FE and the relative per capita GDP is significantly negative in the regions outside the capital cities, as confirmed by the results of the regression analysis (see *Table 5*). The relationship between relative regional development and the share of revenues in the FE is weaker, but significantly negative nonetheless. At the same time, the regression shows the strongest negative association if we relate the regions' relative development to the number of firms in FE within their number in the total economy.

There are some notable differences within the Visegrád Group regarding the regional-level distribution of the share of foundational activities in terms of employment. Expectedly, the extent of the variation between the individual regional values follows the number of regions within each country. In Czechia, the weight of foundational activities within total employment varies between 46 percent (Liberecký kraj) and 67 percent (Karlovarský kraj). In Hungary, the lowest share of FE employment, 45 percent, was measured in Komárom-Esztergom county, and the highest, 76 percent in Tolna county. In Slovakia, the share of FE employment varied between 39 percent (Trenciansky kraj) and 66 percent (Banskobystrický kraj). The highest dispersion in this respect was observed in Poland, where the share of FE employment was the lowest in Plocki region (34%), and the highest in Chelmsko-zamojski region (86%).

Measures of the average size of firms in terms of employment and revenues in the different sectors and regions are also informative and help us to make a distinction between the general development level and the relative importance of the FE sectors. *Figure 7* indicates the average number of employees and the average turnover by NUTS3 regions relative to the total economy in a combined way. When the points

Table 5. The relationship between the weight of FE and relative development in the NUTS3 regions of the Visegrad countries (2016–2021)

Dependent variable	Share of employees	Share of revenues	Share of firms
	in the FE within total		
	employees	revenues	firms
Constant	79.9650* (3.1774)	72.6497* (4.6434)	78.8797* (1.9332)
Per capita GDP, EU-27 = 100	-0.3455* (0.0481)	-0.3429* (0.0702)	-0.2895* (0.0292)
Adj. R-squared	0.3155	0.1720	0.4687
S.E. of regression	9.9862	14.5938	6.0759
F-statistic	51.6971	23.8433	98.0219
Prob.(F)	0.0000	0.0000	0.0000
Obs.	111	111	111

Note: Standard errors are in parentheses. * Indicates significance at the 99 percent level. *Source*: Authors' own elaboration based on Orbis and Eurostat data.

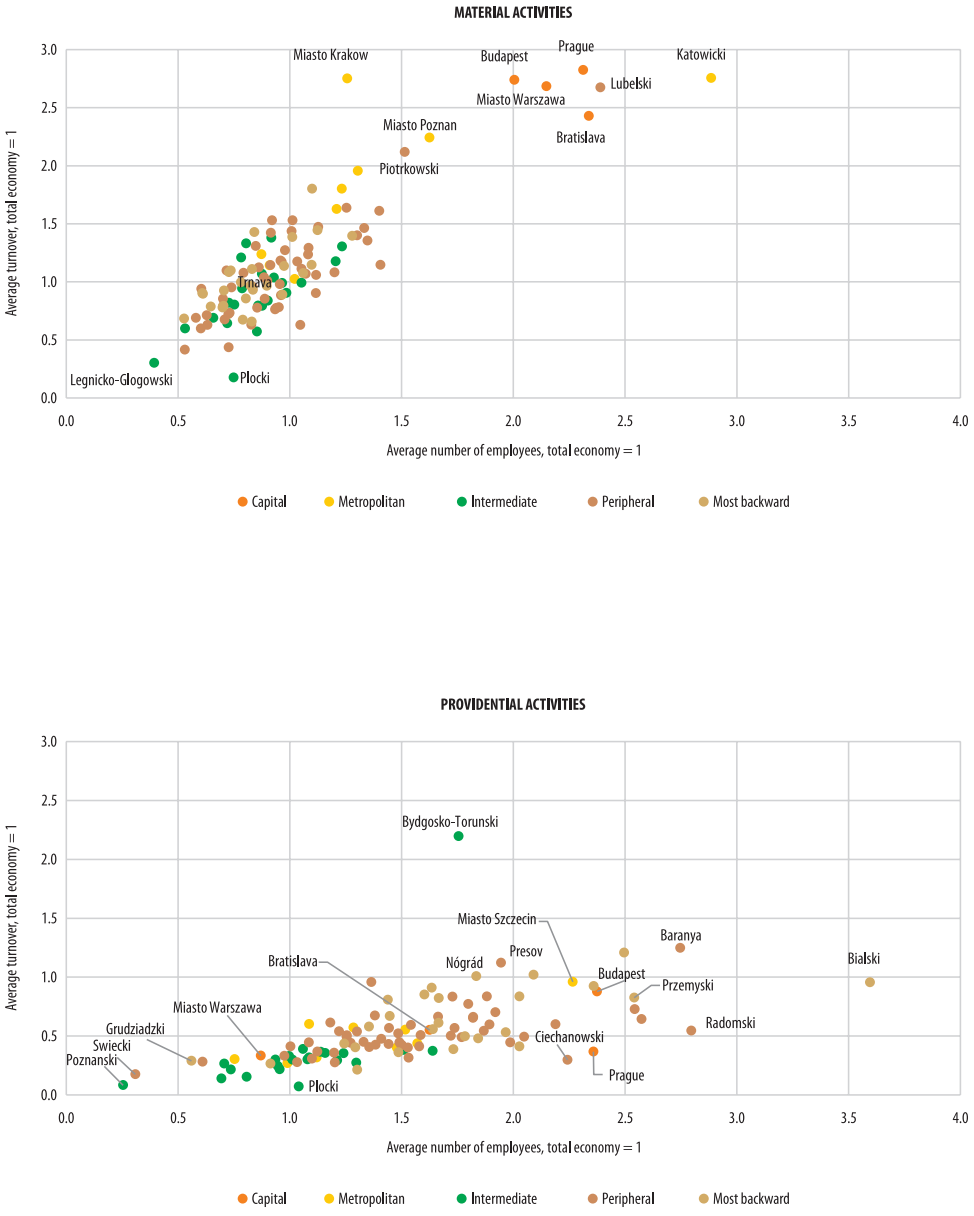


Fig. 7. Average number of employees and average turnover by region types and by activity types in the NUTS3 regions of the Visegrád countries (total economy = 1). *Source*: Authors' own elaboration based on Orbis data.

representing the NUTS3 regions are closer to the vertical axis, it suggests that the relative average turnover of firms is generally higher compared to the total economy, but the average employment of firms is relatively lower. This is the case in the material activities and, especial-

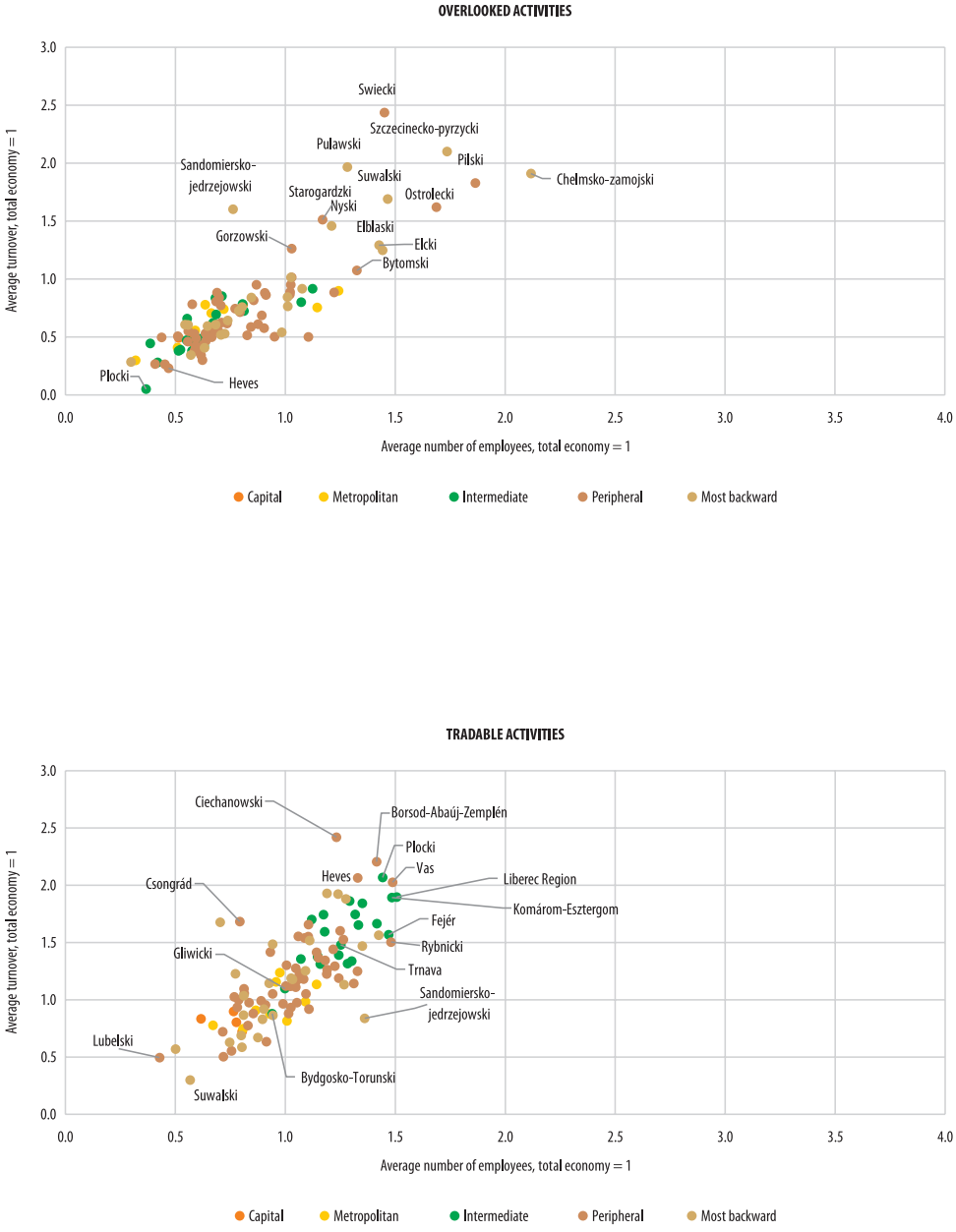


Fig. 7. Continued.

ly, in the tradable activities. In the overlooked activities, the firms' relative average employment is roughly proportional to their relative average turnover. However, in the providential activities, the firms employ a relatively large number of people at an average, but their average turnover is unproportionately low. The highest average employment is observed in the

material and providential activities, especially in the capital regions (partly as a result of the special reporting practices). Average employment is generally the lowest in the overlooked activities. The tradable activities have a higher number of employees in the non-capital regions, especially in the intermediate regions, but the largest firms in terms of employees are found in the providential activities.

Measures of firm-level productivity in the CEE regions

In what follows, we evaluate firm performance on the basis of labour productivity as described in the "Data and methods" section. Our perception is that the four types of labour productivity indicators show roughly similar tendencies, but they show some inconsistencies, therefore, we evaluate their evolution together (*Figure 8*, and *Figure A3* in the Appendix). The turnover-based productivity will be compared to the average of the other three, value-added-based productivity measures.

Based on the available measures of labour productivity, our results confirm the general expectations: in all types of regions tradable activities are more productive than other activities in many cases, but not always. Among FE activities, material activities have a comparably high or even higher labour productivity, especially in the capitals and Polish metropolitan regions. According to all measures of labour productivity, overlooked activities are less productive than material and tradable activities in each of the four Visegrád countries and each type of region, while the lowest efficiency was measured in the providential activities. A downward slope is observed for labour productivity performance according to the level of regional development (represented by the five region categories) across each activity type, which is most evident in Poland, and somewhat less visible in Slovakia. There is also a duality in terms of capital *versus* non-capital regions, especially in Slovakia and to a lesser extent in Hungary. In the case of Czechia, the productivity gap between the capital and non-capital regions is not that large, and the differences between non-capital regions, including the metropolitan region, are not wide either. Productivity differentials among the five types of regions are smaller in the overlooked and the providential activities. Among the non-capital regions, the productivity advantage of intermediate regions over that of other, less developed (peripheral and most backward) regions is not always observable in the case of Czechia or Hungary.

Figure 9 – and *Figure A4* in the Appendix – depicts labour productivity values for each NUTS3 regions by region types and compares them across the four types of activities in the Visegrád countries. The largest capital *versus* rest of the regions disparities are observable in the material industries (due to their highly centralised nature) and in the tradable activities. These are the largest in Slovakia and Hungary, but the distribution is much more balanced in Poland due to the high performance of the metropolitan regions. The most even distribution is observed for the overlooked activities and the providential activities everywhere, with the exception of Hungary. In the providential activities capital regions typically have a medium, or at least not outstanding performance.

Discussion

Comprehensive empirical exploration of the FE is very scarce in the literature so far, therefore we can compare our results with only a few examples. The basic distribution measures that inform about the weight of FE are largely in line with those found in the literature. The most notable of them is Martynovich, M. *et al*. (2023) who investigated the role of FE in times of crisis. According to them, the blow of the crisis was milder in regions where the FE was better integrated with other economic activities. We think that this is similar to the case of CEE, since FE in itself is not stable enough to provide long-term stability because of its regrettably underfinanced nature. The authors propose that

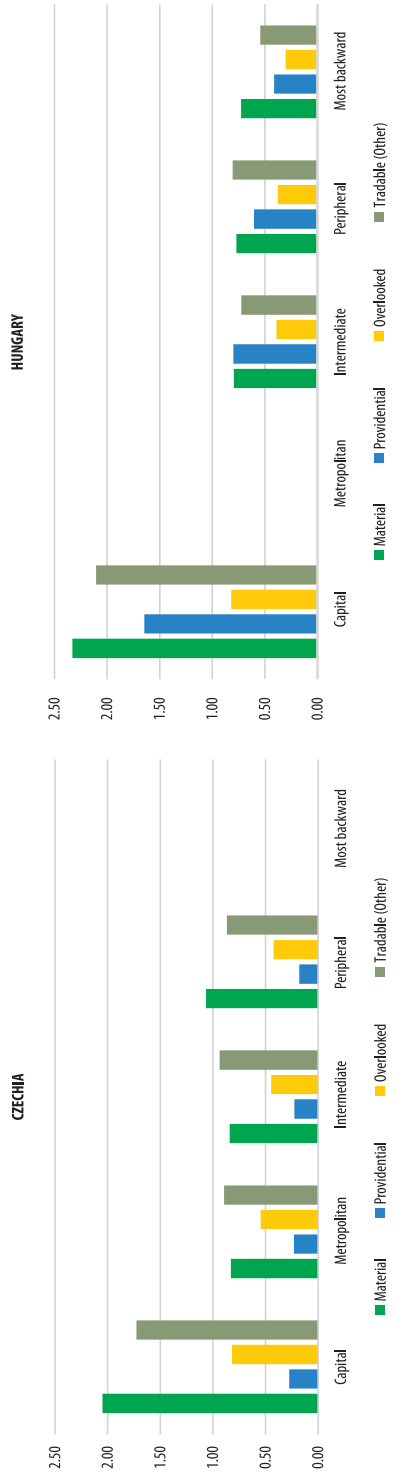


Fig. 8. Turnover-based labour productivity by economic activity types and NUTS types, averages between 2016 and 2021 (national average in the total economy = 1.00). *Source:* Authors' own elaboration based on Orbis and Eurostat data.

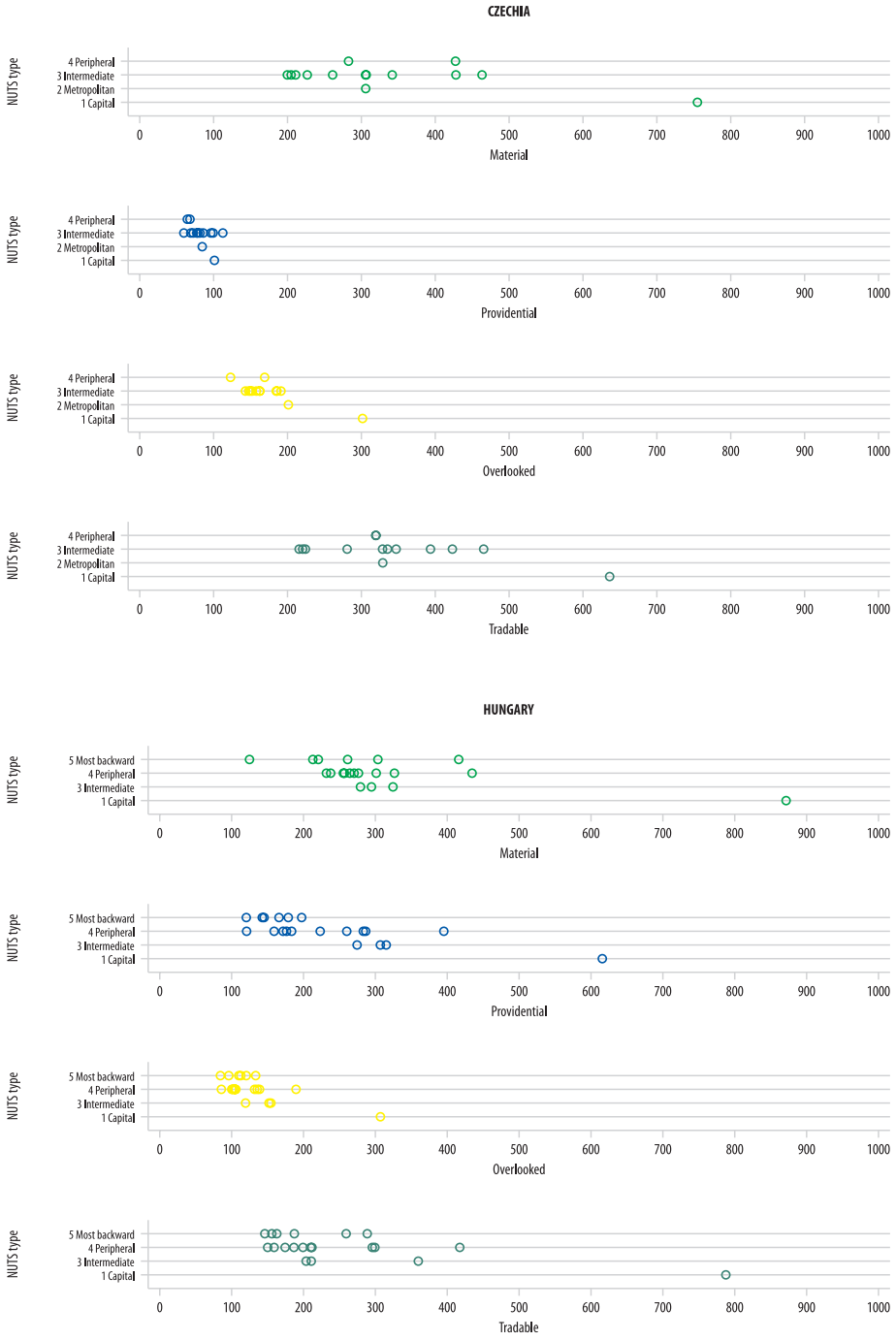


Fig. 9. Average turnover-based labour productivity of the NUTS3 regions by countries, region types and activity types (1,000 USD). *Source*: Authors' own elaboration based on Orbis and Eurostat data.

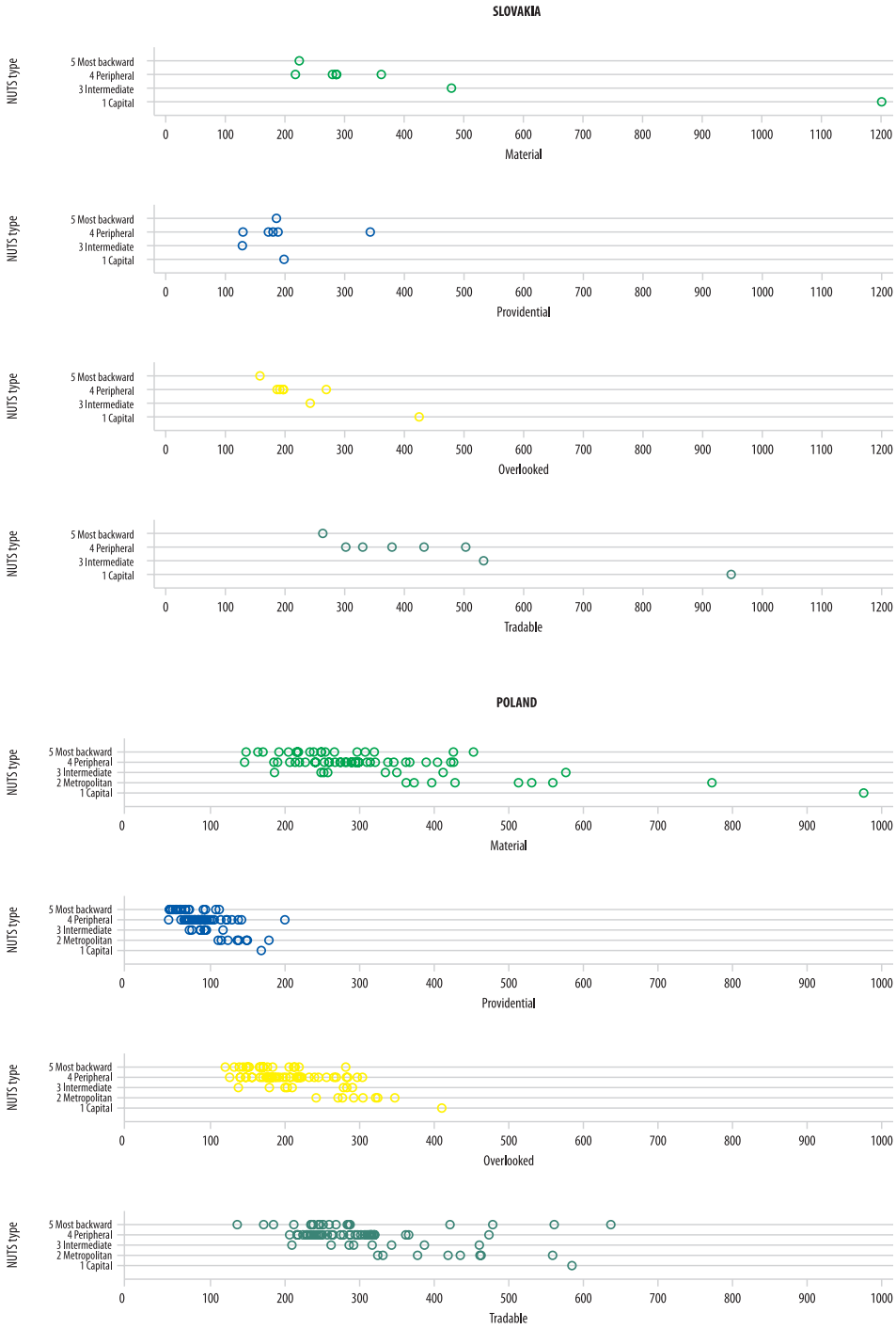


Fig. 9. Continued.

the different roles played by foundational and traded activities during crisis and recovery necessitate a more balanced approach, and more attention should be paid to the integration between these parts of the economy. Namely, to give particular attention to the interconnections between foundational and traded activities in regional policymaking and not to prioritize one over the other.

Our position is in accordance with the results of Nygaard, B. and Hansen, T. (2020) who state that foundational industries are often presented as levers for increased productivity, economic growth and job creation in other industries, thus, arguments for prioritizing them are not simply based on their positive contribution to citizens' welfare. The authors also found that local initiatives related to material services are most prominent, whereas providential services are less frequently prioritized in the municipal development strategies. Similarly, in CEE, material activities are often treated as strategic industries. The authors state that in Danish municipalities providential services are not considered part of the core of wealth production despite their central contribution to citizens' well-being. In general, foundational activities are regarded as unproductive consumption that municipalities can afford when exporting industries are thriving. According to Nygaard, B. and Hansen, T. (2020), it is capital and other metropolitan areas that emphasize initiatives to improve or invest in foundational industries, whereas rural and provincial municipalities are more likely to stress export-oriented industries in their planning strategies. We assume that it reflects the fact that foundational activities are often treated as residual, which is even more the case in CEE.

Bosák, V. *et al*. (2023) in a Czech municipal-level comparative analysis underline that the successful functioning of the tradable economy is conditioned by the FE, in the long-run, as it ensures social reproduction. Actually, an underdeveloped FE severely hinders local development overall, including further expansion of the tradable sectors. In our research we also find that beyond tradable activities, only the well-financed material activities are able to bring prosperity to less developed areas, but there is no significant spill-over effect, since revenues in the overlooked activities largely depend on the local purchasing power, and revenues in the providential activities are dependent on public finances.

Conclusions

In this article we provided an exploratory analysis of the distribution and performance of foundational activities within the regions of four CEE countries. Our findings show that foundational activities account for a significant proportion of employment, but they are considerably less important in terms of revenues. Also, the results confirmed our expectations that foundational activities are more represented in less developed regions, while tradable activities are more widespread in the so-called intermediate regions that form the most developed parts of their respective countries outside the capital cities. The relative economic development of capital cities outperforms their wider environment, nonetheless, the weight of the foundational and non-foundational activities is quite balanced in each of the four capitals of the Visegrád countries, at least in terms of employment and revenues. Among the different types of foundational activities, material activities have a similarly high labour productivity as compared to the tradable sector. Consequently, if we presume that tradable activities are less likely to appear robustly in less developed regions, the strengthening of the presence and performance of material activities might have positive impacts on their prosperity. The countries of the CEE region share many common features in terms of their economic development and geographies, but there also important differences between them. Slovakia and Czechia are characterized with a higher degree of 'capital *versus* rest of the country' duality

compared to Hungary, even though the latter shows wider spatial inequalities in GDP production, while economic development in Poland is the most deconcentrated based on both regional and firm-level data.

The most striking difference in the CEE countries with respect to their Western European counterparts is that the relative weight of manufacturing is significantly higher, but it reflects a weaker efficiency, i.e., the low road of development. Hence, a high reliance on the manufacturing sector cannot guarantee prosperity.

We suspect that in the CEE context, foundational activities might prosper in those regions where a relatively developed tradable sector is present, which is confirmed by the experience of the capital cities and metropolitan regions. Given that in some cases, especially in Hungary and Slovakia, the government's economic policy focuses more on industrial development and treats a large share of foundational activities as residual (excepting, e.g., the energy and financial sectors), the foundational economy could develop only in tandem with the tradable economy. Our impression is that good examples in this respect are found (apart from the highly developed capital cities) in the so-called 'intermediate' regions where a high level of industrialization and economic buoyancy can boost the growth of foundational activities and the services sector in general. Unfortunately, FE activities *per se* will not be able to deliver prosperity in the short run to otherwise underdeveloped CEE regions unless a greater, *deserved* focus is given by national economic policy. However, the opposite is also true, but mainly in the long run (which might explain policy neglect), i.e., regions will lose their attractiveness to investments in the tradable sectors if their foundational economy is underdeveloped.

Acknowledgement: This research has been made within the framework of Project No. 135185 with support from the National Research, Development and Innovation Fund of Hungary, financed under the K20 funding scheme and the János Bolyai Research Scholarship.

REFERENCES

Aiginger, K. 2015. Industrial policy for a sustainable growth path. In *New Perspectives on Industrial Policy for a Modern Britain.* Eds.: Bailey, D., Cowling, K. and Tomlinson, P., Oxford, Oxford Academic Press, 1–33. Available at https://www.oecd.org/economy/Industrial-Policy-for-a-sustainable-growth-path.pdf

Barbera, F., Negri, N. and Salento, A. 2018. From individual choice to collective voice. Foundational economy, local commons and citizenship. In *Rassegna Italiana di Sociologia*. *Rivista trimestrale fondata da Camillo Pellizzi* 2/2018. 371–398. Doi: 10.1423/90584

Bärnthaler, R., Novy, A. and Plank, L. 2021. The foundational economy as a cornerstone for a social-ecological transformation. *Sustainability* 13. (18): 10460.

Bärnthaler, R. and Gough, I. 2023. Provisioning for sufficiency: envisaging production corridors. *Sustainability*: *Science, Practice and Policy* 19. (1): 2218690.

Bentham, J., Bowman, A., Cuesta, M. *et al*. 2013. *Manifesto for the Foundational Economy*. Working paper No. 131. Manchester, Centre for Research on Socio-Cultural Change.

Berry, C. 2018. Industrial policy: impossible, but indispensable. In *New Thinking for the British Economy.* Ed.: Macfarlane, L., London, UK, openDemocracy, 77–91.

Bertus, Z. and Kovács, Z. 2022. The geography of electoral volatility in Hungary: A core-periphery perspective. *Hungarian Geographical Bulletin* 71. (1): 67–81.

Birch, K. and Cumbers, A. 2007. Public sector spending and the Scottish economy: Crowding out or adding value? *Scottish Affairs* 58. 36–56.

Bodnár, G., Kovács, P. and Egri, Z. 2022. Elements of endogenous development in the regions of Visegrad countries. *Deturope* 14. (1): 29–49.

Bosák, V., Slach, O., Paszová, L., Hýllová, L., Mykhnenko, V., Krtička, L. and Nováček, A. 2023. Coping with peripheralization in small cities. What is the role of human agency? *European Planning Studies* Online publication, 1–21. Available at https://doi.org/10.1080/09654313.2023.2219274

Bowman, A., Ertürk, I., Froud, J., Johal, S. and Law, J. 2014. *The End of the Experiment? From Competition to the Foundational Economy*. Manchester, UK, Manchester University Press.

Bowman, A., Froud, J., Sukhdev, J., Leaver, A. and Williams, K. 2015. Reframing industrial policy. In *New Perspectives on Industrial Policy for a Modern Britain*. Eds.: Bailey, D., Cowling, K. and Tomlinson, P., Oxford, Oxford Academic Press, 60–78.

Boyle, M., Jones, A., Sykes, O. and Wray, I. 2019. *'National' Spatial Strategies in an Age of Inequality*

Insights from the United Kingdom, Ireland and France. Liverpool, University of Liverpool, Heseltine Institute for Public Policy, Practice and Place.

Braudel, F. 1981. *The Structures of Everyday Life: Civilization and Capitalism*. New York, Harper & Row.

Calafati, L., Froud, J., Haslam, C., Johal, S. and Williams, K. 2021. Diversity in leading and laggard regions: Living standards, residual income and regional policy. *Cambridge Journal of Regions, Economy and Society* 14. (1): 117–139.

Coote, A. 2020. *Universal Basic Services and the Foundational Economy*. Foundational Economy Collective Working Paper 7. Cambridge, New Economics Foundation.

Coote, A. and Percy, A. 2020. *The Case for Universal Basic Services*. Cambridge, UK, Polity Press.

Crisp, R. 2022. Levelling up through private sector 'wealth creation': Some thoughts on the neglect of alternative approaches. *People, Place and Policy* 16. (2): 157–162.

Engelen, E., Froud, J., Johal, S., Salento, A. and Williams, K. 2017. The grounded city: From competitivity to the foundational economy. *Cambridge Journal of Regions, Economy and Society* 10. (3): 407–423.

Essletzbichler, J. 2022. Engaging with precarious urban futures: From entrepreneurial to grounded cities. *European Urban and Regional Studies* 29. (4): 419–439.

Evenhuis, E., Lee, N., Martin, R. and Tyler, P. 2021. Rethinking the political economy of place: Challenges of productivity and inclusion. *Cambridge Journal of Regions, Economy and Society* 14. (1): 3–24.

Fabula, Sz., Skovgaard Nielsen, R., Barberis, E., Boros, L., Hedegaard Winther, A. and Kovács, Z. 2021. Diversity and local business structure in European urban contexts. *Hungarian Geographical Bulletin* 70. (1): 65–80.

FE Collective 2018. The Foundational Economy Collective, Froud, J., Johal, S., Moran, M., Salento, A. and Williams, K. *Foundational Economy: The Infrastructure of Everyday Life*. PMO Management and Organisation Studies. Manchester, Manchester University Press.

FE Collective 2019. *SIC Code Description. NACE Code and Description*. Available at https://foundationaleconomycom.files.wordpress.com/2019/01/copy-of-fe-listing-sic-2007-matched-to-nace-rev2.xlsx

FE Collective 2020. *The Foundational Approach*. Manchester, UK, The Foundational Economy Collective.

Fioramonti, L., Coscieme, L., Costanza, R. *et al.* 2022. Well-being economy: An effective paradigm to mainstream post-growth policies? *Ecological Economics* 192. (5): 10.1016/j.ecolecon.2021.107261.

Forth, J. and Rincon Aznar, A. 2018. *Productivity in the UK's Low-wage Industries*. York, UK, Joseph Rowntree Foundation.

Froud, J. and Williams, K. 2019. Adding value. In *Everyday Socialism. How to Rebuild Britain*. Ed.: Reeves, R. London, Fabian Society, 23–32.

Froud, J., Haslam, C., Johal, S. *et al.* 2020. (How) does productivity matter in the foundational economy? *Local Economy* 35. (4): 316–336.

Gal, P.N. 2013. *Measuring Total Factor Productivity at the Firm Level Using OECD-ORBIS*. OECD ECO/WP No. 1049. Paris, OECD. Available at https://dx.doi.org/10.1787/5k46dsb25ls6-en

Gál, Z. and Lux, G. 2022. FDI-based regional development in Central and Eastern Europe: A review and an agenda. *Tér és Társadalom* 36. (3): 68–98.

Galgóczi, B., Drahokoupil, J., Bernaciak, M. and Pavlínek, P. (eds.) 2015. *Foreign Investment in Eastern and Southern Europe after 2008. Still a Lever of Growth?* Omaha, University of Nebraska.

Gibson-Graham, J.K. 2008. Diverse economies: Performative practices for 'other worlds'. *Progress in Human Geography* 32. (5): 613–632.

Gibson-Graham, J.K. and Dombroski, K. (ed.) 2020. *The Handbook of Diverse Economies.* Cheltenham, Edward Elgar Publishing.

Gough, I. 2020. The case for universal basic services. *LSE Public Policy Review* 1. (2): 1–9.

Gough, I. 2021. *Two Scenarios for Sustainable Welfare: New ideas for an Eco-social Contract*. Working Paper 2021.12. Brussels, ETUI.

Győrffy, D. 2022. The middle-income trap in Central and Eastern Europe in the 2010s: Institutions and divergent growth models. *Comparative European Politics* 20. 90–113.

Hansen, T. 2022. The foundational economy and regional development. *Regional Studies* 56. (6): 1033–1042.

IPCC 2022. *Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, Cambridge University Press.

Iammarino, S., Rodríguez-Pose, A. and Storper, M. 2019. Regional inequality in Europe: Evidence, theory and policy implications. *Journal of Economic Geography* 19. (2): 273–298.

Leaver, A. and Williams, K. 2014. After the 30-year experiment: The future of the foundational economy. *Juncture* 21. (3): 215–221.

MacKinnon, D., Kempton, L., O'Brien, P., Ormerod, E., Pike, A. and Tomaney, J. 2022. Reframing urban and regional "development" for "left behind" places. *Cambridge Journal of Regions, Economy and Society* 15. (1): 39–56.

Marques, P., Morgan, K. and Richardson, R. 2018. Social innovation in question: The theoretical and practical implications of a contested concept. *Environment and Planning C: Politics and Space* 36. (3): 496–512.

Martynovich, M., Hansen, T. and Lundquist, K-J. 2023. Can foundational economy save regions in crisis? *Journal of Economic Geography* 23. (3): 577–599.

Mátyás, L. (ed.) 2022. *Emerging European Economies after the Pandemic: Stuck in the Middle-Income Trap*? Cham, Springer.

Molnár, E., Kozma, G., Mészáros, M. and Kiss, É. 2020. Upgrading and the geography of the Hungarian automotive industry in the context of the fourth industrial revolution. *Hungarian Geographical Bulletin* 69. (2): 137–155.

Morgan, K. 2021. After the pandemic: experimental governance and the foundational economy. *Symphonia: Emerging Issues in Management* 2021. (1): 50–55.

Nagy, B., Lengyel, I. and Udvari, B. 2020. Reindustrialization patterns in the post-socialist EU members: A comparative study between 2000 and 2017. *European Journal of Comparative Economics* 17. (2): 253–275.

Nagy, Cs., Molnár, E. and Kiss, É. 2020. Industry 4.0 in a dualistic manufacturing sector: Qualitative experiences from enterprises and their environment, Eastern Hungary. *Hungarian Geographical Bulletin* 69. (2): 157–174.

Nölke, A. and Vliegenthart, A. 2009. Enlarging the varieties of capitalism: The emergence of dependent market economies in East Central Europe. *World Politics* 61. 670–702.

Novy, A. 2022. The political trilemma of contemporary social-ecological transformation: Lessons from Karl Polanyi's The Great Transformation. *Globalizations* 19. 1: 59–80.

Nygaard, B. and Hansen, T. 2020. Local development through the foundational economy? Priority-setting in Danish municipalities. *Local Economy* 35. (8): 768–786.

Polanyi, K. 1944. *The Great Transformation: The Political and Economic Origins of Our Time*. Boston, MA, Beacon Press.

Reeves, R. 2018. *The Everyday Economy*. Leeds, UK, Labour. Available at rachelreevesmp.co.uk/wp-content/uploads/sites/96/2020/09/374425087-Rachel-Reeves-The-Everyday-Economy-1.pdf

Rodríguez-Pose, A. 2018. The revenge of the places that don't matter (and what to do about it). *Cambridge Journal of Regions, Economy and Society* 11. (1): 189–209.

Russell, B., Beel, D., Rees Jones, I. and Jones, M. 2022. Placing the foundational economy: An emerging discourse for post-neoliberal economic development. *Environment and Planning A: Economy and Space* 54. (6): 1069–1085.

Scott, J.W. 2021. Post-millennial Visegrad Four geopolitics: Illiberalism and positionality within the EU. *Deturope* 13. (2): 13–33.

Vigvári, A. 2023. A kaláka tényleg örök? Önerős lakásépítés és a háztartási erőforrások szerepe a zártkerti lakhatás megteremtésében (Is the 'kaláka' really eternal? Self-building and the role of households in the creation of housing in allotment gardens). *Szociológiai Szemle* 33. (1): 94–116.

Weresa, M.A. 2017. Innovation, human capital and competitiveness in Central and Eastern Europe with regard to the challenges of a digital economy. In *Condemned to be Left Behind? Can Central and Eastern Europe Emerge from its Low-wage Model?* Eds.: Galgóczi, B. and Drahokoupil, J., Brussels, European Trade Union Institute, 81–109.

Wigger, A. 2023. The new EU industrial policy and deepening structural asymmetries: Smart specialisation not so smart. *Journal of Common Market Studies* 61. (1): 20–37.

Wilkinson, R. and Pickett, K. 2022. From inequality to sustainability. EARTH4ALL: *Deep-Dive Paper* 01. 1–14.

Appendix

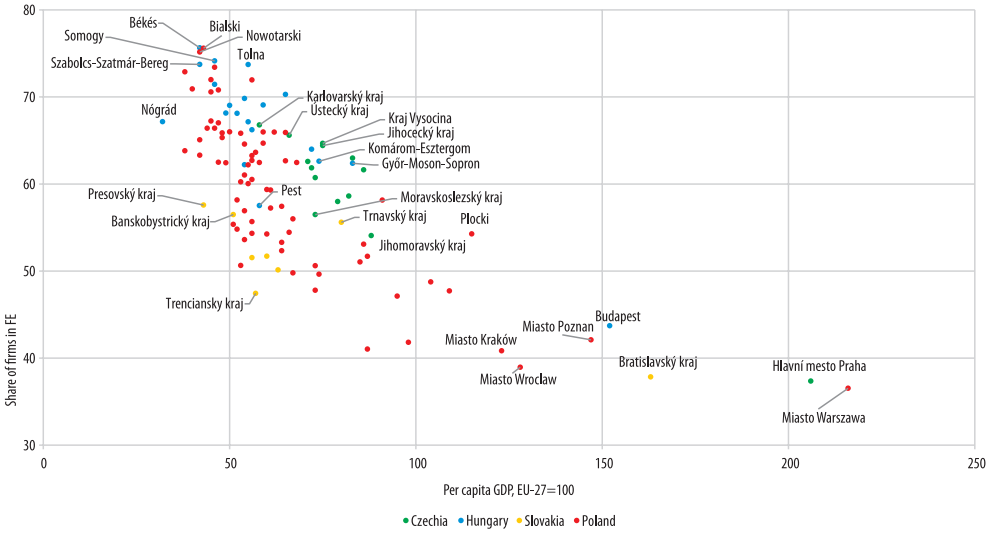


Fig. A1. The distribution of the number of firms among the economic activities by NUTS3 regions. *Source*: Authors' own elaboration based on Orbis and Eurostat data.

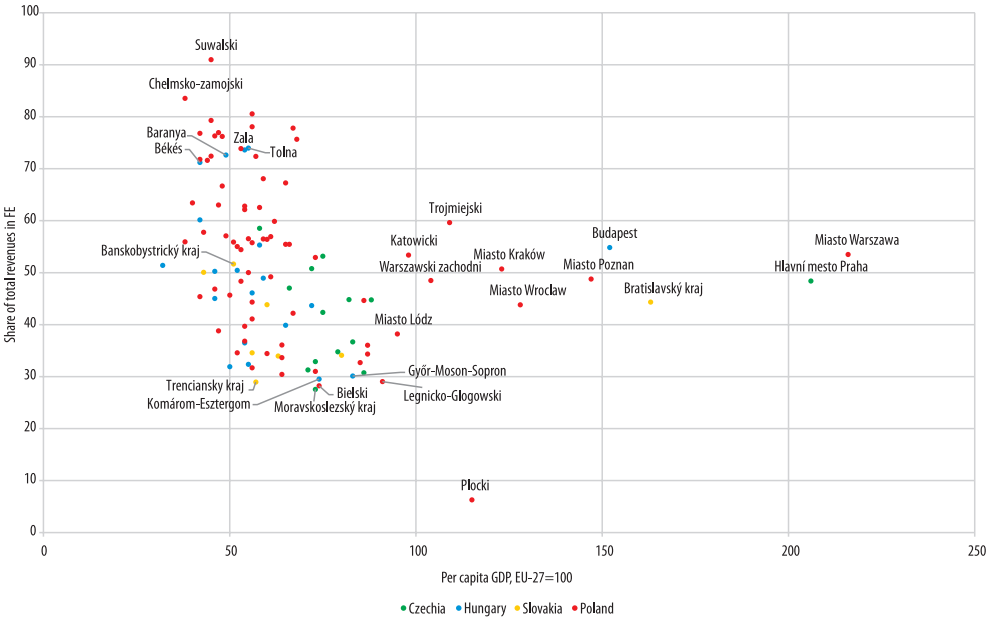


Fig. A2. The distribution of the revenues among the economic activities by region types. *Source*: Authors' own elaboration based on Orbis and Eurostat data.

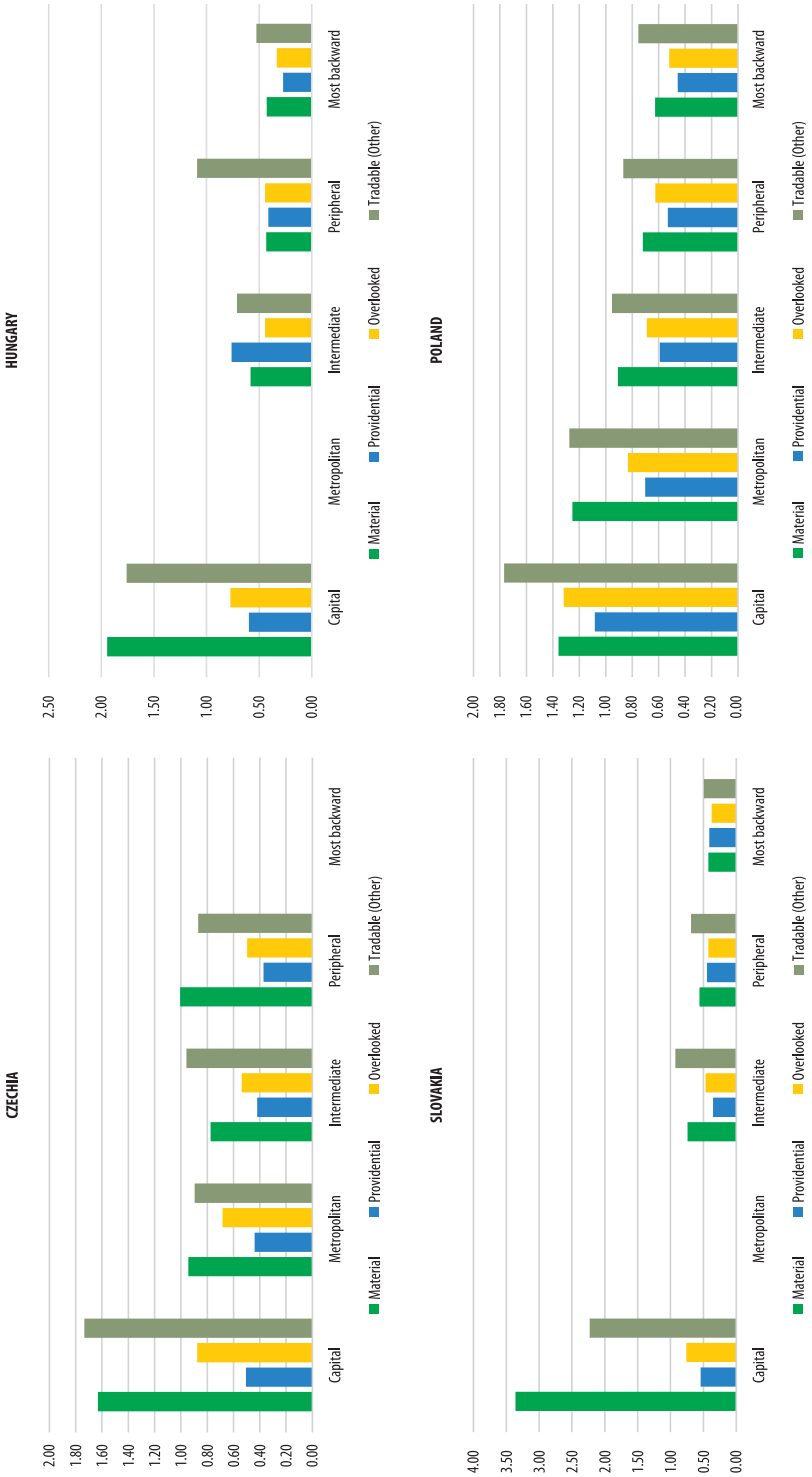


Fig. A3. Value-added-based labour productivity (average of three measures). *Source:* Authors' own elaboration based on Orbis and Eurostat data.

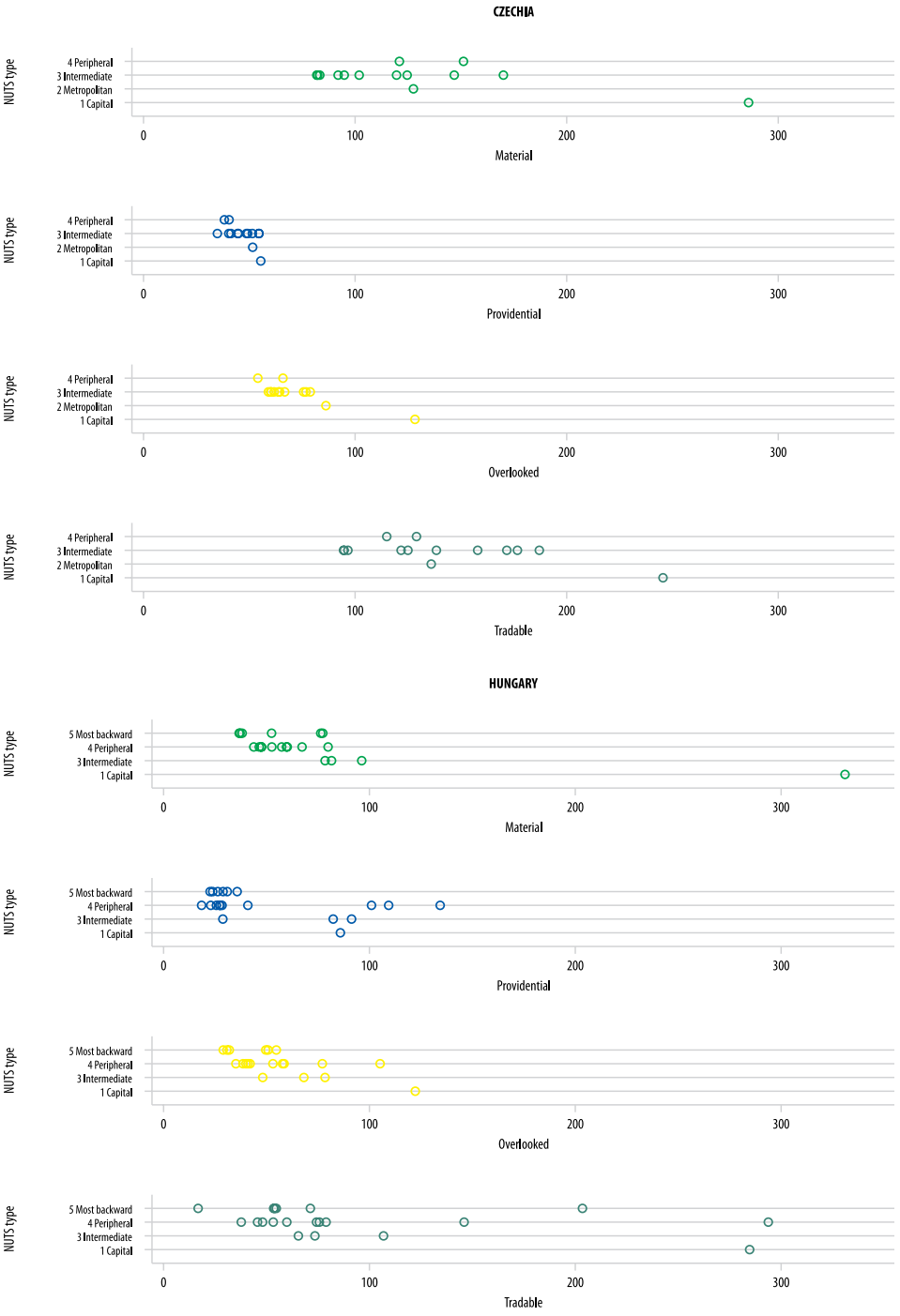


Fig. A4. Average value-added-based labour productivity of the NUTS3 regions by countries, region types and activity types (1,000 USD). *Source:* Authors' own elaboration based on Orbis and Eurostat data.

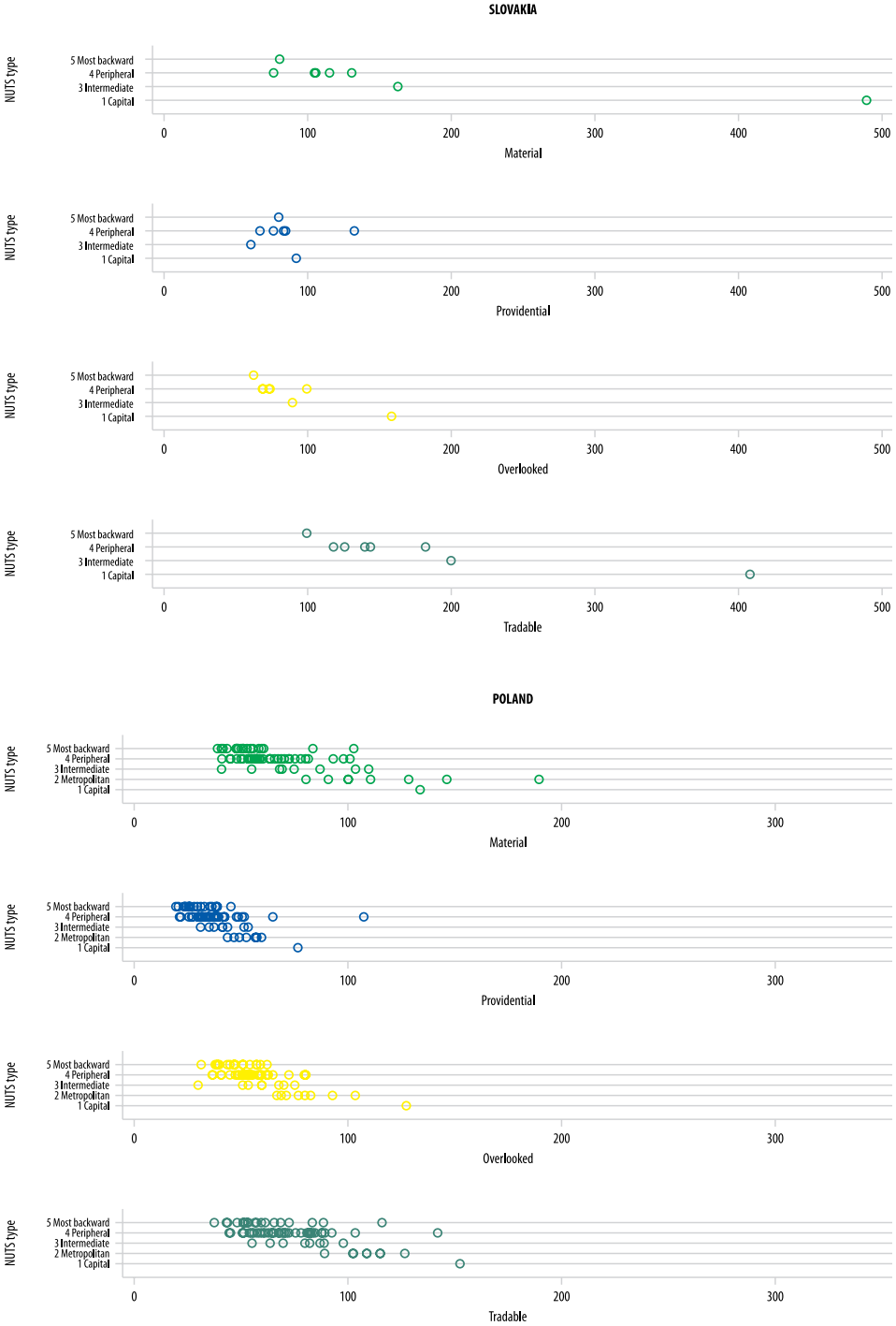


Fig. A4. Continued.

DOI: 10.15201/hungeobull.72.3.5 Hungarian Geographical Bulletin **72** 2023 (3) 287–309.

Green capital East of the Leitha? The chances and disadvantages of major cities in the Pannonian Basin to win the European Green Capital Award

Dalma SCHMELLER[1] and Gábor PIRISI[2]

Abstract

This study focuses on the chances of major cities (over 100,000 inhabitants) in the Pannonian Basin to win the European Green Capital Award. The 28 cities covered by the analysis can be divided into two groups: eleven cities that have already applied (one of them, Ljubljana was a previous winner) and seventeen cities that have not yet applied for the award. During the research, we divided the cities according to these two groups. In the study we applied various statistical and spatial analysis methods to capture similarities and differences in their environmental indicators. The results show that there are no significant differences in environmental indices between these two groups, and the values of the 2016 winner city (Ljubljana) are most similar to Austrian, Slovenian, and Croatian cities. Furthermore, based on the results of the similarity search, it can be stated that the further east we go, the less similar the examined cities are to Ljubljana. We also examined the probability of reaching the finals, indicating that cities that have not yet applied have a low likelihood of winning the award.

Keywords: European Green Capital Award, green cities, environmental indicators, sustainable urban development, Pannonian Basin

Received May 2023, accepted September 2023.

Introduction

Adapting to climate change and mitigating its potential negative impacts will become an increasingly important task for European cities, where nearly 80 percent of the population will be urban by 2050 (Hardi, T. *et al.* 2014; Clark, G. *et al.* 2019). The pursuit of environmental and social resilience and municipal sustainability is becoming increasingly popular among cities (Andersson, I. 2016; Nzimande, N.P. and Fabula, Sz. 2020; Buzási, A. *et al.* 2022). This may include, among others, the need to respond to various external impacts (e.g., natural disasters, extreme weather events), transforming water and waste management at municipal level (e.g., rainwater retention, recycling), reducing air and noise pollution, increasing the number and size of green spaces, or boosting the commitment towards sustainability. However, there are differences between the cities of Western and Eastern Europe about the perception and evaluation of the challanges of sustainability and climate change.

They are reflected by differences in goals, priorities, and structures that appear in European urban development. In former state-socialist countries, territorial and urban development was determined by the state, resulting in limited autonomy for local stakeholders. Urban planning and development were centrally directed and controlled ('top-down'), as noted by Kovács, Z. (1999),

[1] Doctoral School of Earth Sciences, University of Pécs. Ifjúság útja 6. H-7624 Pécs, Hungary. E-mail: dalma.schmeller@gmail.com
[2] Department of Human Geography and Urban Studies, University of Pécs. Ifjúság útja 6. H-7624 Pécs, Hungary. E-mail: pirisig@gamma.ttk.pte.hu

Sailer-Fliege, U. (1999), Szirmai, V. (2004), and Konecka-Szydłowska, B. *et al*. (2018). In contrast, Western Europe saw the emergence of new urban functions in former industrial areas after deindustrialisation, with a significant focus on brownfield rehabilitation (Dannert, É. 2016). In Western European cities local communities play a crucial role in the urban development process, partly due to varying levels of co-financing and a limited role of the central state (Barta, Gy. 2009; Puczkó, L. and Jószai, A. 2015). Following the transition to democracy, many post-socialist cities struggled with the shift to a 'bottom-up' planning approach, a transition they had to go through (Hervainé Szabó, Gy. 2008; Hirt, S. and Stanilov, K. 2009). In the new system, funding became primarily available from external sources, requiring local governments' activity, embeddedness and commitment. Further challenge appeared after the Leipzig Charter (European Commission, 2007) with the transtion to an integrated urban development approach, as it posed difficulties for most post-socialist cities in terms of democratising planning and involving local stakeholders (Bajnai, L. 2007). Furthermore, other factors could not be overlooked either, including the economic decline and unemployment stemming from the collapse of industry, the lack of functioning real estate market until the political transformation, the adverse effects of privatization on land use, the neglect of environmental pollution, the growing social inequality and segregation, the lack of capital for local governments, the absence of an established partnership system, and the negligible presence of the civil sector (Hervainé Szabó, Gy. 2008; Barta, Gy. 2009; Hirt, S. 2013).

To address these challenging issues, post-socialist cities aimed for a secure transition, with governments acting as partners, as seen in the case of Hungary. During this transitional period, while urban development was under government control with the involvement of supervisory authorities, local governments had the opportunity to apply, plan, and execute independently. According to Pintér, T. "the persistence of the eastern periphery was also necessary for the development of the western countries" (Pintér, T. 2015, 127), meaning that the handicap of Eastern European cities inadvertently contributed to the strengthening of Western European cities.

In urban development, the role of the European Union became crucial not only in terms of financing but also in introducing policy measures and fostering cooperation (Verdonk, H. 2014), which can stimulate the development of post-socialist cities. Today, one of the most highlighted aspects of EU urban development is the creation of sustainable and green cities, contributing to mitigating the negative effects of climate change. To achieve this, the European Commission established the European Green Capital Award (EGCA) in 2008, which encourages cities to transition onto a "green path" and promotes long-term development that positively impacts residents' quality of life (Gudmundsson, H. 2015). The effects of implemented developments can be measured through monitoring studies, which can also be considered as performance evaluations, thus, revealing the extent of progress in a given city. The European Union also advocates for the monitoring of cities based on various indicators, which also serve as the basis for awarding the EGCA.

This study focuses on the major cities (i.e., above 100,000 inhabitants) within the Pannonian Basin in East Central Europe. There have been numerous publications related to sustainability in the region, with the application of various environmental indicators being relatively popular. For instance, Bănică, A. *et al.* (2020) examined several Central and Eastern European cities to explore the connections between green infrastructure, resilience, and adaptability. Similarly, Csete, Á.K. and Gulyás, Á. (2021) investigated the urban green infrastructure network of Szeged, and the role of vegetated surfaces in urban water management. Herbel, I. *et al.* (2016) studied the urban heat island phenomena in Cluj-Napoca,

which are considered "byproducts" of increasing urbanization and climate change. Popescu, R-I. and Zamfir, A. (2012) analysed the competitiveness of green cities in the field of "ecological marketing" based on the European Green Capital Award and the Romanian Green City program, finding a close relationship between a city's ecological values and its competitiveness. Buzási, A. and Jäger, B.S. (2021) assessed the sustainability of Hungarian county capitals using various statistical methods, while Sikos, T.T. and Szendi, D. (2023) examined Hungarian major cities from economic and environmental sustainability perspectives based on specific topics related to the UN Sustainable Development Goals. Some publications specifically analyse individual sustainability indicators, such as cycling in Osijek (Dimter, S. *et al.* 2019), the per capita green space in Romanian, Slovenian, and Croatian cities (Badiu, D.I. *et al.* 2016; Selimović, A. 2022), or energy management in Pécs (Kiss, V.M. 2015). Despite the growing number of studies, a comparative analysis of sustainability indicators of cities in the Pannonian Basin is still missing.

The European Green Capital Award

The establishment of the European Green Capital Award began in 2006 with an initiative led by Jüri Ratas (Prime Minister of Estonia between 2016 and 2021, and former Mayor of Tallinn from 2005 to 2007). Fifteen European cities joined this initiative, including Tallinn, Helsinki, Riga, Vilnius, Berlin, Warsaw, Madrid, Ljubljana, Prague, Vienna, Kiel, Kotka, Dartford, Tartu, and Glasgow. The Estonian Cities Association also became associated with the initiative (Sareen, S. and Grandin, J. 2019). The fundamental principles and objectives of the award were outlined in a declaration known as the Tallinn Memorandum 2006. In this memorandum, the award's purpose and thematic areas were defined as follows:

"Following the initiative of Tallinn, we, representatives of European cities, propose to the European authorities to establish the European Green Capital title. This is to be awarded each year to a city that is an environmental role model for other municipalities, e.g., by having followed a consistent environmental policy, implemented sustainable mobility solutions, including an improved public transport system, expanded the territories of parks and green areas, successfully introduced modern waste management principles and technologies, or implemented innovative and enterprising solutions to improve the quality of the urban living environment." (Tallinn Memorandum 2006).

The European Commission introduced the award in 2008, creating the first official recognition by the European Union aimed at promoting and supporting the development of green and sustainable cities (Lönegren, L. 2009; Gulsrud, N.M. *et al.* 2017). The justification for the existence of the European Green Capital Award is based on the growth of urban populations, which has led to the concentration of environmental and social issues primarily in these regions. Cities are seen as having to adapt to these challenges (Kahn, M.E. 2006; Beatley, T. 2011; Carter, J.G. 2011; Beretta, I. 2014). The award aims to evaluate how municipalities respond to various environmental challenges, recognizing efforts directed at improving the urban environment and contributing to the creation of more sustainable and healthier cities. Additionally, it encourages cities to share their experiences, fostering a collaborative and continuously evolving system (Ruiz del Portal Sanz, A. 2015; Diverde, H. 2016; Cömertler, S. 2017; Nurse, A. and North, P. 2020).

Cities with a population of over 100,000 can apply for the award, provided that their country is a member of the European Union, a candidate for accession, or located within the European Economic Area or Switzerland. If the city with the highest population in the country does not meet this threshold, the city with the highest population is allowed to apply.

For cities interested in applying, an annual workshop is organized to explain the application process and allow participants to share experiences and ideas. The first step in the application is registration, which is

entirely non-binding. In other words, cities are not obliged to compete later on, but this registration provides insight into the details and processes of the application. If the city leadership decides to proceed with the application, the application documents must be submitted through an online platform, which needs to be signed by the mayor or the highest-ranking city representative (Gudmundsson, H. 2015). Cities applying for the award must meet various criteria (Meijering, J.V. *et al.* 2014), including presenting their current state, developments carried out in the past five to ten years, and future goals in various thematic areas. It is also important to showcase commitments, agreements, partnerships, and the role of the community in these developments (European Commission, 2021).

At the time of the launch of the award, cities competed based on ten criteria, which have undergone multiple revisions since then *(Figure 1).* This study examines cities based on the thematic areas specified in the 2022 competition announcement. The reason for this is that starting from the 2023 round, the "sustainable land use and soil" criterion is challenging to quantify with data (e.g., soil sealing). Furthermore, this new criterion did not apply to cities that had already applied for the award, and their application materials do not provide information on this aspect.

The submitted applications are evaluated by international experts who create rankings of cities based on the points they have earned. The decision regarding which cities advance to the finals is made by the European Commission based on expert opinions (Gudmundsson, H.

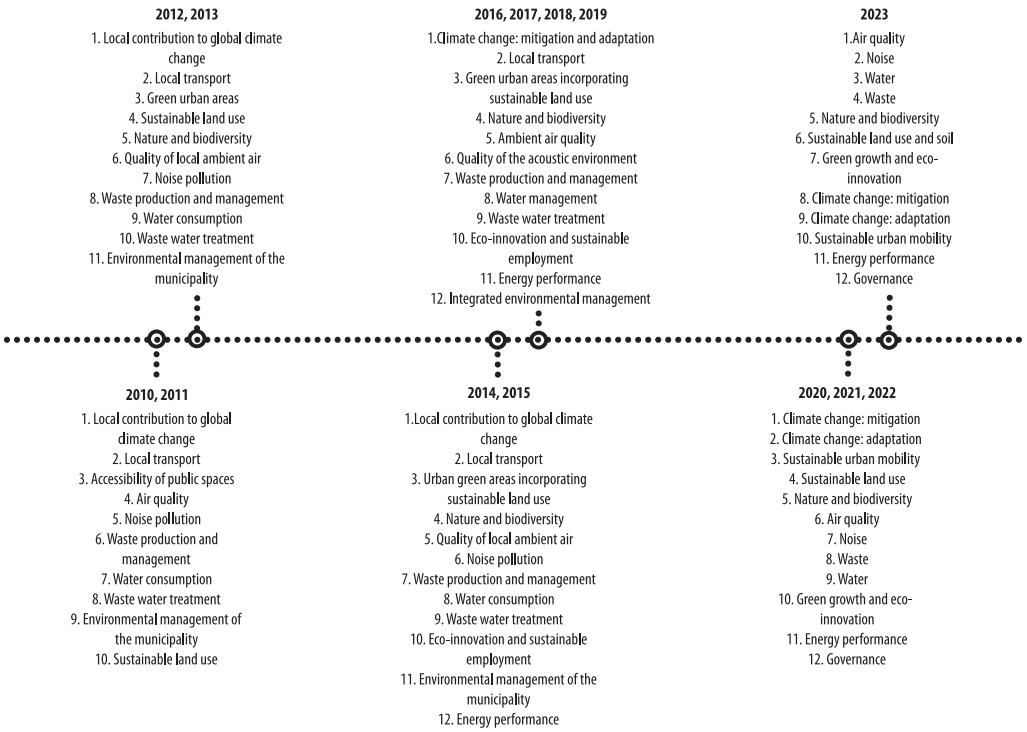


Fig. 1. The change of the EGCA-criteria over time. *Source*: Authors' own elaboration based on the documents of the European Commission.

2015). In the final circle, cities are required to present their results and explain why they could serve as examples to other cities.

By focusing on the identified areas of improvement in the examination of thematic areas, cities can effectively manage their financial and temporal resources. They can prioritize areas of development that are crucial for sustainability, thereby increasing their chances of success in the competition and enhancing the overall sustainability of their city. The results of this study can contribute to the development of sustainable, resilient, and green cities, serve as a model for city governments, and be used to enhance the chances of successful participation in the award competition.

Financial background of the award

The European Green Capital Award does not have its own budget, so it cannot provide direct financial support to the applying cities. Cities must seek other European Union funding opportunities to finance their urban development activities. However, the winning city is entitled to a cash prize introduced since 2019. In 2022, this prize amounted to 350,000 EUR, while the 2023 winner received 600,000 EUR. This prize is funded from the budget of the LIFE program. Cities whose countries do not participate in this program are not eligible for the financial reward (European Commission, 2021).

Benefits after winning the award

Winning the award can come with several benefits. The winning city can gain international recognition and media coverage, which can positively impact tourism and promote the green city brand. New collaborations may be established within the city or with other cities. A notable example is the European Green Capital Network (since 2014)[3], through which winning and finalist cities can share their ideas and experiences, represent European cities in the field of environmental protection and sustainability, encourage other cities to engage in sustainable urban planning, and collaborate with the European Commission. Environmental projects can receive greater emphasis, strengthening the commitment to sustainability. The documentation generated through the award process can help in measuring and analysing the city's development, highlighting weaknesses and problems, and providing comparable data for other cities. Involving city residents in development through public opinion research, informational campaigns, and forums can enhance their commitment to their city, enabling them to contribute to creating a more livable, healthier, and attractive city, ultimately improving their quality of life. Since 2019, the cash prize awarded to cities can be spent on sustainable urban development investments (European Commission, 2021).

Review of the literature on research focusing on the European Green Capital Award

The European Green Capital Award has been of interest to the European Commission since 2006, but it only gained significant recognition in public discourse after the announcement of the first winning city in 2010. Consequently, the research on this topic dates back to around that time. Since the inception of the award, the European Commission has annually published official evaluation documents, and the publications of the winning cities are also made available on the European Union's document repository online[4]. The scholarly literature on the award includes five-year retrospective reports and final publications issued by the municipalities of the winning cities, as well as reports following the evalua-

[3] Available at https://environment.ec.europa.eu/topics/urban-environment/european-green-capital-award/about-awards_en#eu-green-capital-network

[4] Available at https://circabc.europa.eu/ui/group/c6e126de-5b8c-4cd7-8d36-a1978a2a63de/library/017bb562-fdd8-4adeb1ff-d1ac296c79b7

tion of the applications (accessible from 2010 to 2019). One of the earliest publicly available studies on the European Green Capital Award was conducted by Lovisa Lönegren, who wrote her thesis in 2009 titled "The European Green Capital Award – Towards a sustainable Europe?". In her research, she sought to answer whether the European Green Capital Award is a suitable method for addressing environmental challenges in the European Union. She approached the topic from the perspective of environmental protection and ecological modernization, using the example of Stockholm. The most important publications related to the European Green Capital Award are listed in *Table 1*.

Table 1. Research topics and references connected with EGCA

Approaches	Topics	References
Analysing the 12 EGCA criteria	Sustainable land use	Hårsman, B. and Wijkmark, B. (2013); Ruiz del Portal Sanz, A. (2015)
	Local transportation	Müller, M. and Reutter, O. (2020)
	Green space features and green infrastructure networks	Cömertler, S. (2017); Kerr, L. (2017)
	Climate protection	Müller, M. and Reutter, O. (2020)
	Every criteria	Ratas, J. and Mäeltsemees, S. (2013); Pantić, M. and Milijić, S. (2021)
Evaluation process of the applications	Focusing ont he topic of local transportation	Gudmundsson, H. (2015)
Political background, environmental policies	Analysis of winning cities	Ozcan, N.S. (2015); Polato, E. (2017)
	The EGCA as a political tool in municipal sustainability	Diverde, H. (2016); Gulsrud, N.M. *et al.* (2017); Kurstjens, N. (2017); Manca, L.R. (2020)
	Urban governance	Ersoy, A. and Hall, S. (2020)
	Responsibility and accountability	Sareen, S. and Grandin, J. (2019)
	Entrepreneurial spirit and increased economic competitiveness after winning the award, as well as its significance for city management	Nurse, A. and North, P. (2020)
City branding and marketing	Place branding through green spaces and the concept of a green city	Gulsrud, N.M. *et al.* (2013); Andersson, I. (2016)
	Marketing activities of green cities	Demaziere, C. (2020)
	The impact of social media on inter-organizational collaborations	Korpela, T. (2021)
Environmental indicators	Measurement of environmental sustainability	Meijering, J.V. *et al.* (2014); Zoeteman, B. *et al.* (2014, 2015)
	Examination of city monitoring	Sarubbi, M.P. and Schmidt Bueno de Moraes, C. (2016)
	Comparison of urban environmental indexes	Georgi, B. (2016); Feleki, E. *et al.* (2018)
Analysing the cities applied	Based on completed developments	Biscossa, F. *et al.* (2017); Maior, J-C. (2019)
	Revitalization of city centres and renewal of public spaces	Poljak Istenič, S. (2016); Svirčić Gotovac, A. and Kerbler, B. (2019)
	The role of civil organizations and grassroots initiatives	Ersoy, A. and Larner, W. (2019)

Source: Authors's own elaboration.

The cities that have won and applied so far

Between the 2010 and the 2024 round of the EGCA, 110 cities have applied for the award, ten of which are located in the study area of the Pannonian Basin *(Figure 2)*. Among the winners, we primarily find cities from Western and Northern Europe. Germany, France, and Spain have each had two winner cities from the inception of the award up to 2024. There is an "axis of winners" to be observed in the map from Lisbon to Lahti, and also, there is a spatial concentration of the finalist cities in the Northwest of Europe. Among the post-socialist cities, there are only two succesfull candidates: Ljubljana (2016) and Lahti (2023) were able to win the award after many years of continous applications. Over time more and more post-socialist cities have applied to the award, altough most of them have not even reached the final round before the decision.

Research questions and methodology

Up until the 2024 round of the EGCA, a total of 110 cities have applied for the award. Among them, ten are located within the Pannonian Basin, although none of them became finalists or winners. In this study, the cities geographically closest to the cities under examination include Ljubljana (2016), whose environmental values serve as a reference point in some of the analyses. When selecting the reference city, we considered (relatively) similar geographical conditions and urban development paths, as the majority of cities

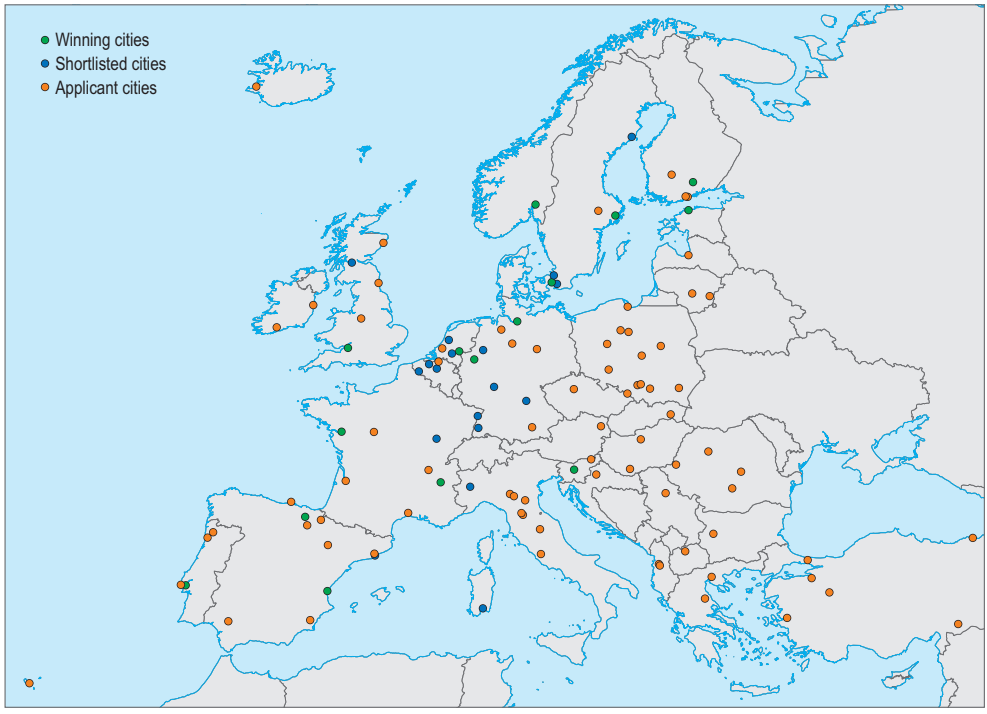


Fig. 2. Cities that applied for the award (2010–2024). *Source*: Authors' own elaboration.

in the Pannonian Basin belonged to the Eastern Bloc, i.e., the state-socialist bloc (Hirt, S. *et al*. 2017).

The primary question in the examination of cities in the Pannonian Basin with a population of over 100,000 was *whether the environmental values of Hungarian cities differ from those of the reference city? If so, which indicators and to what extent do they differ?*

Another question that arose was *whether the two 'Western' cities in the study are positioned higher in the similarity ranking or if their environmental values are more similar to those of post-socialist cities?*

Among the 27 cities examined in this research (excluding Ljubljana), 17 have not yet applied for the award *(Figure 3).* Therefore, we considered these as 'potential applicants' and sought to *determine if there was a variable in which their values were worse than those of the cities that had already applied*.

Furthermore, aside from Ljubljana, can it be concluded that among the examined cities, *those that have not applied for the award have any chance of making it to the final round?*

To explore the similarities and differences in environmental values, we used independent samples *t*-test (Student's *t*), Mann-Whitney *U*-test, Chi-square test of independence, random forest and a geospatial tool, the similarity search. It is important to emphasize that this research is conceived as an exploratory analysis (EDA), i.e., we do not aim to prove or disprove specific hypotheses, as EDA uses different statistical methods to test the strength of the relationship, not to prove hypotheses (Velleman, P.F. and Hoaglin, D.C. 2012). Tukey, J.W. (1977) described EDA as detective work, the aim of which is to uncover patterns. The purpose of a discovery analysis is to detect some pattern, difference or similarity in the values of the items under investigation (Fife, D.A. and Rodgers, J.L. 2022). Although controversial, it appears that the p-value has at least some relevance in exploratory studies (Rubin, M. 2017), and

Fig. 3. Cities covered by the analysis. *Source*: Authors' own elaboration.

therefore these values are included in the results along with the effect size, generally recommended in the literature (Fife, D.A. and Rodgers, J.L. 2022).

Different methods were found to be appropriate for comparing cities that have and have not yet applied for the EGCA, due to the characteristics of the variables under study *(Table 2)*. For the normally distributed variables, the independent samples *t*-test was used, while for variables with a non-normal distribution, the Mann-Whitney *U*-test was applied. The relationship between binary variables and the fact of applying was analysed using Chi-square test.

The chances of cities in the Pannonian Basin to reach the final round were calculated using the random forest method. This first required the creation of a database to determine which sustainability indicators would determine the outcome of the EGCA application. In the database, the values of 100[5] cities that applied for the EGCA were collected according to the indicators identified above. These 100 cities already include the ten applicant cities in the Pannonian Basin. The cities were divided into two groups: the finalists (including the winners) and the non-finalists who didn't make it to the finals. This binary division served as the dependent variable in the binary logistic regression[6]. The independent variables consisted of the applied indicators, totaling 33, which were determined for each city based on the 2019 or 2020 values[7], primarily sourced from pan-European databases and documents and plans issued by local governments.

This uniform definition raises two problems which are seen as limitations for this research. Firstly, the EGCA application process takes into account not only the current ecological values of cities, but also recent changes and future plans. Second, by defining a single point in time, there is a risk that a city that applied for the EGCA at an early round may have improved significantly (or, on the contrary, stagnated[8]). It may not have been a finalist at the time of application due to its poor scores, but due to improvements since then, the model would incorrectly mark it as a finalist. The estimation does not take into account which cities applied in a given year, how strong the competition was, but it is relative to the total sample of 100 cities. This is justified because we do not know the competitors of a potential candidate city, which would apply in the future, so it is appropriate to compare them with the full sample of applicant cities.

Also, the values of the 100 applicant cities were used for the similarity search. As a first step, a rank scale transformation was performed based on all the scale variables of the 100 applicants and the 15 potential candidate cities. Then, as a dimension reduction approach, we run a Multiple Factor Analysis (Pagès, J. 2002). Seven dimensions were created above an eigenvalue of 1, explaining 60.2 percent of the total variance. The reason for using the MFA procedure is that the 33 indicators are unevenly distributed across the EGCA themes, and if all of them had been included with equal weight, some categories could have biased the analysis. The reason for including 100 cities was to get a clearer picture of the relationship between the 33 variables and to avoid the bias due to the small number of elements and the limited geographical location that would have occurred if we had only created dimensions based on the values of the cities located in the Pannonian Basin.

The random forest machine learning method was used to determine the chances of the cities (except Ljubljana) to reach the final round. This is an ensemble method based on decision trees, the results of which are sum-

[5] A total of 110 cities applied to the EGCA, but in ten cases there were missing data for most of the indicators.

[6] If a city applied multiple times, the most recent result was used as the dependent variable.

[7] If these were not available, the data closest in time was used. The difficulty of collecting pan-European sustainability indicators at a single point in time was also identified as a problem in the study by Zoeteman, B. *et al.* (2015).

[8] On the problem of green city indices without temporal monitoring, see Pace, R. *et al.* (2016).

*Table 2. Indicators and data sources used for the analysis of cities in the Pannonian Basin, as well as descriptive statistics for the indicators**

Variable	Mean	Standard deviation	Minimum	Maximum	N	Data source(s)
CO_2 emissions, t/person/year (1)	3.98	2.25	1.19	11.35	27	Eurostat, city documents (Climate Strategy, SECAP, SEAP), Covenant of Mayors website
CO_2 emissions, t/person/year – percentage of the national average (1)	77.62	39.92	31.33	222.63	27	Own calculation based on Eurostat data
Length of cycle paths, m/person (3)	0.37	0.31	0.01	1.01	28	City documents, local media, national statistical offices
Number of cars per 1,000 inhabitants (3)	361.29	67.96	190.00	526.00	28	Documents from Eurostat, national statistical offices, national offices
Number of cars per 1,000 inhabitants – percentage of the national average (3)	97.32	23.55	57.57	183.27	28	Own calculation based on Eurostat data
Percentage of inhabitants travelling to work by car, % (3)	40.44	11.70	23.00	71.00	27	Eurostat, city documents, Sustainable Urban Transport Plan (SUMP), CIVITAS, European Platform on Mobility Management – Modal Split Tool
Percentage of inhabitants travelling to work by public transport, % (3)	28.89	11.05	13.00	49.00	27	Eurostat, city documents, Sustainable Urban Transport Plan (SUMP), CIVITAS, European Platform on Mobility Management – Modal Split Tool
Percentage of inhabitants walking to work, % (3)	23.54	10.25	1,60	42.00	27	Eurostat, city documents, Sustainable Urban Transport Plan (SUMP), CIVITAS, European Platform on Mobility Management – Modal Split Tool
Percentage of inhabitants cycling to work, % (3)	6.68	6.34	0.00	26.70	27	Eurostat, city documents, Sustainable Urban Transport Plan (SUMP), CIVITAS, European Platform on Mobility Management – Modal Split Tool
Size of green areas, m^2/person (4)	15.30	10.13	3.78	43.77	28	Eurostat, Urban Documents, Joint Research Centre – The future of cities (Urban Data Platform)
Population density, inhabitant/km^2 (4)	1,584.14	1,120.84	343.52	4,335.00	28	Eurostat, city documents
Proportion of Natura 2000 sites in relation to the area of the municipality, % (5)	10.66	11.47	0.00	44.90	28	Natura 2000 Network Viewer
NO_2 annual average, $\mu g/m^3$ (6)	26.91	7.90	11.20	48.03	28	Eurostat, city documents, European Environment Agency – Air Quality Statistics
PM_{10} annual average, $\mu g/m^3$ (6)	25.77	5.31	18.47	39.20	28	Eurostat, city documents, European Environment Agency – Air Quality Statistics
$PM_{2.5}$ annual average, $\mu g/m^3$ (6)	16.49	3.03	11.28	23.00	25	Eurostat, city documents, European Environment Agency – Air Quality Statistics
Proportion of people living in > 65 dB noise pollution, %; along roads (7)	15.25	11.10	3.90	54.02	25	European Environment Agency (The Noise Observation and Information Service for Europe), city documents, regional, national environmental documents

*Table 2. Continued**

Variable	Mean	Standard deviation	Minimum	Maximum	N	Data source(s)
	Median**	Mode***				
Proportion of people living in > 55 dB noise pollution, %; along roads (7)	17.95	13.57	2.07	65.21	25	European Environment Agency (The Noise Observation and Information Service for Europe), city documents, regional, national environmental documents
Amount of waste, kg/person/year (8)	349.23	92.65	228.71	566.00	28	Eurostat, Assessment of separate collection schemes in the 28 capitals of the EU (European Commission, Final Report 2015), city documents, local media
Amount of waste, kg/person/year – percentage of the national average (8)	97.66	26.08	51.33	162.71	28	Own calculation based on Eurostat data
Recycling rate, % (8)	24.67	18.03	2.00	69.00	28	Eurostat, Assessment of separate collection schemes in the 28 capitals of the EU (European Commission, Final Report 2015), city documents, local media
Recycling rate, % – percentage of the national average (8)	90.62	63.65	13.33	278.57	28	Own calculation based on Eurostat data
Drinking water consumption, l/person/day (9)	121.04	26.94	77.30	180.00	28	Eurostat, city documents
Drinking water consumption, l/person/day – percentage of the national average (9)	117.52	25.41	70.58	158.75	28	Own calculation based on Eurostat data
Volume of waste water, population.equivalent – p.e. (9)	497,523.3	659,589.8	106,497	2,867,796	26	Urban Waste Water Treatment Directive, Urban Waste Water Treatment Viewer 2018
Number of electric car charging stations per 1,000 inhabitants (10)	0.08	0.07	0.01	0.31	28	Chargemap, Electro Maps, city documents
Energy consumption, MWh/person/year (11)	13.70	6.04	4.38	28.06	28	Eurostat, City documents, Covenant of Mayors website, Energy Cities, European Energy Research Alliance
Energy consumption, MWh/capita – percentage of the national average (11)	301.18	128.44	100.55	701.58	28	Own calculation based on International Energy Agency and Statista data
Existence of a climate strategy (2)	1**	1***	–	–	28	Municipalities' websites
Existence of Sustainable Energy Action Plan (SEAP) / Sustainable Energy and Climate Action Plan (SECAP) (11)	1**	1***	–	–	28	Municipalities' websites
Covenant of Mayors membership (12)	1**	1***	–	–	28	Covenant of Mayors website
Aalborg Charter signatories (12)	0**	0***	–	–	28	Sustainable Cities Platform
Circular Economy Declaration signatories (12)	0**	0***	–	–	28	Circular Cities Declaration website
ICLEI - International Council for Local Environmental Initiatives membership (12)	0**	0***	–	–	28	ICLEI website

*First column: The numbers in brackets indicate the related EGCA theme, showcased in the introduction section.
Source: Authors' own calculations.

marized in the final model (Ho, T.K. 1995). The advantage of random forest is that it is not sensitive to multicollinearity (Triscowati, D.W. *et al.* 2020), so it is not necessary to drop correlated variables. It has excellent high-dimensionality, so it does not require a dimensionality reduction procedure, thus, avoiding the risk that reduced dimensions carry information that is not suitable for estimation (Cutler, A. *et al.* 2012). Thus, for variables, only centering and scaling preprocessing procedures were performed.

The random forest model was fine-tuned to produce the following settings. For each decomposition of the decision tree, 20 random variables were included (mtry), the criteria for the partitioning of the nodes were defined by the extra-tree algorithm (Geurts, P. *et al.* 2006), and the minimum number of observations in each node was set to one. These parameters were selected by grid search during cross-validation. Cross-validation was performed using k-fold cross-validation. Although there is no default recommended value for k, most studies use 5 (Zhou, J. *et al.* 2019), so we adopted it. Since the number of finalists and non-finalists was disproportionately distributed across the 100 cities, care was taken to ensure that each breakdown preserved the proportions of these two groups. The k-fold cross-validation was repeated three times.

As the final model, we chose the one with the highest specificity because this model is the best at correctly categorizing non-finalists, meaning it has the lowest chance of misleadingly giving a city false hopes of being a finalist. The reason for this is that our estimator model aims to provide a realistic presentation for cities. As no other analysed city apart from Ljubljana has yet made it to the final, and as overall Central and Eastern European cities do not excel in the competition, it is advisable to exercise caution in the estimation. The model with the highest specificity is the best at correctly classifying non-finalists, so in this case the chances of falsely misleading a city with finalist hopes are the lowest.

Research results

The analysis shows differences in some variables, but we cannot say that applicant cities are clearly more environmentally oriented *(Table 3).* An independent samples *t*-test and the associated effect sizes show that for two variables the effect size is medium, so an observable difference has been found. The values for NO_2 annual mean and energy consumption are more favourable in the case of the potential candidate cities. If the data table of the 100 cities that have applied for the EGCA is analysed together with the cities in the Pannonian Basin have not applied yet, it can be seen that five potential applicants (Subotica, Szeged, Satu Mare, Baia Mare, Debrecen) are among the top 25 cities with the lowest NO_2 emissions even in this sample. While Brasov and Cluj-Napoca are among the bottom five cities overall, Budapest and Zagreb are also in the bottom third of the list.

These highlighted cities also show that even within countries there can be significant differences, especially in Hungary and Romania (Constantin, D.E. *et al.* 2013), which are linked to the city's role in the countrywide transport and industrial network. In Cluj-Napoca, for example, the overall proportion of people travelling by car or public transport is 63 percent, which increases NO_2 emissions, and the fact that the city has a high number of windless days, which means that air pollutants are not being emitted from the city, further worsens the situation (Chereches, I.A. *et al*. 2023). Furthermore, NO_2 emissions are also closely related to the population size of the settlement (Lamsal, L.N. *et al*. 2013). Energy consumption is also strongly determined, as differences in the political, cultural, economic and climatic conditions of different countries can affect spatial disparities in energy use (Borozan, D. 2018). If the energy use of individual cities is compared with the national average, only small effect size level is associated with a more favourable value for the cities have not applied yet.

There is no clear difference between those who have already applied for the award and

Table 3. Results of the independent samples t-tests

Variable	Mean (cities have not applied yet) (n = 17)	Mean (cities already applied) (n = 11)	t	Cohen's d	Effect size
NO_2 annual average	24.543	30.567	-2.088*	-0.808	medium
PM_{10} annual average	25.716	25.865	-0.071	-0.027	–
$PM_{2.5}$ annual average	16.919	15.846	0.861	0.351	small
Number of cars per 1,000 inhabitants	35.882	369.661	-0.516	-0.199	–
Percentage of inhabitants travelling to work by car	41.406	39.045	0.507	0.198	–
Percentage of inhabitants walking to work	23.268	23.954	-0.167	-0.065	–
Amount of waste – percentage of the national average	99.062	95.511	0.345	0.133	–
Drinking water consumption	121.574	120.220	0.127	0.049	–
Drinking water consumption – percentage of the national average	120.778	112.494	0.837	0.324	small
Energy consumption	12.375	15.747	-1.471	-0.569	medium
Energy consumption – percentage of the national average	285.470	325.470	-0.799	-0.309	small

*$p < 0.05$. *Source*: Authors' own calculations.

those who have not applied yet, as confirmed by the Mann-Whitney *U*-test *(Table 4).* The results show that there is only a notable difference between the two groups in the proportion of people cycling to work and using public transport and recycling (the latter also compared to the national average), as well as in the number of cars per 1,000 inhabitants compared to the national average and in population density. All of those variables have an effect size above the small level.

Of the variables, the proportion of people who cycle to work is the only one that shows a result opposite to the expected pattern, i.e., more people cycle in cities that are potential candidates than in applicant cities. Of the potential candidate cities, Bratislava, Graz and Szeged have rates that are among the highest of all European cities that have already applied for the EGCA. The difference is also somewhat explained by the geographical location: the inhabitants of Košice, Pécs and Brasov, which are partly located on hill slopes and have already applied for the EGCA, rarely use bicycles. However, there is no longer a big difference in the extent of the cycle path network, and in fact the applicant cities have somewhat higher values.

The difference in cycling is also explained by the fact that public transport is much more popular in the applicant cities. Cities that have the worst values in terms of bicycle use (e.g., Pécs and Košice) are among the leaders in terms of public transport usage. Public transport is a priority in all the capital cities surveyed except Ljubljana. In relation to the EGCA criterion "sustainable urban transport", the inhabitants of the applicant cities have fewer cars than the national average, but the difference in terms of travelling by car to work is smaller.

The considerable difference in population density values is influenced by the fact that the potential candidate cities with the lowest population density are located mainly in the lowlands (e.g., Kecskemét, Nyíregyháza, Debrecen), where there was no geographical limit to the dispersion of settlements. However, it is important to note that the population density value does not really tell us much about the compactness of the settlements (which would indeed be a significant

Table 4. Results of the Mann-Whitney U-tests

Variable	Mean (cities have not applied yet)	Mean (cities already applied)	Mann-Whitney U	Biserial rank correlation	Effect size
CO_2 emissions	4.066	3.878	83	-0.056	–
CO_2 emissions – percentage of the national average	81.80	71.45	95	0.079	–
Number of cars per 1,000 inhabitants – percentage of the national average	99.014	94.705	127	0.358	medium
Percentage of inhabitants cycling to work	8.843	3.545	134*	0.522	large
Percentage of inhabitants travelling to work by public transport	25.756	33.454	51.5**	-0.414	medium
Length of cycle paths	0.301	0.480	69	-0.262	small
Percentage of people living in > 65 dB noise pollution	14.834	15.890	87	0.160	small
Percentage of people living in > 55 dB noise pollution	18.098	17.741	96	0.280	small
Size of green areas	15.405	15.152	92	-0.016	–
Proportion of Natura 2000 sites in relation to the area of the municipality	9.032	13.198	69	-0.262	small
Population density	1,140.366	2,269.975	35*	-0.625	large
Amount of waste	339.326	364.551	84	-0.101	–
Recycling rate	19.120	33.254	45*	-0.518	large
Recycling rate – percentage of the national average	71.258	120.558	55.5**	-0.406	medium
Volume of waste water	296,493.687	819,170.881	64	-0.200	small
Number of electric car charging stations per 1,000 inhabitants	0.069	0.111	79	-0.155	small

*p < 0.05, **p < 0.1. *Source*: Authors' own calculations.

factor for sustainability), as it would require a ratio of the population to the actual built-up area rather than to the total administrative area.

There is a considerable difference between the two groups in the value of recycling. This difference remains even when compared to the national average. The data show an interesting pattern, as the Romanian applicant cities have outstanding values at European level compared to the national value, while the Hungarian cities that are potential candidates are mostly in the bottom of the list.

Among the binary variables, the Circular Economy Declaration shows the largest difference between applicant cities and those that are potential candidates *(Table 5)*. Among those already applied, there are three signatories (Ljubljana, Maribor, Budapest), while among the potential candidates, none has signed the declaration. ICLEI membership is also characterised by medium effect size. A total of five cities are ICLEI members, three of which have already applied for the award. All this suggests that EGCA is more popular among cities that are members or signatories of these two organisations.

Table 5. Results of the Chi-square tests

Variable	Chi square	Cramer's V	Effect size
SEAP/SECAP	1.000	0.042	small
Covenant of Mayors membership (12)	0.226	0.294	medium
Aalborg Charter signatories	0.671	0.138	small
Circular Economy Declaration signatories	0.050*	0.430	medium
ICLEI membership	0.0617**	0.3880	medium
Existence of a climate strategy	1.000	0.073	small

*p < 0.05, **p < 0.1. *Source*: Authors' own calculations.

Results of the similarity search

In the similarity search analysis, 24 of the 28 cities were compared on the basis of the seven dimensions created by the MFA procedure (the Serbian cities had missing data and Ljubljana was the benchmark). Based on the analysis, the cities most similar to the winner of round 2016 in terms of their ecological values are: 1. Bratislava, 2. Zagreb, 3. Maribor, 4. Vienna, 5. Graz; the least similar are: 21. Debrecen, 22. Cluj-Napoca, 23. Košice, 24. Oradea. The similarity search also reveals some geographical differences: the western cities are more similar to Ljubljana, while the cities marked in red and orange are all located east of the Danube *(Figure 4).* The top five cities are very similar or identical in terms of location, culture, history, language use, legislation, and so it can be assumed that they are making decisions and implement sustainable developments according to similar guidelines. Bratislava, which closely resembles Ljubljana, is on track to meet the SDG criteria like no other capital city in Central and Eastern Europe (apart from Ljubljana)[9].

The top five most silimar cities also include Graz, which in Egri and Paraszt 's study was placed in a joint cluster with Ljubljana, called "Innovative Green Cities and Urban Areas". (Egri, Z. and Paraszt, M. 2013). The least similar cities to Ljubljana are mainly those that are major transport hubs (Oradea, Debrecen) or have an industrial past or are currently industrialised (Košice, Cluj-Napoca). Among the cities most similar to Ljubljana, Bratislava and Graz have not yet applied for the award.

[9] Available at https://euro-cities.sdgindex.org/#/

Each of the cities in the study scored worse than Ljubljana on only two variables: the length of cycle paths per capita and the amount of waste compared to the national average. In terms of CO_2 emissions per capita, only Budapest, Győr and Kecskemét were slightly worse than the winning city. Târgu Mureș has the lowest number of cars per 1,000 inhabitants (while Graz has the highest value) and also the highest share of pedestrians, while Bratislava has the highest share of cyclists. In terms of green spaces per capita, the Hungarian cities (except Pécs) are in the lead, while Baia Mare has the worst green space coverage. For Natura 2000 sites, the winning city is ranked fourth in our database, and Ljubljana has lower air pollution scores than most cities. Ljubljana ranks in the middle of the pack in terms of night and daytime noise pollution and drinking water consumption, Nyíregyháza has the lowest waste generation (Ljubljana is the fourth). There is no major difference in the amount of waste water treated, but Ljubljana scores poorly in terms of annual energy consumption (per capita). Regarding population density, the Hungarian (except Budapest) and some Romanian cities have values below 1,000 inhabitants/km^2, while the other cities have higher figures.

The position of the Hungarian cities

The ranking of Hungarian cities is as follows: Pécs 6th, Győr 8th, Miskolc 9th, Szeged 12th, Nyíregyháza 13th, Budapest 14th, Kecskemét 19th, and Debrecen 21st. Pécs excelled in the percentage of commuters using public transportation, the representation of Natura 2000

Fig. 4. Result of the similarity search analysis. *Source*: Authors' own elaboration.

areas within the city, per capita CO_2 emissions, and daily drinking water consumption compared to the national average. These factors placed it among the top three cities. However, its performance in other indicators was somewhat poorer, falling more into the middle range. Pécs benefits from a high proportion of Natura 2000 areas within its city limits due to the presence of the Mecsek Mountains, many of which are located within the administrative boundaries of Pécs and are under various protection statuses. Győr did not rank among the top three in any environmental indicators. In fact, it falls into the bottom three cities regarding per capita CO_2 emissions and the percentage of pedestrians in the city. On the positive side, Győr has the third highest per capita green area in the ranking, with 29.8 m^2 per person. It is surpassed only by Szeged (34.7 m^2/person) and Kecskemét (36.4 m^2/person). Miskolc excels in terms of Natura 2000 areas, where it holds the first position when considering its city size (44.9%). However, it ranks second in terms of PM_{10} and $PM_{2.5}$ levels and third in terms of energy consumption compared to the national average. In other variables, Miskolc falls within the middle range. In Szeged, the lowest percentage of people commute by car to work (23%), while 17 percent of the population cycles to work (ranking third best), and the annual average for nitrogen dioxide is the lowest here at 15.3 μg/m^3. Nyíregyháza ranks third highest in terms of PM_{10} annual average levels (31.9 μg/m^3). However, it generates the least municipal waste per capita annually (228.7 kg), making it the second lowest compared to the national average. Nyíregyháza also ranks third best in recycling with a 47 percent recycling rate.

Budapest ranks third highest in terms of per capita annual CO_2 emissions but only slightly exceeds the national average. It takes the first place in the percentage of commuters using public transportation (45%). However, in terms of daily drinking

water consumption (and its value compared to the national average), Budapest does not fare well. Budapest residents use 148 liters of water daily, making it the second highest-consuming city (Debrecen shares the same values in water consumption). Budapest also produces the highest amount of wastewater, which is also influenced by its population size, as it is the second most populous city in the sample. Additionally, Budapest's energy consumption per capita exceeds the national average, ranking it second highest.

Kecskemét and Debrecen show a significant contrast in per capita CO_2 emissions, with Debrecen emitting the second lowest amount while Kecskemét emits the most among all cities in the sample. Kecskemét also stands out for having the second highest difference in the number of cars per 1,000 people compared to the national average (116.9%). Debrecen ranks third best in terms of municipal waste generated per capita (237 kg/person/year), but this does not correspond to a high recycling rate (10%). Kecskemét consumes more energy annually than any other city, including the national average. Regarding population density, Budapest is the most densely populated city, Győr is of average density, and the other Hungarian cities have relatively low population density.

Results of the random forest classification

The AUC of the random forest model run on previously applied 100 cities is 0.74, with a sensitivity of 81.4 percent and a specificity of 40.4 percent. Based on the model, the ten most influential variables are the existence of a climate strategy, the length of cycle paths per capita, the proportion of people using public transport, ICLEI membership, the number of electric car charging stations per population, the exictence of the Aalborg Charter signatory, the proportion of people commuting to work by public transport, population density, the annual average PM_{10} value and recycling. If these variables are examined for the raw data of the 100 applicant cities, it can be seen that the finalists do indeed have better sustainability scores (the only exception being the proportion of people using public transport, where the average for non-finalists is higher). If, therefore, the cities in the Pannonian Basin have good environmental values for these indicators in particular, their chances of reaching the final round of the competition could be increased in a possible bidding process. From the random forest model estimation for 27 cities, the finalists'chances for each city are shown in *Table 6*.

Table 6. The chances of the investigated cities to reach the final round in the EGCA competition

Potential candidates	Probability of reaching the final round, %	Applicant cities	Probability of reaching the final round, %
Bratislava	43.8	Vienna	67.0
Târgu Mureș	32.8	Maribor	32.6
Graz	26.0	Budapest	31.4
Miskolc	18.0	Zagreb	30.6
Győr	17.2	Brașov	14.6
Timișoara	14.4	Arad	9.8
Kecskemét	12.4	Pécs	9.6
Osijek	11.2	Cluj-Napoca	9.2
Szeged	11.2	Košice	6.6
Sibiu	10.6	–	–
Satu Mare	9.2	–	–
Debrecen	8.6	–	–
Baia Mare	8.6	–	–
Nyíregyháza	8.2	–	–
Oradea	5.4	–	–

Source: Authors' own calculations.

Compared to the results of the similarity search presented above, the random forest gives a more accurate estimate, since in the latter case the values of the cities are not compared to a single winning city, but to all winner or finalist cities. In addition, the random forest did not estimate the ranking based on dimensions, created by dimension reduction, but on the values of all indicators, and also took into account which indicators have the most influence on the chances of the outcome of the application. The top ranking based on estimated odds is consistent with the results of the similarity search. Bratislava, Zagreb, Maribor and Vienna all have scores above 30 percent. Vienna's chances are particularly promising, the last time the city applied for the award was in 2014, but failed to make it to the final round. Târgu Mureș has shown a significant improvement compared to its similarity search result, mainly thanks to its favourable population density and air pollution indicators. Oradea is the least likely to make it to the final according to the random forest, which is in line with the result of the similarity search.

Discussion

The study focuses on the examination of cities in the Pannonian Basin with populations exceeding 100,000 based on the EGCA criteria system, for which there are no other existing scholarly examples. Therefore, it can be said that the presented results are novel. The findings of this study gave evidence that there is no significant difference between the two groups of cities in the Pannonian Basin, those that have already applied for the award and those that have not, based on the 33 environmental indicators. However, as Schmeller, D. and Sümeghy, D. (2023) gave evidence, Eastern European cities have less favourable environmental indicators compared to Western European cities.

The most significant differences are observed in air pollution, transportation, waste management, population density indicators, as well as the presence or absence of various documents. It is important to highlight that not all variables are worse for Eastern European cities. For instance, the percentage of commuters using public transport, which is favourable for sustainable urban transportation, is higher in Eastern European cities. However, the number of cyclists and the length of cycling paths per capita are much lower compared to Western European cities. Furthermore, Eastern European cities have lower population density values, which are unfavourable in terms of sustainable land use. The presence of documents related to local governance and climate change is more common in Western European cities than in the East. Therefore, the degree of lagging behind of Eastern European cities, specifically those in the Pannonian Basin, can be reduced through the development of the aforementioned topics, along with changes in political views, goals, and the attitude of local residents.

The chances of cities making it to the final round of the award competition can be influenced by decisions made by city administrations. According to the study by Sümeghy, D. and Schmeller, D. (2023), the intentions of city administrations and the proportion of green-oriented representatives in local councils are correlated with submitting applications. Left-leaning city municipality and a higher proportion of green-oriented representatives in local councils have a positive effect on the chances of application, increasing the intention to apply. However, the studied cities are characterized by predominantly right-leaning city administrations and a low proportion of green-oriented representatives (Sümeghy, D. and Schmeller, D. 2023). The cited literature also reveals that political factors can also be associated with reaching the final round. Making it to the finals is positively influenced by a higher proportion of green-oriented representatives, experience with the award (how many times the city has applied), and a lower environmental index of the local city administration. In the case of Eastern European cities, multiple applications do not guarantee reaching the finals since they perform poorly in other political variables: they have a low proportion of

green-oriented representatives in the local council, and due to right-wing party ideologies, economic interests take precedence over environmental concerns. In general, Eastern European cities have a high environmental index, which is unfavourable (Sümeghy, D. and Schmeller, D. 2023). Based on these findings, the question arises as to whether Eastern European cities apply for the award because they genuinely seek change and aspire to become sustainable and green cities in the long term, or if the applications are merely driven by trends and greenwashing.

Obtaining the award is not just about campaigning for sustainable and green cities during elections; it requires long-term commitment and continuous engagement and education of the population. It is worth noting that a city can still be sustainable, green, or resilient even if it does not apply for the award. Amsterdam and Vienna are good examples of this. They applied for the award initially but have not done so since, yet they are considered among the world's most livable cities according to various indices and are leaders in various sustainability initiatives. The results can provide a solid foundation for the potential success of future applications by cities in the Pannonian Basin. However, there is also the possibility that based on the results, a city that has not applied yet might believe it has no chance of making it to the finals, leading the city administration not to submit an application to the European Green Capital Award. It is essential to consider the limitation that the analysis only examined each city based on data from a single year and did not take into account the strength of the competition in a given year.

Considering the trend that the gravitational centre of cities applying for the European Green Capital Award is shifting towards the south and east, prospective cities in the Pannonian Basin may not need to compete directly with cities like Stockholm or Copenhagen, which have outstanding sustainability indicators. Instead, they would be competing with other cities more similar to them. Thus, despite the relatively low percentage shown in the chance estimation compared to all previous applicant cities, if the field of applicants continues to evolve as per current trends, the chances of making it to the finals will inevitably increase. To illustrate this, even though Graz had a chance estimation of only 26 percent, it had a higher chance than any other city that applied for the 2025 round and did indeed make it to the finals. Furthermore, the model only estimates the likelihood of making it to the finals for the first application (when cities typically do not make it to the finals), and it does not account for the positive impact that can emerge based on experiences from previous applications. In the case of a city reapplying, the real chance of success would likely be even higher than the estimated value. Cities can undoubtedly be sustainable and green without the European Green Capital Award, but the criteria and indicator set of the award can be valuable for achieving sustainability goals and measuring the political, environmental, and livability "performance" of cities across Europe.

Conclusions

The results show that cities that have already applied for EGCA have indeed performed better regarding some environmental indicators, but when looking at Europe as a whole and the 100 EGCA applicant cities, the vast majority of the applicant cities from the Pannonian Basin region are in the bottom third of the ranking. Ljubljana's chances of winning were significantly boosted not only by its continuously improving environmental indicators but also by the fact that the city administration submitted their application to the competition five times. This determination to apply for the award was supported by the estimation made using binary logistic regression.

Both the random forest and the similarity search results show a certain geographical pattern, where the further east we go, the less likely the cities are to be finalists and the less similar they are to Ljubljana (the exception in the case of the random forest is Târgu Mureș).

It can be observed that the similarity among the examined Hungarian cities is closer to the successful Western cities than to the previously unsuccessful Eastern ones, indicating that they are making progress towards achieving the appropriate environmental values. However, it is important to emphasize that compared to the Western or Northern winning cities, Hungarian cities tend to fall more in the middle or even towards the lower end of the ranking. In the cases of Pécs and Miskolc, the high percentage of Natura 2000 areas within the city boundaries positively influenced their rankings in the similarity search.

The analysis also identified areas where urban policies should focus locally if the goal is to join the elite club of green capitals. In the cases analysed, the average discrepancies in the individual indicators are generally not striking, but the estimates of the probability of being a finalist provided by the similarity analysis can be quite sobering, as in 33 percent of the cities analysed it is less than 10 percent. Some of the existing differences can be attributed to geographical factors or to local conditions created by path dependency, which cannot be changed in any meaningful way. Examples include population density, topography, which has a strong influence on the use of bicycles, and some energy economy issues, which are partly the result of the national energy mix and partly the result of local economic conditions. These factors are very difficult to adjust locally and in the foreseeable future. However, it is also possible to identify the elements on which a green-capital focused urban development policy should focus: the shortcomings can be addressed with the least investment and in the shortest time in terms of strategic planning and international conventions, organisations. It is also possible to expand the network of cycle paths or electric charging stations with low investment compared to other areas. However, specific analyses focusing on the specificities of the cities concerned are needed to explore the potential effectiveness and investment required for an urban policy that puts the recognition of green capital status at the heart of the local green transition.

REFERENCES

Andersson, I. 2016. 'Green cities' going greener? Local environmental policy-making and place branding in the 'Greenest City in Europe'. *European Planning Studies* 24. (6): 1197–1215.

Badiu, D.L., Iojă, C.I., Pătroescu, M., Breuste, J., Artmann, M., Niță, M.R., ... and Onose, D.A. 2016. Is urban green space per capita a valuable target to achieve cities' sustainability goals? Romania as a case study. *Ecological Indicators* 70. 53–66.

Bajnai, L. 2007. *Városfejlesztés* (Urban development). Budapest, Scolar.

Bănică, A., Istrate, M. and Muntele, I. 2020. Towards green resilient cities in Eastern European countries. *Journal of Urban and Regional Analysis* 12. (1): 53–73.

Barta, Gy. 2009. Integrált Városfejlesztési Stratégia: A városfejlesztés megújítása (Integrated Urban Development Strategy: Renewal of the urban development). *Tér és Társadalom* 23. (3): 1–12.

Beatley, T. 2011. *Biophilic Cities: Integrating Nature into Urban Design and Planning*. Washington, D.C., Island Press.

Beretta, I. 2014. Becoming a European Green Capital: A way towards sustainability? In *From Sustainable to Resilient Cities: Global Concerns and Urban Efforts*. Ed.: Hol, G.W., Bingley, Emerald Publishing Ltd. 315–338.

Biscossa, F., Botti, M., Cappochin, G., Furlan, G., Lironi, S., Negri, G. and Selmin, T. 2017. Capitali Verdi d'Europa ed EcoCités. Strategie e metodi per la rigenerazione delle città / European Green Capital and EcoCities. Strategies and methods for urban regenearation. In *European Green Capitals – Esperienze di Rigenerazione Urbana Sostenibile / Experiences of Sustainable Urban Regeneration.* Eds.: Cappochin, G., Botti, M., Furlan, G. and Lironi, S., Siracusa, Lettera Ventidue, 15–39.

Borozan, D. 2018. Decomposing the changes in European final energy consumption. *Energy Strategy Reviews* 22. 26–36.

Buzási, A. and Jäger, B.S. 2021. Hazai megyeszékhelyek városi fenntarthatóságának statisztikai alapú elemzése (Statistical analysis of urban sustainability in Hungarian county seats). *Statisztikai Szemle* 99. (8): 731–758.

Buzási, A., Jäger, B.S. and Hortay, O. 2022. Analysing and mapping heatwave vulnerability and urban sustainability. The case of largest Hungarian cities. In *SUPTM 2022 Conference Proceedings Sciforum-050260*. Available at https://doi.org/10.31428/10317/10480

Carter, J.G. 2011. Climate change adaptation in European cities. *Current Opinion in Environmental Sustainability* 3. (3): 193–198. Available at https://doi.org/10.1016/j.cosust.2010.12.015

Chereches, I.A., Arion, I.D., Muresan, I.C. and Gaspar, F. 2023. Study of the effects of the

COVID-19 pandemic on air quality: A case study in Cluj-Napoca, Romania. *Sustainability* 15. (3): 2549.

Clark, G., Moonen, T. and Nunley, J. 2019. *The Story of Your City. Europe and its Urban Development, 1970 to 2020.* Luxembourg, European Investment Bank.

Constantin, D.E., Voiculescu, M. and Georgescu, L. 2013. Satellite observations of NO_2 trend over Romania. *The Scientific World Journal* 2013: 261634. Doi: 10.1155/2013/261634

Cömertler, S. 2017. Greens of the European Green Capitals. *IOP Conference Series: Materials Science and Engineering* 245. (5): 52–64.

Csete, Á.K. and Gulyás, Á. 2021. Green infrastructure-based hydrological modelling, a comparison between different urban districts, through the case of Szeged, Hungary. *Hungarian Geographical Bulletin* 70. (4): 353–368.

Cutler, A., Cutler, D.R. and Stevens, J.R. 2012. Random forests. In *Ensemble Machine Learning: Methods and Applications*. Eds.: Zhang, C. and Ma, Y., New York, Springer, 157–175.

Dannert, É. 2016. *Terra incognita. Barnamezők és kezelésük Európában, valamint Magyarországon.* (Terra incognita. Brownfields and their handling in Europe and Hungary). PhD thesis, Pécs, University of Pécs, TTK.

Demaziere, C. 2020. Green city branding or achieving sustainable urban development? Reflections of two winning cities of the European Green Capital Award: Stockholm and Hamburg. *Town Planning Review* 91. (4): 373–395.

Dimter, S., Stober, D. and Zagvozda, M. 2019. Strategic planning of cycling infrastructure towards sustainable city mobility: Case study Osijek, Croatia. *IOP Conference Series: Materials Science and Engineering* 471. (2019) 092022.

Diverde, H. 2016. *The European Green Capital Award as a tool for the environmental work in Umeå*. MSc thesis, Linköping, University of Linköping. Available at https://www.diva-portal.org/smash/get/diva2:971647/FULLTEXT01.pdf

Egri, Z. and Paraszt, M. 2013. Urbanizáció Kelet-Közép-Európában: A várostipológia kísérletei (Urbanisation in East Central Europe: Experiments of the urban typology). In *Új hangsúlyok a területi fejlődésben.* Eds.: Lukovics, M. and Savanya, P., Szeged, JATE Press, 79–98.

Ersoy, A. and Larner, W. 2019. Rethinking urban entrepreneurialism: Bristol Green Capital – in it for good? *European Planning Studies* 28. (4): 790–808.

Ersoy, A. and Hall, S. 2020. The Bristol Green Capital Partnership: an exemplar of reflexive governance for sustainable urban development? *Town Planning Review* 91. (4): 397–413. Available at https://doi.org/10.3828/tpr.2020.23

European Commission 2007. *Leipzig Charter on Sustainable European Cities.* Available at https://city2030.org.ua/sites/default/files/documents/DL_LeipzigCharta.pdf

European Commission 2021. *European Green Capital Award 2024 and European Green Capital Award 2024. Rules of Contest*. Available at https://eurocid.mne.gov.pt/sites/default/files/repo-sitory/paragraph/documents/9601/regulamento.pdf

Feleki, E., Vlachokostas, C. and Moussiopoulos, N. 2018. Characterisation of sustainability in urban areas: An analysis of assessment tools with emphasis on European cities. *Sustainable Cities and Society* 43. 563–577.

Fife, D.A. and Rodgers, J.L. 2022. Understanding the exploratory/confirmatory data analysis continuum: Moving beyond the "replication crisis". *American Psychologist* 77. (3): 453–466.

Georgi, B. 2016. Assessing the urban environment: The European Green Capital Award and other urban assessments. In *Sustainable Cities: Assessing the Performance and Practice of Urban Environments*. Eds.: Laconte, P. and Gossop, C., London, I. B. Tauris, 50–67.

Geurts, P., Ernst, D. and Wehenkel, L. 2006. Extremely randomized trees. *Machine Learning* 63. 3–42.

Gudmundsson, H. 2015. The European Green Capital Award. Its role, evaluation criteria and policy implications. *Toshi Keikaku* 64. (2): 22–27.

Gulsrud, N.M., Ostoić, S.K., Faehnle, M., Maric, B., Paloniemi, R., Pearlmutter, D. and Simson, A.J. 2017. Challenges to governing urban green infrastructure in Europe: The case of the European Green Capital Award. In *The Urban Forest*. Eds.: Pearlmutter, D. *et al.*, Cham, Springer, 235–258.

Hardi, T., Baráth, G., Csizmadia, Zs. and Uszkai, A. 2014. A városnövekedés területi eltérései Európában, különös tekintettel a járműipari városokra (Spatial disparities of urban growth in Europe with special regard to locations of automotive industry). *Tér és Társadalom* 28. (2): 45–66.

Hårsman, B. and Wijkmark, B. 2013. From ugly duckling to Europe's first green capital: A historical perspective on the development of Stockholm's urban environment. In *Sustainable Stockholm*. Eds.: Rader Olsson, A. and Metzger, J., Milton Park, Routledge, 10–50.

Herbel, I., Croitoru, A.E., Rus, I., Harpa, G.V. and Ciupertea, A.F. 2016. Detection of atmospheric urban heat island through direct measurements in Cluj-Napoca city, Romania. *Hungarian Geographical Bulletin* 65. (2): 117–128.

Hervainé Szabó, Gy. 2008. Az integratív várospolitika tapasztalatai a hazai várostérségekben (Experiences of integrative urban policy in domestic urban areas). *Tér és Társadalom* 22. (1): 77–91.

Hirt, S. 2013. Whatever happened to the (post)socialist city? *Cities* 32. 29–38.

Hirt, S. and Stanilov, K. 2009. *Twenty Years of Tansition*. Human Settlements Global Dialogue Series, No. 5. Nairobi, UN-Habitat.

Hirt, S., Ferenčuhová, S. and Tuvikene, T. 2017. Conceptual forum: The "post-socialist" city. *Eurasian Geography and Economics* 57. (4–5): 497–520.

Ho, T.K. 1995. Random decision forests. In *Proceedings of 3rd International Conference on Document Analysis and Recognition 1.* Montreal, Canada, IEEE Publication, 278–282. Doi: 10.1109/ICDAR.1995.598994

IPCC 2022. *Climate Change 2022. Mitigation of Climate Change*. Intergovernmental Panel on Climate Change. WMO UN. Available at https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf

Kahn, M.E. 2006. *Green Cities – Urban Growth and the Environment*. Washington, D.C., Brookings Institution Press.

Kerr, L. 2017. *A tale of two green cities. Exploring the role of visions in the development of green infrastructure in two European Green Capital Cities*. MSc thesis, Nijmegen, Radboud University.

Kiss, V.M. 2015. Modelling the energy system of Pécs – The first step towards a sustainable city. *Energy* 80. (1): 373–387.

Konecka-Szydłowska, B., Trócsányi, A. and Pirisi, G. 2018. Urbanisation in a formal way? The different characteristics of the 'newest towns' in Poland and Hungary. *Regional Statistics* 8. (2): 135–153.

Korpela, T. 2021. *Social media logic in interorganizational boundary spanning: The case of European Green Capital Award 2021*. BSc thesis, Groningen, University of Groningen. Available at https://frw.studenttheses.ub.rug.nl/3550/

Kovács, Z. 1999. Cities from state-socialism to global capitalism: an introduction. *GeoJournal* 49. (1): 1–6.

Kurstjens, N. 2017. *De duurzaamste stad van Europa. Een onderzoek naar stedelijke duurzaamheid en de rol van het beleidsinstrument "European Green Capital Award"*. MSc thesis, Nijmegen, Radboud University.

Lamsal, L.N., Martin, R.V., Parrish, D.D. and Krotkov, N.A. 2013. Scaling relationship for NO_2 pollution and urban population size: A satellite perspective. *Environmental Science and Technology* 47. (14): 7855–7861.

Lönegren, L. 2009. *The European Green Capital Award – Towards a sustainable Europe?* BSc thesis. Malmö, Malmö University. Available at https://www.diva-portal.org/smash/get/diva2:1483880/FULLTEXT01.pdf

Maior, J-C. 2019. Ljubljana – The Green Capital of EU in 2016. Study case – What has been changed in order to award the title? 2005–2015. *Journal of Innovations in Natural Sciences* 1. (1): 50–56.

Manca, L.R. 2020. *Green Capitals "in the Hearts and Minds of the People". A qualitative enquiry into the perception of the influence of the European Green Capital Award among municipal officials*. MSc thesis, Maastricht, Maastricht University. Available at https://www.researchgate.net/publication/349238896_Green_Capitals_in_the_Hearts_and_Minds_of_the_People_A_qualitative_enquiry_into_the_perception_of_the_influence_of_the_European_Green_Capital_Award_among_municipal_officials

Meijering, J.V., Kern, K. and Tobi, H. 2014. Identifying the methodological characteristics of European green city rankings. *Ecological Indicators* 43. 132–142. Available at https://doi.org/10.1016/j.ecolind.2014.02.026

Müller, M. and Reutter, O. 2020. Benchmark: Climate and environmentally friendly urban passenger transport – the concepts of the European Green Capitals 2010–2020. *World Transport Policy and Practice* 26. (2): 21–43.

Nurse, A. and North, P. 2020. European green capital: Environmental urbanism, or an addition to the entrepreneurial toolbox? *Town Planning Review* 91. (4): 357–372.

Nzimande, N.P. and Fabula, Sz. 2020. Socially sustainable urban renewal in emerging economies: A comparison of Magdolna Quarter, Budapest, Hungary and Albert Park, Durban, South Africa. *Hungarian Geographical Bulletin* 69. (4): 383–400.

Ozcan, N.S. 2015. An opportunity for the sustainable ecological renewal: European Green Capitals. In *Digital Proceeding of ICOCEE – CAPPADOCIA 2015.* 20–23. 05.2015. Nevsehir, Turkey.

Pace, R., Churkina, G. and Rivera, M. 2016. *How Green is a "Green City"? A Review of Existing Indicators and Approaches.* Potsdam, Institute for Advanced Sustainability Studies (IASS).

Pagès, J. 2002. Analyse factorielle multiple appliquée aux variables qualitatives et aux données mixtes. *Revue Statistique Appliquee* 50. (4): 5–37.

Pantić, M. and Milijić, S. 2021. The European Green Capital Award – Is it a dream or reality for Belgrade (Serbia)? *Sustainability* 13. (11): 6182. Available at https://doi.org/10.3390/su13116182

Pintér, T. 2015. Integrált városfejlesztés az Európai Unió keleti és nyugati tagállamaiban: Románia és Németország esete (Integrated urban development in the eastern and western member states of the European Union: The case of Romania and Germany). *Journal of Central European Green Innovation* 3. (1063-201686207): 123–136.

Polato, E. 2017. *Le Capitali Verdi Europee / European Green Capitals*. BSc thesis, Padova, University of Padova. Available at https://core.ac.uk/reader/89389670

Poljak Istenič, S. 2016. Reviving public spaces through cycling and gardening. Ljubljana – European Green Capital 2016. *Etnološka Tribina: Godišnjak Hrvatskog Etnološkog Društva* 46. (39): 157–175.

Popescu, R-I. and Zamfir, A. 2012. Ecological marketing and competitive cities – Best practices for sustainable development of green cities. *International Journal of Arts and Sciences* 5. (1): 411–419.

Puczkó, L. and Jószai, A. 2015. *Települési tervezés* (Settlement planning). Budapest, Nemzeti Közszolgálati Egyetem.

Ratas, J. and Mäeltsemees, S. 2013. Role of environment in strengthening competitiveness of cities by example of European Green Capitals and Tallinn. *Estonian Discussions on Economic Policy* 21. (2). Available at http://dx.doi.org/10.2139/ssrn.2383286

Rubin, M. 2017. Do p values lose their meaning in exploratory analyses? It depends how you define the familywise error rate. *Review of General Psychology* 21. (3): 269–275.

Ruiz del Portal Sanz, A. 2015. Is the European Green Capital Award showcasing appropriate models of best practice for transition? The land use indicator. In *52nd International Making Cities Livable Conference on Achieving Green, Healthy Cities*. Bristol, 29th June – 3rd July. 2015. Available at https://orca.cardiff.ac.uk/id/eprint/85626/1/Angela%20Ruiz%20del%20Portal_paper_.pdf

Sailer-Fliege, U. 1999. Characteristics of post-socialist urban transformation in East Central Europe. *GeoJournal* 49. (1): 7–16.

Sareen, S. and Grandin, J. 2019. European green capitals: branding, spatial dislocation or ca-talysts for change? *Geografiska Annaler: Series B, Human Geography* 102. (1): 101–117. Available at https://doi.org/10.1080/04353684.2019.1667258

Sarubbi, M.P. and Schmidt Bueno de Moraes, C. 2016. Avaliação comparativa de metodologias de indicadores para a sustentabilidade urbana. *Cadernos Zygmunt Bauman* 8. (18): 211–231.

Schmeller, D. and Sümeghy, D. 2023. Is the rival city always greener? – An analysis of the indicators for European Green Capital Award shortlisted and applicant cities. *Regional Statistics* (forthcoming).

Selimović, A. 2022. *Važnost urbane zelene infrastrukture na primjeru grada*. MSc thesis. Zagreb, University of Zagreb.

Sikos, T.T. and Szendi, D. 2023. A hazai megyei jogú városok gazdasági és környezeti fenntarthatóságának mérése, 2020–2021 (Measuring the economic and environmental sustainability of cities with county rank, 2020–2021). *Területi Statisztika* 63. (1): 88–124.

Sümeghy, D. and Schmeller, D. 2023. Giving the green light to sustainability: Key political factors behind the European Green Capital Award applications. *Journal of Urban Affairs* September 2023. Available at https://doi.org/10.1080/07352166.2023.2247504

Svirčić Gotovac, A. and Kerbler, B. 2019. From post-socialist to sustainable: The city of Ljubljana. *Sustainability* 11. (24): 7126. Available at https://doi.org/10.3390/su11247126

Szirmai, V. 2004. Globalizáció és a nagyvárosi tér társadalmi szerkezete (Globalisation and the social structure of large urban spaces). *Szociológiai Szemle* 4. 3–24.

Tallinn Memorandum 2006. *Memorandum on the European Green Capital title*. Available at https://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2011/06/Tallin-Memorandum.pdf

Triscowati, D.W., Sartono, B., Kurnia, A., Dirgahayu, D. and Wijayanto, A.W. 2020. Classification of rice-plant growth phase using supervised random forest method based on landsat-8 multitemporal data. *International Journal of Remote Sensing and Earth Sciences* 16. (2): 187–196.

Tukey, J.W. 1977. *Exploratory Data Analysis*. Reading, MA, Addison-Wesley.

Velleman, P.F. and Hoaglin, D.C. 2012. Exploratory data analysis. In *APA Handbook of Research Methods in Psychology*. Eds.: Cooper, H., Camic, P.M., Long, D.L., Panter, A.T., Rindskopf, D. and Sher, K.J., Washington, D.C., American Psychological Association, 51–70.

Verdonk, H. 2014. Urban policies in Europe. In *Cities As Engines of Sustainable Competitiveness: European Urban Policy in Practice*. Eds.: van den Berg, L., van der Meer, J. and Carvalho, L., Farnham, Ashgate Publishing, 11–83.

Zhou, J., Li, E., Wei, H., Li, C., Qiao, Q. and Armaghani, D.J. 2019. Random forests and cubist algorithms for predicting shear strengths of rockfill materials. *Applied Sciences* 9. (8): 1621. Available at https://doi.org/10.3390/app9081621

Zoeteman, B., Slabbekoorn, J., Mommaas, H. and Dagevos, J. 2014. *Sustainability Monitoring of European Cities. A Scoping Study Prepared in Collaboration with DG Environment for European Green Capital Award applicants*. Telos Project, Tilburg, Tilburg University. Available at https://pure.uvt.nl/ws/portalfiles/portal/29823642/14112_Sustainability_Monitoring_EGCA_cities_8_9.pdf

Zoeteman, B., van der Zande, M. and Smeets, R. 2015. *Integrated Sustainability Monitoring of 58 EU-Cities*. Draft report of Telos Project, Tilburg, Tilburg University.

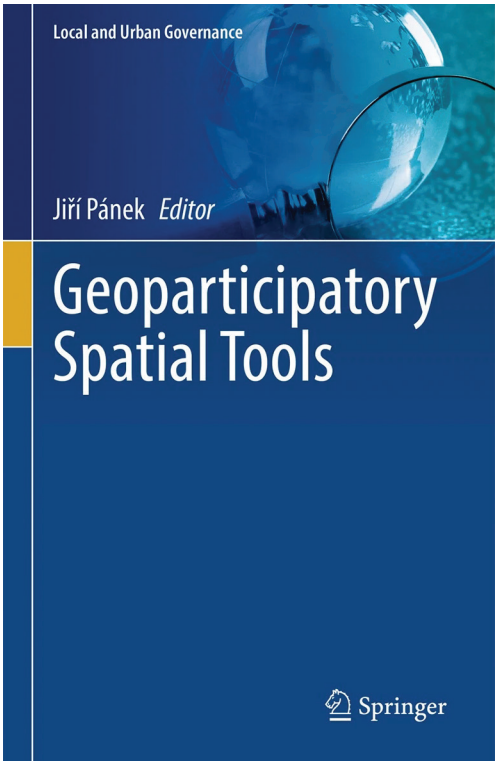
BOOK REVIEW SECTION

Pánek, J. (ed.): Geoparticipatory Spatial Tools. Cham, Springer, 2022. 197 p.

Nowadays, participation is becoming an essential tool in urban development. To manage urban growth, spatial aspects must be considered such as land use, building density, proportion of green areas, and so on. What is also particularly crucial is how the inhabitants of the city or the district feel about the space around them, or, to put it more simply, what do their mental maps look like.

However, participation is facing an ever-growing issue: the lack of citizen motivation (Cupps, D. 1977). Conventional participatory tools on their own are not satisfactory anymore, since people think that their voice does not matter, so they rather would not get involved. The approaches of geoparticipation, or rather the mere consideration of it, can help to better reach out to people and motivate them to engage.

The book is edited by Jiří Pánek and is a collection of studies about the topic of geoparticipation and geoparticipatory spatial tools. It contains eight chapters, including *Introduction*, which build on each other. The volume contains theoretical and empirical chapters as well as case studies. The book focuses on the Czech Republic and the characteristics of its system of local governments. However, it can serve as a base for further studies within the whole of Central and East Europe.



The introduction of the book is the first chapter, written by the editor himself. He briefly guides the reader through the notions of participation, the growing importance of GIS, and how certain digital maps, such as OpenStreetMap, have become co-creational products over the years due to the development of technology. He highlights the notion of e-participation, which is defined by the UN Department of Economic and Social Affairs. To simplify the definition, it is a way of citizen involvement in decision-making and governance with the help of ICT. E-participation can be measured with the E-Participation Index or EPI. It contains three main components: e-information, e-consultation, and e-decision-making. In 2020, the top three countries according to the index were Estonia, the USA, and South Korea.

Another important aspect of this chapter is the definition of geoparticipation and the enumeration of its types. Pánek refers to Zhang, S. (2019), who defines geoparticipation as "geo-enabled practices related to public participation." There are three types of it: consultative, transactional, and passive geoparticipation. Thanks to these definitions, the introduction serves as a solid fundament for the rest of the volume. The last part of the chapter describes the structure of the book.

Chapter 2 (*Geoparticipation and Democratic Theory*) is written by Jakub Bakule. At the beginning, the author aims to place geoparticipation in the context of non-electoral participation. He argues that throughout the years, beginning from the 1940s, the different theories about democracy evolved to a point where geoparticipation is considered as a key factor in differentiating the theories of democracy. The first subsection of the chapter tries to examine the connection between participation and democracy, while seeks to answer the question of how much participation is needed within democracy. He points out two main issues: first, how scholars understand the definition of democracy—more precisely, democracy in terms of government by the people; second, the different understandings of political participation. By taking both together, we arrive at a point where different meanings result in different approaches, thus, different theories. Bakule emphasizes two main branches:

the theory of fragile democracy, and the theory of strong democracy. Both are examined through the lens of participation, or more precisely, the amount of participation. In the first case, the author presents the views claiming that too much and unreasonable participation leads to the excess of democracy, which threaten the liberalism of institutions. In the second case, however, the author claims that participation is very much needed for a strong democracy and plays a significant role in supplementing democratic institutions. In the concluding section of the chapter, the author declares that geoparticipation is in between the two aforementioned concepts and the question of which concept is better, has not yet been decided.

The third chapter is a study of Jaroslav Burian, Jiří Pánek and Vít Pászto (*Geospatial Technologies for Geoparticipation).* The chapter aims to provide an overview of the technologies, tools and approaches used for geoparticipation. It contains four sections (including introduction). The second section is a brief description of the traditional approaches to urban planning. The authors mention strategic planning, spatial planning, and the role of the master plan (or local/urban/spatial plan). The third section is a well-detailed study that leads the reader through various modern approaches to urban planning, such as smart city initiatives, the participation of residents, analysis, modelling, simulation, and geodesign. These methods rely on geoinformation technologies, and while they are progressive ideas, their implementation, as the authors point out, may face difficulties.

The fourth section is a detailed list of tools for data collection, geodesign, and analytical processing and modelling. The authors present different ArcGIS applications, such as Survey 123, Collector and Field Maps. They also describe *Pocitovemapy.cz* and *EmotionalMaps.eu*, which are co-developed by the editor of the book; Ushahidi, which is a Kenyan non-profit company's open-source software; KoBoToolbox, which is an open-source toolset of the Harvard University; and ZmapujTo, which is a Czech application created within an ecological project aiming to oppose illegal landfills. All these are tools for data collection. For geodesign, they also mention Phoenix+, which is used for multi-person participation in the planning process, and Priority Places, which is an interactive mapping tool for easier location and (re) development. In addition, there are three ArcGIS extensions, CommunityViz, which helps users in doing multi-criteria analyses; UPlan, which is a development scenario creator; and GeoPlanner, which is a multi-criteria analysis app for scenarios. For analytical and modelling purposes, they present tools such as CityScope, an MIT project focusing on solving spatial design and urban planning challenges; Mestometer, an interactive game aiming to present the importance of spatial planning; UrbanSIM (or UrbanCanvas), which is a sophisticated simulation model; Index Online and SPARC for creating real-time scenarios; and UrbanAPI, which contains three kinds of software to simulate urban growth and evaluate land-use changes. For the same purpose, the authors include two ArcGIS extensions as well, namely iCity for creating scenarios, which could be then compared with each other, and EnvisonTomorrow for creating multi-criteria analyses and alternative scenarios.

This chapter is highly detailed, which is an evidence for the advancement of technology and new approaches, and a probable justification of their application in the future. However, it is always important to keep in mind that the ArcGIS extensions are not free, so one must calculate with prices when it comes to using these tools.

Chapter 4 (*Open Data and Its Role in Geoparticipation*) is the work of Jaroslav Burian and Barbora Kočvarová. The chapter contains two parts. The first is about open data and their publishing in general, and the second provides a toolset for publishing these data. As the authors emphasize, information has a huge value. Therefore, open data is a necessary component of fruitful analyses, especially if the collected data has no significant value to the private sector. The introduction of the first section draws the reader's attention to this noteworthy fact. In the following part, the authors describe the definition of open data in detail, presenting its main characteristics and the five levels of its openness. They also write about open data in the EU, the convenient use of it, and how and in which formats researchers can access them. They briefly present the publishing process of open data, which is explained in more detail in the second part of the chapter. As I mentioned before, this chapter is a thorough collection and description of tools, metadata and licenses. The authors present the CKAN, the Comprehensive Knowledge Archive Network, which is an open-source portal where datasets can be published, shared, and served. After a meticulous description of the network, the authors present some CKAN sub-platforms or parallels, such as DKAN, Socrata, Junar, ArcGIS Hub, ArcGIS Enterprise Sites, and National Open Data Catalogue. They also refer to metadata and explain the ISO regulations and the different forms of licenses.

Improving Local Democracy Works: Determinants of Participatory Local Governments is the title of the fifth chapter, written by Jakub Lysek. What I have mentioned at the beginning of this review about the motivation of citizens echoes back in the author's thoughts. He argues that citizen trust and motivation considering participation and involvement in decision-making in the countries of Central and Eastern Europe still do not reach the level of democratically more advanced nations. The author presents a study that examines how much Czech local governments involve citizens in decision-making and which factors determine these differences. For this purpose, the chapter explores the peculiarities of the Czech munic-

ipality system and its development through the past few decades, also considering the communist heritage of the country. He presents a significantly fragmented framework of municipalities, which makes studies harder to conduct and shapes politics as well. After the brief presentation of the local governmental framework, the author argues that participation, deliberation, and transparency are the key concepts of democratic innovations. Nonetheless, he also highlights that citizens must be informed at the highest possible level in every form of democracy, otherwise they cannot properly participate and democracy will not be working properly. Lysek also writes about the determinants of participatory institutions at the level of municipalities, and he specifies three main aspects: the institutional factor at the municipal level, political competition and political factors, and socioeconomic development. Each of them has a massive influence on participatory movements on the municipal level.

This part of the chapter is a theoretical introduction, which is followed by the empirical analysis. The dataset includes all municipalities in the Czech Republic, i.e., 6,258 units. The study focuses on the determinants of participatory techniques and transparent government. Based on different questions or indicators, the author builds three clusters from the variables. For example, the communication dimension includes whether the municipality's website is mobile friendly; the participation dimension includes whether the municipality uses opinion polls on a municipality web; and the transparency dimension includes whether the municipality shares information about the council members. After that, the study focuses on measuring institutional, political, and socioeconomic factors, and used descriptive statistics such as the number of population, the proportion of inhabitants with tertiary education, the share of self-employed and elderly people. Interestingly, the author also considers the age and gender of the mayor for each municipality, which suggests that these two factors may have a significant effect on participation in the Czech Republic. Indeed, the study results in that female mayors give more support to participatory governance than males. The author suggests that further studies are still needed.

The sixth chapter, entitled *Participatory Budgeting in the Czech Republic,* is a study by Jiří Chovanečeк. The chapter can be divided into two main parts. First, the author familiarizes the reader with the theoretical foundations of participatory budgeting, by presenting the origins of the concept and its different frameworks. Second, he presents mainly through a case study of the Central Bohemian Region how participatory budgeting works in the Czech Republic, and which political parties and movements support it. The approach itself and the methodology used can be useful for further studies in Central and Eastern Europe. This chapter reveals another component of the complexity of citizen participation. According to the author, money has a significant role, and from the moment the community has a word in where it should be spent, it results in more transparent governance, more satisfied citizens, and perhaps a sense of belonging. Moreover, if citizens could make such financial decisions, they would regard the tax they pay to the local government as an investment into their own city, neighbourhood, and home. On the other hand, local governments could have a better relationship with their citizens who probably would complain less about the local taxes, which would also increase the local government's and the mayor's chance to win the next election.

The case study presented in this chapter shows that between the years 2012 and 2020, 227 participatory budget events occurred. The author reveals significant differences between municipalities, and between political parties and movements. Interestingly, non-parliamentary parties and movements were significantly more willing to use participatory budget initiatives. Another interesting fact is that after the change of political leadership in Central Bohemia, the project of participatory budgeting was abandoned. Through this case study, it is unambiguous that currently there are different limiting factors in the way of a viable and sustainable participatory budgeting system, not to mention the financial damages that the COVID-19 pandemic has caused, or the current war situation. For a better cooperation, not only citizens should learn how to work together with the local government and civil services, but political actors and other stakeholders also have to do the same. Once the human barrier is overcome, it becomes easier to design the system.

Chapter 7 is written by David Žichovský, Jiří Pánek, and Jiří Chovanečeк, and entitled as *GeoParticipatory Tools in Action: Case Study Jeseník, Czech Republic.* The structure of the chapter is a bit unique, because 6 out of its 7 sections raise a question in their title, which the author answer one by one. The case study uses an emotional mapping technology and the questions fit to this. They ask, for example, where the participants feel comfortable or neglected, and where they spend their free time. Interestingly, the biggest number of responses has been received for two questions about comfort and safety, while the lowest number of responses has been received for the question of shortfall. This suggests that citizens are satisfied with the amenities, nonetheless, there are many places where they do not feel safe.

I would like to highlight from this chapter the methodology and its relevance. Undoubtedly, some places are better known for the citizens. For example, 24/7 stores where young people buy alcohol, abandoned areas, where homeless people live, tourist destinations, which are crowded throughout the whole year, clubs, and so on. Yet, in many cases, the problems related to these places are not properly handled by the authorities, or they only receive few com-

plaints. A study like this one of Jeseník shows how citizens feel about different areas in the city, which makes it easier to respond to, prioritize, and solve social conflicts. Participatory movements help the local government and the citizens at the same time and, thus, can improve the relationship between them.

The final chapter (*The Application of City-Building Games in Spatial Planning*) is a study from Jan Piňos and Jaroslav Burian. It presents the relevance of city-building games for spatial planning through introducing a case study where a certain game, called *Cities: Skylines* was used. The game was selected based on the researchers' criteria, which included among others the authors' previous personal experiences. The chapter discusses the relevance of simulator games in general and discusses their IT aspects in detail. The case study focuses on the town of Olomouc in the Czech Republic, and a new neighbourhood called VOP Velkomoravská, which was a former military compound. The project had five stages beginning with the preparation of the rules followed by a design contest and ending with the gathering of feedback from the players and the jury. The criteria for the design included residential housing, public spaces and greenery, infrastructure, building height limitation, and services. The contest lasted for two and a half weeks in January 2021, and 10 designs were submitted. After submission, the models were tested and rated by a detailed list of parameters such as pedestrian crossings, flood protection measures, bike paths, parking, shops, etc. These parameters were split then into three priority groups, and their scores resulted in rankings by each parameter. Finally, a four-membered jury assessed the designs, and their scores were added to the parametrical scores. After the contest, the participants had to fill in a questionnaire about the project. In general, the results were positive. The participants found the rules clear, the challenge interesting and motivating, the game suitable for planning purposes and, surprisingly, the funding of the prize was less important to them. Altogether, this project was a success and proved the relevance of such a participatory tool, despite all the barriers I discussed in this review.

In sum, the book is a well-detailed description of the current tools of geoparticipation in spatial planning. It is a suitable starting point for further studies in Central and Eastern Europe, and it can also be used as a handbook for the practical application of geoparticipatory tools. The theoretical founding of the volume is adequate, and the case studies justify the relevance of the tools presented in the book. Even if one may have less interest in the governmental and financial situation of the Czech Republic, the same research methods and tools can be used in many cities, regions, and countries with similar social characteristics. I very much recommend the volume to both researchers and professionals in the field of spatial planning.

Acknowledgement: This publication has been made within project nr. TKP2021-NVA-09, which has been implemented with the support provided by the Ministry of Innovation and Technology of Hungary from the National Research, Development and Innovation Fund, financed under the TKP2021-NVA funding scheme.

Katinka Tóbiás[1]

REFERENCES

Cupps, D.S. 1977. Emerging problems of citizen participation. *Public Administration Review* 37. (5): 478–487.

Zhang, S. 2019. Public participation in the Geoweb era: Defining a typology for geo-participation in local governments. *Cities* 85. 38–50.

[1] University of Szeged, Department of Economic and Social Geography, Szeged, Hungary. E-mail: tobias.katinka@geo.u-szeged.hu

GUIDELINES FOR AUTHORS

Hungarian Geographical Bulletin (formerly Földrajzi Értesítő) is a double-blind peer-reviewed English-language quarterly journal publishing open access **original scientific works** in the field of physical and human geography, methodology and analyses in geography, GIS, environmental assessment, regional studies, geographical research in Hungary and Central Europe. In the regular and special issues also discussion papers, chronicles and book reviews can be published.

Manuscript requirements

We accept most word processing formats, but MSWord files are preferred. Submissions should be single spaced and use 12pt font, and any track changes must be removed. The paper completed with abstract, keywords, text, figures, tables and references should not exceed **7,000 words**.

The Cover Page of the article should only include the following information: title; author names; a footnote with the affiliations, postal and e-mail addresses of the authors in the correct order; a list of 4 to 8 keywords; any acknowledgements.

An abstract of up to **300 words** must be included in the submitted manuscript. It should state briefly and clearly the purpose and setting of the research, methodological backgrounds, the principal findings and major conclusions.

Figures and tables

Submit each illustration as a separate file. Figures and tables should be referred in the text. Numbering of figures and tables should be consecutively in accordance with their appearance in the text. Lettering and sizing of original artwork should be uniform. Convert the images to TIF or JPEG with an appropriate resolution: for colour or grayscale photographs or vector drawings (min. 300 dpi); bitmapped line drawings (min.1000 dpi); combinations bitmapped line/photographs (min. 500 dpi). Please do not supply files that are optimised for screen use (e.g., GIF, BMP, PICT, WPG). Size the illustrations close to the desired dimensions of the printed version. Be sparing in the use of tables and ensure that the data presented in tables do not duplicate results described elsewhere in the article.

REFERENCES

Please ensure that every reference cited in the text is also present in the reference list (and vice versa).

Reference style

Text: In the text refer to the author's name (small capitals with initials) and year of publication. References should be arranged first chronologically and then further sorted alphabetically if necessary. More than one reference from the same author(s) in the same year must be identified by the letters 'a', 'b', placed after the year of publication.
Examples: (Ridgewell, A.J. 2002; Maher, B.A. *et al.* 2010) or Ridgewell, A.J. (2002); Maher, B.A. *et al.* (2010).

Journal papers:
Aagaard, T., Orford, J. and Murray, A.S. 2007. Environmental controls on coastal dune formation; Skallingen Spit, Denmark. *Geomorphology* 83. (1): 29–47.

Books:
Pye, K. 1987. *Aeolian Dust and Dust Deposits.* London, Academic Press.

Book chapters:
Kovács, J. and Varga, Gy. 2013. Loess. In *Encyclopedia of Natural Hazards.* Ed.: Bobrowsky, P., Frankfurt, Springer, 637–638.

Book reviews

Book reviews should be between 2,000 and 3,000 words (including references).

Submission

Submission to this journal occurs online. Please submit your article via http://ojs3.mtak.hu/index.php/hungeobull/about/submissions

All correspondence, including notification of the Editor's decision and requests for revision, takes place by e-mail.

Publisher:
Research Centre for Astronomy and Earth Sciences
1121 Budapest, Konkoly Thege Miklós út 15–17., Hungary

Editorial office:
Geographical Institute, Research Centre for Astronomy and Earth Sciences
1112 Budapest, Budaörsi út 45., Hungary
Phone, fax: +36 1 309 2628
E-mail: geobull@mtafki.hu, kovacs.zoltan@csfk.org
Distribution: GABRIELLA PETZ, petz.gabriella@csfk.org
Full text is available at https://ojs3.mtak.hu/index.php/hungeobull

Typography: ESZTER GARAI-ÉDLER
Technical staff: FANNI KOCZÓ, ANIKÓ KOVÁCS, GÁSPÁR MEZEI

Cover design: ANNA REDL
Printed by: Premier Nyomda Kft.

HU ISSN 2064–5031
HU E-ISSN 2064–5147

Distributed by the Geographical Institute, Research Centre for Astronomy and Earth Sciences

Subscription directly at the Geographical Institute, Research Centre for Astronomy and Earth Sciences (H-1112 Budapest, Budaörsi út 45), by postal order or transfer to the account IBAN: HU24 10032000-01730841-00000000. Individual copies can be purchased in the library of the Institute at the above address.